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Short Communication

Global food security in the context of COVID-19: A scenario-based exploratory analysis

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Abstract

This study highlights the major players in the global food balance, potential implications of COVID-19 on global food supply, and SDG-2 (zero hunger). It found that developing countries, fifteen from Africa followed by ten from Latin America, six from Oceania, and four from Asia, are the most vulnerable to changes in cereal supply shocks. It concludes that the current pandemic is likely to cause transitory food insecurity across such vulnerable countries. The effects of the pandemic on food security (SDG-2) may persist longer as a combined effect of economic slowdown and increase in poverty, limiting food supply and access beyond 2020.

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1. Introduction

Although arguably the world has enough food to feed everyone, food supply and distribution is not even in space and time. Globally, average diets supply 2881 kcal/person/day against the average dietary energy requirement of 2353 kcal/person/day [4]. At both macro- and micro-levels, regions periodically experience food shortages due to unfavorable conditions for food production, environmental degradation, and labor or supply chain disruptions due to extreme weather, economic crises, conflicts/insecurity, sanctions, and health shocks including epidemics [8]. Climate change impacts such including droughts, floods, heatwaves, and cold spells can also exacerbate pressures on food production and food security [20,21]. For example, Lesk et al. [14] estimate that, globally, droughts and heatwaves combined could cause an approximate 10% decrease in national-level crop production. According to the Global Report on Food Crisis 2020 [8], extreme weather events in 2019 significantly affected food security in the Horn of Africa, Southern Africa, Central America, and Pakistan, while continuing economic crises in Venezuela, Haiti, Sudan, and Zimbabwe continue to influence food security in those nations. Armed conflicts and political instability were reported as primary drivers of food insecurity in the Middle East, and several Asian countries, as well as in the Lake Chad Basin and Central Sahel regions.

Global food supply chains are extremely complex in nature. Potential disturbances in food supply chains can be caused by a range of factors: alterations in the drivers of supply-side components of food balance, e.g., production, stocks, international trade as well as demand-side components, e.g., consumption patterns and population growth in combination affecting overall food supply. Supply-side components play an essential role in ensuring global food security. But what if food production decreases or food stocks becoming widely depleted or if international trade reduces across the world due to a rise in more protectionist policies? Such a situation is unlikely, but if such a scenario did occur, it may have potentially severe repercussions to food supply in food import-dependent countries and worsen food supply in countries that are already suffering from severe food shortages. Poorer countries would be likely to suffer disproportionately, just as the socio-economic impacts of the 2020 Covid-19 pandemics are predicted to hit lower-income countries more severely than elsewhere. According to Sen's entitlement approach, famines are driven by distributional dynamics and socio-economic problems rather than food availability problems [17].

International trade as part of distribution or supply chains is one of the significant components of food balance; if this is affected by any form of global shock, it could have severe and long-lasting impacts on food security. Traditionally, potential drivers of changes in international trade are dominated on the negative side by trade barriers or restrictions imposed by countries to control prices and on the positive side by trade agreements designed to ensure domestic food supply [5]. For example, during the world food crisis of 2007–2008, of a sample taken of 105 countries, 33 adopted food policy restrictive measures [18]. Trade restrictive
measures are also a typical outcome of Public Health Emergencies of international concern; for example, the Ebola outbreak during 2014–2016, known as the West Africa Ebola Epidemic, significantly affected the private sector, agricultural production, and trade [2].

2. Factors affecting food security in the context of COVID-19

The December 2019 outbreak of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) is the result of the wide and rapid spread of a viral strain that causes severe respiratory illness, named coronavirus disease 2019 (hereinafter COVID-19). COVID-19 was declared by the World Health Organization (WHO) as a global pandemic on 30 January 2020. Until the WHO declaration, the potential impacts of COVID-19 at a global scale was only speculated upon, and it is arguable that many nations were unprepared for the subsequent rapid spread of the pandemic. The decision of individual governments on COVID-19 crisis management/emergency response and the variation in the applications of ‘the four Cs strategy’ (Cognition, Communication, Coordination, and Control) remains the predominant approach in the face of the global pandemic – the first to hit in the Technological Age [16]. In efforts to minimize public health vulnerability through reduction to exposure, countries across the world exercised a variety of legislative approaches, often involving emergency laws and powers, to impose lockdowns in domestic and international travel restrictions, curfews and limited availability of services, with the aim to stop spread of COVID-19 at the community level. In addition to travel restrictions, strict imposition of international trade restrictions and movements of raw material exacerbated the adverse impacts at a range of scales - from local to global – on both production and trade ([6,7,12]). Due to widespread labor shortages (both local and migrating workers alike), a significant impact of these lockdowns in different parts of the world will be on food-related activities such as the timely seasonal production and movement of raw agricultural and livestock products mostly in the areas which are intensive in food production and depend on agriculture labor. The reverse migration is likely to cause an increase in the labor availability for local agriculture and allied activities (where people have returned from high labor demand areas). However, the increased availability of laborers for local skilled or unskilled employment in agriculture will limit their income from agriculture, which has a high dependence on natural resources to generate low-value products. On the other hand, the areas which are intensive in agricultural labor demand for agricultural field works, post-harvest activities, managing livestock, fishing, in marketing, and the creation of agricultural infrastructure is likely to experience labor shortages. The potential outcome is a perceivable impact on global food supply. Due to the uncertainties of synergistic, or worse, cascading effects of COVID-19 on food supply (availability) and associated components of food security (Fig. 1), countries are likely to respond in the form of stock procurement, protectionism and international trade restrictions.

COVID-19, therefore, represents an unprecedented public health crisis, which has triggered significant economic slowdown, threatens food production, and has the potential to result in global supply shocks. These effects, along with unilaterally imposed trade restrictions in major producer countries, may have significant repercussions for food security in trade-dependent nations. These impacts could affect global supply chains through 2020 and beyond. In this perspective, we hypothesize that potential production shocks and trade restrictions due to COVID-19 will decrease per capita food supply in often vulnerable, import-dependent countries (ESM S1 Fig. S1–1). We assume that synergistic drivers of supply and demand, including COVID-19 with other externalities, are likely to impact international food trade. We highlight potential implications of COVID-19 combined with other externalities on global food supply using scenario-based exploratory analysis identifying countries most vulnerable to food supply shocks and on UN Sustainable Development Goal 2 (SDG-2: zero hunger goal).

3. Implications of COVID-19 for global cereal supply

The top ten major exporting countries account for 70% of the global cereal export and 45% of global cereal production (ESM S1 Table S1–1). The USA is the largest exporter of cereals, accounting for about 16 and 18% of the share in world cereal production and export, respectively. Although China is the largest producer of cereals in the world (21% of global cereal production), it is one of the top ten cereal importers at the same time. Production shocks and trade restrictions on key players in global food trade will have particularly significant impacts on import-dependent countries. In 2020 alone, COVID-19 induced economic recession is forecast to cause a 24.8% decrease in agri-food exports [13]. As COVID-19 cases continue to rise, so too are the number of nations imposing trade restrictions. As of 5 May 2020, more than 2 million COVID-19 cases have been reported, and 29 countries have imposed restrictions on food exports, resulting in a ~ 5% decrease in global calorie markets [10,12]. For example, Eurasian

Fig. 1. Potential factors likely to affect macro-level food security and progress towards SDG-2 targets in the context of the 2020 COVID-19 pandemic.
Economic Unions have banned certain types of food exports, Indian traders suspended signing new contracts for rice exports, and Myanmar suspended issuing rice export permits. Vietnam is controlling the quantity of rice exports, the Russian Federation has limited quotas for wheat and other cereal exports, Ukraine is controlling wheat export shipments, Sudan has banned maize, and sorghum exports and several other countries have imposed trade restrictions, mainly to secure domestic supplies during and after the COVID-19 pandemic [11]. The latest updates on COVID-19 temporary trade measures are available from Laborde [12] and IFPRI [10]. Countries have taken such stricter measures on food exports in order to secure domestic food supply in case of preliminary impact assessments are complex and prone to uncertainties, a scenario-based analysis such as provided here can highlight major implications for global food security.

Scenario-based change in countries’ domestic food supply (here, cereals) are given in the Electronic Supplementary Materials (ESM S1). At the global level, cereal supply (excluding those used for beer) was ~463 kg/person/year during the period 2014–17. However, the range varied markedly – from 38 to 1447 kg/person/year from the Central African Republic (minimum) to Denmark (maximum). Denmark and the USA both have above 1000 kg/person/year domestic cereal supply, while most countries from sub-Saharan Africa had cereal supplies of well below 160 kg/person/year (Fig. 2a). Thirty-seven countries had above the world-average cereal consumption, which reflects increases (in 50 countries) and decreases (in 87 countries) after adopting Scenario 1 (grouped as Class I and Class II, respectively in Fig. 3). For a description of methods for scenario generation, see ESM S1.

Under scenario 1, where domestic cereal supply was above global average consumption in 12 Class III countries, this subsequently dropped, worsening their food security. Domestic cereal supply dropped below global average consumption in 24 other (Class IV) countries before and after scenario 1. 36 developing countries (15 from Africa, ten from Latin America, six from Oceania, four from Asia and one from Europe) showed a decrease...
in domestic cereal supply under scenario 1, falling into Class III and IV (Table 1). The analysis highlights the most vulnerable countries to supply shock, mainly, in the form of trade restrictions (scenario 1: Fig. 2(b) and ESM S3). Similar patterns were observed with other modeled scenarios for changes in components of the global food balance (ESM S4-S7). Although major producers of cereals (Class I) saw increase in domestic cereal supply, COVID-19-induced trade restrictions could have severe impacts on agricultural income and GDP in those countries due to reduction in international trade. Class II countries were seen as resilient to supply shock; although their supply decreased, cereal consumption remained well above the global average. Class III and IV countries (36 developing countries) were identified as the most vulnerable to cereal supply shocks, and particular attention should be given to secure their food security during 2020 and beyond, i.e., better achieving SDG-2. Classification of countries after adopting scenario 1 related changes in major commodities of world food consumption are given in Table 1.

### Table 1

| Major commodity types          | Classification |
|-------------------------------|----------------|
|                               | Class I | Class II | Class III | Class IV |
| Cereals (food)                | 50      | 87       | 12        | 24       |
| Starchy roots, Other roots    | 21      | 50       | 3         | 53       |
| Sugar crops                   | 11      | 78       | 1         | 30       |
| Pulses                        | 0       | 46       | 9         | 54       |
| Vegetable oils, Vegetables    | 29      | 104      | 0         | 0        |
| Meat                          | 0       | 57       | 2         | 52       |

*Note: See ESM S1 for class descriptions and analyzed data; Total countries considered in the analysis are 175. However, due to missing data, the total of all classes in the respective commodity group is equal to or less than 175.*

## 4. Implications of COVID-19 to SDG-2 progress

Universal access to sufficient quantities of food produced sustainably is key to better achieving SDG-2. The United Nations Economic and Social Council [22] reporting in 2019 on progress towards SDG-2 raised concern regarding the increase in the number of undernourished people from 784 million in 2015 to 821 million in 2019, and decreased government spending on agricultural aid. COVID-19 impacts on food security (in the form of the factors summarized in Fig. 1) are expected to persist beyond 2020. At this time of writing of this article, pandemic-related food insecurity can be classified as transitory food insecurity (i.e., short-term and temporary). Transitory food insecurity is relatively unpredictable yet can be both sudden and chronic (long term/persistent) [3]. The 2020 Global Report on Food Crises (GRFC) [8] reports that ~135 million people in 55 countries and territories analyzed (more than half in Africa) were experiencing acute food insecurity in 2019 (i.e., before the COVID-19 crisis hit). One of the major responses of countries across the world to the health crisis is to prioritize ensuring their own food supply [11]; this is expected to threaten global food security, but disproportionately impact food import-dependent countries most prone to the effects of trade restrictions. In response to this, FAO announced an Advisory [6,7] for countries to resist imposing pre-emptive export restrictions as a typical policy response to the health crisis, as this risked an associated food crisis.

By 2030, the cereal commodity composition of food consumed by the developing countries is estimated to be 159 kg/person/year (global average 160), and cereals for all use is estimated to be 254 (329) [1]. However, the
countries identified as highly vulnerable (Class III and IV) are mostly developing countries with domestic cereal supply (excluding beer) of only 38 to 153 kg/person/year, and with highly variable supply under scenarios adopted for our analysis (Fig. 4a-j). Results presented here show gaps in domestic supply of cereals of 101 to 216 kg/person/year—mostly in sub-Saharan Africa. In South Asia, particularly in India and Pakistan, domestic cereal supply was found to be 210 and 178 kg/person/year respectively under scenario 0, with between 6 and 10 kg/person/year absolute growth under scenario 1 as these countries are significant cereal exporters. Yet, cereals consumed as food in these countries remains far below the global average. According to the World Hunger Index 2019 [9], the hunger situation in sub-Saharan Africa was classed as ‘extremely alarming’ in the Central African Republic, ‘alarming’ in Yemen, Chad, Madagascar, Zambia, and Liberia, and ‘serious’ in other sub-Saharan African countries. Countries from South and South East Asia (Afghanistan, India, Pakistan, Lao PDR, Cambodia, Indonesia, and the Philippines) had a ‘serious’ hunger situation. The majority of the population in these countries are engaged in informal sectors such as agriculture and daily-waged activities [9]. The COVID-19 pandemic is expected to increase global poverty unevenly, setting back progress made over the past decade on reducing poverty [19], directly affecting progress towards the achievement of SDG-2.

5. Conclusions

COVID-19 is causing severe disruptions in local to global level food supply chains in a way that our globalised world has never before experienced. Although the pandemic and associated direct and indirect impacts assessment are characterised by complexities and uncertainties, the scenario-based analysis provided here gives insights into implications for global food security in the form of changes in the components of food balance. In this analysis, the majority of the developed world is found to be resilient to food supply shocks. Although major producers of cereals show increases in domestic cereal supply, COVID-19-induced trade restrictions could have severe impacts on their agricultural income and GDP due to reduction in international trade and prices.
Our analysis shows import-dependent nations (mostly developing countries) to undergo decrease in domestic cereal supply under trade restrictions. These are the nations most vulnerable to cereal supply shocks. African countries are the worst prepared for the pandemic [15]. Several of these are already experiencing chronic food insecurity and could face a food crisis as a result of the cascading effects of COVID-19 (both within countries and at regional levels). Responses made by governments to prevent the spread of the disease within these countries (mostly import-dependent developing nations vulnerable to food supply shocks) are likely to further disrupt their food supply chains. Therefore, particular attention should be given to secure their food security during 2020 and beyond. Investments in relief and humanitarian assistance are likely to be necessary to help to mitigate the worst effects of the pandemic. At the same time, longer-term initiatives boosting households’ purchasing power and encouraging diversification of trade options should be given priority in different governments’ public policy agendas.
Declaration of Competing Interest

None.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.pdisas.2020.100120.

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