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The SDGs and Food System Challenges: Global Trends and Scenarios toward 2030

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Notices

ABSTRACT

Progress toward reducing global hunger has stalled since the mid-2010s. In fact, hunger is on the rise again, driven by slowing economic growth and protracted conflict, intensified by the impacts of climate change and economic shocks in many low- and middle-income countries. In addition, food systems worldwide have suffered disruptions in recent years, caused by the COVID-19-related global recession and associated supply chain disruptions, and exacerbated by the war in Ukraine. These factors have also jeopardized efforts at addressing the challenges to food system sustainability.

The 2030 Agenda for Sustainable Development and the related sustainable development goals (SDGs), defined in 2015, recognize these challenges and set ambitious targets to end hunger and all forms of malnutrition and to make agriculture and food systems sustainable by 2030. Many other fora have restated and reiterated these ambitions, including the 2021 United Nations Food System Summit (UNFSS). While governments around the world have subscribed to these ambitions, collectively they have not been very specific as to how to achieve the SDGs and related goals and targets, except for three means of implementation (MOI) involving (i) increases in research and development, (ii) reductions in trade distortions, and (iii) improved functioning and reduced volatility in food markets.

This paper is part of a wider effort at assessing the international community's follow-through on the above ambitions and the related (implicit or explicit) commitments made toward action for achieving them. While not presenting new research findings, we bring together available evidence and scenario analyses to assess the progress made toward the ambitions for transforming food systems, the actions taken in regard of the internationally concerted agenda, and the potential for accelerating progress.

The number of hungry people in the world has risen from 564 million in 2015, when the SDGs were agreed, to 735 million in 2022. While declines to between 570 and 590 million by 2030 are projected, this is far above the 470 million projected in the absence of the COVID-19 pandemic and the Ukraine war. The share of the world's people unable to afford healthy diets is projected to decline from 42 percent in 2021 to a still far too high 36 percent by 2030.

On the means of implementation, levels of spending on agricultural research and development have increased, particularly in key developing countries such as Brazil, China and India. However, rates of investment remain too low for comfort, particularly in low-income countries. Also, little progress has been made in reducing agricultural trade distortions and many countries continue to use trade policy measures, such as export restrictions, which have proven to increase the volatility of both world and domestic food prices.

We conclude that progress toward the SDG-2 targets has been dismal, and that the food system challenges have only become bigger. But we also find that it is not too late to accelerate progress and that the desired food system transformation can still be achieved over a reasonable timespan and at manageable incremental cost. Doing so will require unprecedented concerted and coherent action on multiple fronts, which may prove the biggest obstacle of all.

ACKNOWLEDGMENTS

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1. Introduction

A major global challenge is to ensure affordable access to sufficient nutritious and safe food for a growing world population while reducing the environmental impacts of agriculture and addressing the threat posed by climate change. Between now and 2050, global demand for food is expected to increase strongly with rising incomes, urbanization, and the growing world population, projected to reach almost 10 billion by 2050. Urban lifestyles and income growth will bring shifts in dietary preferences toward more demand for resource- and emission-intensive meat, dairy, other livestock products, and processed foods. Climate change is no longer a distant threat, but already imposes adverse impacts on agriculture and food production. Agrifood systems and related land use change are major contributors to global warming, generating about one-third of global greenhouse gas (GHG) emissions. At the same time, climate change is affecting agricultural productivity, especially in tropical agriculture, putting pressure on food systems' ability to meet the growing and changing food demand. Food systems have shown enormous innovative capacity over the past century, but to meet tomorrow's challenges, enormous technological progress will be needed to enable production practices that are climate-resilient and environmentally sustainable and focused on efficient delivery for healthy diets. Currently, food systems benefit from substantial government support, costing at least US$800 billion per year worldwide. Past and current support have an impact on GHG emissions by influencing production practices and the composition and location of output.

The 2030 Agenda for Sustainable Development and the related sustainable development goals (SDGs) defined in 2015 recognize these challenges and set ambitious targets to end hunger and all forms of malnutrition and to make agriculture and food systems sustainable by 2030. These ambitions have been restated and reiterated in many other fora, including the 2021 United Nations Food System Summit (UNFSS). While governments around the world have subscribed to these ambitions, collectively they have not been very specific as to how to achieve the SDGs and related goals and targets. The second SDG (SDG 2) for "Ending Hunger" includes a set of targets described as "means of implementation" (MOI), as follows:

> MOI 2A: Increase investment, including through enhanced international cooperation, in rural infrastructure, agricultural research and extension services, technology development and plant and livestock gene banks.
>
> MOI 2B: Correct and prevent trade restrictions and distortions in world agricultural markets in accordance with the mandate of the Doha Development Round.
>
> MOI 2C: Adopt measures to ensure the proper functioning of food commodity markets and their derivatives and facilitate timely access to market information, including on food reserves, in order to help limit extreme food price volatility.

At the 2021 UNFSS, a multistakeholder gathering, efforts were made to come to a broader program for action and led to the formation of coalitions to enhance social protection targeting access to (healthy) food for all, repurposing of existing agricultural support for food system transformation, investing in green innovations, and reducing food loss and waste (FLW). While not comprising any formal commitments to action, this broader call for action provides more specific entry points for food system actors to come together and for assessing the feasibility of achieving sustainable food systems and ending hunger within the foreseeable future.

This paper is part of a wider effort at assessing the international community's follow-through on the above ambitions and the related (implicit or explicit) commitments made toward action for achieving them. While not presenting new research findings, we bring together available evidence and scenario analyses to assess the progress made toward the ambitions for transforming food systems, the actions taken in regard of the internationally concerted agenda, and the potential for accelerating progress. We conclude that progress toward the SDG 2 targets has been dismal, and that the food system challenges have only become bigger. But we also find that it is not too late to accelerate progress and that the desired food system transformation can be achieved over a reasonable timespan and at manageable incremental cost. Doing so will require unprecedented concerted and coherent action on multiple fronts, which may prove the biggest obstacle of all.

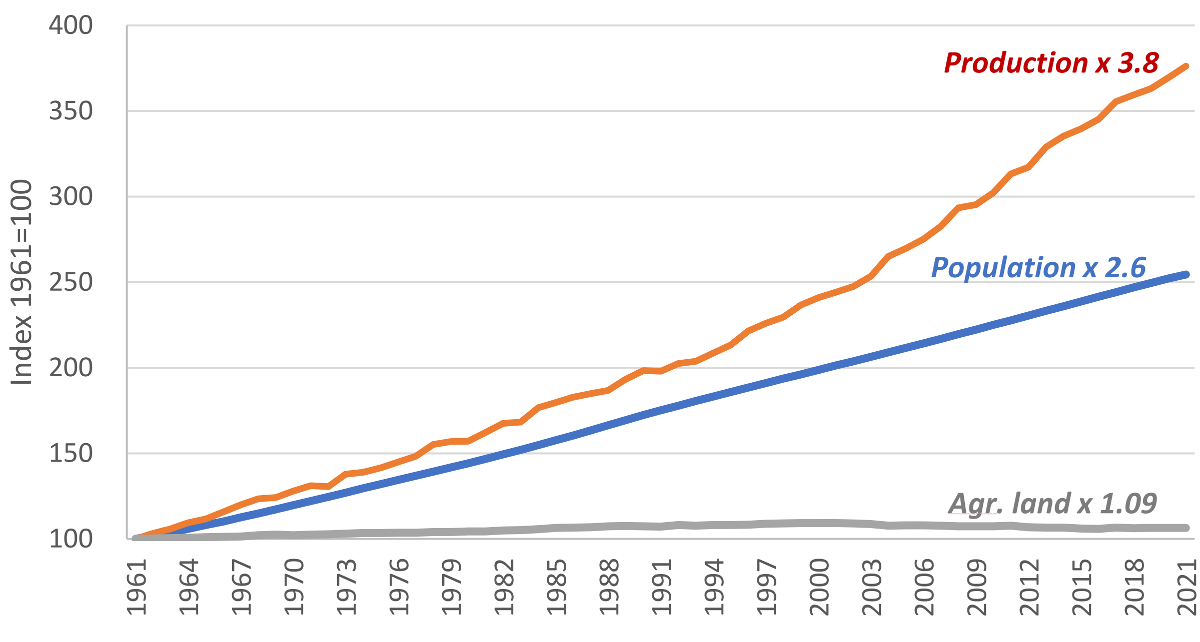
The remainder of this paper is organized as follows: section 2 lays out the main trends and issues in current food systems and provides projections of trends toward 2030, showing inter alia that—at ongoing trends—the goal of ending hunger and all forms of malnutrition by 2030 remains elusive and that agricultural productivity growth will further slow because of the impacts of climate change. Section 3 assesses to what extent the international community has lived up to its commitment to the three MOIs identified above and shows what could be achieved if they were followed through upon, as well as the potential for achieving sustainable food system transformation if the UNFSS agenda were to be realized. Section 4 concludes.

2. Food system challenges, climate change, and prospects for achieving SDG 2

2.1 The remarkable growth of global food production

Global food production expanded at a remarkable pace over the past 60 years. Per capita food production grew by a factor of 3.8 between 1961 and 2021 (Figure 1). A key driver was the diffusion of "Green Revolution" technologies for calorie-rich staple crops, especially cereals. High-yielding varieties developed by, among others, CGIAR (the international network of agrifood research centers) contributed to the worldwide expansion of food production during this period (see, for example, Fuglie et al. 2020). The associated agricultural productivity growth lowered staple food prices and facilitated structural transformations of poor economies, both helping to reduce poverty and hunger worldwide (Ivanic and Martin 2018; Gollin, Hansen, and Wingender 2021). While agricultural land use also expanded during this period, this expansion was limited vis-à-vis production and population growth, reflecting a significant increase in land productivity, despite substantial degradation of land quality (FAO 2022b).

Figure 1: Increase in food production, population, and agricultural land, 1961–2021 (Index 1961=100)



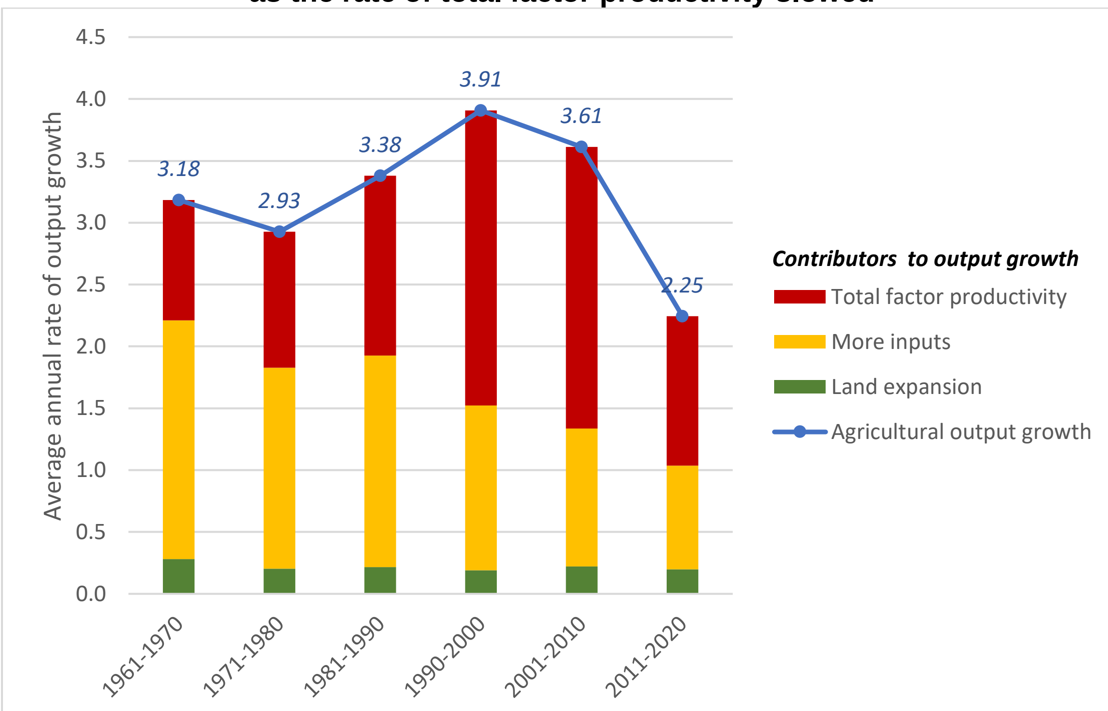
Source: Authors, based on data from FAOSTAT.

Looking forward, global food demand is expected to grow by 50 percent (from 2015 levels), considering expected population and income growth and shifts in dietary patterns (FAO 2017; Vos and Bellù 2019)**.** Moreover, a significant, additional demand pressure for agricultural produce is expected due to increased demand for biofuels.

2.2 *Climate change is slowing agricultural productivity growth*

If past trends were our guide, accelerating agricultural productivity growth would not appear as an unsurmountable challenge. However, to quote Yogi Berra, "The future ain't what it used to be." Growth in food production per capita is already showing signs of slowing down, having peaked in about 2010 (USDA 2022; Gautam et al. 2022). The slowdown is strongest in developing countries, where the growth of agricultural output declined from almost 4 percent per year in the 1990s to barely 2 percent in the 2010s (Figure 2).

Figure 2: Agricultural output in developing countries slowed in the 2010s as the rate of total factor productivity slowed



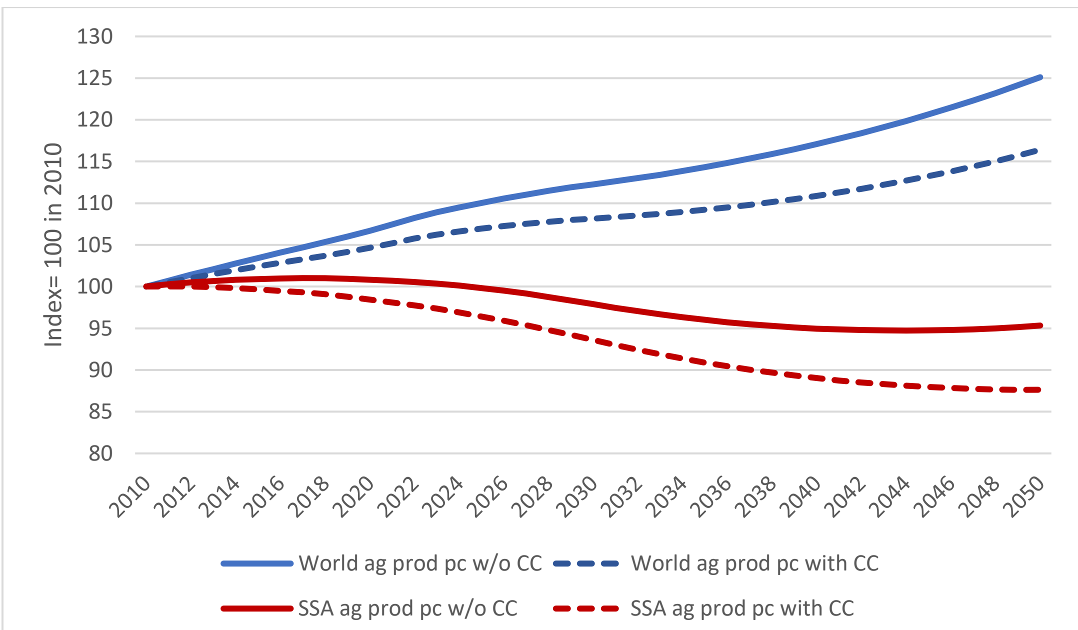
Source: Estimates based on USDA, Economic Research Service (ERS) International Agricultural Productivity data product (https://www.ers.usda.gov/data-products/international-agricultural-productivity/).

Importantly, food production worldwide will have to adjust to the threat of climate change and the erosion of land, water, and other natural resources, and to better serve human health. Global hunger, measured in terms of deficits in calorie intake, remains a pressing problem affecting over 700 million people. In addition, an estimated 3 billion people cannot afford a nutrition-adequate diet and suffer from micronutrient deficits or "hidden hunger" (FAO et al. 2022). More so than for traditional staple foods like maize, rice, wheat, and other cereals, efficiency gains will have to be reached in the provisioning of micronutrient-rich foods, such as fruits, vegetables, pulses, fish, meats, and dairy products. However, with existing technologies, the production of those foods is more resource-intensive, especially for livestock. Such production is also a major contributor to global GHG emissions. The subsections below detail these challenges.

The slowdown in agricultural productivity growth can be attributed in part to climate change. A recent study by Ortiz-Bobea et al. (2021) estimates that climate change has reduced global agricultural productivity growth by 21 percent since 1961, equivalent to losing roughly a decade of productivity growth. The impacts hit hardest on tropical agriculture, with productivity declines in some areas of 40 percent or more. Areas highly vulnerable to climate shocks, often compounded by civil strife and conflict, are witnessing rising levels of hunger and protracted food crises, affecting large parts of Africa, Central America, parts of South Asia, and the Middle East (FAO et al. 2022; FSIN 2023; Holleman et al. 2017).

Nonetheless, long-term projections from IFPRI's IMPACT model (IFPRI 2022, p. 142) suggest global per capita agricultural output will continue to rise until at least 2050, including after accounting for the adverse effects of climate change on yields. Unabated climate change would lower per capita agricultural production by 5–10 percent by 2050, in part because agricultural production in temperate zones may still benefit initially from higher temperatures (note that these projections assume no impacts from extreme weather events). Projections for per capita agricultural output in Sub-Saharan Africa are even more concerning. Even without climate change, per capita production is projected to fall from 2022 onward, as yield growth is expected to be outpaced by population growth. By 2050, per capita production is expected to fall by 5 percent from current levels without climate change, and by double that (10 percent) with climate change (Figure 3).

Figure 3: Lower per capita agricultural production due to climate change, 2010–2050



Source: Projections based on IFPRI's IMPACT model (see IFPRI 2022) and UN Population Division for Population Projections (medium variant). We used grafted polynomials to generate a projection path with a continuous slope (Fuller 1969).

Climate change affects food availability through its increasingly adverse impacts on crop yields, fish stocks, and animal health and productivity, especially in Sub-Saharan Africa and South Asia, where most of today's poor and food insecure live. It limits access to food through negative impacts on rural incomes and livelihoods. Poor people, including many smallholder farmers and agricultural workers, also tend to be more vulnerable to the impacts of extreme events. Intensified and more frequent occurrence of droughts and floods will sharply reduce incomes and cause asset losses that erode the future income-earning capacity of those affected. In addition, to the extent that food supply is reduced by climate change, food prices will increase. Both the urban and rural poor will be disproportionally affected, as they spend much higher shares of their income on food.

2.3 Agrifood systems generate one-third of global GHG emissions

Agriculture and food systems are not only affected by climate change but are also major contributors to it. The contribution of the global food system is larger than usually considered with available data focusing on GHG emissions from agricultural production and land use change. Recent estimates of emissions across the food system by Tubiello et al. (2021) indicate that GHG emissions from the food system were about 16 Gt CO_2eq in 2018, or one-third of the global anthropogenic total (Figure 4a).

About 45 percent of these emissions, 7 Gt CO_2eq/year, were generated within the farm gate, while an additional 35 percent, 6 Gt CO_2eq/year, emanated from pre- and postproduction activities, such as agrifood manufacturing, transport, processing, and waste disposal. The remainder was generated through land use change at the conversion boundaries of natural ecosystems to agricultural land.

While food system emissions declined from 43 percent to 34 percent as a share of global GHG emissions between 1990 and 2018, these emissions increased in absolute terms from 15 to 16.0 Gt CO_2eq/year (Figures 4a–b), driven mainly by increases in emissions from livestock production and energy use in postharvest food sector activities. By contrast, emissions from land use change have decreased since 1990.

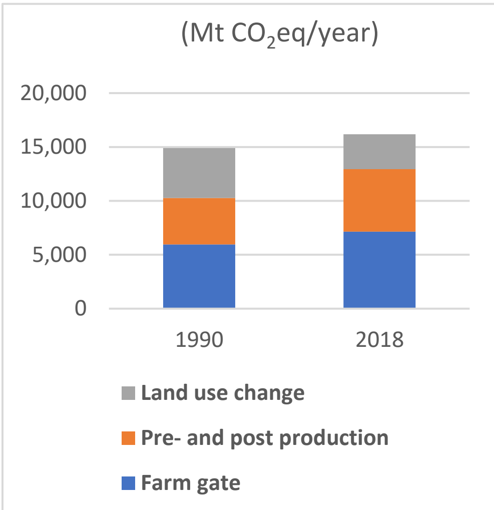
The estimates indicate that emissions by food sectors in developing countries are far greater than those by developed countries. Pre- and post-farmgate food sector emissions generated in developing countries have increased substantially since 1990: from 1.3 to 3.1 Gt CO_2eq/year (Figure 4c).

The conversion of land from natural habitats and current agricultural practices has other large negative externalities. Agriculture is the biggest driver of biodiversity loss, with enormous economic costs due to lost ecosystem services (World Bank 2021; FAO, UNDP, and UNEP 2021). Beyond the environment, current production patterns encourage unhealthy diets, with large human capital and health costs. Furthermore, production practices undermine both current and future economic growth as key resources—land, water, and energy—are degraded and misallocated, constraining the pace of structural transformation and progress on poverty reduction.

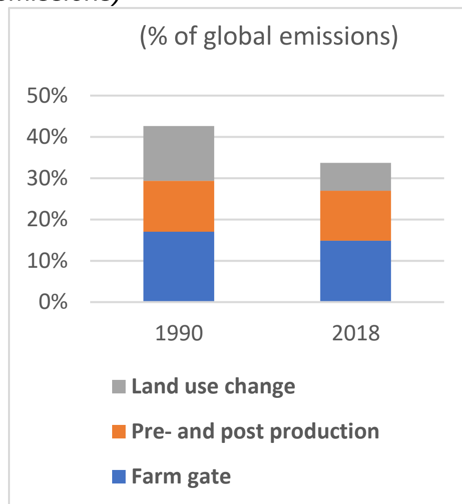
At the core of finding viable solutions to making agriculture more productive, sustainable, and nutrition-sensitive are improved technologies and practices as much as market incentives for both adoption of improved practices and shifting consumer demand. In other words, do current agricultural support policies create the right incentives for producers to make appropriate decisions for achieving the desired goals? Sections 3 addresses these issues.

Figure 4: Food system greenhouse gas emissions by type of activity and country groupings, 1990–2018

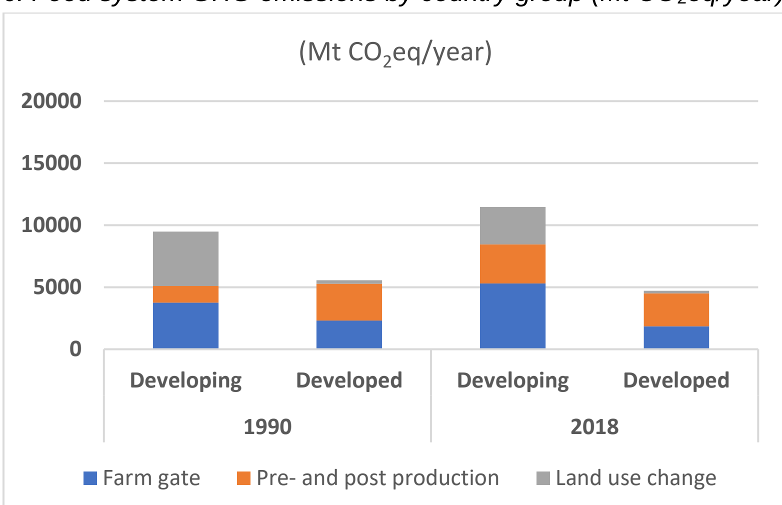
a. Food system emissions (Mt CO_2 eq/year)



b. Food system emissions (% global GHG emissions)



c. Food system GHG emissions by country group (Mt CO_2eq/year)



Source: Tubiello et al. 2021.

Note: Developed and developing country groupings refer to, respectively, Annex I and Non-Annex I categories of the Kyoto Protocol.

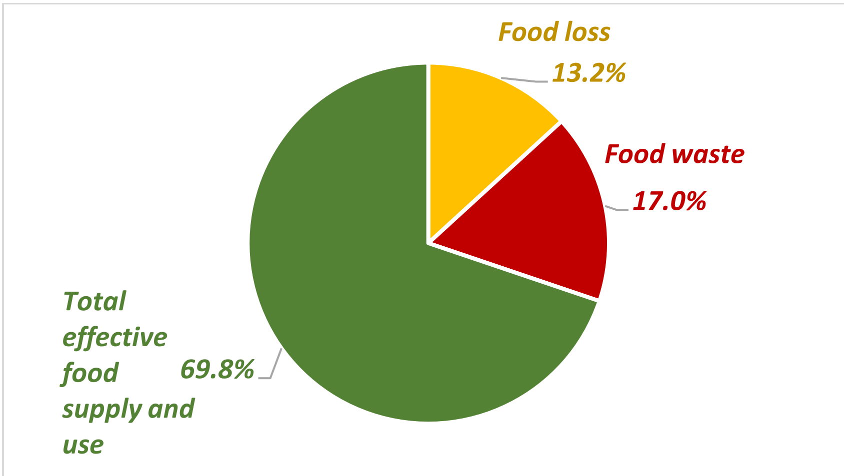
2.4 Food loss and waste remains a serious problem

Massive FLW continues to hamper affordable food availability for human consumption. An estimated 30 percent of all food production is either lost at the farm level or during postharvest handling or wasted at the retail and household level (Figure 5a). Food loss is a bigger problem in developing countries, where lack of adequate logistics (such as cold storage and transportation), processing capacity, and poor market connectivity often contribute to poor handling of produce.

FAO (2019) estimates that about 13 percent of all food meant for human consumption is lost every year between the harvest and retail stages of food production. At the same time, an estimated 17 percent of food is wasted by households or in retail and food services (UNEP 2021).

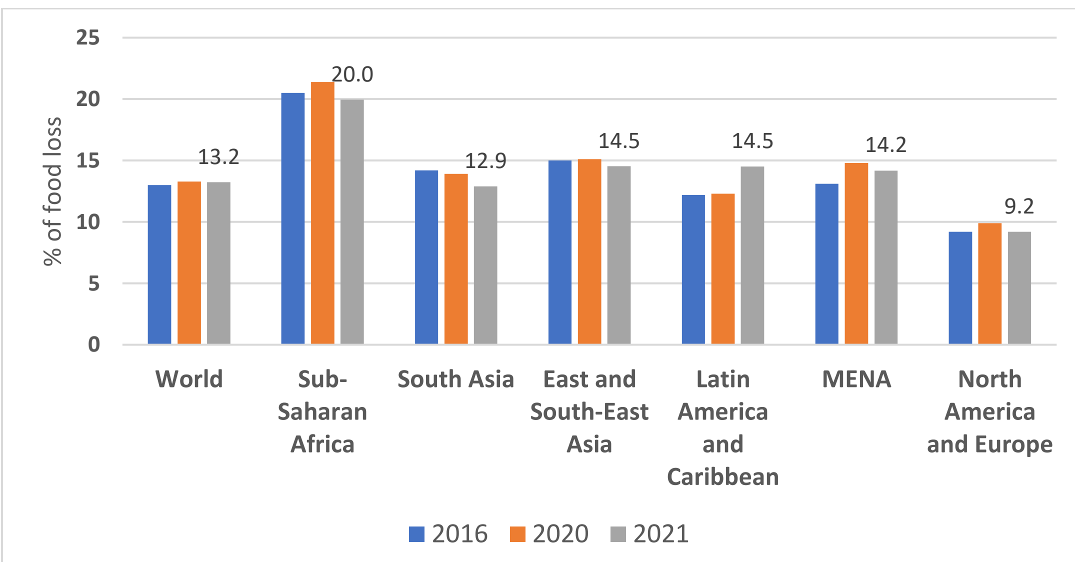
Figure 5: Global food loss and waste

a. Shares of food production that is lost or wasted (in percent)



Source: FAO (2019); UNEP (2021); Technical Platform for the Measurement and Reduction of Food Loss and Waste, https://www.fao.org/platform-food-loss-waste/en; and IFPRI, https://www.ifpri.org/topic/food-loss-and-waste.

b. Trends in food loss by region, 2016–2021 (% of food production)



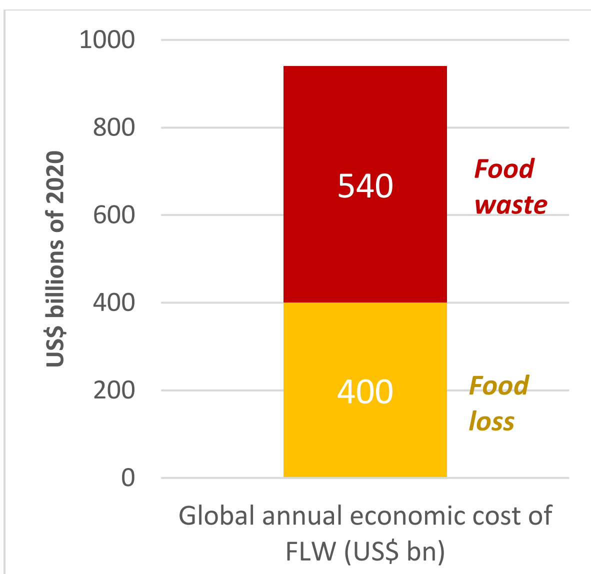
Source: FAO SDG data portal (https://www.fao.org/sustainable-development-goals-data-portal/data/indicators/1231-global-food-losses/en).

The degree of *food loss* is closely related to economies' level of development, and with it, that of the efficiency in the functioning of food supply chains. The highest shares of food losses (more than 20 percent) are found in low-income Sub-Saharan Africa and other least developed countries, and the lowest shares (less than 10 percent) in high-income countries in Europe and North America (Figure 5b). Little progress has been made in reducing food losses since 2015. *Food waste*, in turn, is more significant in high-income countries, but is also becoming a greater problem in developing countries.

FAO (2019) and UNEP (2021) estimate the annual economic cost of FLW at almost US$1 trillion (2020 prices) (Figure 6) and, according to UNEP (2021), FLW accounts for about 8–10 percent of global GHG emissions. While these are upper-bound estimates of potential gains their very magnitude points to the potential scope for improvement.

Clearly, SDG12, target 12.3 which aims to reduce FLW is related to the goal of ending hunger and making agriculture and food systems sustainable. Reducing FLW is critical to reduce production costs and increase the efficiency of the food system, improve food security and nutrition, and contribute to environmental sustainability. The agreed target is to halve per capita global food waste at the retail and consumer levels and reduce food losses along production and supply chains, including postharvest losses, by 2030. Unfortunately, insufficient comparable data are available to judge how much progress was made on this front by 2015. However, given the sheer magnitude estimated for around 2020, without major additional efforts to address the issue, FLW will likely still be a major drag on food availability and affordability and will contribute to unnecessary use of natural resources by 2030.

Figure 6: Food loss and waste come with an economic cost of about US$1 trillion per year



Source: FAO (2019); UNEP (2021); Technical Platform for the Measurement and Reduction of Food Loss and Waste, https://www.fao.org/platform-food-loss-waste/en; and IFPRI: https://www.ifpri.org/topic/food-loss-and-waste.

2.5 Economic slowdown and macroeconomic woes affect food insecurity, especially in low-income countries

Macroeconomic woes facing many of the countries with high prevalence of undernourishment have caused major setbacks in the progress toward SDG2.

Economic growth in low- and middle-income countries (LMICs) is uneven and has slowed since the end of the first decade of the millennium, with particularly large growth slowdowns in many poorer and fragile countries (Table 1). For LMICs as group, per capita GDP growth slowed to around 3 percent per year during the 2010s, down from almost 5 percent per year during the 2000s. Per capita income in low-income countries (LICs), including most fragile and conflict affected countries, actually declined at 1 percent per year between 2010 and 2022. These countries had done relatively well economically speaking during the 2000s, after the two "lost decades these countries suffered during the 1980s and 1990s.

Intensifying intra-state conflicts over the past two decades (Holleman et al., 2017) culminated in growth collapses in a fair number of LICs. Most LICs, however, have been highly vulnerable to a volatile global macroeconomic landscape. global market shocks, including in food markets. In fact, there have been three food and fuel crises over the last 15 years (2007-08, 2010-11 and 2021-22), with sharp surges in agricultural input costs and food prices in international markets and many domestic markets The most recent food crisis started with the COVID-19 pandemic in 2020-2022, which disrupted global supply chain disruptions and contributed to inflationary pressures just as the pandemic itself was easing off. Vegetable oil prices rose sharply in 2021, followed by sharp increases in wheat and fertilizer markets after the Russian invasion of Ukraine. Diet quality is projected to have deteriorated as a result of these recent shocks, as measured by the Reference Diet Deprivation (ReDD) index, which captures diet shortfalls across several distinct food groups that constitute the EAT-Lancet healthy diet (Pauw et al. 2023). Another recent study shows that increases in the real price of food increase the risk of child wasting and stunting, especially among the poor and landless rural households (Headey and Ruel 2023). While international food prices fell again over 2023, these past episodes of volatility underscore the vulnerability of many food systems to unanticipated global shocks.

Due to the global shocks and the ensuing low growth, many countries are currently grappling with continuing macroeconomic woes, with rising debt distress and borrowing costs, which are hampering their efforts at meeting the SDGs. Shifts in the financial landscape have also contributed to rising public and external debt distress with recent rises in interest rates and a longer-term trend away from concessional lending toward private sector creditors, who charge higher interest rates. This combination of factors-- low growth, greater demand on public spending to address impacts of crises, increased import bills, and higher borrowing costs—has led to further increasing debt burdens, especially for sub-Saharan Africa (Devarajan, Gill, and Karakülah 2021). Even before the COVID-19 pandemic LMICs were facing major debt challenges. According to the IMF, debt levels were higher going into the pandemic than on the eve of the global financial crisis in 2008.[1] Debt servicing consequently has crowded out investments in productive and social

[1] See https://www.imf.org/en/Blogs/Articles/2021/02/01/the-pre-pandemic-debt-landscape-and-why-it-matters

sectors, such as health, agriculture, and education (Federspiel, Borghi, and Martinez-Alvarez 2022), all of which are key to shifting outcomes on hunger and malnutrition. In addition, the debt burdens and widening balance-of-payments deficits put pressure on national currencies to devalue, which in turn have kept domestic (food) inflation rates high in the LICs also during 2023, even after global agricultural commodity, fertilizer and fuel prices had fallen (Vos, Glauber, Kim & Rice, 2023).

Table 1: Per capita GDP growth in low- and middle-income countries, 1970–2022 (annual average % change for sub-periods; cumulative change for 1970–2022)

	1970-1980	1980-1990	1990-2000	2000-2010	2010-2022	Increase in pc GDP over 1970-2022 period
Fragile and conflict-affected situations	2.4%	-1.5%	-1.4%	2.8%	-0.6%	15.1%
Sub-Saharan Africa	0.9%	-1.5%	-0.5%	2.5%	0.2%	18.1%
Low-income countries		-0.9%	0.5%	2.4%	-1.0%	8.4%
Middle-income countries	3.2%	1.4%	2.1%	5.0%	3.4%	370.8%
Low- & middle-income countries	3.1%	1.3%	2.0%	4.8%	3.2%	340.9%

Source: World Bank, World Development Indicators
Notes: Estimates refer to growth of per capita GDP measured in constant US dollars of 2015. Cumulative change for LICs refers to 1981-2022**.** "Fragile and conflict-affected situations" refer to country contexts characterized by high-levels of institutional and social fragility and/or by violent conflict, as defined by the World Bank. For the list of countries/contexts, see https://www.worldbank.org/en/topic/fragilityconflictviolence/brief/harmonized-list-of-fragile-situations .

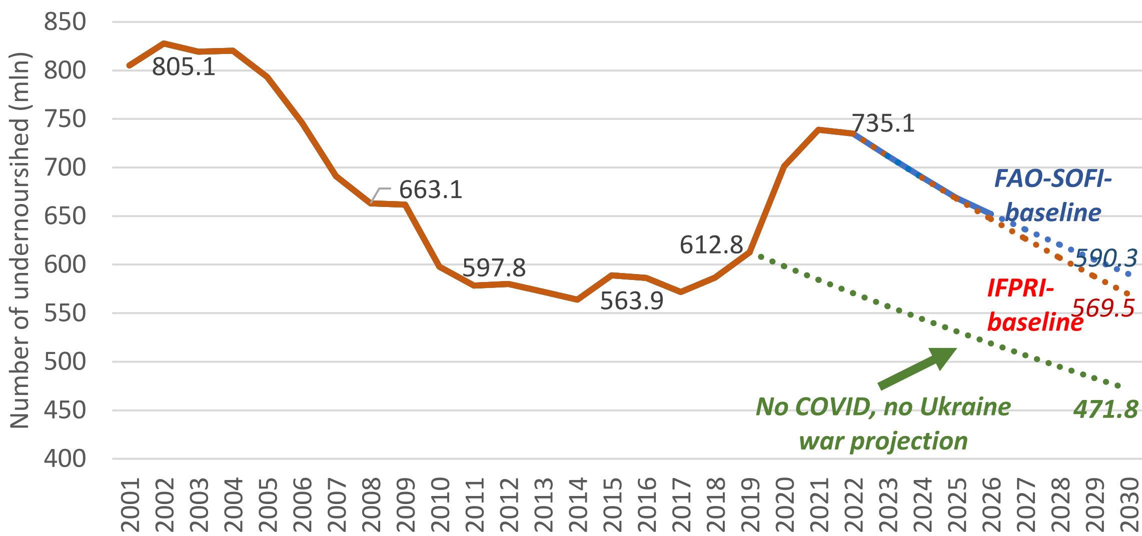
Growth slowdowns in low-income countries can have particularly large impacts on poverty and hunger. Analysis linking macroeconomic slowdown with poverty rates suggested that the relatively modest slowdown in the global economy projected by the IMF in 2017 would result in 38 million fewer people escaping poverty than would have been the case under earlier scenarios (Laborde and Martin 2018). A similar analysis for the COVID-19 pandemic, with its adverse impacts on employment and incomes, would result in 150 million more people falling into poverty (Laborde, Martin and Vos 2020).

2.6 SDG 2 will not be met by 2030

2.6.1 Undernourishment

Given the major food system challenges, the SDG 2 goal of ending hunger and all forms of malnutrition by 2030 seems elusive. Moreover, food security is affected by conflict in many low- and middle-income developing countries. Intensifying conflict often compounded by extreme weather shocks are considered major drivers behind the resurgence in global hunger estimates since 2015 (FSIN 2023; FAO et al. 2017, 2023; Holleman et al. 2017). Recent global economic shocks—specifically those caused by the COVID-19 pandemic in 2020–2022, the global supply chain disruptions and food price hikes of 2021–2022, and the shock to global wheat, vegetable oil, and fertilizer markets caused by the war in Ukraine—have further driven up global food insecurity, affecting 735 million people in 2022 (up from 564 million in 2015). Even if the world realized unfettered economic recovery without any major new upheavals until 2030, the zerohunger goal would remain far out of reach. Under such a scenario, both FAO (FAO et al. 2023) and IFPRI (Glauber and Laborde 2023) project that while falling again, global hunger would still be above 2015 levels, affecting 570 million people or more (Figure 7, dotted lines). Ending global hunger by 2030 also remains elusive in a hypothetical scenario in which the global economy and food systems were not shocked by COVID-19 or the war in Ukraine during 2020–2022.

Figure 7: The world is off track to reach the "End Hunger" goal by 2030

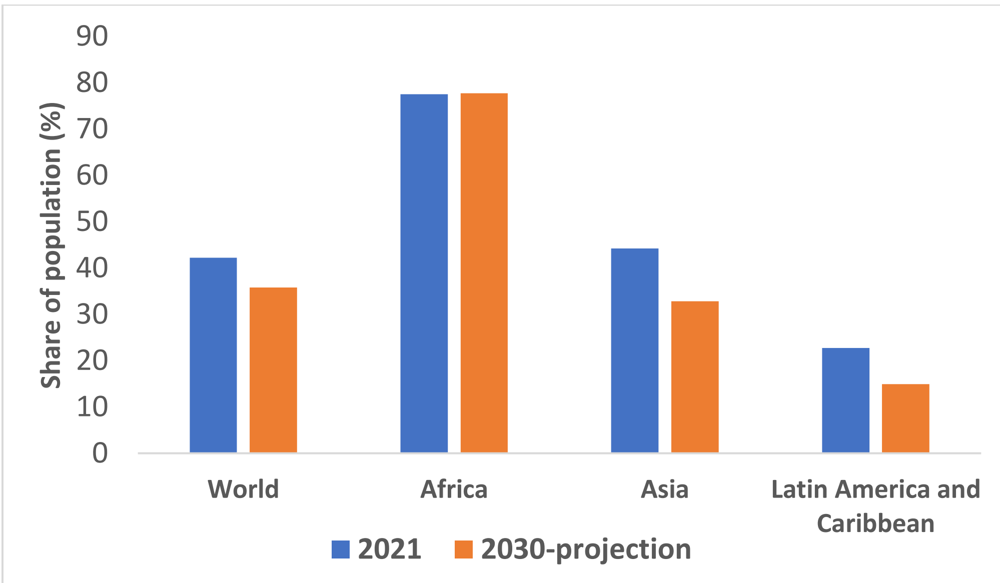


Source: FAO et al. 2023. The State of Food Insecurity and Nutrition in the World, Fig. 5; and Glauber, J. and D. Laborde. 2023. Repurposing food and agricultural policies to deliver affordable healthy diets, sustainably and inclusively: What is at stake? Background paper for The State of Food Security and Nutrition in the World 2022. FAO Agricultural Development Economics Working Paper 22–05. Rome, FAO. https://doi.org/10.4060/cc4348en

2.6.2 *"Hidden hunger" and access to healthy diets*

Next to persistent widespread undernourishment (in the sense of deficient food energy or calorie intake), an estimated 3 billion people worldwide cannot afford the cost of a healthy diet and are likely affected by micronutrient deficiencies, a condition labeled "hidden hunger." By far, most people lacking the means to cover the cost of a healthy diet live in Sub-Saharan Africa (875 million) and South Asia (1,283 million). FAO (FAO et al. 2023) and IFPRI projections (Glauber and Laborde 2023) suggest that under baseline assumptions more than one-third of the world population will still not be able to afford the cost of a healthy diet in 2030, while three-quarters of the population in Africa will still be suffering from hidden hunger (Figure 8).[2]

Figure 8: The cost of a *healthy diet will remain unaffordable to more than one-third of the world population in 2030*



Source: FAO et al. 2023. The State of Food Insecurity and Nutrition in the World, Fig. 5; and Glauber, J. and D. Laborde. 2023. Repurposing food and agricultural policies to deliver affordable healthy diets, sustainably and inclusively: What is at stake? Background paper for The State of Food Security and Nutrition in the World 2022. FAO Agricultural Development Economics Working Paper 22–05. Rome, FAO. https://doi.org/10.4060/cc4348en

2.6.3 *The dietary transition*

The finding that healthy diets will remain expensive and, hence, unaffordable to billions by 2030 is another sign that food system change is not keeping pace with the ongoing dietary transition. With urbanization and income growth, demand for more nutritious foods, like fruits and vegetables and animal-source foods, increases relative to starchy foods (Bennett's Law). While supplies of

[2] FAO estimates the cost and affordability of a healthy diet for each country to show the population's physical and economic access to least expensive locally available foods to meet requirements for a healthy diet, as defined in food-based dietary guidelines. The indicators use observed retail food consumer prices for key food components of the "healthy diet" and income distribution parameters to provide an operational measure of people's access to locally available foods in the proportions needed for health. See: https://www.fao.org/faostat/en/#data/CAHD

these types of foods have been expanding, their relative high cost suggests the production shift has not kept up with changing demand.

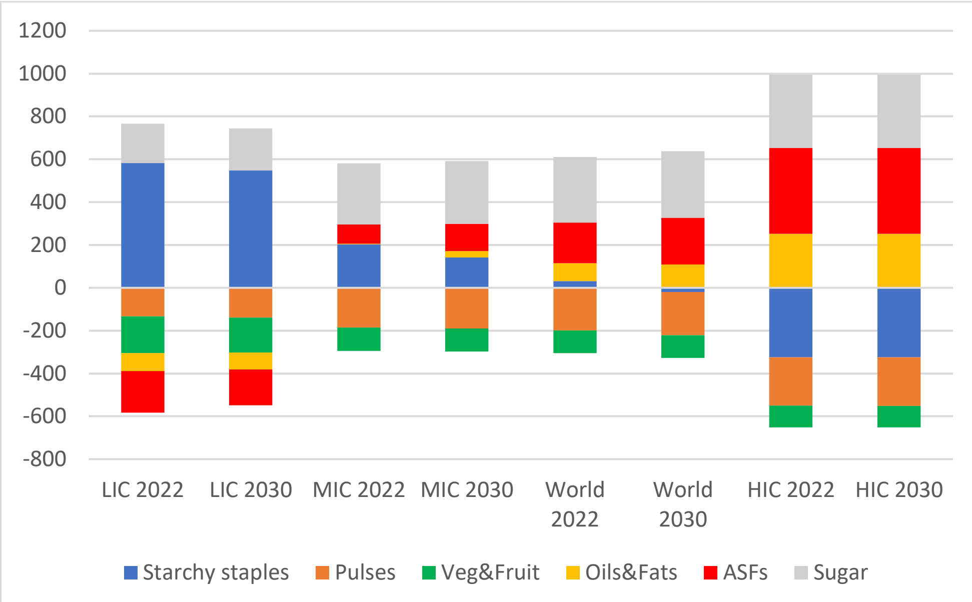
The dietary transition is not all benign. Next to greater dietary diversity, income growth and urban lifestyles are also associated with excessive food consumption and increased intake of (ultra-)processed foods. National dietary guidelines specify quantities of broad food types to meet these needs and tend to be remarkably similar across countries. Comparing consumption patterns by country with these guidelines provides a useful guide to the quality of diets. Modern demand systems focused on the relationship between income levels and consumption patterns provide a basis for projecting changes in consumption patterns as per capita incomes grow.

The approach used for this analysis allows assessment of the effects of income growth on diets over time and at different levels of income. Over a wide range of incomes, diets improve as incomes rise to around the World Bank's definition of upper-middle-income level. But they deteriorate as incomes grow above that level. Extending World Bank income growth projections to 2030 suggests that the incomes of consumers in today's low-income countries will rise by around 28 percent between 2022 and 2030. This should help improve diet quality in those countries. Slightly more rapid income growth (32 percent) in today's middle-income countries is likely to result in a modest decline in diet quality in those countries. High-income countries will likely experience very little decline in diet quality given their likely relatively modest increases in real incomes (17 percent).

Figure 9 provides a summary of the changes in shortfalls and excesses in consumption patterns; consumption of each food type was converted into its calorie equivalent to provide a uniform measure of consumption patterns. These were then converted into shares of total consumption for a 2,330 kcal/day/person diet. Measuring the excesses and deficits relative to a "healthy-diet-basket" norm based on the recommendations in 10 national food guidelines (FAOSTAT 2023) provides a basis for measuring deviations at each income level. Projecting changes in consumption patterns for 2022 and 2030 in the figure provides a guide as to whether diet quality is improving or deteriorating.

Actual and projected demand patterns for food are very different from dietary guidelines at all levels of income. In poor countries, consumption of starchy staples greatly exceeds their recommended share, while consumption of animal-source foods falls well below recommended levels. By contrast, consumption of animal-source foods and oils and fats exceeds those levels in middle- and high-income countries. Consumption of pulses and vegetables and fruits, in turn, is too low in all country groupings, while consumption of sugar and sweeteners is too high.

Figure 9: Dietary excesses and deficits by food type and income level (kcal/person/day**)**



Source: Authors, based on Martin and Masters (2023).

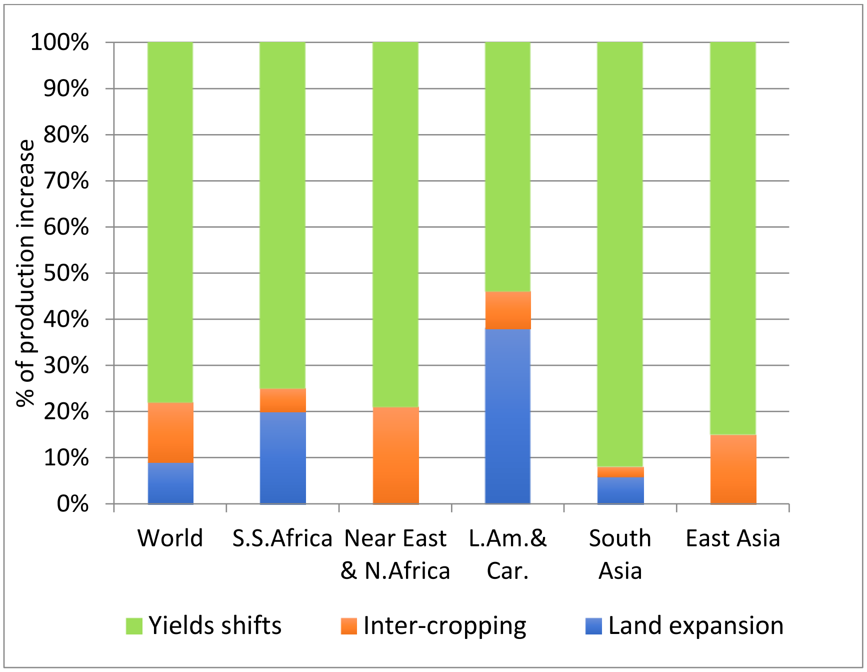
Note: On the x-axis, "LIC 2022" and "LIC 2030" refer to consumption patterns of the World Bank's classification of low-income countries (LICs) in, respectively, 2022 and 2030 (projected), while "MIC 2022" and "MIC 2030" and "HIC 2022" and "HIC 2030" refer to those for middle- (MICs) and high-income countries (HICs). "World 2022" and "World 2030" refer to the averages for all countries. ASF = animal-source foods.

3. Meeting SDG 2 commitments on the "means of implementation"

3.1 The imperative of sustainable intensification

SDG 2 aims not only to end hunger and all forms of malnutrition by 2030, but also to ensure "sustainable food production systems and implement resilient agricultural practices that increase productivity and production, that help maintain ecosystems." As discussed, climate change is threatening this outcome. Moreover, in most regions of the world, further expansion of arable land is very limited. In the Middle East and Northern Africa (MENA) and parts of Central Asia and Sub-Saharan Africa, potential land expansion is constrained by water scarcity. In other parts of Sub-Saharan Africa and Latin America, most of the still available land lies in remote areas, where lack of infrastructure prevents its use for agricultural purposes, at least at current agricultural price levels. In all regions, agricultural land expansion could lead to more deforestation, undesirable from the perspective of sustainability, in part because of increased GHG emissions and biodiversity loss. Climate change will constrain agricultural land expansion in other ways, as reduced and more variable rainfall as well as rising sea levels will make agriculture less viable in some areas. Crop intensification can be an alternative to land expansion. However, the scope for doing so while ensuring durable soil quality is relatively limited given the present state of technology (Alexandratos and Bruinsma 2012; Vos and Bellù 2019). Growth in future agricultural production will have to come mainly from yield increases (Figure 10), yet another complication.

Figure 10: Future sources of agricultural output growth under a business-as-usual scenario, 2012–2050



Source: Vos and Bellù (2019).

3.2 The intensifying battle for land and water

One big challenge to sustainable intensification is that future production and productivity growth will be hampered by growing scarcity, lower quality, and greater competition for land and water resources. Projections for 2050 confirm the likelihood of growing scarcity of agricultural land, water, forest, marine capture fisheries, and biodiversity resources. Additional land requirements for agricultural production between now and 2050 are estimated at just under 0.1 billion ha (FAO 2017). Increased competition for land has already emerged, due to increases in the demand for bioenergy. The greater competition between food and nonfood uses of biomass has increased the interdependence between food, feed, and energy markets. This competition may be harmful for local food security and access to land resources. Input subsidies on energy, fertilizers, and water, as well as public purchases of agricultural produce, put additional pressure on natural resources.

Water availability for agriculture will also become a growing constraint, particularly in areas that use a high proportion of their water resources, exposing systems to high environmental and social stress and limiting the potential for expanding irrigated areas. Water withdrawals for agriculture represent 70 percent of all withdrawals. More than 40 percent of the world's rural population lives in water-scarce river basins (FAO 2017). Future water stress will not only be driven by increasing demand for drinking water, industrial water use, and irrigation of agricultural lands, but also by changes in the availability of water resources driven by climate change—which will cause greater variability in precipitation, leading to substantially higher risk of prolonged droughts as well as excessive rainfall.

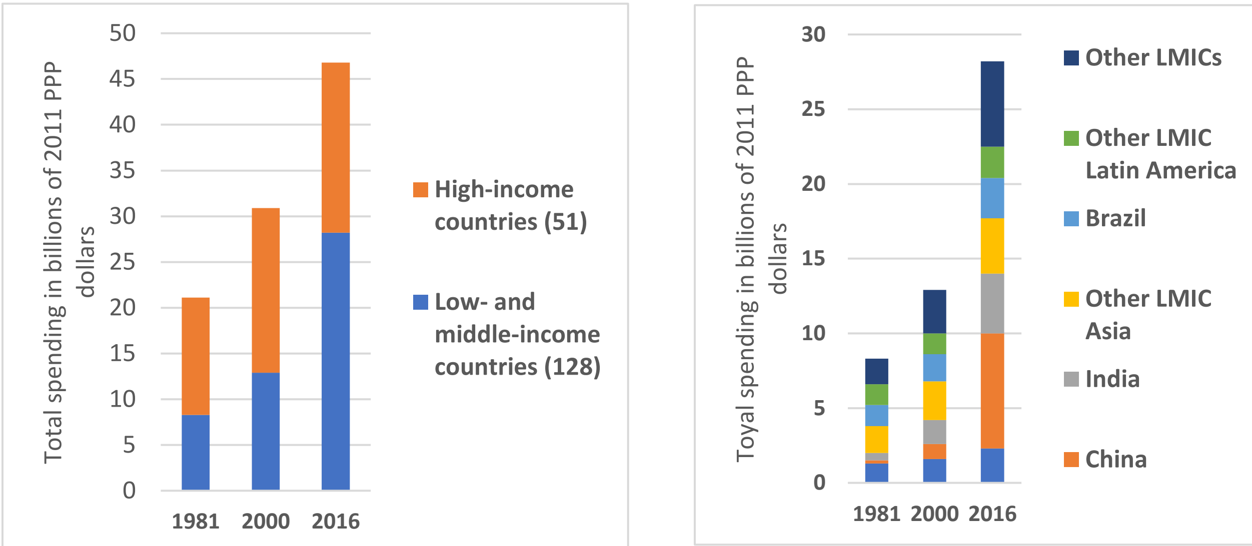
3.3 SDG 2's "Means of Implementation"

While the 2030 Agenda for Sustainable Development's three MOIs are far from a complete set of instruments to induce sustainable food system transformation, progress on these three fronts will be essential to facilitate sustainable intensification, ease market access to food products, and create more stable food market conditions. Unfortunately, little to no progress has been made to date on these action areas, as discussed next.

3.3.1 ***MOI 2A – Investment in agricultural R&D has slowed despite the high economic returns***

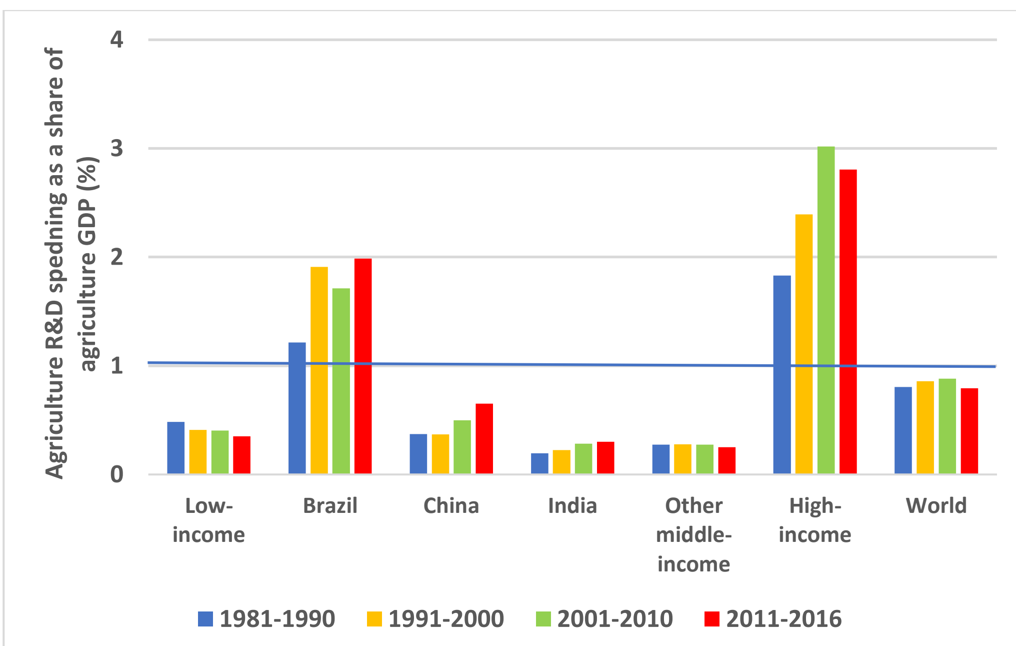
Underinvestment in the development of improved technologies in recent decades is a main factor hampering the acceleration of agricultural productivity. Levels of spending on agricultural research and development (R&D) increased in recent decades, with much of the growth coming from a few developing countries, especially Brazil, China, and India (Figure 11). Nonetheless, current levels of R&D expenditures are too low for comfort, especially in low-income countries. A commonly used indicator to assess countries' relative agricultural research efforts is the agricultural research intensity index (ARI), which expresses national expenditure on public agricultural R&D as a share of agricultural gross domestic product (GDP). Clearly, low-income countries lag far behind high-income countries and are increasingly losing ground (Figure 12). While it is hard to define an "adequate" level of ARI, overall government R&D expenditure for science and technology of at least 1 percent of national GDP has been recommended (FAO 2017). For the agriculture sector, countries in both the low-income and the lower-middle-income groups are generally well below this threshold (Figure 12). This also holds for major food producing middle-income countries, like China and India. Brazil is an exception with strong growth of R&D expenditures in recent decades and reaching an agriculture research intensity ratio close to 2 percent of its agricultural GDP.

Figure 11: Agricultural research spending by income group and selected countries, 1981–2016



Source: Beintema, Nin Pratt, and Stadts (2020). ASTI Global Update. https://ebrary.ifpri.org/digital/api/collection/p15738coll2/id/134029/download.

Figure 12: Agricultural research intensity, by country income group, 1981–2016



Source: Beintema, Nin Pratt, and Stadts (2020).

Note: Simple average of annual agricultural research intensity (ARI), measured as the ratio of public expenditure on agricultural R&D to agricultural GDP.

Based on IFPRI's database of Agricultural Science and Technology Indicators (ASTI), Beintema (2020) estimates the global gap for agricultural R&D investment at 34 percent of attainable investment.[3] Although high-income countries do spend more than 1 percent of agricultural GDP on agricultural research, they also show an investment gap when also accounting for income level, size of overall economy and technological spillovers (see footnote). in 2016, the gap in agricultural research investment averaged 25 percent for high-income countries and 39 percent for both low- and middle-income countries (Beintema et al. 2020). The Commission on Sustainable Agriculture Intensification (CoSAI), in turn, focused on the gap in investments for R&D for technologies and practices for sustainable intensification. It estimates this R&D investment gap at US$15 billion per year to be allocated toward innovations for sustainable intensification tailored to production conditions in low- and middle-income countries (LMICs) (CoSAI 2021). Meanwhile, private investment in R&D has increased, currently contributing an estimated 20 percent of total agricultural R&D expenditures (FAO 2017, 2022a).

This provides opportunities as much as it poses challenges. Recent R&D has brought many new promising "disruptive" technologies providing new solutions for efficiency gains throughout the agrifood system; some of these are discussed below. One key challenge is that most private sector research focuses on technology improvements for fully developed large-scale commercial agriculture and food businesses. In addition, the transfer of many new technologies (such as biotechnologies and applications of digital technology) and their adaptation to developing country needs are hampered by restrictions emanating from intellectual property rights. At the same time, their diffusion in low-income country contexts is often constrained by lack of adequate extension services, poor transport and communications infrastructure, and lack of credit access among local farmers. In this regard, lessons could be drawn from the Green Revolution in Asia, where success in accelerating productivity growth and dramatically reducing hunger and poverty was not just a result of the development of input-responsive high-yielding crop varieties, but was facilitated by major public investment in irrigation, transportation and communications infrastructure, input supply arrangements, public pricing and procurement systems, and commitments to making technology an international public good freely available to crop-breeding programs worldwide. Nearly half a century later, these same technologies have failed to lift agricultural productivity growth in Sub-Saharan Africa precisely because such enabling institutional arrangements and public support are absent.

3.3.2 *Many promising new technologies and practices are available*

As noted, the perceived underinvestment in agricultural and food system R&D does not mean that new technological breakthroughs are lacking. In fact, a growing portfolio of food system innovations could accelerate change toward sustainable food system transformation. These include numerous digital innovations such as precision agriculture, robotics, and applications for e-commerce, e-procurement, e-payment systems, and product quality traceability, as well as a

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[3] In the ASTI database, a country's attainable level of investment is defined by the size of a country's agricultural sector combined with three additional variables: the size of its economy, its income level, and the availability of relevant technology spillovers from abroad.

wide array of other innovations, such as genomics for development of climate-resilient crop and breeding varieties, process-synthesis approaches to plant-based, protein-rich foods mimicking meat structures, biodegradable coatings of fruits and vegetables, and new drying methods (Barrett et al. 2020; Herrero et al. 2020; Reardon and Vos 2021, 2023; FAO 2022).

Several of these innovations have proven potential to both raise productivity and reduce emission intensity in agrifood production. On a top-ten list of new technologies and practices ranked by readiness, adoption potential, and potential impact, four relate to replacement food and feed for humans, livestock, and fish through plant-based substitutes, insects, microalgae and cyanobacteria, and seaweed (Barrett et al. 2020). Such innovations will be critical given livestock's contribution to global GHG emissions. For instance, sophisticated livestock breeding methods can help improve livestock productivity using advanced genetic and genomic selection methods have the potential to contribute to heat tolerance and methane mitigation (Pryce and Haile-Mariam 2020). Algal-derived feed supplements (for example, seaweed) help reduce methanogenesis in ruminant digestive systems to enteric fermentation and methane generation, while improving productivity in the livestock sector (Mernit 2018; McCauley et al. 2020). Another innovation is the use of insects as feed. Insects are often rich in protein and some vitamins and minerals (Henchion 2017). Use of some insect-derived protein may reduce GHG emissions, though, to date, strong evidence on this impact is scant (Parodi et al. 2018). In addition, methane production in rice cultivation, another major source of GHG emissions, can be significantly reduced through alternate wetting and drying in rice cultivation (Chidthaisong 2018). These promising new practices could reduce methane emissions from rice and cattle by up to 50 percent.

Switching to healthier diets with much-reduced meat consumption from present levels is considered to simultaneously improve people's and planetary health (EAT Lancet Commission 2019; Willet et al. 2019; Loken and DeClerck 2021). Global GHG emissions from agriculture could drop by as much as 80 percent according to some estimates, though impacts may vary greatly across countries depending on current levels of meat consumption and efficiency in livestock production (Springman et al. 2018). These studies do not call for a complete switch to vegetarian or vegan diets, but to much lower than current levels of meat consumption for much of the world population, though recognizing the needs of the poor to raise their intake of animal-source food to meet minimum nutritional standards. The important point is that huge gains for planetary health could be achieved from the consumption side. Changing dietary habits is not easy, however. Innovations through product innovation in the form of plant-based and cellular meat substitutes that mimic the taste and texture of meat can help sway consumer demand and raise awareness of the environmental impacts of consuming livestock. This is still a small but growing business. If part of a gradual process, it should allow current livestock and feed crop producers to adjust to the desired change in the demand for proteins.

3.3.3 *Efforts are needed to overcome hurdles to adoption of sustainable technologies and practices*

The hurdles to adoption of these new technologies can be formidable (see, for example, Liu 2013). Even if policymakers and policy advocates feel confident that adoption of a particular technology will reduce costs, raise productivity, and increase resilience, uncertainty remains about the productivity impact of that technology in any specific environment. For instance, certain innovations may need additional inputs, like—as mentioned—in the case of Green Revolution technologies that boosted productivity where farmers could access fertilizer, irrigation, and adequate market infrastructure, such as in Asia, but did not in Africa, where such complementary inputs were difficult to access or simply unavailable. Similarly, sustainably produced foods may meet consumer resistance, for instance, if produce labelled as, say, "organic" has a higher price or consumers consider it inferior to produce that is not. As a result, the technology cannot be brought to scale because of limited demand. Given this, any policy that encourages or requires adoption of climate-resilient technologies must recognize the risk of producers' perceptions that they may not improve productivity enough compared with their cost of adoption.

The increasing involvement of the private sector and the use of proprietary technologies is making an important contribution to raising agricultural productivity in areas where intellectual property protection allows investors to appropriate some of the gains from new technologies. However, the higher costs to farmers associated with proprietary technologies raise concerns about access of poorer farmers to some of these technologies. In addition research on many technologies, such as open-pollinated crops, continue to be under-provided by the private sector. This public good problem reinforces the need for continued support to public agricultural R&D through both national agricultural research systems and the CGIAR system at a global level. The continuing high rates of return to public R&D spending (Alston, Pardey and Rao 2020) suggest a strong case for increased support. Importantly, new technologies not only need to significantly improve productivity but must also ensure they substantially lower emissions and underpin sustainable intensification in agriculture and low-emission energy use in postharvest food sector activity.

A mix of emergent circular feed, controlled environment agriculture, precision fermentation, and cellular tissue engineering technologies can dramatically reduce the terrestrial and marine footprint of farming, especially in producing higher-value foods and high-quality diets. The production costs of these methods are falling fast, making them increasingly viable. Orderly substitution of capital for land in food production will require cross-sectoral coordination; creation of ecopayment systems rewarding landowners for biodiversity conservation, carbon sequestration and other ecosystem services; a shift from production-based agricultural subsidies to incentives for rural investment in renewable energy; and implementation of robust safety nets for those disrupted and marginalized by inevitable transitions.

New technology adoption will also require raising awareness among consumers and tapping their latent valuation of more sustainable and healthy foods to incentivize beneficial innovation and technology adoption. Public policies can help raise such awareness. Policies will be needed to steer change by providing tangible incentives to both consumers and producers through taxes (on high-emission or unhealthy foods), subsidies (on low-emission and healthy foods), adequate food labeling and certification, and compensatory schemes for producers to overcome the cost of switching to sustainable practices or to low-income consumers facing greater difficulties to access nutrient-rich foods. A good starting point will be to rethink current agricultural support policies and assess the potential for repurposing resources for more R&D and incentive schemes that would promote food security and healthy diets through sustainable production. We now turn to this question.

3.4 MOI 2A – Repurposing agricultural support measures for food security and food system sustainability

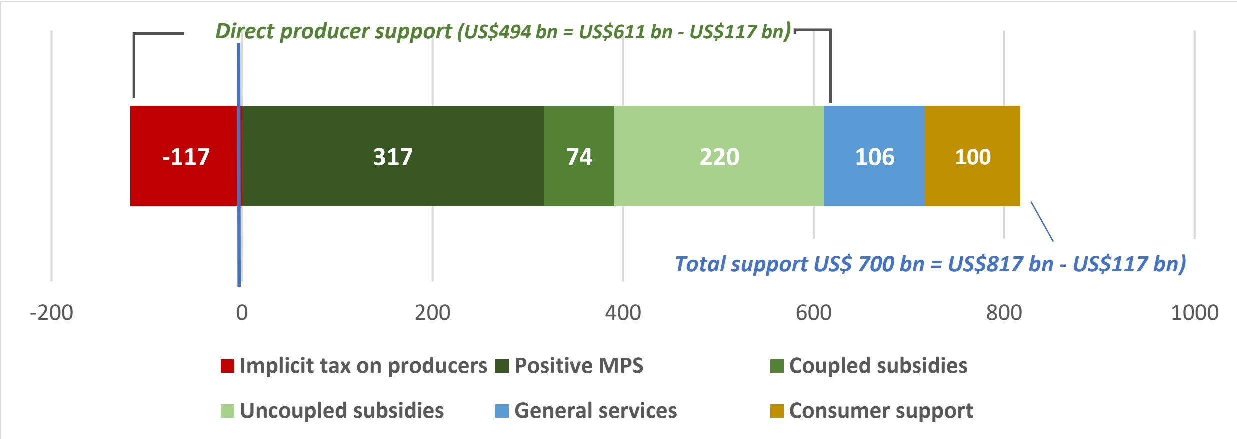
MOI 2A calls not only for more investment in R&D, but also for enhanced international cooperation, investments in rural infrastructure, and plant and livestock gene banks. The discussion in the previous section made clear that without supportive incentive structures, adoption of improved technologies and practices may be limited.

This highlights the importance of reviewing the existing policy environments for agriculture and food systems. Currently, governments spend over US$800 billion per year on agricultural support measures. Clearly, given the signaled challenges to and shortcomings of food systems around the world, this support is not well aligned with the outcomes desired by SDG 2. Hence, enormous potential should exist for redirecting ("repurposing" of) this vast public support. Recent studies by IFPRI and partners have shown how this potential could be tapped (Laborde et al. 2021; Gautam et al. 2022; Vos, Martin, and Resnick 2022; Glauber and Laborde 2023). Some key findings are summarized below.

3.4.1 *Current agricultural support amounts to over US$ 800 billion per year*

Current agricultural support goes largely to agricultural producers, primarily in forms that affect market prices and distort incentives for producers and consumers. Agricultural support (provided by 54 countries for which comparable data are available) amounted to US$817 billion per year in 2019–2021 (OECD 2022). Individual producers received US$611 billion per year in positive support (that is, support excluding taxes on exports), representing 17 percent of gross farm receipts in Organisation for Economic Co-operation and Development (OECD) countries and 13 percent in the 11 emerging economies for which data are available. Of this support to producers, more than one-half, or US$317 billion per year, took the form of support through higher market prices paid by consumers ("market price support" or MPS), while the remaining US$293 billion was paid by taxpayers through farm payments (Figure 13), of which US$74 billion was subsidies coupled to output levels or input use and US$200 billion in decoupled payments to farmers. Direct subsidies to consumers totaled US$100 billion per year during 2019–2021 and US$106 billion was for "general services," which include expenditures on agricultural R&D, rural infrastructure, and extension services.

Figure 13: Agricultural producer support by main types of support, 2019–2021 (billions of US$ per year)



Source: Compiled from data from OECD (2022).

Not all of this support comprises the use of government budget resources. The market price support (MPS) involves implicit transfers from consumers to producers by creating a price gap between domestic market prices and border prices for specific agricultural commodities. Border measures include tariffs, tariff rate quotas, or import licenses that raise domestic prices, benefiting the farm sector. Some emerging and developing countries—including Argentina, India, Indonesia, Kazakhstan, Russia, and Vietnam—implicitly tax producers of certain agricultural commodities through export taxes or export restrictions, depressing their domestic prices. This "negative" market price support amounted to US$117 billion per year over 2019–2021 (Figure 13), but rose significantly in 2022, as many countries responded with such measures to the global food, feed, and fertilizer market impacts of the war in Ukraine.

Support measures requiring fiscal expenditures amounted to US$500 billion per year in 2019–2021. As mentioned above, these include direct transfers to producers in the form of coupled and decoupled farm payments amounting to US$293 billion per year, consumer subsidies (US$100 billion), and general services support (US$106 billion). Thus, a limited portion of total support (about 12 percent) is for R&D and agricultural innovation systems, infrastructure, and other general services for the sector, with only 4 percent of total support allocated specifically to R&D in 2019–2021.

In absolute terms, agricultural support is concentrated in a few large economies. The European Union (EU) and the United States (US), both large agricultural producers, jointly account for two-thirds of the total support provided by rich countries, amounting to around US$230 billion per year, by far most of which is in the form of direct farm payments. Support in the non-OECD developing countries increased to US$360 billion per year in 2019–2021, of which China alone provided about US$280 billion per year, mostly in the form of market price support to farmers. Other non-OECD developing countries provide most support in the form of coupled direct payments to farmers and general services. For this group as whole, MPS is negative, meaning a net tax on producers, mainly due to negative MPS.

Countries' support has a long history and has been grounded foremost in perceived needs to promote agricultural productivity, protect farm incomes, and/or ensure adequate and accessible food availability. In many instances, support measures have proven instrumental toward achieving these objectives. At the same time, they have provided incentives for modern farming systems that are a major cause of global GHG emissions and excessive pressure on land, water, and other natural resource systems.

3.4.2 *Current support is market distorting and promoting unsustainable food production suggesting high potential repurposing*

Few existing agricultural support measures were explicitly designed to meet environmental objectives, such as the reduction of GHG emissions from agriculture. In fact, some countries allocate much of their support to emission-intensive agricultural products like rice, beef, and dairy, unintentionally contributing to higher GHG emissions.

It would therefore be logical, although perhaps naïve, to ask the question, "Would the world be environmentally better off by doing away with all agricultural support?" The short answer is, probably not. Despite its significant influence over time, recent global model-based analysis points to two important insights (Gautam et al. 2022).

Since we are interested in substantial global impacts, the scenarios assume internationally concerted strategies in which all countries agree to conduct the same type of policy reform.[4]

Figure 14 summarizes the global impacts of four key agricultural policy reform scenarios:

(i) Abolishing all existing support (both domestic farm support and trade barriers to agrifood products).

(ii) Converting market-distorting reforms (output and input subsidies) to direct farm payments, conditional on farmers switching to at least 25 percent organic farming practices (no use of inorganic fertilizers and pesticides), mimicking an element of the EU's reformed Common Agricultural Policy (CAP) (EC 2022a, 2022b).

(iii) Shifting part of existing support to increase investments (by 1 percent of agricultural output value) in R&D for technologies and practices that both increase the efficiency of production and reduce emission intensities, complemented by incentives to farmers for the adoption of these "green innovations".

(iv) Shifting support for consumer price subsidies on products that are part of nationally defined healthy diets, in which nutrient-dense foods are subsidized at 10 times the average for all food items, and carbohydrate-rich and low-nutrient foods at one-half the average.

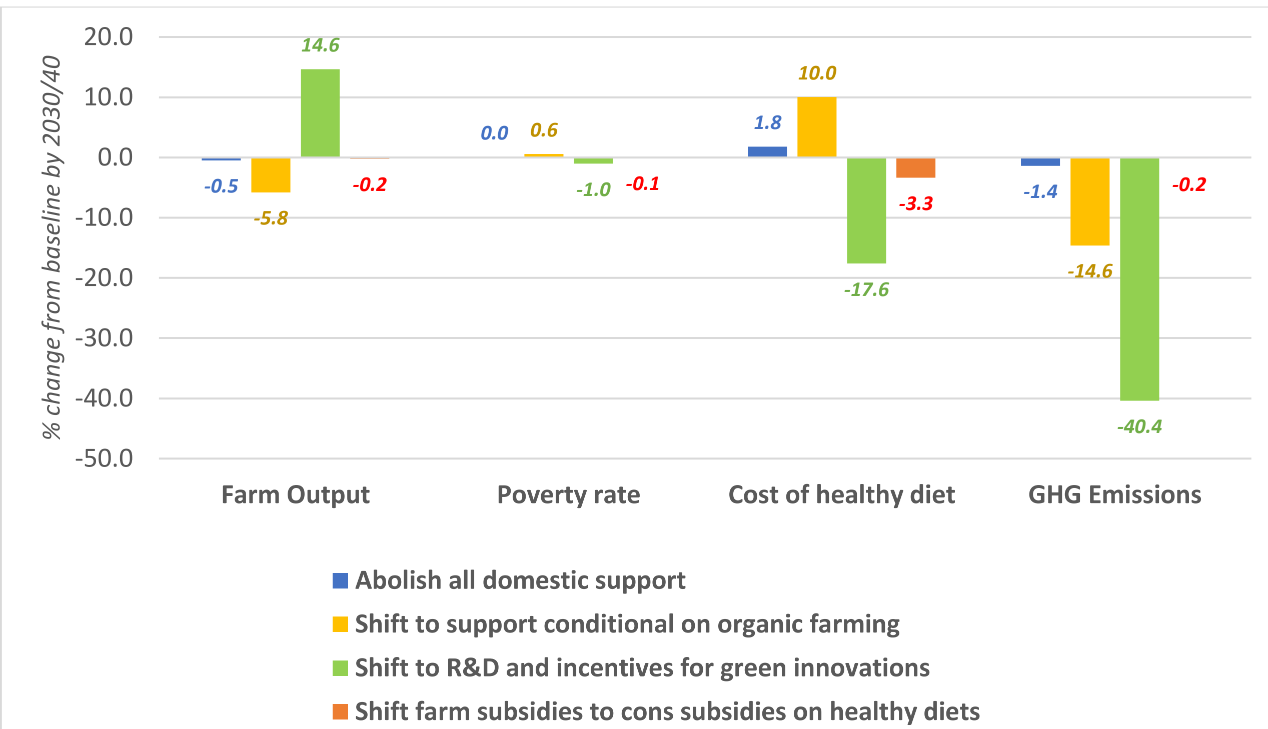
[4] However, see Gautam et al. (2022) for global outcomes of scenarios that assume countries conduct reforms individually. Of course, such scenarios have much smaller, if any, global impacts.

(i) Abolishing all existing support

The first scenario could also be seen as a counterfactual for the impacts of existing support. Simple removal of domestic producer support would involve important trade-offs. Just removing all domestic support would have small but favorable impacts on the climate and on nature by reducing agricultural GHG emissions by the equivalent of about 103 megatons of CO_2 (CO_2eq), or 1.5 percent of the total baseline level of agricultural emissions. It would reduce the territorial footprint of agriculture, saving 27 million hectares, or about 49 percent of the projected conversion of land to agriculture. However, these environmental gains are far short of what is needed to appreciably curb agriculture's contribution to climate change. Moreover, the economic outcomes would be mixed. On one hand, removing distortionary domestic support would generate some efficiency gains, reflected in a small increase in real world income (0.05 percent) per year relative to the baseline projections for 2040. On the other hand, major political economy issues would likely emerge, as farm output and real farm income per worker would decline, reinforcing policymakers' concerns about food security and farmers' welfare.

Figure 14: Global implications of repurposing agricultural support

(% change relative to baseline projections for 2040[a])



Source: Gautam et al. (2022) and Glauber and Laborde (2023).

Note: [a] Results for the policy scenario are reported as a percentage change from the baseline scenario in 2040 for all indicators, except for the poverty rate, which shows changes in percentage points from the baseline in 2040. The fourth scenario for repurposing the existing support toward consumer subsidies (red bars) shows changes relative to the baseline for 2030.

Economic income gains would be slightly larger when both trade barriers and domestic support are reduced (an increase of 0.09 percent from baseline values in 2040) and global poverty would fall slightly. With a more muted decline in global agricultural output as compared to removing only direct support, however, this more comprehensive reform would limit the reduction in global GHG emissions induced by the removal of domestic support to about 39 megatons of CO_2eq, or 0.55 percent of total agricultural emissions in the baseline. This muted impact is explained in part by the effect of removing protection on food prices, which would fall in protecting countries, thereby increasing global demand for food, and offsetting some of the decline in global production from the removal of domestic support.

Clearly, current farm support regimes were not designed to reduce poverty or to improve diets, but their abolition would likely increase food prices, contributing to more poverty (albeit marginally) and raising the cost of healthy diets**.**

(ii) Repurposing toward direct payments to farmers conditional on switching to organic farming

Making support "conditional" on reducing emissions would be positive for planetary health but could entail trade-offs for people and economic prosperity. Promotion of production methods and practices that improve environmental outcomes could potentially deliver important reductions in GHG emissions but might also come with economic and social costs, as current organic farming practices would imply a loss of productivity. Drawing on the literature on emission reductions and cost increases associated with existing policy proposals for this type of conditionality, an illustrative simulation makes farm support conditional on production techniques that reduce emission intensities by 10 percent, while raising costs by the same amount (Seufert, Ramankutty, and Foley 2012; Smith et al. 2019). As a result, while global GHG emissions from agricultural production drop in this scenario by 19 percent (through the reduction in emission intensity and a decline in global output), this gain would be offset by increases in emissions from increased land use change (lower food supply would induce use of additional land for agriculture). The net reduction in emissions from agriculture and land use change would be 15 percent. This environmental gain would come at the cost of a 0.8 percent decline in global income, and a drop of more than 5 percent in agricultural production, while both global poverty and the cost of a healthy diet would increase. Additionally, biodiversity losses would be incurred with the loss of forest habitat associated with the expected land use change.

(iii) Repurposing toward R&D for green innovations and incentives for adoption by farmers

The results of this global agricultural policy reform scenario are more promising. This repurposing option—which would redirect a part of domestic support toward targeted investments in technologies that are both productivity-enhancing and emissions-reducing—appears to hold the potential to deliver "triple wins" for a healthy planet, economy, and people. The scenario assumes that some of the domestic support is redirected toward R&D and incentives for the development and adoption of green innovations, specifically, technologies and practices that would reduce emissions while increasing productivity. Some such innovations already exist or are emerging. Based on an examination of the literature on the potential of recent innovations to raise productivity and reduce agricultural emissions (Laborde et al. 2021), this illustrative scenario assumes a 30 percent increase in production and a 30 percent reduction in emissions per unit of output. The literature on past agricultural productivity growth suggests that the cost of raising agricultural productivity by 30 percent on a sustainable basis would be roughly equivalent to 1 percent of the value of farm output. The scenario considers repurposing the equivalent of 1 percent of the value of farm output from the current domestic support for agriculture to invest in R&D, under the assumption that with reoriented R&D priorities, this level of research intensity would also apply to the generation of green innovations. The remaining domestic support would amount to a saving for taxpayers and would be potentially available to deliver as nondistorting transfers to producers and other stakeholders to compensate them for any losses they might incur due to this reform, and for spending on extension services, rural infrastructure, and other essential public goods and services fostering agricultural and rural development.

With the productivity shock, global welfare and food output would increase, food prices would fall, and, with it, healthy diets would become more affordable for many people. Poverty would also fall worldwide (Figure 14). Global GHG emissions from agriculture and land use change would drop by about 40 percent, both because of the direct reduction in emissions from crop production and because higher productivity reduces the need for agricultural land. Farm incomes would fall with the removal of subsidies, although returns to farm labor would rise if policy reform were combined with rural development policies to facilitate a benign movement of labor out of agriculture.

(iv) Repurposing toward fiscal subsidies on nutrient-rich foods

This scenario analysis borrows from Glauber and Laborde's (2023) background study to the 2022 report on The State of Food Security and Nutrition in the World (FAO et al. 2022). Shifting some producer support toward consumer subsidies favoring nutritious foods would significantly reduce the cost of a healthy diet (by 3.3 percent relative to the baseline), and the share of the world population able to afford a healthy diet would increase by 0.8 percentage points (or by 60–65 billion people). Poverty, food insecurity, and net global GHG emissions would decrease in this scenario, but only slightly. Glauber and Laborde (2023) show that promoting healthy diets through targeted consumer subsidies is more effective than subsidizing producers. This said, all benign impacts in this scenario are muted compared with the "green innovations" scenario. This is because subsidizing nutrient-rich foods at the consumer end by itself would not induce the kind of positive productivity shock expected from the "green innovation" strategy. Furthermore, supporting consumers while reducing producer support would affect farm incomes, including those of poor smallholder farmers, thereby mitigating the effect on reducing poverty and food insecurity. Lower producer support would induce lower agricultural production, thereby also reducing GHG emissions from agricultural production and land use change, but only by a marginal 0.2 percent from the baseline. If, instead, healthy diets were promoted through targeted producer subsidies, GHG emissions from agriculture would increase, especially in low- and middle-income countries.

In short, mere promotion of healthy diets will not make major inroads into simultaneously addressing global poverty, food insecurity and malnutrition, and the threat of climate change. Such promotion would need to go hand in hand with investing in and providing incentives for green innovations in food systems.

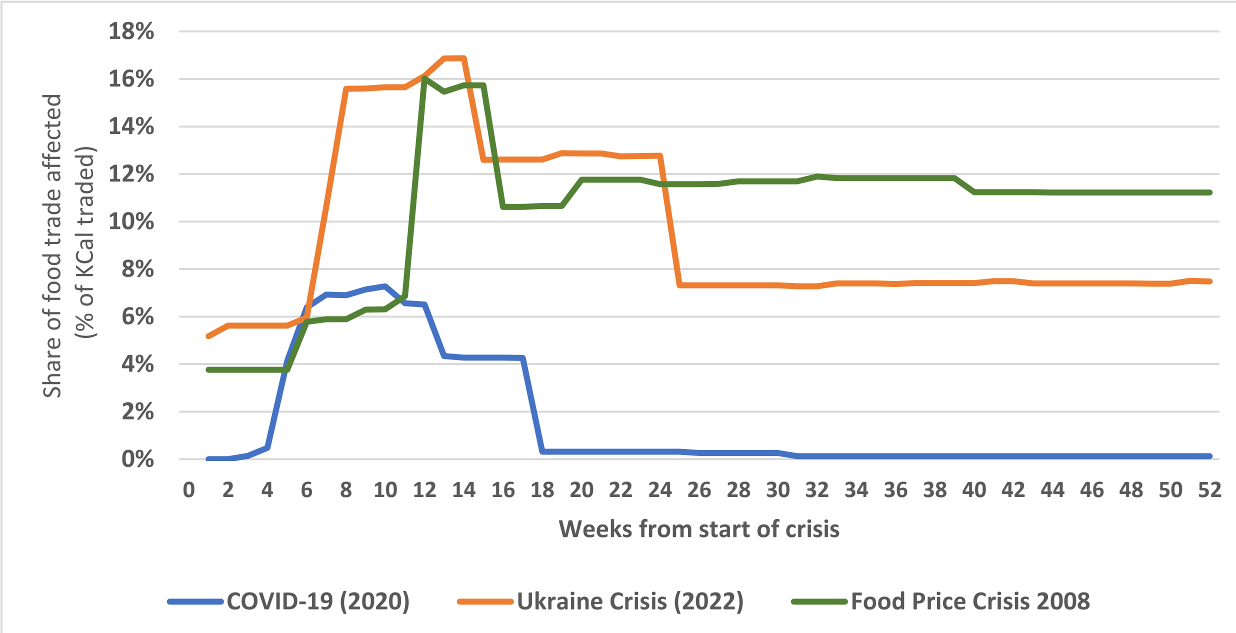
3.5 MOI 2B – Prevent trade restrictions and distortions in world agricultural markets

Trade restrictions have been a longstanding challenge in agricultural markets. Powerful interest group pressures result in high average rates of protection in many countries, and particularly in high-income countries. By contrast, food production is frequently taxed in many developing countries following consumer-oriented policies. The problem with agricultural protection is not just with the average rate of protection provided by agricultural trade policy measures such as export restrictions, import and export taxes, licensing, and quotas. Another key problem arises from variations in rates of agricultural distortions over time, which result in substantial economic costs to the countries imposing them (Francois and Martin 2004).

Much of the variation in agricultural protection rates is systematically designed to reduce the volatility of domestic prices by, for instance, lowering protection in periods of high prices. This is an understandable response given the sensitivity of policymakers to sharp changes in food prices. But the cumulative effect of these adjustments in countries' policies is to increase the volatility of world prices, creating more serious problems for those unable to shelter from these shocks, such as people in poor import-dependent countries. Another problem with current policies is that many are egregiously ineffective in reducing the volatility of domestic prices. Many reasons explain this, such as the volatility resulting from domestic output changes when trade is subject to quantitative restrictions, and lags in updating administered prices. But the end result is that domestic prices of key staple foods are barely any less volatile than world prices—even after the size of shocks to world prices of staple foods has been roughly doubled by price-insulating policies.

One of the most striking features of the recent shocks to world food markets—such as the Ukraine war, the COVID-19 crisis, and the 2008 global food price crisis—has been the widespread use of export restrictions, which dramatically increased following the onset of each of these crises (Figure 15). Each of these shocks was also associated with dramatic increases in the prices of the affected foods, particularly rice in the 2008 crisis and wheat in the Ukraine war crisis. Export restrictions reduce the supply of food to world markets just when it is most needed, magnifying the increase in world prices needed to respond to the original shock. While they may seem logical to policymakers concerned about ensuring adequate supplies of food domestically, they also have serious disadvantages for the countries imposing them. Once trade is restricted, any shock to the domestic market—such as news about a change in the likely harvest—requires a change in domestic prices unless the country is able to absorb the shock using costly changes in domestic stockholding. Domestic production is generally much more volatile than world production and the needed changes in domestic prices are typically large because the price responsiveness of demand is low.

Figure 15: Large share of global food trade (in Kcal) continues to be affected by export restrictions introduced during global food crises



Source: Food Security Portal, Food and Fertilizer Export Restrictions Tracker. For documentation of the tracker, see: Laborde and Mamun. 2022. Documentation for Food and Fertilizers Export Restriction Tracker: Tracking export policy responses affecting global food markets during crisis. Food and Fertilizer Trade Policy Tracker Working Paper 2. Washington, DC: International Food Policy Research Institute (IFPRI). https://doi.org/10.2499/p15738coll2.135857.

Note: The COVID-19 pandemic covers the one-year period from the start of lockdowns in the first week March 2020; the Ukraine crisis covers the one-year period from February 24, 2022; and the 2008 global food price crisis covers the one-year period from January 2008.

Export restrictions are not the only form of market-distorting trade policies that magnify the volatility of world prices. Many countries use changes in import barriers, such as reductions in import tariffs, in attempts to stabilize domestic prices. Prior to the Uruguay Round, the EU used a combination of variable import levies and adjustable export subsidies (known as export restitutions) to support administered domestic prices. During price surges, variable import levies reduce import barriers, stimulating demand for imports and discouraging domestic producers from responding to higher prices. Martin and Minot (2022) examine the effects of both export- and import-oriented price insulation measures on world wheat prices. They find that *price-insulating responses more than doubled the magnitude of the price increase* associated with the outbreak of the Ukraine war.

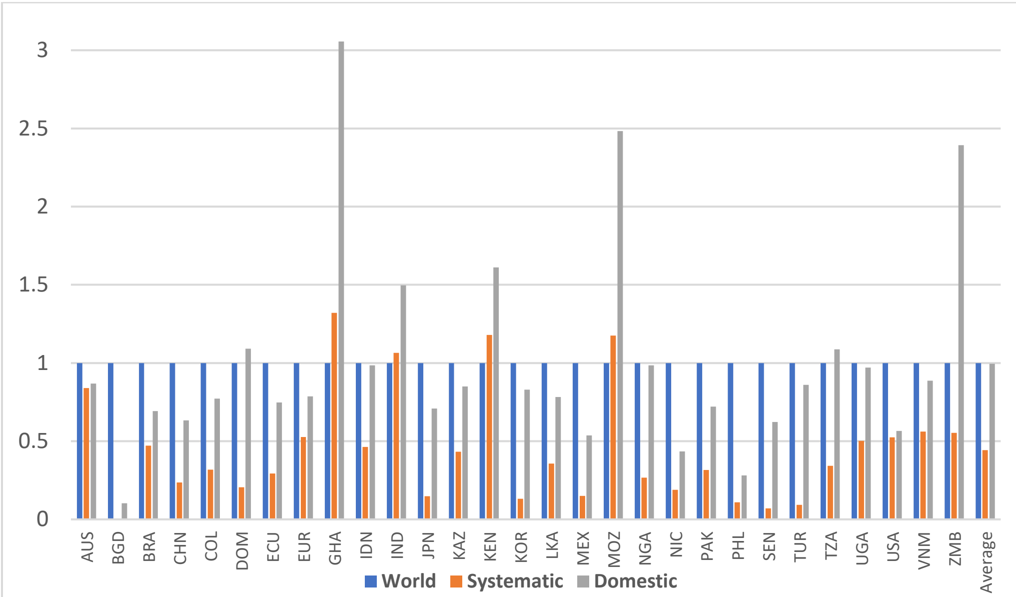
Martin, Mamun, and Minot (2023) also examine the effects of changes in world prices on domestic prices in 29 economies for which relatively long (1955 to 2021) data series for comparable domestic and world prices are available from research on the restrictiveness of agricultural trade barriers. Looking at the full range of price shocks that have occurred, they find that price-insulating behavior roughly doubled the magnitude of the changes in world prices—or, equivalently, quadrupled the variance of world prices. At the same time, they find that these policies were far less effective than might have been expected in reducing the volatility of domestic prices. The random shocks to domestic prices associated with policies such as export restrictions offset most of the stabilization that might have been anticipated. On average, these random policy shocks completely offset the stabilizing impact of the price-insulating policies. Looking at the effects in more detail at the individual country level reveals that current policies were effective in stabilizing domestic prices for some countries and commodities, and wildly unsuccessful in others.

Figure 16 shows the variances of rice prices in different countries, while Figure 17 shows the same results for wheat. The first bar for each country/region shows the variance of the external price facing that economy. This generally refers to an export price for a net exporting country and an import price for a net importer and is normalized to one for each economy to make clear the impact of policies on domestic relative to external price volatility. Because the prices used are for representative commodities, this variance would apply domestically in the absence of intervention.

The second bar—labelled “Systematic”— for each economy shows the variance that would have prevailed in that country had its policymakers followed a systematic policy rule designed to avoid both sharp changes in domestic prices and excessive deviations from their desired long run level of support to producers.. This variability is generally low in countries that insulate strongly against changes in world prices. For rice prices in economies like Bangladesh (BGD), Japan (JPN), the Philippines (PHL), and Senegal (SEN), this volatility is very low because only a very small fraction of any world price shock is transmitted into the domestic economy. For wheat, price transmission is particularly low in India (IND), Japan (JPN), Turkey (TUR), and Norway (NOR), and intermediate in economies like China (CHN), Colombia (COL), and Switzerland (CHE). The “average” bars show substantial reductions for both rice and wheat in the simple average of variability across countries.

The third bars of each threesome in Figures 16 and 17 show the actual variance of domestic prices relative to the variance of the external prices facing the country. These results take into account both the insulating effects of trade policies and the random shocks to domestic prices caused by factors such as volatility of domestic output, lags in adjustment of administered prices, discretionary changes in protection rates, and the collapse of unsustainable price support arrangements. A striking feature of the graphs is that domestic price volatility is frequently much higher than the volatility of external prices. For rice, most of the countries with extremely high price volatility are in Africa, although India also sees high domestic price volatility. For wheat, the countries with very high domestic price volatility include Bangladesh (BDG), Zambia (ZMB), and Zimbabwe (ZWE), while Brazil (BRA), Chile (CHL), Ethiopia (ETH), Korea (KOR), and Russia (RUS).

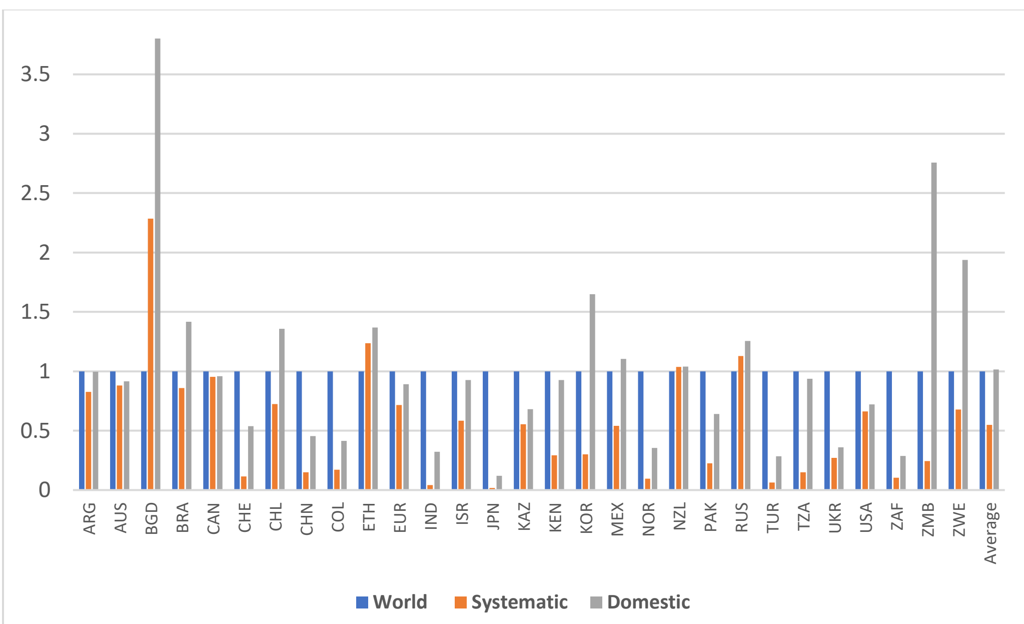
Figure 16: Variances of rice prices by economy (Index = 1 in absence of intervention)



Source: Martin, Mamun, and Minot (2023).

Note: Variances of the changes, rather than levels, of log prices are used because the level series are nonstationary, with their means and variances changing over time. Averages are simple averages across countries.

Figure 17: Variances of wheat prices by economy (Index = 1 in the absence of intervention)



Source: Martin, Mamun, and Minot (2023).

Note: Variances of the changes, rather than levels, of log prices are used because the level series are nonstationary, with their means and variances changing over time. Averages are simple averages across countries.

The data presented in Figures 16 and 17 suggest a strong case for reform of policies at both national and global level. While the strong price insulation evident in the "Systematic" policy bars reduces the volatility of domestic prices relative to world prices, this insulation magnifies the volatility of world prices by, for instance, reducing supplies to world markets and/or by increasing demand for food at times of high world prices. The analysis suggests that these policy responses roughly double the size of shocks to world market prices—or quadruple their variances. The much higher volatility of domestic prices than implied by the extent of price insulation means that, for many countries, current policies destabilize domestic prices even relative to the world prices whose volatility has been exacerbated by price insulation.

Reforms of global trade rules to reduce the adverse externalities imposed on other countries by the magnification of world price volatility. The Uruguay Round reforms were critically important by ruling out the type of variable levy formerly used by the European Community. In previous price spikes, the major industrialized countries sharply reduced protection and added fuel to the fire of world price rises (Anderson and Nelgen 2012). Unfortunately, the Doha Agenda, which was intended to strengthen the disciplines on agricultural trade rules inherited from the Uruguay Round, has failed. However, some modest progress has been made, with the World Trade Organization (WTO) agreement to exempt food aid shipments from food export bans (WTO 2022) and the agreement to abolish all agricultural export subsidies (WTO 2015). Calls from G20 Ministers to refrain from use of export restrictions may have had some favorable impact during the COVID-19 period. Clearly, however, more systematic reform of rules is needed to reduce the magnification of price shocks on world markets and their adverse impacts on poor, vulnerable participants in world trading systems. Such reform will be much easier if countries have already reformed their domestic policies to reduce the unnecessary domestic shocks to which their producers and consumers are currently exposed.

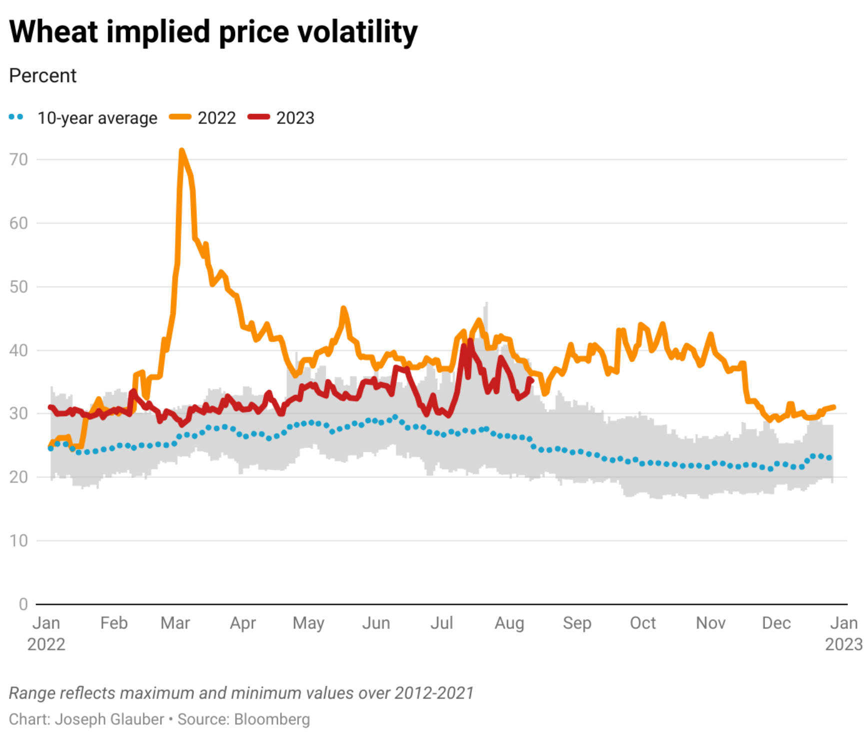
MOI 2C – Limit food price volatility through proper functioning of food commodity markets, facilitate timely access to market information, including on food reserves

A certain degree of price volatility is normal in food markets. As new information about production and demand for food becomes available, prices need to adjust to balance supply and demand for food. However, many factors can cause price volatility to become excessive and so compromise the role of market prices in allocating resources and real income. Some key influences on price volatility include the role of trade policies, as discussed in the previous subsection, as well as the role of stockholding and of market information.

A key outcome of the 2008 food price crisis was a realization that information about key aspects of agricultural markets was inadequate and that this contributed to excessive food price volatility. The G-20 leaders' summit in 2011 decided to develop an Agricultural Market Information System (AMIS) that would help generate more information about markets and make it publicly available. This brings together representatives of major producing and consuming countries to assemble technical information and to promote discussion of major market developments. Its combination of technical analysis and engagement with policy makers appears to have helped promote stability in world markets (FAO 2024).

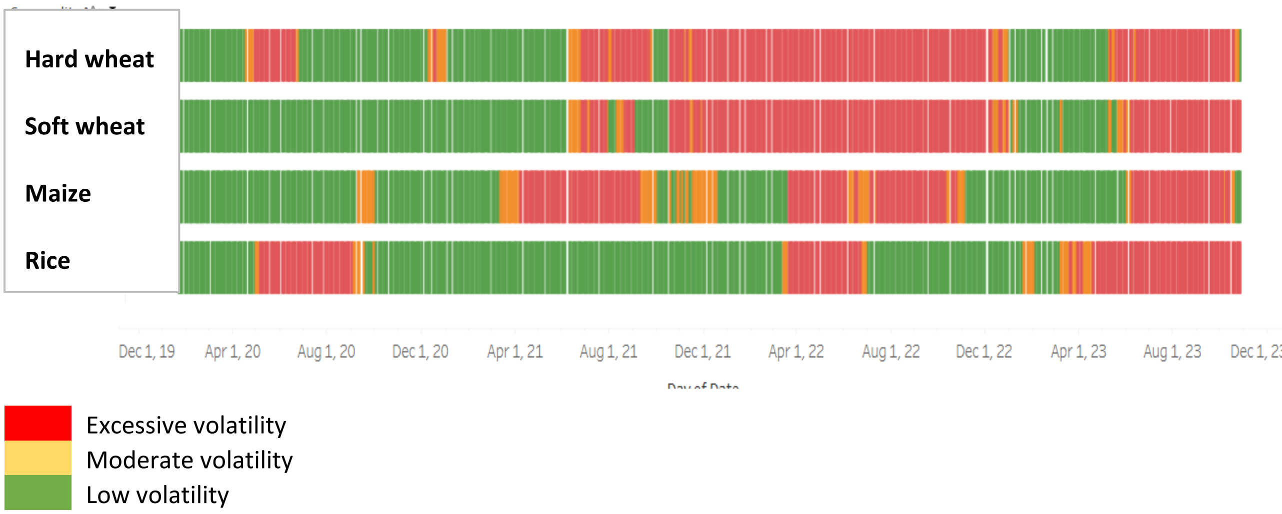
The outbreak of the war in Ukraine, a major grains exporter, was a major shock to world markets in 2022. It induced well-above-“normal” volatility in wheat prices during 2022 and 2023 (Figure 18). According to IFPRI’s Food Security Portal daily food price variability index, both international wheat and maize prices suffered “excessive” price volatility during most of 2021, 2022, and 2023, as global supplies initially tightened because of the war but subsequently exacerbated by spells of both climatic shocks and export restrictions by major producing countries. Rice markets, in turn, were relatively calm during 2021 and 2022, except for an episode of export restrictions imposed by several major rice-producing countries during the first months of the COVID-19 lockdowns. During 2023, however, rice markets showed greater volatility as markets tightened and uncertainty heightened, with weather shocks affecting several producing countries as well as export restrictions imposed by major producers, India in particular (Glauber and Mamun 2023).

Figure 18: Implied volatility of international wheat prices during the Ukraine war (2022–2023)



Source: Glauber (2023).

Figure 19: Volatility in international staple food prices (Dec. 2019–Nov. 2023)



Source: Food Security Portal, Excessive Food Price Variability Early Warning System. https://www.foodsecurityportal.org/tools/excessive-food-price-variability-early-warning-system (follow link for an explanation of the underlying methodology and for daily updates).

Stocks of storable food commodities (that is, food reserves) can play an extremely important role in mitigating price volatility. Without storage, the prices of food products would likely be even more volatile, particularly in the absence of trade or in the context of export restrictions. Output of many staple foods in an individual country—particularly when they are produced under rainfed conditions—tends to be highly volatile. The volatility of world output is typically much lower because of diversification across regions, making trade a potent force for price stability. Even with trade, however, the prices of staple foods would be very high because the elasticities of supply and demand tend to be very low. In this situation, even small shocks to supply can translate into large shocks to prices. The ability to store food helps mitigate this volatility because the elasticity of demand for stocks is much higher than the elasticity of demand for consumption. If there is a positive shock to output, stockholders are likely to increase their demand for storage, hoping to carry stocks into the next marketing year when prices will rise nearer to normal levels. If there is a negative shock to output and stocks are sufficient, this shock can be accommodated without a large increase in prices. The key problem arises when stocks are not sufficient to accommodate a negative shock to availability. In this situation, prices may rise dramatically. This results in a pattern of commodity prices characterized by long periods in the doldrums, punctuated by short but intense price spikes (Deaton and Laroque 1992).

Helpman and Razin (1978) show that the case for volatility-mitigating price policy interventions can be made when markets are “incomplete”; that is, when not all commodities are available to be traded. Under such conditions, Gouel and Jean (2013) analyze the optimal combination of trade and storage policies for small, open economies. They find a case for interventions to subsidize storage and, from the viewpoint of individual countries, a case for partial insulation from changes in world prices. However, as analyzed in the previous subsection when taking account of the magnification effect of such price insulation on world prices, such individual country action is at risk of being of the "beggar-thy-neighbor" kind, such that trade and storage policies would require international coordination to avoid adverse spillovers.

The volatility of prices will almost certainly be higher when stock levels are low and the option of drawing down stocks in response to adverse supply shocks is not available. One important challenge in world markets is knowing the level of stocks. Glauber (2023) examines the challenges involved in identifying the level of stocks—including differences in accessibility—with public stocks typically less accessible to markets than private stocks; variations in quality; and simple differences in obtaining information about stock levels. Glauber concludes that the G20's Agricultural Market Information System[5] has improved information on stocks and other dimensions of market performance, but the task of having good information on stocks remains challenging.

Many have argued that another cause of price volatility is speculation in commodity markets and particularly financial investment in commodity futures. Baffes and Haniotis (2010) identified this as one of the potential causes of the 2007–2008 surge in food and energy prices. More detailed subsequent modelling has tended to cast doubt on the importance of this explanation (Irwin and Sanders 2011). This explanation played very little role in discussions of the 2020 and 2022 food price spikes.

Staple food price volatility was extraordinarily high between March and May of 2022 and remains well above the 10-year trend. What might cause such high volatility? Clearly, during the early months following Russia's invasion of Ukraine, a great deal of uncertainty arose about the extent of shocks to world food markets. Would Ukrainian exports of wheat and maize continue? Would sanctions cut off Russia's much larger exports from the Black Sea region? What might be the impact of high fertilizer prices on production? The effects of these primary shocks on world prices were magnified by the price insulation policy decisions of major traders (Martin, Mamun, and Minot 2023). Uncertainty about stock levels, and the availability of those stocks to world markets, further contributed to price volatility. As the uncertainty about access of Black Sea basin exports to markets declined, the implied volatility of world prices declined to more normal levels which, it should be remembered, include the magnification effect of countries' price-insulating policy responses.

Reforms to WTO rules could potentially help reduce the volatility associated with trade measures that magnify the volatility of world prices. Important progress was made in the Uruguay Round to outlaw measures such as the variable levies used under the original European CAP. But policies such as export restrictions and tariff reductions in periods of high prices are still widely used. The extended debate on public stockholding at the WTO has yielded little by way of reform. Oddly, this debate has ignored a key feature of current WTO rules—that purchases of food for domestic food aid or for food security stocks are exempt from disciplines as long as purchases are made at market rather than administered prices (WTO 2002, p. 49). These rules were designed in part to raise the cost of using administered domestic prices, since such prices can only be sustained

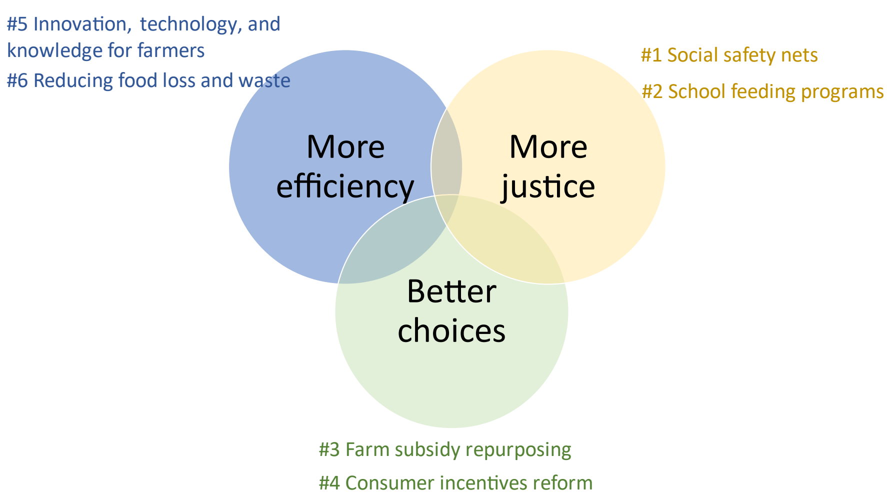
[5] See https://www.amis-outlook.org/amis-about/en/

in any but the shortest run by using price-insulating trade barriers that destabilize world markets. Countries can avoid any constraints on purchasing for domestic food aid or for food security stockholding simply by purchasing their needs at market prices.

3.6 Beyond the SDGs: Promises and commitments of the UN Food System Summit 2021

The 2021 UNFSS reconfirmed the food-related SDG goals through multistakeholder consensus. Since the UNFSS had no outcome document, the Summit did not solicit new formal commitments. However, the UNFSS did lead to the creation of so-called coalitions behind six areas defined as game-changing actions: social safety nets, school feeding programs, repurposing of farm subsidies to incentivize the production of nutritious and low-emission foods; consumer taxes and subsidies to promote purchases of healthy foods; R&D and incentives for adoption of green innovations; and reduction of FLW. These action programs aim to: bring more justice to food systems through improving food security and reducing poverty, influence both producers and consumers to make better choices for healthy and sustainable diets; and improve food system efficiency by reducing FLW and enhancing productivity through green innovations (Figure 20).

Figure 20: UNFSS's game-changing action agenda and coalitions



Source: Adapted from Laborde and Torero (2023).

Using IFPRI's MIRAGRODEP model also deployed for the scenario analysis presented in section 3.5, Laborde and Torero (2023) simulated the potential impacts on food system transformation of each of these game changers, as well as their combined effects. Their model simulations suggest that widespread implementation of these programs would generate important gains toward meeting SDG targets. At the same time, these programs could also generate significant tradeoffs, between, for instance, progress toward food security and nutrition goals and gains in reducing GHG emissions.

Specifically, the scenarios involve the following assumed program characteristics:

- *#1 Social safety nets*: Food stamps or income transfers to be spent on food are provided to all poor, with the average size of the transfer enough to eliminate the gap between the per capita income of poor households and the basic cost of a healthy diet.
- *#2 School feeding programs:* All children between 6 and 11 years old are given access to school feeding programs for 200 days per year.[6]
- *#3 Repurposing of farm subsidies for nutritious and low-emission foods:* All farm subsidies (outputs, inputs, others) are reallocated for direct payment to farmers proportional to farm revenue. The rate of support is computed endogenously to maintain farm subsidy budgets constant, but favors farmers producing nutritious and low-emissions products, which are subsidized at twice the average rate, while farmers producing foods with low nutrient content and high emission intensity are subsidized at one-half the average rate.
- *#4 Consumer incentive reforms:* These consider disincentives for excessive meat consumption by taxing red meat products in high- and upper middle-income countries.[7]
- *#5 Innovation, technology, and knowledge for farmers:* This is assumed to comprise three components: (a) expansion and improvements of irrigation systems differentiated by needs across regions; (b) improved livestock breeding and better practices for higher productivity and lower emissions per unit of output; and (c) extension services and farmer training to adopt improved practices and increase farm productivity.
- *#6 Reducing food loss and waste (FLW*): This program targets a reduction by 25 percent in all countries through investing in improved handling of produce on and off the farm up to the retail level.

The key findings of the scenario analysis for these proposed game-changing actions with the given assumptions indicate that (Figures 21a–b):

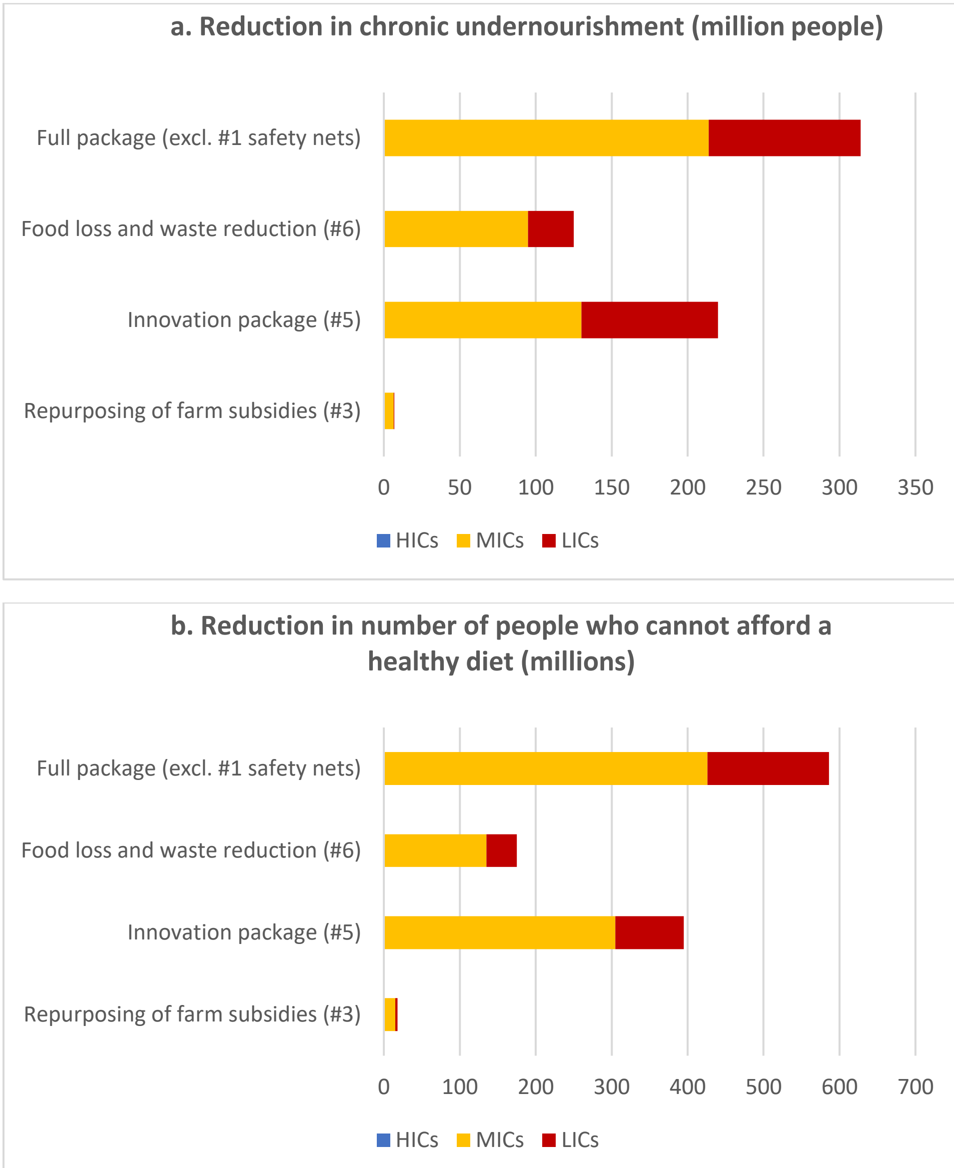
- All actions (except reshuffling farm subsidies across crops) would substantially reduce hunger and improve access to healthy diets, but none by themselves suffice to achieve SDG 2 (see Figures 21a–b, showing the findings for actions #1, 3, 5, and 6 only for presentational purposes). While no intervention alone, at a realistic scale, could solve the problem, key structural interventions to increase the efficiency of agrifood systems through increased farm productivity and a reduction of FLW will reduce the number of people in chronic hunger by 314 million in 2030 (Figure 21a). Beyond hunger, 568 million people will be able to afford healthy diets (Figure 21b). To target the remaining population, safety nets and well-targeted programs, such as school feeding interventions, will be required. When adding such safety

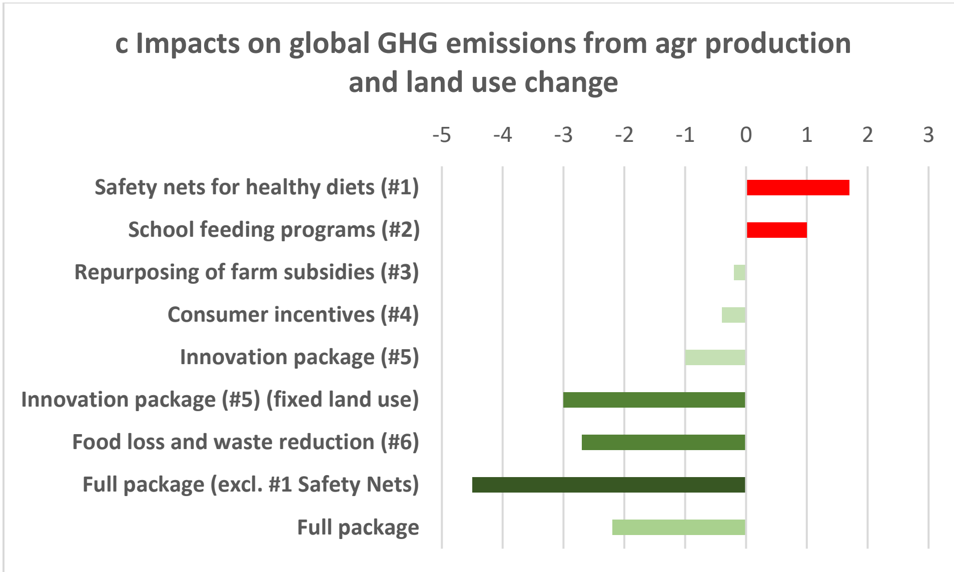
[6] The daily per capita ration includes 320 grams (g) of fruits, 102 g of grains, 51 g of animal proteins (meat, fish, eggs), 480 g of milk, and 100 g of vegetables.

[7] The level of tax is computed by the model to obtain a reduction of consumption of 15 percent in high- and upper-middle-income countries (HIC and UMIC in Europe), and 7.5 percent in other UMIC (except those in Africa).

nets into the model by designing them endogenously to leave no one behind, it is possible to cover the 2.4 billion remaining people who currently cannot afford the cost of a healthy diet.

Figure 21: UNFSS's game-changing actions: Impacts on undernourishment and access to healthy diets (changes from baseline in 2030; millions of people)





Source: Laborde and Torero (2023).

Note: HIC = high-income countries; MIC = middle-income countries; LIC = low-income countries

- Efforts targeting food security goals may entail trade-offs with environmental sustainability goals. Social protection programs (#1 and #2) would increase demand and, hence, production, emissions, and use of natural resources would increase (all else equal). Reducing FLW (#6) and green innovations (#5) would substantially improve food security while significantly reducing emissions and pressure on natural resources. Implementing the full package would have the biggest wins for both people and the planet, although as indicated, increased food demand induced by the social protection component would offset some of the environmental gains through increased emissions and resource use.

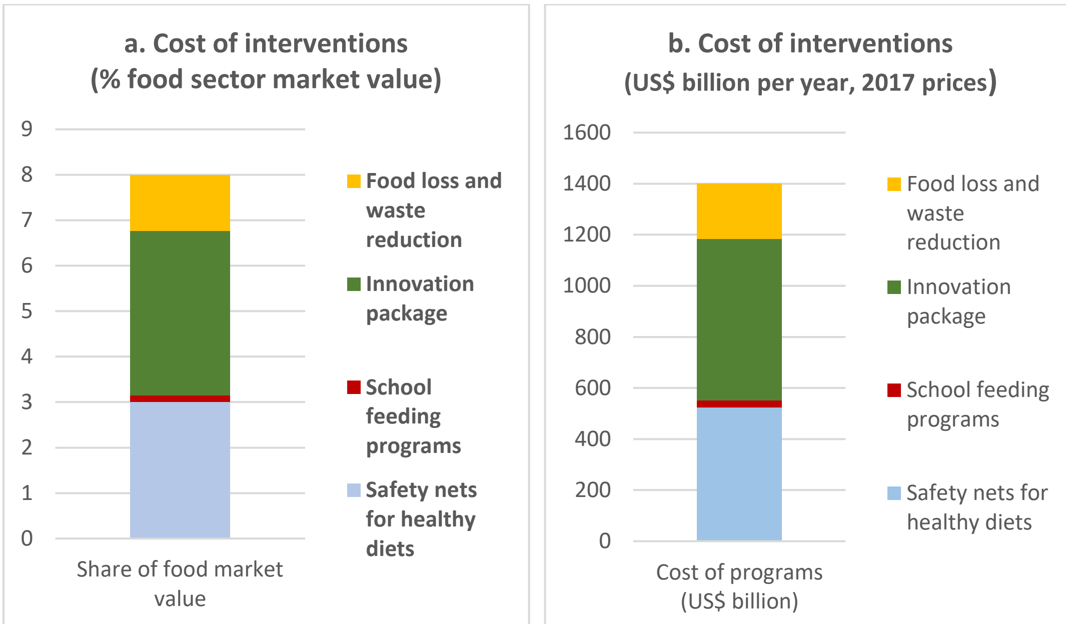
The study by Laborde and Torero (2023) suggests that ending hunger requires mobilization of significant resources, but that the global cost is manageable, representing an estimated 8 percent of the size of food markets, equal to US$1.4 trillion at 2017 prices. Figure 22 provides the decomposition of this total cost for the six action areas (both as a share of the value of food markets in 2017, left panel, and in 2017 US$, right panel).

- The actions referred to as "better choices" in Figure 20 (that is, consumer incentives and the repurposing of farm subsidies) do not add to costs because they are designed to be budget neutral to governments. The incremental cost would come mainly (45 percent) from the combined large structural investment in physical, human, and knowledge capital of the innovation package and social safety nets (36 percent of total cost).

The findings from this analysis are congruent with those of the repurposing scenarios discussed in section 3.4 They highlight the need for policies that stimulate investments in green innovations and related payment schemes for ecosystem services (or incentives to adopt those innovations). Jointly, countries would have to redistribute US$1.4 trillion annually to fill the income gap of the 3 billion people who cannot afford healthy diets. However, as estimated by Laborde and Torero

(2023), the synergies between the interventions can lower this cost to US$428 billion globally in 2030. A coherent program that bundles all interventions would also help address the environmental trade-offs associated with some of the interventions.

Figure 22: Impacts on food system outcomes of UNFSS's game-changing actions



Source: MIRAGRODEP model simulations as presented in Laborde and Torero (2023).

4. Conclusions

Sadly, progress toward reducing global hunger has stalled since adoption of the 2030 Agenda for Sustainable Development. The setting of ambitious goals and targets, of course, cannot be blamed for the reversal in human progress. However, having the 2030 Agenda in place clearly was no guarantee to prevent continued and intensifying conflict in many parts of the world, a main driver of the rise in global hunger since 2015. The 2030 Agenda also did not promulgate substantial progress in making food systems more resilient to the impacts of climate change or to the disruptive impacts on livelihoods and food supply chains of other global crises, such as the COVID-19 pandemic and the war in Ukraine. These crises only upped the challenges food systems already face, including the slowing of productivity growth, the persistence of inefficiencies as evidenced by substantial FLW, the economic inequities that hamper adequate access to food for hundreds of millions, and the continuation of market incentives that are biased against the adoption of sustainable practices in food production and of healthy dietary choices by consumers.

At the same time, this paper highlights the enormous innovative capacity of food systems, which has underpinned sustained productivity growth for many decades. To meet tomorrow's challenges, however, accelerated technological progress is needed to establish climate-resilient and environmentally sustainable agrifood value chains and to ensure adequate and stable delivery of food while making healthy diets affordable for all. Behaviors of market actors (producers and consumers alike) will need to change accordingly.

The 2030 Agenda and the related SDGs do recognize these challenges, as well as the potential for sustainable food system change. The "means of implementation," defined as part of the same Agenda, could leverage this potential, but too little concerted effort has been made to: increase investment in R&D for sustainable technologies and incentives for their adoption (MOI 2A); facilitate food trade rather than hampering it (MOI 2B); and reduce food market volatility (MOI 2C). At the 2021 UNFSS, more comprehensive actions—when enacted upon in a coherent and internationally concerted manner—have been shown to hold substantial potential to accelerate food system transformation with major gains for people, the planet, and prosperity.

The SDGs and the UNFSS reflect moments of strong political will by the global community to effectuate such change, but neither have led to commensurately strong formal commitment to undertake the necessary actions. Our review of evidence suggests that it is not too late to accelerate progress and achieve the desired food system transformation over a reasonable timespan at manageable incremental cost. Doing so will require unprecedented internationally concerted and coherent action on multiple fronts, which in today's divided world seems the biggest obstacle.

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