The Impacts of the Russia–Ukraine War on Global Food Security: Pathways Towards More Sustainable and Resilient Food Systems

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The Russia–Ukraine war has significantly disrupted global food systems, exposing vulnerabilities in agricultural production, trade, and supply chains. As two major exporters of wheat, maize, sunflower oil, and fertilizers, Russia and Ukraine play a critical role in ensuring global food availability and price stability. The conflict has led to reduced agricultural output, export restrictions, rising transportation costs, and volatility in food and fertilizer markets. These disruptions have disproportionately affected food-importing and low-income countries, increasing food insecurity, malnutrition risks, and economic instability. This study examines the direct and indirect impacts of the Russia–Ukraine war on global food security, focusing on food availability, accessibility, affordability, and stability. It further explores policy responses and adaptive strategies adopted by governments and international organizations to mitigate the crisis. The paper argues that the conflict highlights the need for more sustainable and resilient food systems through diversification of supply sources, investment in climate-smart agriculture, strengthened regional food networks, and enhanced international cooperation. Building resilient food systems is essential not only for addressing current disruptions but also for preparing for future geopolitical, environmental, and economic shocks.

Keywords: Russia–Ukraine War, Global Food Security, Food Supply Chains, Agricultural Trade, Food Price Volatility

Introduction:

When "all people at all times have physical and economic access to sufficient, safe, and nutritious food to meet their dietary needs and food preferences for an active and healthy life," food security is achieved [1]. The four standard dimensions of food security are: availability (having a sufficient amount of food available on a regular basis); access (having enough resources to acquire appropriate and healthy food); utilization (having a reasonable food use based on knowledge of essential nutrition and care); and stability of availability, access, and utilization of food [2][3]. These four elements are still essential, but they lack other characteristics like agency and sustainability that are now known to be crucial for changing food systems in the way needed to achieve the SDGs [4]. Research indicates that the primary causes of food insecurity worldwide are wars and conflicts [5][6].

In fact, war and instability were the main causes of the 139 million people who experienced crisis or severe food insecurity in 24 countries and territories in 2021 [7].

Russia began a full-scale military invasion of Ukraine in the early hours of February 24, 2022, which led to the destruction of vital infrastructure and the deaths and injuries of civilians [8]. As a result, the US, Europe, and numerous other western Sanctions against individuals,

banks, corporations, big state-owned enterprises, and exports have been implemented by nations including Canada and Australia [9]. The lives lost and the humanitarian catastrophe in Ukraine brought on by a large number of besieged and displaced people are the war's most important effects. Global food security is at risk as a result of the war's simultaneous devastation of commodities markets, particularly those for food and energy, which has affected global patterns of trade, production, and consumption in ways that will keep prices at historically high levels until the end of 2024 [10][11][12].

In fact, the conflict between two significant participants in the global food and fertilizer sectors, as well as the context of globalized agricultural markets, is causing a great deal of concern over the security of the world's food supply [13][14]. Russia and Ukraine are both regarded as "global breadbaskets" and significant producers and exporters of essential agricultural commodities, minerals, fertilizers, and energy, where exportable resources are frequently concentrated in a small number of nations, despite their small role in the world economy—they account for only 2% of the world's GDP. These markets may be more susceptible to shocks and volatility as a result of this concentration [15]. Food prices were already high due to supply chain disruptions brought on by the COVID-19 epidemic, high demand worldwide, drought, and low harvests in South America the year before, so the war coincided with a difficult period for the world's food markets. Food prices rise as a result of these factors taken together [16]. The conflict between Russia and Ukraine will make these problems worse. Four months into the conflict, the effects are evident: exports from Ukraine have stopped, future harvests are uncertain, and the price of agricultural commodities has soared globally, putting millions at risk of starvation and destitution. Furthermore, by reducing the availability of humanitarian aid to prevent and treat acute malnutrition, price rises and trade disruptions may contribute to an increase in the number of malnourished people [17]. According to the World Food Programme (WFP), the number of people experiencing acute hunger will increase by 47 million from the pre-war baseline of 276 million. This suggests that by 2022, up to 323 million people could experience extreme food insecurity [18]. Ten million people fall into extreme poverty for every percentage point increase in food prices, according to World Bank projections. Global poverty could increase by almost 100 million people if food prices stay this high for a year [19][20].

The impact of the war on food security in the medium (6 months–2 years) to long term (>2 years) is highly unknown. This covers the consequences of Russia's present and upcoming sanctions as well as the immediate expenses of the conflict.

In that regard, the combined effects of sanctions and conflict will have a profound effect on global agri-food markets and food security, causing shockwaves all over the world, particularly in low- and middle-income countries (LMICs) that rely heavily on imports [13]. For example, a number of nations in the Middle East and North Africa (MENA) region import over half of their cereal requirements, particularly wheat, from Russia and Ukraine.

Table 1. Core dimensions of food security

Dimension	Description
Availability	Sufficient quantities of food available
Access	Economic and physical access to food
Utilization	Nutritional use of food
Stability	Consistent access over time
Agency	Ability to make food-related decisions
Sustainability	Long-term food system resilience

To comprehend the entire impact on global food security, it is essential to comprehend how disruptions caused by conflicts in the global food and fertilizer markets may have significant, long-term effects on supply and price. Additionally, the consequences of the conflict on global food systems and supply chains indicate that this study is extremely necessary, urgent,

and timely. However, as the full scope of the war's effects is still unknown, assessing how the conflict has affected food security is difficult. Therefore, the purpose of this research is to examine the direct and indirect effects on global food security of the Russia-Ukraine war.

The study is based on a review of grey literature, which includes reports, policy documents/briefs, and working/discussion papers written by a range of organizations in English, French, and Arabic. These organizations include international organizations (like FAO, World Bank, World Food Programme (WFP), International Food Policy Research Institute (IFPRI), International Monetary Fund (IMF), United Nations Conference on Trade and Development (UNCTAD), United Nations Development Programme (UNDP), Organization for Economic Co-operation and Development (OECD), NGOs (like Oxfam), consulting firms (like Deloitte, KPMG, McKinsey, Oxford Business Group), international newspapers (like The New York Times, Le Monde, The Guardian, and The Independent).

Table 2. Strategic importance of Russia and Ukraine in global agriculture

Indicator	Value
Share of Global GDP	2%
Share of Global Wheat Trade	34.1%
Share of Global Sunflower Oil Trade	72.7%
Share of Global Calorie Trade	12%
Wheat Production Share	14%
Barley Production Share	19%
Maize Production Share	4%

Overview of the War's Immediate and Long-Term Impacts:

There are numerous short-term and long-term indirect effects of the conflict on the world's food security.

Table 3. Direct impacts of the war on food security

Impact Area	Effect
Port Closures	Export disruption
Railway Damage	Logistics bottlenecks
Labor Shortages	Reduced cultivation
Input Scarcity	Lower productivity
Fertilizer Shortages	Reduced yields
Harvest Disruptions	Lower food availability

The War's Direct Effects on Food Security:

The conflict has a number of immediate and direct effects on food security, including disruptions to shipping and harvesting as well as significant effects on the cost and availability of staple foods [21].

First, if port infrastructure and railroads are destroyed, military operations may have both immediate and long-term effects on Ukraine's capacity to transport agricultural goods both inside and outside its borders. In actuality, grain exports from Ukraine were directly impacted by the conflict, mostly for maize, usually in the spring and early summer. In fact, 95% of Ukraine's grain exports are shipped by sea through the severely damaged ports of Odessa, Mariupol, and Kherson. Additionally, the majority of Ukrainian exports have been stopped due to the blocking of all Black Sea ports. Even if inland transportation infrastructure remained intact, shipping grain by rail would be difficult because there would be no functional railway system. For example, on May 17, 2022, four traders reported that approximately 300,000 tonnes of Ukrainian wheat that Egypt's state grains buyer had contracted for delivery in February and March were stuck in Ukraine, with one cargo being held in port and four more needing to be loaded [22], according to Reuters.

Potential alternatives to using Ukrainian ports include exporting food via Romania or Poland. Western politicians have been lining up to support these choices in recent weeks. Other strategies might increase exports, but experts believe this won't be enough to meet the world's food needs. There are many difficulties, including the fact that Ukraine's train gauge is different from that of the majority of EU countries. It will take some time to increase storage capacity. Additionally, the port of Constanta in Romania is unable to handle the influx of crops from Ukraine [23]. However, it can become a vital commerce route, particularly to North African nations, with investments in railway networks and port facilities. Additionally, it is difficult to attract private investment for the infrastructure needed for such alternatives because the duration of the embargo is undetermined. Additionally, higher insurance premiums for the Black Sea region will exacerbate already high transportation costs, driving up the cost of imported food [24].

Secondly, the war already prevented farmers from working in their fields, and the conscription and population displacement resulted in labor shortages. Negative effects on agricultural activity are also anticipated when vital public services are disrupted. This reduced availability and access to vital agricultural inputs, such fertilizers, exacerbates the issue. The ongoing spring planting campaign and the upcoming winter crop harvesting, which typically occurs in June or July, may therefore be disrupted by the war [25]. For example, even though there are enough seeds (both imported and local) to plant 70% of the anticipated spring area, getting them to farmers safely is a significant difficulty [26]. As a result, by 2022, one-third of crops and agricultural land might not be harvested or cultivated, according to FAO. It's also unclear if other exporters will be able to cover the shortfall.

Thirdly, future prospects for Russian exports are quite dubious because of the economic sanctions imposed on Russia. No major disruption to agricultural production is anticipated in the foreseeable future, and Russian Black Sea ports are now open. However, the financial sanctions imposed on Russia have resulted in a significant devaluation, which, if sustained, may impede productivity and development while eventually raising agricultural output costs. In reaction to Western sanctions, Russia also pledged in April 2022 to restrict food and agricultural exports to only "friendly" nations. The limitation would make the world's food shortage worse [27]. Prices would likely increase and hundreds of millions of people's accesses to food would be compromised by an ongoing conflict and sanctions.

The War's Indirect Effects on Food Security Additionally, there are some cascading and indirect effects of the battle. First, the cost of vital inputs like fertilizers is almost at an all-time high [28]. As a result, numerous farmers globally, including in the USA, are substituting low-fertilizer crops like soy for expensive commodities like wheat and maize. This could worsen the present supply shortages and increase the cost of bread, cereals, and other essential foods because soybeans are mostly utilized in animal feed and biofuel [29]. In a similar vein, fertilizer shortages and high prices may have detrimental impacts, especially in underdeveloped nations where price ramifications may severely restrict consumption and lead to lower yields during periods of limited global availability and record global prices [30]. Second, as was evident during the food crisis of 2007–2008, many nations-imposed export restrictions to protect local food supplies and reduce inflation (India: wheat; Serbia: grains and vegetable oils; Indonesia: palm oil, etc.). As a result, other food exporters were compelled to restrict exports in order to protect their populations as well, which made the situation worse [31]. The number of nations imposing export restrictions, including export bans and export licensing requirements, has grown from three to twenty-six since the start of the war, encompassing forty different food categories. Approximately 15.68% of all calories traded worldwide are accounted for by the total volume of exports affected by the limitations, which is the same percentage as during the food crisis of 2007–2008.

Table 4. Scope of export restrictions introduced during the crisis

Indicator	Value
Countries imposing restrictions	26
Food categories affected	40
Share of globally traded calories affected	15.68%
Wheat exports affected	36%
Maize exports affected	17%
Palm oil exports affected	55%
Sunflower oil exports affected	78%

For the following commodities, export restrictions are particularly important in terms of calories: Soybean oil (6%), wheat (31% of total calories affected), palm oil (29%), maize (12%), and sunflower oil (11%). Export limitations have an impact on the overall commerce in specific goods influence on 78% of sunflower oil exports, 6% of soybean oil exports, 17% of maize exports, 55% of palm oil exports, and 36% of wheat exports. Even while these policies could be popular locally, they have a significant impact on food security and prices worldwide. As seen during the 2007–2008 food crisis, export limitations increased prices on the global market rather than containing price increases. In fact, growing protectionism is making the war-related instability in the world's food markets worse. These actions may raise costs and exacerbate food insecurity issues already made worse by the COVID-19 pandemic, which might have catastrophic unintended consequences for vulnerable people in food-importing countries. During the 2007–2008 food crisis, export restrictions made shortages worse, resulting in food riots throughout Asia and Africa. Thirdly, another cascading effect of the war is panic buying at the national and individual levels. During the COVID-19 epidemic, stockpiling and panic buying were major aspects of consumer behavior related to crises and disasters that garnered significant media attention. In fact, during a crisis, food becomes more significant in people's life, and panic shopping is a normal human response to a stressful situation. As noted in the early months of the pandemic, panic buying increased in a number of European nations in March 2022 as a result of the conflict. For instance, in the UK, several merchants began to ration specific food goods, and over one-third of consumers rushed to stock up on essential staples like pasta and cooking oils. Similar to this, people in northern Italy kept a lot of pasta in storage, and German trade analysts saw panic purchases of goods. In addition, people in Finland's border regions were rushing to acquire food in anticipation of a potential conflict with Russia. Additionally, some nations, like China, were stockpiling food to guarantee domestic food supplies, which is a lesser-known factor contributing to the rise in food prices. To prevent shortages and reduce dependency on imports, the Chinese government is stockpiling food on a massive scale. China, which makes up less than 20% of the world's population, is predicted to hold 69% of the world's reserves of maize, 60% of its rice, and 51% of its wheat by mid-2022, according to figures from the US Department of Agriculture (USDA). The data clearly shows that China continues to stockpile grains, which contributes to increasing global food costs, and the forecasts suggest increases of almost 20% over the past ten years.

Table 5. China's grain reserves relative to global stocks

Commodity	Share of Global Reserves (%)
Maize	69
Rice	60
Wheat	51

Table 6. Examples of food stockpiling and panic buying during the crisis

Country	Observed Behavior
United Kingdom	Rationing of food products
Italy	Pasta stockpiling

Germany	Panic purchases
Finland	Emergency food buying
China	Strategic grain stockpiling

Fourth, the war may have an impact on national and individual purchasing power by slowing the post-COVID-19 economic recovery, which could have an impact on financial access to food. As the world economy was still recovering from the COVID-19 pandemic, the conflict in Ukraine actually broke out at the worst conceivable moment. The conflict worsened the already difficult worldwide social and economic conditions. Prior to the war, it was anticipated that the post-pandemic recovery would continue in 2022 and 2023, supported by persistent international vaccination campaigns, encouraging macroeconomic policies, and advantageous financial circumstances, even in the face of rising inflation in a number of nations. However, the war caused a fresh negative shock to the global economy, impacting the market for food, energy, and other commodities worldwide, contributing to ongoing inflation, and igniting a global food crisis. The International Monetary Fund forecast in April 2022 that global growth will drop from an anticipated 6.1% to 3.6% in 2022 and 2023. Fuel and food costs would also rise by 2.3% in 2023 and 3% in 2022. Since the poor and middle classes will be disproportionately affected by rising food and energy costs, this could have serious societal repercussions.

Fifth, the increase in global prices has put pressure on the foreign reserves and, consequently, the exchange rates of countries that import food. The majority of countries that rely on food imports already have significant debt; prior to the crisis, developing nations typically spent 16% of their export earnings on debt repayment. As of April 2022, for example, the Egyptian pound has lost 17%, the Moroccan dirham 4.5%, the Tunisian dirin 3%, and the Lebanese pound 25% of its value in relation to the dollar. It is projected that currency depreciation will have a detrimental impact on inflationary pressures for food and other goods and services, lowering consumer wages' purchasing power and increasing the burden on government budgets. Food prices had already increased in a number of nations in February and March of 2022. For instance, food prices in Egypt rose by an estimated 17% in February 2022.

Furthermore, a number of importing nations rely on food supplies from Russia and Ukraine, making them more vulnerable than others. For example, the countries of the Middle East and North Africa (MENA) region import a significant portion of wheat, maize, and barley from Russia and Ukraine, as well as more than 50% of their cereal needs. For instance, 80% of Lebanon's wheat comes from Ukraine. In nations like Egypt and Lebanon, where government-subsidized bread dominates diets, this could result in greater food insecurity and poverty. At a time when governments have little budgetary flexibility to mitigate the impact of rising food costs due to economic restraints brought on by COVID-19 restrictions, the conflict in Ukraine also restricts food supplies in the region. The ability of governments in many low- and middle-income countries (LMICs) to sustain social safety-net programs and provide ongoing subsidies for necessary food items will be put to the test.

Table 7. Dependence of selected countries on wheat imports from Russia and Ukraine

Country	**Wheat Import Dependence (%)**
Lebanon	80
Egypt	>50
Tunisia	>50
Yemen	>50
Sudan	>50

Additionally, as they spend the majority of their income on food, low-income families will be especially impacted by rising food costs. For example, the government of Egypt imports over $3 billion worth of wheat annually, the majority of which is used for the Tamween ration card program, which provides bread subsidies to 73% of Egyptian families.

The cost of running this program has significantly increased as a result of the recent jump in wheat prices. Additionally, another element aggravating these price shocks is commodities speculation. On the other hand, "extreme speculation" may result in greater upward movements than would have been expected based just on supply and demand considerations. For other commodities, this means more profits or losses for investors; but, for food, it means higher real-world prices that hurt the world's poorest people. Futures prices surged over the 2007–2008 period due to a notable increase in speculative financial investment. A survey by Lighthouse Reports revealed a huge influx of investor capital into specialist agricultural funds, the majority of which came from speculators who had nothing to do with the actual production or distribution of wheat but saw an opportunity to profit quickly. The "Hunger Profiteers" inquiry claims that the price increase is the result of investment firms and funds speculating more in the commodities markets. For example, the top two US agricultural funds, Teucrium's wheat fund and Invesco's agriculture fund, received a net investment of $1.2 billion by April 11, 2022, as opposed to $197 million for the entire year of 2021. They possessed wheat futures contracts worth more than half of the UK's yearly flour consumption by the middle of April. Lastly, the war will postpone the sustainable transformation of food systems in numerous nations.

In an effort to boost agricultural output in reaction to the conflict, a number of nations are pressuring Europe to delay the shift to greener agriculture. In fact, the European Commission said in March 2022 that the release of environmental and sustainable farming proposals would be postponed. Several countries are doubting the European Union's environmental efforts due to the impact of the war in Ukraine on food supplies. Additionally, the EU's "Farm to Fork" policy, which aims to dedicate a quarter of agricultural area to organic farming by the end of the decade, cut pesticide use in half, and reduce fertilizer use by 20%, was scheduled to be published in legislative texts in March 2022. Indefinitely, it has been delayed. Some federal legislators in Brazil are trying to allow potash mining on protected indigenous territories because of the high prices.

In actuality, the battle may have an effect on the advancement of the UN Sustainable Development Goals (SDGs), as was noted during the pandemic. In fact, the war may make it more difficult to achieve the SDGs, especially SDG 1 (No Poverty) and SDG 2 (Zero Hunger), by causing a worldwide food crisis. Furthermore, several governments have increased the production of fossil fuels due to high energy costs, postponing the transition to renewable energy. For example, governments are more interested in lowering the price of gas and oil than in rapidly reducing emissions, and fossil fuels are experiencing a wartime renaissance. Governments are also giving up on attempts to phase out the usage of coal. They are racing to find more oil and investing billions of dollars in building facilities for liquefied natural gas. Additionally, the cost of renewable energy, which depends on metals like battery-grade nickel and aluminum, is growing due to rising metal prices. The execution of SDG 12 (Responsible Sustainable Production and Consumption) may be compromised as a result.

The Impact of the Ukraine Crisis on the Global Agri-Food Markets:

Following the dissolution of the Soviet Union in the early 1990s, agricultural productivity and output fell, and Russia and Ukraine became net food importers. However, after three decades of intense modernization and mechanization, agricultural outputs and food commodities exports increased significantly, making the region the world's breadbasket. Today, the two countries are among the world's top producers of various agricultural products, primarily cereals and sunflower oil, accounting for 72.7% of global trade in 2020.

Russia and Ukraine became net food importers as agricultural output and productivity fell after the Soviet Union broke up in the early 1990s. However, following three decades of intense industrialization and mechanization, the region is now the world's breadbasket due to the substantial growth in agricultural outputs and food commodity exports from Russia and

Ukraine. These days, the two nations are among the top producers of a variety of agricultural goods worldwide, primarily sunflower oil and cereals. Together, they will be responsible for 34.1% of the world's wheat trade and 72.7% of the world's sunflower oil and seed commerce in 2020. Russia and Ukraine export almost 12% of the world's total calorie trade

Table 8. Food price inflation indicators during the conflict

Indicator	Value
FFPI increase over previous year	21%
FFPI increase over previous record	2.2%
FFPI increase March 2022	17.1%
Wheat and maize price increase	35%
Global food price increase	5%
FFPI increase April 2022 vs April 2021	29.8%

The War's Effect on the World Market for Cereals:

In terms of grains, Russia and Ukraine contribute significantly to the world's supply of barley, wheat, and maize. From 2016–17 to 2020–21, the Two countries produced 19%, 14%, and 4% of these crops worldwide, respectively. Russia and Ukraine were two of the top three exporters of wheat and maize worldwide in 2021

Similarly, future prospects for Russian exports are quite dubious due to economic sanctions imposed on Russia. Both nations have a promising early production prognosis for winter crops in 2022–2023. However, as previously mentioned, the conflict may negatively impact Ukrainian agricultural operations by making it impossible for farmers to tend to their crops, harvest their produce, and sell it.

A key component of human nutrition is wheat. It provides 20% of the daily calories and protein for over 35% of the world's population, making it a necessary food.

About 40–43% of daily calories and proteins in West Asia and North Africa come from wheat. Wheat exports from Russia and Ukraine could drastically decline as a result of the current conflict. The next campaign, which begins in July 2022, is the subject of significant uncertainty.

The silos won't be able to produce the summer harvests if shipments don't pick up speed. The most severe scenario would be if the war continued to negatively impact Ukraine's upcoming harvest. Such supply disruptions won't be filled by global stocks for very long. Furthermore, there is very little short-term unrealized production potential worldwide. The ability of other exporters to close the gap is unknown. Canada already has a limited supply of wheat, and as the government works to ensure local supply, exports from the US, Argentina, and other countries are probably going to be restricted.

Given that Russia is a minor producer, Ukraine is primarily responsible for the effects on the maize market. With over 15% of the global market, Ukraine is the fourth-largest exporter of maize. After the droughts that affected Brazil's output and Argentina, the market is competitive, and the conflict threatens Ukraine's export potential as well as the upcoming harvest. For maize, the first query concerns planting in the spring of 2022 (April–May) in anticipation of a fall harvest. The world maize market, which is already extremely tight, will not be able to make up for the shortage of deliveries from Ukraine if the war delays sowing. This might lead to further increases in the price of animal feed and challenges for Latin America's food supply. In addition, the war has increased the need for rice feed due to supply issues with wheat and maize, pushing rice prices into highly volatile regions. Broken rice supplies have been reduced in the Asian rice market due to both domestic and foreign feed demand inflow. Global food costs had already reached an all-time high prior to the war. The market conditions were the main cause of this, although high energy, fertilizer, and other agricultural service expenses also played a role. The FAO Food Price Index (FFPI), which is composed of the average of five commodity price indices (cereal, vegetable oil, dairy, meat, and sugar), weighted by the average

export proportion of each category from 2014 to 2016, reached a new record high in February 2022, 21% higher than the previous year and 2.2% higher than the previous high in February 2011. The index measures the monthly change in international food commodity prices. The FFPI reached its highest level since 1990 in March 2022, averaging 170.1 points, up 24.9 points (17.1%) from February 2022. costs for wheat and maize have climbed by 35% since the start of the conflict, while worldwide food costs have increased by 5%. The FFPI was still 29.8% greater in April 2022 than it was in April 2021, despite an average decline of 1.2 points (0.8%) from its peak in March 2022. In April's Food and Feed Price Index (FFPI), vegetable oil prices suffered the most, despite a slight decline in grain prices. The pricing sub-indices for dairy, meat, and sugar all witnessed slight increases.

Table 9. Effects of the war on global vegetable oil markets

Indicator	Value
Palm Oil Share of Trade	58%
Soybean Oil Share	14%
Sunflower Oil Share	13%
Rapeseed Oil Share	7%
Sunflower Oil Price Increase	>40%
Rapeseed Oil Increase (2021)	65%
Sunflower Oil Increase (2021)	63%

Given the importance of wheat as a dietary staple, some countries may increase imports now to secure supplies out of concern that wheat markets will tighten and prices will rise. The resulting supply shortages for importers may be especially relevant for buyers in the Near East and North Africa. Global markets would be more strained as a result. With agricultural prices on the rise, governments across the globe are attempting to secure local cereals supply. For instance, India suspended wheat exports on 14 May 2022, with immediate effects to ensure its national food security and domestic availability and manage inflation. Following the war in Ukraine, India sought to cover the global wheat supply shortfall and intends to export a record 10 million tonnes in 2022–2023. How-ever, a record-breaking heatwave during India's warmest March on record has reduced this year's wheat harvest, potentially cutting production by up to 50% in some regions of the country. India's export ban has been denounced by the G7 developed countries, who believe it would exacerbate the crisis. Indeed, the impact of India's decision was immediate: prices on the European market skyrocketed on Monday, 16 May 2022. At the closure, the wheat price hit 438 euros/tonne. Likewise, in April 2022, the Serbian government announced a limitation on the quantities of wheat, maize, flour, and cooking oil planned for export to mitigate the risks of market disruptions caused by rising demand on both the international and domestic markets.

The War's Effect on the World Market for Vegetable Oil:

On average, 92% of vegetable oils marketed in international markets are made up of palm oil (58%), soybean oil (14%), sunflower oil (13%), and rapeseed (canola) oil (7%). 2021 and 2019. For the past two years, there has been a tightening of global vegetable oil supplies due to a number of variables, including strong demand and prolonged global supply constraints. As a result, prices have been growing gradually. Rapeseed oil and sunflower oil saw price increases of 65% and 63%, respectively, in 2021. Drought has also decreased soybean crops in South America, particularly in Brazil, a significant producer. Typhoon Rai, severe labor shortages, and other issues made worse by COVID-19-related limitations on worker migration caused Malaysia's palm oil output to decline in December 2021. Drought-affected rapeseed production decreased by 35% in 2021–2022 in Canada, the world's largest exporter of rapeseed oil. As a result, it is anticipated that Canada will export half as much rapeseed and 20% less rapeseed oil. Due to the disruption of Black Sea sunflower oil exports caused by the war, prices in volatile

trade increased. The crisis has significantly increased the price of vegetable oil, and Russia and Ukraine are major exporters of sunflower oil. About half of the sunflower oil harvested last year remained in Ukraine due to the lack of alternative routes to the west via Romania or Poland. East of the Dnieper River, where most of the combat has subsequently stopped, is a large portion of Ukraine's sunflower-growing region. Russian exports are currently limited as a result of Black Sea marine trade restrictions, Russian export limits, and business operations sanctions. Since the invasion, sunflower oil has increased by more than 40%, making it the most directly impacted. It makes up around 13% of all vegetable oils sold internationally, with approximately 50% and 25% of all sunflower oil sold worldwide coming from Ukraine and Russia, respectively. High expenses have already been passed on to customers and retailers because vegetable oils don't require significant processing.

As a result, as stores and eateries react to growing costs, certain customers are being restricted in their purchases of cooking oil in a number of nations, including the United Kingdom. In fact, cooking oil purchases have been regulated by grocery chains in Spain, Greece, Turkey, Belgium, and other nations. Global trade policy responses to the problem have further limited supply and increased prices. For example, Indonesia banned the export of palm oil at the end of April 2022 due to domestic price increases, which increased pressure on the price of cooking oil worldwide. In order to reduce local shortages and control price hikes that could lead to serious domestic unrest, Indonesia will limit exports of all cooking oils and associated raw materials. In the meantime, Malaysia, the world's second-largest producer of palm oil after Indonesia, continues to struggle with a persistent labor shortage that affects farmers' output and yields.

The War's Effect on the World Fertilizer Market:

Fertilizers continue to be an essential component of agricultural output despite efforts to minimize nutrient losses to the environment. Generally speaking, farmers need to employ three primary types of mineral fertilizers—nitrogen (N), phosphate (P), and potash (K)—to ensure crop development. A small number of miners (P and K) and a somewhat larger group of chemical companies (N) control the supply of all three of these mineral fertilizers, which are marketed globally. Russia is a major source of nitrogen, while Belarus and Russia are important producers and miners of potash. With an anticipated $7.6 billion in exports, Russia was the largest fertilizer exporter in the world in 2020. Russia exports about one-sixth of the global supply of potash fertilizers, more than one-tenth of nitrogen fertilizers, and about one-sixth of mixed fertilizers (containing two or more of nitrogen, potassium, and phosphate). Belarus was the sixth-largest exporter in the world in 2020 with $2.96 billion in fertilizer exports. Belarus produced about 17.6% of the world's potash (K) in the same year. Belarus and Russia both participate in a cartelized potash market that controls the price of potash on the global market and accounts for one-third of global exports (Canada and the USA make up the other half). Furthermore, Russia is a major source of natural gas, which is the main ingredient used to make nitrogen fertilizer. This is especially important for the EU and India, whose domestic nitrogen production is largely dependent on imported natural gas.

The worldwide fertilizer market was already under extreme strain prior to the war. Fertilizer prices increased by 80% in 2021 due to rising energy costs, supply restrictions, and trade policies, reaching levels not seen since the global financial crisis of 2008–2009. First, throughout 2021, the cost of fertilizer increased in tandem with the cost of electricity. Since natural gas (or coal in China's case) is used to make nitrogen-based fertilizers, the cost of natural gas skyrocketed in 2021, driving some fertilizer prices to their highest point since 2010. For example, the production of ammonia, a necessary component of nitrogen fertilizers, was drastically reduced in Europe as a result of skyrocketing natural gas prices. Due to growing gas prices, a number of European fertilizer companies were already struggling to stay in business; two UK factories closed in 2021. For example, due to increased gas prices, the fertilizer major

Yara said in March 2022 that it was cutting its capacity to produce urea and ammonia in Europe by 55%.

Second, the global market is under more pressure due to additional supply restrictions brought about by trade policy actions made by individual nations. For instance, China, a significant manufacturer and exporter of fertilizers based on phosphate, has chosen to limit fertilizer exports to guarantee domestic supplies, fertilizer exports will take place between July 2021 and June 2022. Additionally, the international potash market experienced increased volatility in 2021 as a result of numerous nations' sanctions on Belarus. As part of a broader set of economic penalties, the European Union later limited the import of fertilizers from Belarus and Russia on April 8, 2022, after the war.

Food supplies may become more scarce as a result of the conflict in Ukraine, which has left the world lacking both essential cereals and fertilizers. The World Bank's Fertilizer Price Index reached an all-time high in nominal terms during the first quarter of 2022, rising more than 10% (q/q).

Throughout 2021, fertilizer benchmark prices increased globally, with many quotations hitting all-time highs. The nitrogen fertilizer showed the biggest increases. Over the past 12 months, the cost of urea, a necessary N fertilizer, has increased by 2.5 times. Phosphorous fertilizer costs have also increased during this time, while potash (K-fertilizer) prices have not changed much. Russia and Belarus are major suppliers of fertilizer, particularly potash, to a large portion of South and Central America, West Africa, and Europe, including Ukraine. Furthermore, Russia is the leading exporter of natural gas, which powers the manufacturing of nitrogenous fertilizers throughout Europe. According to the International Energy Agency (IEA), as tensions increased, Gazprom's gas deliveries to Europe fell by almost 25% in the final three months of 2021 compared to the same period in 2020. Russia accounts for around 20% of the world's natural gas trade and 40% of EU imports. If trade is stopped by sanctions, natural gas prices may increase far more. Additional fertilizer shortages may have global consequences, especially in developing countries where price repercussions might dramatically restrict usage and result in poor local harvests during lower global supplies and record global prices. Indeed, higher fertilizer prices make the world's food supply more expensive and less abundant, as farmers skimp on nutrients for their crops and get lower yields. For instance, given Africa's still-limited fertilizer usage (an estimated average of 25 kg per hectare, a fraction of the worldwide average of 121 kg/ha), a decrease in fertilizer use would result in much lower production for the continent, possibly with significant ramifications for food security.

Table 10. Strategic recommendations for building resilient food systems

Policy Area	Recommended Action
Trade Policy	Avoid export restrictions
Food Security	Expand social safety nets
Agricultural Research	Increase climate-smart innovation
Fertilizer Supply	Diversify suppliers
Food Sovereignty	Promote local crops
Agroecology	Increase investment
Debt Relief	Support vulnerable countries
Monitoring Systems	Real-time market analysis
Humanitarian Assistance	Increase funding
International Cooperation	Strengthen global coordination

Conclusion:

Moving Towards Food Systems That Are More Resilient and Sustainable Russia launched a full-scale military invasion of Ukraine in the early hours of February 24, 2022, which led to civilian casualties and deaths as well as the destruction of important infrastructures. Global

trade, production, and consumption habits have all been impacted by the war, which has threatened global food security and kept commodity prices high until 2024.

Understanding the entire impact on food security requires analyzing the long-term and extensive repercussions of conflict-related disruptions in the global food and fertilizer markets. The study emphasized how the conflict had immediate and significant knock-on effects on the world's food security. First, Ukraine's capacity to export agricultural goods will be impacted by the conflict in both the short and long term. Second, labor shortages were brought on by population dislocation and conscription, which prohibited farmers from working their fields. Access to vital agricultural supplies, such fertilizers, was restricted, which made the situation worse. The ongoing spring planting campaign and the upcoming winter crop harvest could be affected by the war. Additionally, there are some cascading and indirect effects of the battle. First off, the cost of fertilizer is almost at an all-time high, which could significantly restrict use and lower production. Second, many nations-imposed export restrictions during the 2007–2008 food crisis, which increased prices on the global market and made the situation worse. Thirdly, another cascading effect of the war is panic buying at the national and personal levels. Lastly, the war will postpone many nations' efforts to restructure their agricultural systems in a sustainable manner. The SDGs, particularly SDG 1 (No Poverty), SDG 2 (Zero Hunger), and SDG 12 (Responsible Consumption and Production), may be impacted by the war. The potential extent of economic and physical disruptions to food and energy systems increases while the war rages on. Indeed, with the war doubtful to be resolved shortly, its influence on global resource markets will grow, as will the possibility of highly significant 'ripple effects' or 'risk cascades' on economies and society across the globe. In areas and sectors distant from the original occurrence, these effects could have immediate and serious repercussions.

Unlike the previous global food-price crisis, driven by the 2007–2008 financial crash, the current upheaval comes after governments and households spent two years coping with the COVID-19 pandemic—the most significant economic shock since World War II. Consequently, humanitarian needs are unprecedented, with climate shocks, conflicts, COVID-19, and growing prices pushing millions closer to famine. The war threatens to worsen the situation by pushing up food prices even further, causing shortages, and creating a global food crisis, especially in conflict-affected countries, such as Yemen, Sudan, Nigeria, and Ethiopia. Meanwhile, from an economic and food security perspective, some countries and regions, including several Middle Eastern, Northern and Sub-Saharan African, and South Asian countries, are more vulnerable than others. Indeed, over 30 countries rely on Russia and Ukraine for at least 30% of their wheat imports, while at least 20 countries rely on those two countries for more than 50% of their wheat imports, making them very sensitive to price shocks and/or supply shortages.

Nevertheless, despite the war's detrimental effects, there may be some opportunity to mitigate them. In fact, early signs suggest that rising prices for soybeans and other oilseeds will motivate farmers to increase oilseed plantings in the European Union and the United States. Canada may be able to partially overcome the global supply shortfall with increased wheat acreage. High fertilizer prices will also encourage producers to increase output. Similarly, international fertilizer traders will modify or reorganize trading patterns to move the extra supply to the regions with the highest demand (mostly Latin America). But according to many analysts, the war in Ukraine has sparked a third global food price crisis in fifteen years because food systems have not been reformed. In actuality, a number of underlying rigidities, vulnerabilities, and inefficiencies in global food systems—such as reliance on food imports, speculative and inefficient grain markets, vicious cycles of conflict, poverty, and food insecurity—are making the effects of the war on food security worse. As a result, some urgent measures are needed, like removing trade barriers that prevent people from accessing nourishment, preserving or growing social security programs, protecting national nutrition budgets, and raising more funds for humanitarian help. In order to create a more resilient and sustainable food system that enables

people to eat healthful food in a reasonable manner, governments, philanthropic organizations, the corporate sector, and civil society organizations must ultimately collaborate. The international community must address the structural causes of hunger and malnutrition as well as war, armed conflicts, and widespread violence in order to stop future global food crises.

Food systems are under increased pressure to provide enough food for the world's population, reduce the environmental effects of production, and function as a buffer against complex global change in a more complicated and uncertain world. The conflict serves as both a cautionary tale about how agri-food systems function and a catalyst for their innovation.

In order to effectively handle the various issues that food systems face, it is necessary to do cross-disciplinary research and innovate at their intersections to produce a variety of solutions that address the social, economic, technical, and policy aspects of these challenges. However, current and future studies will lay the groundwork for government and organizational preparedness for shocks, crises, and pandemics in the future. In fact, future shocks may be addressed and the food system transformed with the help of the lessons learnt from the worldwide reaction to the COVID-19 pandemic.

Meanwhile, the shock susceptibility of food systems is increased by rising internal and external hazards. The most vulnerable people may be disproportionately affected by these shocks, which could potentially jeopardize the security of the food supply and disturb other facets of food systems, leading to lower productivity, market disruption, price volatility, and overall system instability as well as food insecurity. According to Hendrickson, "the current economic and social organization of our food system presents social, ecological, and economic risks that threaten the long-term capability of humanity to provide its food needs." (page 418). Therefore, it is crucial to lessen and manage these vulnerabilities by creating partnerships, policies, technologies, and behaviors that make food systems more resilient.

Additionally, authorities in low- and middle-income countries (LMICs) should refrain from enforcing price controls or export restrictions as these could exacerbate the increase in commodity prices.

Funding may be channeled toward targeted assistance for vulnerable households due to rising inflation, tighter financial circumstances, and high debt levels limiting policy alternatives. The shift to a wholesome, just, and environmentally sustainable food system needs to be reinforced rather than abandoned in light of the conflict between Russia and Ukraine. In order to reduce supply and price shocks and increase the resilience of food systems to future crises, a new CGIAR research identifies seven crucial actions for international policymakers:

Invest in real-time analyses:

Country-specific assessments of the risks to food security posed by price shocks and trade restrictions, along with real-time monitoring of food and input price volatility, offer insights into effective national and international policy responses;

Examine market actions; for example, farmers may receive subsidies or reduced taxes on products like energy and fertilizer;

Don't make matters worse:

Governments should learn from the 2007–2008 food price crisis and avoid limiting exports, enforcing penalties that hinder the trade of food and fertilizer, stockpiling or panic buying, and abandoning environmental projects;

Focus on short-term solutions: removing biofuel mandates and subsidies, expanding social safety nets to the most underprivileged, and addressing inefficiencies in existing subsidies (such as bread subsidies in Egypt and Tunisia) are examples of short-term solutions that have worked in previous crises and seem pertinent now;

Make long-term investments in climate-friendly agriculture research: knowledge and innovation in agriculture not only greatly contribute to food security and sustainability, but they are also essential to achieving the various SDG 2 goals of eliminating hunger, achieving food

security and improving nutrition, and promoting sustainable agriculture; 6. Take advantage of promising innovations and scale them up: satellite and remote sensing photos and data may help farmers optimize their use of inputs like fertilizer, and scientists monitor the spread of pests and diseases; and Invest in policy research: In addition to funding agricultural science, nations, multilateral organizations, and donors should also fund studies on the best programs, policies, and interventions that could boost resilience.

In addition, we support debt relief for underdeveloped and food-insecure countries, the adoption of policies that support food sovereignty and reduce reliance on a limited number of grain crops and exporting nations, and the replacement of wheat and maize with traditional and regionally adapted crops. Lastly, financing for agroecology should be increased to make domestic food systems more resilient, there should be an increase in agroecological research and reduced reliance on external inputs (such as fertilizers and pesticides).

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