Vulnerability of the Global Food Supply Chain

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Abstract: We are probably at a significant turning point when we think about the long-term stability of the entire global food, agriculture and trade market. The vulnerability of the global food system has become particularly evident in the last few years due to major disruptions in food supply chains, which have caused profound shocks to the global food supply, affecting the poorest and most vulnerable populations the most. Prices may remain at historically high levels for the long term, further exacerbating food insecurity and inflation, which was already high due to the effects of the pandemic. The study reviews the main risk factors that can affect global food security due to the cascading effects of the pandemic, the Ukraine-Russian war and global warming.

Keywords: Food supply, Safety, Risk factors, Supply Chain, Ukraine conflict

1 Introduction

We are probably at a major turning point when we think about the long-term stability and security of the entire global food, agriculture and trade market. This turning point, however, is by no means a new one, but merely an acceleration of the cumulative effects of the past period by the Ukrainian-Russian conflict.

International cooperation on food security has long been of concern to the international community. The creation of the Food and Agriculture Organization (FAO) in 1943 was one of the first tangible results of global concerns about food security. The second turning point was the world food crisis of 1972-1974, which led the UN General Assembly to establish the International Emergency Food Reserve or IEFR. Between 2005 and the summer of 2008, wheat and maize prices tripled and rice prices increased fivefold, triggering food riots in almost two dozen countries and pushing a further 75 million people into poverty [1]. (Fig.1)

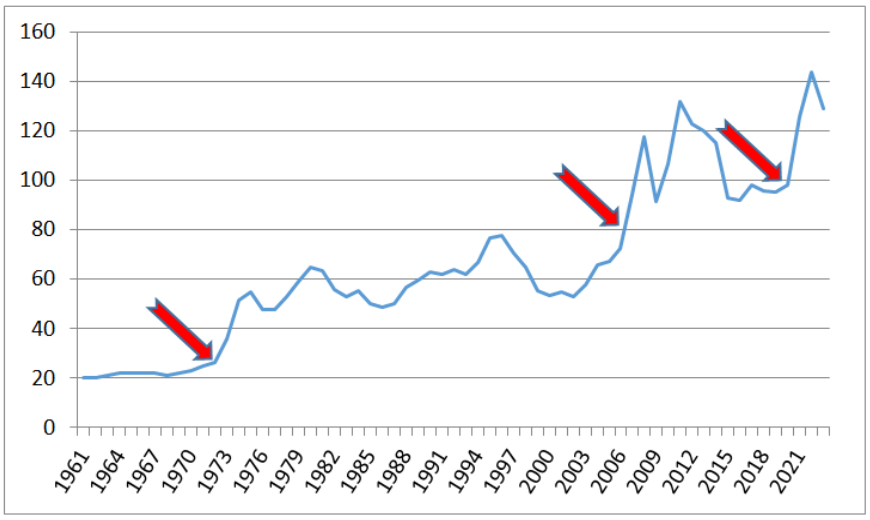

Figure 1
Food crises points, FAO Food Price Index (FFPI)

There has been some recovery in prices, but the underlying problems that triggered this latest crisis persist: low stocks, a growing population and flattening crop growth. The situation is exacerbated by climate change, with warmer production seasons, increasing water scarcity and increasingly extreme weather. These problems have not disappeared, but have been compounded in a short time. Our current food supply system is highly dependent on two factors: the global supply chain and modern high-yield production techniques.

Although intensive farming guarantees the highest yields, modern farming methods rely on the availability of sufficient quantities of cheap water and fertilizers. However, most fertilizers and pesticides are fossil fuel-based, and we also need fossil fuels to run modern machinery. In the summer of 2022, Europe experienced its worst drought in 500 years [2]. Nearly half a century of intensive irrigation, fertilization, pesticide use and monoculture has not been kind to soil and groundwater. According to a study by the Ukrainian Academy of Sciences, for example, more than 40% of all agricultural land in Ukraine could lose fertility [3]. And the growing demand for food, feed and bio-fuels has clearly become a major driver of tropical deforestation.

The vulnerability of the global logistics supply chain became clear in 2021-22, first due to closures, consumer panic buying and hoarding during the pandemic, followed by the problem of declining production rates due to restrictions, and finally the difficulties of restarting. During the Covid-19 pandemic, supply chains were exposed to unprecedented disruption, uncertainty and risk, highlighting the interdependence of the global system. The latest shocks, the war in Ukraine and sanctions against Russia, further weakened production routes that cut across multiple countries and were already severely disrupted by Covid-19 [4]. The UN

estimates that the number of food insecure people worldwide could be at a 15-year high as, in addition to the effects of the pandemic and climate change, the war in Ukraine has a major impact on global food security [5]. It is predicted that harvests will continue to decline in much of the world in the future, raising the specter of a perpetual food crisis.

Food security can be described in several ways. One such definition includes the challenges associated with adequately feeding populations in developing countries, both at the household and at the national or regional level, especially in times of external stress. In developed countries, food security at the household level is most commonly defined in relation to food affordability and access for low-income consumers. The traditional definition of food security is the FAO's 1996 definition: “Food security exists when all people have access at all times to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life” [6]. The term can also be used in the context of national 'self-sufficiency', in terms of whether a country, such as Hungary, can meet its own food needs. The OECD defines food security as "the concept that does not support the opening of domestic markets to foreign agricultural products on the principle that a country should be self-sufficient to the maximum extent possible to meet its basic nutritional needs" [7].

1.1 The Russian-Ukrainian conflict

On 21 February 2022, the day after the Winter Olympics, Putin signs decrees recognizing the independence and sovereignty of the so-called Luhansk People's Republic (LNR) and Donetsk People's Republic (DNR) at a Kremlin ceremony and orders Russian troops to be sent to the separatist territories. Three days later, in the early morning, Russian troops cross the Ukrainian border and launch missiles at Ukrainian cities, airports and other strategic targets. Putin describes the invasion as a "special military operation". Russia's military attack on Ukraine has prompted other countries to impose extraordinary, coordinated economic sanctions against Russia (and to a lesser extent Belarus). The measures are aimed at restricting normal trade and financial links with Russia and potentially crippling its economy, all in the hope of deterring Putin from waging and then continuing a war. However, the scope and severity of these measures vary widely, and their impact on the Russian economy will only be felt in the long term (Russia was already subject to Western sanctions after the invasion and annexation of Crimea in 2014, which did not deter escalation). Moreover, sanctions have a serious impact on the economic activity of other countries [8].

The first strikes were directed against Ukraine's military infrastructure, airports, air defense facilities and other strategic targets, but when the expected military successes did not come, Russia switched to a scorched earth policy. Seaports were closed, Russian invaders targeted infrastructure, stole agricultural equipment and thousands of tons of grain from Ukrainian farmers in the occupied territories, and targeted food storage sites with artillery [9]. Russian attacks on key agricultural

infrastructure centers destroyed large quantities of food. The blockade of Ukrainian ports has stifled the country's exports, cutting off a key source of income and exacerbating a global food crisis that could force millions of people to migrate. Global food and energy prices have soared to record highs, with millions of tons of grain and vegetable oil stuck in Ukraine. Recent events in Syria have highlighted what the massive destruction of the Russian military could mean for Ukraine and the world. Syria's gross exports amounted to $11.9 billion in the year before the war, but will be a mere $0.8 billion in 2020 [10].

2 Methodology

For researchers with a broad perspective, especially when dealing with timely and changing topics, "grey literature" can be an important source of information. Grey literature is the set of materials and research produced by organizations outside traditional commercial or academic publication and dissemination channels [11]. I have delineated seven food supply chain risk groups that defined the scopes to be monitored in this study. I developed a tailored search plan through Google, targeted websites and news reports, supplemented with relevant peer-reviewed articles from e.g. Google Scholar, EBSCO and Researchgate databases. I used the following search terms: 'Ukraine', 'Russia', 'war', 'conflict', 'food security' as well as keywords for each of the identified broader areas. The searches were run between January and February of 2023.

3 Risk factors

The conflict threatens not only short-term but also long-term food security in several ways (Table 1).

Trade	a sharp and steep drop in shipments from both countries, shortages of goods
Price risk	steep increases in food, raw material and energy prices
Logistics	damage to roads, rail networks, sea ports, storage facilities
Cultivation and production	condition of crops in the soil, planting of next seasonal crops, field damage, water pollution, food processing, impacts on labor
Energy, energy carrier dependent	fuel, electricity, fertilizers, pesticides, lubricants

Financial	exchange rate fluctuations, significant devaluation of foreign currencies, insolvency, financing problems, reduced economic growth, transport insurance premiums
Political	land ownership issues

Table 1.
Risk factors (own editing)

3.1 Price risk

The USDA forecasts that Ukrainian wheat production will fall by 35% a year and corn production by more than 50%. Worldwide, 26 countries import at least half of their wheat from Russia and Ukraine. Indonesia receives 28%, Bangladesh 21%, while Egypt imports almost 80% of its wheat from Ukraine and Russia [12]. The main destinations for maize exports from Ukraine are countries with upper-middle economies such as China, the Netherlands and the Republic of Korea. Ukraine supplies 55.55% of China's maize imports [13]. Between 1993 and 2005, per capita pork consumption in the world's most populous country increased by 45%. Large-scale integrated industrial units depend on breeds fed a mixture of high-tech maize, soybean meal and supplements for rapid growth [2]. The situation is similar in the European Union. In the edible oil market, Ukraine and Russia are the world's largest exporters of sunflower seeds and oil, together accounting for more than 50% of world production (Table 2).

Commodity	Ukraine	Russian Federation	Belarus	Total
Wheat	10%	24%		34%
Maize	15%	2%		17%
Barley	13%	14%		27%
Sunflower oil	31%	24%		55%
Sunflower cake	61%	20%		81%
Finished Fertilizers		16%	6%	22%
Potash		21%	17.6%	39%

Table 2.
Percentage share of global exports 2021, Source: FAO

According to FAO simulations, the number of undernourished people globally could increase by 8-13 million in 2022/2023, with the largest increases in Asia-Pacific, sub-Saharan Africa, the Middle East and North Africa [15].

3.2 Inflationary pressures

As for maize, oilseeds and fertilisers, the effects of low stocks and high prices could spill over, pushing up the prices of other commodities. The FAO recently announced that the global food price index reached an all-time high in February, after rising steadily for most of last year (Figure 2) [16].

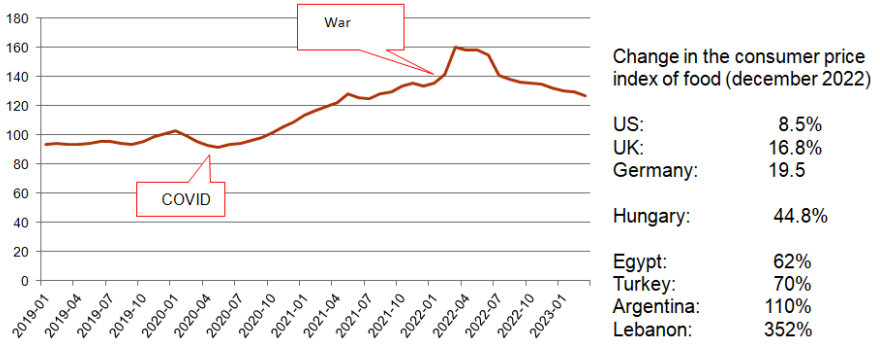

Figure 2

Food crises points, FAO Food Price Index (FFPI)

According to the World Bank's April 2022 "Commodity Market Outlook" report, the war in Ukraine has altered the global trading system, production and commodity consumption in such a way that prices could remain at historically high levels until the end of 2024, exacerbating food insecurity and inflation [17].

3.3 Supply Chain

Prior to the invasion, more than 90% of cereal and vegetable oil exports were made via sea routes. Russia blockaded Ukrainian ports in March and April. By mid-May, almost 70% of grain was being exported by rail, thanks to new rail transport corridors to the east of the country, but it is unlikely that Ukraine will be able to deliver all the grain the world was expecting, especially as the conflict could cause further damage to land transport infrastructure. The larger shipping companies suspended shipments to and from Ukraine and Russia, citing unpredictable operational consequences. The increase in insurance premiums for ships intending to dock in the Black Sea region could further exacerbate the already high cost of maritime transport [15].

3.4 Fossil Addiction

Russia plays a key role in the global energy market. Agriculture uses large amounts of energy directly in the form of fuel, gas and electricity, and indirectly through the

use of fertilizers, pesticides and lubricants. Russia is the number one, two and three exporter of fertilizers based on different bases. Along with Belarus, nearly 60% of EU fertilizer imports come from this region [21]. The current fertilizer shortages and high prices are a major concern, mainly due to the long-term decline in yields.

3.5 Outlook

Domestic food price inflation remains high around the world. However, FAO Food Price Index marks 12th consecutive monthly decrease ().

The National Oceanic and Atmospheric Association (NOAA) Climate Prediction Center has issued an El Niño Watch. El Niño likely to increase global average temperatures and alter rainfall patterns for 2023 and 2024, additionally could exacerbate the impacts of recent extreme weather events ().

Protectionism and food security concerns are on the rise. Following Russia's invasion of Ukraine, trade-related policies imposed by countries have surged. The global food crisis has been partially made worse by the growing number of food trade restrictions put in place by countries with a goal of increasing domestic supply and reducing prices.

Conclusions

The short-term solution to minimize disruption to global supply chains is obviously to find alternative sources of lost crops and raw materials and to try to reduce consumption. However, the current crisis also highlights the high dependency of most countries' food systems on imported inputs such as fossil fuels, fertilizers and feed, which confirms the need to fundamentally transform agriculture and food systems towards sustainability. Efforts should be made to promote new food production systems such as aquaponics and hydroponics, short supply chains and circular economies, although the benefits of these will undoubtedly only be felt in the long term.

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