

The Russia-Ukraine war: Implications for global and regional food security and potential policy responses

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ABSTRACT

This paper analyzes the implications of the Russian-Ukraine war on global and regional food security. We start with a global vulnerability analysis to identify most vulnerable regions and countries. The Middle East and North Africa (MENA) region is particularly vulnerable to trade shocks because of its high food import dependence. Thus, we provide descriptive evidence characterizing how food systems and policies impact vulnerability to the price shock in selected MENA countries: Egypt, Sudan, and Yemen. Within these countries, we show that the crisis will differentially impact poor and non-poor households as well as rural and urban households. Although the absolute level of food insecurity may still be higher in rural areas where larger numbers of poor households are located, urban poor are likely to suffer most because of the Russia-Ukraine crisis and associated hikes in food prices, especially in those countries where social protection and food subsidies are missing. We review lessons from previous food crises and identify actions needed to take (and to avoid) to protect most vulnerable countries and households in the short-term while also highlighting long-term policy options to diversify food, fertilizer and energy production and trade.

1. Introduction

The Russia-Ukraine crisis poses serious global and regional food security challenges. Russia's invasion of Ukraine has displaced millions and disrupted agricultural production and trade from one of the world's major exporting regions. Besides these immediate human sufferings and loss of lives and livelihoods within Ukraine, the Russia-Ukraine crisis is ravaging global food markets and imperiling global food security. This is not surprising given the recently increasing role of the Black Sea region in global food markets. A net food importer only 25 years ago, the Black Sea region has emerged as a major supplier of grains and oilseeds. Over the last few years, Russia and Ukraine exported 34 percent of globally traded wheat, 17 percent of maize and 73 percent of sunflower oil (UNComtrade, 2022; FAO, 2022a). Similarly, Russia and Ukraine together account for about 27 and 17 percent of the global barley and maize trade, respectively. These exports represent substantial share of

global consumption and diets, accounting for about 12 percent of total calories traded in the world. Russia is also major exporter of nitrogen and potash fertilizers, accounting for about 15 percent of global trade in nitrogenous fertilizers while Russia and Belarus account for 33 percent of global potash fertilizer exports (Laborde and Mamun, 2022). Russia is also a major producer and exporter of energy (oil and gas), which are major inputs for the transportation, production and processing of food and fertilizers (e.g., Dillon and Barrett, 2016). The overall impact of the Russia-Ukraine war on global food markets, both directly and indirectly through fertilizer and energy, is unparalleled at least over the last half of century.

While disruptions in production and trade threaten the supply of grains to countries traditionally reliant on imports from Ukraine and Russia, the major risk to food security is coming from the immediate surge in global food and fertilizer prices. Global food markets witnessed a significant surge in prices immediately after Russia invaded Ukraine

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on February 24th, 2022. The FAO Food Price Index (FFPI) reached the highest level recorded since its inception in 1990 in March 2022, averaging at 159.3 points, 12.6 percent higher than in February 2022 (FAO, 2022b). The Russia-Ukraine crisis and associated sanctions on Russia and Belarus has also disrupted fertilizer supplies, which is accelerating increases in fertilizer prices.

Besides the direct impacts, the Russia-Ukraine war has significantly increased uncertainty for global market actors. This uncertainty, which is both reflected in and caused by rising price volatility in internationally traded commodities, affects production and marketing decisions (e.g., Feder et al., 1980; Moschini and Hennessy, 2001) and spurs speculative market behavior. When prices fluctuate, it is more difficult for farmers to make decisions about what to produce and how much to trade; businesses are more reluctant to invest in food and agriculture; and ultimately consumption decisions are affected through higher prices and/or lesser availability. The war and associated surge in food, energy and fertilizer prices have triggered a range of policy responses, especially export restrictions, which have exacerbated the situation (Laborde and Mamun, 2022). These dynamics could fan further food price inflation in already ailing global economy which was recovering from the COVID-19 pandemic.

Food prices increases will adversely affect the wellbeing of low-income households who spend most of their income on food. Furthermore, the massive humanitarian crisis caused by the war is shifting attention and resources from other conflict-affected and vulnerable communities in Africa and Asia, aggravating the food security crisis in these regions. The World Food Program (WFP) projects that global population facing acute hunger will increase by 47 million people if the Russian-Ukraine war continues unabated, most of which come from vulnerable and already food insecure regions (WFP, 2022a).

The timing of the Russia-Ukraine crisis is an additional complicating factor for several reasons. First, the global economy in general, and many vulnerable countries in particular, were yet to recover from the repercussions of the COVID-19 pandemic. Thus, many import-dependent countries have limited resources to withstand another crisis. Second, even immediately before the war, food and fertilizer pricing were increasing (Headey and Hirvonen, 2022). FAO's Food Price Index shows that commodity prices hit an all-time high in February, before the full impacts of the invasion could be felt (FAO, 2022b). Third, the first quarter of the year is, when many food importing countries stock their reserves from Russia and Ukraine. For example, Egypt, the world's largest wheat importer usually procures a third of the total import in the first quarter of the year. Finally, the timing of the Russian invasion of Ukraine preceded Ramadan, which is usually associated with significant increases in food prices in predominately Muslim countries (e.g., Yucel, 2005).

The scale, timing and potential ramifications global economies are witnessing suggest that this war will havoc global food markets if it continues unabated (FAO, 2022c). The global food security crisis triggered by this war demands immediate national as well as global responses to provide relief in the short term, as well as policy changes to diversify the world's food markets over the long term to build resilience and avoid future crises. Some countries are particularly vulnerable, including those experiencing slow and uneven economic recovery to the COVID-19 pandemic, conflict affected and fragile economies, and low-income countries with high levels of import dependence for food. Globally, spikes in food prices are likely to disproportionately affect poorer households due to their larger budget share on food. Governments in import-dependent low-income countries may have limited fiscal space to protect the purchasing power of low-income families and prevent higher food prices from causing greater food insecurity and further deterioration of diets. This necessitates understanding and identifying regional and national vulnerabilities to inform immediate and longer-term responses. For example, government responses to past food crises and the unfolding war in Ukraine have entailed policies that would restrict exports, thus benefitting those in domestic markets but at

the expense of net food importing countries. Lessons from past food crises, including the 2007/8 and 2010/11, suggest that these trade restrictions will put additional pressure on available food stocks hence push food prices up. Thus, domestic and regional policy responses to the unfolding crisis require careful consideration of potential adverse impacts to domestic and regional markets.

This paper analyzes the implications of the Russian-Ukraine crisis for global and regional food security. We start by providing a global vulnerability analysis to identify the most vulnerable regions and countries. The Middle East and North Africa (MENA) region is particularly vulnerable to trade shocks because of its high food import dependence. Thus, we provide a deeper focus on short and long-term food security implications in selected MENA countries (Egypt, Sudan and Yemen). We also document important lessons from previous food crises and highlight the effectiveness of these policy responses and instruments to protect the most vulnerable countries and households. We conclude by listing several immediate and longer-term policy actions for diversifying food, fertilizer and energy production and trade in the MENA region. This is an absolute necessity in the context of the MENA region, where looming threats from climate change and water scarcity are affecting agricultural production and productivity (e.g., World Bank, 2018; Perez et al., 2021).

2. Vulnerability analysis

Since Russia invaded Ukraine, global food, energy and fertilizer markets have witnessed major turbulence because of anticipated and realized disruption of exports from the Black Sea region (Glauber and Laborde, 2022b). Before the crisis, food and fertilizer prices were already rising, mainly due to: (i) reduced harvests in Latin America, Southeast Asia, and Europe in 2021, (ii) COVID-19 induced supply disruptions, and (iii) increasing demand for food in Asia. These combined drivers have led to low inventory levels in key staple crops, creating perfect conditions for any new shock to lead to major price hikes. With the outbreak of the conflict in Ukraine, global markets feared the loss of expected agricultural exports from Russia and Ukraine. Therefore, the war triggered major increases in food prices and major policy responses by several exporting countries, including export restrictions, which have exacerbated the situation (Laborde and Mamun, 2022).

However, global increases in food, energy and fertilizer prices entail heterogeneous consequences for countries depending on their underlying conditions and vulnerabilities. It is important to identify the nature and degree of vulnerability to understand the potential impacts of the crisis on regional and national food security. We develop a country-level vulnerability typology, especially focusing on short-term impacts. This analysis helps to identify "hot spots" and inform discussions on potential interventions to avert further impacts of the war. We reviewed 25 indicators intended to quantify the various channels that can affect countries' food security vulnerability, ranging from direct impact on available inventories, to macroeconomic and microeconomic exposure to price changes. As shown in Table A1 (in the Appendix), these include the existing dependency on the Black Sea region, exposure to other suppliers that have put in place export restrictions, and current level of wheat stocks to determine countries' buffer capacity to absorb these trade shocks. Beyond these first order indicators of exposure to immediate supply disruptions, we also consider the consequences of price increases of various commodities (food, energy and fertilizer) on countries' current account (positive or negative effects depending on trade structure of countries, e.g., oil exporters currently enjoy a positive terms of trade change) to capture the changes in purchasing power of countries on world markets, and potential pressures on their currencies and exchange rate. Finally, we look at existing level of undernourishment, food price inflation and expected impacts of the changes in world price on domestic food bill - assuming perfect price transmission-to assess to which extent the rising food prices could impact short-term household food security.

By applying these criteria, we obtain the map displayed in Fig. 1, which classifies countries into 10 categories. Fig. 1 identifies several countries that are directly and strongly exposed to the conflict and/or subsequent export restrictions. Some countries in MENA and Central Asia as well as few countries in Africa are extremely vulnerable to the crisis. The extremely high vulnerability (because of direct exposure and low stocks) country list includes some countries in the MENA region such as Lebanon, Sudan, and Yemen and Mauritania in West Africa (which imports over 50 percent of its wheat from the Black Sea) while the very high vulnerability category (direct exposure to conflict) includes countries like Egypt and some countries in Central Asia (e.g., Mongolia and Tajikistan). We note that rising fuel prices associated with the Russia-Ukraine war are generating windfall gains to some oil-exporting countries in the MENA region while oil-importing countries (e.g., Egypt) are facing double burden coming from high food and fuel prices. While many of the MENA countries generally rely heavily on cereal and related food imports, some countries (e.g., Bahrain, Kuwait, Oman, Qatar, Saudi Arabia, United Arab Emirates) are also major oil-exporters. Oil-exporting countries may redirect these windfall gains to support vulnerable households and hence strengthen resilience of households and economies in oil exporting countries. On the other hand, the surges in oil and food prices have triggered macroeconomic imbalances and hence major devaluations in currencies in Egypt, Lebanon, and Morocco.

Finally, Fig. 1 shows that the vast majority of low- and middle-income countries (LMICs) are highly vulnerable due to indirect effects, as they face significant increases in the cost of food relative to GDP. We focus our in-depth analysis in the following section on three countries associated with extreme or very high vulnerability, namely, Sudan, Yemen and Egypt.

3. Country case studies

As shown in Section 2, the MENA region is the most vulnerable to the Russia-Ukraine war and related price increases. We select three countries from the MENA region for a deeper analysis: Egypt, Sudan and Yemen. The three countries rely heavily on cereal imports from Russia and Ukraine. Wheat is a key food item and major source of calorie for these countries, representing 39, 20 and 46 percent of caloric intake per person in Egypt, Sudan and Yemen, respectively (Fig. 2). Much of the wheat demand is satisfied through imports from Russia and Ukraine. Wheat imports usually account for about 62 percent of total wheat use in Egypt, making Egypt the world's largest importer of wheat, and about 85 percent of wheat imports comes from Russia and Ukraine. Cereal import dependence is even higher in the case of Sudan and Yemen where the large majority of wheat and wheat products are imported (Fig. 2). The share of Russia and Ukraine in these imports remains large (Fig. 3).

Besides wheat, Ukraine and Russia are important suppliers of other important agricultural products in MENA countries. For example, Ukraine supplies about 30 percent of Egypt's corn imports (UNComtrade, 2022). Russia and Ukraine are major sources of sunflower oil for Egypt, supplying about 85 percent of sunflower oil. Because of these dependencies, the MENA countries are witnessing a major surge in food prices. This is further fueled by export restrictions in several food exporting countries (Laborde and Mamun, 2022). For example, Egypt, Sudan and Yemen import a large share of their palm oil consumption from Indonesia and Malaysia.¹ However, recent export restrictions on palm oil export by Indonesia threaten the supply of palm oil to these countries (Laborde and Mamun, 2022). Furthermore, the increase in demand for food during April as a result of changing consumption patterns during Ramadan probably contributed to increases in food prices in these countries in the second quarter of 2022. These various pathways

contributed to the fact that food prices in the three countries reached record levels in the period immediately after the outbreak of the Russian-Ukraine conflict.

3.1. Differences in vulnerabilities across countries

Despite their heavy reliance on Russia and Ukraine for food imports, Egypt, Sudan, and Yemen each face unique vulnerability arising from underlying conditions and existing policies, which also affect their fiscal and institutional capacity to withstand the adverse effects of the Russia-Ukraine war.

Egypt has become increasingly dependent on imports to meet food needs for its population of 105 million growing at a rate of 1.9 percent a year, and cereal import dependence has been steadily increasing over the last three decades at a rate higher than that of domestic production. The government of Egypt has been spending about \$3 billion annually for wheat imports, most of which are devoted to a long-standing bread subsidy program, the *Tamween* ration card system which covers 73 percent of the households in Egypt (MSIT, 2019). This program provides beneficiaries with up to 150 loaves of subsidized *baladi* bread per month, with about 90 percent of the production cost borne by the government at an annual cost of \$3.24 billion (MSIT, 2019; Breisinger et al., 2021). The program requires about 9 million tons of wheat annually, which is about half of the total wheat consumption in Egypt. The recent increase in wheat price introduces a major increase in cost of running the *Tamween* program to the government. Immediately after the outbreak of the war, food prices in Egypt increased significantly and food price inflation reached a five-year high record of 31 percent in November 2022 (CAPMAS, 2022).

The government of Egypt is responding to the crisis using both fiscal and monetary policy instruments to cushion the adverse effects of the crisis. In March 2022, the government announced a price cap on unsubsidized bread and banned export of basic food commodities such as wheat, flour, oil and corn for three months. The government also opened its strategic wheat reserve and increased planned wheat procurement from domestic market through a combination of offering higher prices to farmers and introducing a quota required to be sold to the state for all wheat farmers (Enterprise, 2022).² Other fiscal measures being taken include: expansion of social protection programs to reach more vulnerable people as well as tax relief for firms and salary increases for civil servants. In particular, the government has decided to expand the existing *Takaful* and *Karama* program to cover an additional 0.5 million households. Similar expansion of social protection programs proved to be effective in mitigating some of adverse impacts of the COVID-19 pandemic, both in Egypt and other African countries (e.g., Krafft et al., 2021). These fiscal policy responses are likely to cushion some of the adverse impacts of the surge in food and energy prices. To conserve and attract foreign currency, Egypt continued devaluing its currency after the outbreak of Russia-Ukraine war while increasing the interest rate. Since the outbreak of the war in February 2022 and up until January 2023, the Egyptian Pound experienced consecutive devaluations that led to about 100 percent loss in its value against U.S. Dollar.

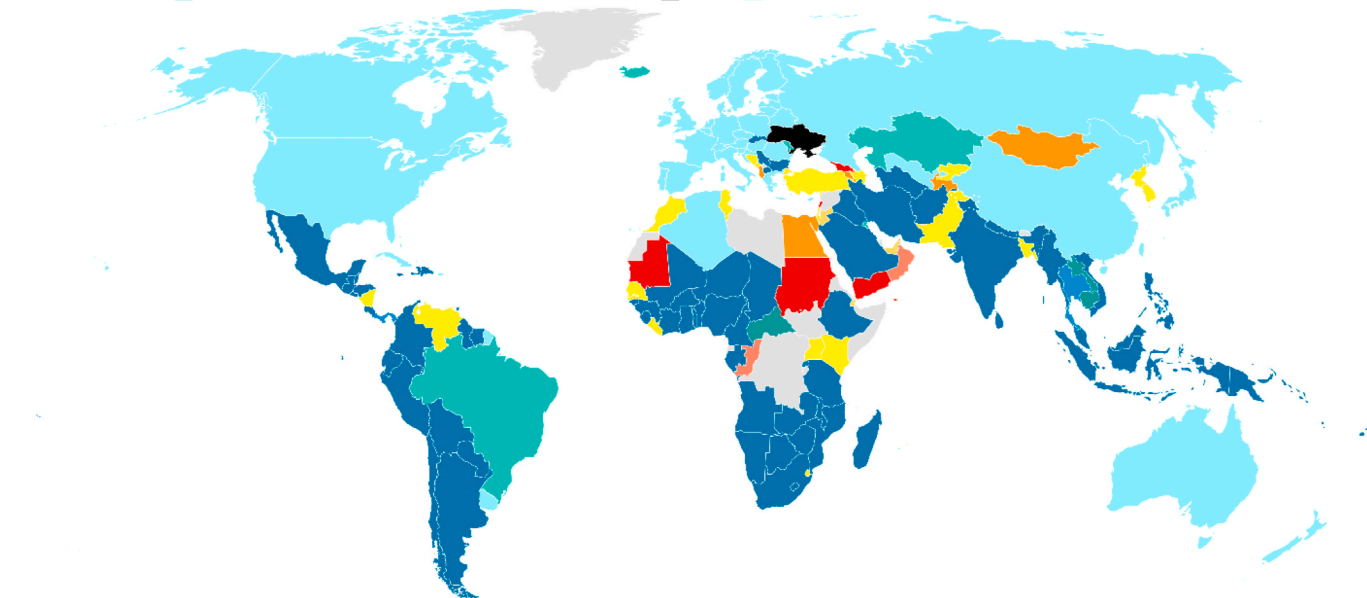
Sudan faces a uniquely difficult set of circumstances as these disruptions loom. The Russia-Ukraine war arrived when Sudan was continuing to confront a complex set of macroeconomic, health, humanitarian and political crises that continue to worsen poverty and food insecurity. According to the IMF, the Sudanese economy has contracted by 2.3 and 2.5 percent in 2018 and 2019, respectively. The economy is projected to have contracted by 3.6 percent in 2022, mainly because of COVID-19 and other shocks such as the locust invasion, which all came on the top of the political instability (IMF, 2022). After starting a

¹ Indonesia and Malaysia account for about 92 percent of global palm oil exports over 2019–2021.

² <https://enterprise.press/stories/2022/03/17/carrots-sticks-for-local-wh-eat-farmers-to-up-supply-67145/>.

Vulnerability Map

1 - Extremely High - Food consumption directly exposed to conflict and low stocks 2 - Extremely High - Food consumption directly exposed to export restrictions and low stocks 3 - Very High - Food consumption directly exposed to conflict 4 - Very High - Food consumption directly exposed to export restrictions 5 - High - Food consumption exposed to export restrictions or conflicts 6 - High - Large Increase in Food Cost compared to GDP expected 7 - High - High Risk of Food Price increase due to last month changes 8 - Moderate - High Risk of Food Price increased driven by the last 12 month changes 9 - Moderate - No immediate risks but Fertilizer supply compromised Ukraine x - Minor Risk



Assessment based on March 28th 2022 data
Map: David Laborde

Fig. 1. Overview of country-level vulnerability.



Food Balance Sheet, 2018, with authors' computations and adjustments for Egypt

Fig. 2. Food consumption, Kcal per day and source of calories across countries.

political transition in 2019, Sudan has been held back by the October 2021 military coup. This is a major setback and a turning point that forced international investors and the donor community to halt most of their activities in the country, a prominent component of which is the

Samarat program, a social protection program led by the World Bank. This therefore is likely to impede the government's response to the crisis. Wheat remains a strategic and political commodity and wheat import dependency is even higher than the case of Egypt. Only about 15 percent

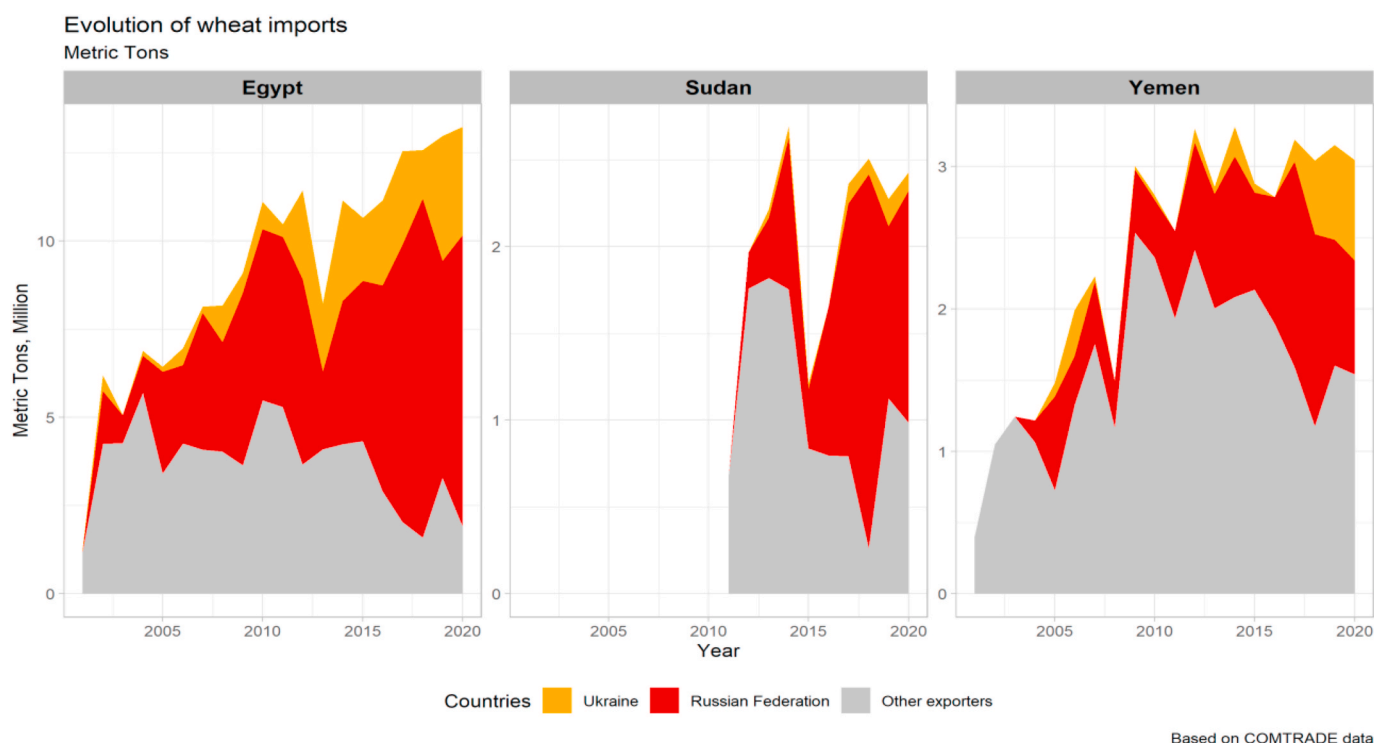


Fig. 3. Evolution of wheat imports and the role of Russia and Ukraine in wheat imports.

of the wheat consumed in Sudan is grown domestically—and this share may shrink due to rising fertilizer and energy prices; the rest is imported, with a majority sourced from Russia and Ukraine in recent years (Fig. 3). Because of a series of domestic problems, including high inflation, major currency depreciation, and political instability, prices for wheat and fuel were already spiking before the war began, compounding the risk of rising food insecurity. According to WFP (2022b), wheat flour prices have increased by a national average of 14 percent in March 2022 (681 SDGs per kg) relative to February 2022 (598 SDGs per kg). The average wheat flour price peaked in October 2022, reaching 744 SDGs per kg, which is 73 percent higher than it was in October 2021, before it starts slightly decreasing in November and December 2022 to 730 SDGs and 733 SDGs, respectively (CBS, 2023). However, they are still 39 percent and 36 percent, respectively, higher than their counterparts in 2021 (Ahmed and Siddig, 2023). Cereal markets in Sudan are poorly integrated, which will likely contribute to further uncertainties and dispersion in market prices (Abay et al., 2023a).

Sudan used to have a long-standing bread subsidy program that benefited the general population. However, recent removal of this subsidy has triggered significant increase in bread prices (Breisinger et al., 2022). On January 1st, 2022, the Sudanese government abandoned all forms of subsidies on wheat (grain, flour and bread), forcing milling companies to obtain grain in the higher-priced open market (e.g., Abdelaziz et al., 2022). The lack of alternative social protection programs in Sudan, especially after the suspension of the Samarat cash transfer program after the military coup of October 2021, threatens food security of poorer and vulnerable households. The recent political crisis and transition will also likely limit the government's capacity and response to the Russian-Ukraine crisis. The IMF projects that in 2022 government revenue as share of GDP will decline by 2 percent relative to that of 2021, while government general expenditure as share of GDP is expected to grow by 18 percent in 2022 (IMF, 2022).

Yemen, which was already one of the poorest countries in the MENA region, has been ravaged by a civil war since 2015 and this has increased malnutrition and deteriorated the whole economy. Yemen has an even greater degree of import dependence on cereals than Egypt. Due to high

costs for irrigation, increasing commercial production of khat and dependence on remittances from migrant labor to neighboring Gulf countries, cereal production in Yemen was extremely limited even before the civil war.

Currently, food imports alone exceed total export of all goods from the country. Yemen relies heavily on remittances and international aid to finance imports. While crude oil remains the core exported commodity, the country spends about 3.5 billion dollars on average on import of food products and refined oil alone, about 15 percent of its GDP. Large spending for these products creates a large vulnerability to rising prices on world markets. While the increase in crude oil prices could partially mitigate the balance of trade deficits, the conflict has also constrained oil production and transport significantly.

Unlike in Egypt or Sudan, there is no tradition of government subsidies of staple food commodities in Yemen, though fuel has been subsidized. In the southern part of the country that is controlled by the internationally recognized government, wheat is imported through the crucial port city of Aden. Wheat also enters the more populous northern portion of the country, which is controlled by the de facto authorities et al. Hodeidah port. Because wheat is distributed by a network of small traders after being imported, wheat prices in Yemen track fairly closely with international prices with additional costs for transportation in areas farther from these two ports.

Approximately 12 percent of the cereal imports in Yemen come in the form of humanitarian food aid (FAO, 2021). More than 50 percent of Yemeni households reported receiving some type of in-kind food assistance in 2020 (Ghorpade and Ammar, 2021). The World Food Program alone usually aims to reach 13 million people (43 percent of the Yemen population). WFP's assistance to Yemen includes processed products such as fortified wheat flour and ready to use supplementary food (RUSF) that is often sourced from other MENA countries (Egypt, UAE, and Turkey) that imported wheat from Ukraine and Russia. Thus, recent export restrictions in these neighboring countries will induce additional pressure on food prices in Yemen.

As crucial as this assistance is to Yemen, international funding for maintaining this level of support is uncertain as the crisis drags on and

competing priorities continue to emerge. The coordinated humanitarian appeal for Yemen in 2022 requested \$4.27 billion to meet beneficiary needs, of which only 54% was received, the lowest level share relative to needs since the beginning of the civil war (OCHA 2023).

Fuel prices have risen dramatically in the southern governorates in Yemen, which is attracting traders from the northern part of the country. This results in a situation of fuel shortages even in the southern governorates and high prices in both regions. It is estimated that local transport and distribution costs and taxes represent about three-fourths of the consumer cost of fuel in the northern governorates and two-thirds of the cost in the southern governorates (ACAPS, 2021). These high fuel prices will increase food prices in the short-term through increased transport costs while also making local agricultural production prohibitively expensive due to increases in cost of irrigation.

3.2. Anticipated heterogeneities in impacts across households

Besides the cross-country variations in the impact of the crisis, the hikes in food, energy and fertilizer prices triggered by the Russian-Ukraine crisis are likely to have differential impact across households within the same country. We highlight differences across poor and non-poor households as well as across rural and urban households. There are two broad empirical patterns that may generate differences in impacts of

trade shocks (and associated increase in food and energy prices) across poor and non-poor households. First, according to the Engel curve hypothesis, poorer households allocate larger share of their budget (income) to food consumption. This implies that trade shocks that increase prices of foods are likely to be more impactful on poorer households than on richer households. Second, within the category of food spending, the poor are likely to rely more heavily on cereals and cheaper energy-dense foods because the cost per calorie is lower (Headey and Alderman, 2019; Hirvonen et al., 2020).

To examine the importance of these mechanisms within our focus countries, we compile household survey data from different sources. For Egypt, we use data from Ecker et al. (2016), coming from the 2010/11 Egypt Household Income, Expenditure, and Consumption Survey (HIECS) to investigate the relationship between wheat calorie intake per day and wealth of households. For Sudan we employ a nationally representative household sample used by Dorosh (2021), which are based on. These data cover the whole Sudan and provide substantial variation in household welfare across states. However, we note that these data from Egypt and Sudan are relatively old. We are using them mainly due to lack of recent and publicly available nationally representative data. For Yemen, we use data from Kurdi (2021), which use household survey data collected in two rounds in 2015 and 2017 from a selected sample of households in Al Hodeidah governorate. The Yemen

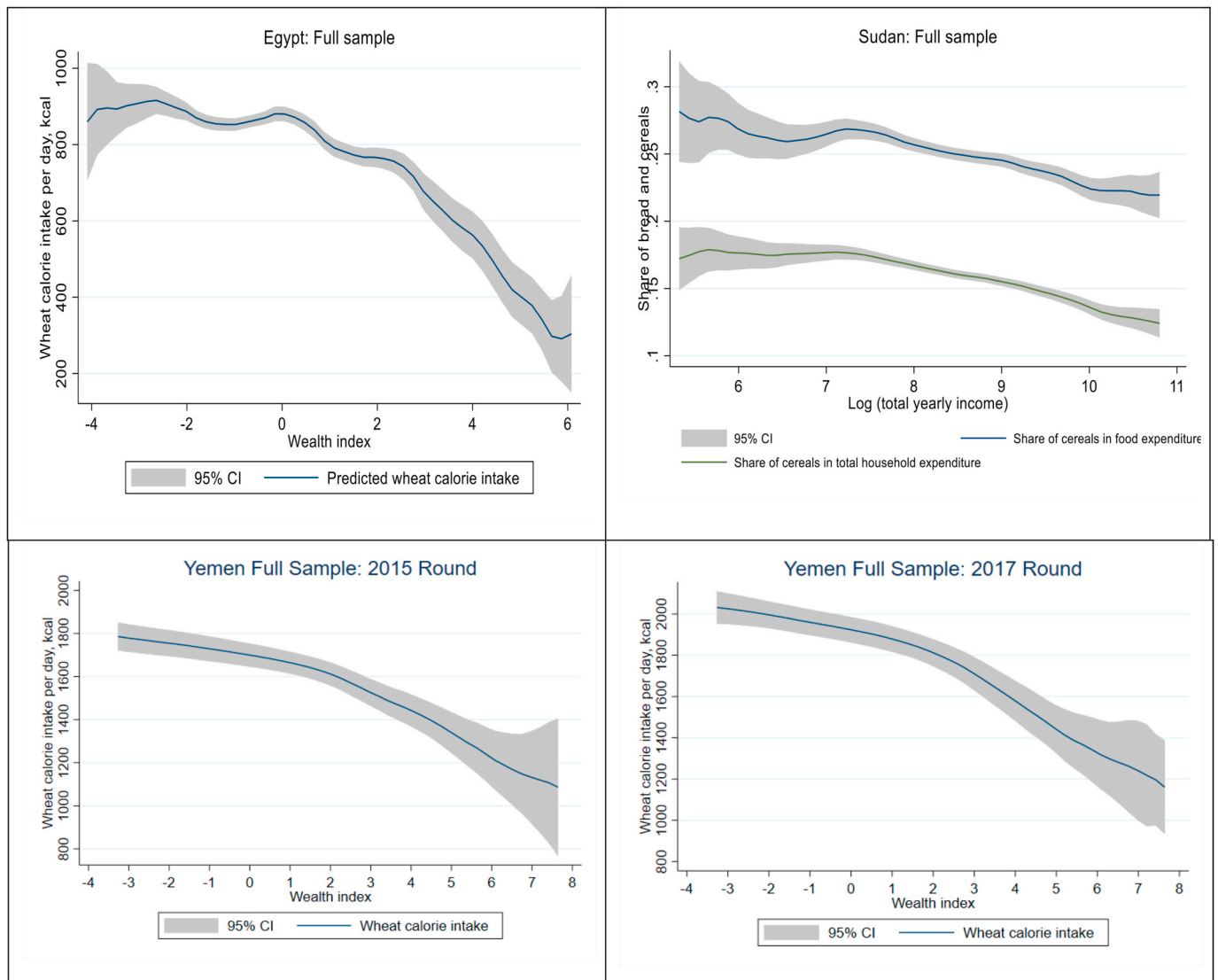


Fig. 4. Relationship between wheat/cereals consumption and household wealth/income.

survey data are not nationally representative, but these data can serve our purpose of evaluating the relationship between wheat consumption and household wealth as well as potential heterogeneities across rural and urban households within a smaller slice of the population in Yemen. We plot polynomial (nonparametric) relationships between wheat consumption per capita and a household wealth index (based on asset ownership in the case of both Egypt and Yemen) or logged household income (Sudan).

The first graph in Fig. 4 confirms that in Egypt wheat calorie intake per day declines with wealth: poorer households consume significantly larger wheat calorie per day than richer households. We note that given that more than 70 percent of the households in Egypt benefit from the bread and flour subsidies, much of the wheat calorie intake comes from the bread subsidy program. This implies that large share of household wheat calorie intake expenditure is covered by the food subsidy program and hence the share of household expenditure on wheat is low. However, in terms of calorie intake, wheat remains a major source of calorie for many households, especially for poorer households as reflected in the first graph in Fig. 4. The importance of wheat declines quickly with wealth, implying that wealthier households have more diversified diet with larger share coming from non-wheat sources. This is not surprising given that diets in Egypt are already reasonably diverse; dietary diversity in Egypt is higher than many countries in Africa and increases with income or wealth (Ecker et al., 2016; Breisinger et al., 2018).

The second graph shows that in Sudan the share of household expenditure on bread and cereals also declines with household income. This holds both for the share of expenditure on cereals in food expenditure as well as the share of expenditure on cereals in total household expenditure.

Similarly, the last two graphs in Fig. 4 clearly show that wheat calorie intake per day declines with wealth in Yemen, both for the 2015 and 2017 rounds. The relationship between wheat/cereal consumption and household wealth gets steeper with increasing wealth, implying potential nonlinearities in the relationship, with wheat consumption remaining fairly constant at low levels of wealth. The fact that these patterns consistently hold for all the three countries suggest that the relationship is robust and evident. In the Yemen data, we also see that for the same sample of households, reliance on calories from wheat increased across the distribution between the first round collected in 2015 prior to the civil war and the second round (2017) collected in the midst of the economic devastation of the war. This increased consumption of calories from wheat was accompanied by a decrease in consumption of non-staple foods as households with diminished economic resources cut spending on higher value food items and relied increasingly on food aid (Kurdi, 2021). This suggests that fragility and conflicts may further increase households' reliance on limited cereals and hence their vulnerability to trade shocks.

The increasing reliance on cereals is also harmful from a nutrition standpoint. Given that high-value food items are major sources of micronutrients and proteins (Headey and Alderman, 2019), this implies that high cereal and bread prices do not only reduce access to calories but also access to micronutrients.

To explore potential heterogeneities across urban and rural households, we split the sample into rural and urban samples. Fig. 5 shows that wheat consumption is generally smaller in rural areas and the inverse relationship between wheat calories consumption and household wealth gets stronger in urban areas. The graphs in Fig. 5 clearly show that income/wealth elasticities associated with wheat and cereals demands are much higher in urban areas than rural areas. Again, this pattern holds for all three countries, likely because rural households have greater ability to substitute wheat by other locally produced food items. Intuitively, this implies that urban poor are likely to be most affected by food price increases triggered by the Russia-Ukraine crisis, although the absolute level of food insecurity may still be higher in rural areas where larger numbers of poor households are located.

There are two caveats worth noting while interpreting the patterns in

Figs. 4 and 5. First, existing government social protection infrastructure and related government responses can play important role in cushioning the differential impact of rising food prices. Even if urban and poorer households may be more vulnerable to food price shocks, food subsidy programs in some countries can absorb the adverse impacts of these shocks. For example, the government of Egypt continued subsidizing key food items, including bread, and hence kept their prices unchanged, which has at least partly protected households' consumption of these food items (Abay et al., 2023b). Second, the Russian-Ukraine war led to surge in food, energy and fertilizer prices while the discussion and heterogeneities discussed in Section 3.2 only focus on the implication of increases in food prices. Hikes in fuel and fertilizer prices may have different implications across poor and rich households as well as across urban and rural households. For example, increases in fuel prices may increase costs of irrigation and hence disproportionately affect rural households.

4. Policy options to minimize repercussions in the MENA region

As discussed above, Egypt, Sudan and Yemen have responded differently to the food security challenges posed by the Russian-Ukraine war depending on existing institutional contexts and instruments. In addition to some of the measures that have already been taken by the three countries and its international partners, there are additional short-term and longer-term measures that the countries could consider both on the supply and demand sides.

In the short-term, all three countries should consider diversifying their wheat supply. When doing so, countries must carefully weigh the costs and benefits of such an "insurance" mechanism as wheat from the Black Sea usually comes at lower costs compared to other regions such as Europe or the USA. In Egypt, for example, the General Authority for Supply Commodities (GASC) is actively exploring diversification of import sources. These initiatives should comply with national and international rules in terms of transparency and procurement procedures to ensure that these interventions encourage competition and efficiency in cereal markets.

In the very short run, there is an urgent need to protect poor and vulnerable households against food price hikes. Safety nets can be effective tools to support poor households against this crisis and countries like Egypt are expanding existing social protection programs to cover more households (Belhaj et al., 2022). As bread subsidies have been removed in Sudan, a cash transfer system targeting the poorest households could be reintroduced. Such a program could build on the experiences from the Sudan Family Support Program (Samarat) introduced in 2021 but then halted, as well as lessons from successful cash transfer programs in other countries, including Egypt's Takaful and Karama programs. International partners and the Yemeni government may consider expanding the use of existing cash transfers and vouchers, which are proved to be effective and more cost-efficient than in-kind food distribution (Kurdi et al., 2019; Schwab, 2020).

In the longer term, countries need to explore options to balance the benefits of trade openness with the potential costs of vulnerability to trade shocks. Countries may also incorporate support for local production of crops that have a comparative advantage and provide adequate nutrition for domestic consumption in their agricultural policies. For Egypt, boosting domestic wheat production will be challenging, as Egyptian farmers are already achieving high yields (Nin Pratt et al., 2018). While there are some opportunities to expand arable land, Egypt should focus on adapting the farming system to address imminent water shortages and climate change rather than unsustainably expanding production. By modernizing its farming systems and improving water management practices Egypt can also increase resilience of the agri-food system as a whole (Perez et al., 2021). In Sudan increasing domestic wheat production and productivity is possible but would have important trade-offs with other higher-value agricultural commodities (Abay et al., 2022a). There is a need for additional research and extension efforts to

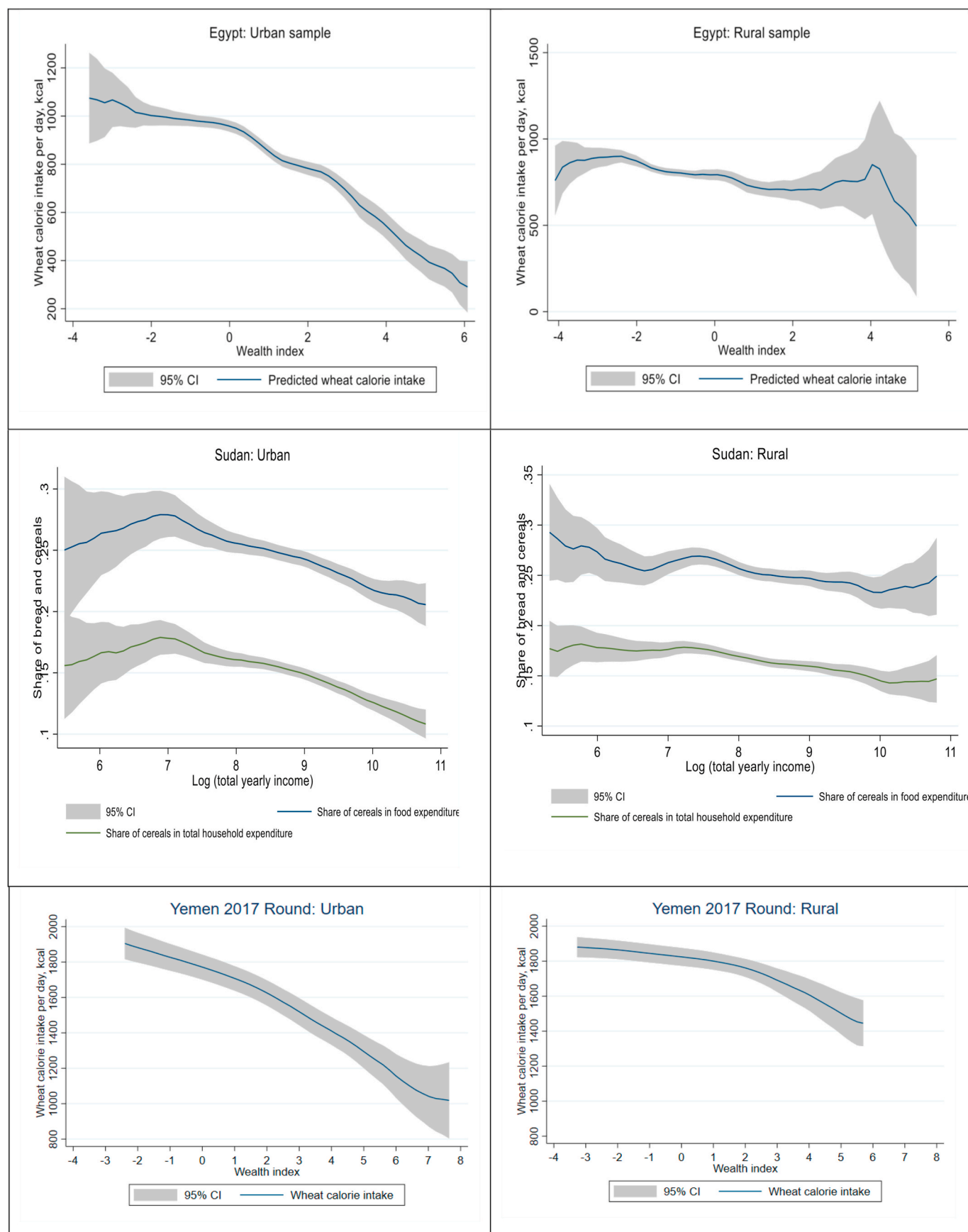


Fig. 5. Rural-urban differences in wheat/cereal consumption and household wealth/income.

increase production of alternatives to wheat production, including drought-tolerant sorghum, millet and high value export crops. Such a shift in production has the potential to increase foreign exchange earnings and promote overall growth and employment. In conflict-affected contexts like Yemen, support for agricultural production needs to be adapted to the reality of disruptions in transportation and related shocks to fuel and fertilizer supplies. Development organizations and partners should focus on supporting conflict-resilient farming systems such as drip irrigation and solar powered irrigation systems.

On the demand side, there are important differences among countries in terms of their potential to reduce reliance on wheat. Reducing the high consumption and waste of bread has significant potential in Egypt. Egyptians on average consume about 145 kg of wheat per capita annually—double the global average (FAO, 2022a). Reductions in wheat consumption and food waste can serve the dual purpose of improving Egypt's wheat self-sufficiency while also addressing malnutrition by shifting consumption from wheat to a more diverse set of food groups. Egypt has high rates of overweight and obesity, which are linked to food subsidies and associated consumption of energy-dense foods (e.g., Ecker et al., 2016; Abay et al., 2022b). In Sudan and Yemen, where food insecurity remains high and there are no wheat subsidies in place, there is less room for reducing wheat consumption through direct policy interventions. Instead, a longer-term effort might highlight the important role of other cereal grains, particularly sorghum, which can be more advantageously cultivated in Sudan's and Yemen's drylands. Just as changing consumer tastes drove greater demand for wheat bread, marketing, nudging and information campaigns may encourage consumption of less-expensive, locally grown alternatives to wheat.

Implementing some or all of these short-term and longer-term policy options can help to build a more resilient agri-food system in Egypt, Sudan and Yemen while also supporting households to better withstand future economic shocks.

5. Lessons from previous food crises

The Russian-Ukraine war kept food and fertilizer prices high through 2022 and into 2023 (e.g., Glauber and Laborde, 2022a; Baffes and Koh, 2022). Unfortunately, some policy responses, however well-meaning, have exacerbated global price increase and instability. The lessons of previous food price spikes (such as 2007/08 and 2010/11) is that the best approach may be the simplest: allow markets to work by removing distortions and support the most vulnerable countries and households via social safety nets, and where most needed, through humanitarian assistance. The current crisis presents immediate humanitarian challenges (particularly for those in war-torn Ukraine), but over time and if supported effectively, markets should eventually return to more normal patterns. In the meantime, as countries take action to respond to high prices and other fallout from the war, they should take care to avoid exacerbating the impacts for others.

The most effective measures to combat food insecurity will be those that aim to keep trade in food and fertilizer products open and those that target to mitigate the impacts of high food prices on the most vulnerable. Below is a list of recommendations for governments and other actors in local and global food systems to best address the crisis.

- (i). *Trade sanctions should exempt food and fertilizer*: It is important that trade and financial sanctions continue to exempt food products, and critical agricultural inputs like fertilizer. These products account for less than 5 percent of Russia's export earnings, but if sanctioned could have adverse impacts on global food security. By the end of 2022, Russia wheat exports and exports of key fertilizer components such as urea and potash had resumed normal flows though exports of anhydrous ammonia remained far below year ago levels (Glauber and Laborde, 2022b).
- (ii). *Countries should refrain from implementing export bans and restrictions*. Export restrictions drive global prices even higher, making it even more difficult for net food importing countries to purchase food. Moreover, export bans tend to be contagious, as other exporting countries follow suit and implement their own bans. The way the global community handled this issue in early 2020 (during the outbreak of the COVID-19 pandemic) should be an example to follow now: Most countries refrained from implementing bans, and those that were implemented were relatively short-lived. However, the current trend is worrying, as several countries are quickly resorting to alternative trade restrictions and bans (Laborde and Mamun, 2022).
- (iii). *Countries should avoid hoarding and panic buying*. Panic buying can disrupt the orderly marketing of commodities and drive prices up in the short run. Supply hoarding—importing and storing many months of grain—can exacerbate price volatility and potentially be costly as prices fall over time as more supplies become available. In particular, importers from fragile and conflict affected states, which are at a disadvantage in terms of access to liquidity and credit, are the most likely to end up unable to find suppliers in artificially tight markets. With improved market information provided by international efforts such as the Agricultural Market Information System (AMIS), countries can make more informed purchasing decisions and hopefully avoid the panic buying that occurred during earlier price spikes.
- (iv). *Countries should target social protection and food subsidies towards the most vulnerable households*. While the world will not run out of wheat, prices are likely to remain high for some time, and could go higher if harvest problems cause further drawdowns in global stocks. High food prices are difficult to absorb in poor households with limited resources that consume a limited range of foodstuffs. To avoid an increase in food insecurity, and as was seen in 2007/08 and 2010/11, food riots and increased political instability, countries have provided subsidies to keep food costs low. Accurate targeting is crucial to ensure that subsidies go to the truly needy and not to more prosperous households that can absorb increased food costs, or households that can readily switch to lower-cost alternative foods. Too often, existing schemes (e.g., in Egypt) are poorly targeted and waste significant resources, especially when rising prices increase the cost of running domestic food aid programs (Breisinger et al., 2021).
- (v). *Countries should provide humanitarian aid through programs such as the World Food Program (WFP)*. Some countries remain heavily dependent on humanitarian aid to meet food security needs. Higher commodity prices mean humanitarian aid agencies like the WFP will have to spend far more than previously budgeted to meet those needs. Countries in the position to do so should ensure that WFP and other organizations are adequately funded. To the extent possible, assistance should not be tied to national export interests—organizations like WFP operate most efficiently when they are able to source food from the lowest cost suppliers or distribute cash where conditions allow.
- (vi). *Countries should suspend biofuel mandates and subsidies*. Global biofuel production is at record levels. With vegetable oil prices skyrocketing immediately after the outbreak of the conflict, now is not the time to be encouraging the conversion of food crops to energy through artificial policy incentives or mandatory blending targets. While beneficial to farmers and landlords, such policies come at the expense of those who can least afford it. Similarly, now is high time to reduce food waste and grain for animal feed.
- (vii). *Food self-sufficiency policies will exacerbate, not solve global food insecurity*: World markets are more stable than domestic markets, because they are larger and more diversified. The global farming community is more flexible and able to react to shocks more rapidly than any individual country. Self-sufficiency is also prohibitively expensive for most net food importing countries, many

of which are among the poorest in the world. The world will become less, not more food secure, if countries resort to self-sufficient policies that expose them to production uncertainties caused by drought, floods, pests, and animal or plant diseases—all increasingly frequent with climate change. Policies should not segment markets but aim at creating more opportunities for a larger number of countries—helping global markets to become more diversified and inclusive.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data will be made available on request.

Appendix

Table A1

Classification criteria for the vulnerability analysis.

External driver/threat		Initial food insecurity	
Criteria 1	Criteria 2	Criteria 3	Category
Share of calories imported from countries involved in the conflict >10 percent of domestic caloric consumption	Less than 60 days of stock of wheat	Prevalence of undernourishment above 7.5 percent	1 -Extremely High - Food consumption directly exposed to conflict and low stock.
Share of calories imported from countries implementing export restrictions (on the commodities traded) > 10 percent of domestic caloric consumption	Less than 60 days of stock of wheat	Prevalence of undernourishment above 7.5 percent	2 -Extremely High - Food consumption directly exposed to export restrictions and low stocks
Share of calories imported from countries involved in the conflict >10 percent of domestic caloric consumption	Less than 90 days of stock of wheat	Prevalence of undernourishment above 3 percent	3 -Very High - Food consumption directly exposed to conflict
Share of calories imported from countries implementing export restrictions (on the commodities traded) > 10 percent of domestic caloric consumption		Prevalence of undernourishment above 3 percent	4 -Very High - Food consumption directly exposed to export restrictions
Share of calories imported from countries implementing export restrictions (on the commodities traded) > 10 percent of domestic caloric consumption		Prevalence of undernourishment above 2.5 percent	5 -High - Food consumption exposed to export restrictions or conflicts
Last month's increase of commodity prices, if continued during the year, will represent more than 5 percent of GDP (to capture price increase and economic resilience)		Prevalence of undernourishment above 2.5 percent	6 -High - Large increase in food import cost compared to GDP expected
The rate of increase in average diet cost, estimated at world prices, increased by more than 5 percent in the last month.		Prevalence of undernourishment above 2.5 percent	7 - High - High Risk of food price increase due to last month changes.
The rate of increase in average diet cost, estimated at world prices, increased by more than 30 percent in the previous 12 month		Prevalence of undernourishment above 2.5 percent	8 - Moderate - High Risk of food price increase driven by the last 12-month changes.
Dependency on countries in conflict (import/total agriculture use) for at least one type of fertilizers (N or P or K) is above 25 percent			9 - Moderate - No immediate risks but fertilizer supply compromised.

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