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## Biofuels and trade policies to mitigate food price shocks: Reinforcing global food markets

Jan Rieländer, Kate Chalmers, Kerstin Schopohl, Håvard Halland



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# Abstract

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Extreme weather events and large-scale conflicts lead to fluctuations in global food prices, intensifying food insecurity in developing countries. Between 2014 and 2021, the population affected by moderate or severe food insecurity increased by 10 percentage points. Following Russia's aggression against Ukraine in 2022, global prices rose by 37% for maize and 69% for wheat. External shocks that lead to food price spikes are difficult to predict and even more difficult to prevent, making poor households vulnerable to food insecurity. This paper examines how biofuels and trade policies can be used to dampen the impact of global food price swings on domestic markets, especially in developing countries. Simulations using the OECD-FAO Aglink-Cosimo model show that reducing biofuel feedstock commodities by 20% dampens the price increase from an extreme weather event by 53-67% while a 50% cut fully offsets maize and wheat price increases. Multilateral co-ordination could help biofuel systems to contribute to global food security by acting as a reserve and releasing feedstocks during periods of scarcity.

JEL classification: O11, O13, Q01, Q02, Q16, Q17, Q18, P42

Keywords: biofuel, food security, trade, developing countries, agriculture

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# 1 Introduction

**The perspective of future crises in global food prices like the one experienced in 2022, points to the need for global response mechanisms and effective policy instruments that can reduce food price shocks.** Following Russia's aggression on Ukraine in February 2022, global prices reached levels of 37% (for maize) to 69% (for wheat) above those of the previous year, when they were already high due to a range of factors, including climate change and droughts. The events that lead to food price volatility are difficult to predict and even more difficult to prevent. Policies that can help mitigate food price shocks would need to have relatively quick impact, so as to provide markets with some expectations for future supply of food products, thus keeping prices low despite shocks.

**This paper examines biofuel and trade policies as possible instruments to mitigate the price fluctuations from shocks to agricultural production, especially in developing countries.** Two shocks to agricultural production are examined: the first is the geopolitical shock from Russia's invasion of Ukraine in 2022, and the second one is a future extreme weather event simulated for 2026. This paper explores the potential of reducing biofuel use to mitigate food price shocks. Specifically, it looks at the effects of reducing the use of biofuel feedstock commodities by 20% and 50% on the price of wheat, maize and vegetable oils. It also examines the impact of trade restrictions on food prices, in the context of the simulated extreme weather event in 2026. Specifically, a 10% reduction in global exports of wheat, maize, vegetable oils, rice and other cereals is simulated in 2026 alongside the extreme weather event. The analysis is based on the OECD-FAO Aglink-Cosimo model, a recursive-dynamic partial equilibrium model used to simulate developments of annual market balances and prices for over 90 commodities, including biofuels.

**The results show that cuts to biofuel production and measures to ensure open trade can have meaningful impact on food prices during crisis situations.** A 20% cut in the use of maize and vegetable oils for biofuels has a mitigation effect of 53-67% in the case of an extreme weather shock, while a 50% cut would fully offset the initial increase in maize and wheat prices. In developing countries, consumer prices for maize and wheat increase more than in developed countries, making price hike mitigation measures vital for livelihoods. The reductions in biofuel production will generate losses for producers of feedstock commodities, who will see their prices decline. The paper also shows that export restrictions in the context of a major loss in grain production and ensuing grain price shock further exacerbate this shock, making free trade an essential instrument to mitigate against price fluctuations and protect vulnerable populations. In the context of an extreme weather event, a 10% decrease in export leads to increases in wheat, maize and vegetable oil prices by 8-16% from already high levels, with wheat prices increasing the most.

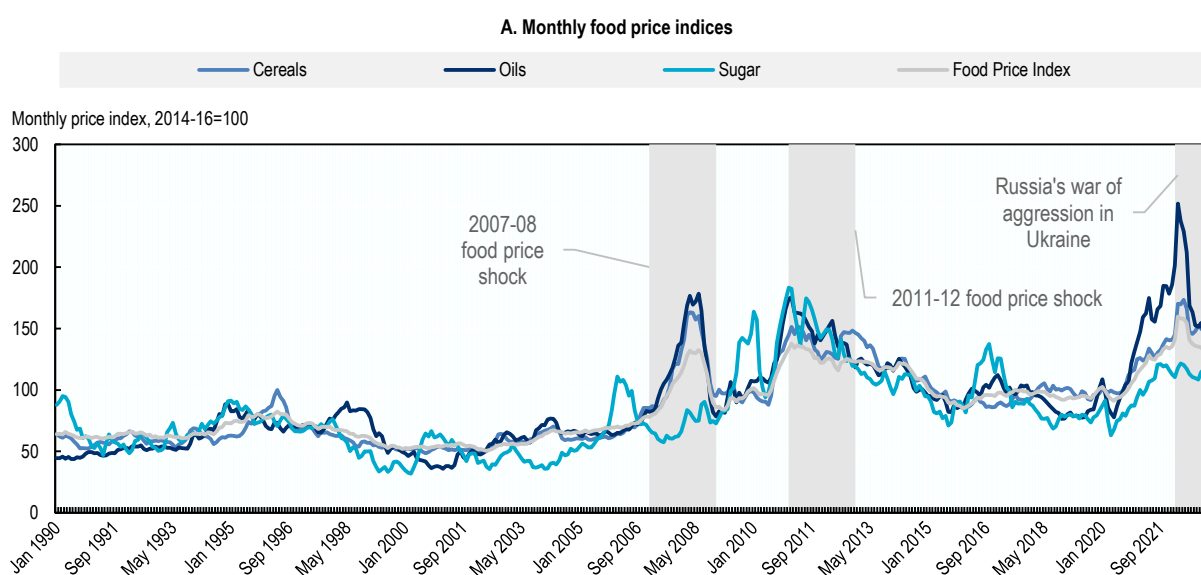
**This paper is organised in four sections.** Section 2 motivates the analysis by providing evidence for increased food price volatility and its impact on food insecurity in poor countries. Section 3 explores two possible channels for policy intervention during international food price shocks: biofuels and trade openness. In Section 4, the OECD-FAO Aglink-Cosimo model is used to analyse how reductions in biofuel production and trade policies can mitigate international food price shocks. Section 5 summarises the main results and outlines concrete policy options for implementation.

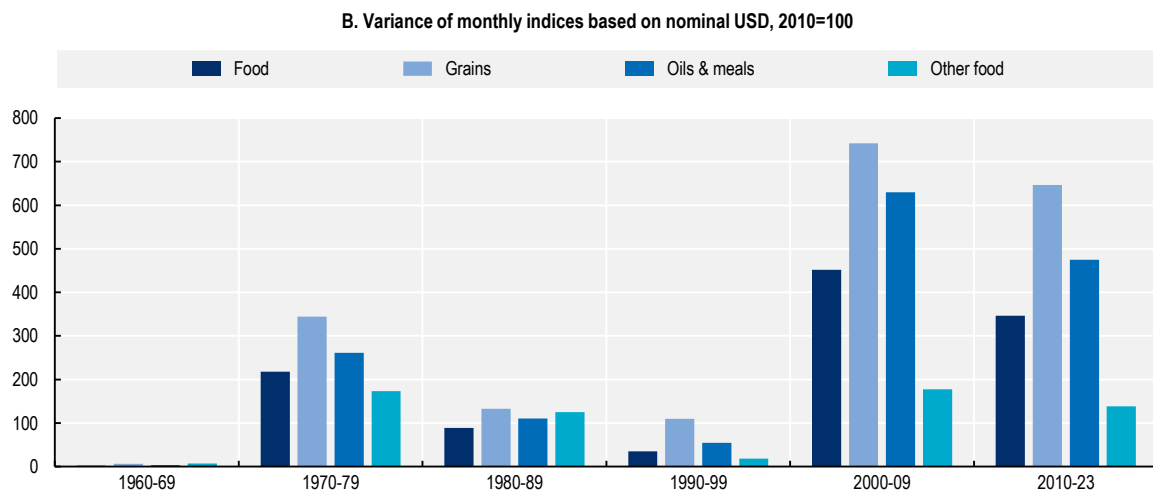
## 2 Context: More frequent food price shocks are exacerbating food insecurity in least developed countries

**A rise in food price volatility is driven by more frequent extreme weather events and other international shocks**

**Food prices have become more volatile over the last two decades.** A series of mostly weather-related spikes in food prices has greatly increased the volatility and overall level of food prices. This includes, most notably, the 2007-08 food price shock, the 2011-12 food price shock, and a third food price shock in 2021-22 (Figure 1, Panel A). Between mid-2020 and mid-2022, the FAO's food price index increased by more than 60% as a result of extreme weather in different parts of the world in 2021 and Russia's war of aggression in Ukraine that began in February 2022 (FAO, 2023<sup>[1]</sup>). Food products that are most commonly internationally traded are far more exposed to international price volatility compared to domestically processed foods (World Bank, 2019<sup>[2]</sup>), with grains and oils showing considerably higher levels of volatility than other food products (Figure 1, Panel B).

**Figure 1. Food price volatility has been on the rise**





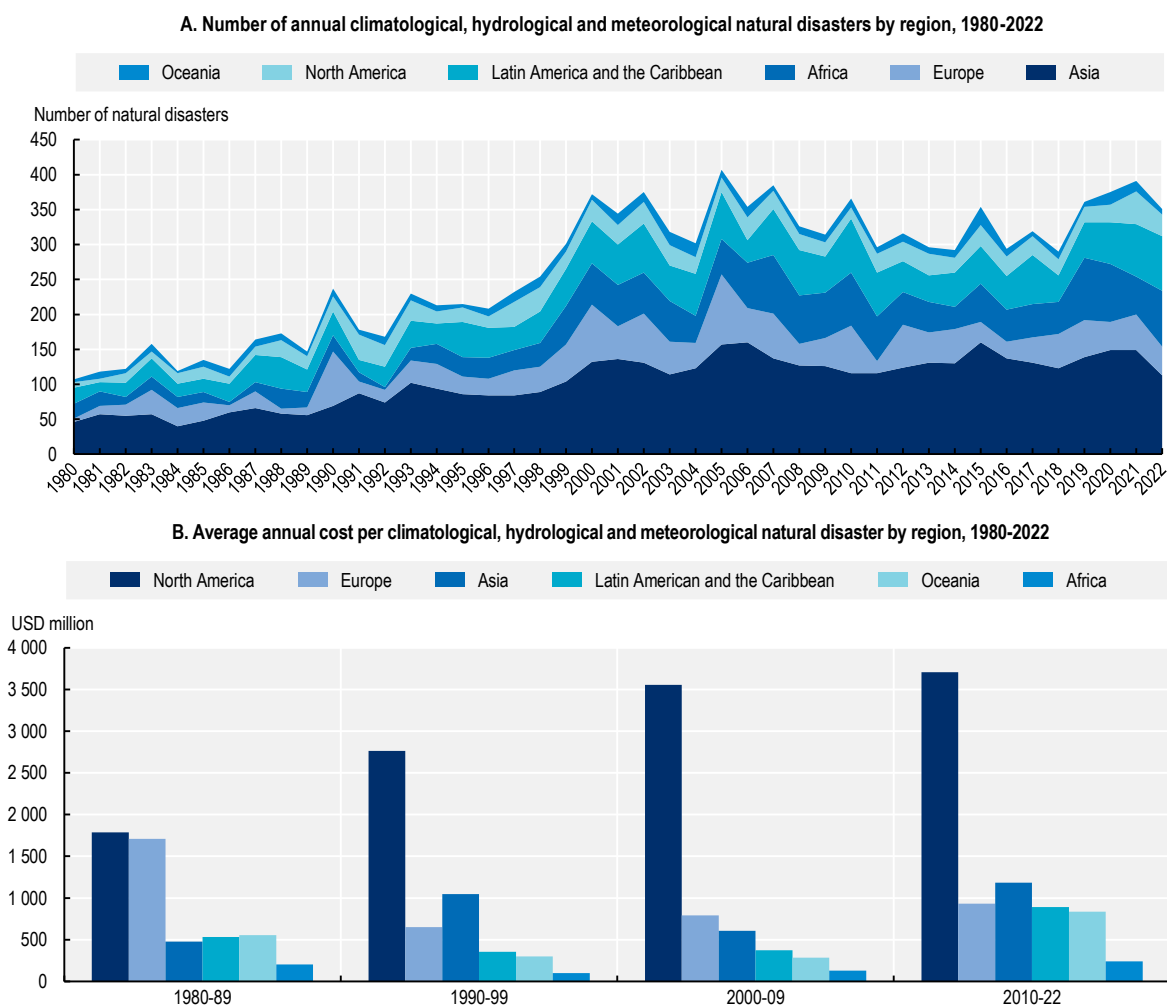
Source: A. FAOStat (2023<sup>[3]</sup>); B. World Bank Pink Sheets (2023<sup>[4]</sup>).

**Extreme weather events and geopolitical factors are key drivers of food price shocks.** The 2007-08 food price crisis has been attributed to a combination of factors, including increased demand, low stocks, high oil prices, and bad harvests, which were made worse by trade restrictions. The 2007-08 shock was followed by another in 2011-12, when the United Nations Food and Agricultural Organization reported that its food price index was the highest since it was established 20 years earlier (FAO, 2011<sup>[5]</sup>). Like the previous shock, the 2011-12 shock had complex causes including very dry summers in the US and Europe (Global Food Security Programme, 2015<sup>[6]</sup>). Although the 2022 food price shock is commonly seen as resulting from Russia's war of aggression in Ukraine, food prices were already at record highs before the invasion as a result of extreme weather in major agricultural producers: the La Niña weather phenomenon caused flooding and severe droughts in North America, South America and Europe, thereby driving up agricultural commodity prices (Terazono and Romei, 2022<sup>[7]</sup>; Hodgson and Bernard, 2022<sup>[8]</sup>).

**As a result of climate change, the number of climate- and weather-related natural disasters worldwide has been increasing and is projected to increase further** (FAO, 2021<sup>[9]</sup>). The number of weather- and climate-related natural disasters has been much higher over the last two decades than in the 1980s and 1990s (Figure 2, Panel A). Whereas there were on average 141 climate- or weather-related natural disasters<sup>1</sup> per year in the 1980s and 90 in the 1970s, the 2010s and 2020s saw an average of 334 distinct climate- and weather-related natural disasters per year (FAO, 2021<sup>[9]</sup>; CRED, n.d.<sup>[10]</sup>). The frequency of extreme weather events is likely to increase even further in a warmer world, and such events are expected to have an even stronger impact (Mbow et al., 2022<sup>[11]</sup>).

**As the frequency of extreme weather events has increased, so has their intensity and the severity of their impact on food crops** (Zurich Insurance, 2022<sup>[12]</sup>; WMO, 2021<sup>[13]</sup>). Extreme weather-related production shocks that had a probability of occurring once every 100 years in 2015 are projected to occur once every 30 years by 2040 (Global Food Security Programme, 2015<sup>[6]</sup>). This is reflected in the average damage per natural disaster, which has already increased in most of the world's regions since the 1980s (UN, 2021<sup>[14]</sup>). Importantly, the average cost was much higher in the 2010s than in previous decades (Figure 2, Panel B). Even these higher cost estimates are likely to reflect lower bounds of the actual cost, since they include mainly rapid-onset and large-scale disasters and fewer of the slow-onset and smaller-scale disasters, which often affect agriculture (FAO, 2021<sup>[15]</sup>).

**Figure 2. The frequency and intensity of natural disasters worldwide have been increasing**



Note: Climatological natural disasters are droughts and wildfires, hydrological natural disasters are floods and landslides and meteorological natural disasters are storms, extreme temperatures and fog.

Source: EM-DAT (2023<sup>[16]</sup>).

**Agriculture is one of the sectors hit hardest by climate- and weather-related natural disasters.** From 2008 to 2018, as a result of declines in crop and livestock production in the aftermath of disasters, USD 30 billion were lost in sub-Saharan and North Africa, USD 29 billion in Latin America and the Caribbean, USD 8.7 billion across Small Island Developing States (SIDS) in the Caribbean and USD 49 billion in Asia (FAO, 2021<sup>[15]</sup>). Between 2008 and 2018 in low- and middle-income countries, 26% of total losses resulting from natural disasters were in agriculture. This compares to 15.3% in industry, commerce and tourism. The impact of droughts is almost exclusively borne by agriculture. Between 2008 and 2018 in low- and middle-income countries, 82% of all drought-related damage and loss took place in the agricultural sector (FAO, 2021<sup>[9]</sup>). In addition to more frequent climate and weather-related natural disasters there has been an increase in the number of outbreaks of transboundary animal and plant pests and diseases (FAO, 2021<sup>[15]</sup>). Rising temperatures and water levels are causing insects and weed seeds to migrate, leading to outbreaks in previously unaffected regions (Baptista et al., 2022<sup>[17]</sup>).

**There is evidence that extreme weather events contribute to spikes in the international prices of agricultural commodities.** As a result of the interconnectedness of the global food system, local crises

quickly propagate globally, affecting food prices and disrupting food markets worldwide (Mbow et al., 2022<sup>[11]</sup>). A study by the IMF finds that staple food prices rise by an average of 1.8% following natural disasters, but that the spike in food prices lasts only three months on average (Okou, Spray and Unsal, 2022<sup>[18]</sup>). However, this is likely to be the lower bound for price spikes following such events, since data in affected food markets might not be collected during the period following a natural disaster, which is when staple food prices would be at their highest (Okou, Spray and Unsal, 2022<sup>[18]</sup>). Willenbockel (2012<sup>[19]</sup>) estimates that the world market price would temporarily increase by 32.9% for wheat and by 139.7% for maize if a drought similar to the scale of the 1988 drought were to occur in 2030 in North America, as compared to 2030 baseline prices. Baseline prices in 2030 are estimated to be more than 100% higher than in 2010 as a result of climate change.

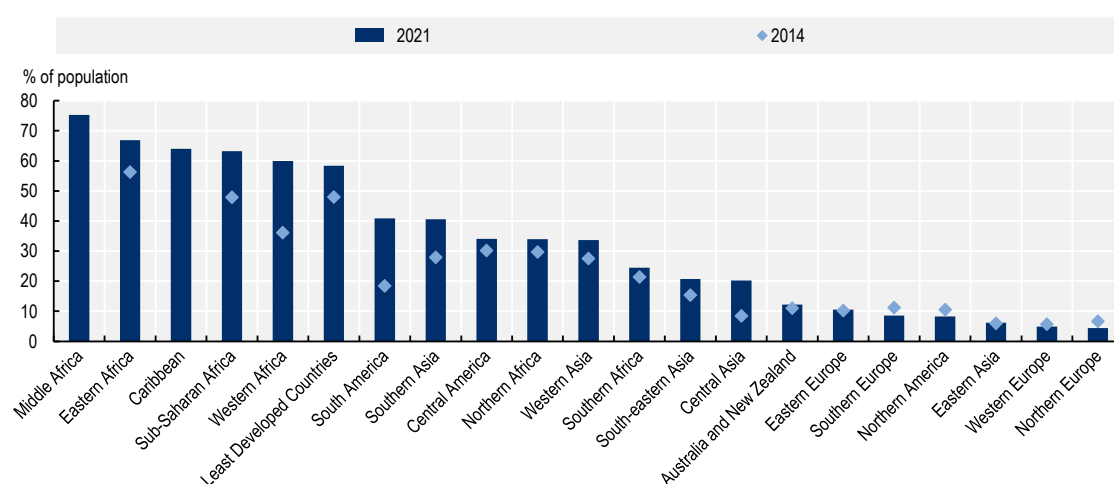
## Least developed countries are most vulnerable to international food price shocks

**Food price volatility has a particularly severe impact on vulnerable populations in developing countries, where food insecurity is increasing.** Whereas the prevalence of food insecurity has remained stable or decreased in the developed world, food insecurity has been expanding in developing countries worldwide since 2014 (Baptista et al., 2022<sup>[17]</sup>). In least developed countries (LDCs), there has been a 10-percentage point increase in the population affected by moderate or severe food insecurity between 2014 and 2021 (Figure 3).

**Least developed countries are particularly vulnerable to extreme weather events given the importance of agriculture for their economies and the vulnerability of food production and distribution in these countries** (FAO, 2021<sup>[15]</sup>). Agriculture accounts for 20% of GDP and 55% of employment in least developed countries compared to only 8.7% of GDP and 29.0% of employment in middle-income countries, and 1.4% of GDP and 4.8% of GDP in OECD countries (2021) (World Bank, 2023<sup>[20]</sup>). In many LDCs, rainfed agriculture prevails and there is often a lack of drainage systems for flood protection. The quality and coverage of transport infrastructure also tends to be poor and infrastructure such as roads, bridges, train tracks and ports are exposed to damage by severe weather. This can hinder food distribution and the supply of agricultural products such as fertiliser within countries and across countries (Baptista et al., 2022<sup>[17]</sup>).

**Figure 3. Food insecurity has increased in developing countries while it has remained constant or decreased in developed countries**

Prevalence of moderate or severe food insecurity (% of population)

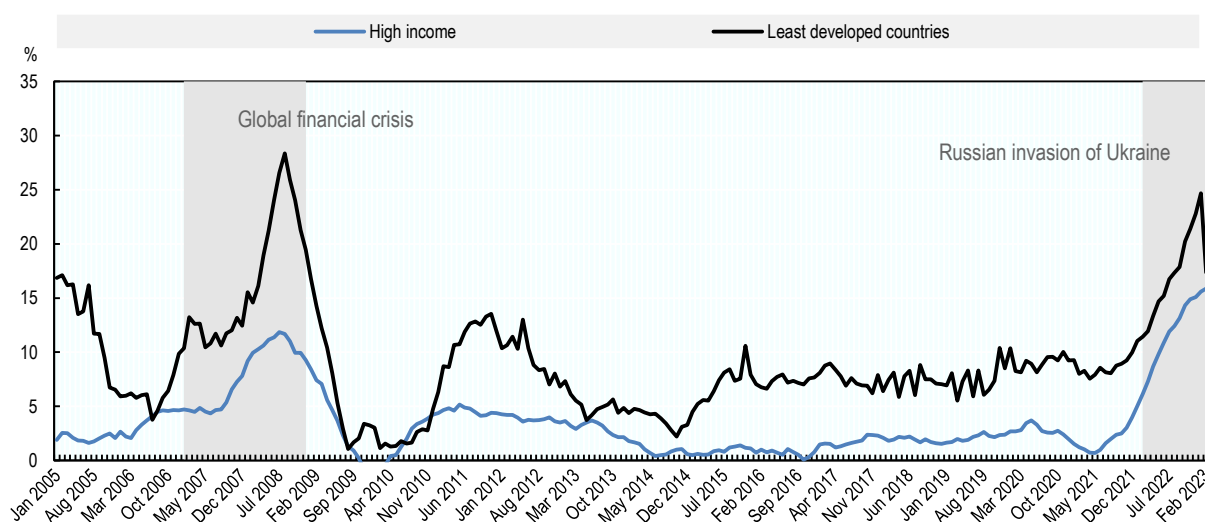


Source: FAOStat (2023<sup>[3]</sup>).

Since food accounts for a large share of household expenditure in low-income countries, populations are more vulnerable to food price increases. Food price inflation disproportionately affects poorer households, since they spend a much larger share of their incomes on food compared to higher-income households. Since poverty is high in low-income and some middle-income countries, food price inflation has a strong impact on these countries' populations (Baptista et al., 2022<sup>[17]</sup>; Rother et al., 2022<sup>[21]</sup>). In least developed countries, households spend on average 55% of their income on food compared to 30% in upper middle-income countries (2010) (World Bank, 2023<sup>[22]</sup>) and 14.9% in OECD countries (OECD, 2022<sup>[23]</sup>). As a result, the weight of food products is large in most least developed countries' consumer price index and the pass-through of higher food prices into overall inflation tends to be higher than in advanced countries (Rother et al., 2022<sup>[21]</sup>; Baptista et al., 2022<sup>[17]</sup>). Furthermore, more than one-third of low-income countries' food expenditure is directed towards staple foods such as cereals, which are most exposed to international price volatility (World Bank, 2019<sup>[2]</sup>). The negative impact of adverse weather events on food production tends to largely outweigh any positive impact of higher food prices on farmers in poor countries, since their populations are predominantly net buyers of food (World Bank, 2019<sup>[2]</sup>; Bloem, Semba and Kraemer, 2010<sup>[24]</sup>; Baptista et al., 2022<sup>[17]</sup>).

**Figure 4. Food inflation has been much higher and more volatile in low-income countries than in high-income countries**

Monthly food inflation, CPI (%)



Source: Authors' calculations based on the IMF Consumer Price Index dataset (2023<sup>[25]</sup>).

**Food price increases following international shocks tend to be much larger in low-income countries than in high-income countries** (Figure 4). This is the result of both high food import dependence and a high share of household expenditure on food. For example, during the 2007-08 and 2010-11 food price shocks, inflation increased from 6.9% in 2006 to 11% in 2008 in LDCs, and from 4.7% in 2009 to 7.1% in 2011. Inflation growth was less pronounced in high-income and OECD countries. Between 2006 and 2008 inflation went from 2.5% to 4.5% in high-income countries and from 2.6% to 4.1% in OECD countries. Between 2009 and 2011, it went from 1.4% to 3.3% in high-income countries and from 1.1% to 3.4% in OECD countries (World Bank, 2019<sup>[2]</sup>; World Bank, 2023<sup>[20]</sup>).

**Food volatility caused by increasingly frequent extreme weather events will likely have the strongest impact on least developed countries, leaving them more at risk of food insecurity.** With more frequent extreme weather events such as droughts and floods, it is likely that there will be more

frequent volatility in food prices. This volatility can be further exacerbated by other unpredictable events, such as war, changes in policies and shocks to the energy market. LDCs and low-income countries are the most exposed to these price changes, which are likely to affect vulnerable populations the most in these countries. This can lead to an even greater increase in food insecurity in already vulnerable regions.

**Swift policy interventions that can reduce food price shocks must be considered.** The events that lead to food price volatility are difficult to predict and even more difficult to prevent. As climate change reversal is a slow process and geopolitical factors are difficult to control, policies that can help mitigate food price shocks consistently and in the short term need to be considered. Such policies would also need to take effect quickly, so as to provide markets with some expectations for the future supply of food products, thus keeping prices low despite shock events.

**Governments have several policy tools to address international food price shocks.** Once a food price shock has occurred, governments must act swiftly to protect vulnerable populations through targeted safety nets and emergency reserves. Well-designed social protection mechanisms, such as conditional cash transfers, school feeding programmes, and input subsidies, can cushion the impact on poor households without distorting market signals. Establishing emergency food reserves ahead of time ensures rapid response capacity, particularly if they are geographically strategic and linked to reliable early warning systems. These interventions should be rule-based, shielded from political interference, and supplemented by international support when domestic fiscal space is limited. Over the long run, governments can reduce the underlying causes of food price volatility by investing in agricultural productivity, sustainability, and infrastructure. Public investments in agricultural research, rural roads, irrigation systems, and market-access infrastructure strengthen resilience and improve supply stability. By fostering a favourable investment climate and reducing post-harvest losses, such policies contribute to steadier production levels and more predictable markets, thereby minimising the frequency and severity of future price shocks (FAO, 2011<sup>[26]</sup>).

# 3 Hypothesis: Biofuels and trade are possible channels to explore for policy intervention during international food price shocks

## Biofuels are one potential policy lever to mitigate food price shocks

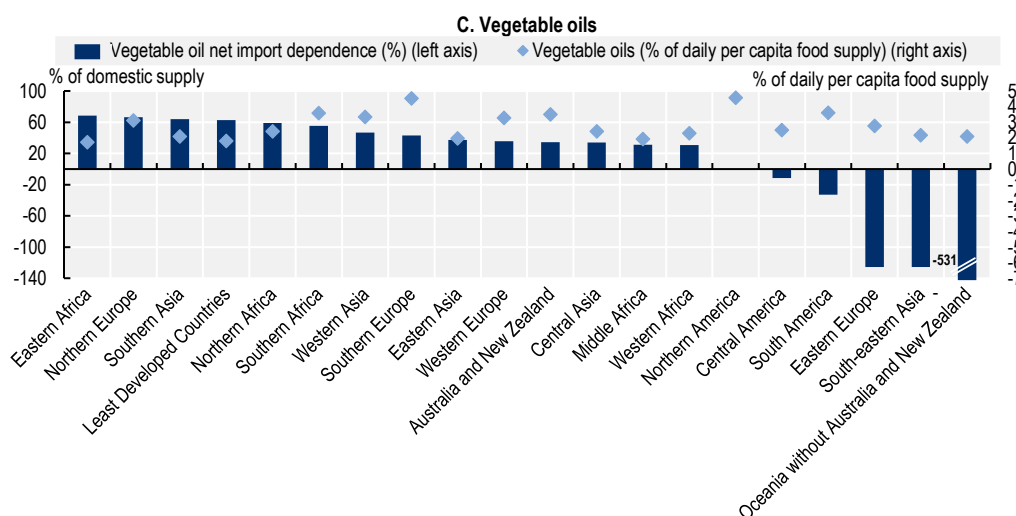
**Biofuels are liquid transport fuels derived from biomass.** There are several types of biofuels and different ways of producing them. The two most common types of biofuels in use today are ethanol and biodiesel. Ethanol is usually produced from sugar and starchy crops such as cereals, whereas biodiesel is produced mainly from oilseed crops, including rapeseed, palm, sunflower seed and soyabeans. Other crops and organic wastes such as used cooking oils and animal fats and wastes are also used for biodiesel production. Advanced, next-generation biofuels made from wastes, cellulosic biomass or algae, which would require less land and labour to grow, are still in early development stages.

**Grains used for biofuels are likely of sufficient quality to serve for human consumption.** Evidence indicates that biomass produced for biofuels in the United States and the European Union is suitable for human consumption, although it may be nutritionally poorer and less tasty. European Union ethanol producers generally use the lowest grade of wheat for biofuel production, which is also used for animal feed. Most ethanol producers in the United States buy maize, which allows for 5% damages and places limits on mycotoxin levels in order to provide Dried Distillers Grains (a by-product of biofuel production used for animal feed) of acceptable quality (Locke et al., 2013<sup>[27]</sup>). This means the biomass usually used to produce biofuels could be reallocated to food markets in times of necessity.

**Biofuel production has been identified as a potential aggravator of food price shocks in the past.** The 2007-08 food price shock coincided with the 2007 US Energy Bill, which almost quintupled the US biofuels target while the European Union and the US alike had already rapidly increased their biodiesel and ethanol production, respectively, in the early to mid-2000s. Several studies find a connection between the growth in biofuels and the 2007-08 food price shock (Mittal, 2008<sup>[28]</sup>; FAO, 2008<sup>[29]</sup>; UNDESA, 2011<sup>[30]</sup>; Helbling and Roache, 2011<sup>[31]</sup>). Similarly, a significant part of the price increase in the 2011-12 food price shock has been attributed to biofuels as high oil prices increased demand and production of biofuels (Global Food Security Programme, 2015<sup>[6]</sup>; World Bank, 2019<sup>[2]</sup>; IEG, 2013<sup>[32]</sup>; UNDESA, 2011<sup>[30]</sup>; Helbling and Roache, 2011<sup>[31]</sup>).

**Governments are not blind to biofuels' food price risks and many have designed policies to buffer price spikes.** Brazil operates flexible ethanol and biodiesel mandates that allow blending levels to be adjusted in response to feedstock price fluctuations, helping to stabilise domestic food markets (Presidency of the Republic of Brazil, 2024<sup>[33]</sup>). In the United States, the Renewable Fuel Standard includes waiver provisions that permit the Environmental Protection Agency (EPA) to reduce blending requirements in cases of severe economic harm, including food price volatility. EPA also regularly conducts impact assessments to





Note: Net import dependence =  $100 \times (\text{Imports} - \text{exports}) / (\text{production} + \text{imports} - \text{exports})$ . Daily per capita food supply refers to percentage contribution of the agricultural product to total kilocalories consumed per capita each day in each region.

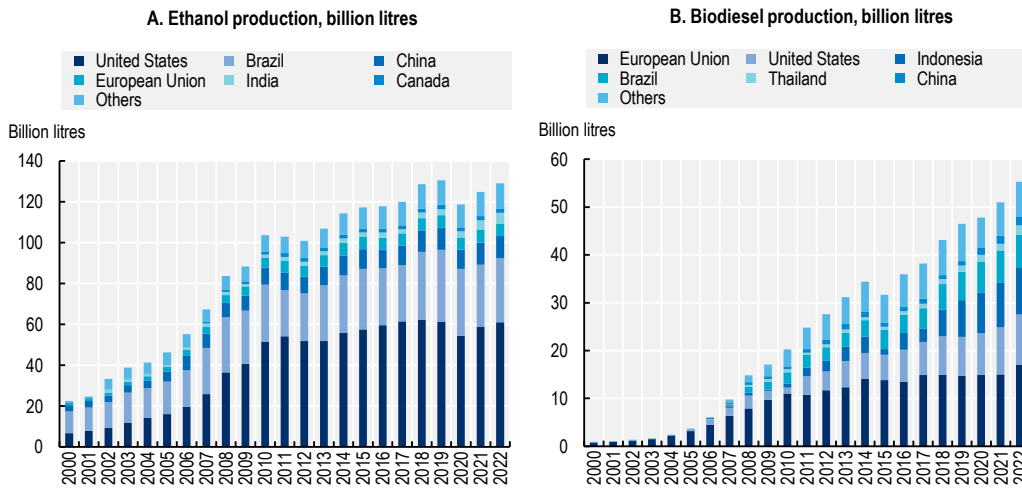
Source: FAOStat (2023<sup>[3]</sup>).

**The hypothesis of this paper is that during shocks events, feedstocks usually used in biofuel products could be reallocated to the food market.** Through shifting the end use of feedstocks from biofuels to human consumption, it would be possible to increase the supply of staple crops such as wheat, maize, and vegetable oils available on the market. This in turn could lower prices of these crops, or at least provide the markets with some expectation of increased supply in the future to temper prices in the short term, even if the policy would not have an immediate impact on supply. As a result, the spike in food prices during shock events could be somewhat reduced, alleviating the pressure of these events on LDCs.

### **Background on biofuels**

**Global biofuel production started expanding rapidly in the 2000s with ethanol production growth continuing at a slower pace in the 2010s** (Figure 6). Global biodiesel production continued expanding at a rapid pace in the 2010s, mainly driven by policies in the United States, Indonesia, Brazil and Argentina. Global ethanol production continued expanding at a slower pace as a result of technical constraints that act as an impediment to increased ethanol use in the United States<sup>2</sup> (OECD/FAO, 2016<sup>[36]</sup>) and a decrease in production during the COVID-19 pandemic. The United States and Brazil account together for more than 70% of the world's ethanol production (47.3% and 24.4% respectively) (2022). The European Union is the world's largest biodiesel producer (30.9% of global production), followed by Brazil (19%) and Indonesia (17.6%) (2022) (OECD, 2023<sup>[37]</sup>).

**Figure 6. Biofuel production started expanding rapidly in the 2000s in the United States, the European Union and Brazil**

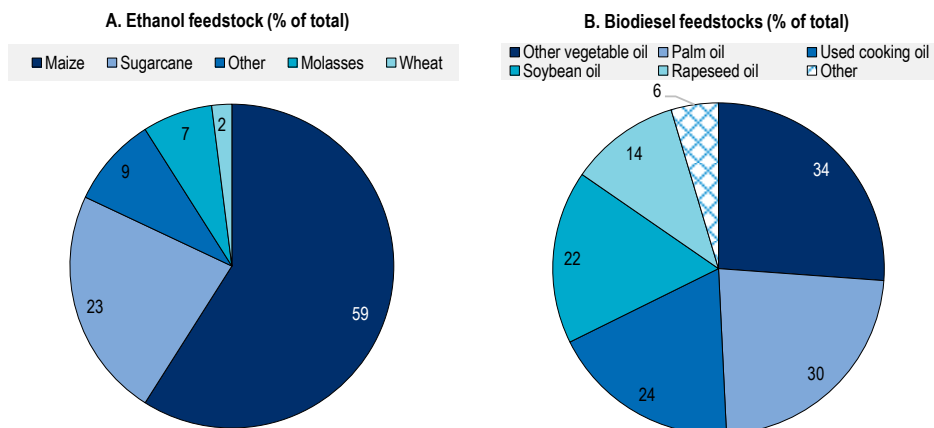


Source: OECD Agricultural Outlook database, OECD Stat (2023<sup>[37]</sup>).

**Maize and sugar products make up the majority of the feedstock for ethanol, while biodiesel production relies mainly on vegetable oils and used cooking oils.** In 2022, ethanol’s total feedstock was made up of 59% maize, 23% sugarcane, 7% molasses and 2% wheat, with the remaining 9% being a mix of assorted grains, cassava and sugar beets (Figure 7 – Panel A) (OECD/FAO, 2023<sup>[38]</sup>). Despite making up a large portion of ethanol feedstock, sugar products (sugarcane, molasses and sugar beets) are excluded from this analysis because their low nutritional content makes them less relevant in a food security context. Furthermore, sugarcane has a relatively long growing cycle (9-24 months) when compared to other crops like wheat or maize (Sugar Nutrition Resource Centre, 2021<sup>[39]</sup>). This would make it difficult to switch out sugarcane for more nutritious crops during food price shocks. In 2022, biodiesel’s total feedstock consisted of 70% vegetable oils (30% palm oil, 22% soybean oil, 14% rapeseed oil) and 24% used cooking oils, with the other 6% being made up of non-edible oils and animal fats (e.g. tallow) (Figure 7 – Panel B) (OECD/FAO, 2023<sup>[38]</sup>; Elgharbawy et al., 2021<sup>[40]</sup>).

**Figure 7. Maize and sugar products make up the majority of ethanol feedstocks, while biodiesel production relies primarily on vegetable oils**

Biofuel feedstocks (% of total), 2022

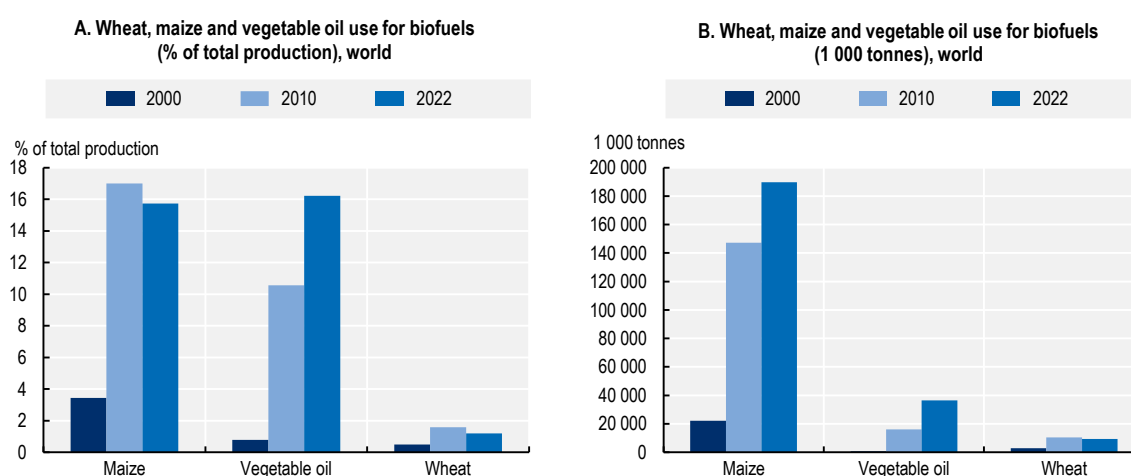


Source: OECD/FAO (2023<sup>[38]</sup>).

Whereas the absolute amounts of crops used for biofuels grew uniformly in the 2000s, only the amounts of maize and vegetable oils used for biofuels continued expanding in the 2010s. The amount of maize, vegetable oils and wheat used for biofuel production increased sharply in the 2000s, both in absolute value and as shares of total production. However, only vegetable oil and maize use for biofuels continued expanding in the 2010s, with vegetable oils growing both in absolute value and as a share of global production and maize growing only in absolute terms (Figure 8). Wheat use for biofuels has declined both in absolute terms and as a share of global production. Maize and vegetable oils used for biofuels account for an important share of global production: In 2022, approximately 16% of global production of both maize and vegetable oil were used for biofuels, while only 1.2% of wheat produced worldwide was used for biofuels.

**Figure 8. The use of grains for biofuel production increased sharply in the 2000s but has further expanded in the 2010s only in the case of vegetable oils**

Wheat, maize and vegetable oil use for biofuels (% of total production), world



Source: OECD Agricultural Outlook database, OECD Stat.

## Biofuel mandates would be a channel to enact policy interventions that temporarily reduce biofuel production

**Biofuel production has been made possible by public support policies and continues to depend on them.** Governments encourage the use of biofuels for two main reasons: to achieve a reduction in greenhouse gas emissions and to bolster energy security. To encourage biofuel production, countries have relied on support policies to build biofuel markets. This is because production costs for biofuels are higher than those of fossil fuels, despite recent efficiency gains (OECD, 2008<sup>[41]</sup>; IEA, 2024<sup>[42]</sup>). Fossil fuels are themselves an input for biofuel production,<sup>3</sup> which undermines biofuels competitiveness relative to fossil fuels. Disruptions in agricultural markets, such as feedstocks price volatility and supply chain bottlenecks, also make it difficult to maintain consistent biofuel production (OECD, 2008<sup>[41]</sup>). As a result, public intervention has been necessary to bridge the price spread between biofuels and fossil fuels for consumers and provide incentives for biofuel producers.

**Biofuel support policies fall into three categories: budgetary support measures, blending or use mandates, and trade restrictions.** Budgetary support measures include tax concessions for both suppliers and consumers, as well as direct support for biomass supply or equipment for biofuel users such as flex-engine vehicles (OECD, 2008<sup>[41]</sup>). Blending or use mandates set a minimum share of ethanol or

biodiesel content (often called admixture) for either gasoline or diesel use, most often in the transport fuel market, although use requirements are sometimes extended to industry and agriculture markets as well. Trade restrictions come in the form of import and export tariffs and quotas limiting exports, and are employed to protect less cost-efficient biofuel industries from comparatively cheaper foreign products or for energy security purposes (OECD, 2008<sup>[41]</sup>).

**Budgetary support measures are employed in all biofuel producing countries.** These support measures will often favour either ethanol or biodiesel depending on the cost efficiency of production within the country. These policies include incentive programmes that provide financial assistance to landowners and operators that deliver feedstock crops to biofuel production facilities, grant and loan guarantees for biofuel refineries, alternative fuel infrastructure tax credits, and various research grants for projects related to biofuels (US Department of Energy, 2023<sup>[43]</sup>). Countries like Brazil focus on encouraging vehicles equipped with flex fuel engines and provide tax related benefits for the purchase of such vehicles (USDA, 2022<sup>[44]</sup>). In India ethanol production is supported via guaranteed pricing and long-term contracts (IEA, 2025<sup>[45]</sup>). Indonesia sets a biodiesel blending mandate, but it ensures it is met via incentives that reduce the cost differential between biodiesel and diesel (IEA, 2020<sup>[46]</sup>). Other policies include the setting of procurement prices, tax rebates, VAT exemptions and low-interest loans with increasing support dedicated to advanced biofuels made from waste oils or cellulosic material.

**Blending and use mandate rates range from 2% to 30%** (Table 1). Under the Renewable Fuel Standard (RFS) programme, the United States currently blends ethanol into gasoline at an average rate of E10 (S&P Global, 2022<sup>[47]</sup>). Brazil has kept an ethanol mandate of E27 since 2015 and its current biodiesel mandate is B10 (a 14% admixture of biodiesel) (USDA, 2022<sup>[44]</sup>). Ethanol blend rates in the European Union vary by country, from 5% to 10%, while biodiesel has been fixed at B7 for several years as per the Fuel Quality Directive. While the biodiesel blend limit is set at 7%, higher overall biofuel blending is possible through the use of renewable diesel, which is fully compatible with diesel engines. For example, Finland has a 22.5% obligation through 2027, and the Netherlands mandates 28.4% in 2024 (EPURE, 2020<sup>[48]</sup>). The People's Republic of China (hereafter "China") has an official mandate of E10, although the actual annual admixture is estimated at 1% to 2% for ethanol and 0.2% for biodiesel due to lax enforcement (USDA, 2022<sup>[49]</sup>). Indonesia, which produces mainly biodiesel, has the highest blend mandate for biodiesel at B30 with the ambition to increase it further to B40 in the future (USDA, 2022<sup>[50]</sup>).

**In addition to blending mandates, some jurisdictions have implemented performance-based policies such as Low-Carbon Fuel Standard (LCFS), where blending may also be used as one way to meet carbon intensity targets.** Unlike volume-based programmes such as the RFS, LCFS frameworks focus on reducing the lifecycle emissions of fuels rather than prescribing specific volumes. Fuel suppliers can meet the target by blending low-carbon fuels, purchasing credits from other suppliers, or improving production efficiency. Performance-based policies are increasingly used in the transport sector to promote clean fuels. The most established example is California's LCFS, launched in 2011, (California Air Resources Board, 2025<sup>[51]</sup>).

**Table 1. Blend mandates vary based on national feedstock availability**

Average blend mandate (%), 2022

	<b>Ethanol</b>	<b>Biodiesel</b>
United States	10%	2.5%
Brazil	18 – 27%	14%
European Union	5 – 10%	7%
China	10%	0.2%
Indonesia	-	30%
Argentina	12%	12.5%
Thailand	10%	5-10%
India	9.3%	5%
Canada	6.3%	2.3%
Malaysia	-	10%

Note: These figures are targets set out by countries and do not always reflect actual production or use levels.

Source: USDA Annual Biofuel Publications (2022<sup>[52]</sup>).

**The majority of the largest biofuel producers have moderate to high import tariffs to protect domestic production and these are sometimes accompanied by quotas to restrict the exports of biofuel.** Import tariffs are often set based on the cost-efficiency of the biofuel product within the country with the aim of protecting domestic production (OECD, 2008<sup>[41]</sup>). Across most biofuel producers, tariffs start at 5% for denatured<sup>4</sup> biofuels and reach upwards of 150% for undenatured ethanol and vary depending on the trade partner. Indonesia and India are the two largest biofuel producing countries with export restrictions, where Indonesia limits annual exports of biofuel to 200 million litres and India allows biofuel to be exported only when the biofuel feedstock itself has been imported in the first place or will be used for non-fuel purposes (USDA, 2022<sup>[50]</sup>; USDA, 2022<sup>[53]</sup>).

**There is some evidence that biofuel's reliance on support policies has waned slightly.** US and Brazilian producers have seen a reduction in the price spread between biofuels and gasoline in the 2010s (IEA, 2019<sup>[54]</sup>). This is the result of years of investment in biofuel infrastructure, economies of scale and their access to relatively cheaper feedstocks compared to other producers. Most price reductions have taken place in ethanol markets which can be related to less costly cultivation of ethanol feedstocks like maize and sugarcane compared to those of biodiesel (IEA, 2019<sup>[54]</sup>). Furthermore, the cost of ethanol production in Brazil has decreased due to investments in efficient mills that are able to produce ethanol and sugar simultaneously, allowing producers to react easily to market fluctuations and optimise production. Furthermore, these mills can convert bagasse, a waste product of sugarcane conversion to ethanol, into a fuel input for the conversion process, lowering energy costs and even in some cases generating additional revenue for mills. However, even with such advances, it is unlikely that the biofuel market would continue to develop without policy support due to high costs of production and limited demand on the consumer side.

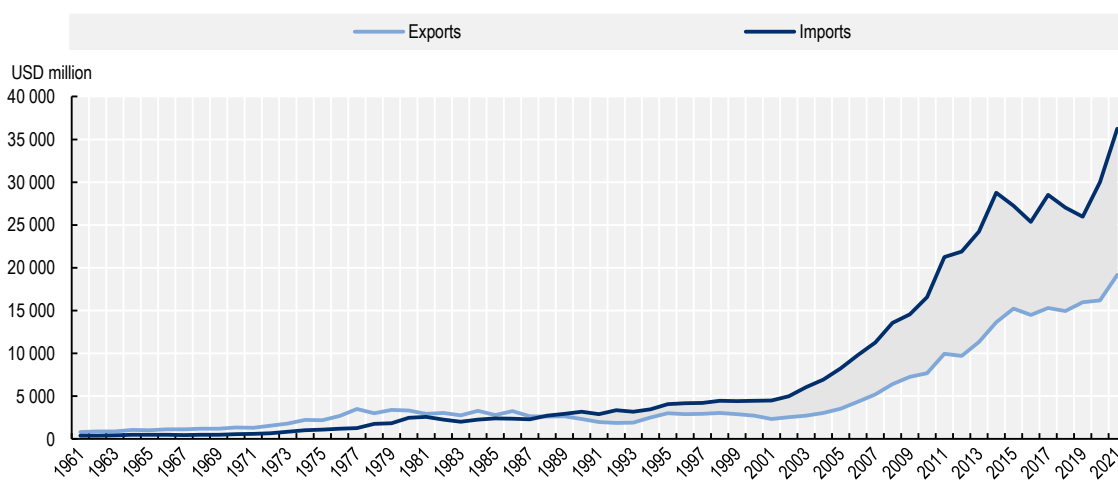
**A reduction in biofuel mandates could be a channel to enact changes in the use of biomass used to produce biofuels.** Biofuel production relies primarily on support policies. In reducing policies temporarily during a food price shock, it could allow the market to reallocate biomass destined for biofuel production to the food market. This could increase the supply of maize and other oilseed products on the market which could be converted to food use, potentially offsetting the loss in supply caused by extreme weather or geopolitical events and stabilising prices. Since biofuel mandates in practice often operate alongside other regulatory frameworks such as LCFS, achieving impact would require integrating specific provisions into these broader policies. Co-ordinated adjustment across both mandate- and performance-based systems would be necessary to deliver effective responses.

## Maintaining open trade during shock events is another strong candidate for a global policy response instrument

Many least developed countries are net food importers and therefore particularly sensitive to fluctuations in international food prices and any form of trade restriction on food items. Countries with large net food imports suffer the most from sudden food price increases (World Bank, 2019<sup>[2]</sup>) and 71% of least developed countries are net food importers (2021). LDC's trade deficit in food products has widened since the 1990s (FAO, 2023<sup>[3]</sup>) (Figure 9).

Figure 9. LDCs' trade deficit in food products has expanded since the 1990s

Food imports and exports in least developed countries, USD million, 1961-2021



Source: FAOStat (2023<sup>[3]</sup>).

**Past food price crises have been further exacerbated by export restrictions imposed by food exporting countries.** Most recently, in 2022 many countries used or contemplated using restrictions on the exports of key food products, particularly rice and vegetable oils, with immediate consequences for prices in countries dependent on such imports (OECD, 2022<sup>[55]</sup>). Looking further back, the WTO estimates that 40% of the increase in global wheat prices during the food crisis of 2011 was the result of hoarding (Guardian, 2022<sup>[56]</sup>). In 2020, agriculture ministers from the G20 reaffirmed their agreement to exempt from export restrictions food bought for humanitarian purposes by the WFP (IISD, 2020). Yet around 21% of wheat, for example, is still covered by import or export controls (Barron's, 2022).

**Maintaining open trade during food price shocks could reduce pressure on international food prices and prevent additional food shortages.** In an increasingly connected world, trade affects food availability, access, utilisation and stability. Restricting trade in food products in the context of a shock to agricultural production, which affects international markets, could further limit the availability of those products, thereby further pushing up their prices. An OECD study (Adenäuer, Frezal and Chatzopoulos, 2023<sup>[57]</sup>) finds indeed that trade integration makes countries less vulnerable to the consequences of negative shocks to agricultural production by reducing the risk of extreme food prices and stabilising food availability whereas the opposite is true for protectionist measures.

# 4 Analysis: Simulating how reductions in biofuel production and changes in trade policies can mitigate international food price shocks

## A partial equilibrium model is employed to evaluate the effect of policy interventions on food prices

**This paper employs the OECD-FAO Aglink-Cosimo model to examine how biofuels and trade policies can mitigate the impact of two respective shocks to agricultural production.** The Aglink-Cosimo model is a recursive-dynamic partial equilibrium model used to simulate developments of annual market balances and prices for over 90 commodities (see Box 1 for more details). Among the model's many commodities are biofuels, which are modelled using relevant market drivers such as policy mandates and relative prices of competitors (e.g. gasoline and diesel) for large producers (OECD/FAO, 2023<sup>[58]</sup>). This study employs the biofuel module to evaluate how a reduction in biofuel use or biofuel mandates could smooth food prices during a geopolitical conflict or during an extreme weather event. In the context of the extreme weather simulation, the study also explores the impact of a decrease in trade openness on food prices.

### Box 1. The OECD-FAO Aglink-Cosimo model of global agricultural markets

Aglink-Cosimo is an economic model of global agricultural markets which can be used to analyse supply and demand of major agricultural commodities, as well as biodiesel and ethanol. It is managed by the Secretariats of the OECD and the Food and Agriculture Organization of the United Nations (FAO). The model is used to generate the annual *OECD-FAO Agricultural Outlook* and for scenario analysis (OECD/FAO, 2023<sup>[38]</sup>).

Aglink-Cosimo is a recursive-dynamic partial equilibrium model used to simulate development of annual market balances (production, consumption, exports, imports and stocks) and prices for major agricultural commodities: cereals (maize, wheat, rice and other coarse grains), oilseeds and oilseed products (protein meal and vegetable oil), sugar, meat (beef and veal, poultry, pork, and mutton), dairy (fresh dairy products, cheese, butter and milk powders), biodiesel, ethanol, cotton, pulses, and roots and tubers.<sup>1</sup> As a recursive-dynamic model, outcomes for one year influence those for the following years (e.g. through herd size dynamics).

The model has a global coverage.<sup>2</sup> World markets for agricultural commodities are assumed to be competitive, with buyers and sellers acting as price takers. Market prices are determined through global and regional equilibrium in supply and demand. Domestically produced and traded commodities are

assumed to be perfect substitutes from the point of view of buyers and sellers. However, the model own- and cross price elasticities do not account for isocaloric compensation with other agricultural commodities. This implies that consumers do not have food calorie targets and likely over- or underestimate market impacts of shocks in food markets. Aglink-Cosimo includes exports and imports but does not track bilateral trade flows.

More information (including detailed model documentation of Aglink-Cosimo) is available at [www.agri-outlook.org](http://www.agri-outlook.org).

Note:

1. The model does not consider highly processed foods which account for 30% of food consumption.
  2. Specifically, the Aglink component of the model consists of 15 modules: ten OECD countries (Australia, Canada, Norway, Japan, Korea, Mexico, New Zealand, Switzerland, the United Kingdom and the United States) and the European Union, and four non-OECD countries (Argentina, Brazil, China and the Russian Federation). The Cosimo component of the model completes the world coverage and consists of 42 endogenous modules: three OECD countries (Chile, Israel and Türkiye), a further 27 single countries, and 12 regional aggregates.
- Source: (OECD/FAO, 2023<sup>[38]</sup>), *OECD-FAO Agricultural Outlook 2023–2032*.

**Aglink-Cosimo models biofuel policies explicitly in its biofuel module.** The policies focus primarily on blending obligations, which are set as a percentage of required blending of ethanol or biodiesel with gasoline or diesel, and import and export ad valorem tariffs. The United States and the EU27 were the only countries with significant values modelled for tariffs in the 2022 edition of the Aglink-Cosimo model. Furthermore, budgetary support policies such as tax incentives and renewable fuel standards are only modelled for the United States and Brazil. These policies are quantified and used alongside prices of gasoline and diesel to set the production level of ethanol and biodiesel.

## Analysing two types of shocks: Geopolitical and climate

**The first shock to agricultural production consists of a geopolitical shock, Russia’s war of aggression in Ukraine.** It draws upon actual price data for agricultural commodities for the 2021–22 food price shock that was the result of Russia’s invasion of Ukraine and extreme weather that occurred in 2021. Both Ukraine and Russia are among the top global exporters of seed oils, maize and wheat and their exports declined substantially as a result of the war, which included a four-month Russian blockage of Ukrainian grain exports through Black Sea ports (World Bank, 2023<sup>[59]</sup>; European Council, 2023<sup>[60]</sup>). According to data from UN Comtrade, before the Ukraine war, in 2021, Russia and Ukraine together accounted for 23% of global wheat exports, 14% of global maize exports and 52% of global exports of sunflower products (UN, 2023<sup>[61]</sup>). Ukraine is also an important exporter of rapeseed and barley. Furthermore, in 2021, Russia accounted for 18% of global potassium fertiliser exports and 15% of global nitrogen fertiliser exports, important agricultural inputs. In 2022, Ukraine’s wheat exports declined by 43.2% compared to 2021. Sunflower oil and oilcake exports declined by 17% in 2022 but were largely replaced with unprocessed sunflower seed exports, which were 31 times as high in 2022 as in 2021. Maize exports remained at similar levels to 2021 (UN, 2023<sup>[61]</sup>). The reduction in production and export capacity in Ukraine and restrictions on Russia’s exports combined with high energy and fertiliser prices pushed up international food prices in 2022 (OECD, 2022<sup>[55]</sup>).

**The second shock to agricultural production consists of a simulation of a future extreme weather event in 2026.** This extreme weather shock is assumed to reduce worldwide production of wheat by 8.7%, maize by 4.6% and vegetable oils by 3.2%. The extreme weather event is simulated using partial stochastic analysis (Box 2). It corresponds to the historical worst-case scenario for the global supply for cereals combined with the worst case for the global oilseed supply. Translating such an event to a real-world scenario, the most similar year-on-year loss in global cereal production occurred in 1993 (-3.3%), which coincides with a long-term drought and a flood that occurred in the United States during the same period

(US National Oceanic and Atmospheric Administration, 1993<sup>[62]</sup>), although the severity of the drop may somewhat be explained by the bumper crop in cereals that occurred the previous year and lead to better than average yields for the 1992 growing season. Losses in vegetable oil production can be compared to the 2019 drop in oilseed production (-4.3%), which relates to an intense drought in the western half of the United States (European Commission, 2021<sup>[63]</sup>).

**In the context of both shocks to agricultural production, this paper explores the potential of reductions in biofuel use to mitigate food price shocks.** Specifically, the paper examines the mitigating effect of reductions in the use of biofuel feedstock commodities by 20% and 50% on the price of wheat, maize and vegetable oils. For this modelling exercise, the levels of biofuel production, consumption and prices are treated as exogenous and biofuel markets are turned off in the Aglink-Cosimo model.<sup>5</sup> Therefore, the impact of the cuts to the use of biofuel feedstock commodities on these exogenous indicators cannot be analysed. However, the cuts to the use of biofuel feedstock commodities can be assumed to translate into cuts of similar magnitude in biofuel production. To explore how such cuts would be achieved by implementing biofuels policies, the paper models these policies separately in a second step. This is done by reducing biofuel blend mandates by 20% and 50% respectively, in the context of the simulated extreme weather event for 2026.

**The paper also examines the impact of trade restrictions on food prices, in the context of the simulated extreme weather event in 2026.** Instead of cuts in biofuel mandates, this analysis considers a 10% reduction in global exports of wheat, maize, vegetable oils, rice and other cereals that occurs alongside the 2026 extreme weather event. The 10% reduction in exports has similar effects as the implementation of export restrictions in major producer countries of these products.

### Box 2. Calibration of the extreme weather shocks in the OECD-FAO Aglink-Cosimo Model

The *OECD-FAO Agricultural Outlook* presents 10-year projections for global agricultural markets, with the latest publication covering the period 2023 to 2032. In recent years, internal projections have been produced until 2040. The present analysis makes use of this extended baseline.

The partial stochastic analysis that is usually performed on the Outlook projections highlights how alternative scenarios diverge from the baseline by treating a number of variables stochastically. These variables usually target the main sources of uncertainty for agricultural markets, such as country-specific macroeconomic variables, the crude oil price (as a proxy for input costs), and country- and product-specific yields. In the extreme weather shock analysis, only crop yields are treated as uncertain within this partial stochastic framework to focus on the potential impact of extreme weather events on agricultural markets.

The approach applied to determine the stochastic draws of crop yields is based on a simple process, which captures the historical variance of each single variable and generates 500 sets of combinations of the stochastic variables or draws. This method generates future variations of the variables from their past variability, which implies that extreme weather events would occur with the same intensity and frequency as they did over the past 25 years.

However, research suggests that one consequence of climate change is increasing frequency and intensity of extreme weather events in the future. Therefore, this methodology has been adjusted to factor increased frequency and intensity of extreme weather events into the shocks on future crop yields. Specifically, the following changes have been made to the original methodology:

- 1) Country clusters: uncertainty factors (i.e. the relative difference between observed yields and the trend estimate) are now drawn for country clusters, rather than for all countries at the same time. Clusters have been chosen according to climatic zones, assuming correlated climate variability within these zones.

- 2) Increased frequency of extreme yields: the procedure to draw uncertainty factors for future years has been adjusted such that extreme yields have an increasing probability to be drawn over time. Specifically, with the previous methodology, an extreme yield had a probability of 5% of being drawn for any future year. With the new methodology, this probability is gradually increased to between 10% and 23% in 2040, depending on the country cluster.
- 3) Increased intensity of extreme yields: while the previous methodology did not allow for uncertainty factors to fall below their lowest historical value this has been changed to model increased intensity of extreme weather events. A gradual increase from the first to the final simulation year was implemented so that by 2040, crop yields can be 10% below their historical minimum.

Once the increased frequency and intensity of extreme weather events had been factored in, out of the 500 sets of combinations of the stochastic variables, those draws causing the biggest reductions in the production of cereals and oilseeds respectively (oilseeds and cereals are not strongly correlated) are then used as a realistic potential extreme weather shock in 2026. This corresponds to the historical worst-case scenario for the global supply of cereals and the worst case for oilseeds on top of that.

Source: OECD (2023<sup>[57]</sup>), "Mitigating the impacts of extreme weather events on agricultural markets through trade", OECD Food, Agriculture and Fisheries Papers, No. 198.

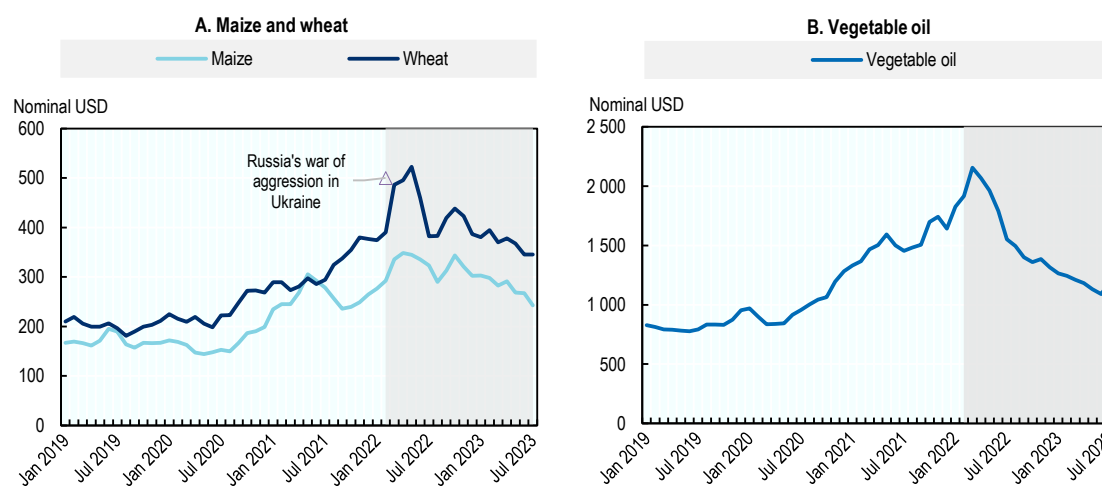
## Caveats, assumptions and limitations

**While a baseline is used in the simulation of the 2026 extreme weather shock, such a baseline has not been calibrated for the 2022 geopolitical shock to agricultural production.** For the simulation of the extreme weather shock, the paper uses the *OECD-FAO Agricultural Outlook* projection as the baseline. This baseline shows how prices, quantities produced and consumed, and other variables would have looked in the absence of the simulated extreme weather shock. However, a baseline estimating 2022 without Russia's war of aggression in Ukraine has not been calibrated since the geopolitical shock scenario relies on observed data for 2022. Generating a "no-shock" reference for 2022 would have been theoretically complex and would have required making assumptions on the very large number of factors that affect prices. Naturally, such a counterfactual scenario would have been difficult to justify and quantifying it explicitly would have introduced many additional uncertainties to the model.

**The Aglink-Cosimo model output exhibits lower agricultural commodity prices than those that actually transpired in 2022.** Prices for maize, vegetable oil and wheat peaked in March 2022 at levels of 37% (for maize) to 69% (for wheat) above those seen in March 2021 and gradually declined throughout the rest of the year. In the Aglink-Cosimo model, wheat prices increase by 19.1% in 2022 relative to 2021, maize prices by 12.6% and vegetable oil prices by 11.3%. These differences reflect the use of annual level data in the Aglink-Cosimo model, which is designed to look at medium-run implications of changes to global agriculture (Durham, Davies and Bhattacharyya, 2012<sup>[64]</sup>). As a result, some of the monthly fluctuation in prices is smoothed by the yearly averages. Furthermore, the model applies a three-year moving average to all outputs, which contributes further to the dampening effect on the prices seen in the model's 2022 output. Furthermore, since the model is designed for the medium run, it may exaggerate the ability of the economy to respond over the course of a single year and more concretely the response of farmers to a price spike. As a result, the model underestimates both the size of the spike and the potential of short-run policies to mitigate such a spike (Durham, Davies and Bhattacharyya, 2012<sup>[64]</sup>). However, the model's assumptions do not affect the conclusions that can be drawn from the results. Although the price effects are somewhat smaller, the dynamics can be assumed to be similar to those that would occur in the actual scenario with larger price fluctuations.

**Figure 10. The 2022 price spike occurred during the first months of the year and then decreased steadily for the rest of the year**

Monthly world commodity prices, nominal USD



Note: Vegetable oil is the average of coconut oil, groundnut oil, palm oil, palm kernel oil, soybean oil, rapeseed oil, sunflower oil prices.  
Source: World Bank (2023<sup>[4]</sup>), *World Bank Pink Sheet Data* (database), <https://www.worldbank.org/en/research/commodity-markets>.

**The analysis is based on calendar year average prices whenever available.** The calendar year average varies slightly from the standard practice of measuring agricultural commodity prices according to growing seasons. Calendar year prices capture better the effects of Russia's war of aggression in Ukraine in early 2022 – the geopolitical shock. However, in the Aglink-Cosimo model not all variables are available as calendar year averages and the analysis has therefore used growing season prices whenever calendar year averages were not available.

**This analysis assumes that grain used for biofuels is of sufficient quality to serve for human consumption.** Evidence indicates that this is the case for maize, wheat and oilseed biomass, although the quality is somewhat reduced. One challenge might be that the maize used for biofuel production in the United States tends to be yellow maize whereas in some countries white maize is preferred for human consumption. Furthermore, the higher level of broken grains and moisture may have implications on the length for which the grains can be stored (Locke et al., 2013<sup>[27]</sup>).

**The results of this paper also only hold under the assumption that refiners have sufficient flexibility to reduce their intake of ethanol and biodiesel.** For example, in the United States, fuel refiners use ethanol, which has an octane level of 115, as an oxygenate to increase the octane level of gasoline for retail sale from 84 to 87. It takes three to six months for refineries to adjust to producing 87 octane gasoline rather than 84 gasoline (Tyner, Taheripour and Hurt, 2012<sup>[65]</sup>). Additional research would be required to determine whether there is sufficient flexibility in fuel refineries in different biofuel producing countries for the rapid reduction of biofuel intake.

**It is unlikely that lower biofuel consumption would result in energy shortages and push up international energy prices as a result of higher fossil fuel consumption.** Crops used for biofuels produce only a limited amount of energy: biofuels account for approximately only 0.5% of global energy consumption and are in terms of energy content equivalent to only 1.7% of global oil production (as of 2019) (World Bank, 2022<sup>[66]</sup>). The United States uses 30-40% of its maize supply for ethanol, to produce only 5% of US transport fuel. On the other hand, crops used for biofuels are equivalent to a significant amount of food: whereas human daily caloric needs are around 2 000 calories per day, a single litre of bioethanol contains 7 000 calories, enough to feed a human for 3.5 days. The positive impact of a reduction

in the production of biofuels on global food supply, prices, and human health is therefore likely to exceed any negative impact on fuel prices (Hanson et al., 2022<sup>[67]</sup>).

**Nevertheless, in the short term, the removal of biofuels from the market is likely to result in their replacement by fossil fuels, with implications for both emissions and import dependency.** Reducing biofuel blending mandates is likely to increase fossil fuel consumption and overall emissions for the duration of such an intervention. Most biofuels produce fewer GHG emissions than fossil fuels. When countries reduce biofuel blending mandates, the gap is typically filled by increased fossil fuel use. This substitution effect means that cutting back on biofuels leads to higher overall emissions (IEA, 2024<sup>[68]</sup>). In addition, biofuel blending mandates are often designed not only to support decarbonisation goals, but also to reduce reliance on imported fossil fuels. This is particularly true in countries where biofuels account for a sizable share of transport energy. In such contexts, abrupt reductions in blending levels and the need to replace lost biofuel volumes with imported gasoline or diesel could pose challenges, especially when global oil prices are elevated (IEA, 2023<sup>[69]</sup>).

**However, in the long run it is uncertain whether lower biofuel consumption would result in higher fossil fuel consumption or higher overall GHG emissions** (Locke et al., 2013<sup>[27]</sup>). There are a range of emission factors for liquid biofuels. There is some controversy on whether the net impact of biofuels on CO<sub>2</sub> emissions is actually positive or negative. There have been concerns over biofuels' actual environmental benefits and potential to reduce GHG emissions, due to the loss in biodiversity. In addition, much of the GHG impact from biofuels stems from land-use change, both direct and indirect. Reducing biofuel demand could, over time, ease pressure to convert natural ecosystems into cropland, potentially avoiding these emissions. There are further doubts about total emission reduction due to biofuel's high energy requirements during the production process (FAO, 2011<sup>[70]</sup>; Vural Gursel et al., 2020<sup>[71]</sup>; Helming, Pronk and Woltjer, 2010<sup>[72]</sup>; US Energy Information Administration, 2022<sup>[73]</sup>; IEA, 2024<sup>[68]</sup>). Nonetheless, there is also evidence that targeted biofuel policies might stimulate more efficient and sustainable biofuel production, thereby reducing the rates of deforestation and detrimental impacts on the environment often associated with biofuels (Vural Gursel et al., 2020<sup>[71]</sup>).

## Triggers and length of intervention

**A cut in biofuel production would be most feasible as a measure of last resort during periods of crisis and as a short-run intervention.** Specifically, a cut in vegetable oil-based biodiesel production coupled with reduced maize and wheat-based ethanol production could be a short-term measure to smooth food price spikes. Situations in which such a measure could be justified are during food price spikes with significant adverse effects on the nutrition of lower-income populations. Such price spikes could resemble those of 2007-08, 2011-12, or the more recent one in 2021-22. A cut in biofuel production could be implemented for a maximum of six months to one year, as a longer-term or permanent intervention could be politically challenging to justify and implement (Locke et al., 2013<sup>[27]</sup>). In the absence of a significant rise in food prices, it might be difficult to get sufficient political support to implement such cuts.

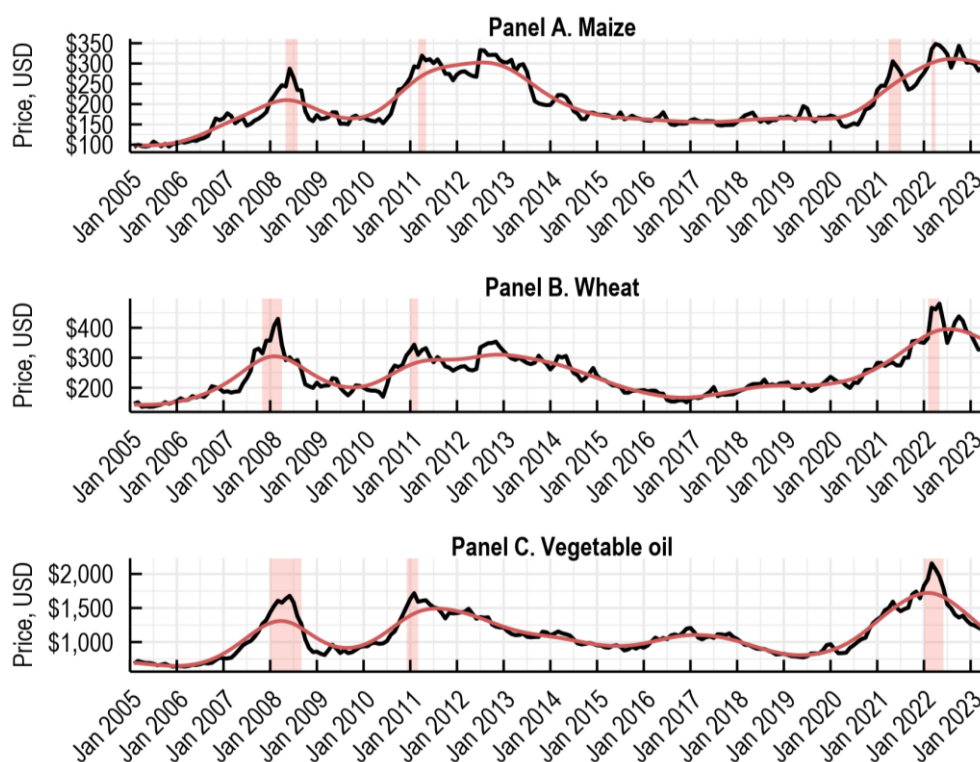
**Selected indicators could serve as triggers for policies that reduce biofuel production.** Since the objective is to improve vulnerable populations' access to food, it would be pertinent to use some measure of food insecurity as a trigger. This measure could be the share of population affected by moderate or severe food insecurity or undernourishment (FAO, 2011<sup>[70]</sup>). However, the data required to build such a measure are usually collected on an annual basis and with a time lag, and not all countries and regions are covered. Therefore, food prices might be a simple and more readily available indicator, even though they do not directly measure the vulnerability of poor consumers and their access to food (Locke et al., 2013<sup>[27]</sup>; FAO, 2011<sup>[70]</sup>; Tyner, Taheripour and Hurt, 2012<sup>[65]</sup>). A rule for triggering policies to reduce biofuel production could either be based directly on the prices of biofuel feedstock commodities such as maize, wheat and vegetable oil, or on food price indices such as the FAO's food price or cereal indices. An

alternative trigger could be linked to low levels of grain inventories, or a combination of food prices and the current level or short-term forecast for grain inventories. However, the unreliability of data on inventories constitutes a challenge (Locke et al., 2013<sup>[27]</sup>; Tyner, Taheripour and Hurt, 2012<sup>[65]</sup>).

**Policies to reduce biofuel production could kick in when food prices breach certain predefined thresholds.** Such thresholds could be defined in line with deviations from a trend in food prices or relative to a fixed value. The advantage of using a trend rather than defining a fixed value is that price variations measured against a flexible trend reflect both shifts in demand and supply over time and inflation (Locke et al., 2013<sup>[27]</sup>; Tyner, Taheripour and Hurt, 2012<sup>[65]</sup>). Figures 20 and 21 below illustrate the use of a Hodrick-Prescott filter to define dynamic trends for the prices of biofuel feedstock commodities. The figures illustrate how much biofuel feedstock commodity prices deviated from these trends during the three most recent food price shocks in 2007-08, 2011 and 2021-22, measured by standard deviations. During all three shocks, biofuel feedstock commodity prices were found to have deviated more than three standard deviations from the dynamic trend (Figure 11). This could hence be a potential trigger for policies to reduce biofuel production to kick in. Since a dynamic trend, set in accordance with values most commonly applied in macroeconomic analysis, might lead to underestimation of critical food price variations that are measured by deviations from the trend, Figure 12 proposes a flatter, more linear trend.<sup>6</sup> A flatter but still dynamic trend captures long-term food price variations while permitting short-term variations to show earlier up as deviations.

**Figure 11. The fitted trend captures spikes relative to agricultural market fluctuations**

Monthly prices, nominal USD, shaded areas refer to 3 standard deviations from trend, fitted trend

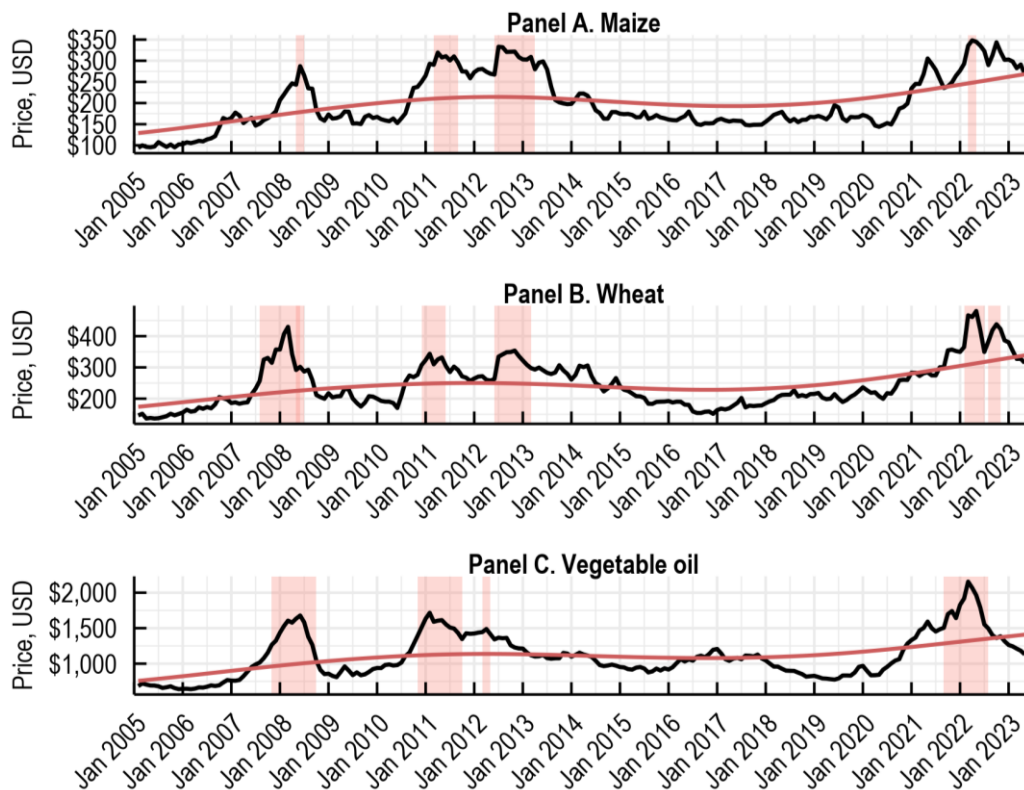


Note: The Hodrick-Prescott filter variable lambda for the trends displayed in the panels was based on the number of observations following business cycle standards applied in the literature.

Source: Authors' elaboration based on World Bank (2023<sup>[41]</sup>), *World Bank Pink Sheet Data* (database), <https://www.worldbank.org/en/research/commodity-markets>.

**Figure 12. A more linear trend better captures prolonged periods of elevated food prices**

Monthly prices, nominal USD, shaded areas refer to 3 standard deviations from trend, linear trend



Notes: The Hodrick-Prescott filter variable lambda for the trends displayed in the panels was defined following experimental methodology as there as little guidance in the literature on this specific application.

Source: Authors' elaboration based on World Bank (2023<sup>[4]</sup>), *World Bank Pink Sheet Data* (database), <https://www.worldbank.org/en/research/commodity-markets>.

## Results

### Geopolitical shock

**As a result of Russia's war of aggression in Ukraine, annual average wheat, maize and vegetable oil prices increased even further in 2022 from already high levels in 2021** (Table 2). Wheat prices increased the most in 2022 (19.6%), followed by maize prices (12.9%) and vegetable oil prices (11.5%). However, as a result of extreme weather in different parts of the world, prices had already reached record highs in 2021 when annual average vegetable oil prices increased by 66.4% relative to 2020, maize prices by 56.8% and wheat prices by 31.4% (Figure 13).

**Cuts in the use of biofuel feedstock commodities in the context of this geopolitical shock would have resulted in only moderate reductions in wheat, maize and vegetable oil prices.** A 20% reduction in the use of biofuel feedstock commodities in 2022 would dampen the price hike by approximately 3% to 4% in wheat, maize and vegetable oil prices (Table 2). A 50% reduction in the use of biofuel feedstock commodities in 2022 would decrease the price hike by approximately 7% to 9% in wheat, maize and vegetable oil prices (Figure 13). Maize and vegetable oil prices would have declined more in response to cuts in biofuel feedstock commodities than wheat prices. This could be explained by the lower share of the global wheat supply used for biofuel production as compared to maize and vegetable oils (see section on

biofuel production). Therefore, decreases in wheat prices as a result of cuts in biofuel production are largely indirect effects generated by substitution between different cereals.

**Table 2. Effects of cuts in the use of biofuel feedstock commodities for the 2022 geopolitical shock**

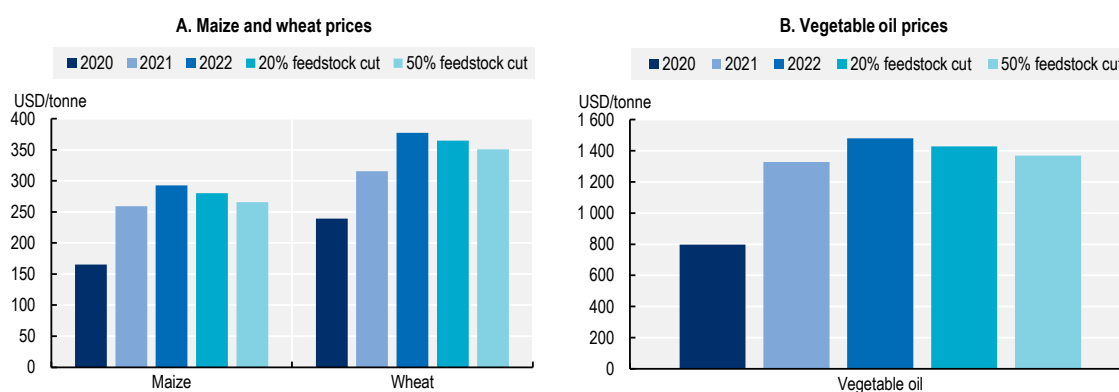
	Wheat	Maize	Vegetable oils
		<b>2021</b>	
Price (USD/tonne)	315.3	259.3	1 328.1
		<b>2022</b>	
Price (USD/tonne)	377.1	292.7	1 480.3
Price change relative to 2021 (%)	19.6%	12.9%	11.5%
		<b>20% feedstock cut</b>	
Price (USD/tonne)	364.7	280.1	1 427.8
Price change relative to 2022 (%)	-3.3%	-4.3%	-3.5%
		<b>50% feedstock cut</b>	
Price (USD/tonne)	350.8	265.6	1 368.1
Price change relative to 2022 (%)	-7.0%	-9.3%	-7.6%

Note: The table shows the price change in 2022 relative to 2021 as a result of the geopolitical shock. The table further shows by how much commodity prices would have changed in 2022 following 20% and 50% cuts in biofuel feedstock commodities. All calculations are based on world reference prices (calendar year average).

Source: Authors own calculations based on Aglink-Cosimo output.

**Figure 13. Cuts in the use of biofuel feedstock commodities lead to only relatively small reductions in biofuel feedstock prices of approximately 3% to 9%**

World reference price, calendar year, USD/tonne



Source: Aglink-Cosimo model (2023<sub>[58]</sub>), The Aglink-Cosimo Model.

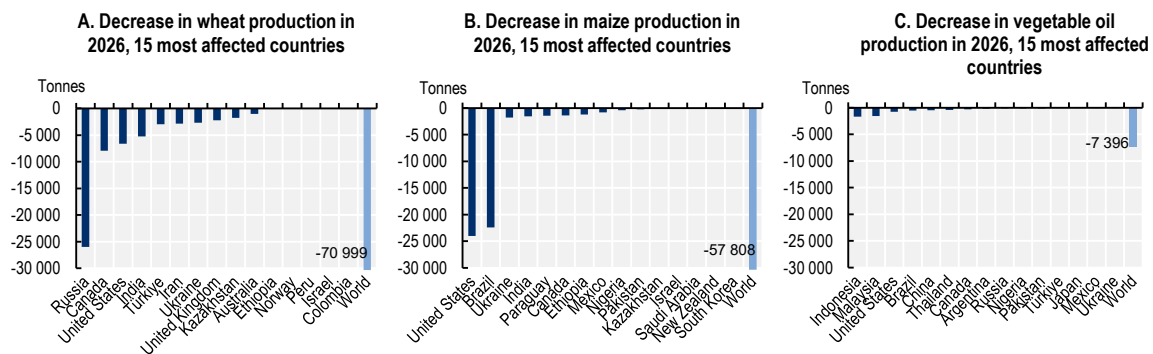
### **Extreme weather shock**

**Global wheat and maize production and prices are most affected by the hypothetical extreme weather shock in 2026, with losses in vegetable oils being relatively smaller.** The extreme weather shock results in an almost 80 000 tonne decline in worldwide wheat production compared to the baseline, which is equivalent to an 8.7% decline in worldwide wheat production. Russia, the leading producer of wheat in Aglink-Cosimo, experiences by far the largest decline in wheat production at 26 018 tonnes, followed by losses in North America at 7 953 tonnes in Canada and 6 648 in the United States (Figure 14, Panel A). Global maize

production declines by almost 58 000 tonnes, which is equivalent to 4.6% of global production. Losses are concentrated in the United States (a decline of 24 014 tonnes) and Brazil (a decline of 22 411 tonnes), which are both important producers of the grain. Vegetable oil production is least affected by the climate shock and decreases only 7 395 tonnes worldwide, which translates to 3.2% of worldwide production. The most affected countries, Indonesia and Malaysia, saw losses of 1 679 and 1 569 tonnes respectively. In line with the different magnitudes of the shocks to the production of wheat, maize and vegetable oils, global wheat prices increase the most, by 45%, followed by maize prices by 19% and vegetable oil prices by 9% (Figure 14).

**Figure 14. Extreme weather shock affects staple production in different world regions**

Tonnes



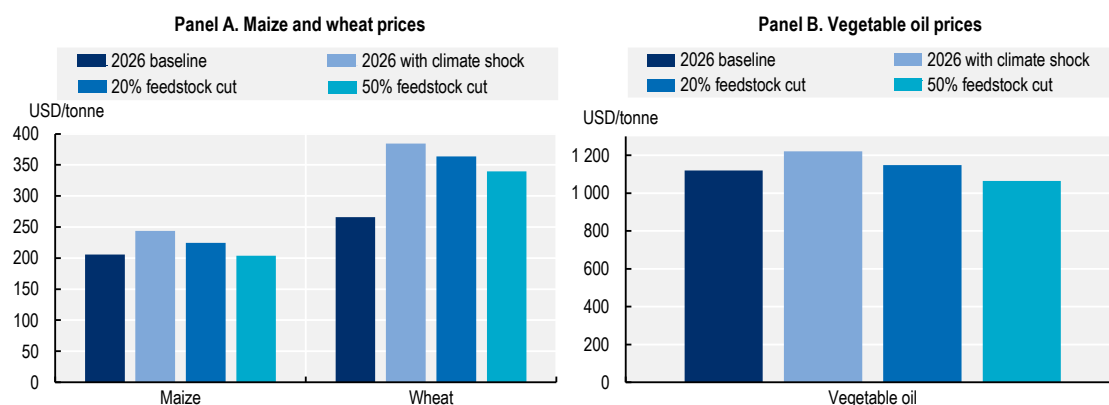
Source: Authors' own calculations on Aglink-Cosimo output.

### **Reductions in the use of biofuel feedstock commodities**

Similarly to the geopolitical shock, in the context of the extreme weather, a reduction in the use of biofuel feedstock commodities has the strongest impact on maize prices, followed by vegetable oil prices. A 20% cut in the use of biofuel feedstock commodities reduces maize prices by 7.9%, vegetable oil prices by 6% and wheat prices by 5.4%. A 50% cut in the use of biofuel feedstock commodities reduces maize prices by 16.3%, vegetable oil prices by 12.8% and wheat prices by 11.6% (Figure 15). The larger reductions in grain prices resulting from the cuts in the use of biofuel feedstock commodities as compared to the geopolitical shock could be explained by the smaller initial increases in maize and vegetable oil prices in the extreme weather shock and hence the lower initial grain prices. Furthermore, in the context of the extreme weather shock, the highest production loss for maize occurs in the United States whereas in the context of the geopolitical shock, maize production declines outside the United States. Therefore, in the context of the extreme weather shock, cutting maize use for biofuels in the United States has a direct mitigating impact on the domestic market while this is not the case for the geopolitical shock. Finally, since the geopolitical shock analysis is based on actually observed data, factors other than the biofuel production cuts also affect prices while in the case of the extreme weather shock everything else is held constant.

**Figure 15. Cuts in the use of biofuel feedstock commodities largely offset the 2026 extreme weather shock for vegetable oils and maize but to a lesser extent for wheat**

World reference price, calendar year, USD/tonne



Source: Authors' own calculations on Aglink-Cosimo output.

**Table 3. Effects of cuts in the use of biofuel feedstock commodities for the extreme weather shock in 2026**

	Wheat	Maize	Vegetable oils
		<b>Baseline</b>	
Price (USD/tonne)	265.8	205.6	1 119.1
		<b>Weather shock</b>	
Price (USD/tonne)	384.4	243.7	1 220.3
Price change relative to baseline	44.6%	18.5%	9.0%
		<b>20% feedstock cut</b>	
Price (USD/tonne)	363.8	224.4	1 147.4
Price change relative to weather shock (%)	-5.4%	-7.9%	-6.0%
Price change relative to baseline (%)	36.8%	9.1%	2.5%
Mitigation effect (% of extreme weather shock)	17.8%	52.6%	66.7%
		<b>50% feedstock cut</b>	
Price (USD/tonne)	339.7	203.9	1 064.0
Price change relative to weather shock (%)	-11.6%	-16.3%	-12.8%
Price change relative to baseline (%)	27.8%	-0.8%	-4.9%
Mitigation effect (% of extreme weather shock)	37.8%	105.3%	155.6%

Note: The table shows the price change relative to the baseline in the context of the extreme weather shock without biofuel feedstock cuts, with a 20% biofuel feedstock cut and with a 50% biofuel feedstock cut. It further shows the price change as a result of a 20% feedstock cut and as a result of a 50% feedstock cut relative to prices with the extreme weather shock. Finally, the mitigation effect of the 20% and 50% feedstock cuts is shown: the mitigation effect is the share (%) of the observed price spike which is mitigated by biofuel feedstock reductions. The baseline is defined as the model projections for the year 2026 without any weather shock. All calculations are based on world reference prices (calendar year average).

Source: Authors' own calculations on Aglink-Cosimo output.

**The price decreases resulting from the cuts in the use of biofuel feedstock commodities can offset a much larger share of the initial price shock for maize and vegetable oils than for wheat. This can**

be explained by the larger initial increase in wheat prices as a result of the extreme weather event as compared to maize and vegetable oil prices, which experience much smaller price shocks. In addition, wheat is much less used for biofuel production than maize and vegetable oils, and decreases in wheat prices as a result of cuts in biofuel production are largely indirect effects as a result of substitution between different cereals. A 20% cut in the use of biofuel feedstock commodities mitigates the increase in vegetable oil prices by 67%, the increase in maize prices by 53% but the increase in wheat prices by only 18%. A 50% cut in the use of biofuel feedstock commodities more than offsets the price increases in vegetable oil and maize prices, which fall below baseline prices, but only offsets 38% of the initial price increase in wheat prices (Table 3).

**Cuts in biofuel blend mandates have significantly weaker effects on maize and wheat prices than cuts in the use of biofuel feedstock commodities.** A 20% cut in biofuel blend mandates reduces vegetable oil prices by 9.6% and a 50% cut by 13.9%, thereby more than offsetting the initial price increase in the context of the extreme weather shock (Table 4). However, maize and wheat prices decrease by only 2-3% following the 20% cut in biofuel blend mandates and by 5-6%, following the 50% cut in biofuel blend mandates. This translates into a mitigation effect of the 50% cut in blend mandates of only 18% for wheat and 42% for maize (Table 4).

**Table 4. Effects of cuts in biofuel blend mandates for the extreme weather shock in 2026**

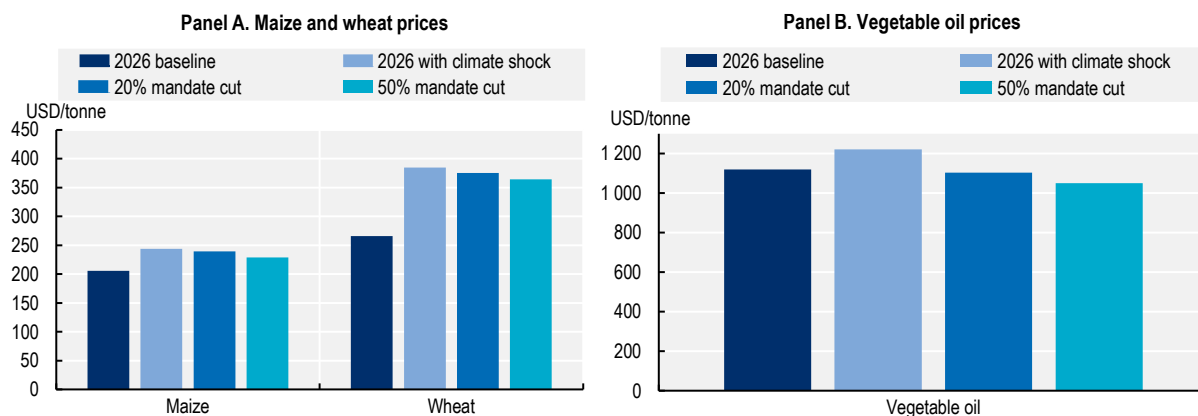
	Wheat	Maize	Vegetable oils
		<b>Baseline</b>	
Price (USD/tonne)	265.8	205.6	1 119.1
		<b>Weather shock</b>	
Price (USD/tonne)	384.4	243.7	1 220.3
Price change relative to baseline	44.6%	18.5%	9.0%
		<b>20% mandate cut</b>	
Price (USD/tonne)	375.0	239.1	1 103.6
Price change relative to weather shock (%)	-2.5%	-1.9%	-9.6%
Price change relative to baseline (%)	41.1%	16.3%	-1.4%
Mitigation effect (% of extreme weather shock)	8.9%	15.8%	111.1%
		<b>50% mandate cut</b>	
Price (USD/tonne)	364.4	229.0	1 050.1
Price change relative to weather shock (%)	-5.2%	-6.0%	-13.9%
Price change relative to baseline (%)	37.1%	11.4%	-6.2%
Mitigation effect (% of extreme weather shock)	17.8%	42.1%	166.7%

Note: The table shows the price change relative to the baseline in the context of the extreme weather shock without biofuel blend mandate cuts, with a 20% biofuel blend mandate cut and with a 50% biofuel blend mandate cut. The baseline is defined as the Aglink-Cosimo model projections for the year 2026 without an extreme weather shock. The table further shows the price change as a result of a 20% cut in biofuel blend mandates and as a result of a 50% cut in biofuel blend mandates relative to prices with the extreme weather shock. Finally, the mitigation effect of the 20% and 50% cuts in biofuel blend mandates is shown: the mitigation effect is the share (%) of the observed price spike which is mitigated by reductions in biofuel blend mandates. All calculations are based on world reference prices (calendar year average).

Source: Authors' own calculations on Aglink-Cosimo output.

**Figure 16. Cuts in biofuel blend mandates are effective in reducing vegetable oil prices in the context of an extreme weather shock in 2026 but have only a very small impact on maize and wheat prices**

World reference price, calendar year, USD/tonne

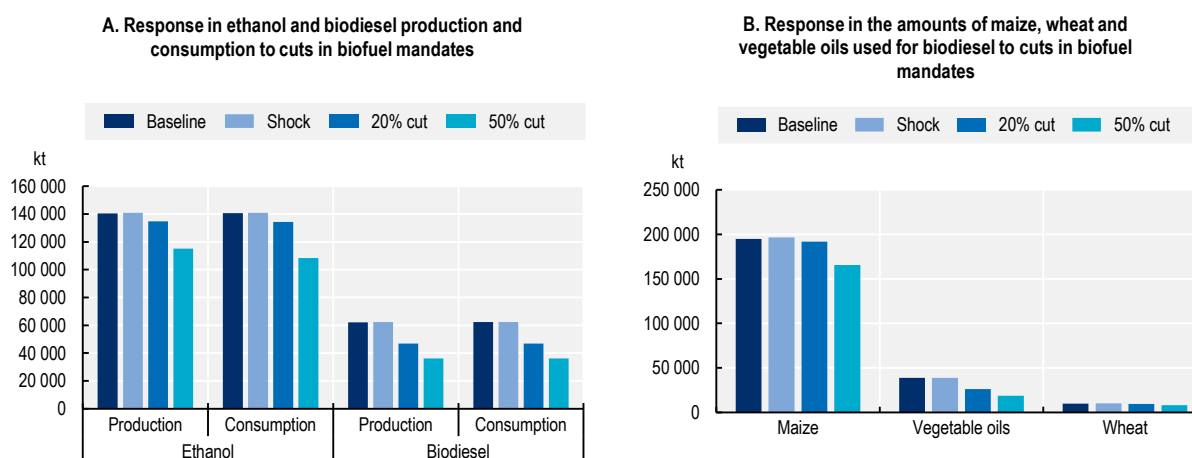


Source: Authors' own calculations based on Aglink-Cosimo output.

**The weaker effects of cuts on biofuel blend mandates on maize and wheat prices can be explained by the imperfect passthrough of cuts in blend mandates into ethanol production and consumption levels.** While global biodiesel production declines by 25-42% following the blend mandate cuts, world ethanol production declines by only 4-18% following the cuts (Figure 17, Panel A). The weaker passthrough of reductions in blend mandates for ethanol as compared to biodiesel can be attributed to ethanol's lesser dependence on support policies, stronger commercial viability and lower cost of production (OECD, 2008<sup>[41]</sup>).

**The imperfect passthrough of blend mandate cuts for ethanol production and consumption translates into less significant reductions in demand for its main inputs than in the case of biodiesel.** In addition, the stronger passthrough of cuts in blend mandates for vegetable oils can be attributed to the production of biodiesel from used cooking oils, largely in the United States, the EU and China. Since the modelling exercise assumes that the absolute amounts of these oils do not react to mandate cuts, vegetable oils have to overcompensate. While the blend mandate cuts translate into a 32-51.7% reduction in the amount of vegetable oils used for biodiesel production, they translate only into a 2.5-15.8% reduction in the amount of wheat and a 5.7-18.5% reduction in the amount of maize used for ethanol production (Figure 17, Panel B). This much larger decrease in the amount of vegetable oils used for biodiesel production than in the amounts of wheat and maize used for ethanol production results in a much larger decline in vegetable oil prices than in wheat and maize prices.

**Figure 17. Biodiesel markets and those of biodiesel feedstock commodities react much stronger to biofuel mandate cuts than ethanol markets on those of ethanol feedstock commodities**



Source: Authors' own calculations on Aglink-Cosimo output.

### Trade restrictions

The introduction of trade restrictions further exacerbates the price increases which agricultural commodities experience in the context of the extreme weather shock. With a 10% reduction in exports of wheat, maize, vegetable oils, rice and other cereals, wheat prices increase by an additional 16%. Maize prices increase by an additional 8% and vegetable oil prices by an additional 9% (Table 5 and Figure 18).

**Table 5. Impact of trade restrictions in the context of an extreme weather shock in 2026**

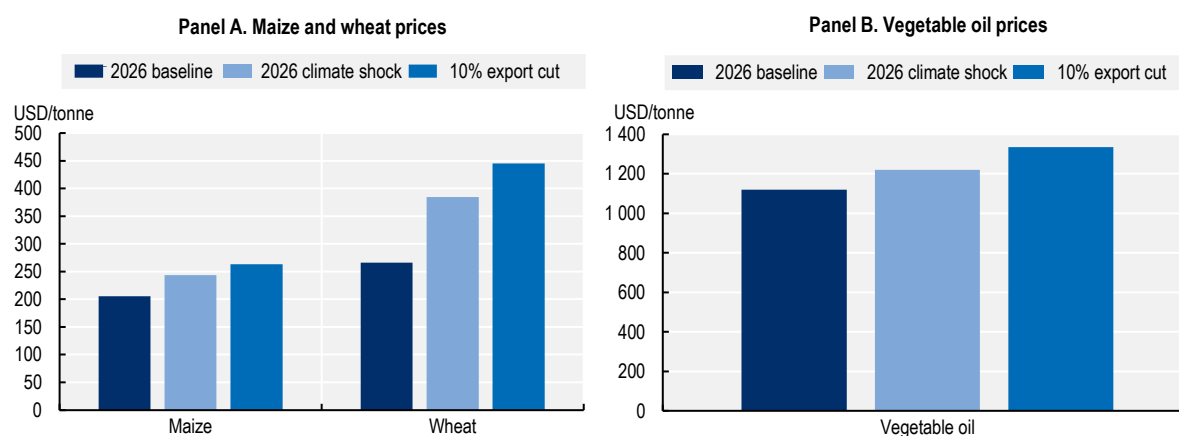
	Wheat	Maize	Vegetable oils	Rice
<b>Baseline</b>				
Price (USD/tonne)	265.8	205.6	1 119.1	424.9
<b>Weather shock</b>				
Price (USD/tonne)	384.4	243.7	1 220.3	505.2
Price increase relative to baseline (%)	44.6%	18.5%	9.0%	18.9%
<b>10% reduction in exports</b>				
Price (USD/tonne)	445.4	262.9	1 333.9	565.8
Price change relative to weather shock (%)	15.8%	7.9%	9.3%	12.0%
Price change relative to baseline (%)	67.5%	27.8%	19.2%	33.1%

Note: The table shows the price change relative to the baseline in the context of the extreme weather shock with and without a 10% decrease in trade openness. The baseline is defined as the Aglink-Cosimo model projections for the year 2026 without an extreme weather shock. The table further shows the price change as a result of a 10% decrease in trade openness relative to already elevated prices in the context of the extreme weather shock. All calculations are based on world reference prices (calendar year average).

Source: Authors' own calculations based on Aglink-Cosimo output.

**Figure 18. A reduction in traded quantities of agricultural commodities in the context of an extreme weather shock in 2026 further exacerbates price increases**

World reference price, calendar year, USD/tonne



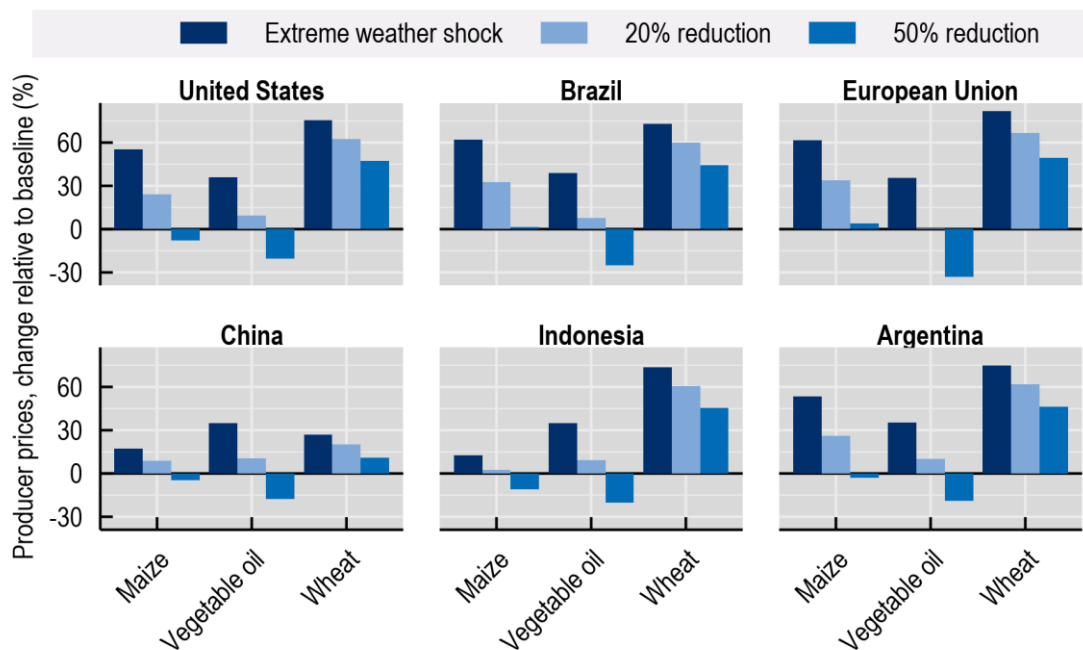
Source: Authors' own calculations from Aglink-Cosimo output.

### ***Impact on grain producer and consumer prices in major biofuel producing countries***

**The analysis shows that biofuel feedstock commodity producer prices<sup>7</sup> in important biofuel producer countries respond strongly to the extreme weather shock in 2026.** Producer prices for wheat react the strongest and increase approximately 70-80% compared to the baseline in the selected biofuel producer countries shown in Figure 19 in response to the extreme weather shock (except for China). Maize prices increase approximately 50-60% in all countries (except for China and Indonesia) and vegetable oil prices by 35-39%. The larger increase in wheat prices, followed by maize prices and the smaller increase in vegetable oil prices reflects the different magnitudes of the production shocks for wheat, maize and vegetable oils respectively as a result of the extreme weather event. The smaller increases in maize prices in China and Indonesia and in wheat prices in China can be attributed to China's and Indonesia's self-sufficiency in maize production and China's self-sufficiency in wheat production and large buffer stocks of wheat combined with the limited impact of the extreme weather shock on their harvests.

**Figure 19. Producer prices in the main biofuel producing countries respond strongly to the extreme weather shock**

Extreme weather shock with cuts in biofuel feedstock commodities, consumer price changes relative to baseline (%)



Source: Aglink-Cosimo.

**Biofuel feedstock commodity producer prices decline significantly in response to cuts in the use of biofuel feedstock commodities, with vegetable oil prices decreasing the most, followed by maize prices.** In response to the cuts in the use of biofuel feedstock commodities, wheat producer prices decrease by approximately 7-18% (except for China), maize producer prices by 17-41% (except for China and Indonesia)<sup>8</sup> and vegetable oil producer prices by 18-50% (Figure 19). The 50% reduction in the use of biofuel feedstock commodities fully sets off the initial increase in vegetable oil and maize producer prices as a result of the extreme weather shock, which fall below baseline countries in most of the biofuel producer countries shown, but only partially for wheat prices. This can be explained by the stronger initial increase in wheat prices in the context of the extreme weather shock. Vegetable oil producer prices in the European Union more strongly to the cuts in the use of biofuel feedstock commodities than in other biofuel producer countries. This can be attributed to the large amount of biodiesel produced in the EU and therefore the large reduction in the amount of vegetable oils used for biodiesel production as a result of the feedstock cuts.

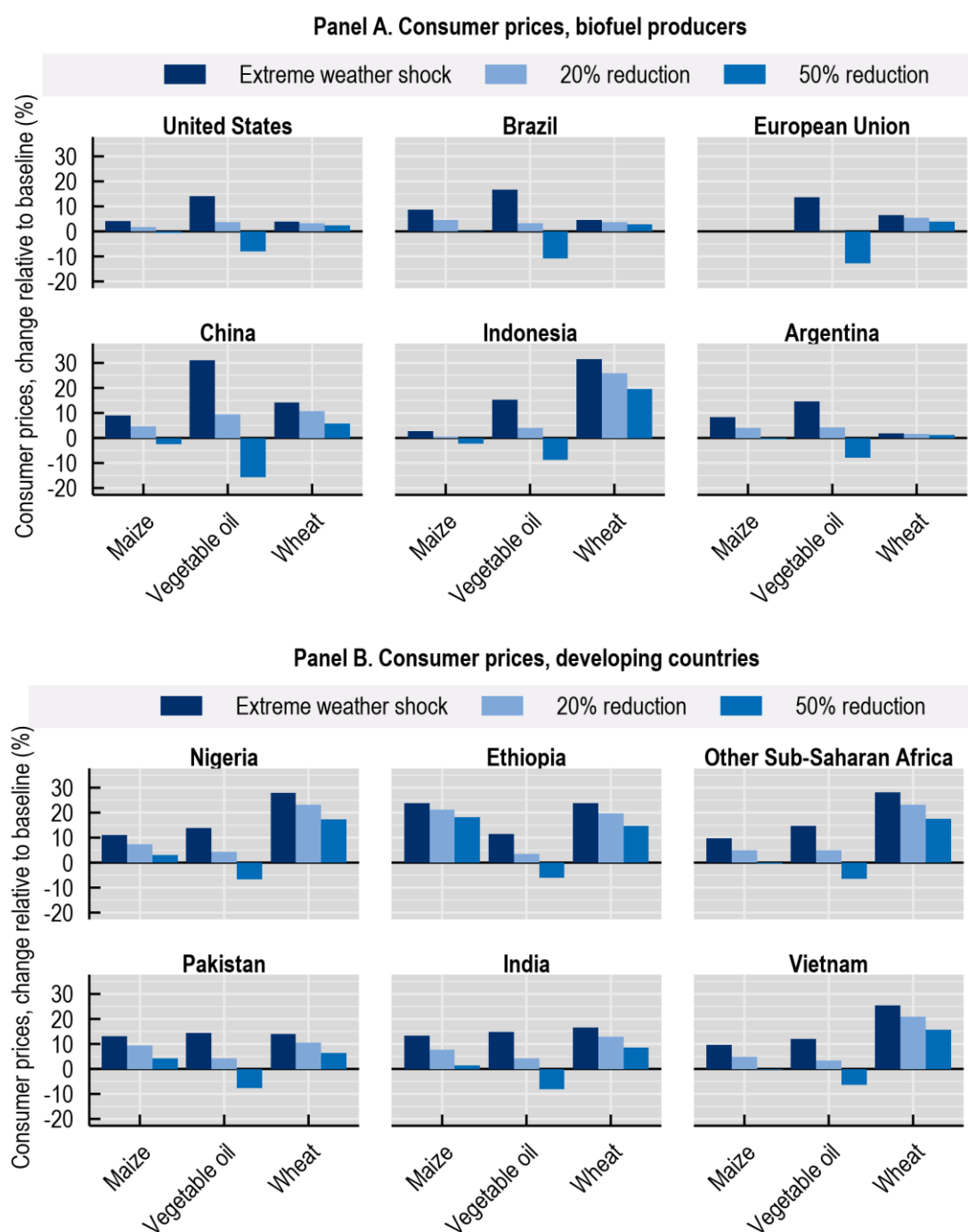
### ***Impact on staple crops' consumer prices in biofuel producers and developing countries***

**The passthrough of these fluctuations in producer prices into consumer prices in the main biofuel producing countries is only partial.** Consumer prices in biofuel producer countries experience similar changes as producer prices in response to the extreme weather shock and the cuts in the use of biofuel feedstock commodities but these changes are much smaller in magnitude in all countries (Figure 20, Panel A). This can be explained by the Aglink-Cosimo Model's additive margin between producer and consumer prices, which does not react to the shock. Only Indonesia experiences larger fluctuations in wheat consumer prices than the other countries. This can be explained on one side by its very low local

wheat production and on the other side by its development status when compared to other larger biofuel producers. Indeed, there is a higher passthrough of food price shocks into inflation in developing countries.

**Figure 20. The largest mitigating effect of cuts in biofuel feedstock commodities is seen in vegetable oils for both developed and developing countries whereas wheat is the least reactive**

Extreme weather shock with cut in biofuel feedstock commodities, consumer price changes relative to baseline (%)



Source: Aglink-Cosimo.

**Wheat and maize consumer prices in developing countries experience larger increases following the extreme weather shock than consumer prices for these crops in developed countries.** In selected developing countries shown in Panel B of Figure 20, consumer prices for wheat increase the most by 16-28% as a result of the extreme weather shock, followed by vegetable oils by 12-15% and by maize by 10-13% (except for Ethiopia). The large increase in maize consumer prices in Ethiopia by 28% could be explained by the large decline in maize production in Ethiopia in response to the extreme weather shock (-12.8%, Figure 14) combined with the importance of maize in Ethiopia's diet.

**Biofuel feedstock consumer prices in developing countries decline the most for vegetable oils, followed by maize in response to the cuts in the use of biofuel feedstock commodities.** Cuts in the use of biofuel feedstock commodities reduce consumer prices for vegetable oils in the countries shown in Panel B of Figure 20 by 7-21% and for maize by 2-11%. With a 50% cut in the use of biofuel feedstock commodities, vegetable oil prices decline below the baseline, where no extreme weather event occurred, and maize prices return close to baseline prices in all countries except for Ethiopia. Wheat prices fall by 3-9% in response to a cut in the use of biofuel feedstock commodities, but remain considerably above baseline prices. Again, this can be attributed to the higher initial increase in wheat prices as a result of the extreme weather shock as well as to the lesser importance of wheat as a feedstock for biofuel production.

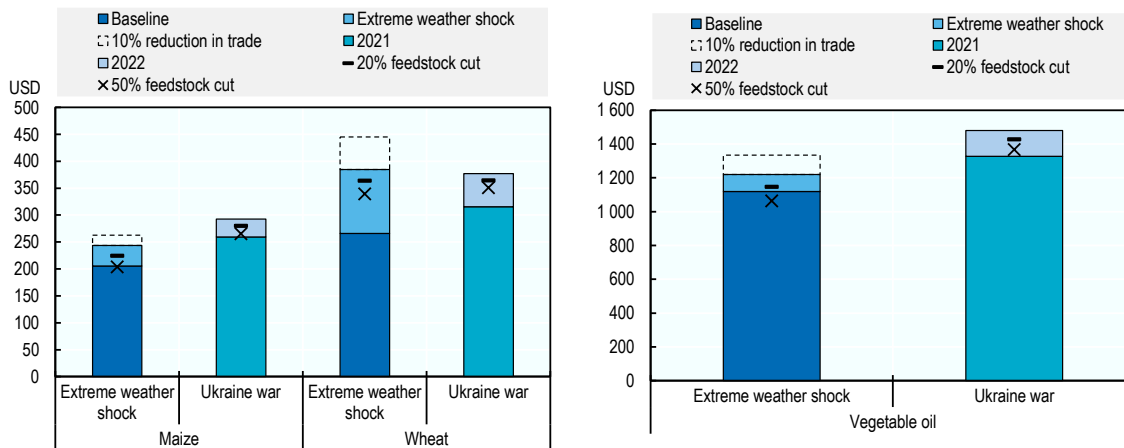
# 5 Policy conclusions: Instruments for smoothing food prices through a reduction of biofuel mandates and open trade

**Cuts in biofuel production have the potential to reduce grain price hikes in the context of geopolitical shocks.** A 20% cut in the use of biofuel feedstock commodities would lead to a 3-4% decrease in the 2022 grain prices, which had increased by 12-20% from 2021 prices due to the geopolitical shock. In the context of an extreme weather shock in 2026, a price dampening of 5-8% is expected (Figure 12). A 50% cut in the use of biofuel feedstock commodities would have resulted in a 7-9% decline from the 2022 grain prices in the context of the geopolitical shock and a 12-16% decline in the context of an extreme weather shock in 2026. This corresponds to a mitigation effect of 53-67% of the extreme weather shock for maize and vegetable oils for the 20% cut in the use of biofuel feedstock commodities while the 50% cut would fully offset the initial increase in maize and wheat prices. For wheat, 20% and 50% cuts in the use of biofuel feedstock commodities would offset 18-38% of the extreme weather shock. These differences in the effectiveness of cuts in biofuel feedstock commodities in reducing commodity prices can be explained by the smaller proportion of global wheat supply used in biofuel production when compared to maize and vegetable oils.

**Cuts in biofuel production in the context of shocks to agricultural production are particularly relevant for developing countries.** In developing countries, consumer prices for maize and wheat increase more in response to shocks to agricultural production than in developed countries. This in combination with high levels of poverty makes mitigation measures particularly important for these countries. In the context of the 2026 extreme weather shock, a 20% cut in the use of biofuel feedstock commodities reduces consumer prices for vegetable oils in sub-Saharan Africa (Nigeria, Ethiopia, other sub-Saharan Africa) and Asia (India, Pakistan and Viet Nam) by 7-10% and a 50% cut reduces them below the baseline, where no extreme weather event occurred, thus fully offsetting the initial shock. Similarly, for maize, a 20% cut in the use of biofuel feedstock commodities reduces maize consumer prices in these countries by 2-5% and a 50% brings prices back to baseline levels in all countries except for Ethiopia. Wheat prices fall by 3-9% in response to 20-50% cuts in biofuel feedstock commodities but remain considerably above baseline prices as a result of the stronger initial increase in wheat prices and the lesser importance of wheat in biofuel production.

**Figure 21. Cuts in biofuel production reduce food prices during major food price shocks while trade restrictions exacerbate food price spikes**

Price per tonne (USD)



Notes: In the context of the 2026 extreme weather shock, the 20% and 50% cuts in biofuel feedstock commodities and the 10% reduction in world exports of selected staples were simulated separately. The 20% and 50% cuts in biofuel feedstock commodities were not applied to the scenario with a 10% reduction in world exports.

Source: Authors' elaboration based on Aglink-Cosimo output.

**Cuts in biofuel production as a policy instrument can significantly mitigate the impact of shocks on food prices, but cannot fully offset very large food price shocks.** In the context of a large shock to grain prices, cuts in biofuel production can offset this initial shock only partially. This is the case of the 2021-22 food price shock as a result of the Ukraine war and extreme weather, where grain prices increased by more than 50% between 2020 and 2022. The same holds true for the extreme weather shock, which leads to a 45% increase in wheat prices in 2026. In the context of this shock, a 20% cut in the use of biofuel feedstock commodities can offset the initial increase in wheat prices by 18% and a 50% cut by 28%.

**Cuts in biofuel production have a significant cost for the producers of feedstock commodities.** Biofuel feedstock commodity prices for producers decline significantly in response to cuts in the use of biofuel feedstock commodities. Vegetable oil prices decrease the most (by 18-27% in response to the 20% cut in the use of biofuel feedstock commodities in selected biofuel producers), followed by maize prices (by 17-20%) and wheat prices experience the smallest decrease (7-8%).

**Maintaining free trade in the context of food production and food price shocks is essential to mitigate the impact of shocks and to protect vulnerable populations.** The results of the analysis show that export restrictions in the context of a major loss in grain production and grain price shock further exacerbate this shock. In the context of the extreme weather shock, a 10% decrease in exports leads to further increases in wheat, maize and vegetable oil prices by 8-16% from already elevated levels, with wheat prices increasing the most.

## Policy instruments

**Reductions in biofuel blend mandates or flexible mandates conditional on food prices are one potential policy instrument to implement cuts in biofuel production following large shocks to agricultural production but they are effective only for biodiesel.** Flexible mandates depending on sugar and fuel prices exist already to a certain extent in Brazil, in the United States and in California (Box 3). The results of the analysis show that biofuel blend mandate cuts are highly effective in reducing

biodiesel production from vegetable oils, but much less so in reducing ethanol production from maize and wheat. This can be explained by the much stronger commercial viability of ethanol as opposed to biodiesel. In many cases, ethanol production remains profitable even without mandates or other policy support. In addition, the effectiveness of biofuel blend mandates in reducing biofuel production depends on both international gasoline and diesel prices and prices of biofuel feedstock commodities. In the context of high international fuel prices or very low biofuel feedstock commodity prices, the production of biofuels is more likely to be commercially viable even in the absence of biofuel mandates and other support policies. Thus, in such a context, reductions in biofuel blend mandates may not be effective (Locke et al., 2013<sup>[27]</sup>; Tyner, Taheripour and Hurt, 2012<sup>[65]</sup>; FAO, 2011<sup>[70]</sup>; Wright, 2012<sup>[74]</sup>).

**Reductions in biofuel blend mandates could be combined with limits on the total amount of grains used by the biofuel industry or the phasing out of other support policies for biofuels to render them more effective.** In the case of a food price crisis, individual countries could place limits on the total amounts of wheat, maize and vegetable oils used for ethanol and biodiesel production (Locke et al., 2013<sup>[27]</sup>). India, for example, has taken such measures in response to domestic food supply concerns, limiting the use of sugarcane and rice for ethanol production in 2023/2024 due to poor harvests and food security concerns (USDA, 2024<sup>[35]</sup>). It would also be possible to reduce or phase out other biofuel support policies such as budgetary support. When combined with reductions in biofuel blend mandates, these policy instruments could potentially be more effective in reducing ethanol production than blend mandate cuts on their own. In addition, since biofuel mandates often function alongside broader regulatory frameworks such as LCFS, effective reductions would require co-ordinated adjustments across both mandate- and performance-based systems.

**To enable biofuel systems to contribute to global food security by acting as a reserve and releasing feedstocks during periods of scarcity, a co-ordinated multilateral approach would be necessary.** One practical option could be to embed biofuel-related contingency measures within existing global food market monitoring and response frameworks, such as the Agricultural Market Information System (AMIS), a G20-initiated platform that tracks key agricultural markets. AMIS already facilitates international dialogue and transparency on agricultural markets and has a Rapid Response Forum that could serve as a venue for co-ordination among major biofuel-producing and -consuming countries. Through AMIS or a similar forum, governments could agree to pre-defined principles or triggers, such as threshold levels of global food price volatility or supply shortfalls, that would prompt synchronised policy actions, including temporary reductions in blend mandates or limits on the diversion of food commodities to biofuels. However, challenges to such co-ordination include divergent national interests especially differing domestic priorities for food versus energy security. Overcoming these would require not only technical co-operation but also political commitment to balancing national responses with global food security objectives.

### Box 3. Examples of flexible biofuel policies

#### Variable blend mandates in Brazil combined with flex mills and flex fuel cars

**Brazil has variable blend mandates between E18 and E27, which are supported by flex mills and flex fuel cars.** Brazil adjusted its ethanol mandate eight times between 2006 and 2020 in order to respond to fluctuations in sugarcane and fossil fuel oil prices (Vural Gursel et al., 2020<sup>[71]</sup>). This has been possible because about 75% of sugar processing plants in Brazil are flex mills, meaning that they are able to convert sugarcane into both sugar and ethanol simultaneously (Czarnikow, 2021<sup>[75]</sup>). This allows the market to determine if the sugar should be converted into either sugar or ethanol depending on whether sugar or energy prices are high. Flex mills have the flexibility to maximise the production of sugarcane to sugar rather than ethanol when sugar is more profitable (USDA, 2022<sup>[44]</sup>). In addition, the introduction of the flex-fuel technology has been a critical factor in allowing for variable blend mandates and biofuel demand in Brazil. Flex-fuel technology allows cars to operate on any ethanol blend or on

common gasoline and is found in 90% of cars in Brazil (Vural Gursel et al., 2020<sup>[71]</sup>). In addition to flexible blend mandates, Brazil has also been using changes in import tariffs to balance biofuel supply and demand. During the COVID-19 pandemic and in May 2022, following the start of the Ukraine war, Brazil temporarily reduced import duties for biodiesel (USDA, 2022<sup>[44]</sup>).

#### **Renewable Identification Number trading, banking and borrowing in the United States**

**In the United States, biofuel underproduction in one year can be compensated by overproduction in another year and biofuel underproduction by one producer can be compensated by overproduction by another producer.** Under the Renewable Fuel Standard (RFS), the US Environmental Protection Agency calculates annual renewable volume obligations (RVOs) for refiners, blenders and importers of gasoline and diesel fuels. Renewable Identification Numbers (RINs) serve as a tracking system for batches of biofuels. By the end of each year, each supplier must have sufficient RINs to meet its share of four mandated standards. Since RINs can be borrowed, banked and traded, in practice, suppliers can meet their obligations not only by producing sufficient biofuels but also by using banked RINs, buying RINs from other producers with excess production or by borrowing against future years' production. This system allows to balance times of surplus with times of shortfalls. One limitation is that no more than 20% of the RVO in a given year can be met using RINs banked from previous years. A RIN trading system has developed to balance supply and demand across time and regions. For example, between 2005 and 2010, more ethanol than mandated was produced every year. Many of the RINs, which were banked during this period of time, were subsequently used when a drought hit US maize production in 2012 (Vural Gursel et al., 2020<sup>[71]</sup>).

#### **Flexible feedstock sourcing in California**

**The State of California has a system of flexible feedstock sourcing based on feedstock costs.** The LCFS sets targets for the carbon intensity of fuels rather than for volumes of biofuels produced and provides producers meeting these targets with financial incentives. The LCFS allows the market and producers to determine which feedstocks are most cost-effective in producing fuels at any point in time based on the cost of different feedstocks and the financial incentives that can be obtained by meeting carbon intensity targets (Vural Gursel et al., 2020<sup>[71]</sup>).

Source: Vural Gursel, I. et al. (2020<sup>[71]</sup>), "Variable demand as a means to more sustainable biofuels and biobased materials", *Biofuels, Bioproducts and Biorefining*, Vol. 15/1, pp. 15-31, <https://doi.org/10.1002/bbb.2164>; USDA (2022<sup>[44]</sup>), *Brazil: Biofuels Annual*; Czarnikow (2021<sup>[75]</sup>), *Ethanol vs sugar: the price relationship that keeps Brazil's sugar market guessing*, <https://www.czarnikow.com/blog/brazil-sugar-market-ethanol-sugar>.

# Notes

<sup>1</sup> Droughts, extreme temperatures, floods, glacial lake outbursts, insect infestations, storms, landslides and wildfires

<sup>2</sup> Most US cars cannot consume gasohol with more than 10% of ethanol.

<sup>3</sup> Fossil fuels are an input in the cultivation, harvesting and transportation of biomass. They are also required as part of the conversion process of biomass to biofuels, although the amount of energy needed for conversion varies by biomass (Hill et al., 2006<sup>[78]</sup>).

<sup>4</sup> Undenatured ethanol refers to unmodified ethanol with no additives or denaturants. It is considered safe for human consumption and when sold is often classified as an alcoholic beverage. The denaturation process adds in compounds toxic for humans and is undergone to circumvent the high excise duties applied to the sale of alcoholic beverages in many countries (European Renewable Ethanol, 2020<sup>[76]</sup>).

<sup>5</sup> The ethanol markets of the EU, the United States, China and Brazil are switched off. For biodiesel, the markets of the EU, Brazil, the United States, China, India, Indonesia and Thailand are switched off.

<sup>6</sup> The two trends are based on different values of the Hodrick-Prescott filter variable lambda, which dictates the sensitivity of a trend to short-term fluctuations. The more dynamic trend applies a more strict lambda based on the number of observations in the time series following business cycle standards whereas the more linear trend has a less restrictive lambda value calibrated to capture longer-term trends. The lambda for the more linear trend was defined following experimental methodology as there is little guidance in the literature on this specific application.

<sup>7</sup> Producer prices measure prices received by domestic producers for goods and services sold on the domestic or/and on the export markets whereas consumer prices measure prices from the household purchasers' perspective (OECD, n.d.<sup>[77]</sup>).

<sup>8</sup> The weaker reaction of maize producer prices in China and Indonesia and of wheat producer prices in China to the cuts in the use of biofuel feedstock commodities can be explained by the lesser initial increases in the prices of these commodities in these countries in the context of the extreme weather shock.

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