Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

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Deciphering the impact of COVID-19 pandemic on food security, agriculture, and livelihoods: A review of the evidence from developing countries

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ABSTRACT

With COVID-19 now spreading in developing countries, massive consequences on health and livelihoods are feared. Food security is the most important and crucial aspect of sustainable development. The agricultural sector forms the backbone of the economy and provides livelihood to a large section in developing countries. Therefore, the disruption in food security and the agricultural sector will have far-reaching impacts on these countries. Owing to the importance of these sectors, this paper performs a comprehensive assessment of the effect of COVID-19 on food security and agriculture. The research suggests coping and mitigation mechanisms that can be adopted to sustain livelihoods.

Contents

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1. Introduction

Our planet has a long history of exposure to fatal health crises and pandemics. These crises are mostly the result of an unprecedented disaster, which has forced people to compromise on their existing lifestyles. The COVID-19 pandemic is getting worse day-by-day, with interruptions in human activities, a huge death toll, and a direct hit on the global economy. Saqr and Wassan (Saqr and Wasson, 2020) argued that the wreaking havoc due to COVID-19 is not a surprise since pandemics viz Spain flu, Polio, HIV, Severe Acute Respiratory Syndrome (SARS), Zika, the Middle East Respiratory Syndrome (MERS), and Ebola are the recent realities of the modern world. Adda (Adda, 2016) reported that in the past century, death due to viral diseases was far more than the major armed conflicts. For instance, at the beginning of the last century, Spain flu was one of the worst catastrophic pandemics, which led to a loss of 50 million lives worldwide. In the previous pandemics, the risks were reduced as travel and urbanization were not as pronounced as today and therefore, the infection could not spread as it can today.

In December 2019, the novel Corona Virus Disease, which was later named "COVID-19" after World Health Organization (WHO) had categorized it as a pandemic, was initially reported in Wuhan city, China (Chakraborty and Maity, 2020). Since then, it became an epidemic and widely spread to other provinces in mainland China (Muhammad et al., 2020). Subsequently, several cases were confirmed in neighboring countries like Thailand, Japan, Singapore, and South Korea (Huang et al., 2020). Six weeks after the first case was confirmed, WHO declared COVID-19 as a pandemic and an international concern that needed public health emergency (Tay Juhana Foundation Brief Indonesia, 2020). However, the pandemic quickly spread and became a challenge for medical facilities especially in southern Europe and North America. Failure to take lessons from previous disasters, laxity to adopt too early preparedness from warnings by health organizations and scientists, globalization, and highly interconnected living systems are believed to trigger the pandemic spreading and impacts (Saqr and Wasson, 2020). As per the reports, in the second week of September 2020, more than 28 million confirmed cases with more than 20.5 million recoveries and more than 900 thousand deaths have been recorded globally, of which the USA shared the largest number, followed by India, Brazil and Russia (World Health Organization, 2020).

As the world becomes more interconnected to each other as a global village, it is more likely that all countries would be vulnerable to this health disaster. Therefore, failure to prevent the pandemic in one country means the whole world is exposed as well. The aftermath of a pandemic has not only negatively affected the health sector, rather it has resulted in distressing economic, social, and political crises that will lead to deep scars if it is not contained in time. The situation is dire and exacerbated in the developing countries where meeting the basic livelihood needs of a majority of the population who are underprivileged is impossible. A recent report by the United Nations Sustainable Development Goals (UNSDGs) (United Nations Sustainable Development Goals, 2019), noted that 55% of the global population with a majority from developing countries do not have access to social protection. This vulnerability will aggravate socio-economic losses whose effects will spill to human rights and educational sectors in addition to depriving the poor and marginalized food and proper nutrition.

The COVID-19 prevention measures such as lockdown, stay-at-home order, mass quarantine, and transport halt are highly challenging in those societies. Many developing countries imposed a short state emergency when the first case was confirmed. The movement of imports and exports is becoming slower or even stopped in some cases. During this economic crisis, the countries have to depend on emergency packages, which might not be adequate to cushion them and their vulnerable population. The transport sector has also halted operations owing to lockdown imposed in several countries and this has disrupted the supply chain for essential goods, especially food (Reardon et al., 2020) and humanitarian aid donated by different agencies.

Although the levels of implementing these measures vary, their effects in controlling COVID-19 has been considerably successful. However, a comprehensive assessment of the pandemic's impacts in the developing world is missing. Given these facts, we highlighted the effects of COVID-19 on sustainability, particularly concerning food security and agriculture in the developing world. Additionally, the authors attempted to provide possible mitigation and coping mechanisms.

2. Sustainability and exposure to the pandemic

United Nations has set seventeen development strategies aimed at improving the life quality of people living in different parts of the world, commonly referred to as Sustainable Development Goals (SDGs), to be achieved by 2030. SDGs comprise basic agendas that will lead to the development of various aspects of life which was initiated in 2015. The COVID-19 poses a potential threat to retard or even undo the progress achieved towards all SDGs. The two food-security dependent goals (i.e. SDG 1- "No Poverty" and SDG 2- "Zero hunger") will be hit hard during the lockdown period imposed by governments to contain the spread of the virus, particularly in developing countries. The World Food Program (WFP) estimated that 265 million individuals could be affected by acute food insecurity by the end of 2020, which is an increment from 135 million individuals before the crisis (Food Security Information Network, 2020). In these times of crisis, the world's poorest, who predominantly depend on agriculture, are likely to run out of food. Consequently, hunger, starvation, and malnutrition due to inadequate and unhealthy feeding habits, put their health and well-being at risk (United Nations/Department of Economic and Social Affairs, 2020). Indeed, COVID-19 added fuel to the adverse effects on the vulnerable communities who are already grappling with malnutrition and other problems. Further, countries that count heavily on food imports and developing countries that depend on primary exports like oil are also badly affected.

3. Data sources and evidence from the literature

The COVID-19-induced pandemic disturbs the whole food system, from the primary supply to the final demand. The impact in the agricultural and food demand includes various macro-economic aspects, significant instability in credit markets, exchange rates, energy, and primarily, the expected upwelling in unemployment, and the shrinkages in the overall economic activity. Data gathered for these factors proved to be one of the biggest challenges in conducting this study. Thus, owing to the quantitative data gaps regarding every food security indicator and the pandemic time series considered, the authors are obliged to reduce the scale of quantitative analysis. Accordingly, we have assessed the possible disruptions of COVID-19 on the developing countries' food security and agriculture following their supply/demand chains, import/export activities, and the diverse choke-points therein. To guarantee the trustworthiness and consistency of the study, the data sources chosen are all UN-based international organizations including FAO, UNSDG, UNCTAD, WB, WHO, FSNI, WFP, and World Economic Forum.

4. Response to food security during the COVID-19 pandemic

The COVID-19 pandemic impacts have shocked the global and national food systems. The shock is mainly due to inadequate preventive measurements, whose characteristics and intensity will be based on how governments and residents respond to, and how equipped they are for the crisis. For instance, it is difficult to make timely decisions or provide support to the vulnerable communities in the absence of useful data and tools, particularly where governments lack the means to advise food system management. The food supply and demand channels, which indicate a decrease in food stock and a rise in food prices, can be directly affected by the pandemic. When the pandemic worsens, the purchasing power and the ability to produce and dispense food will indirectly be affected. However, the latter will vary concerning the degree of impact, and will excessively affect the

vulnerable (generally women, elders, and children) and the poor (Food and Agriculture Organization, 2020).

4.1. Food supply

During the COVID-19 pandemic, disturbances in food supply chains and shocks in food production as well as a decline in incomes and remittances have created tensions and food insecurity in countries (World Bank, 2020). On the contrary, most developing countries would be less exposed to supply shocks due to their restricted dependence on intermediate inputs (energy, seeds, fertilizer, and pesticides) and fixed capital. But, the majority of the farming systems such as countries are largely labor-intensive, and the pandemic will expose production to possible shortages in labor. Shortages in labor (through travel restrictions, morbidity, rules for social distancing) affect traders, producers, processors, and logistics in the food supply chain – mainly for food products where workers must be nearby (Schmidhuber et al., 2020). Estimates by the Centre for Monitoring Indian Economy, for example, indicated that the unemployment shot up to 23% in the first week of April from the 8.4% in mid-March. In urban areas, unemployment ascended to 30.9% as of April 5 (Mahesh, 2020). The lockdown and shutdown will lead to untold misery for the poor and the workers of the informal sector. This will disrupt almost all steps in the production process. But, due to their high degree of subsistence on farming, it would also lead precarious lives to hunger and malnutrition. Also, reduction in income and payments is depleting the ability of people to buy food and compensate agriculturalists for their production. This has led the whole economy to a standstill.

As cases of COVID-19 increase around the world, the agri-food supply chains are likely to be badly disrupted. Although there might be sufficient food in the supply chains at the beginning of the crisis, an imbalance to food supplies is instigated through panic-buying by the public who foresee the possibilities of scarcity in supplies during lockdowns. This imbalance may occur due to agriculturists falling ill or due to interruptions in the markets by strategies to contain the virus. Diminishing demand by the reduction in purchasing power would also affect the ability of producers to invest in their products and will further deplete food production. The developed countries depend on the supplies provided by other countries (mainly developing countries). Therefore, the disruption in the supply will affect the developed countries, Europe, and Central Asia the most as seen in Fig. 1. For instance, a 33.42% decline in exports was noticed for cereals excluding rice, 28.28% for rice, 45.48% in the case of meat and poultry products, and 69.85% concerning oil meals from India during March 2020 (Statista India, n.d.). Similarly, developing countries including India, Indonesia, Ethiopia, Kenya, Mozambique, Rwanda, and Tanzania recorded food price increments of 3.8, 2.5, 3.4, 4.2, 10.5, 19.5, and 12.3%, respectively according to the Global Alliance for Improved Nutrition (Global Alliance for Improved Nutrition, n.d.) due to a shortage in production and import/export sources. Cariappa et al. (Cariappa et al., 2020) argued that despite immediate spiraled food prices post COVID-19 induced lockdown, there was no evidence of structural break implying the convergence of the agro-system and resilience in Indian agriculture. Food supply has a direct effect on ensuring SDG goals viz., no poverty (SDG 1), and zero hunger (SDG 2). Developing countries have to safeguard their vulnerable sections like wage earners, landless laborers, malnourished sections of the society including women and children against the pandemic to be on track of achieving the SDGs.

4.2. Food demand

The shocks in the supply-side extend to the demand-side too. However, demand risks are predominantly restricted to developing nations where consumers have insufficient savings and availability to safety nets. They are more vulnerable since they rely mostly on food imports and devote a major chunk of their expenditure on food. People in South Asia, the Middle East, and sub-Saharan Africa are particularly exposed (see Fig. 2). COVID-19 will result in a shock on the food demand by depleting the purchasing power and economic accessibility leading to widespread loss of jobs and income for workers of the informal sector. At this stage of the pandemic, the final income and the final price effects are not clear. Therefore, the increased exposure of labor-intensive products including dairy products and vegetables leads to negative effects originating from the pandemic which results in a deterioration in the utilization (i.e. nutritional quality) of the diet instead of an increase in calorie deficits (Shafiur et al., 2020).

The COVID-19 stay-at-home order has made a higher demand for food because people spend more money to stock up food supplies. Some cases led to panic-buying (Cariappa et al., 2020; Loxton et al., 2020) which induced temporary scarcity in grocery supplies, followed by drastic changes in consumer behavior. Regulation to stabilize the supply was implemented in many countries, which limits the purchase of essential grocery items. Nevertheless, the spike in buying may be trailed by a diminishing drift in demand. This can be both through the ability to buy food and through income loss and decrement in purchasing power which in turn is related to the loss of jobs and the stagnation of the economic sectors (FAO, 2020). Post-lockdown, the household income in India witnessed a sharp fall for 37.9% of sampled households on March 29, further increased to 43.5% on April 5, followed by 43.7% on April 12 (Statista India, n.d.). In Pakistan, 64% of the sampled respondents witnessed a fall in income (Ali et al., 2020). Food demand in developing nations is highly associated with income where the income loss could influence consumption. *Albeit*, households with fixed income haven't shown a significant change in food demand but literature evidence shows that they felt the disruption owing to the pandemic (Cariappa et al., 2020). Income influenced food demand and its availability have a direct effect on food as well as nutrition security. Reduced access to food will lead to a reduction in intake having a negative

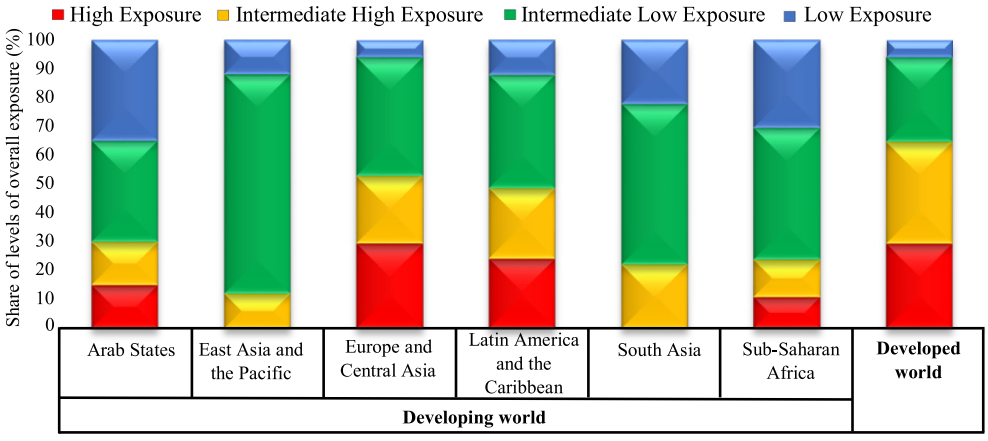

Fig. 1. Comparison of the overall supply exposure of developing nations to developed nations (Schmidhuber et al., 2020).

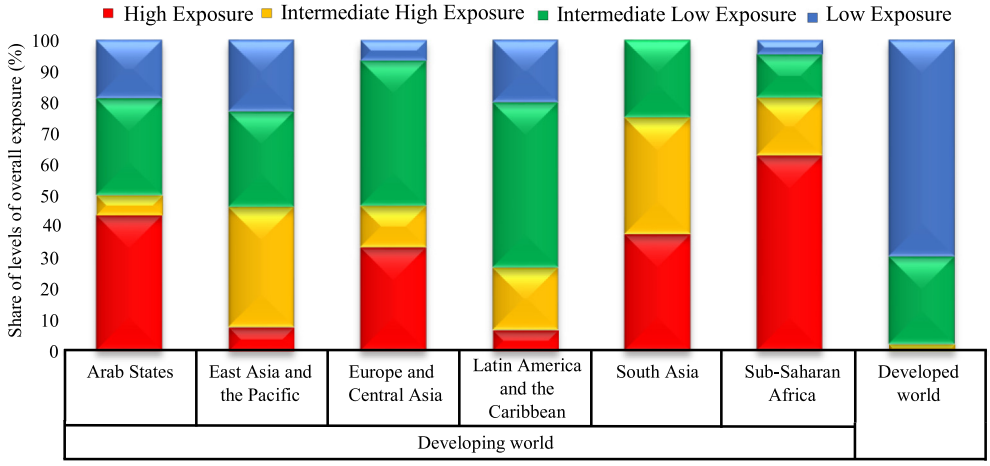

Fig. 2. Comparison of the overall demand exposure of developing nations to developed nations (Schmidhuber et al., 2020).

consequence on their health which might increase the risk of infection (Short et al., 2020). The implication is that it has a direct adverse effect on attaining the SDG 2: Zero hunger and SDG 3: Good health and well-being and indirect effect on SDG 1: No poverty and SDG 10: Reduced inequalities.

4.3. Imports and exports

The surge in food prices bans on exports, and loss of revenue because of economic contraction have severe problems on food security. During the pandemic, governments across the world impose lockdowns and shut their borders. Therefore, the fear that food markets are going to be affected by logistical constraints and shortages in labor, puts pressure on the prices. Due to the fear of anticipated logistical interruptions in the supply markets of China, (major soybeans importer), the prices of soybeans hiked in response to this demand. Recently, UNCTAD (United Nations Conference on Trade and Development, 2020) reported that low-income nations utilized 37% of their export income for importing food products. This rate is 5 times greater than the corresponding value by developed countries. Therefore, external shocks affect these countries more. The estimated cost reduction owing to lockdown in India stood at 26% in billion USD (Statista India, n.d.).

In addition to the domestic perishable products that decay, the major cereal product suppliers, including Russia (wheat), Kazakhstan (wheat), Vietnam (rice), and Cambodia (rice), have lowered exports to ensure that their countries have enough supplies to deal with the pandemic (United Nations Conference on Trade and Development, 2020). This could drive the 'consuming countries' into difficult situations, which could lead to a global food crisis as in 2008. Restrictions on export imposed by such major actors can jeopardize food insecurity across the globe, particularly in exclusive food-importing developing countries. Sub-Saharan Africa is the largest importer of rice. It could be transforming from a health crisis to a food security crisis, as the World Bank has warned (World Bank, 2020). More widely, the WFP (World Food Program, 2020) reported that coronavirus could multiply the number of individuals without consistent access to nutritious food by two times, i.e., to 265 million globally by the end of 2020.

5. Impact of COVID-19 on the agricultural sector

Agriculture provides incomes to more than 1 billion people across the globe and is the backbone of many developing nations. The preventive measures taken to control the pandemic hinder the production and distribution of agricultural products. Agricultural production is a long process from planting, nurturing, harvesting to commodity shipment, which involves labor at various stages. The food and agricultural sectors are therefore considered less resilient due to their dependency on the market value chains. These activities are hampered by travel limits imposed by governments across the globe to stem the spread of coronavirus. Agriculture is an input-intensive industry. The dependence on each factor of production can differ significantly in agricultural systems and therefore can expose agriculturalists and planters to surges in input costs. These are a result of various factors, including congested ports or roads, delays in customs clearance, interruptions in transportation, a dearth of credit access, and increased interest rates and capital costs, which can lead to additional costs on the inputs. These additional costs make the production of agricultural products less profitable and may lead to a huge loss to the agriculturists.

5.1. Farming and farmers

Low supplies of insecticides and pesticides were already disturbing the efforts to protect the crops in countries affected initially. This would result in reduced yields this year. Transportation costs of pesticides to regions including eastern parts of Africa have amplified almost 3 times. This has hindered the locust fighting progress and is worsening the threat to food security (Food and Agriculture Organization, 2020). Movement restrictions and import delays therefore could affect farmers as the planting season approaches (Schmidhuber et al., 2020).

The floriculture sector has been widely affected in India due to the imposing of lockdown which coincided with the usual marriage and religious celebration wherein the use of flowers is abundant. Further, harvesting of *Rabi* (winter) crops followed by sowing of *Kharif* (summer) crops have been severely affected owing to the reverse migration of laborers across the country. Even this has led to an increase in the area under Direct Seeing of Rice (DSR), a popular technology which was not widely adopted earlier by the farmers of Punjab – a state well-known for its contribution to the Green Revolution – but because of COVID-19, it is expected around 25% coverage of the total area under rice.[1] A majority of the developing nations encountered disruption, especially in logistics and marketing. Distress sale was quite evident in some places like Odisha in India (Cariappa et al., 2020; Ceballos et al., 2020).

The Workers in the informal sector form another key area where the livelihood and food security challenges have intensified. Thy is at risk of COVID-19 infestation as they work in crowds and in crowded areas where it is impossible to maintain and practice the precautionary measures set by the WHO. On the other hand, staying indoors is also not an option for them due to their need for money for their daily subsistence. Hence, an all-inclusive and organized plan is essential to curb the effect of such unforeseen events, especially for the vulnerable section in the developing nation,

[1] https://www.thehindu.com/news/national/other-states/farmers-in-punjab-to-plant-around-25-paddy-with-dsr-technology/article31772645.ece

covered under the target of SDG 3, wherein strengthening capacity is advocated for prediction, reducing the risk as well as tackling the health risks.

The spreading of the virus to the rural areas will have far-reaching ill-effects that can hinder production, marketing processes, and harvesting. The rural infection rate has remained relatively low as compared to urban cases. But if the infection spreads to the rural areas or the containing measures affect the production, then there would be alarming situations. Therefore, the food scarcity can get intensified by the spread of the pandemic to rural areas (Taffesse and Minten, 2020).

5.2. Fishery, dairy, and meat

The decrease in the production of food supplies of high-value (like vegetables and fruits) is predictable. The aquaculture and fisheries sectors are areas where the consequences can differ and can be complex to apprehend the impact. The change in demand for fish and meat, transportation restrictions, and the reduction in market accessibility have led to hostile situations in these sectors. The restrictions in logistics, closure of borders, and the decreased demand in restaurants can create substantial market changes that affect the selling prices of fish. Similarly, the effect of the pandemic on the livestock sector can also not be neglected. It is mainly due to decreased access to feeds and a restricted capacity of slaughterhouses (due to transportation restrictions and shortage in labor).

6. External factors and post-pandemic scenarios

An estimated 113 million people around the globe were already chronically food insecure due to pre-existing shocks before the COVID-19 crisis (World Bank, 2020). This means the aforementioned sections in the world were already on the verge of hunger and are not in a position to fend off the virus. Currently, many countries are facing multiple crises including the recent desert locust plague in East Africa (World Economic Forum, 2020); destruction of crops, extreme weather events; flood and drought events, and forced displacement due to political turmoil, which worsens the food insecurity status (Phillipson et al., 2020). Conflict-affected states, (like Syria) where transport and supply are tough even in the absence of morbidity and social distancing, will be impacted severely. Nations with substantial depreciation of the currency and those experiencing the collapse of other commodity prices are more vulnerable to the pandemic crisis (Food Security Information Network, 2020).

The present crisis should be transformed into an opportunity for global structural change. Governments need to focus on saving lives while minimizing the disruption in the day-to-day lives of societies. The food insecurity impact aggravated by COVID-19 may extend beyond the pandemic period if the vulnerable people and poor are not supported to access food. As noted by the FAO (Food and Agriculture Organization, 2020), they would be required to abandon their livelihoods. They would be forced to sell their assets, agricultural equipment, animals, or their fishing boats for money to ensure food for their families. Farming households may consume the majority of their seeds instead of replanting them. This makes it difficult for typical families in rural areas to be self-reliant. Some victims are forced to leave their homes/businesses, and even be subjected to trafficking, in search of subsistence and livelihoods elsewhere.

7. Proposed coping strategies

The aforementioned problems encountered in the developing countries call for immediate interventions so that the ill-effects of the pandemic are reduced. A potential pathway is a need of the hour for all the emerging economies to be on the track of achieving the set targets of SDGs by 2030, despite a huge setback. In the milieu, the following possible strategies can curb the fallout from the pandemic if the COVID-19 persists or recurs.

- Food Assistance Program: There is a need to attentively expand social and food safety programs, especially in rural areas, to provide food and necessities for households with a considerable decline in incomes. Barrett (Barrett, 2020) has also noted the need for such actions by stating the food price spikes that happened in 2008 and 2011.
- Cash Transfer: An alternate and effective coping strategy for the food assistance program wherein the vulnerable sections like migrants, landless laborers, pregnant women, pro-poor, etc. can be assisted with a fixed amount of cash transfer to meet their basic livelihood needs.
- Supply Chain Management: A majority of the developing nations faced supply disruption during the pandemic. Hence, appropriate interventions like strengthening the storage capacity for enhancing the buffer stock, processing (Financial Express India, 2020), and distribution will help to counter the adverse situation.
- Leveraging Technology: Capitalising the advantage of Information and Communication Technologies (ICTs), functioning and efficiency of the supply chain management can be increased extensively. For instance, the mobile procurement of perishable commodities can be incentivized (Kumar et al., 2020).
- Decentralizing Food System: Promotion of a decentralized food system to make the emerging economies self-reliant and protecting the local food system. This also will help to facilitate in achieving a healthier food system (Nature India, 2020) targeting the SDG 2.
- Fair Trade Policy: Gradually loosening necessary food import restrictions and commodity tax reductions, which may be possible are urgent measures to meet the national food demand resulting from the crisis (Arumugam et al., 2020).
- Disaster Relief Package: The special assistance package and policies against the crisis announced by governments should encompass farmers and agricultural workers. This would benefit the primary sector, which in turn will have positive impacts on the other sectors of the economy and therefore help to achieve the SDGs.
- Self-reliance Policy Initiatives and Reforms: The government should focus on supporting local business and agriculture, which will eventually lead to a self-sufficiency situation like *Aatma Nirbhar Krishi*, a self-reliant agriculture initiative in India (Cariappa et al., 2020). This would imply that public funds should be allocated to support local farmers and improve the supply chain so that local crops are more accessible for all than the imported ones.
- International Cooperation: SDG 17 focuses on strengthening the global partnership for sustainable development. It is also highly recommended that developed countries extend debt payment timelines and due dates or even cancel the interest for developing countries. This will help them to turn the focus to fighting the pandemic, cushion them from the current economic crises, and enable them to easily recover from it.
- Public Awareness: Proper public awareness should be provided such that the people become informed not to hoard essential items and to maintain basic hygiene which is vital for stabilizing the markets.

Concerted efforts and integrated global response are inevitable for the effective response, control, and prevention of the pandemic. Further research is imperative to fill the knowledge gaps on the impacts of the pandemic and possible cures. Many times, each country's agri-food status during the lockdown period tends to be ignored though it is the backbone of the economy. Hence, these recommended mitigation strategies would help to revive the countries affected by COVID-19.

8. Conclusion

Livelihoods and lives are at risk from the coronavirus pandemic which is evident from this analysis. Furthermore, the advances towards the achievement of SDGs will be jeopardized. The containing measures and restrictions adopted by various countries are likely to intensify the food insecurity, specifically for food-insecure and developing countries. The global food availability and food prices are also affected since the pandemic started to proliferate through various countries.

Vulnerable groups including landless laborers, wage earners, and small-scale farmers have been obstructed from their day-to-day work and faced the worst hit among all. The migrant laborers will also be hit hard by job and income losses. As of now, food accessibility will be severely affected

followed by its availability compared to other food security dimensions. In the long term or post-pandemic, food availability could be harshly impacted if no actions have been taken by the concerned. The governments must swiftly plan to enhance their capacity in the agricultural sector by implementing new risk management programs and reforms coupled with insulating the livelihood of people by cash or food assistance programs to meet their basic needs. These measures would in turn be beneficial to achieve the SDG goals. The impact of the pandemic is analogous to that of a natural calamity, which is hence a justified reason for devising prevention and risk reduction strategies. The posed recommendations would help to rejuvenate the agricultural sector, which is also expected to revive the economies and therefore transform them to be self-reliant.

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Authors' contribution

Conceptualization- EW and JM, Writing and drafting- JN, Editing- JM and SR.

Declaration of Competing Interest

The authors report no competing interests in this manuscript.

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