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**Global Food Security Impacts of Extreme Weather Events and  
Occurrence of Breadbasket Failures**

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## ABSTRACT

Agricultural yield shocks are frequently correlated across countries and much of the recent literature concludes that both the volatility of shocks and the extent of correlations across countries are likely to increase substantially with climate change. Given this background, it seems important to consider the potential impacts of large, synchronized yield shocks in both developing and developed countries. These shocks are examined using IFPRI's MIRAGRODEP model and the linked POVANA household models to assess the impacts on real incomes, food prices, poverty and food insecurity. The results of a 25% reduction in productivity in South Asia and Eastern and Southern Africa are compared with a similar productivity reduction in Europe and North America. The results make clear that the adverse impacts on global poverty and food security are much more severe when the shock originates in developing countries. The results point to a need for quite different policy responses in the case of a multiple breadbasket failure arising in the global south, rather than—like the three most recent food crises—in the global north.

**Keywords:** climate change; extreme weather; breadbasket failure; food prices; food insecurity; poverty.

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## 1. INTRODUCTION

The world has experienced three food price crises in the past two decades—the 2008 food price crisis centered on rice, the 2010-11 price crisis centered on wheat, and the 2022 food price crisis associated with the supply disruptions that had emerged during the COVID pandemic and Russia’s invasion of Ukraine. None of these global crises were driven primarily by harvest failures in developing countries. However, as noted by WFP (2025) and FSIN (2015), extreme weather is a major driver of hunger and food insecurity in Eastern and Southern Africa and other parts of the developing world. Extreme weather conditions (e.g., those associated with strong El Niño/La Niña phenomena) often affect multiple production regions at the same time, enhancing the risk of the occurrence of multiple breadbasket failures (MBBFs), and may lead to increases in world food prices. Food price crises resulting from harvest shortfalls in poor countries compound the risks of food insecurity by enhancing food access problems for low-income households worldwide and severe loss of income of farmers in affected production areas. This means that this type of food crisis may require different policy responses from those associated with the global food price crises of recent decades. A key goal of this paper is to analyze and help prepare for the inevitable future food price crises involving adverse weather events in developing countries. Currently, 80% of the world’s people rely on just three agricultural commodities as main ingredients for their food consumption: maize, wheat, and/or rice. Much of the production of these staple foods is concentrated in a small number of countries and regions, which as such can be identified as “breadbaskets”. Crop models show that the yields of these staple crops could decline significantly by the end of the century (or sooner) owing to climate change and many of these models also project substantial increases both in output volatility and in covariation across regions (Jägermeyr et al. 2021). Extreme weather events already pose an immediate threat, often affecting multiple producing areas. In 2022, for instance, half of the European continent was under official drought warnings following a summer of heatwaves, resulting in record low water levels and below-average corn and grain yields. At the same time, the United States suffered major agricultural losses caused by droughts, in some cases

forcing farmers to sell off their livestock to make up for financial losses from crop failures. Both the United States and Europe are major producers of wheat and maize. Also in 2022, a third of Pakistan was affected by devastating floods, causing a plummeting rice harvest, while India - the world's biggest rice exporter - suffered extreme temperatures and drought shrinking the country's rice farming area in that same year. These events had a major impact on global food supplies and were exacerbated by non-climate driven, geopolitical events notably Russia's invasion of Ukraine, which is one of the world's biggest producers of wheat. This substantially pushed up global food prices, increasing food insecurity risks. The early summer 2025 heatwave across a large part of Europe broke many temperature records set in 2022 and made clear that the 2022 event was not a one-off.

The impacts of these primary shocks on world markets for food and fertilizers were exacerbated by trade policy responses that sought to insulate home markets from increases in world prices. These policies of price insulation include measures such as export bans that aim to stop increases in world prices from raising domestic prices in exporting countries. Many importing countries seek to achieve the same result by reducing import barriers when prices rise, either on a discretionary basis or by automatically adjusting tariffs on imported foods to mitigate impacts on domestic consumer prices (Martin, et al. 2024). A related phenomenon arises when a country's agricultural sectors experience adverse productivity shocks. Amodio et al. (2025) find that weather-induced declines in agricultural productivity result in larger tariff cuts in trade negotiations. Bastos et al. (2024) find a similar result for applied tariffs. Hoskins (2022) concluded that a similar dynamic operates in export markets, with India introducing an export ban that lowered domestic wheat prices—but raised world prices—following a heatwave-induced slump in output.

A key ingredient in this analysis will be an assessment of past volatility in crop yields, and—based on the now-extensive literature—an estimate of likely changes in crop yield volatility and synchronicity.

Simulations of the effects of these shocks will provide layers of estimates—starting from assessments of the effects of adverse yield shocks on farmers' incomes and, subsequently, consider the effects of sustained productivity shocks on national food prices, agricultural employment, wages, output, poverty and food security. A simple framework for this analysis is provided in Appendix A.1. This shows that the

impacts of yield shocks on world markets depend on changes in volatility at regional level, changes in production shares across regions, and on correlations in yields across countries. In related work, we are examining changes in these three elements over time.

In this paper, we compare the global ramifications of two hypothetical multiple breadbasket failures caused by extreme climate events in different regions. The first assumes extreme weather shocks in Southern and Eastern Africa and South Asia. The second analyzes the ramifications of an MBBF in North America and Europe. Under both scenarios crop yields decline by 25% for all crops. We also experimented with 10% declines and found similar results for directions of change for all key outcomes, with differences essentially only in terms of magnitude. For this reason, we only discuss the findings for the case of the 25% decline in yields. This magnitude of agricultural supply shocks is in the range found in the empirical literature on breadbasket failures and especially in the literature on prospective shocks under climate change (see e.g., Gaupp et al. 2019; Hasegawa et al. 2022; and the discussion in Section 2). The literature is clear that multiple breadbasket failures caused by extreme weather shocks are more likely to occur with unabated climate change and that these will potentially pose enormous threats to global food security. The likelihood of increases in the frequency of such events is subject to some dispute. Some refer to moving from events occurring once every 100 years to once every 30 years (e.g., Challinor et al. 2015), while others predict MBBFs might occur at much higher frequency (e.g., Gaupp et al. 2019). In our scenario analysis, we further experiment with once-every-30-year events (which would be once in the simulation period from 2025-2050) and MBBFs recurring in the same regions every 4 years.

Not surprising, we find that MBBFs indeed cause substantial increases in global food insecurity and poverty, especially when they directly affect developing-country agriculture. When MBBFs of the assumed severity occur in Eastern and Southern Africa and South Asia, global food insecurity, as measured through the prevalence of undernourishment, would increase by 2 percentage points (compared with the baseline), affecting 160 million more people. In the affected regions though, food insecurity may increase by as much as between 4 and 10 percentage points, as farm households are hurt by lower incomes and other vulnerable households by starkly rising food prices. However, in regions not directly

affected by the weather extremes, agricultural production may expand (subject to available capacity) compensating for the shortfalls caused by the MBBF, allowing income improvements for farmers, and partially offsetting the poverty impacts of higher food prices in countries outside of the affected regions. MBBFs in high-income regions could generate a stronger adverse impact on global real income—and increases in world prices—given the weight of, in this case, North America and Europe in the global economy and international trade. International food prices would also rise much more sharply. Yet, we find a more muted impact on global poverty and food security, as in this scenario most developing-country regions gain from expansion of food outputs and their farmers from higher output prices. Countries in Eastern and Southern Africa, however, with limited capacity to expand production would also see poverty and food insecurity increase in this scenario, while many other LMICs may even see small decreases.

The remainder of this paper is organized as follows. Section 2 identifies what is meant by multiple breadbasket failures, reviews the evidence regarding the role of extreme weather and climate change in causing such failures and the frequency of their occurrence. Section 3 spells out the framework for analyzing the short- medium- and long-term impacts of MBBFs on global welfare, food availability and prices, food security and poverty. Section 4 describes the scenario design for the model-based analysis to assess those impacts as applied in this paper and presents the key findings of the scenario analysis. Section 5 concludes and identifies needs for further analysis, especially of policy responses to mitigate the adverse impacts of MBBFs.

## **2. EMERGING EVIDENCE ON THE IMPACTS OF CLIMATE CHANGE AND EXTREME WEATHER EVENTS AND RISK OF BREADBASKET FAILURES**

In this section, we review some of the evidence on the occurrence of extreme weather events and the risk of breadbasket failures. Most model-based assessments of the impacts of weather variability on agricultural yields and food security incorporate the effects of higher temperatures and changes in rainfall associated with global warming. These effects imply gradual changes to conditions for agricultural production. However, global warming is also considered to increase the likelihood of increased intensity and frequency of extreme weather events, which may cause big and sudden shocks to agricultural production in affected regions. When affecting major staple food production areas, such events could lead to what some observers call breadbasket failures or even multiple breadbasket failures.

In what follows we address three basic questions that should help guide the design of the global scenarios to assess the consequences of extreme weather shocks leading to bread basket failures: (i) what is a breadbasket failure; (ii) what do we now know about the likelihood of breadbasket failures to occur in the coming decades; (iii) what do we know about the (potential) impacts of breadbasket failures on global food security?

### **2.1 What is a breadbasket failure?**

A breadbasket failure (BBF) is typically defined as a significant decline in crop yields within major staple food (basic grains) production hubs, known as breadbaskets (e.g., Anderson et al. 2023). BBFs may occur at (sub-)national, regional and global levels. Considering that many of these failures are triggered by global extreme weather events (such as strong El Niño/La Niña phenomena), simultaneous crop failures across different regions are common. This compounds the impact on food security by causing simultaneous decreases in the supply of essential food crops. The concept of Multiple Breadbasket Failures (MBBF) highlights the risk of concurrent crop production losses across various regions, leading to global supply disruptions and price shocks, as discussed, for instance, in Anderson et al. (2019; 2023) and Gaupp et al. (2019).

Accordingly, for the global scenario analysis, we will focus on weather-related MBBFs defined as large-scale declines in crop yields across several major production areas. These failures are critical to global food security as they lead to a substantial reduction in the global supply of staple crops such as maize, wheat and rice. Historical data shows that such events have occurred in the past, and numerous studies emphasize the increasing risk of these events in the future due to climate change. A key question that we address is are the impacts of MBBFs occurring in developing countries with large numbers of poor and vulnerable people different from those occurring in countries with higher incomes?

## **2.2 How likely are multiple breadbasket failures (MBBFs) to occur?**

There is an emerging literature pointing examining the probability of multiple breadbasket failures and the likelihood of increasing volatility based on historical trends (see e.g., Anderson et al. 2019, 2023; Gaupp et al. 2019; Hasegawa et al 2022, Janetos et al. 2017). Based on past events and accounting for further global climate change, these studies have tried to estimate the probability of similar occurrences in the future using different methods, though many taking probabilistic climate and crop modeling approaches. In the past, weather extremes have caused MBBFs, among others in 1983, 1988, and 2003, when maize, wheat, and soybean production suffered substantial declines in several regions, strongly reducing global supplies. In 1983, for example, a strong El Niño event simultaneously affecting several breadbasket production areas, led to a 20% deficit in global maize supplies.

Gaupp et al. (2019) estimate the risk of simultaneous crop failures (multiple breadbasket failures) in major agricultural regions under 1.5°C and 2°C global warming scenarios. Using climate models from the HAPPI experiment<sup>1</sup> they examine the impacts on wheat, maize, and soybean yields across five global breadbaskets: the U.S., Argentina, Brazil, China, and India. Their results highlight the significant effect of global warming in increasing the risk of MBBF events. Specifically, for maize, the risk of multiple breadbasket failures rises from 6% under historical conditions to 54% at 2°C warming. For wheat and

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<sup>1</sup> The HAPPI project calls on climate modelling groups to undertake a simple series of experiments specifically designed to quantify the relative risks associated with 1.5°C and 2°C of warming, drawing directly on the “Climate of the 20th Century” experiments that already focus on extreme weather and the relative risks of low-probability extreme weather events.

soybeans, the risks of simultaneous failures increase by 40% and 23%, respectively. Their results further suggest that simultaneous breadbasket failures at 2°C warming could result in crop losses of up to 19.8 million tonnes of maize (or 5% of current global production of maize), 8.6 million tonnes of wheat (1% of total supply), and 9.9 million tonnes of soybeans (3% of global supply). The return period for maize crop failures across all five breadbaskets drops from 16 years to less than 2 years at 2°C warming, indicating a significant increase in the frequency of these events.

Caparas et al. (2021) considered the combined impacts of water scarcity and temperature changes due to climate change in globally important breadbaskets. Using models from the Agricultural Model Intercomparison and Improvement Project (AgMIP), they project crop failure probabilities for maize, wheat, rice, and soybeans through mid-century and highlight water scarcity challenges across breadbaskets in India, China, and the U.S. Their results suggest that by 2030, crop failure probabilities will be up to 4.5 times higher compared to the present, and by 2050, as much as 25 times higher. For example, in India, wheat failures are projected to occur every other year by 2050, primarily driven by water scarcity and climate stress. Other studies also show that the magnitude of production losses due to extreme weather events has increased over time. Lesk et al. (2016) argue that more recent droughts (1985–2007) caused 13.7% cereal production losses, compared to 6.7% losses from earlier droughts (1964–1984).

Similarly, Challinor et al. (2015) emphasize the increasing future risk of multiple breadbasket failures, driven by both the increased frequency and intensity of extreme weather events and the concentration of global food production in countries across different regions, such as the U.S., China, India, and Brazil. They estimate that a 1-in-100-year-production-loss event from the 20th century could become a 1-in-30-year event by mid-century.

Chen et al. (2024) also find that extreme climate events in breadbasket regions have become more frequent due to climate change, exposing crops to a greater frequency and intensity of abiotic stress. At the same time, however, based on observed crop yield data and using multiple statistical models, they conclude that the frequency of crop yield shocks in breadbasket regions has been decreasing over the last

six decades, due to both climate and non-climate factors. In this context, non-climate factors refer to interannual variability to factors such as biotic stress<sup>2</sup> and farm management decisions. They find that although the risk posed by extreme heat to crop yields has been increasing, this risk has been offset by changes to precipitation, extremely cold days, and average growing season temperature in most breadbaskets. As a result, total climate-related crop yield shocks have been decreasing for soybeans and wheat, while they have remained roughly constant for maize. Meanwhile, non-climate risks to crop yields have decreased in nearly every breadbasket region across crops. Because non-climate risks have decreased faster than climate risks, Chen et al. (2024) do find that the climate accounts for a greater proportion of crop yield shocks in the recent period (1991-2020) compared to an earlier period (1961-1990). Nonetheless, in line with other studies, they do conclude that extreme climate events are more important than ever to the relative stability of the food production system, even as the overall frequency of multiple breadbasket yield shocks may have decreased.

Challinor et al. (2015) outline four plausible scenarios for future production shocks, estimating global production losses of up to 10% for each major crop under severe weather events. The study's Maize Production Shock Scenario (based on the 1988 case) estimates a total global loss of 12% (56 million tonnes). While its Soybean Production Shock Scenario (based on the 1988/2009 cases) leads to a total global loss of 7% (7.2 million tonnes). The study's Wheat Production Shock Scenario (based on the 2003 case) estimates a total global loss of 6% (36.5 million tonnes) and the Rice Production Shock Scenario (based on the 2002/2003 cases) indicates a total global loss of 4% (21.7 million tonnes).

### **2.3 What do we know about the consequences of MBFFs for global food security in the short and the long run?**

Another strand of the literature focuses on the (potential) consequences of BBFs for global food security. Chatzopoulos et al. (2021), for instance, examine the growing risks of concurrent and recurrent climate extremes on the global food system using a partial-equilibrium model to predict the impacts of heat and

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<sup>2</sup> Biotic stress refers to conditions when living organisms, predominantly viruses, bacteria, fungi, nematodes, insects, arachnids, and weeds, disrupt the normal metabolism of the plants.

water stress events on crop yields, trade, prices, and food security by 2030. They highlight the increasing threats to food supply stability due to the rising frequency and intensity of extreme climatic events such as heatwaves and droughts. Their findings show that import-dependent countries are highly vulnerable to price volatility caused by concurrent climate extremes that affect major producing regions, such as the U.S., Brazil, Russia, and India. The findings suggest further that recurrent climate shocks create long-term market uncertainty, increasing the risk of persistent and “record-high” food prices.

Bren d’Amour et al. (2016) examine ‘tele-connected’ food supply shocks, where climate-induced crop failures or trade policies in major exporting countries impact food availability and prices in distant, import-dependent countries. Their results highlight the vulnerability of countries that rely heavily on food imports from a few key exporters. According to the study, regions such as Africa and Central America are particularly at risk from disruptions in wheat, maize, and rice supplies. Sub-Saharan Africa (SSA), the region with the highest poverty rates, faces the greatest impact from supply shocks, with 200 million people at risk of falling below the poverty line due to export bans imposed by one or more major producing countries. Their findings show that a 10% simultaneous reduction in global exports of wheat, maize, and rice would cause a 5% decrease in caloric intake for at least 55 million poor people. Export bans from major producers, such as Russia for wheat, the U.S. for maize, and Thailand for rice, could reduce cereal supply for up to 200 million people, with 90% of those affected living in Sub-Saharan Africa.

Verschuur et al. (2021) study a regional case of crop failure and investigate synchronous crop failures in Lesotho and South Africa during the 2007 drought, which caused severe food insecurity in Lesotho, where 20% of the population required emergency assistance. The drought led to a 40% reduction in maize production in Lesotho and two consecutive years of below-average production in South Africa. As a result, maize prices in South Africa increased by 41% compared to 2006, making basic food unaffordable for many households in Lesotho. The combined effect of production losses and rising prices pushed many small-scale farmers from being net sellers to net buyers of maize, increasing their vulnerability. The study emphasizes the role of climate change, estimating that it increases the likelihood of a similar drought by a

factor of 5.36 in Lesotho and 4.70 in South Africa, with the risk of a synchronous drought event between the two countries rising by a factor of 2.14. Koo et al. (2021) examine the 2015-16 El Niño event in Southern Africa, where fears of a harvest failure caused Zambian policy makers to ban maize exports, compounding the losses to many poor net-selling farmers and increasing poverty incidence.

Janetos et al. (2017) highlight the growing risks of MBBFs driven by climate change and compounded by population growth and global trade dependencies. They conclude that the global food system is becoming increasingly vulnerable to MBBFs due to these factors. Their report outlines a research agenda to evaluate the potential impacts of simultaneous crop failures in key agricultural regions. Among key research priorities, they emphasize the limited understanding of how trade and policy responses affect food price volatility and food security, as well as the need for empirical studies and economic models to better assess how such failures affect the global food systems.

A natural disaster may only lead to a temporary reduction in agricultural production. However, studies find that after subsequent recovery, economies may remain permanently below its pre-shock growth trajectory due to the loss of physical and human capital, and interrupted economic growth, as Ashizawa et al. (2022) assess after reviewing impacts of floods. Impacts of droughts may also be felt beyond the year the drought takes place. They may deplete water storage systems, which in turn may intensify competition (and conflict) over water resources and affect yields and crop production in subsequent years. Droughts have also been found to reduce land values, contribute to insect outbreaks, increases in wildfires and altered rates of carbon, nutrient and water cycling (NIDIS 2025). During droughts, lack of water and access to feed frequently reduce livestock capital through reductions in births, deaths, early livestock sell-offs and slaughtering (NIDIS 2025). Such medium-to-long term impacts are more likely in contexts with already stressed water systems and vulnerable production systems.

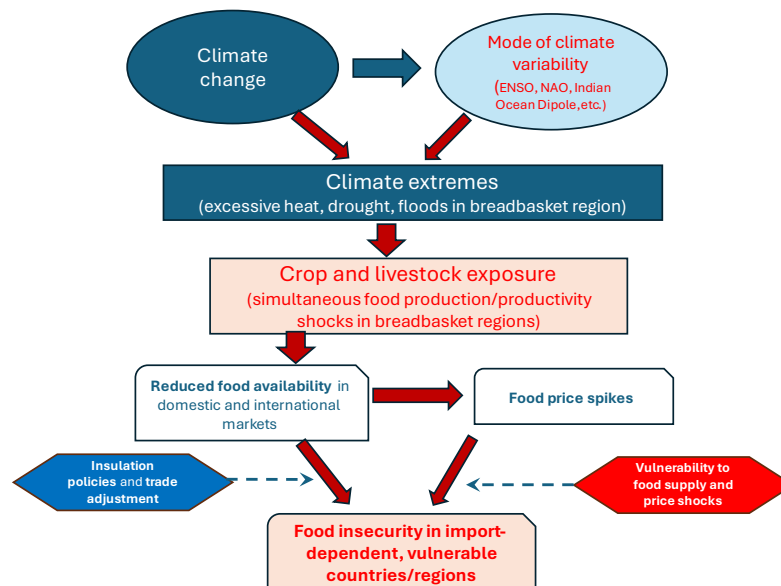
The predominance of the available evidence points to serious risks of MBBFs causing both reductions in incomes in the affected areas and increases in food prices. The increases in food prices associated with these shocks extend their impacts—potentially far beyond the people directly engaged in agriculture. This paper seeks to extend our understanding of these impacts in the short-, medium- and long-run to provide a

guide to policies for responding to them. Specifically, we seek answers as to whether the impacts on global food security differ whether MBBFs occur in high-income or in low- and middle-income countries, whether such shocks are one-off or recurrent events, and whether MBBFs only damage crops in the year of the shock or also cause longer lasting loss of natural and human capital.

### 3. HOW TO ASSESS THE IMPACTS OF MBBFS ON GLOBAL FOOD SECURITY?

The review of evidence indicates that multiple breadbasket failures have happened in the past and are expected to pose major threats to global food market stability and food security, owing to climate change and the concentration of staple crop production in a few key production regions. These conditions underscore the critical role of global trade in shaping domestic food prices and food security. To better understand the impact of breadbasket failures on food security, it is important to develop a research framework that captures key economic interactions in a highly interconnected world. This framework needs to account for both trade pattern changes and production adjustments following consecutive climate disasters in vulnerable regions. This is especially critical for many food-importing developing countries, making them particularly vulnerable to crop failures not just within their own borders or regions but also in major crop-exporting countries elsewhere in the world.

**Figure 1 Channels of influence from breadbasket failures**



Source: Authors' elaboration, based on Hasegawa et al. (2022).

Figure 1 summarizes the channels of influence between climate variability, breadbasket failures and global food security. Climate change is already affecting agricultural yields (see also discussion below on

the baseline assumptions) but is also seen as a cause of increased variability in precipitation and temperatures, associated with large-scale ocean-surface temperature oscillations, such as the El Niño Southern Oscillation (ENSO). Such sea-surface temperature oscillations often induce weather extremes in widely different regions, affecting food production. as indicated in the previous section. Extreme droughts or floods affect crop yields and livestock breeding across production areas, thus leading to synchronized agricultural losses, reducing food availability and driving up food prices, thus undermining food security, especially in low- and middle-income countries. The review of evidence by Hasegawa et al. (2022) indicates that, historically, synchronized crop-production losses have induced global production deficit of as much as 20 percent and have often been associated with the mentioned large-scale sea-surface temperature oscillations.

In the assessment in this paper, we focus on the interactions spelled out in the bottom part of the flow chart of Figure 1, starting from presumed shocks to agricultural supplies caused by ‘synchronized’ and ‘tele-connected’ extreme weather conditions in breadbasket areas.

IFPRI’s MIRAGRODEP model is a useful tool for studying these issues. As detailed further in Appendix A.2, it is a global computable general equilibrium model which captures the relevant interactions and accounts for the relevant production, trade and price adjustments and feedback mechanisms in the face of weather shocks. The model has considerable detail on crop and livestock production and is linked to a system of household models that allow us to assess impacts on poverty, food security and nutrition. The model is recursive dynamic, allowing us to consider changes in productive capacity, technology, labor supply, consumer demand, etc. over time and hence to assess short-, medium- and long-run impacts of supply shocks. The model captures the degree of concentration in production and dependence on food supplies from breadbasket regions for all regions, thereby capturing the degree of vulnerability and exposure of a wide range of countries to the consequences of MBBFs. It also models the demand and supply responses to international and domestic food price changes, including through adjustment in trade and domestic production.

A key feature of the MIRAGRODEP model is its linkage to the POVANA set of household models which allow us to translate economy wide outcomes for agricultural productivity, farm and non-farm outcomes, and food prices into impacts at the household level in terms of poverty, food security, and diets, as explained further in Appendix A.2.

One change we make to the basic model specification is to increase the elasticity of substitution between domestic and imported agricultural products in countries affected by weather extremes. The original values of these elasticities were estimated using data on generally small changes in prices over time. In simulations with the large productivity shocks considered here, these standard estimates can result in implausibly large changes in domestic prices relative to external prices and to implausibly large increases in farm employment. Our assessment is that, in response to large shocks of this type, producers, consumers and traders will be more willing to switch between imported and domestic goods than they would in response to smaller shocks. In Appendix A.4 we provide an analysis of the sensitivity of the model findings to the adjusted values for the elasticity of substitution, showing the dampening effect of a higher elasticity on global prices and more realistic supply responses in regions affected by extreme weather shocks.

## 4. SCENARIO DESIGN AND ANALYSIS

We undertake the model-based scenario analyses in three steps. First, we define an appropriate baseline from 2025-2050 to be used as a reference for assessing short-, medium-, and long-term impacts of MBBFs. The impacts are assessed in terms of deviations from the baseline.

Second, using the global MIRAGRODEP model, we run alternative scenarios simulating MBBFs by imposing negative productivity shocks on crop cultivation and livestock activity in countries/regions affected by extreme climate. We vary the shocks in terms of geography (which countries/regions are hit by extreme weather?), intensity (by how much is agricultural production affected?), and frequency (is the shock a once-every thirty-plus year event, recurrent, or permanent?). We assess the impacts of the supply shocks in varying magnitude and frequency on food availability, prices, trade, factor payments, aggregate household welfare, food consumption and environmental outcomes in the affected countries and regions, as well as the spillover effects to the rest of the world.

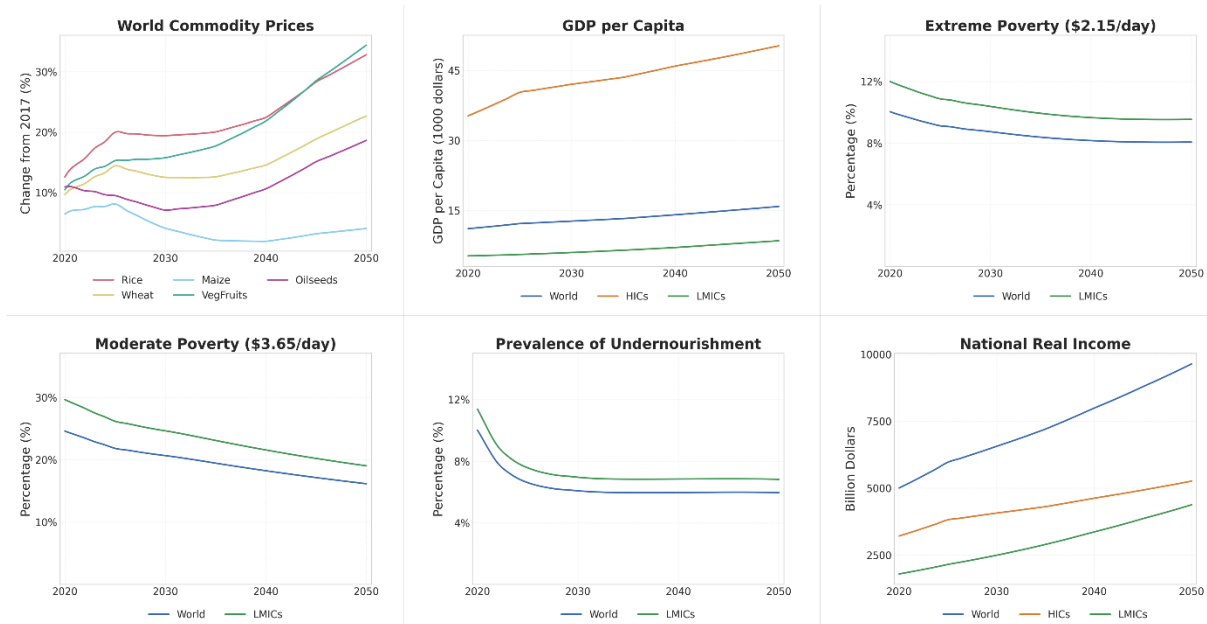
Third, we take the results of the MIRAGRODEP simulations for each scenario to translate those into impacts at the household level for poverty, food security and diets.

### 4.1 Scenario design

#### 4.1.1 Key characteristics of the baseline

The MIRAGRODEP baseline scenario builds on the new Shared Socioeconomic Pathways (SSP) database of July 2024 as provided by the International Institute for Applied Systems Analysis (IIASA). We use their middle-of-the-road (SSP2) scenario for population and GDP growth. The scenario assumes a global temperature rise of 3.6 degrees Celsius above pre-industrial levels by the end of the century, as projected under IPCC's Representative Concentration Pathway (RCP) 7.0, i.e. scenario SSP2-7.0 as defined in the latest IPCC report (IPCC 2023). This climate scenario is paired with IFPRI's most recent projections for crop yields by country and crop (irrigated and non-irrigated) under the business-as-usual scenario of IFPRI's foresight multimarket global crop model IMPACT and further informed by the OECD-FAO (2025) outlook for crop yields and livestock production.

**Figure 2. Key Features of the Baseline, 2020-2050**



Source: Authors' Simulation Results.

This baseline scenario puts the global economy and agrifood sector on a path of moderate but steady growth to 2050, with gradually slowing agricultural productivity growth over time, owing in part to a global slowdown in investments in agricultural R&D (see e.g., Martin & Vos 2024). As shown in Figure 2, real food prices increase over time with lower growth of supply than demand. Rice and sugar experience the largest price increases by about 40% and 30%, respectively, by 2050 (compared with the base year). Prices for wheat, oilseeds, vegetables, and fruits all show more modest increases in the 10–15% range. The exception is maize, whose prices remain relatively stable throughout the simulation period and, as the crop receives a boost from global warming in temperate zones, the average maize price even shows a slight (4%) drop by 2050. The expected food price increases would slow progress towards the reduction of global poverty and hunger. Despite rising food prices and slow progress in tackling extreme poverty and hunger, moderate poverty declines substantially. Estimates show a drop by 6 percentage points globally and a 7-percentage point drop in developing countries.

#### **4.1.2 MBBF scenarios**

A key research question of the present study is whether it matters for global food security and market adjustment whether MBBFs emerge in high-income countries or in low- and middle-income countries. To test this, we experiment with extreme weather shocks affecting the bread baskets of North America and Europe and compare the results with those for a MBBF occurring simultaneously in South Asia and Eastern and Southern Africa. The Europe and North American grouping was chosen because of its importance in global agriculture (23% of global production)<sup>3</sup> and because there appear to be significant yield correlations within this group, at least for wheat. The South Asia group is important in global agriculture, with 13% of the value of global production and was chosen partly because yields appear to show significant positive correlations within this group of countries. The Eastern and Southern Africa group was chosen because of high poverty rates, strong dependence on agricultural production and consequent vulnerability to agricultural shocks, and yield correlations such as those associated with El Niño events.

We made these assessments under alternative assumptions regarding: (a) intensity of the weather shock in terms of impacts on supply (based on the review of evidence we assume adverse agricultural total factor productivity shocks of -10% and -25% for all major agricultural activity in affected regions); (b) “after-shocks”, that is, impacts spilling over to subsequent years because of damage to agricultural assets (land and water availability, livestock death or sell-off, etc.), which we simulate through a depreciation of those assets in the year of the shock and (c) frequency of the shock, assuming the shock is one-off in the 25-year simulation period or intermittent (recurrent every fourth year). While large, these shocks are not completely out of the range of anticipated future shocks. They are intended to provide broad indications of the effects of large, adverse shocks to agricultural productivity and output, and hence to provide a potential basis for interventions to deal with the resulting problems.

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<sup>3</sup> Estimate based on FAOSTAT (accessed 19 May 2025).

Table 1 summarizes the resulting set of 12 scenarios. In the discussion of the results, we will focus mainly on the findings from the single-year (P), “after-shock” (D) and intermittent repeated (I) shock scenarios that assume a 25% reduction in agricultural productivity in, respectively, the South Asia and the East and Southern Africa regions and Northern Hemisphere breadbasket regions.

While we recognize that a 25%-shock every four years is implausible as a real-world scenario, we use it as a basis for comparison with the 25% one-off shocks. As previously noted, we also examined 10% shocks and found the differences between these shocks and the 25% shocks to be broadly similar in the nature of their effects, although different in magnitude. The discussion below focuses on the main findings from the scenarios, assuming 25% productivity shocks. Detailed results for both the 10%- and 25%-shock scenarios, as well as comparative results for all scenarios can be found in Appendix A.3.

**Table 1 Description of the MBBF scenarios**

Basic code	Description	P Once-in-30-year event (one-off in 2026)	I Intermittent repeated extreme weather events (every 4 years from 2026 to 2050)	D Weather shock in year 1 causes loss of agricultural assets (capital depreciation)
SP10	10% agricultural productivity decrease (all crops) in breadbaskets of <i>East &amp; Southern Africa and South Asia</i>	SP10P	SP10I	SP10D
SP25	25% agricultural productivity decrease (all crops) in breadbaskets of <i>East &amp; Southern Africa and South Asia</i>	SP25P	SP25I	SP25D
NP10	10% agricultural productivity decrease (all crops) in breadbaskets of <i>North America and Europe</i>	NP10P	NP10I	NP10D
NP25	25% agricultural productivity decrease (all crops) in breadbaskets of <i>North America and Europe</i>	NP25P	NP25I	NP25D

Source: Author’s elaboration.

## 4.2 Results

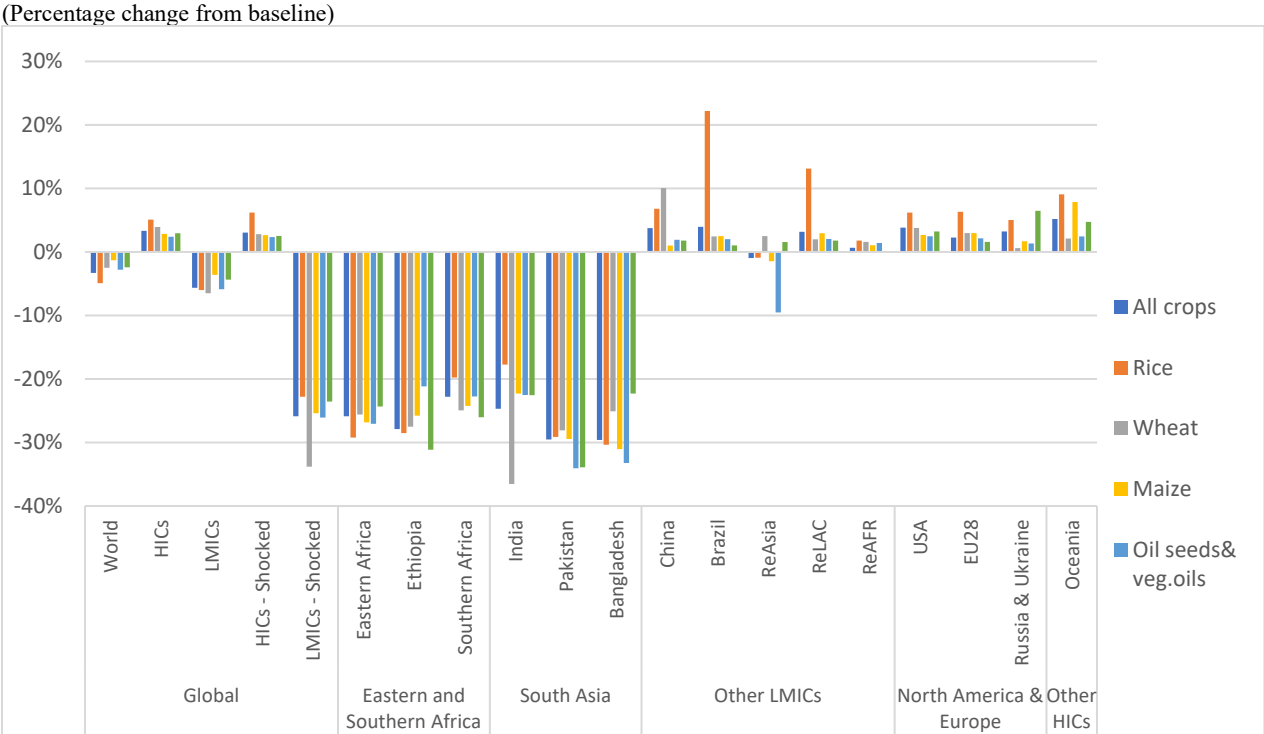
### 4.2.1 Extreme weather shocks causing MBBFs in Eastern and Southern Africa & South Asia – Short-term impacts (SP25P)

In this set of scenarios, we assume “multiple breadbasket failures” occurring simultaneously due to co-variant extreme climate events in three developing country regions (South Asia and Southern and Eastern

Africa), involving 25% reductions in productivity in all crops. While no simulation can capture the complexities of weather patterns over large areas, Swapna et al. (2025) suggest such an adverse outcome might occur with a synchronized strong ENSO and strong positive Indian Ocean Dipole (IOD) causing catastrophic floods and droughts seriously affecting much of crop production in Indian Ocean rim countries.

Crop (and livestock) production would decline broadly in line with the assumed yield reduction in the affected regions (Figure 3). The reductions differ slightly from pure output shocks because producers respond to the changes in profitability associated with the adverse productivity shocks and the resulting changes in prices. Sometimes producers reduce their use of intermediate inputs in response to lower productivity, yielding a larger adverse impact on output. But, in other cases, the local prices of agricultural products rise enough to create an incentive to increase use of intermediate inputs, and variable factors such as labor, resulting in smaller output reductions.

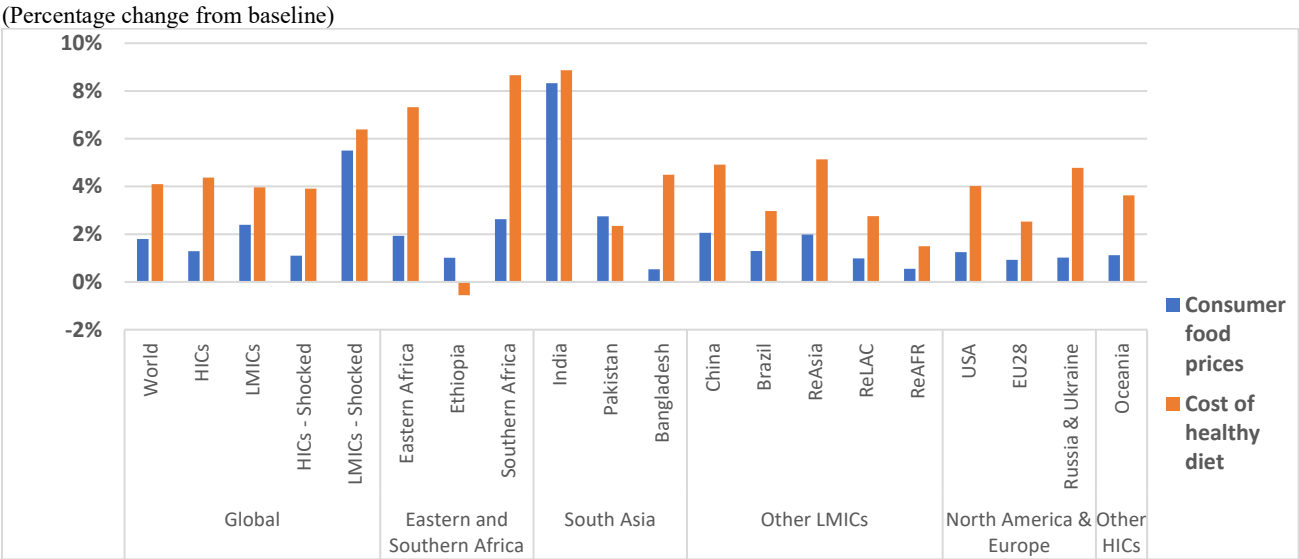
**Figure 3 Scenario SP25P: Impacts on crop production (year of the shock)**



Source: Authors' simulations with MIRAGRODEP model. See further results in Appendix Table A.3.1.

The production losses in these breadbasket regions reduce global supplies, pushing up world market prices of agricultural commodities by 5.6% (See Table A3.1) and producer prices in the affected countries by more than 10% in many cases. The shock to world market prices is softened by increased production in regions not affected by the weather shock, where producers attempt to benefit from higher prices. As a result, the reductions in global supplies of rice (-4.9%), wheat (-2.5%), and maize (-1.3%) are smaller than would have occurred without the supply responses in the regions not affected by the weather shock. The supply shocks also push up domestic consumer food prices, most strongly in the affected regions (Figure 4). Consumers in India would see the biggest price increase (8% above baseline inflation), while domestic food prices in Eastern and Southern Africa would rise by 2-3%. Domestic food price increases would be more modest in non-affected regions at around 1.5-2.0% above the baseline. Notably, though, the increase in the cost of a healthy diet would be larger than the increase in overall food prices in nearly all countries and regions, as Figure 4 further shows.

**Figure 4 Scenario SP25P: Impacts on domestic consumer food prices and cost of healthy diet (year of the shock)**

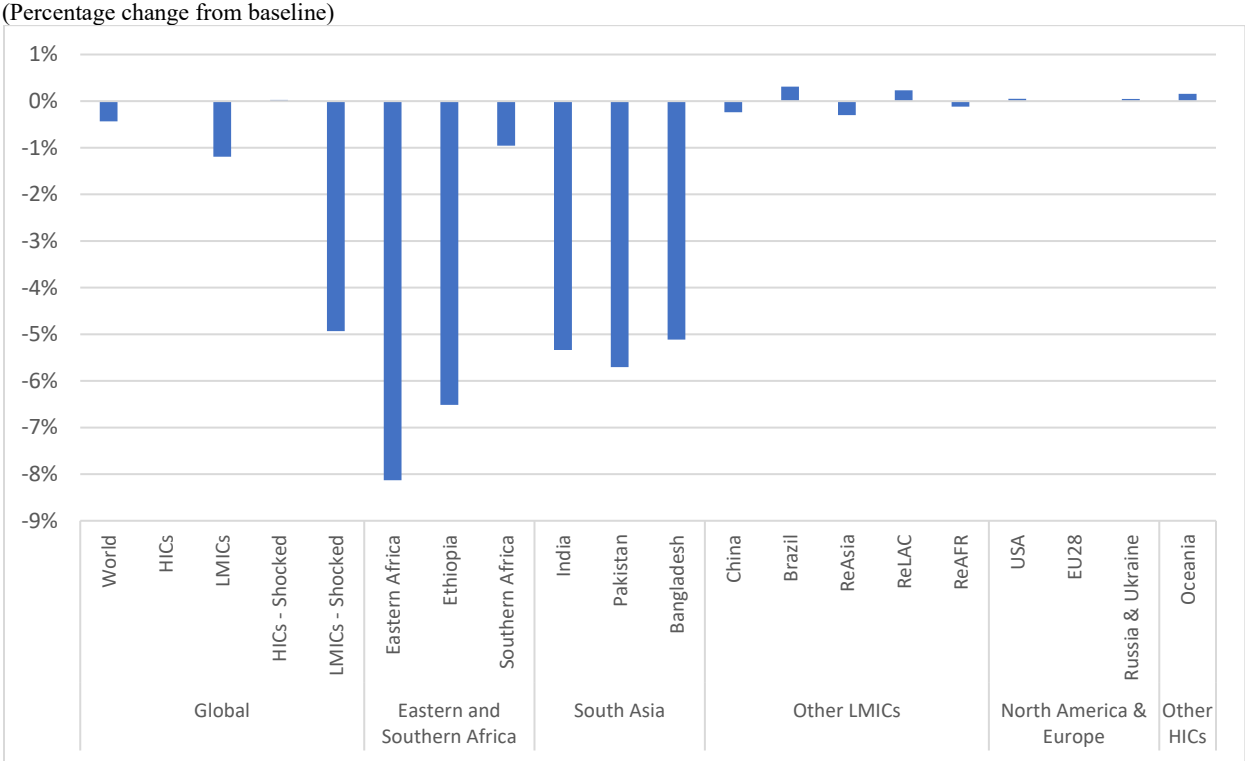


Source: Authors’ simulations with MIRAGRODEP model. See further results in Appendix Table A.3.1.

The impacts on food production and cost of living cause a downturn in the economies of the affected regions, as visible in substantially lower real national incomes, falling by as much as 8% vis-à-vis the baseline in Eastern Africa in the year of the shock (Figure 5). The South Asian countries also would

suffer strong real income declines of between 5.0% and 5.5%. Globally real national income would also see a slight decline, though adverse impacts in HICs and China are very small, with some small gains in agricultural exporters, such as Brazil and in other parts of Latin America, as well as in Australia and New Zealand, who would benefit from improved terms of trade.

**Figure 5 Scenario SP25P: Impacts on real national income (year of the shock)**



Source: Authors’ simulations with MIRAGRODEP model. See further results in Appendix Table A.3.1.

Accordingly, also, the short-run adverse impacts on poverty and food insecurity are strong in the affected regions (Figure 6). In the shock-affected regions, extreme poverty (at the international poverty line of PPP\$2.15 per person per day) would rise by 6-7 percentage points in East and Southern Africa and 2.5-4.5 percentage points in South Asia. Impacts on moderate poverty (at PPP\$3.65 pp/pd) would be somewhat less strong in the case of the affected regions in Africa, but substantially stronger in India, Pakistan and Bangladesh in South Asia. Also, the prevalence of undernourishment would rise more strongly in South Asia (up by almost 4 percentage points in India, 7.7 points in Pakistan and 19.5 points

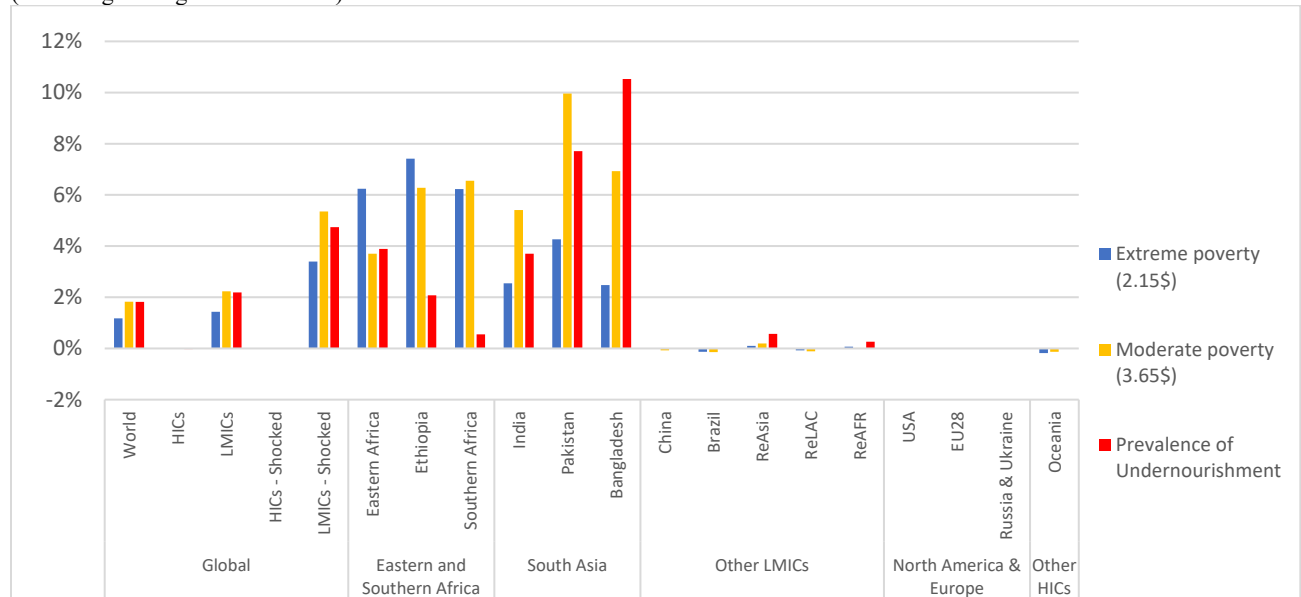
in Bangladesh), as compared with the affected countries in Eastern Africa (up by almost 4 percentage points) and Southern Africa (1 percentage point).

These outcome differences are driven by several factors, First, farm households are most directly hit by the fall in agricultural productivity. Given that more farmers are at the lower end of the income distribution, the increase in the extreme poverty incidence is greater than that of the moderate poverty incidence in the weather-affected parts of Africa (see Table A.3.1 for the results for poverty among farm households). Second, in South Asia, the rural poor comprise relatively more non-farm households as well as a higher concentration of near poor with incomes around moderate poverty line, whose welfare is very sensitive to food price increases, being net buyers of food.

The limited spillover of food security threats to other developing countries in this scenario is the result of the relatively limited increase in world prices of food (5.6%). Domestic prices in these countries are further muted by imperfect substitution between domestic and imported foods, with consumer prices in regions not directly affected by the shock rising by only around 1% in many cases.

**Figure 6 Scenario SP25P: Impacts on poverty and food insecurity**

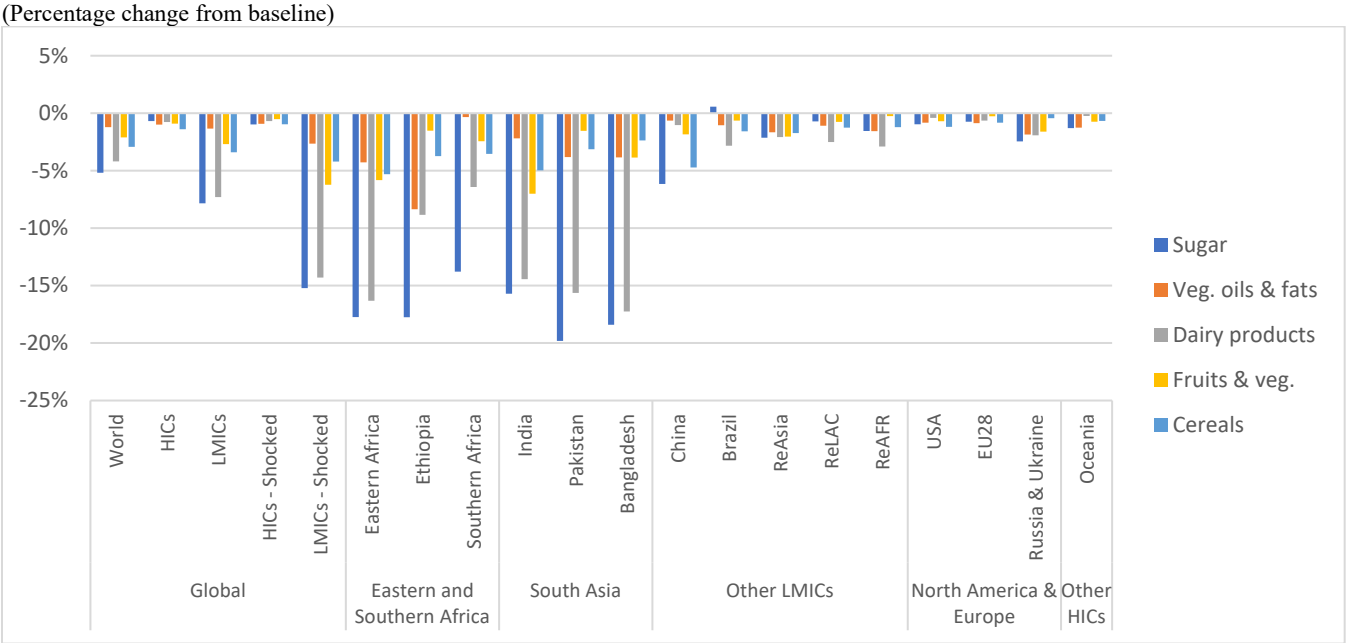
(Percentage change from baseline)



Source: Authors' simulations with MIRAGRODEP model. See further results in Appendix Table A.3.1.

MBBFs in Eastern and Southern Africa and South Asia would have notable impacts on diets (Figure 7). First, because of income losses and higher food prices in general, per capita food consumption would decline across all major food groups in most countries and regions. Second, unsurprisingly, the decline in food consumption is strongest in the regions suffering breadbasket failures with some items, especially sugar and dairy products, seeing declines of 15% or more compared with the baseline. Third, the result on dietary quality would appear to be mixed, showing, on the one hand, strong declines in the consumption of sugars and calorie-rich cereals (which could improve diets for those households consuming these in excess), though, on the other hand, dairy consumption also falls strongly as does, to a lesser extent, consumption of fruits & vegetables. For food insecure households, though, despite the consequent shift in the composition of their diets, the news is not good as they would be able to consume less of all key dietary ingredients.

**Figure 7 Scenario SP25P: Impacts on diets**



Source: Authors' simulations with MIRAGRODEP model. See further results in Appendix Table A.3.1.

#### **4.2.2 Extreme weather shocks causing MBBFs in North America & Europe (NP25P) – Short-term impacts**

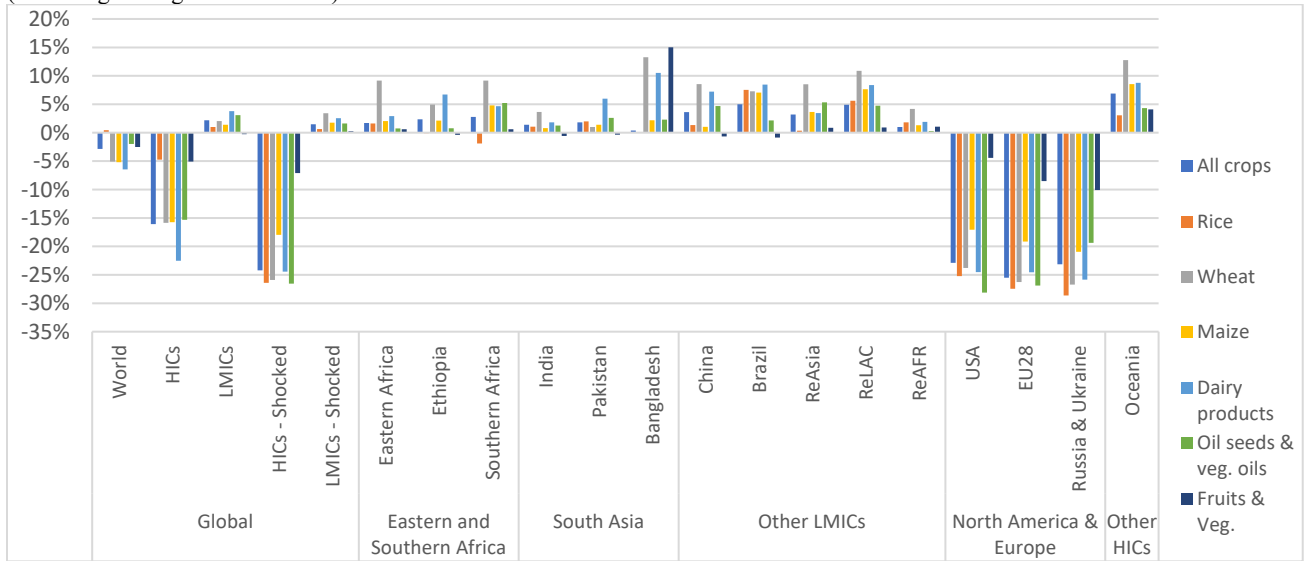
A MBBF occurring in North America and Europe (mainly HICs) would cause reductions in global supplies of staple foods, if only because of these countries' large share in global agricultural production. The sharp reductions in output in North America and Europe would only partially be offset by expansion of production elsewhere in the world, especially (in terms of volume) in Latin America and Oceania (Australia, New Zealand) (Figure 8). Higher food prices would also induce agricultural output expansion for most food commodities in Africa and Asia.

MBBFs in North America and Europe would have a slightly greater adverse impact on global national income than those of the previous scenario (Figure 9). However, the declines in real incomes in the affected countries would be much smaller than was the case for declines in developing countries. Real national income would also decline in most other countries and regions, despite expanding crop production. Exceptions are Brazil, the rest of Latin America and Oceania, which would see rising national income in response to improvements in their terms of trade.

An important drag on the global economy would be substantially higher food prices. World market prices for agricultural commodities would increase by 11.2%, an increase roughly double that resulting from the South Asia and Africa shock. This larger increase in world prices results in larger increases in output in unaffected regions than was the case for the MBBF in South Asia and Africa. The increase in producer prices is particularly large for wheat, given its importance in the Europe and North America grouping. Domestic food prices in the affected high-income countries would increase by almost 4% and the cost of a healthy diet by over 14% (Figure 10). While non-affected regions would also see domestic food prices increase, the increases in consumer prices would be smaller—especially in countries like Bangladesh with small import shares—because of product differentiation that results in modest pass-through from world to domestic prices. The increases in output are rather muted as a result.

**Figure 8 Scenario NP25P: Impacts on crop production (year of the shock)**

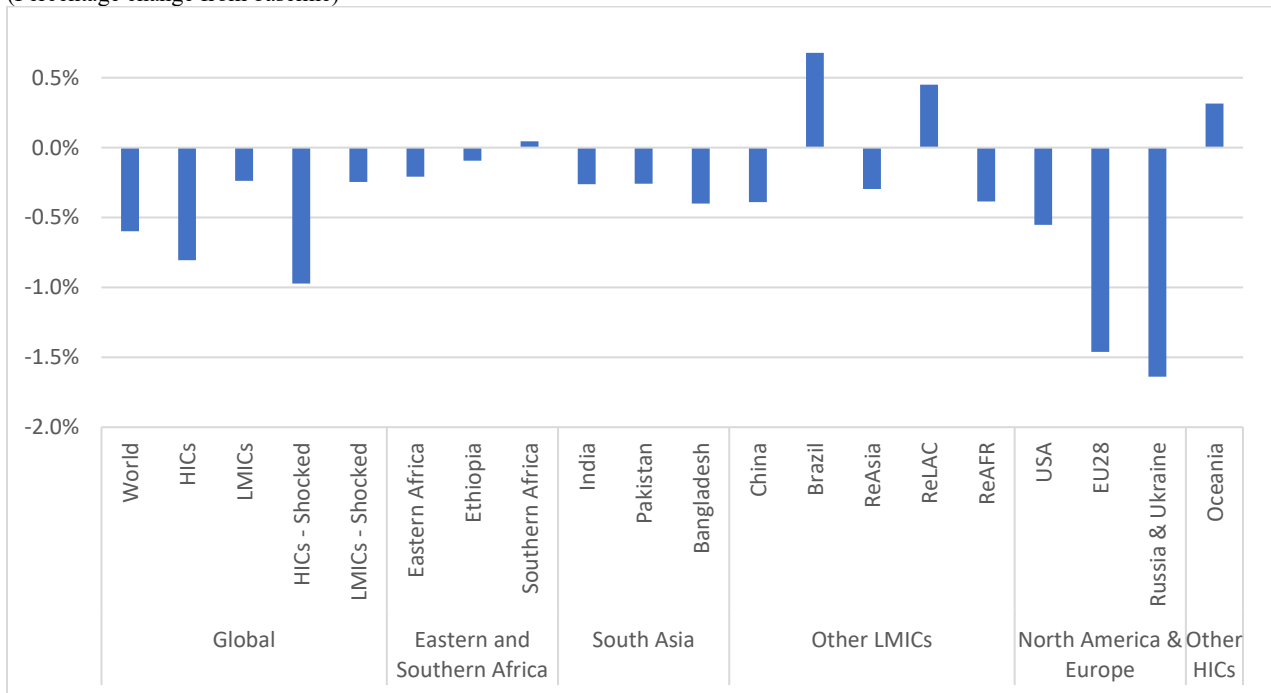
(Percentage change from baseline)



Source: Authors' simulations with MIRAGRODEP model. See further results in Appendix Table A.3.2.

**Figure 9 Scenario NP25P: Impacts on real national income (year of the shock)**

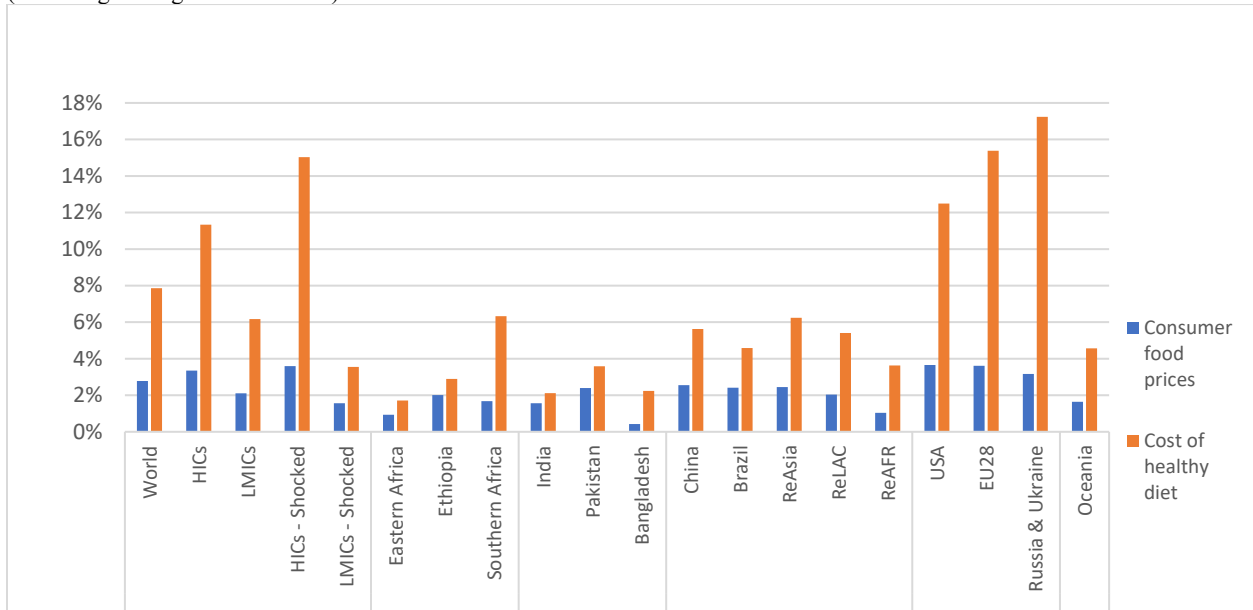
(Percentage change from baseline)



Source: Authors' simulations with MIRAGRODEP model. See further results in Appendix Table A.3.2.

**Figure 10 Scenario NP25P: Impacts on domestic consumer food prices and cost of healthy diet (year of the shock)**

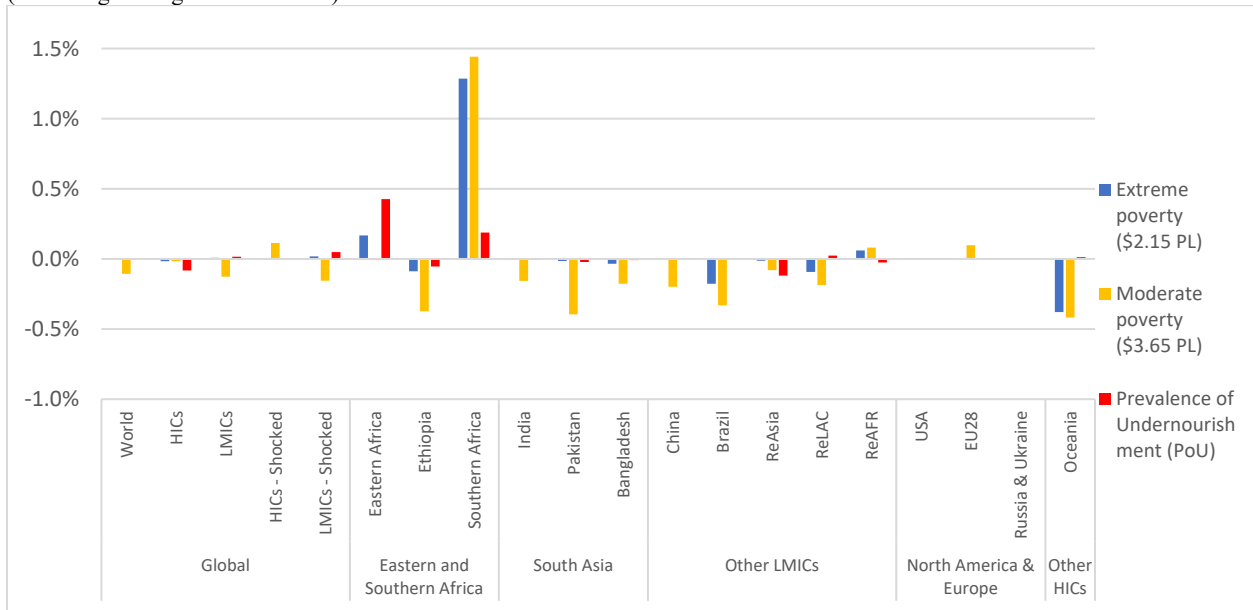
(Percentage change from baseline)



Source: Authors' simulations with MIRAGRODEP model. See further results in Appendix Table A.3.2.

**Figure 11 Scenario NP25P: Impacts on poverty and food insecurity (year of the shock)**

(Percentage change from baseline)

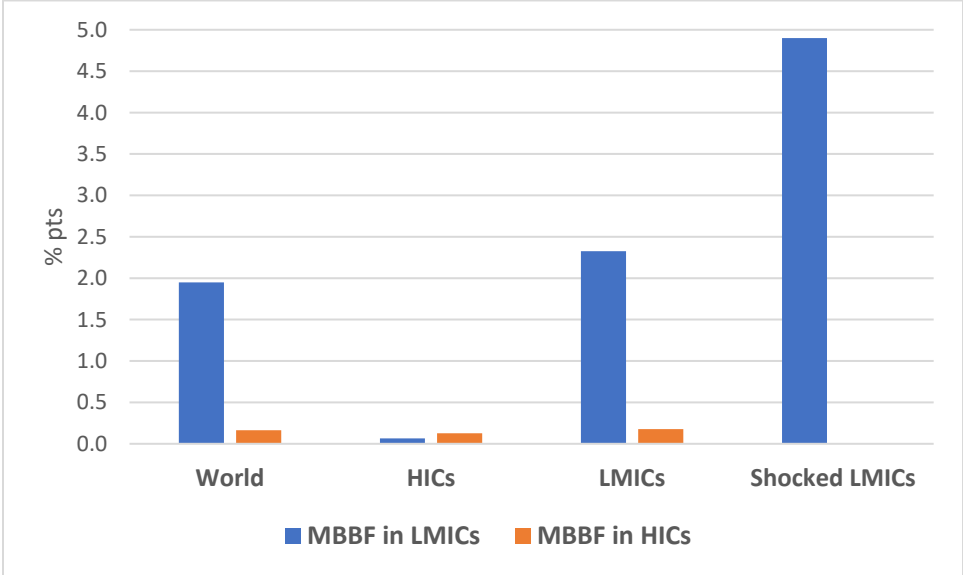


Source: Authors' simulations with MIRAGRODEP model. See further results in Appendix Table A.3.2.

The overall impact on global food insecurity of a MBBF in the high-income regions on global food security is muted, according to the scenario analysis (Figure 11), showing even a very slight reduction in the prevalence of undernourishment in the year of the shock. The higher food prices would cause an increase in food insecurity in Eastern and Southern Africa, but which – at the global level- would be offset by increased food production and farm incomes in other developing country regions.

Consequently, we find a stark contrast between the impacts on food insecurity of MBBFs striking in rich and poor countries. This contrast is highlighted in Figure 12. From the graph, it is clear that the adverse impacts on global food insecurity are much greater when the shock occurs in developing countries than when they occur in rich countries. When the shock occurs in rich countries, the primary impacts on poverty are through food prices, which can have substantial impacts on poverty (Ivanic and Martin 2008) and on food insecurity. But when the shock arises in developing countries, there is a direct link from income losses to poor farmers. In addition, the resulting increases in prices facing poor consumers are likely greater in this situation.

**Figure 12. Comparison of food insecurity impacts of MBBFs in HICs and LMICs in the year of the shock, % points**



Source: Authors' simulations with MIRAGRODEP model. See further results in Appendix Table A.3.2

### **4.2.3 Aftershocks and repeated extreme weather shocks causing MBBFs (SP25D & I and NP25D & I)**

As pointed out in Section 2.3, a natural disaster may not just cause a temporary loss of agricultural production but may also cause more lasting losses from loss of physical and human capital. These losses are perhaps most obvious with livestock grazing systems where livestock inventories can be severely depleted during droughts, slowing recovery from the original disaster. Droughts and/or floods may damage water management systems, which in turn may intensify competition (and conflict) over water resources in subsequent years. Droughts, floods and fires may also cause loss of physical and natural capital such as fences, roads, buildings, fruit trees and standing timber.

In this section, we assess added impacts over time of extreme weather causing MBBFs under two additional conditions: (i) “after-shocks” caused by agricultural capital losses, assuming the initial weather shock causes a 25% productivity loss in the year of the shock compounded by a loss of agricultural capital proxied by a tenfold increase in the ‘normal’ depreciation rate under the baseline scenario;<sup>4</sup> and (2) “repeated shocks” in which the extreme weather shock occurs every four years (in each case with and without the presumed capital destruction). While these are hypothetical scenarios, we want to assess the extent to which the capital destruction resulting from extreme weather shocks and the repeated occurrence of weather shocks will cause sustained falls in welfare and food security in the affected countries and across the globe.

Tables 2 and 3 show the impacts of MBBFs in the two sets of regions in the year of the extreme weather event and the subsequent three years (2026-2029) under two scenario assumptions: (i) the temporary productivity loss (25%) as in the scenarios analyzed in the previous section, and (ii) the productivity shock is accompanied by a loss of agricultural capital (simulated through an increase in the depreciation rate).

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<sup>4</sup> On average, across crops and countries affected by the weather extreme, this assumption implies an assumed loss of capital-based production capacity (defined here as the loss of capital stock times the share of capital in the total production costs) of about 12%, which is felt in the year after the shock.

Tables 2 and Appendix Table A.3.6 show the findings of those scenarios in the case of the MBBFs in North America and Europe. If there is only a temporary productivity shock caused by extreme weather, incomes, food prices, and crop production volumes bounce back to baseline levels in the year after the shock. Accordingly, also the rise in global poverty and food insecurity during the year of the occurrence of the extreme weather shock is repaired in the years immediately after. As indicated in the previous section, MBBFs in high-income countries tend to only slightly impact global poverty and food insecurity. Higher food prices in the year of the shock would, however, induce a slight increase in the prevalence of undernourishment in LMICs in the year of the shock (and stronger with loss of productive agricultural capital), but recovery in food supplies and drop in food prices, food security would improve again in the years after the shock.

**Table 2 Scenarios NP25 and NP25d10: Short-to-medium run impacts of MBBF in North America and Europe with and without capital destruction (% change from baseline)**

		2026	2027	2028	2029
<b>Crop production volume</b>					
World	<i>productivity shock only</i>	-2.85	0.21	0.15	0.11
	<i>productivity shock + capital loss</i>	-3.87	-0.35	-0.17	-0.08
Shocked HICs	<i>productivity shock only</i>	-24.21	-0.19	-0.17	-0.15
	<i>productivity shock + capital loss</i>	-32.77	-5.48	-3.59	-2.51
All HICs	<i>productivity shock only</i>	-16.09	0.05	0.01	-0.02
	<i>productivity shock + capital loss</i>	-21.77	-3.28	-2.10	-1.45
LMICs	<i>productivity shock only</i>	2.18	0.27	0.20	0.15
	<i>productivity shock + capital loss</i>	3.01	0.72	0.52	0.40
<b>Global food prices</b>					
World	<i>productivity shock only</i>	11.20	-0.72	-0.48	-0.33
	<i>productivity shock + capital loss</i>	14.99	1.53	0.79	0.45
<b>Food insecurity (PoU) (changes in percentage points from baseline)</b>					
World	<i>productivity shock only</i>	0.16	-0.03	-0.02	-0.01
	<i>productivity shock + capital loss</i>	0.23	-0.01	-0.01	-0.01
Shocked HICs	<i>productivity shock only</i>	0.02			
	<i>productivity shock + capital loss</i>	0.15			
All HICs	<i>productivity shock only</i>	0.13	-0.03	-0.01	-0.01
	<i>productivity shock + capital loss</i>	0.15	0.00	0.00	0.00
LMICs	<i>productivity shock only</i>	0.18	-0.04	-0.03	-0.01
	<i>productivity shock + capital loss</i>	0.25	-0.01	-0.01	-0.01

Source: Authors' simulations with MIRAGRODEP model.

As might be expected, poverty and food insecurity would be affected much more strongly with MBBFs in regions with high pre-existing levels of those living conditions. Tables 3 and Appendix Table A.3.7 show a similar pattern for the impacts of MBBFs in Eastern and Southern Africa and South Asia. The global

extreme poverty incidence would increase by 1.6 percentage points and the prevalence of undernourishment by 2.5 percentage points in the year of the shock (2026) with partial recovery in subsequent years in the scenario case of MBBFs with agricultural capital destruction in Eastern and Southern Africa and South Asia. The regions directly impacted by the shock would see poverty rise by 4.2 percentage points and food insecurity by 6.4 percentage points for the scenario with agricultural capital destruction. Under the given assumptions, the latter adds between 1.0 and 1.5 percentage points to the poverty and food insecurity impacts. Recovery of agricultural production and gradual recovery of the agricultural capital stock (through new investments induced by increased rates of return in agriculture owing to the initially higher prices) subsequently helps a near return to pre-shock rates of poverty and undernourishment.

**Table 3 Scenarios SP25 and SP25d10: Short-to-medium run impacts of MBBF in Eastern and Southern Africa and South Asia with and without capital destruction (% change from baseline)**

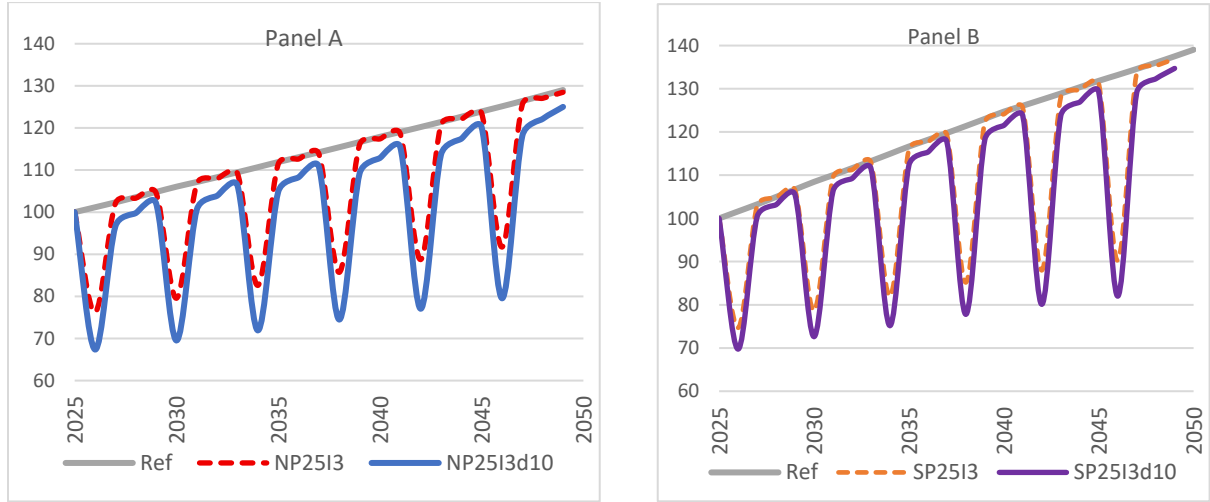
		2026	2027	2028	2029
<b>Crop production volume</b>					
World	<i>productivity shock only</i>	-3.29	0.19	0.14	0.10
	<i>productivity shock + capital loss</i>	-3.94	-0.19	-0.08	-0.04
Shocked LMICs	<i>productivity shock only</i>	-25.88	-0.30	-0.21	-0.16
	<i>productivity shock + capital loss</i>	-30.92	-2.80	-1.71	-1.16
All HICs	<i>productivity shock only</i>	3.34	0.40	0.28	0.20
	<i>productivity shock + capital loss</i>	4.04	0.68	0.46	0.32
LMICs	<i>productivity shock only</i>	-5.63	0.11	0.09	0.07
	<i>productivity shock + capital loss</i>	-6.75	-0.49	-0.27	-0.17
<b>Global food prices</b>					
World	<i>productivity shock only</i>	5.59	-0.49	-0.35	-0.24
	<i>productivity shock + capital loss</i>	6.68	-0.23	-0.26	-0.23
<b>Food insecurity (PoU)( changes in percentage points from baseline)</b>					
World	<i>productivity shock only</i>	1.95	0.00	0.00	0.00
	<i>productivity shock + capital loss</i>	2.54	0.33	0.18	0.14
Shocked LMICs	<i>productivity shock only</i>	4.90	0.03	0.03	0.02
	<i>productivity shock + capital loss</i>	6.42	0.89	0.50	0.37
All HICs	<i>productivity shock only</i>	0.07	-0.02	-0.01	-0.01
	<i>productivity shock + capital loss</i>	0.07	-0.02	-0.01	-0.01
LMICs	<i>productivity shock only</i>	2.33	0.00	0.01	0.00
	<i>productivity shock + capital loss</i>	3.04	0.40	0.21	0.16

Source: Authors' simulations with MIRAGRODEP model.

These patterns of adjustment to MBBF shocks are similar in the scenario of repeated shocks, as assumed in scenarios SP25I(D) and NP25I(D) (see Table 1). This is illustrated though the shock and adjustment patterns for crop production over the 2025-2049 period in Figure 13. In each year following the MBBF, production recovers very close to pre-shock baseline trends if we assume no capital destruction. If there is

capital loss, there is still quick recovery but only partially, depending on the degree of loss of agricultural capital caused by the extreme weather. This pattern is similar for all other outcome variables.

**Figure 13. Impacts on crop production value added in affected HICs (Panel A, scenarios NP25I3 and NP25I3d10) and LMICs (Panel B, scenarios SP25I3 and SP25I3d10) caused by climate shocks repeated every four years, 2025-2049**



Source: Authors' simulations with MIRAGRODEP model.  
Note: "Ref" refers to the baseline trend.

## 5. CONCLUSIONS AND IMPLICATIONS FOR POLICIES

The evidence on the impacts of global warming on agricultural climate shocks suggests that there is a strong risk that these will both increase in intensity and become more strongly correlated over time. If these predictions are borne out, this will increase the risks of weather shocks that reduce yields in multiple, major producing countries at the same time. In this situation, the risks facing vulnerable people are compounded. Small producers are likely to see their incomes decline sharply as a direct consequence of the weather shocks, while net buyers of food are likely to suffer from higher food prices eating into their purchasing power.

If these shocks occur in poor developing countries, the effects are likely to be considerably different from those of the three food price shocks the world has experienced since 2008. The adverse effects of these food price shocks primarily arose from reductions in the access of vulnerable net food buying households to food. By contrast, the most direct impacts of weather-induced productivity shocks in developing countries arise from the direct impacts of reduced farm productivity on the incomes of farm households. These shocks could sharply reduce the incomes of many poor and vulnerable farm households, as well as adversely affect the incomes of net food buyers by raising the prices of the foods that they purchase. For this reason, they are likely to require quite different policy responses compared with those employed following previous food crises. It will, for instance, be important to ensure that social safety net and other income support measures include farmers, as well as the net food buyers who are frequently the focus of concern when considering policy responses to other food crises. Longer term responses would include investments that would make agriculture and food systems more climate resilient, e.g. through introduction of drought-resistant crop varieties, water-efficient irrigation systems, agroforestry, or conservation agriculture.

This paper used simulations of the MIRAGRODEP model to investigate the impacts of climate shocks occurring in an important group of developing countries. We compare the global ramifications of two hypothetical multiple breadbasket failures caused by extreme climate events occurring simultaneously

across countries. The first assumes extreme weather shocks in Southern and Eastern Africa and South Asia. The second analyzes the ramifications of a MBBF in North America and Europe. The simulated magnitude of agricultural supply shocks (10-25% loss in total factor productivity) is in the range found in the empirical literature on breadbasket failures.

Not surprisingly, we find that MBBFs indeed cause substantial increases in global food insecurity and poverty, especially when they directly affect developing-country agriculture. However, the consequences for world food markets may be less devastating than would be expected from the sharp reductions in food production in the affected regions. When MBBFs of the assumed severity occur in Eastern and Southern Africa and South Asia, global food insecurity, as measured through the prevalence of undernourishment, would increase by 2 percentage points (compared with the baseline), affecting 160 million more people. In the affected regions though, food insecurity may increase by as much as between 4 and 10 percentage points, as farm households are hurt by lower incomes and other vulnerable households by starkly rising food prices. However, in regions not directly affected by the weather extremes, agricultural production may expand (subject to available capacity) compensating for the shortfalls caused by the MBBF, allowing income improvements for farmers and partially offsetting the poverty impacts of higher food prices in countries outside of the affected regions.

MBBFs in high-income regions would generate a stronger adverse impact on global real income given the weight of, in this case, North America and Europe in the global economy and trade. International food prices would also rise much more sharply. Yet, we find a more muted impact on global poverty and food security, as in this scenario most developing-country regions gain from expansion of food outputs and their farmers of higher output prices. Countries in Eastern and Southern Africa, however, with limited capacity to expand production would also see poverty and food insecurity increase in this scenario, while many other LMICs may even see small decreases.

If climate shocks of this type become more frequent and/or if they cause losses of human and agricultural capital stock, it is important to consider their sustained economic impacts as well as those arising in the immediate aftermath of the shocks. To consider these situations, we examined cases where adverse

climate shocks caused a substantial depreciation of agricultural capital and where the shocks were repeated every four years. By repeatedly reducing incomes, and consequently investment, these shrank the economies of adversely impacted countries. The impacts on other countries differed, depending on whether those countries are net food importers or exporters. Repeated shocks and/or capital loss in developing country regions would exacerbate the poverty and food insecurity impacts. Yet, permanent losses may be limited even in these scenarios, if subsequent recovery of agricultural production and gradual recovery of agricultural capital stock (through new investments induced by increased rates of return in agricultural owing to the initially higher prices) facilitates renewed income growth and lower food prices, which in turn could help a near return to pre-shock rates of poverty and undernourishment. The present analysis did not consider policy responses. Popular responses to adverse climate shocks in the past have included reductions in tariffs on food products in importing countries and the imposition of export bans in shock-affected producer countries. Such responses have tended to exacerbate the magnitude of global food price surges as well as their volatility (Martin et al. 2024), thus turning bad situations for food security into worse. In a sequel to this paper, we will assess the effects of such trade policy responses as well as of domestic price insulation, income support measures, and investments in climate resilience.

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## APPENDIX A.1: YIELD VOLATILITY AND CORRELATIONS

As discussed in Section 2, what matters for food output simulations is the share of affected countries in global production, the size of the shock to each country, and the extent of correlations across countries, with any synchronized shock affecting all countries through changes in world prices.

The literature reviewed in Hasegawa et al (2019) essentially looks at the variance and correlations across countries to identify synchronicity and to estimate whether it is increasing. The framework of Mehrabi and Ramankutty (2019) formalizes the impacts of these on global crop yields, focusing on rice, wheat, soybeans and maize. In compact matrix notation for just two regions and one crops, their model is:

$$x_w^2 = \begin{bmatrix} 1 & 1 \end{bmatrix} \begin{bmatrix} x_1^2 & x_{12} \\ x_{21} & x_2^2 \end{bmatrix} \begin{bmatrix} 1 \\ 1 \end{bmatrix} \quad (1)$$

Where  $x_w^2$  is the variance of world output;  $x_i^2$  the variance of output of crop  $i$ ; and  $x_{21}$  the covariance of output across regions.

This model can usefully be re-expressed as:

$$\sigma_w^2 = \begin{bmatrix} s_1 & s_2 \end{bmatrix} \begin{bmatrix} \sigma_1^2 & \sigma_{12} \\ \sigma_{21} & \sigma_2^2 \end{bmatrix} \begin{bmatrix} s_1 \\ s_2 \end{bmatrix} \quad (2)$$

Where  $\sigma_w^2$  is the proportional variance of world detrended output;  $\sigma_i^2$  the proportional variance of detrended output of crop  $i$ ; and  $\sigma_{21}$  the covariance of proportional deviations from detrended output across regions.

Equation (2) makes clear that changes in the variance of global output depend on the individual variances and the output shares (or more generally, the concentration of world production). Equation (2) can be rewritten in terms of correlations between proportional shocks to output as:

$$\sigma_w^2 = \begin{bmatrix} s_1 \sigma_1 & s_2 \sigma_2 \end{bmatrix} \begin{bmatrix} 1 & \rho_{12} \\ \rho_{21} & 1 \end{bmatrix} \begin{bmatrix} s_1 \sigma_1 \\ s_2 \sigma_2 \end{bmatrix} \quad (3)$$

This makes a clear distinction between the size of output shocks and the correlations between them.

Recognizing that none of the matrices above can be estimated with any precision, Mehrabi and Ramankutty (2019) create a measure of synchrony that compares the variance of world output with the

variance when all elements of the correlation matrix are unity. They estimate these statistics using 8-year samples to allow them to change over time.

## **APPENDIX A.2: THE MIRAGRODEP AND POVANA GLOBAL MODELING FRAMEWORK**

The model-based scenario analysis uses estimates of the productivity impacts of large scale and geographically widespread weather or disease related disasters that significantly affect crop production in major agricultural regions to generate productivity shocks for the MIRAGRODEP global equilibrium model. This, in turn, generates estimates of changes in the commodity prices and wages that—along with changes in productivity—affect the incomes of households. These changes are then applied as shocks to the POVANA household model, with detailed information on roughly 300,000 households, that is used to assess the impacts on global poverty.

A key challenge for the analysis is to properly identify the productivity shocks caused by breadbasket failures to be applied to the general equilibrium model. The available information on yield changes is closely—but imperfectly—related to the empirical evidence on the magnitudes of production losses caused by past breadbasket failures, as summarized in Section 2. In the discussion below, we first describe the methodology underlying the global general equilibrium modeling framework. After that, we consider the productivity shocks to be used in the analysis. Finally, we return to the POVANA model used to assess poverty impacts.

### **A.2.1 The MIRAGRODEP Model**

MIRAGRODEP is a global Computable General Equilibrium (CGE) model based on MIRAGE (Decreux & Valin, 2007). The model was developed and improved with the support of the African Growth and Development Policy Modeling Consortium (AGRODEP). It is a multi-region, multi-sector, recursively dynamic CGE model. The model allows for a detailed and consistent representation of the economic and trade relations between countries (Laborde, Robichaud & Tokgoz, 2013). In each country, a representative consumer maximizes a CES-LES (Constant Elasticity of Substitution-Linear Expenditure System) utility function subject to an endogenous budget constraint to generate the allocation of expenditures across goods. Once total consumption of each good has been determined, the origin of the

goods consumed is determined by another CES nested structure, following the Armington assumption of imperfect substitutability between imported and domestic products (Armington 1969).

On the production side, demands for intermediate goods are determined through a Leontief production function that specifies intermediate input demands in fixed proportions to output. Total value added is determined through a CES function of unskilled labor and a composite factor of skilled labor and capital. This specification assumes a lower degree of substitutability between the last two production factors. In agriculture and mining, production also depends on land and natural resources. In the present application of the model, we assume that new capital investment is perfectly mobile across sectors, while installed capital is immobile. Furthermore, skilled labor is assumed to be fully mobile across sectors, while unskilled labor is only partially mobile between agricultural and non-agricultural sectors.

We use the GTAP 11 database as MIRAGRODEP's main source of data and parameters. In addition, the database is enhanced by datasets on land use, agricultural production, food balance sheets, agricultural domestic support measures and trade policies, as well as updated Social Accounting Matrices for all individually specified countries. For this specific study, we condensed the model to 22 sectors, of which 15 are related to agri-food activities (primary production and downstream activities) and 34 regions/countries.

## **A.2.2 Modeling Technological Change and Productivity Shocks**

For the present analysis, we simulate the impacts of breadbasket failures as negative productivity shocks.

In MIRAGRODEP, technical change that determines productivity is introduced first in the form of changes in the coefficients of a technology represented by a quadratic profit function:

$$\pi = a_0 + a_1p + a_2w + \frac{1}{2} \begin{bmatrix} p & w \end{bmatrix} \begin{pmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{pmatrix} \begin{bmatrix} p \\ w \end{bmatrix} \quad (1)$$

where  $p$  is the price of output; and  $w$  is the price of inputs; and the  $a$  coefficients characterize the technology. If a change in technology can be represented by an increase in the  $a_1$  coefficient to  $a_1'$  and a smaller increase in the  $a_2$  coefficient to  $a_2'$  then the move to the new technology may be profitable despite higher input costs. Because these coefficients are the intercepts of the supply curve for output and the

demand curve for inputs, these changes correspond to vertical shifts in both these curves. At initial prices, the change in profits associated with adoption of this technology will be given by:

$$\Delta\pi = (a_1' - a_1).p + (a_2' - a_2).w \quad (2)$$

Clearly, if we are considering this type of technical change, the increase in input requirements associated with the technical change has a first-order impact on profits and must be considered along with the impact of the change in the coefficient on output price.

For our purpose, the key feature of the model is the representation of production and consumption of agricultural products. At the individual commodity level, the model's production and demand structure results in a representation of supply and demand that can be characterized by a profit function in effective prices of outputs and inputs, and a demand function in actual prices. The supply function is the derivative with respect to the effective price of the profit function associated with farm production, while the (compensated) demand function is the derivative with respect to the actual price of the good.

Effective prices are defined as  $p^* = p.\tau$ , while effective quantities of output are defined as  $q^* = q/\tau_o$ . An increase in productivity that increases output at any given level of inputs is represented by an increase in  $\tau_o$ . A similar distinction arises with inputs such as fertilizer, whose productivity appears to be much higher with modern than with traditional varieties, for instance. With inputs, technological advances are represented by a decline in  $\tau_i$  (and inversely with a decline in productivity). With this terminology, we can define the supply of a good as the first derivative of a restricted profit function, with the quantity of input  $i$  fixed at  $x^*$ :

$$q^* = \frac{\partial\pi}{\partial p^*}(p^*, x^*) \quad (3)$$

Recalling the definition of effective prices and quantities, this implies that:

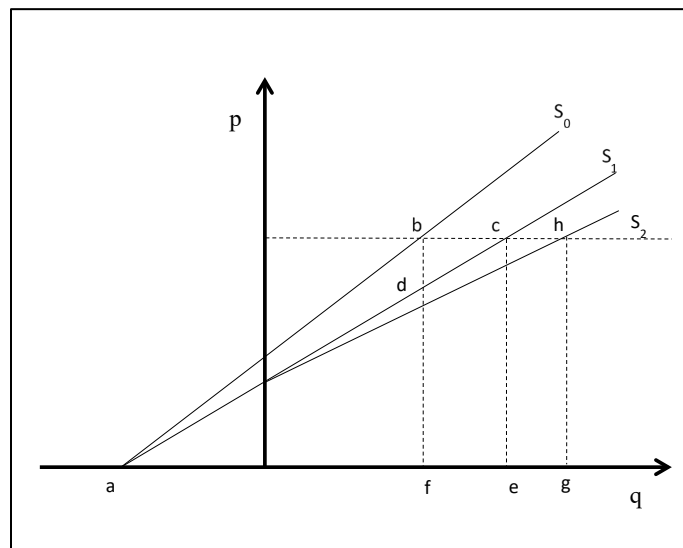
$$q = \tau_o. h(p^*, x^*) = \tau_o. h(p^*, \frac{x}{\tau_i}) = \tau_o. h(p\tau_o, \frac{x}{\tau_i}) \quad (4)$$

With a negative productivity shock  $\tau_o$  decreases and  $\tau_i$  increases, such that output declines at constant input use because of both these changes. The decrease in output will be the pure effect of the negative productivity shock, having a first-order impact on producer profits. A second-round decrease in output

occurs because of the decrease in  $p^* = p\tau_0$ . This change in the effective price of the good lowers the return to using resources in this activity, generating a second reason for declining output, and has a second-order impact on welfare (Martin and Alston 1997). The overall change in output is an empirical question, with its direction depending on whether the increase in the market price is large enough to overcome both the direct reduction in output associated with the productivity shock and the reduction in resource use resulting from the decline in the effective price relative to the market price.

If we assume linear supply functions (or equivalently, a quadratic profit function) Equation (4) can be depicted in actual price and quantity space as in Figure A.2.1.

**Figure A.2.1 Impacts of an adverse productivity shock on output**



Source: Authors' conception.

As shown in Figure A.2.1, the productivity change has two effects on output at any given actual price. The first effect is a decrease in output at any given input level. It decreases output in the positive quadrant and, hence, corresponds to the move from  $S_2$  to  $S_1$  in Figure A.2.1. The second effect arises from the expected decline in profitability created by the adverse productivity shock and is associated with the  $\tau_0$  term within the parentheses on the right side of equation (2). It changes the output (or input demand at points to the left of the vertical axis) at all prices above zero and, hence, corresponds to the move from  $S_1$  to  $S_0$  in Figure A.2.1. Note that this effect increases the cutoff price at which positive quantities of output

will be produced. As is clear from equation (2), the move from  $S_2$  to  $S_1$  is a proportional change in output (from  $g$  to  $e$  in Figure A.2.1) that is independent of the slope of the supply curve. By contrast, the drop in output (from  $e$  to  $f$  in Figure A.2.1) associated with the drop in effective price depends upon the slope of the supply curve as well as the size of the productivity shock.

A substantial negative productivity (and, hence, supply shock) may cause a sharp rise in the price of agricultural products. If there are perfect substitutes for a product affected by the shock and no impediments to trade, the price increase would be muted by an increase in imports. In the MIRAGRODEP model, however, each country's product is differentiated from that of other countries, hence domestic and imported goods are considered imperfect substitutes (this is often labeled, as the Armington assumption). If the country is an importer, imperfect substitutability between domestic goods and imported goods means that the price of the domestic good must increase if production falls. Conversely, experiments with higher agricultural productivity in Gautam et al. (2022) find that the resulting declines in prices are substantial.

In case of a breadbasket failure, the immediate impact of the reduction in supply is an increase in domestic output prices. This will make imported food commodities relatively cheaper. Imports will increase but, given the Armington assumption, this will only partially compensate for the decline in domestic supply and, at best, moderate the initial domestic price increase. If the supply shock is strong, as in our case of a multiple breadbasket failure, one should expect countries to make bigger efforts to allow imports to flow in to avoid major domestic food shortages. Accordingly, we allow a higher Armington import demand elasticity (i.e. greater substitutability) in the countries hit by a climate extreme and in the year of the supply shock. This dampens the domestic output price ( $p$ ) increase in affected countries/regions to an extent that the price increase is insufficient to compensate for the adverse impact of the productivity shock on farm profitability, i.e. the effective price ( $p^*$ ) declines. See also Appendix A.4 for the effect on the model results of assuming different parameter values for the Armington elasticities in regions affected by extreme weather shocks.

### **A.2.3 Modeling Poverty and Food Security Impacts**

The POVANA model uses a top-down modeling approach to estimate the impacts of changes in productivity on household incomes. The changes in productivity in farm production for each country are imposed directly on each farming household, and changes in commodity prices and wages derived in the model analysis are used to estimate the impact of changes in agricultural productivity on the real incomes of the households covered by the surveys. Once a poverty line has been chosen, this allows the full impact of productivity shocks on poverty to be estimated.

Changes in the cost of a healthy diet are determined by the baseline cost of a basket of nutritious foods and changes in the prices of these foods. The prevalence of undernutrition is determined using a baseline level of income needed to afford a satisfactory diet. Then, at the household level, changes in affordability are determined using changes in real income and in the cost of the standard diet, in a manner similar to that used to measure changes in poverty. The specific procedures used for this analysis are presented in *Appendix A.1.2* of Laborde, Martin and Vos (2021).

## APPENDIX A.3: KEY RESULTS TABLES FOR MULTIPLE BREADBASKET FAILURES (MBBF) SCENARIOS<sup>5</sup>

**Table A.3.1 Scenario SP25P: Short-term Impacts of MBBFs in South Asia and Eastern & Southern Africa (25% negative productivity shock, all crops).**

(Impacts measured as percentage change from baseline in 2026)

SP25P	Global					Eastern and Southern Africa			South Asia			Other LMICs					North America & Europe			Other HICs
<i>25% AG productivity decrease in E-S AFRICA and S Asia - Pulse</i>	World	HICs	LMICs	HICs - Shocked	LMICs - Shocked	Eastern Africa	Ethiopia	Southern Africa	India	Pakistan	Bangladesh	China	Brazil	ReAsia	ReLAC	ReAFR	USA	EU28	Russia & Ukraine	Oceania
<b>Macroeconomic</b>																				
National real income	-0.43	0.00	-1.19	0.02	-4.93	-8.13	-6.51	-0.96	-5.34	-5.70	-5.11	-0.24	0.31	-0.30	0.23	-0.12	0.05	-0.01	0.05	0.16
World market price agricultural commodities	5.59	5.59	5.59	5.59	5.59	5.59	5.59	5.59	5.59	5.59	5.59	5.59	5.59	5.59	5.59	5.59	5.59	5.59	5.59	5.59
Terms of trade						-2.19	-1.24	0.20	-2.64	-3.53	-4.37	0.25	1.67				0.36	0.04		0.47
<b>Trade</b>																				
Agricultural exports value	32.24	25.28	38.20	21.10	-13.49	-37.33	-16.65	-24.29	-53.31	-30.81	52.51	201.78	17.81	62.91	18.45	33.91	24.09	18.65	21.52	8.63
Agricultural imports value	32.24	2.98	55.72	0.75	209.18	128.69	190.88	19.90	412.64	136.59	175.74	7.53	8.70	15.69	4.67	2.91	3.43	-4.39	3.92	3.00
Agricultural exports volume	25.24	20.15	29.55	16.04	-24.27	-42.20	-26.03	-31.87	-59.62	-35.91	37.53	178.21	12.79	51.69	13.43	26.34	17.57	15.72	16.15	5.44
Agricultural imports volume	25.24	-1.32	46.46	-3.62	183.78	113.19	171.91	14.44	362.06	116.43	149.58	3.34	4.01	10.33	0.58	-1.62	-0.59	-9.18	-0.42	-0.29
<b>Farm Sector</b>																				
<i>Production volume</i>																				
- Crops	-3.29	3.34	-5.63	3.04	-25.88	-25.87	-27.89	-22.80	-24.68	-29.52	-29.59	3.75	3.96	-0.94	3.18	0.66	3.82	2.26	3.22	5.18
- Rice	-4.91	5.09	-6.00	6.19	-22.81	-29.21	-28.51	-19.77	-17.73	-29.12	-30.37	6.79	22.20	-0.90	13.13	1.79	6.19	6.33	5.03	9.07
- Wheat	-2.48	3.93	-6.50	2.81	-33.80	-25.59	-27.50	-24.95	-36.52	-28.09	-25.08	10.06	2.44	2.49	1.99	1.60	3.77	2.98	0.60	2.13
- Maize	-1.30	2.85	-3.61	2.65	-25.39	-26.83	-25.76	-24.24	-22.30	-29.46	-31.03	1.00	2.50	-1.46	2.94	1.05	2.66	2.97	1.68	7.85
- Oil seeds & vegetable oil	-2.80	2.39	-5.86	2.34	-26.08	-27.07	-21.16	-22.75	-22.53	-34.06	-33.22	1.91	2.02	-9.52	2.05	1.40	2.47	2.15	1.33	2.43
- Fruits & vegetables	-2.43	2.95	-4.35	2.52	-23.55	-24.35	-31.15	-26.01	-22.56	-33.91	-22.29	1.79	1.03	1.56	1.79	-0.08	3.22	1.60	6.49	4.72
- Livestock	-1.71	0.52	-3.57	0.60	-15.85	-8.08	-9.81	-4.37	-21.06	-12.57	-7.85	-1.18	0.79	-0.21	1.24	0.43	0.44	0.73	0.63	0.40
<i>Farm income and employment</i>																				
Real farm income	3.35	7.02	1.99	6.23	-8.77	-10.43	-16.77	-1.20	-7.57	-8.77	-14.19	9.22	7.76	5.48	6.59	1.87	8.15	4.65	7.11	6.76
Real farm income per worker	2.93	3.84	1.68	3.46	-6.65	-9.16	-12.20	-0.89	-6.22	-7.50	-8.66	4.64	4.39	4.33	3.62	0.90	4.97	2.34	3.88	3.53
Farm employment	0.41	3.07	0.31	2.68	-2.27	-1.40	-5.20	-0.31	-1.44	-1.37	-6.06	4.38	3.22	1.11	2.87	0.96	3.03	2.25	3.11	3.12
<i>Land use</i>																				
- Pastureland	-0.32	-0.46	-0.26	-0.35	-0.61	-0.61	-0.47	-0.74	-0.06	0.70	1.65	-1.37	0.14	-0.24	0.22	0.31	-0.72	-0.14	0.35	-0.25
- Crop land	0.19	0.47	0.08	0.43	-0.57	-0.73	-0.72	0.63	-0.54	-0.60	-0.28	0.34	0.41	0.30	0.48	0.25	0.43	0.31	0.38	0.75
<b>Poverty and food security</b>																				
Extreme poverty (at PPP\$ 2.15 poverty line)	1.18	-0.01	1.43	0.00	3.39	6.24	7.41	6.23	2.55	4.26	2.48	0.00	-0.13	0.10	-0.07	0.07	0.00	0.00	0.00	-0.18
Moderate poverty (at PPP\$ 3.65 poverty line)	1.83	-0.01	2.23	0.00	5.35	3.70	6.28	6.55	5.41	9.96	6.93	-0.08	-0.15	0.19	-0.11	0.02	0.00	0.00	0.00	-0.13
Extreme poverty among farmers (at PPP\$ 2.15 p	2.80	-0.15	2.89	0.00	4.86	7.81	8.80	10.41	2.87	4.26	2.65	0.00	-0.41	0.23	-0.26	0.06	0.00	0.00	0.00	-0.20
Moderate poverty among farmers (at PPP\$ 2.15	2.44	-0.17	2.50	0.00	6.16	3.91	6.87	10.15	4.99	9.96	8.51	-0.14	-0.52	0.50	-0.39	-0.06	0.00	0.00	0.00	-0.86
Prevalence of undernourishment (PoU)	1.82	-0.02	2.19	0.00	4.74	3.89	2.08	0.55	3.70	7.71	10.53	0.00	0.00	0.57	0.00	0.26	0.00	0.00	0.00	0.01
<b>Food prices, consumption and diets</b>																				
Domestic food prices	1.80	1.29	2.40	1.10	5.51	1.93	1.01	2.63	8.32	2.75	0.53	2.06	1.29	1.98	0.98	0.55	1.25	0.92	1.02	1.12
Healthy diet food prices	4.10	4.37	3.97	3.91	6.39	7.32	-0.55	8.66	8.87	2.34	4.49	4.91	2.97	5.13	2.76	1.50	4.02	2.53	4.78	3.63
Sugar Consumption Per Capita	-5.18	-0.68	-7.83	-0.98	-15.21	-17.73	-17.75	-13.78	-15.70	-19.81	-18.41	-6.16	0.56	-2.14	-0.72	-1.55	-0.96	-0.74	-2.45	-1.30
Fats Consumption Per Capita	-1.22	-0.99	-1.34	-0.93	-2.65	-4.28	-8.35	-0.34	-2.18	-3.81	-3.85	-0.64	-1.05	-1.66	-1.09	-1.56	-0.83	-0.87	-1.85	-1.25
Dairy Consumption Per Capita	-4.19	-0.76	-7.29	-0.68	-14.30	-16.32	-8.85	-6.42	-14.44	-15.64	-17.26	-1.03	-2.83	-2.08	-2.51	-2.89	-0.40	-0.65	-1.92	-0.24
Veg&Fruits Consumption Per Capita	-2.11	-0.91	-2.70	-0.52	-6.23	-5.83	-1.52	-2.45	-7.01	-1.54	-3.86	-1.84	-0.65	-2.04	-0.75	-0.25	-0.70	-0.27	-1.60	-0.75
Cereals Consumption Per Capita	-2.93	-1.40	-3.40	-0.96	-4.21	-5.31	-3.73	-3.54	-4.98	-3.13	-2.37	-4.73	-1.58	-1.73	-1.25	-1.21	-1.19	-0.82	-0.43	-0.67

Source: Authors' simulations with MIRAGRODEP model.

Note: Results for poverty and food security are in percentage point changes from baseline.

<sup>5</sup> Please note that results for EU28 refer to the 27 members of the European Union and the United Kingdom.

**Table A.3.2 Scenario NP25P: Short-term Impacts of MBBFs in North-America and Europe (25% negative productivity shock, all crops).**

(Impacts measured as percentage change from baseline in 2026)

NP25P	Global					Eastern and Southern Africa			South Asia			Other LMICs					North America & Europe			Other HICs
	World	HICs	LMICs	HICs - Shocked	LMICs - Shocked	Eastern Africa	Ethiopia	Southern Africa	India	Pakistan	Bangladesh	China	Brazil	ReAsia	ReLAC	ReAFR	USA	EU28	Russia & Ukraine	Oceania
<b>25% AG productivity decrease in N.AMERICA and EUROPE - Pulse</b>																				
<b>Macroeconomic</b>																				
National real income	-0.60	-0.80	-0.24	-0.97	-0.25	-0.21	-0.09	0.05	-0.26	-0.26	-0.40	-0.39	0.68	-0.30	0.45	-0.39	-0.55	-1.46	-1.64	0.31
World market price agricultural commodities	11.20	11.20	11.20	11.20	11.20	11.20	11.20	11.20	11.20	11.20	11.20	11.20	11.20	11.20	11.20	11.20	11.20	11.20	11.20	11.20
Terms of trade						0.44	2.52	0.26	-0.26	-0.90	-0.88	0.03	3.53				0.15	-0.42		0.99
Trade																				
Agricultural exports value	21.07	-9.34	47.07	-23.88	30.88	28.75	29.86	18.08	18.11	14.33	1116.10	191.77	25.55	52.42	29.47	40.77	-19.28	-34.81	-17.49	18.59
Agricultural imports value	21.07	43.78	2.85	78.72	-5.02	1.00	-10.68	1.32	-14.96	-9.98	0.54	3.04	5.93	2.16	3.99	-0.35	48.10	136.47	46.86	0.55
Agricultural exports volume	8.87	-19.46	33.57	-34.53	23.92	20.73	15.83	9.87	15.86	11.08	1019.17	164.64	14.17	40.84	18.10	29.97	-30.58	-42.54	-33.13	11.37
Agricultural imports volume	8.87	29.51	-7.65	60.65	-13.54	-7.44	-23.06	-5.96	-23.34	-20.44	-8.75	-7.85	-4.76	-7.61	-7.59	-10.15	34.02	111.72	32.53	-7.75
<b>Farm Sector</b>																				
<b>Production volume</b>																				
- Crops	-2.85	-16.09	2.18	-24.21	1.49	1.70	2.35	2.77	1.41	1.82	0.39	3.61	4.99	3.19	4.90	1.01	-22.89	-25.50	-23.13	6.88
- Rice	0.43	-4.75	1.01	-26.42	0.64	1.61	-0.09	-1.90	1.05	1.97	-0.03	1.34	7.53	0.36	5.60	1.82	-25.22	-27.46	-28.63	3.05
- Wheat	-5.07	-15.86	2.04	-25.89	3.42	9.16	4.93	9.15	3.66	1.00	13.26	8.56	7.27	8.52	10.86	4.19	-23.79	-26.26	-26.71	12.76
- Maize	-5.20	-15.74	1.39	-17.96	1.76	2.04	2.12	4.81	0.80	1.40	2.17	1.03	7.06	3.65	7.64	1.30	-17.07	-19.14	-20.94	8.55
- Oil seeds & vegetable oil	-6.46	-22.53	3.79	-24.45	2.56	2.93	6.71	4.66	1.82	5.99	10.51	7.21	8.47	3.45	8.38	1.90	-24.51	-24.54	-25.85	8.77
- Fruits & vegetables	-1.99	-15.32	3.08	-26.54	1.61	0.75	0.78	5.23	1.24	2.61	2.30	4.67	2.17	5.33	4.73	0.28	-28.12	-26.88	-19.36	4.33
- Livestock	-2.51	-5.08	-0.28	-7.10	0.24	0.60	-0.38	0.61	-0.56	-0.35	15.01	-0.67	-0.84	0.86	0.92	1.07	-4.43	-8.51	-10.09	4.10
<b>Farm income and employment</b>																				
Real farm income	7.38	7.57	7.31	5.66	3.25	3.89	5.06	10.82	2.17	2.59	5.09	10.17	12.93	9.41	12.04	3.21	9.12	3.47	3.23	14.05
Real farm income per worker	4.24	3.26	4.22	3.65	1.29	1.51	2.52	6.68	0.83	1.57	2.58	4.93	7.52	4.87	6.40	1.60	4.06	2.03	1.53	6.61
Farm employment	3.01	4.17	2.96	1.94	1.93	2.34	2.48	3.88	1.33	1.00	2.44	4.99	5.03	4.33	5.30	1.58	4.86	1.42	1.67	6.97
<b>Land use</b>																				
- Pastureland	0.01	0.32	-0.13	0.74	-0.01	0.12	-0.26	-0.24	-0.24	-0.15	1.41	-1.22	-0.70	-0.11	-0.15	0.45	0.74	1.54	0.14	0.61
- Crop land	0.59	0.57	0.60	0.29	0.33	0.40	0.68	1.70	0.16	0.06	0.14	0.45	1.53	0.88	1.53	0.28	0.51	0.13	0.12	2.15
<b>Poverty and food security</b>																				
Extreme poverty (at PPP\$ 2.15 poverty line)	0.00	-0.02	0.01	0.00	0.02	0.17	-0.09	1.29	0.00	-0.01	-0.03	0.00	-0.18	-0.01	-0.09	0.06	0.00	0.00	0.00	-0.38
Moderate poverty (at PPP\$ 3.65 poverty line)	-0.11	-0.02	-0.13	0.11	-0.16	-0.01	-0.37	1.44	-0.16	-0.39	-0.18	-0.20	-0.33	-0.08	-0.19	0.08	0.00	0.10	0.00	-0.42
Extreme poverty among farmers (at PPP\$ 2.15 p	-0.01	-0.30	0.00	0.00	0.03	0.18	-0.13	2.01	0.01	-0.01	-0.05	0.00	-0.55	-0.10	-0.30	0.02	0.00	0.00	0.00	-0.23
Moderate poverty among farmers (at PPP\$ 2.15 p	-0.25	-0.25	-0.25	0.27	-0.26	-0.02	-0.52	2.10	-0.29	-0.39	-0.24	-0.33	-1.03	-0.22	-0.55	-0.01	0.00	0.27	0.00	-1.29
Prevalence of undernourishment (PoU)	0.00	-0.08	0.02	0.00	0.05	0.43	-0.05	0.19	-0.01	-0.02	-0.01	0.00	0.00	-0.12	0.02	-0.03	0.00	0.00	0.00	0.01
<b>Food prices, consumption and diets</b>																				
Domestic food prices	2.78	3.35	2.11	3.60	1.57	0.93	2.01	1.68	1.56	2.39	0.42	2.55	2.41	2.45	2.04	1.04	3.65	3.62	3.17	1.64
Healthy diet food prices	7.86	11.34	6.17	15.03	3.55	1.71	2.89	6.32	2.11	3.58	2.24	5.62	4.58	6.24	5.41	3.63	12.49	15.38	17.24	4.56
Sugar Consumption Per Capita	-5.57	-12.44	-1.50	-15.79	-0.77	-1.03	-1.86	-0.05	-0.22	-0.64	-0.26	-0.92	-0.15	-1.90	-0.34	-1.71	-15.73	-16.48	-13.36	-4.34
Fats Consumption Per Capita	-4.00	-4.80	-3.58	-5.39	-3.73	-3.28	-4.85	-1.51	-4.32	-5.50	-3.63	-2.89	-2.75	-4.10	-3.52	-2.59	-5.19	-4.95	-10.41	-2.93
Dairy Consumption Per Capita	-5.11	-7.18	-3.24	-8.58	-1.43	-3.31	-2.14	-4.64	-0.76	-1.04	-8.02	-3.07	-1.55	-3.74	-3.11	-6.57	-7.43	-9.04	-10.40	-2.78
Veg&Fruits Consumption Per Capita	-2.26	-2.34	-2.22	-2.85	-0.82	-0.51	-1.05	-1.48	-0.69	-0.96	-0.90	-3.14	-1.20	-2.39	-1.68	-0.57	-2.40	-2.67	-6.23	-0.88
Cereals Consumption Per Capita	-2.28	-4.81	-1.52	-6.45	-0.68	-1.71	-2.11	-2.12	-0.63	1.43	-0.49	-1.84	-1.99	-1.76	-2.34	-2.08	-8.68	-4.71	-3.66	-1.15

Source: Authors' simulations with MIRAGRODEP model.

Note: Results for poverty and food security are in percentage point changes from baseline.

**Table A.3.3 Scenario SP10P: Short-term Impacts of MBBFs in South Asia and Eastern & Southern Africa (10% negative productivity shock, all crops).**

(Impacts measured as percentage change from baseline in 2026)

SP10P	Global					Eastern and Southern Africa			South Asia			Other LMICs					North America & Europe			Other HICs
	World	HICs	LMICs	HICs - Shocked	LMICs - Shocked	Eastern Africa	Ethiopia	Southern Africa	India	Pakistan	Bangladesh	China	Brazil	ReAsia	ReLAC	ReAFR	USA	EU28	Russia & Ukraine	Oceania
<b>10% AG productivity decrease in E-S AFRICA and S Asia - Pulse</b>																				
<b>Macroeconomic</b>																				
National real income	-0.18	0.00	-0.50	0.01	-2.01	-3.81	-2.58	-0.37	-2.13	-2.30	-1.74	-0.12	0.12	-0.13	0.08	-0.02	0.02	0.00	0.01	0.03
World market price agricultural commodities	2.14	2.14	2.14	2.14	2.14	2.14	2.14	2.14	2.14	2.14	2.14	2.14	2.14	2.14	2.14	2.14	2.14	2.14	2.14	2.14
Terms of trade						-0.77	-0.41	0.14	-1.10	-1.68	-1.90	0.14	0.62				0.16	0.01		0.08
<b>Trade</b>																				
Agricultural exports value	13.05	8.73	16.75	7.19	-9.47	-25.97	-3.73	-14.32	-37.81	-33.76	246.73	116.28	6.43	24.38	5.81	10.12	9.58	5.29	5.78	1.18
Agricultural imports value	13.05	0.96	22.76	-0.25	84.06	43.50	87.80	-9.24	164.05	50.65	85.57	5.22	3.18	6.56	1.38	1.10	0.53	-1.91	0.99	-0.73
Agricultural exports volume	10.69	7.12	13.73	5.48	-14.52	-28.28	-8.50	-18.12	-41.15	-34.11	233.24	106.57	4.65	20.84	4.18	7.47	6.91	4.37	4.74	0.65
Agricultural imports volume	10.69	-0.39	19.54	-1.63	76.01	39.20	82.88	-10.88	147.66	43.69	76.88	3.54	1.88	4.68	0.09	-0.05	-0.59	-3.67	-0.46	-1.47
<b>Farm Sector</b>																				
<b>Production volume</b>																				
- Crops	-1.24	1.21	-2.11	1.09	-10.71	-9.55	-11.87	-6.93	-10.25	-13.13	-14.59	2.15	1.62	-0.39	1.19	0.11	1.60	0.70	1.12	1.24
- Rice	-2.02	2.64	-2.54	2.02	-10.33	-11.96	-12.50	-6.12	-7.44	-14.33	-15.96	3.94	10.63	-0.49	5.85	0.56	1.96	2.10	2.01	2.34
- Wheat	-1.04	1.03	-2.34	0.15	-16.33	-8.43	-10.59	-8.12	-18.75	-11.65	-6.51	7.53	0.12	1.25	-0.46	0.30	0.88	0.46	-1.43	-1.31
- Maize	-0.42	1.32	-1.41	1.22	-10.38	-10.40	-10.19	-9.66	-9.07	-13.86	-15.22	0.47	1.22	-0.66	1.36	0.34	1.30	1.20	0.68	3.65
- Oil seeds & vegetable oil	-0.98	0.99	-2.16	0.98	-10.43	-10.12	-5.21	-7.26	-8.47	-14.95	-14.86	0.83	1.14	-3.97	1.11	0.33	1.02	0.90	0.67	0.81
- Fruits & vegetables	-0.79	0.56	-1.27	0.45	-7.47	-9.23	-15.63	-10.41	-6.40	-16.73	-6.02	0.66	-0.04	0.76	0.26	-0.22	0.21	0.27	3.15	-1.28
- Livestock	-0.71	0.11	-1.39	0.19	-5.48	-3.13	-3.87	-1.59	-7.52	-3.91	1.92	-0.75	0.05	-0.34	0.19	0.17	0.08	0.25	0.08	-0.08
<b>Farm income and employment</b>																				
Real farm income	1.41	2.40	1.04	2.07	-3.53	-3.10	-8.35	1.71	-3.16	-4.15	-9.06	5.12	2.87	2.14	2.14	0.49	3.01	1.46	1.86	1.11
Real farm income per worker	1.10	1.46	0.76	1.23	-2.78	-3.60	-5.64	0.76	-2.56	-3.43	-4.55	2.62	1.66	1.50	1.23	0.26	1.93	0.75	0.92	0.63
Farm employment	0.30	0.93	0.28	0.83	-0.77	0.52	-2.87	0.95	-0.61	-0.75	-4.72	2.44	1.19	0.63	0.89	0.22	1.07	0.71	0.93	0.48
<b>Land use</b>																				
- Pastureland	-0.18	-0.18	-0.18	-0.18	-0.19	-0.18	-0.14	-0.22	0.20	0.42	1.62	-0.82	-0.05	-0.13	-0.01	0.12	-0.34	-0.06	0.03	-0.12
- Crop land	0.07	0.19	0.02	0.14	-0.25	-0.20	-0.22	0.50	-0.35	-0.35	-0.01	0.26	0.11	0.17	0.19	0.09	0.23	0.09	0.06	0.01
<b>Poverty and food security</b>																				
Extreme poverty (at PPP\$ 2.15 poverty line)	0.40	0.00	0.48	0.00	1.14	2.63	2.34	2.13	0.71	1.25	1.01	0.00	-0.07	0.05	-0.04	0.03	0.00	0.00	0.00	-0.04
Moderate poverty (at PPP\$ 3.65 poverty line)	0.69	0.00	0.85	0.00	2.05	1.68	1.99	2.42	1.97	4.00	2.92	-0.01	-0.07	0.05	-0.04	-0.02	0.00	0.00	0.00	-0.03
Extreme poverty among farmers (at PPP\$ 2.15 p	1.02	0.00	1.05	0.00	1.76	3.25	2.80	3.50	1.06	1.25	0.95	0.00	-0.23	0.10	-0.12	0.03	0.00	0.00	0.00	0.03
Moderate poverty among farmers (at PPP\$ 2.15	0.90	-0.02	0.92	0.00	2.29	1.77	2.16	3.78	1.58	4.00	3.25	-0.04	-0.19	0.12	-0.13	-0.07	0.00	0.00	0.00	-0.07
Prevalence of undernourishment (PoU)	0.59	0.00	0.70	0.00	1.53	2.90	0.64	0.24	0.77	4.27	1.47	0.00	0.10	0.00	0.13	0.00	0.00	0.00	0.00	0.00
<b>Food prices, consumption and diets</b>																				
Domestic food prices	0.76	0.48	1.10	0.39	2.43	1.08	-0.17	1.25	3.69	0.70	-0.61	1.12	0.53	0.88	0.37	0.14	0.45	0.32	0.38	0.29
Healthy diet food prices	1.42	1.21	1.53	1.17	2.74	3.23	-3.39	3.70	4.22	-0.41	2.70	2.52	1.03	2.36	0.85	0.23	0.88	0.70	2.17	-0.13
Sugar Consumption Per Capita	-2.62	0.26	-4.33	-0.14	-8.83	-12.40	-10.05	-6.34	-9.38	-5.77	-11.07	-4.18	1.56	-0.18	0.35	0.10	-0.21	0.11	-0.96	-0.09
Fats Consumption Per Capita	-0.39	-0.39	-0.39	-0.33	-0.68	-1.06	-3.79	-0.13	-0.10	-2.24	-1.32	-0.18	-0.49	-0.65	-0.49	-0.64	-0.28	-0.33	-0.68	-0.47
Dairy Consumption Per Capita	-1.73	-0.19	-3.13	-0.18	-6.53	-9.24	-2.54	-4.11	-6.44	-6.78	-8.72	-0.42	-0.71	-0.65	-0.59	-0.94	-0.09	-0.18	-0.41	0.25
Veg&Fruits Consumption Per Capita	-0.95	-0.27	-1.28	-0.09	-3.15	-2.79	0.87	-1.03	-3.54	0.01	-1.68	-0.90	-0.14	-0.90	-0.15	0.05	-0.03	-0.04	-0.67	0.22
Cereals Consumption Per Capita	-1.42	-0.58	-1.68	-0.30	-1.41	-3.47	-1.59	-1.87	-1.51	0.02	-0.25	-3.17	-0.73	-0.68	-0.48	-0.32	-0.48	-0.19	0.05	0.05

Source: Authors' simulations with MIRAGRODEP model.

Note: Results for poverty and food security are in percentage point changes from baseline.

**Table A.3.4 Scenario NP10P: Short-term Impacts of MBBFs in North America and Europe (10% negative productivity shock, all crops).**

(Impacts measured as percentage change from baseline in 2026)

NP10P	Global					Eastern and Southern Africa			South Asia			Other LMICs					North America & Europe			Other HICs
	World	HICs	LMICs	HICs - Shocked	LMICs - Shocked	Eastern Africa	Ethiopia	Southern Africa	India	Pakistan	Bangladesh	China	Brazil	ReAsia	ReLAC	ReAFR	USA	EU28	Russia & Ukraine	Oceania
<b>10% AG productivity decrease in N.AMERICA and EUROPE - Pulse</b>																				
<b>Macroeconomic</b>																				
National real income	-0.24	-0.32	-0.12	-0.38	-0.11	-0.10	-0.05	-0.04	-0.11	-0.11	-0.17	-0.17	0.22	-0.13	0.12	-0.17	-0.20	-0.58	-0.66	0.09
World market price agricultural commodities	4.11	4.11	4.11	4.11	4.11	4.11	4.11	4.11	4.11	4.11	4.11	4.11	4.11	4.11	4.11	4.11	4.11	4.11	4.11	4.11
Terms of trade						0.05	0.94	-0.03	-0.13	-0.40	-0.49	0.01	1.16				0.10	-0.06		0.28
Trade																				
Agricultural exports value	3.63	-9.31	14.70	-15.16	4.07	4.54	10.85	1.36	-1.05	0.73	151.25	81.74	8.11	15.28	6.71	5.87	-10.22	-25.99	-8.89	5.33
Agricultural imports value	3.63	8.41	-0.20	14.30	-2.64	-0.59	-4.48	-1.00	-6.47	-4.32	-0.18	1.73	2.25	0.26	0.05	-1.23	8.40	29.83	-2.39	-1.72
Agricultural exports volume	-0.46	-13.56	10.84	-20.30	2.50	2.38	5.67	0.35	-1.58	-0.01	146.59	74.29	4.57	12.11	3.89	2.93	-15.33	-30.32	-16.50	3.25
Agricultural imports volume	-0.46	4.21	-4.20	9.78	-6.08	-3.64	-10.26	-3.58	-10.28	-8.73	-3.60	-2.42	-1.36	-3.60	-4.00	-5.02	4.36	24.72	-6.14	-5.01
<b>Farm Sector</b>																				
<b>Production volume</b>																				
- Crops	-0.91	-5.63	0.83	-8.41	0.45	0.39	0.92	0.25	0.46	0.56	0.18	1.56	1.69	1.07	1.40	0.30	-8.58	-8.40	-7.33	1.71
- Rice	0.15	-1.57	0.34	-8.91	0.11	0.61	-0.11	0.48	0.23	0.23	0.00	0.56	3.49	-0.01	2.58	0.69	-9.18	-8.06	-11.01	1.02
- Wheat	-2.00	-6.55	0.95	-10.84	1.37	3.49	1.93	3.54	1.51	0.36	5.18	4.18	2.81	3.18	4.30	1.77	-9.33	-10.89	-11.83	4.55
- Maize	-1.79	-5.29	0.28	-6.25	0.64	0.77	0.86	1.64	0.26	0.49	0.85	0.21	1.83	1.20	2.21	0.48	-6.13	-5.87	-8.56	3.14
- Oil seeds & vegetable oil	-2.42	-8.44	1.31	-9.14	0.91	1.07	1.90	0.98	0.54	2.21	4.11	2.78	3.11	1.21	2.93	0.67	-9.85	-8.16	-10.16	-0.50
- Fruits & vegetables	-0.44	-5.19	1.33	-8.50	0.50	0.01	0.34	0.43	0.44	0.80	1.02	2.11	-0.10	1.93	0.47	-0.01	-11.17	-8.40	-1.07	0.74
- Livestock	-0.92	-1.73	-0.22	-2.51	0.00	0.16	-0.12	0.34	-0.19	-0.09	1.97	-0.30	-0.25	0.35	0.10	0.19	-1.19	-3.34	-3.89	1.63
<b>Farm income and employment</b>																				
Real farm income	3.06	4.11	2.67	4.30	0.97	0.92	2.03	1.83	0.71	0.86	0.95	4.29	4.14	3.29	3.11	0.83	4.28	4.01	5.30	4.28
Real farm income per worker	1.94	2.26	1.59	2.09	0.36	0.34	1.00	1.17	0.26	0.51	0.38	2.10	2.41	1.71	1.83	0.39	1.84	1.99	2.92	2.02
Farm employment	1.10	1.81	1.07	2.16	0.61	0.58	1.02	0.65	0.45	0.35	0.56	2.14	1.68	1.55	1.26	0.44	2.40	1.98	2.32	2.22
<b>Land use</b>																				
- Pastureland	0.01	0.22	-0.08	0.34	0.02	0.02	-0.09	0.04	-0.08	-0.05	0.24	-0.54	-0.25	0.01	-0.10	0.11	0.43	0.31	0.06	0.31
- Crop land	0.22	0.26	0.21	0.12	0.12	0.15	0.27	0.56	0.06	0.02	0.12	0.20	0.53	0.33	0.55	0.11	0.23	0.15	-0.03	0.67
<b>Poverty and food security</b>																				
Extreme poverty (at PPP\$ 2.15 poverty line)	0.00	0.00	0.00	0.00	0.00	0.08	-0.02	0.37	-0.02	-0.02	0.03	0.00	-0.08	0.00	-0.03	0.02	0.00	0.00	0.00	-0.12
Moderate poverty (at PPP\$ 3.65 poverty line)	-0.04	0.00	-0.04	0.03	-0.06	0.00	-0.33	0.40	-0.06	-0.20	0.03	-0.07	-0.09	-0.03	-0.03	0.06	0.00	0.03	0.00	-0.13
Extreme poverty among farmers (at PPP\$ 2.15 p	0.00	-0.04	0.00	0.00	0.01	0.09	-0.05	0.56	0.00	-0.02	0.00	0.00	-0.25	-0.04	-0.09	0.02	0.00	0.00	0.00	-0.20
Moderate poverty among farmers (at PPP\$ 2.15 p	-0.09	-0.07	-0.09	0.07	-0.11	-0.01	-0.43	0.55	-0.07	-0.20	-0.01	-0.13	-0.30	-0.10	-0.09	0.04	0.00	0.07	0.00	-0.86
Prevalence of undernourishment (PoU)	0.02	-0.02	0.02	0.00	0.04	0.21	0.03	0.05	0.01	0.02	0.00	0.00	0.00	-0.03	0.03	0.03	0.00	0.00	0.00	0.00
<b>Food prices, consumption and diets</b>																				
Domestic food prices	1.23	1.57	0.84	1.76	0.55	0.28	0.81	0.47	0.56	0.85	0.14	1.08	0.80	0.94	0.66	0.35	1.54	1.99	1.90	0.58
Healthy diet food prices	3.40	5.67	2.30	8.21	1.09	0.47	1.20	1.09	0.80	1.28	0.84	2.45	1.12	2.48	1.03	0.95	5.30	8.41	9.97	1.29
Sugar Consumption Per Capita	-2.13	-5.53	-0.11	-7.21	0.20	0.24	0.05	0.74	0.18	0.13	0.35	-0.23	0.36	-0.37	0.78	-0.28	-6.18	-9.23	-6.37	-0.58
Fats Consumption Per Capita	-1.62	-1.99	-1.43	-2.28	-1.57	-1.61	-1.92	-0.56	-1.83	-2.33	-1.49	-1.07	-1.11	-1.65	-1.39	-1.11	-1.79	-2.31	-5.07	-1.19
Dairy Consumption Per Capita	-2.04	-2.96	-1.20	-3.62	-0.46	-0.86	-1.02	-1.83	-0.27	-0.41	-1.78	-1.35	-0.33	-1.48	-0.65	-1.89	-2.85	-3.76	-5.18	-1.02
Veg&Fruits Consumption Per Capita	-1.04	-1.19	-0.96	-1.68	-0.29	-0.09	-0.46	-0.12	-0.25	-0.33	-0.34	-1.44	-0.18	-0.93	-0.29	-0.12	-1.15	-1.62	-4.19	-0.17
Cereals Consumption Per Capita	-0.95	-1.95	-0.64	-2.66	-0.22	-0.69	-0.92	-0.81	-0.22	0.64	-0.15	-0.96	-0.61	-0.63	-0.76	-0.80	-3.31	-2.25	-1.51	-0.34

Source: Authors' simulations with MIRAGRODEP model.

Note: Results for poverty and food security are in percentage point changes from baseline.

**Table A.3.5 Comparison of key results across MBBF scenarios for impacts on national real income, domestic food prices, crop production, and food insecurity**

<i>National real income</i>	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049
<b>World</b>																								
25% AG prod. decrease in E-S AFR. and S Asia	-0.43	0.01	0.01	0.01	-0.41	0.01	0.01	0.01	-0.37	0.01	0.01	0.01	-0.34	0.01	0.01	0.00	-0.30	0.01	0.01	0.00	-0.26	0.01	0.00	0.0
25% AG prod. decrease in E-S AFR. and S Asia + Capital loss	-0.55	-0.08	-0.08	-0.07	-0.58	-0.15	-0.13	-0.12	-0.60	-0.19	-0.18	-0.17	-0.60	-0.23	-0.21	-0.20	-0.59	-0.26	-0.24	-0.23	-0.57	-0.29	-0.27	-0.2
10% AG prod. decrease in N AMER. and EUR.	-0.60	0.03	0.03	0.02	-0.53	0.04	0.03	0.03	-0.48	0.04	0.04	0.03	-0.44	0.05	0.04	0.04	-0.41	0.04	0.04	0.04	-0.38	0.04	0.04	0.0
10% AG prod. decrease in N AMER. and EUR. + Capital loss	-0.88	-0.17	-0.14	-0.12	-0.90	-0.25	-0.21	-0.19	-0.90	-0.30	-0.26	-0.23	-0.88	-0.32	-0.28	-0.25	-0.85	-0.34	-0.29	-0.26	-0.83	-0.34	-0.30	-0.2
<b>HICs</b>																								
25% AG prod. decrease in E-S AFR. and S Asia	0.00	0.02	0.01	0.01	0.01	0.02	0.02	0.02	0.02	0.03	0.02	0.02	0.03	0.03	0.03	0.02	0.04	0.03	0.03	0.02	0.05	0.03	0.03	0.0
25% AG prod. decrease in E-S AFR. and S Asia + Capital loss	0.00	0.02	0.01	0.01	0.02	0.03	0.02	0.02	0.03	0.03	0.03	0.03	0.04	0.04	0.03	0.03	0.05	0.04	0.04	0.03	0.06	0.04	0.04	0.0
10% AG prod. decrease in N AMER. and EUR.	-0.80	0.03	0.02	0.02	-0.74	0.03	0.03	0.03	-0.69	0.04	0.03	0.03	-0.65	0.04	0.03	0.03	-0.61	0.04	0.03	0.03	-0.59	0.04	0.03	0.0
10% AG prod. decrease in N AMER. and EUR. + Capital loss	-1.21	-0.27	-0.23	-0.20	-1.28	-0.40	-0.34	-0.31	-1.32	-0.48	-0.42	-0.38	-1.33	-0.53	-0.46	-0.42	-1.32	-0.56	-0.50	-0.45	-1.31	-0.58	-0.51	-0.4
<b>LMICs</b>																								
25% AG prod. decrease in E-S AFR. and S Asia	-1.19	0.01	0.00	0.00	-1.09	0.00	0.00	-0.01	-0.98	-0.01	-0.01	-0.01	-0.86	-0.01	-0.02	-0.02	-0.76	-0.02	-0.02	-0.03	-0.66	-0.02	-0.03	-0.0
25% AG prod. decrease in E-S AFR. and S Asia + Capital loss	-1.52	-0.26	-0.23	-0.21	-1.56	-0.42	-0.38	-0.35	-1.55	-0.53	-0.48	-0.45	-1.50	-0.61	-0.56	-0.52	-1.44	-0.67	-0.61	-0.57	-1.37	-0.70	-0.64	-0.6
10% AG prod. decrease in N AMER. and EUR.	-0.24	0.04	0.03	0.03	-0.20	0.05	0.04	0.04	-0.17	0.06	0.05	0.04	-0.15	0.06	0.05	0.04	-0.14	0.05	0.05	0.04	-0.13	0.05	0.04	0.0
10% AG prod. decrease in N AMER. and EUR. + Capital loss	-0.30	-0.01	0.00	0.00	-0.27	-0.02	-0.01	-0.01	-0.26	-0.02	-0.02	-0.01	-0.24	-0.03	-0.02	-0.02	-0.23	-0.04	-0.03	-0.03	-0.23	-0.05	-0.04	-0.0
<b>HICs - Shocked</b>																								
10% AG prod. decrease in N AMER. and EUR.	-0.97	0.02	0.02	0.02	-0.90	0.03	0.03	0.02	-0.84	0.03	0.03	0.03	-0.80	0.03	0.03	0.03	-0.76	0.03	0.03	0.03	-0.74	0.03	0.03	0.0
10% AG prod. decrease in N AMER. and EUR. + Capital loss	-1.48	-0.35	-0.30	-0.27	-1.60	-0.53	-0.46	-0.42	-1.67	-0.64	-0.57	-0.52	-1.70	-0.72	-0.65	-0.59	-1.71	-0.77	-0.69	-0.64	-1.72	-0.81	-0.73	-0.6
<b>LMICs - Shocked</b>																								
25% AG prod. decrease in E-S AFR. and S Asia	-4.93	-0.08	-0.08	-0.08	-4.53	-0.16	-0.16	-0.15	-4.11	-0.22	-0.21	-0.21	-3.70	-0.27	-0.26	-0.25	-3.30	-0.29	-0.28	-0.27	-2.88	-0.31	-0.29	-0.2
25% AG prod. decrease in E-S AFR. and S Asia + Capital loss	-6.30	-1.23	-1.07	-0.97	-6.54	-1.94	-1.74	-1.60	-6.51	-2.42	-2.19	-2.02	-6.36	-2.73	-2.48	-2.30	-6.09	-2.91	-2.65	-2.47	-5.72	-3.00	-2.74	-2.5
<b>Domestic food prices</b>																								
<b>World</b>																								
25% AG prod. decrease in E-S AFR. and S Asia	1.80	-0.16	-0.11	-0.08	1.77	-0.19	-0.14	-0.10	1.76	-0.20	-0.15	-0.12	1.73	-0.21	-0.16	-0.13	1.66	-0.22	-0.17	-0.14	1.55	-0.23	-0.18	-0.1
25% AG prod. decrease in E-S AFR. and S Asia + Capital loss	2.06	-0.07	-0.09	-0.08	2.04	-0.11	-0.13	-0.12	2.02	-0.12	-0.15	-0.15	1.99	-0.13	-0.17	-0.17	1.93	-0.14	-0.18	-0.18	1.81	-0.14	-0.19	-0.2
10% AG prod. decrease in N AMER. and EUR.	2.78	-0.18	-0.12	-0.08	2.59	-0.19	-0.13	-0.09	2.45	-0.17	-0.13	-0.09	2.33	-0.16	-0.12	-0.09	2.22	-0.15	-0.11	-0.08	2.08	-0.14	-0.10	-0.0
10% AG prod. decrease in N AMER. and EUR. + Capital loss	3.60	0.36	0.17	0.08	3.39	0.34	0.15	0.06	3.22	0.35	0.14	0.06	3.08	0.35	0.14	0.05	2.95	0.36	0.15	0.06	2.81	0.37	0.15	0.0
<b>HICs</b>																								
25% AG prod. decrease in E-S AFR. and S Asia	1.29	-0.18	-0.12	-0.08	1.29	-0.21	-0.15	-0.11	1.34	-0.22	-0.16	-0.12	1.38	-0.24	-0.18	-0.13	1.41	-0.25	-0.19	-0.14	1.42	-0.26	-0.20	-0.1
25% AG prod. decrease in E-S AFR. and S Asia + Capital loss	1.53	-0.14	-0.12	-0.09	1.53	-0.18	-0.16	-0.12	1.58	-0.20	-0.18	-0.15	1.62	-0.22	-0.20	-0.16	1.65	-0.23	-0.21	-0.18	1.65	-0.24	-0.23	-0.2
10% AG prod. decrease in N AMER. and EUR.	3.35	-0.19	-0.13	-0.08	3.11	-0.19	-0.13	-0.09	2.91	-0.17	-0.12	-0.08	2.72	-0.15	-0.11	-0.07	2.53	-0.13	-0.09	-0.07	2.30	-0.11	-0.08	-0.0
10% AG prod. decrease in N AMER. and EUR. + Capital loss	4.27	0.55	0.28	0.16	4.00	0.56	0.27	0.14	3.78	0.58	0.28	0.14	3.56	0.59	0.29	0.15	3.35	0.61	0.29	0.15	3.10	0.63	0.31	0.1
<b>LMICs</b>																								
25% AG prod. decrease in E-S AFR. and S Asia	2.40	-0.14	-0.10	-0.08	2.31	-0.17	-0.13	-0.10	2.20	-0.18	-0.14	-0.11	2.08	-0.19	-0.15	-0.12	1.90	-0.20	-0.16	-0.13	1.67	-0.20	-0.17	-0.1
25% AG prod. decrease in E-S AFR. and S Asia + Capital loss	2.70	0.01	-0.05	-0.07	2.61	-0.02	-0.10	-0.12	2.50	-0.03	-0.12	-0.15	2.38	-0.04	-0.14	-0.17	2.21	-0.05	-0.16	-0.19	1.97	-0.05	-0.16	-0.1
10% AG prod. decrease in N AMER. and EUR.	2.11	-0.16	-0.11	-0.08	2.01	-0.18	-0.13	-0.10	1.96	-0.18	-0.13	-0.10	1.94	-0.17	-0.13	-0.10	1.91	-0.17	-0.13	-0.10	1.88	-0.16	-0.12	-0.1
10% AG prod. decrease in N AMER. and EUR. + Capital loss	2.81	0.13	0.04	0.00	2.70	0.10	0.01	-0.03	2.63	0.10	0.00	-0.04	2.60	0.11	0.00	-0.04	2.56	0.11	0.00	-0.03	2.53	0.13	0.02	-0.0
<b>HICs - Shocked</b>																								
10% AG prod. decrease in N AMER. and EUR.	3.60	-0.18	-0.12	-0.08	3.32	-0.17	-0.12	-0.08	3.06	-0.15	-0.10	-0.07	2.83	-0.12	-0.08	-0.06	2.59	-0.10	-0.07	-0.05	2.30	-0.08	-0.06	-0.0
10% AG prod. decrease in N AMER. and EUR. + Capital loss	4.52	0.65	0.34	0.20	4.21	0.66	0.34	0.18	3.91	0.69	0.34	0.18	3.65	0.70	0.35	0.19	3.39	0.72	0.35	0.19	3.08	0.73	0.37	0.2
<b>LMICs - Shocked</b>																								
25% AG prod. decrease in E-S AFR. and S Asia	5.51	-0.14	-0.10	-0.08	4.79	-0.15	-0.12	-0.09	3.86	-0.13	-0.11	-0.10	2.88	-0.12	-0.11	-0.10	1.82	-0.12	-0.11	-0.10	0.62	-0.13	-0.11	-0.1
25% AG prod. decrease in E-S AFR. and S Asia + Capital loss	5.93	0.43	0.11	-0.03	5.13	0.40	0.04	-0.12	4.19	0.41	0.01	-0.16	3.22	0.41	-0.01	-0.20	2.18	0.41	-0.03	-0.22	1.01	0.43	-0.02	-0.2

<i>Crop production</i>	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048
<b>World</b>																							
25% AG prod. decrease in E-S AFR. and S Asia	-3.29	0.19	0.14	0.10	-3.32	0.23	0.17	0.14	-3.40	0.24	0.19	0.15	-3.47	0.26	0.21	0.17	-3.56	0.27	0.22	0.18	-3.66	0.29	0.24
25% AG prod. decrease in E-S AFR. and S Asia + Capital loss	-3.94	-0.19	-0.08	-0.04	-4.09	-0.24	-0.11	-0.07	-4.26	-0.31	-0.15	-0.10	-4.40	-0.35	-0.18	-0.13	-4.54	-0.38	-0.20	-0.14	-4.68	-0.40	-0.22
10% AG prod. decrease in N AMER. and EUR.	-2.85	0.21	0.15	0.11	-2.74	0.24	0.18	0.13	-2.69	0.24	0.18	0.14	-2.65	0.23	0.18	0.14	-2.62	0.22	0.17	0.13	-2.59	0.21	0.16
10% AG prod. decrease in N AMER. and EUR. + Capital loss	-3.87	-0.35	-0.17	-0.08	-3.78	-0.32	-0.14	-0.06	-3.71	-0.32	-0.13	-0.05	-3.65	-0.31	-0.12	-0.04	-3.59	-0.30	-0.12	-0.04	-3.55	-0.30	-0.12
<b>HICs</b>																							
25% AG prod. decrease in E-S AFR. and S Asia	3.34	0.40	0.28	0.20	3.73	0.49	0.35	0.25	4.14	0.53	0.39	0.28	4.41	0.56	0.41	0.29	4.65	0.57	0.42	0.31	4.86	0.58	0.43
25% AG prod. decrease in E-S AFR. and S Asia + Capital loss	4.04	0.68	0.46	0.32	4.56	0.81	0.55	0.37	5.03	0.86	0.58	0.39	5.31	0.87	0.58	0.38	5.54	0.87	0.57	0.37	5.72	0.86	0.56
10% AG prod. decrease in N AMER. and EUR.	-16.09	0.05	0.01	-0.02	-16.24	-0.02	-0.04	-0.06	-16.47	-0.08	-0.08	-0.08	-16.75	-0.13	-0.12	-0.11	-17.06	-0.18	-0.15	-0.13	-17.41	-0.23	-0.19
10% AG prod. decrease in N AMER. and EUR. + Capital loss	-21.77	-3.28	-2.10	-1.45	-22.38	-3.64	-2.36	-1.65	-22.77	-3.82	-2.47	-1.73	-23.11	-3.88	-2.51	-1.76	-23.46	-3.94	-2.54	-1.77	-23.86	-4.03	-2.60
<b>LMICs</b>																							
25% AG prod. decrease in E-S AFR. and S Asia	-5.63	0.11	0.09	0.07	-5.73	0.14	0.11	0.09	-5.90	0.15	0.13	0.11	-6.02	0.16	0.14	0.12	-6.13	0.18	0.16	0.14	-6.26	0.20	0.18
25% AG prod. decrease in E-S AFR. and S Asia + Capital loss	-6.75	-0.49	-0.27	-0.17	-7.03	-0.60	-0.34	-0.22	-7.33	-0.69	-0.39	-0.26	-7.53	-0.74	-0.42	-0.28	-7.69	-0.76	-0.44	-0.30	-7.85	-0.78	-0.46
10% AG prod. decrease in N AMER. and EUR.	2.18	0.27	0.20	0.15	2.19	0.33	0.25	0.20	2.15	0.34	0.27	0.21	2.12	0.34	0.27	0.22	2.10	0.34	0.27	0.22	2.08	0.34	0.27
10% AG prod. decrease in N AMER. and EUR. + Capital loss	3.01	0.72	0.52	0.40	3.12	0.84	0.62	0.48	3.08	0.86	0.65	0.50	3.04	0.86	0.65	0.50	3.00	0.85	0.63	0.49	2.96	0.84	0.63
<b>HICs - Shocked</b>																							
10% AG prod. decrease in N AMER. and EUR.	-24.21	-0.19	-0.17	-0.15	-24.49	-0.31	-0.27	-0.23	-24.87	-0.40	-0.33	-0.28	-25.27	-0.46	-0.38	-0.31	-25.72	-0.53	-0.42	-0.34	-26.27	-0.59	-0.47
10% AG prod. decrease in N AMER. and EUR. + Capital loss	-32.77	-5.48	-3.59	-2.51	-33.82	-6.09	-4.03	-2.86	-34.44	-6.34	-4.21	-2.99	-34.93	-6.44	-4.27	-3.04	-35.42	-6.50	-4.30	-3.05	-36.01	-6.62	-4.38
<b>LMICs - Shocked</b>																							
25% AG prod. decrease in E-S AFR. and S Asia	-25.88	-0.30	-0.21	-0.16	-26.98	-0.46	-0.34	-0.26	-28.28	-0.58	-0.43	-0.33	-29.51	-0.66	-0.49	-0.38	-30.80	-0.71	-0.54	-0.42	-32.19	-0.75	-0.58
25% AG prod. decrease in E-S AFR. and S Asia + Capital loss	-30.92	-2.80	-1.71	-1.16	-32.76	-3.44	-2.18	-1.53	-34.50	-3.83	-2.47	-1.77	-35.98	-4.06	-2.65	-1.92	-37.39	-4.22	-2.75	-2.00	-38.80	-4.33	-2.86
<b>Prevalence of Undernourishment</b>																							
<b>World</b>																							
25% AG prod. decrease in E-S AFR. and S Asia	0.16	-0.03	-0.02	-0.01	0.17	-0.04	-0.03	-0.02	0.15	-0.03	-0.02	-0.01	0.15	-0.03	-0.02	-0.01	0.16	-0.03	-0.02	-0.02	0.15	-0.01	-0.01
25% AG prod. decrease in E-S AFR. and S Asia + Capital loss	0.23	-0.01	-0.01	-0.01	0.21	-0.01	-0.02	-0.01	0.23	0.00	-0.01	-0.01	0.20	0.01	-0.01	-0.01	0.20	0.01	0.00	-0.01	0.21	0.02	0.00
10% AG prod. decrease in N AMER. and EUR.	1.95	0.00	0.00	0.00	1.66	0.01	0.00	0.01	1.42	0.02	0.02	0.01	1.02	0.02	0.02	0.01	0.81	0.02	0.03	0.02	0.58	0.02	0.02
10% AG prod. decrease in N AMER. and EUR. + Capital loss	2.54	0.33	0.18	0.14	2.38	0.46	0.28	0.23	2.16	0.39	0.26	0.20	1.69	0.41	0.31	0.27	1.46	0.35	0.30	0.25	1.12	0.39	0.29
<b>HICs</b>																							
25% AG prod. decrease in E-S AFR. and S Asia	0.13	-0.03	-0.01	-0.01	0.12	-0.02	-0.02	-0.01	0.11	-0.02	-0.01	-0.01	0.11	-0.02	-0.02	-0.01	0.12	-0.01	-0.01	0.00	0.12	-0.01	0.00
25% AG prod. decrease in E-S AFR. and S Asia + Capital loss	0.15	0.00	0.00	0.00	0.15	0.01	0.00	0.00	0.14	0.02	0.00	0.00	0.15	0.02	0.00	0.00	0.16	0.02	0.01	0.00	0.15	0.03	0.01
10% AG prod. decrease in N AMER. and EUR.	0.07	-0.02	-0.01	-0.01	0.06	-0.01	-0.01	-0.01	0.03	-0.01	-0.01	-0.01	0.03	-0.01	-0.01	-0.01	0.03	-0.01	-0.01	0.00	0.02	0.00	0.00
10% AG prod. decrease in N AMER. and EUR. + Capital loss	0.07	-0.02	-0.01	-0.01	0.06	-0.01	-0.02	-0.01	0.04	-0.01	-0.01	-0.01	0.03	-0.01	-0.01	-0.01	0.03	0.00	-0.01	0.00	0.03	0.00	0.00
<b>LMICs</b>																							
25% AG prod. decrease in E-S AFR. and S Asia	0.18	-0.04	-0.03	-0.01	0.19	-0.04	-0.03	-0.02	0.16	-0.04	-0.02	-0.02	0.16	-0.03	-0.03	-0.02	0.17	-0.03	-0.02	-0.02	0.16	-0.02	-0.02
25% AG prod. decrease in E-S AFR. and S Asia + Capital loss	0.25	-0.01	-0.01	-0.01	0.23	-0.02	-0.02	-0.02	0.25	-0.01	-0.01	-0.01	0.21	0.01	-0.01	-0.01	0.21	0.01	0.00	-0.01	0.23	0.01	0.00
10% AG prod. decrease in N AMER. and EUR.	2.33	0.00	0.01	0.00	1.97	0.01	0.01	0.02	1.69	0.03	0.03	0.02	1.21	0.02	0.02	0.02	0.95	0.03	0.04	0.03	0.68	0.03	0.03
10% AG prod. decrease in N AMER. and EUR. + Capital loss	3.04	0.40	0.21	0.16	2.83	0.55	0.33	0.27	2.57	0.46	0.31	0.24	2.00	0.48	0.36	0.32	1.72	0.42	0.35	0.29	1.32	0.46	0.34

Source: Authors' simulations with MIRAGRODEP model.

Note: Results for poverty and food security are in percentage point changes from baseline.

**Table A.3.6 Scenarios NP25 and NP25d10: Short-to-medium run impacts of MBBF in North America and Europe with and without capital destruction (% change from baseline)**

		2026	2027	2028	2029
<b>National income</b>					
World	<i>productivity shock only</i>	-0.60	0.03	0.03	0.02
	<i>productivity shock + capital loss</i>	-1.21	-0.27	-0.23	-0.20
Shocked HICs	<i>productivity shock only</i>	-0.97	0.02	0.02	0.02
	<i>productivity shock + capital loss</i>	-1.48	-0.35	-0.30	-0.27
All HICs	<i>productivity shock only</i>	-0.80	0.03	0.02	0.02
	<i>productivity shock + capital loss</i>	-1.21	-0.27	-0.23	-0.20
LMICs	<i>productivity shock only</i>	-0.24	0.04	0.03	0.03
	<i>productivity shock + capital loss</i>	-0.30	-0.01	0.00	0.00
<b>Crop production volume</b>					
World	<i>productivity shock only</i>	-2.85	0.21	0.15	0.11
	<i>productivity shock + capital loss</i>	-3.87	-0.35	-0.17	-0.08
Shocked HICs	<i>productivity shock only</i>	-24.21	-0.19	-0.17	-0.15
	<i>productivity shock + capital loss</i>	-32.77	-5.48	-3.59	-2.51
All HICs	<i>productivity shock only</i>	-16.09	0.05	0.01	-0.02
	<i>productivity shock + capital loss</i>	-21.77	-3.28	-2.10	-1.45
LMICs	<i>productivity shock only</i>	2.18	0.27	0.20	0.15
	<i>productivity shock + capital loss</i>	3.01	0.72	0.52	0.40
<b>Global food prices</b>					
World	<i>productivity shock only</i>	11.20	-0.72	-0.48	-0.33
	<i>productivity shock + capital loss</i>	14.99	1.53	0.79	0.45
<b>Domestic food prices</b>					
World	<i>productivity shock only</i>	2.78	-0.18	-0.12	-0.08
	<i>productivity shock + capital loss</i>	3.60	0.36	0.17	0.08
Shocked HICs	<i>productivity shock only</i>	3.60	-0.18	-0.12	-0.08
	<i>productivity shock + capital loss</i>	4.52	0.65	0.34	0.20
All HICs	<i>productivity shock only</i>	3.35	-0.19	-0.13	-0.08
	<i>productivity shock + capital loss</i>	4.27	0.55	0.28	0.16
LMICs	<i>productivity shock only</i>	2.11	-0.16	-0.11	-0.08
	<i>productivity shock + capital loss</i>	2.81	0.13	0.04	0.00
<b>Real farm income per worker</b>					
World	<i>productivity shock only</i>	4.24	-0.43	-0.29	-0.19
	<i>productivity shock + capital loss</i>	5.21	0.30	0.09	0.01
Shocked HICs	<i>productivity shock only</i>	3.65	-0.77	-0.52	-0.35
	<i>productivity shock + capital loss</i>	5.06	1.35	0.64	0.30
All HICs	<i>productivity shock only</i>	3.26	-0.82	-0.55	-0.37
	<i>productivity shock + capital loss</i>	3.14	0.39	0.06	-0.07
LMICs	<i>productivity shock only</i>	4.22	-0.25	-0.16	-0.11
	<i>productivity shock + capital loss</i>	5.79	0.23	0.09	0.03
<b>Extreme poverty (changes in percentage points from baseline)</b>					
World	<i>productivity shock only</i>	0.00	-0.02	-0.01	-0.01
	<i>productivity shock + capital loss</i>	-0.01	-0.01	-0.01	-0.01
Shocked HICs	<i>productivity shock only</i>				
	<i>productivity shock + capital loss</i>				
All HICs	<i>productivity shock only</i>	-0.02	-0.01	0.00	0.00
	<i>productivity shock + capital loss</i>	-0.03	-0.01	-0.01	0.00
LMICs	<i>productivity shock only</i>	0.01	-0.02	-0.01	-0.01
	<i>productivity shock + capital loss</i>	0.00	-0.02	-0.01	-0.01
<b>Food insecurity (PoU) (changes in percentage points from baseline)</b>					
World	<i>productivity shock only</i>	0.16	-0.03	-0.02	-0.01
	<i>productivity shock + capital loss</i>	0.23	-0.01	-0.01	-0.01
Shocked HICs	<i>productivity shock only</i>	0.02			
	<i>productivity shock + capital loss</i>	0.15			
All HICs	<i>productivity shock only</i>	0.13	-0.03	-0.01	-0.01
	<i>productivity shock + capital loss</i>	0.15	0.00	0.00	0.00
LMICs	<i>productivity shock only</i>	0.18	-0.04	-0.03	-0.01
	<i>productivity shock + capital loss</i>	0.25	-0.01	-0.01	-0.01

Source: Authors' simulations with MIRAGRODEP model.

**Table A.3.7 Scenarios SP25 and SP25d10: Short-to-medium run impacts of MBBF in Eastern and Southern Africa and South Asia with and without capital destruction (% change from baseline)**

		2026	2027	2028	2029
<b>National income</b>					
World	<i>productivity shock only</i>	-0.43	0.01	0.01	0.01
	<i>productivity shock + capital loss</i>	-0.55	-0.08	-0.08	-0.07
Shocked LMICs	<i>productivity shock only</i>	-4.93	-0.08	-0.08	-0.08
	<i>productivity shock + capital loss</i>	-6.30	-1.23	-1.07	-0.97
All HICs	<i>productivity shock only</i>	0.00	0.02	0.01	0.01
	<i>productivity shock + capital loss</i>	0.00	0.02	0.01	0.01
LMICs	<i>productivity shock only</i>	-1.19	0.01	0.00	0.00
	<i>productivity shock + capital loss</i>	-1.52	-0.26	-0.23	-0.21
<b>Crop production volume</b>					
World	<i>productivity shock only</i>	-3.29	0.19	0.14	0.10
	<i>productivity shock + capital loss</i>	-3.94	-0.19	-0.08	-0.04
Shocked LMICs	<i>productivity shock only</i>	-25.88	-0.30	-0.21	-0.16
	<i>productivity shock + capital loss</i>	-30.92	-2.80	-1.71	-1.16
All HICs	<i>productivity shock only</i>	3.34	0.40	0.28	0.20
	<i>productivity shock + capital loss</i>	4.04	0.68	0.46	0.32
LMICs	<i>productivity shock only</i>	-5.63	0.11	0.09	0.07
	<i>productivity shock + capital loss</i>	-6.75	-0.49	-0.27	-0.17
<b>Global food prices</b>					
World	<i>productivity shock only</i>	5.59	-0.49	-0.35	-0.24
	<i>productivity shock + capital loss</i>	6.68	-0.23	-0.26	-0.23
<b>Domestic food prices</b>					
World	<i>productivity shock only</i>	1.80	-0.16	-0.11	-0.08
	<i>productivity shock + capital loss</i>	2.06	-0.07	-0.09	-0.08
Shocked LMICs	<i>productivity shock only</i>	5.51	-0.14	-0.10	-0.08
	<i>productivity shock + capital loss</i>	5.93	0.43	0.11	-0.03
All HICs	<i>productivity shock only</i>	1.29	-0.18	-0.12	-0.08
	<i>productivity shock + capital loss</i>	1.53	-0.14	-0.12	-0.09
LMICs	<i>productivity shock only</i>	2.40	-0.14	-0.10	-0.08
	<i>productivity shock + capital loss</i>	2.70	0.01	-0.05	-0.07
<b>Real farm income per worker</b>					
World	<i>productivity shock only</i>	2.93	-0.23	-0.17	-0.12
	<i>productivity shock + capital loss</i>	4.34	-0.14	-0.23	-0.25
Shocked LMICs	<i>productivity shock only</i>	-6.65	-0.21	-0.17	-0.14
	<i>productivity shock + capital loss</i>	-6.97	-0.25	-0.56	-0.67
All HICs	<i>productivity shock only</i>	3.84	-0.34	-0.23	-0.16
	<i>productivity shock + capital loss</i>	4.60	-0.25	-0.22	-0.18
LMICs	<i>productivity shock only</i>	1.68	-0.20	-0.15	-0.12
	<i>productivity shock + capital loss</i>	2.76	-0.15	-0.26	-0.29
<b>Extreme poverty (changes in percentage points from baseline)</b>					
World	<i>productivity shock only</i>	1.18	0.00	0.00	0.00
	<i>productivity shock + capital loss</i>	1.57	0.24	0.12	0.10
Shocked LMICs	<i>productivity shock only</i>	3.39	0.02	0.01	0.01
	<i>productivity shock + capital loss</i>	4.53	0.72	0.37	0.29
All HICs	<i>productivity shock only</i>	-0.01	-0.01	0.00	0.00
	<i>productivity shock + capital loss</i>	-0.01	-0.01	0.00	0.00
LMICs	<i>productivity shock only</i>	1.43	0.00	0.00	0.00
	<i>productivity shock + capital loss</i>	1.91	0.29	0.15	0.12
<b>Food insecurity (PoU) (changes in percentage points from baseline)</b>					
World	<i>productivity shock only</i>	1.95	0.00	0.00	0.00
	<i>productivity shock + capital loss</i>	2.54	0.33	0.18	0.14
Shocked LMICs	<i>productivity shock only</i>	4.90	0.03	0.03	0.02
	<i>productivity shock + capital loss</i>	6.42	0.89	0.50	0.37
All HICs	<i>productivity shock only</i>	0.07	-0.02	-0.01	-0.01
	<i>productivity shock + capital loss</i>	0.07	-0.02	-0.01	-0.01
LMICs	<i>productivity shock only</i>	2.33	0.00	0.01	0.00
	<i>productivity shock + capital loss</i>	3.04	0.40	0.21	0.16

Source: Authors' simulations with MIRAGRODEP model.

## **APPENDIX A.4: SENSITIVITY OF MODEL RESULTS TO THE IMPORT ELASTICITY OF SUBSTITUTION**

As mentioned in Appendix A.2, a key feature of most applied general equilibrium models is the assumption of imperfect substitution between domestic and imported products. This assumption allows these models to capture key features of modern trade such as the frequent presence of two-way trade and trade flows that are far more diverse and far less linked to transport cost differentials than would be implied by models of spatial equilibrium (Thompson 1981). A challenge with this approach arises when there are shocks to domestic supplies, which can cause unrealistic increases in domestic relative to world prices. For this analysis, we overcame this problem by raising the Armington elasticity of substitution between domestic and imported agricultural products.

The key challenge resulting from use of this approach is evident in the change in producer prices caused by extreme weather-induced loss of production in either southern countries (SP25) or northern countries (NP25). In both these cases, the increase in domestic prices—under the standard Armington elasticities—for the countries that experience the shock is dramatically greater than the associated increase in world prices. This is particularly so in economies with relatively low trade shares, such as India, where the price of maize rises by 48 percent, while the world price rises by only 4 percent. Such agricultural price increases would induce implausibly strong supply responses and increases in farm employment following the adverse weather shock. Temporarily raising the elasticities by a factor of five tempers the increases in domestic prices and mitigates the agricultural supply and employment demand responses.

**Table A.4.1 Implications of higher Armington elasticities for model outcomes for prices, farm incomes and employment (% change from baseline)**

Variable	Scenario	Factor of increase Armington elasticity*	World	Eastern Africa	Ethiopia	Southern Africa	India	USA	EU28**
World Prices	NP25	5	11.2	11.2	11.2	11.2	11.2	11.2	11.2
	SP25	5	5.6	5.6	5.6	5.6	5.6	5.6	5.6
	NP25	1	12.4	12.4	12.4	12.4	12.4	12.4	12.4
	SP25	1	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Production Volume - Crops	NP25	5	-2.8	1.7	2.4	2.8	1.4	-22.9	-25.5
	SP25	5	-3.3	-25.9	-27.9	-20.8	-24.7	3.8	2.3
	NP25	1	-3.0	2.2	2.3	4.9	1.8	-21.5	-22.4
	SP25	1	-3.7	-20.5	-22.5	-20.7	-20.6	2.0	2.0
Producer Price - Crops	NP25	5	10.0	4.0	7.6	6.7	2.4	23.1	24.3
	SP25	5	8.5	18.4	8.5	15.0	21.4	5.9	3.6
	NP25	1	9.8	4.9	7.4	11.1	3.2	28.4	33.3
	SP25	1	9.6	38.4	40.8	19.1	41.0	3.2	2.8
Real Farm Income	NP25	5	7.4	3.9	5.1	10.8	2.2	9.1	3.5
	SP25	5	3.4	-10.4	-16.8	-1.2	-7.6	8.2	4.6
	NP25	1	7.3	4.4	4.9	17.4	2.8	14.8	11.7
	SP25	1	3.8	3.5	-1.0	3.3	6.9	4.6	3.5
Farm Employment	NP25	5	3.0	2.3	2.5	3.9	1.3	4.9	1.4
	SP25	5	0.4	-1.4	-5.2	-0.3	-1.4	3.0	2.3
	NP25	1	2.5	2.8	2.5	6.2	1.7	6.7	5.5
	SP25	1	3.8	7.5	3.5	1.0	6.9	1.7	1.7

Source: Authors' simulations with MIRAGRODEP model.

Notes: \* Change in Armington elasticity applied only to countries/regions facing MBBF. \*\* EU28 includes EU27 and the United Kingdom.

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