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Near- to long-term measures to stabilize global wheat supplies and food security

The Ukraine–Russia war will impact global food security over months if not years. In the wake of COVID-19 and in the face of increasing climate change, we propose responses to a multi-layered global food crisis that mitigate near-term food security risks, stabilize wheat supplies and transition towards long-term agri-food system resilience.

Alison R. Bentley, Jason Donovan, Kai Sonder, Frédéric Baudron, Janet M. Lewis, Rachel Voss, Pieter Rutsaert, Nigel Poole, Sophien Kamoun, Diane G. O. Saunders, David Hodson, David P. Hughes, Christine Negra, Maria Itria Ibba, Sieglinde Snapp, Tesfaye Shiferaw Sida, Moti Jaleta, Kindie Tesfaye, Inbal Becker-Reshef and Bram Govaerts

The Ukraine–Russia war has directly impacted global wheat prices, raising wheat futures at a near-linear rate to their highest levels since 2012. In March 2022, the Food Price Index reached a record high since its introduction in 1990[1], increasing by 12.6%, driven by cereal and vegetable oil prices — the wheat price alone rose by 19.7% in March. Trade restrictions resulting from sanctions on Russia have also increased energy and transport costs and restricted fertilizer exports, further disrupting wheat markets. More than 2.5 billion people worldwide consume wheat-based products, and the food security impacts of supply changes are likely to be inequitably felt.

In 2020, Russia and Ukraine produced 28% of the world's total wheat exports[1]. At pre-crisis levels, the 2-year average (2018–2019) of wheat exported from Russia was 38.6 million tonnes and from Ukraine was 18.7 million tonnes (Fig. 1a)[1]. Current dependence on wheat imports from Russia and Ukraine (Fig. 1c) imperils food security in lower- and middle-income countries in North Africa and the Middle East, the Mediterranean, sub-Saharan Africa, South Asia and throughout Southeast Asia. Supply disruptions are likely to have particular ramifications for Egypt, which imports more than half of the 21 million tonnes of wheat that it consumes annually — in 2021, 50% of its import provision came from Russia and 30% came from Ukraine. Some of the most food-insecure countries in the world (such as Yemen, Sudan and Bangladesh) are highly reliant on wheat imports from Russia and Ukraine, posing social and economic concerns for short-, medium- and long-term food security.

Few will remain unaffected by the new global food shock given the highly interconnected nature of contemporary agri-food systems. With this in view, we propose essential actions to mitigate near-term food security crises, to stabilize wheat supply and to concurrently transition towards greater agri-food system resilience.

Mitigating the immediate crisis

A short-term response is required to mitigate negative near-term food security effects. Production should be stimulated to meet demand, access to grain ensured and options for use of flour blending to maintain flour supply explored.

Intensifying existing production. Wheat productivity is below the theoretical maxima in many regions and, where there is capacity, production can be increased in traditional high-productivity wheat regions. For example, in Eastern Europe, a major wheat-exporting country like Ukraine has an average yield gap of 50% and production could be increased by 70 million tonnes if the gap was reduced to 20% of water-limited yields[2]. Bundled agronomic and breeding improvements along with policy interventions such as targeted, time-bound subsidies for productivity-enhancing inputs, machinery and services could increase yields in low- and medium-productivity environments. Investments in rural infrastructure and seed system development, and policies that promote domestic wheat utilization (local context mandates), will provide much-needed additional support for local efforts to improve productivity. In the poorest countries with the greatest dependency on imported fertilizer, such as Malawi, production-expansion strategies will face headwinds created by record-high fertilizer prices. In these contexts, coordinated, broad-scale approaches to promote sustainable intensification and associated technologies, including soil fertility management and integrated pest management, can shape more resilient production within regional socio-economic contexts. Where wheat yields are generally high, direct economic incentives to expand wheat production can contribute to easing the global supply crunch — for example, spring wheat planting acreage increases across Canada, the United States and Europe.

Ensure grain access. When high food prices exert negative impacts that are politically, socially and economically unacceptable, there is a powerful rationale for government intervention in commodity markets to influence price, use and production volumes. Various countries have implemented wheat export controls and taxes in recent years in response to production and currency crises, including Russia, Ukraine and India. In the current crisis, coordinated and multilateral state approaches, potentially at the level of the United Nations, would be more effective than isolated country-level interventions. For example, directives on the demand side could conserve grain stocks for human consumption rather than industrial and livestock production. Promoting policy dialogues and market transparency will be essential to maintain adequate global wheat trade and avoid further trade restrictions (or measures that limit trade), which are likely to have the most substantial effects in low-income countries. On the supply side, policies that support minimum and stable prices for wheat and other grains could be (re-)instated to incentivize farmers to invest in wheat production, particularly where it is low at present.

Reduce domestic utilization. Rising grain prices lead directly to increased flour costs, which are passed on to consumers or food-subsidizing governments.

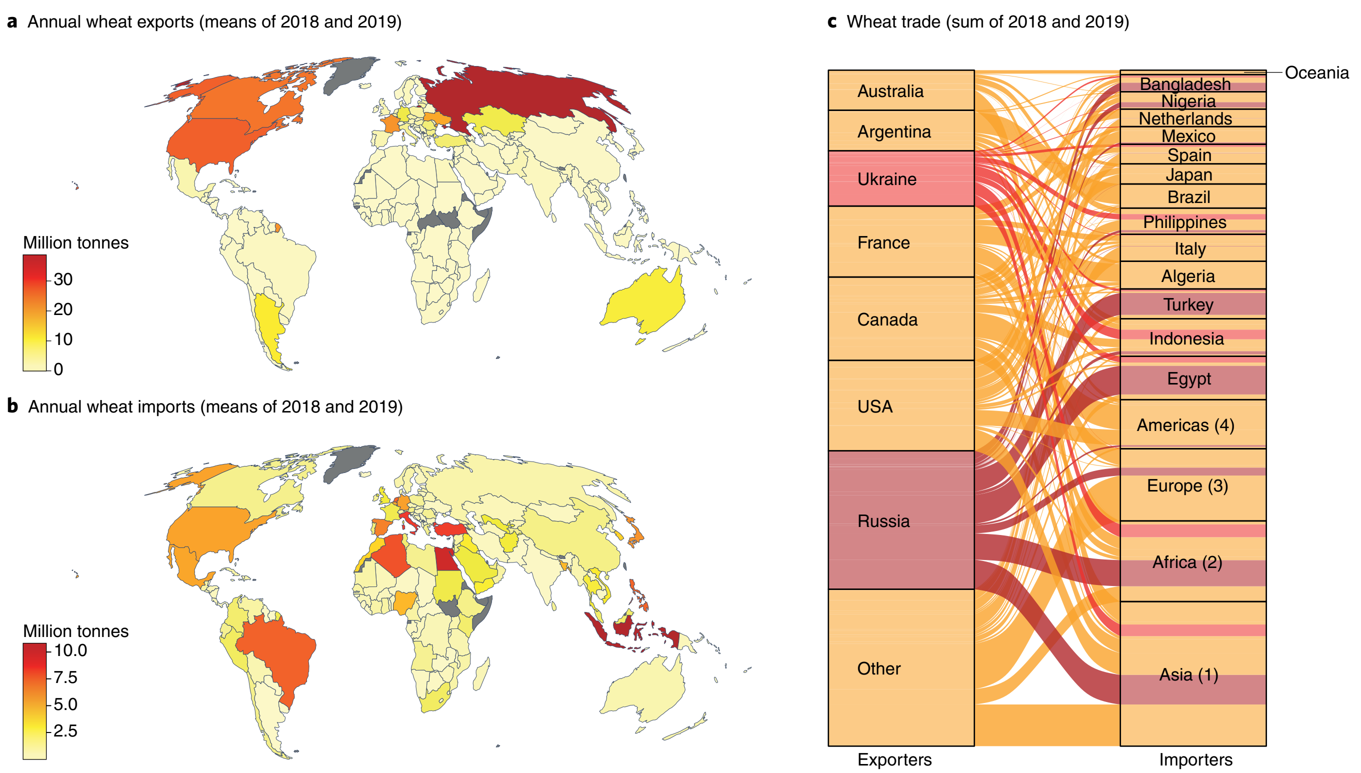

Fig. 1 | Dynamics of the global wheat trade. a–c, The central role of Russia and Ukraine is highlighted in data[1] on annual wheat exports (**a**), annual wheat imports (**b**) and in the provision of wheat exports to import-dependent countries, particularly in the Global South (**c**): Asia (1) excluding Indonesia, Turkey, Philippines, Japan and Bangladesh; Africa (2) excluding Egypt, Algeria and Nigeria; Europe (3) excluding Italy, Spain and the Netherlands; and Americas (4) excluding Brazil and Mexico. Data[1] and code are available from https://github.com/FBaudron/Figure_Bentley_et_al. Countries with no data available are coloured in grey in **a** and **b**. In **c**, the height of a block is proportional to the volume of wheat exported or imported by the corresponding country, and the width of a stream field is proportional to the volume of wheat traded between the two countries connected by the stream field. Exports from Ukraine are shown in light red and exports from Russia are shown in dark red, with all other exporting countries shown in orange. World map data generated using the spData package[10]. Publ. note: Springer Nature is neutral about jurisdictional claims in maps.

The potential exists to use lower-cost cereals in flour blends to partially offset wheat flour price increases. Partial substitution with nutrient-rich or drought-tolerant crops such as legumes, cassava, sorghum and millet[3] could also reduce dependence on imported cereals. Governments may mandate blended wheat flour to reduce utilization of and dependence on imported wheat. However, caution is advised, as limited information exists on the implications of blending on the functional properties of bread and other wheat-based foods, or consumer acceptance of foods made with blended flours.

Increasing the resilience of wheat supply

In the mid-term, actions must address the resilience of wheat supply from the local to global scale. This includes targeted expansion of production and support for wheat self-sufficiency along with provision of accompanying technical support and monitoring capacity.

Expanding production. Expansion of production area can be a viable resilience strategy in areas with a comparative advantage, including agroecological suitability, existing infrastructure or farmer support mechanisms, availability of locally adapted and climate-resilient varieties, local seed production and value chains for wheat-based products. Ex ante assessments have shown that many countries have potential for expanded wheat production (for example, East African highlands and southern Africa), although this must be aligned with national priorities. For example, the Government of Ethiopia has developed a policy directive and implementation framework to achieve wheat self-sufficiency. This includes substantially expanding wheat production to less-densely populated lowland areas and to the midlands as a double crop where water resources are available to support irrigated wheat. In 2021–2022, the aim is expansion of irrigated wheat on 400,000 hectares, expected to produce 1.6 million tonnes[4]. Crop switching could also be incentivized, although trade-offs on other markets would inevitably arise, for example, the switch from white maize to wheat production in eastern Africa.

Build self-sufficiency pathways. Wheat self-sufficiency can be encouraged through shifts in policy, regulation and the agri-sector that shape public and private investments, prices of agricultural inputs and outputs, and the provision of agricultural services, such as credit, logistics, education and communications. In many contexts, the basic systems needed for building self-sufficiency in wheat are underdeveloped. For example, effective wheat seed systems, to include varietal development, quality control, and seed multiplication and distribution, remain underdeveloped in countries where wheat production has persistently been low. Smallholder value chains, including those for wheat, often lack basic services and are highly vulnerable to shocks. To effectively target public support, documenting and understanding existing wheat seed systems and value chains is key, including acquiring new data and analysing performance, competition, innovation, and gender and social inclusion dynamics[5].

Expand technical support. Comprehensive technical support encompasses mechanization, crop management, input use and highly productive, disease-resistant wheat varieties with threshold grain quality. There are multiple lines of evidence that wheat yields can be increased at least twofold through improved agronomic practices in many environments[6]. High returns are achievable from modest investments (for example, sowing seeds in rows, targeted use of fertilizer, improved pest control, integration with legume crops and livestock systems, and input recommendations to meet grain-quality market specifications). With an estimated 15% of wheat grain production lost to insufficient or inadequate storage, investments targeting grain losses can take advantage of relatively low-cost infrastructure.

Monitor capacity. Satellite Earth observation offers objective and transparent real-time data on crop conditions, planted area and yield prospects across geographies and scales. Data are also pivotal for assessing production prospects, as an early warning of potential supply shortfalls, and for forecasting and targeting interventions to increase wheat production. While a major focus for satellite-driven monitoring systems is on quantifying the impact of weather, they are increasingly being integrated with more granular ground data to support global pathogen surveillance activities. This will be increasingly important as expanded wheat production areas and shifting trade routes elevate the risk of pathogens appearing in new territories. Several new initiatives are building capacity to promote extensive pest and pathogen monitoring, capitalizing on new technologies including artificial intelligence, phone-based software and cloud-based surveillance to conduct surveillance and provide forecasting. Building on this, a genomics-based system (using genotyping and/or sequencing methods to screen for quarantine pathogens) for threat surveillance in wheat grain imports could be effectively implemented at the point of entry. Investments in satellite technologies now allow access to weekly images to 10 m resolution across the globe, allowing the mapping of croplands on an annual basis. Commercial providers also now offer daily revisit products at 3 m resolution as well as sub-metre products. It can be expected that the resolution, revisit time, cost and spectral bands available will further improve in future. In combination with machine learning and ground truthing, initiatives such as WorldCereal (esa-worldcereal.org) are using remote-sensing products to map global wheat areas at high resolution and to develop automated systems to generate these products for every cropping cycle.

Transition to system-level resilience

Mitigating food shocks in the short-term and stabilizing wheat supply in the medium-term will not adequately protect the world from risks to food and nutritional security. In parallel, a transition towards long-term agri-food system resilience requires strategies to enhance overall agroecosystem diversity, address gender disparities and sustain investment in agricultural development.

Enhance agroecosystem diversity. To reduce risks and buffer shocks, it is necessary to balance sufficiency in wheat production with climate change mitigation, more resilient agroecosystems, and sustainable management of biodiversity and natural resources. Expansion into unused or under-utilized land presents risks, and decisions should involve careful attention to the role these spaces play in biodiversity conservation, carbon sequestration and other ecosystem services. Previous work has shown that protecting the 30% of land most important for conservation globally can secure 60% of global biomass and soil organic carbon, reduce by 88% the extinction risk of terrestrial plants and vertebrate species, and maintain 65% of clean water provision[7]. Intensification is probably necessary to respond to the current crisis, but long-term resilience will depend on further exploration of conservation-based agricultural technologies.

Recognize gender disparities. The food price spike of 2008 exposed women's vulnerabilities, including limited control over response decisions, heavier than normal workloads and tendency to forgo food so that other family members can eat[8]. Policy responses to the current crisis also have important gender implications. Flour blending can change processing and cooking times, with implications for women's time allocations to these tasks, as well as to fuel collection. New tensions could arise within the household if men were to take greater control over wheat production in response to perceived market opportunities, as has been witnessed in other contexts[9]. Gender-responsive design and monitoring of solutions will be needed, at a minimum, to ensure that food price spikes and policy and programmatic responses do not negatively affect women. Gender-intentional solutions are needed to actively address women's barriers to entry into growing wheat markets.

Invest in agri-food transformation. Agricultural research has been essential to constraining the number and severity of food crises, yet knowledge and technology needs are extensive across production systems, value chains and monitoring systems. Investments are required in the science of agriculture as well as the science of effective policy interventions to mitigate and manage food system risks, especially the risks to staple cereal crops such as wheat, as well as trade-offs with environmental, gender and livelihood goals. In the longer term, ensuring food security requires a renewed emphasis on larger-scale investments in seed development, mitigating and adapting to climate change, reducing losses pre- and post-harvest, and increasing the efficiency and resilience of food systems.

Conclusions

As the current crisis unfolds, international attention is focused on the many supply-related effects that compound existing failings and inequalities of the global food system, which were amplified by the COVID-19 pandemic. We may again see civil unrest as witnessed during the 2008 food crisis. The war in Ukraine and trade sanctions are triggering a level of volatility that could easily overwhelm existing mitigation mechanisms. The top priority must be to mitigate near-term food security crises through increased production and demand-side interventions supported by appropriate policy incentives (such as price guarantees and subsidized agricultural inputs). Demand-side interventions that conserve grain stocks for human consumption and shift to lower-cost flour blends can also improve food insecurity in the short term. Beyond this, we see opportunities for expanding wheat production into new locations that have comparative advantages, for optimizing seed systems and other requirements of local wheat production and supply, and for establishing wheat-production monitoring capacities. In parallel, a transition to agri-food system resilience will require balancing food supply needs with imperatives for climate change mitigation and adaptation, gender equity, nutritional sufficiency and livelihood security. ❐

Alison R. Bentley[1]✉, Jason Donovan[1], Kai Sonder[1], Frédéric Baudron[2,3], Janet M. Lewis[1], Rachel Voss[4], Pieter Rutsaert[4], Nigel Poole[5], Sophien Kamoun[6], Diane G. O. Saunders[7], David Hodson[1], David P. Hughes[8], Christine Negra[9], Maria Itria Ibba[1], Sieglinde Snapp[1], Tesfaye Shiferaw Sida[10], Moti Jaleta[10], Kindie Tesfaye[10], Inbal Becker-Reshef[11] and Bram Govaerts[1,12]

[1]International Maize and Wheat Improvement Center (CIMMYT), Texcoco, Mexico. [2]International Maize and Wheat Improvement Center (CIMMYT), Harare, Zimbabwe. [3]University of KwaZulu-Natal, Pietermaritzburg, South Africa. [4]International Maize and Wheat Improvement Center (CIMMYT), Nairobi, Kenya. [5]SOAS University of London, London, UK. [6]The Sainsbury Laboratory, Norwich, UK. [7]John Innes Centre, Norwich, UK. [8]Current and Emerging Threats to Crops Innovation Lab, The Pennsylvania State University, Pennsylvania, PA, USA. [9]Versant Vision LLC, New York City, NY, USA. [10]International Maize and Wheat Improvement Center (CIMMYT), Addis Ababa, Ethiopia. [11]Department of Geographical Sciences, University of Maryland, College Park, MD, USA. [12]Cornell University, Ithaca, NY, USA.

✉*e-mail: a.bentley@cgiar.org*

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Author contributions

A.R.B., J.D., K.S., F.B., R.V., P.R., N.P. and B.G. conceived and designed the work. A.R.B., J.D., K.S. and F.B. produced the primary content and analysed the data presented. J.D., K.S., F.B., D.P.H., I.B.-R. and B.G. contributed materials and analysis tools. All authors wrote and reviewed the paper.

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S.K. receives funding from the agricultural biotechnology and seed industry, and has filed patents in the area of plant health. All other authors declare no competing interests.

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