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Modeling impacts of food and fertilizer trade disruptions on global food security

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Geopolitical tensions are increasingly affecting global trade in food and essential agronomic inputs such as fertilizers. This imperils food production and security in import-dependent countries. Major disruptions, such as armed conflicts or the formation of isolated political blocs, are expected to further disrupt bilateral trade as countries tend to save resources for their own populations or because of the destruction of trade infrastructure. Countries not directly involved in such conflicts may also choose to stop exporting and start stockpiling products as a precautionary measure. This will create a situation where the global trade network will be fragmented.

This study estimates the consequences of such trade disruptions on fertilizer supply and food security through network analysis and statistical modeling using global data on food and fertilizer trade, fertilizer inputs, and crop yields. We consider several hypothetical scenarios, including a military conflict between major military alliances, political separation into major (emerging) blocs, economic scenario, where the world is divided into Global North and Global South, and stochastic scenarios that model probable division into groups based on the structure and intensity of historical trade between partners through community detection in graphs. A first prototype considers major staple crops: rice, wheat, maize, potato, and cassava.

The results demonstrate that in the event of a political, military, or economic separation that disrupts trade, Non-Aligned and Global South countries will experience dramatic reductions in the availability of certain critical crops and fertilizers, with losses of more than 25 percent compared to uninterrupted supplies in 2022. In the military scenario, Non-Aligned nations will be most sensitive to the decline in maize, wheat, and fertilizer, while in the political scenario, access to maize, potatoes, rice, and wheat will be problematic. The economic scenario shows drops in availability of maize, rice, cassava, wheat, and fertilizer for the Global South block. Military alliances, political blocs, and Global North countries have limited supplies of at least two critical crops in every scenario, but their losses are less disruptive (excluding cassava, which is expected to decline by 95 percent in the Global North). For all groups of countries, the drops in food supply are compounded by a further reduction in expected agricultural output due to the loss of fertilizer supplies. Stochastic network simulations generally provide more balanced scenarios as they are based on interwoven historical trade data. Further research will refine the results using process-based crop modeling and explore scenarios for improving the resilience of the global food system.