McKinsey & Company

Agriculture Practice

A reflection on global food security challenges amid the war in Ukraine and the early impact of climate change

Geopolitical and climatic events are impacting the food system's resilience. Here's what happened this year, what may come next year, potential consequences, and considerations that may mitigate the impact.

This article is a collaborative effort by Daniel Aminetzah, Artem Baroyan, Nicolas Denis, Sarah Dewilde, Nelson Ferreira, Oleksandr Kravchenko, Julien Revellat, and Ivan Verlan, representing views from McKinsey's Agriculture Practice.

August 2022

The COVID-19 pandemic. Supply chain strains. Climatic events. These disruptions were already pushing food prices up when Russia invaded Ukraine in late February. Today, war in one of the world's six breadbasket regions[1] and in the Black Sea, a critical supply and transit hub for wheat and fertilizers, is tilting global food security into a state of high risk.

A deal signed on July 22 intended to free approximately 20 million tons of grain stuck in Black Sea ports[2] has brought some relative relief to the market, enabling the price of some cereals to return to preinvasion levels.[3] In spite of this optimistic turn of events, a confluence of immediate concerns and longer-term complications continue to point to elevated risk levels. Immediate concerns include the fact that though the grain deal may alleviate some logistical problems in ports, the outcome is uncertain, and there are significant inland bottlenecks and other complexities that could continue to make it difficult for grain to reach customers.[4] Also, if the roughly 20 million tons of grain in question has not been stored in optimal conditions for the five to six months it has been sitting in Ukrainian silos, it may have declined in quality and could be unfit for human consumption.[5] Also daunting is the fact that our projection for the 2022–23 harvest in Ukraine is below normal levels by more than 30 million tons, due to lower acreage planted and lower input availability (and the fact that some grain is likely to remain unharvested).

These immediate concerns converge with longer-term complications that began in early 2020 when the COVID-19 pandemic began, convulsing global supply chains. Next, monetary and fiscal policies aimed at alleviating the pandemic's impact pushed up commodity prices starting in mid-2020. Even before the invasion, price levels for wheat and corn were 40 to 50 percent higher than the average price over the past decade. Fast-forward to 2022: the blockade of Black Sea ports caused by the war in Ukraine severely restricted supply access. This situation has provoked numerous countries to try to protect their food access by curbing grain exports. Add to this picture the recent heat waves in India and the current dry summer in Western Europe that together could limit supply to world markets by more than ten million tons of grain—vivid demonstrations of the higher risk for food commodities posed by climate change. Lastly, while the price of grain has come down, fertilizer prices remain high, causing some farmers to use them sparingly as grain commodity prices show signs of contraction.

The consequences of a looming food crisis may be more pronounced than during the 2007–08 global food crisis[6] and the 2010–11 food price hikes that contributed to the Arab Spring.[7] Today's more negative outlook could ultimately result in a deficit of roughly 15 million to 20 million metric tons of wheat and corn from the world's supply of exported grain in 2022. The deficit in 2023 could reach roughly 23 million to 40 million metric tons, according to our worst-case scenario, assuming a prolonged crisis in which the recently signed agreements don't work.

The larger deficit represents a year's worth of nutritional intake for up to 250 million people, the equivalent of 3 percent of the global population. In addition to the human suffering this implies, based on the experiences of recent food crises, there are a host of other possible destabilizing consequences.

[1] Globally, there are six breadbaskets that together supply roughly 60 to 70 percent of global agricultural commodities.
[2] Matina Stevis-Gridneff, "Russia agrees to let Ukraine ship grain, easing world food shortage," *New York Times*, July 22, 2022.
[3] Caitlin Ostroff, "Wheat, corn prices fall as Ukraine dispatches grain," *Wall Street Journal*, August 1, 2022.
[4] Dalton Bennett and Isabelle Khurshudyan, "After Russian port strike, Ukraine grain deal hangs in the balance," *Washington Post*, July 26, 2022.
[5] "Lebanese buyer refuses cargo from first grain ship since Ukraine-Russia agreement over quality doubts," VRT News, August 9, 2022.
[6] Douglas Belkin and Bob Davis, "Food inflation, riots spark worries for world leaders," *Wall Street Journal*, April 14, 2008.
[7] Caroline Henshaw, "The politics of food prices in Egypt," *Wall Street Journal*, February 1, 2011.

What follows is our perspective on four dimensions of the unfolding and constantly changing crisis[8]:

— This year, exports have dropped due to logistical constraints in Ukraine and export limitations from other countries.

— Next year may be even worse. We estimate that crop production in Ukraine will decline by 35 to 45 percent in the next harvesting season, which started in July.

— Some countries will likely suffer more than others, and overall consequences may be more pronounced than in recent, comparable crises.

— Swift mitigations may help to avoid the worst outcomes, and the window of opportunity is narrowing.

The conflict in Ukraine is shaking important pillars of the global food system in an already precarious context. Understanding what has happened, what is likely to come next, who is most affected by it, and what may be done is complex. Managing the circumstances and supporting the best possible outcomes may require decisive action and collaboration.

Exports have dropped due to logistical constraints in Ukraine and export limitations from other countries

Today, the global food supply faces two crucial obstacles: a drop in exports from Ukraine and, to some extent, from Russia, and knock-on effects that could further constrain global supply. The current export deficit has largely been due to the reduced ability to move siloed grain out of the Black Sea region.[9] If the signed agreement fully delivers on its promise, much of the short-term problem could be alleviated, though this optimal outcome is far from certain.

Global export volumes have declined

The world's grain mostly comes from six growing regions, including Ukraine and Russia, which together produce roughly 28 percent of the wheat and 15 percent of the corn exported globally (Exhibit 1). There has been an immediate reduction of export volumes due to blocked Black Sea ports, mines along the shipping routes,[10] and limited alternative routes. Wheat and corn supplies that needed to exit Ukraine via rail or truck transport have faced logistical bottlenecks, including different rail track gauges used in Ukraine versus neighboring countries,[11] a shortage of rail cars, and limited shipping capacity in Polish and Romanian ports.[12] Despite the recent agreement aimed at allowing grain exports from Ukraine's three major Black Sea ports,[13] the situation will likely remain uncertain and fragile.[14]

Sea logistic constraints alone have lowered export volumes from Ukraine by an estimated 16 million to 19 million metric tons (however, if grain soon start flowing in large amounts from Black Sea ports, exports could be higher) and two million to three million metric tons from Russia. Roughly 5 percent of the 400 million metric tons traded globally may

[8] The invasion of Ukraine in February 2022 is having deep human, as well as social and economic, impact across countries and sectors. The implications of the invasion are rapidly evolving and are inherently uncertain. The analysis in this article was formulated based on the best-available data as of mid-July. As a result of the dynamic situation, this article should be treated as a best-efforts perspective at a specific point of time, which seeks to help inform discussion and decisions taken by leaders of relevant organizations. The document does not set out economic or geopolitical forecasts and should not be treated as doing so. It also does not provide legal analysis, including but not limited to legal advice on sanctions or export control issues.

[9] Andrew Higgins and Erika Solomon, "As food shortages loom, a race to free Ukraine's stranded grain," *New York Times*, June 1, 2022.

[10] Matthew Luxmoore, Alistair MacDonald, and Nancy A. Youssef, "Mines, port damage threaten revival of sea route for Ukraine grain," *Wall Street Journal*, July 2, 2022.

[11] Matina Stevis-Gridneff and Michael Schwirtz, "After Ukraine-Russia meeting, U.N. sees 'a ray of hope' to free grain," *New York Times*, July 13, 2022.

[12] "The bottlenecks on alternative routes to export Ukrainian grain," BBC News, July 21, 2022.

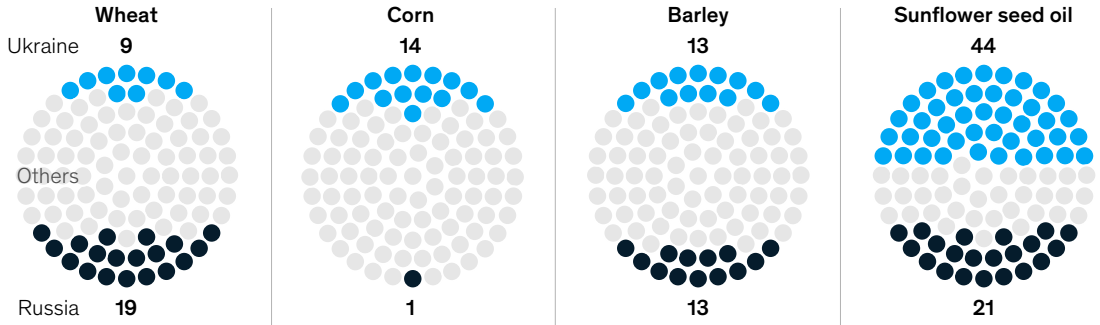
[13] "Black Sea grain exports deal 'a beacon of hope' amid Ukraine war–Guterres," UN News, July 22, 2022.

[14] Karin Strohecker, "Ukraine grain deal won't fix warzone logistics, top producer says," Reuters, July 14, 2022.

Exhibit 1

Ukraine and Russia export 28 percent of the world's wheat and 15 percent of its corn, contributing a total of 105 million metric tons of grain.

Global export volume, selected crops, %



Total, million metric tons

	Wheat	Corn	Barley	Sunflower seed oil
Ukraine	18	28	5	7
Russia	37	2	5	3

Source: FAOSTAT 2019, 2020; US Department of Agriculture (USDA) Foreign Agricultural Service

seem like a relatively small amount. However, it may be enough to cause significant disruption to the two-year commodity cycle because it creates a call for new contracts and erodes confidence in the liquidity of the market, which can motivate some countries to increase their reserves.

In the next planting season, due to the war's disruption of Ukrainian planting and harvesting and combined with less-than-optimal inputs into Russian, Brazilian, and other growing countries' crops, supply will likely tighten. We estimate that these impacts could create a 23 million to 40 million metric ton deficit of globally traded grain in 2023 (Exhibit 2). The smaller deficit is possible if agreements are respected and Black Sea exports from Ukraine become sizable. The more pessimistic scenario reflects what could happen should Ukrainian ports remain largely obstructed, farmers' liquidity and access to agricultural inputs is limited, and lower acreage is planted.

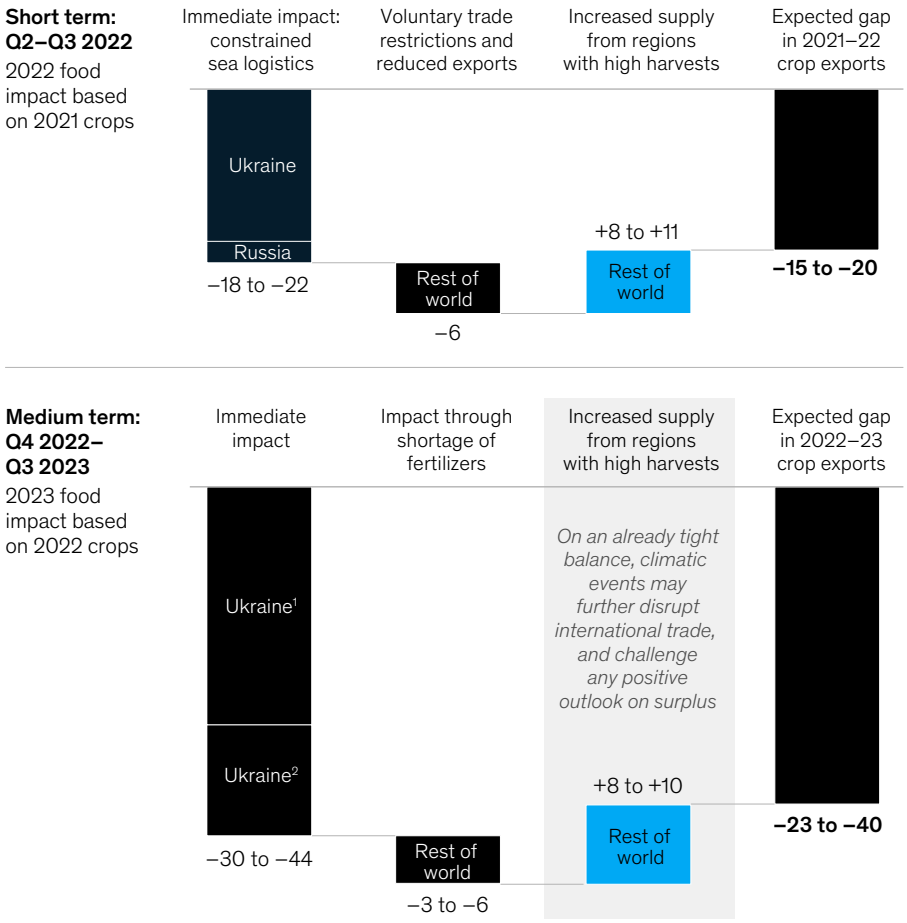
Supply has been tightened further by countries that have attempted to shield domestic markets with trade restrictions. Roughly 40 new export bans and export licensing requirements have been introduced between the beginning of the war and May 2022.[15] While these measures can bring a perceived gain for the imposing country, history suggests they put additional pressure on available food stocks, push prices up, and further threaten food security for the world's poor.[16]

[15] *IFPRI Blog*, "From bad to worse: How Russia-Ukraine war-related export restrictions exacerbate global food insecurity," blog entry by Joseph Glauber et al., April 13, 2022.
[16] Vibhuti Agarwal, Jason Douglas, and Jon Emont, "Export curbs spread globally, adding to food-inflation pressures," *Wall Street Journal*, May 25, 2022.

Exhibit 2

Global grain trade volumes are likely to drop by 5 to 10 percent by Q3 2023, due to both short- and medium-term factors.

Estimated annual crop export volume drop in relation to expected 2021 export baseline, million metric tons



Note: Analysis based on exports of wheat, corn, barley, and sunflower seeds.
[1]Scenario in which conflict is limited in duration and scale, and Black Sea ports are unblocked.
[2]Scenario in which conflict is prolonged in duration beyond 2022, and Black Sea ports remain blocked.
Source: Bloomberg; interviews with agricultural companies (>1 million hectacres under management); Reuters; Ukraine national crop statistics; UN Food and Agriculture Organization; McKinsey ACRE advanced analytics

Negative impacts have been dampened to some extent, and could be further alleviated by increased exports—some from areas expecting record crops and some from countries that have been loosening grain reserves in a bid to benefit from increased prices. The relief these measures could bring is unclear, as these actions are voluntary and will undoubtedly be driven by market dynamics and politics.

Next year may be worse

Unfortunately, there may be more damage to the global food supply coming by the end of this

year and throughout 2023. This year's logistical problems have resulted in up to 18 million to 22 million fewer metric tons of grain being exported from Ukraine and Russia as of this writing. The ongoing conflict is interfering with farmers' ability to prepare fields, plant seeds, and protect and fertilize crops, which will likely result in even lower volumes next harvest season. Some of this deficit may be recuperated depending on the success of Black Sea export agreements, logistics improvements, and other interventions. However, factors including the impact of drought throughout the world's breadbaskets—a trend expected to worsen over time—cloud the outlook.

The coming Ukrainian harvest and exports will likely be the lowest in the past decade

Based on interviews with growers and on local data, we have modeled the potential harvest for each of Ukraine's oblasts (administrative divisions). In sum, we estimate that crop production in Ukraine will decline by 35 to 45 percent in the next harvesting season. The main reasons are reduced harvest area due to ongoing military actions and land mines, farmers' lack of liquidity (due to the inability to ship a large part of last year's harvest), decreased yields due to reduced access to fertilizers, disrupted timing, less advanced plant protection, and ripple effects from increased diesel and fertilizer costs.

On top of farming challenges, export logistics may continue to be a challenge. Due to these combined factors, exports from Ukraine are likely to decrease by a total of 30 million to 44 million metric tons for the 2022–23 marketing year from a prewar baseline.

What happens in other countries could further reduce global trade volumes

Despite the good harvest that is likely this summer and fall, Russian yields may be lower in upcoming seasons due to global trade restrictions. Hybrid seeds, plant protection products, and, to a lesser extent, machinery and software might be subject to import bans, primarily impacting wheat output.

Fertilizer shortages and higher prices for fertilizers are also expected to reduce yields in countries that depend heavily on fertilizer imports, such as Brazil. This will likely further decrease the volume of grain on the world market.

What other exporting countries do could either add more grain to the global supply or further reduce it. On the one hand, continued or even further trade restrictions could exacerbate global scarcity, while high harvests and loosening reserves could dampen the impact. Climate events may also affect the delicate balance. It is unknown which scenario will prevail.

Overall consequences are likely to be more pronounced than in recent, comparable crises

We face a context in which consumer behavior has been gradually undergoing a paradigm shift, producing more global demand for protein and biofuels at the same time that climate change has introduced more risk to the agricultural sector. The food supply chain is increasingly interconnected, reliance on trade is high, and stocks are low and concentrated in a handful of countries. Oil and fertilizer prices, logistics costs, and the number of trade restrictions in place are close to the highest they have been in the past decade, and the changing climate is having a negative impact on crops.

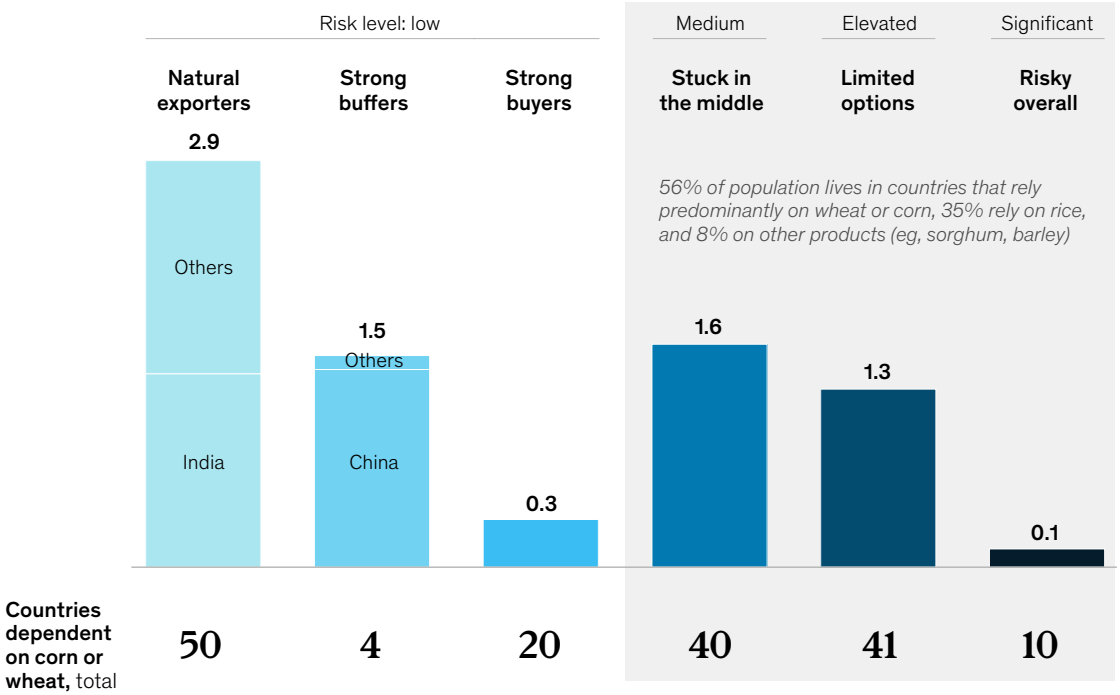
Some countries are positioned to weather disruptions to a system that requires exquisite balance. Others are less so: highly vulnerable countries account for 18 percent of the global population and 41 percent of the world's undernourished population.[17] In 2020, 811 million

[17] *The state of food security and nutrition in the world 2019: Safeguarding against economic slowdowns and downturns*, Food and Agriculture Organization of the United Nations, International Fund for Agricultural Development, World Food Programme, and World Health Organization, July 2019; Total population data, World Bank, accessed July 25, 2022.

Exhibit 3

Some countries—and 1.4 billion people living in them—are highly vulnerable to supply shocks; this number could increase to 1.9 billion as reserves deplete.

Population by archetype, billion people



Note: 165 countries included in analysis, excluding small island states and territories.
Source: FAOSTAT; USDA; World Bank

people worldwide suffered from high levels of malnutrition or undernourishment.[18]

Impact by country varies—and is potentially devastating for some

While high global food prices will affect all countries, some are more exposed than others (Exhibit 3). Some, including China, the United States, and countries within the European Union, are relatively well protected. They have high local production, high stock levels, and high purchasing power.

But numerous countries, including Bangladesh, Ethiopia, Somalia, and Yemen, are highly vulnerable. They rely heavily on grain imports, have limited stocks, and have low purchasing power. These countries may be hit hard by price increases. More than 1.4 billion people live in such areas, mostly in Africa and Asia; if the global shortage continues and countries deplete their reserves, this figure could increase to about 1.9 billion people.

The picture is even gloomier when considering some countries' ability to cope with the fiscal

[18] *The state of food security and nutrition in the world 2021*, Food and Agriculture Organization of the United Nations, October 2021.

This year's logistical problems have resulted in up to 18 million to 22 million fewer metric tons of grain being exported from Ukraine and Russia as of this writing.

and social consequences of their vulnerability. In many nations, local currencies have devalued sharply in 2022, making US dollar–denominated imported commodities such as wheat and oil even more costly for locals. Largely due to the COVID-19 pandemic, these countries are already experiencing higher-than-usual budget deficits and levels of unemployment. As food supplies constrict, these nations will face elevated inflation, which will exacerbate budgetary stress as they attempt to protect their populations from rising food prices. If they cannot do so, malnutrition levels could rise.

Potential consequences

Past food shortages have resulted in consequences such as the following:

- *Inflation:* Consumer prices increase due to tightened supply, high input and transportation costs, and speculative effects.
- *Budgetary and fiscal stress:* Increased pressure on financial and fiscal systems to handle inflation, ensure sufficient trade, and provide subsidies to the neediest. These efforts are often hampered by increased external debt and slower GDP growth.
- *Malnutrition and hunger:* Human suffering increases, especially for the most vulnerable populations, due to higher prices and, to a lesser extent, shortages of actual supplies.

Similar effects—as well as other economic and social difficulties—are possible in the current situation. But this time, the governments of some vulnerable countries may have less ability to cope with constrained supply than they did before other crises, including the Arab Spring and the COVID-19 pandemic (Exhibit 4).

Overall risk to the food system may surpass contemporary crises

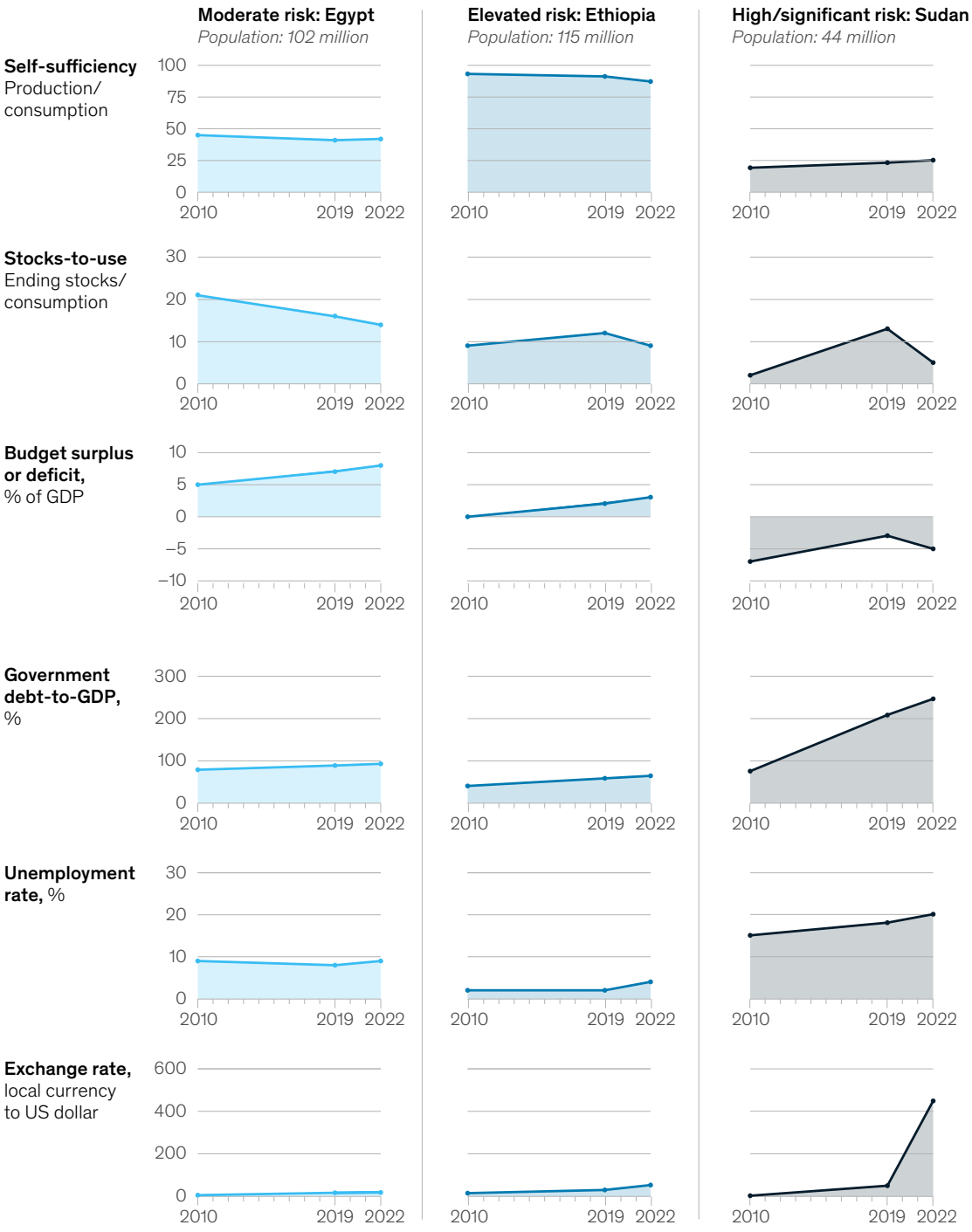
The pandemic has depleted countries' budgets and currency reserves and sent their debts to record levels, making them less resilient in the face of price hikes. Food purchases represent a larger-than-usual share of consumer spending, and unemployment is high in many countries; if governments can't dampen the shock, households will have no choice but to dedicate more of their budgets to buying food. In this context, even a slight disruption in supply could substantially disturb global food prices and societies' abilities to cope with them.

When examining the conditions that were present leading up to the 2007–08 global food crisis and the 2010–11 food price hike that contributed to the Arab Spring, we observe even higher risks to the global food system today.

Exhibit 4

Some countries' ability to cope with food shortages and price shocks have deteriorated since 2010.

Selected countries; not exhaustive



Source: Oxford Economics; USDA; World Bank

Swift mitigations may help avoid the worst outcomes

Stakeholders around the world may be able to take actions to help avoid the gloomiest scenarios becoming reality. In the short term, three fundamental steps can help reduce risks:

— unblock and de-risk Black Sea logistic routes

— reduce trade restrictions and release buffer stocks; to rebalance global supply, individual countries need to increase the supply of grain traded on the world market

— provide financial aid to the most impacted areas and populations

While thinking about how to mitigate the current crisis, stakeholders should plan for how to avoid the next one. Both governments and players in the food agriculture value chain need to improve how they manage supply–demand shocks. Resilience in the face of the multiple risks highlighted here is essential, particularly in an era when climate change is provoking more extreme events, such as droughts. Though such disruptions may occur in a specific part of the world, prices can skyrocket globally as a result—as the Black Sea situation has so aptly demonstrated.

Fundamental changes to global behavior, coming from both the public and private sectors, could boost transparency and resilience to the global food system. Potential steps to take include the following:

— sustainably transform agriculture to boost yields, especially in importing countries with fast-growing populations

— find ways to reduce global food waste and optimize use of land for food and biomass production

— accelerate the development and adoption of alternative meat and encourage the consumption of the most efficient proteins

---

Historically, supply shocks within the food system have led to inflation, lower fiscal strength, and malnutrition—and in some cases, to periods of political instability and violence. Depending on the duration and severity of the war, the caloric requirements of 250 million people could be lacking from the global supply. These sobering statistics underscore the magnitude and urgency of the situation.

Daniel Aminetzah is a senior partner in McKinsey's New Jersey office; **Artem Baroyan** is a consultant in the Kyiv office, where **Oleksandr Kravchenko** is a partner; **Nicolas Denis** is a partner in the Brussels office, where **Sarah Dewilde** is a consultant; **Nelson Ferreira** is a senior partner in the São Paolo office; **Julien Revellat** is a partner in the Paris office; and **Ivan Verlan** is a partner in the Philadelphia office.

Designed by McKinsey Global Publishing