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OPINION

Addressing another threat to food safety: Conflict

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Societal Impact Statement

The conflict between Ukraine and Russia will negatively affect not only food security but also food safety. Crops produced in Ukraine and Russia are at little risk of contamination by mycotoxins such as aflatoxin. However, due to the conflict, wheat, maize, sunflower, and other crops that would have been produced in and exported from Ukraine will need to be produced somewhere else. If done in warm production areas, strategies will need to be implemented to prevent mycotoxin contamination, which has negative health, social, and economic impacts.

Summary

Conflicts across the globe affect food security and also have a heavy toll on food safety. Many of the areas affected by conflict are breadbaskets for multiple countries. When the production of staple crops is compromised by diverse conflicts, it becomes necessary to grow them somewhere else to satisfy local, regional, and/or international requirements. However, if that production is done in tropical and subtropical zones, it must be done incorporating strategies to prevent mycotoxin contamination, which has negative health, social, and economic impacts. Otherwise, increased production of susceptible crops in mycotoxin-prone areas may augment the already occurring negative impacts, which are severe in the global south.

KEYWORDS
conflict, food safety, food security, mycotoxins, trade

1 | HOW DOES CONFLICT IMPACT FOOD SECURITY?

Attaining food security is a global concern in the face of multiple challenges: climate change (earth.org, 2022) (e.g., the recent, dramatic floods in Pakistan have disrupted food production in the region [World Food Programme, 2022]), COVID-19 disruptions (IFPRI, 2022), and conflict. To date, several countries across the globe, unfortunately, are affected by diverse conflicts in multiple regions of their territories: Ukraine, Ethiopia, Sudan, Somalia, Mali, Nigeria, Mozambique, Afghanistan, Palestine, Mexico, and Haiti, among others. Such conflicts are preventing the full potential of food production from being achieved, and this results in severe repercussions, which transcend frontiers (Shemyakina, 2022). For instance, the conflict in Ukraine is affecting many countries that usually import significant amounts of crops produced in Ukraine and Russia (Bentley, 2022; Our World in Data, 2022). Many of the importing countries are already food insecure, including many in Africa (e.g., Somalia, Ethiopia, Nigeria, Benin, Sudan, and DR Congo; Figure 1) that rely heavily on wheat from Ukraine and Russia (UNCTAD, 2022). Large quantities of wheat, maize, and sunflower from Ukraine are no longer reaching most importing countries because of the stalemate in agricultural production and/or trade; only a small fraction of the crops usually exported have left Ukraine since the conflict began (Al Jazeera, 2022). The importing countries will therefore need to locally produce those crops, if possible, or buy them from other countries, if available, to

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FIGURE 1 Populations in most African countries rely on wheat from Ukraine and Russia to achieve food security. With shortfalls because of conflict, consumers in affected countries must increase intake of other staples. This may increase exposure to dangerous mycotoxins if appropriate measures are not implemented. Two ladies in Gezira, Sudan, winnowing sorghum grains collected from the ground to meet the dietary needs of their families (a). Farmers in Oyo, Nigeria, winnowing maize to store it in the safest way possible (b). Photographs: Alejandro Ortega-Beltran (a) and Ranajit Bandyopadhyay (b)

avoid further food insecurity. Of course, this may result in higher food prices, and poor countries may be unable to produce and/or buy sufficient food. Some opine that enough reserves exist to cover the shortfalls (Tollefson, 2022); however, even if sufficient reserves are available, it will be a challenge to supply them in time. Alternatively, affected countries will have to increase local production of other staples (e.g., potato, groundnut, cassava, and sorghum; Figure 2). If shortfalls in global food production are met by increasing production in tropical and subtropical agricultural areas, strategies will be required to deal with the resulting complex spillover problems such as mycotoxins, which have potential health, social, and economic negative impacts (Logrieco et al., 2018; Matumba et al., 2021).

2 | HOW DOES CONFLICT IMPACT FOOD SAFETY?

Mycotoxin contamination of staple crops (particularly aflatoxin and fumonisin, produced by *Aspergillus* and *Fusarium* spp., respectively) is common in tropical and subtropical areas (Figure 3) and, regrettably, often overlooked (JECFA, 2018). The contamination causes many untoward impacts/effects that seriously affect health, trade, and income. About 25% of crop products globally and an estimated 40% in many African countries are contaminated with mycotoxins above legal limits (Eskola et al., 2020). From a food safety perspective, an advantage of growing wheat, maize, and sunflower in Ukraine and Russia is related to their prevailing climate, which is unfavorable for crop contamination by some of the most dangerous mycotoxins, particularly aflatoxins, which are among the most toxic substances found in nature. Thus, the production of those staples in Ukraine and Russia is extremely important; the populations of countries that import their crops from this region are, in principle, less exposed to aflatoxins. On the other hand, several staple crops produced in tropical areas—especially those produced by subsistence farmers—are commonly contaminated with mycotoxins. Technological, institutional, and policy challenges result in frequent mycotoxin contamination and chronic exposure (Ortega-Beltran & Bandyopadhyay, 2021). The reduction in crops coming from Ukraine and the increased production of

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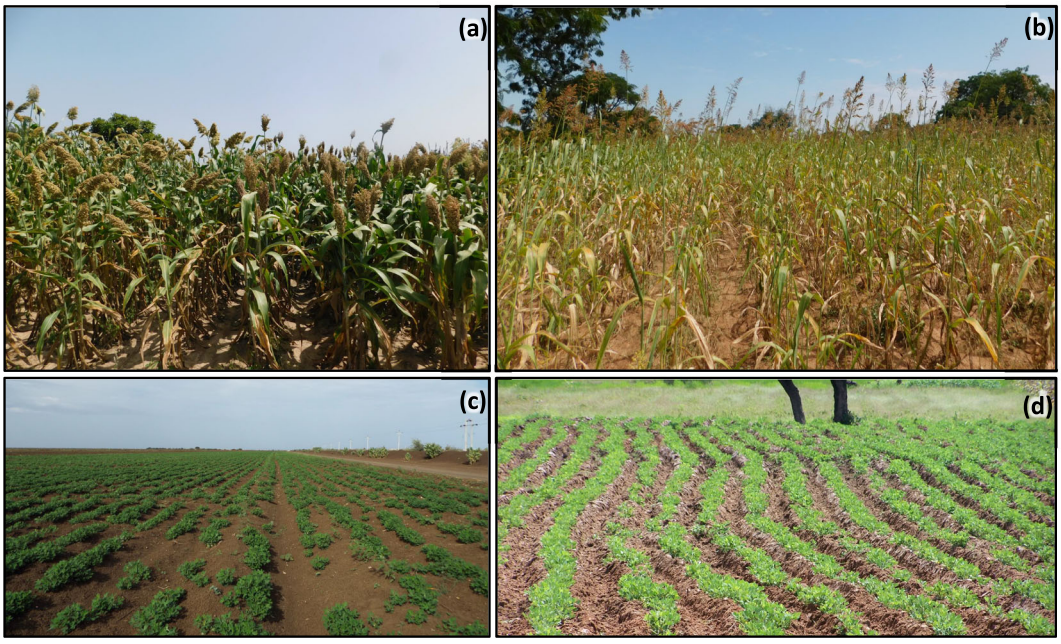

FIGURE 2 Reduced imports of wheat and maize from Ukraine and Russia will push affected countries to increase local production of other staples such as improved (a) or landrace (b) sorghums, or groundnut (c,d). In low- and middle-income countries, both sorghum and groundnut are greatly affected by mycotoxin contamination. Photographs: Alejandro Ortega-Beltran (a,b,c) and Ranajit Bandyopadhyay (d)

FIGURE 3 Mycotoxin contamination of staple crops is common in tropical and subtropical areas. Although the contamination may start in the field, drying crops on plastic tarps but with no sanitation practices (a), drying crops on the soil (b), or inadequate storage structures (c,d) drastically accentuate the problem. Photographs: Alejandro Ortega-Beltran (a,b,c) and Ranajit Bandyopadhyay (d)

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susceptible crops in mycotoxin-prone countries to meet shortfalls will exacerbate the mycotoxin challenges for decades. For billions of people, the food that should nourish will poison them, causing chronic or acute symptoms. The UN considers exposure to toxic chemicals a severe violation of the fundamental right to life. Repeated or continuous mycotoxin exposure seriously threatens life. Ignoring the toxins creates a barrier to meeting several sustainable development goals (Ortega-Beltran & Bandyopadhyay, 2021).

3 | NEGATIVE IMPACTS OF MYCOTOXIN CONTAMINATION ON HEALTH, TRADE, AND INCOME

Climate change is already exacerbating the mycotoxin challenge. Aflatoxins are regulated at parts per billion (ppb) and strictly legislated in high-income countries because of the immense effects of carcinogenic toxins on human health. These stringent regulatory limits demonstrate how seriously the governments of high-income countries take the prevention of human exposure to these dangerous chemicals. Reliable infrastructure, capacity to perform mycotoxin analyses, and the enforcement of regulations result in little to no mycotoxin exposure in high-income countries (e.g., European and North American countries, Australia, Japan, New Zealand, and South Korea) (JECFA, 2018). The situation is quite different in low- and middle-income countries. Therefore, plans to attain food security globally must both circumvent the three threats (climate change, pandemics disruptions, and conflict) and ensure the safety of foods and feeds prepared with crops that would previously have been produced and/or exported from Ukraine and Russia. Otherwise, increased production of susceptible crops in mycotoxin-prone areas may augment the negative impacts already occurring, which are briefly stated below and with an emphasis on African countries.

3.1 | Health

Over 30% of liver cancer cases in Africa are linked to aflatoxins. The African Union's Partnership for Aflatoxin Control in Africa estimates that annual health costs due to aflatoxin-related cancer cases in Nigeria are US$ 1600 million (m); Tanzania US$ 1100 m; Uganda US$ 577 m; Malawi US$ 393 m; Senegal US $161 m; and The Gambia US $22 m (PACA, 2015). Extremely high aflatoxin exposure results in death. Several acute aflatoxin poisoning episodes caused the death of hundreds in East Africa in the last two decades (CDC, 2004; Kamala et al., 2018). Many other poisoning events may also have occurred but gone unreported. Aflatoxins and fumonisins are also linked to stunting and immune system impairment. Fumonisins are linked to impaired brain function and esophageal cancer (JECFA, 2018). Mycotoxin exposure makes people less able to cope with diseases (PACA, 2015), which is relevant to the current COVID-19 context. The health of livestock, fisheries, and pets also becomes affected by mycotoxins, resulting in reduced productivity and/or mortality (Logrieco et al., 2018).

3.2 | Trade

Africa loses over US$ 670 m/year in export earnings due to aflatoxin. Farmers producing crops that exceed mycotoxin thresholds cannot reach premium markets or even regional markets (e.g., maize ban from Uganda and Tanzania by the Governments of Kenya and Burundi) (Kitimo, 2021). Companies lose their reputation when their contaminated products are banned; there are many examples in East Africa. Food and feed companies and breweries frequently reject locally produced crops due to high mycotoxin content.

3.3 | Income

Farmers in sub-Saharan Africa typically do not have access to organized markets (Figure 4). When they do, it is not easy for them to enter such markets as their crops frequently contain mycotoxin levels above legal thresholds, resulting in a loss of income. Livestock and fisheries producers also may lose income due to reduced productivity or increased mortality.

4 | CONVERGENCE OF FOOD SAFETY AND FOOD SECURITY PROGRAMS IS A MUST

The risks associated with increased wheat, maize, and sunflower production in areas prone to mycotoxin contamination must be adequately addressed to prevent the production of crops that do not meet food safety standards. Plans to design agro-food systems to realize their maximum potential, to meet shortfalls from breadbaskets, and to build access to markets must ensure the production of foods and feeds with the highest possible quality.

Food safety must be included in food security programs in order to cope with the concerns raised above. The importance of food safety in agri-food systems, the One Health concept, trade and income, and poverty reduction cannot be overemphasized. Although challenging, food safety can be protected using integrated strategies converging policy, institutional, and technical innovations. Significant progress has been made by the International Institute of Tropical Agriculture [IITA; a Consultative Group for International Agricultural Research (CGIAR) organization] and partners to develop technologies to reduce mycotoxin contamination (Bandyopadhyay et al., 2022). Integrated mycotoxin management strategies (composed of sound pre- and post-harvest interventions, extension services, mycotoxin testing, improved storage, and access to markets, among other practices; Figure 5) are resulting in safer food, improved health, and greater income in various African countries [e.g., AgResults Aflasafe Project in Nigeria (Abt Associates, 2022)]. However, their implementation must be accompanied by appropriate support from the trade, health, and policy sectors with close links to the agricultural sector, both public and private. Additionally, time, context-specific innovations, and perseverance are required, since their implementation is generally slow and positive impacts of decreased aflatoxin

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FIGURE 4 Groundnut being dried prior to being offered to consumers in a local, unregulated market, which abound across sub-Saharan Africa. Crops offered in this type of market are very difficult to regulate for food safety parameters, including mycotoxin content. Photograph: Alejandro Ortega-Beltran

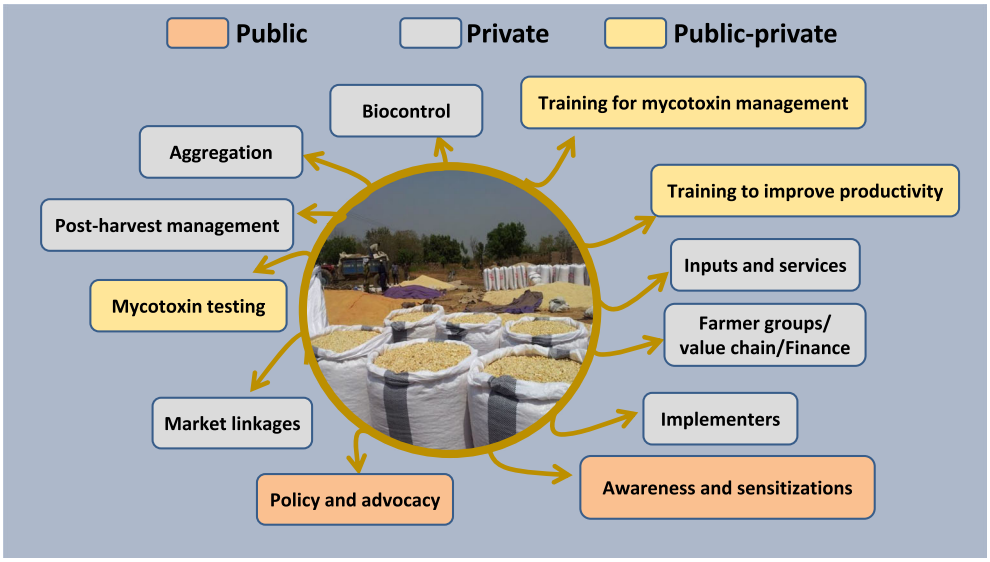

FIGURE 5 Integrated mycotoxin management strategies converging public, private, public–private sector efforts can result in reduced mycotoxin contamination, improved health, and greater income. Such strategies must be context-specific and composed of sound pre- and post-harvest interventions, extension services, mycotoxin testing, improved storage, and access to premium markets, among other actions/ options.

contamination and exposure are perceived in the medium- to long-term. However, there is no time to lose. One CGIAR Plant Health Initiative is implementing integrated mycotoxin management systems coupled with traceability to reduce incidences and severities of contamination in areas continuously suffering from mycotoxin contamination. This is resulting in hundreds of thousands of tons of mycotoxin-compliant crops (CGIAR, 2022a). Other One CGIAR initiatives are also scaling technologies to address climate change (CGIAR, 2022b) and mitigate the effects of COVID-19 (CGIAR, 2020) and are designing strategies to avert the effects of the conflict on global food security (CGIAR, 2022c). Of course, there are several other interventions, concepts, and initiatives developed by various institutions that can greatly protect food safety such as the Dry Chain (Bradford et al., 2018) or the European Green Deal (European Commission, 2019). In short, options for farmers are already available or can be quickly adapted to locally produce safe crops in sufficient quantities. It is high time all possible technical, institutional, and policy solutions are converged to prevent crises of food security, food safety, and malnutrition. This has been repeatedly stressed for decades.

5 | CONCLUSIONS

Evidently, the conflict in Ukraine is having negative repercussions on food security and food safety in African countries. Similarly, conflicts in any other region also affect food safety, in addition to food security, locally, regionally, and internationally. Farmers in conflict-affected areas may be unable to tend their crops, and there may be delayed harvests and/or poor storage leading to more mycotoxin contamination. For example, in Ukraine, about 20 million tons of crops are stored, and there is limited storage space for new crops already being harvested (NY Times, 2022); both previous and current season crops in

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Ukraine are at risk of spoilage. Conflict can impede the proper delivery of extension services and mycotoxin-reducing inputs (e.g., biocontrol products and hermetic bags) to farmers. Furthermore, unsafe conditions may affect grain transport, leading to poor grain quality with higher mycotoxin contamination. We hope that programs aiming to increase food security (both in nonconflict and conflict zones) will also ensure food safety, to doubly improve economic growth, market diversification, gender equality, decent job creation, technology transfer, and private sector linkages and to tackle climate change. Integrated food safety management can contribute to the fulfilment of the objectives of such programs. Coping with the three threats—climate change, pandemics, and conflict—will require more than obtaining higher yields. Technologies to obtain higher yields should be accompanied by measures that will enable farmers to provide the necessary high-quality, safer food to nourish themselves and consumers.

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CONFLICT OF INTERESTS

The authors declare no competing interests.

AUTHORS CONTRIBUTION

Alejandro Ortega Beltran and Ranajit Bandyopadhyay conceptualized the idea and wrote the manuscript.

DATA AVAILABILITY STATEMENT

Data sharing not applicable to this article as no datasets were generated or analyzed during the current study.

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