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FORUM: COVID-19 Shock to Food Supply Chain: The Necessity of Moving toward Modern Paradigms

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ABSTRACT

Besides damage to the environment, current industrial agriculture has decreased ecosystem capacity and provided the context for spreading various diseases in human communities. The covid-19 crisis and traffic restrictions not only had a hygienic, economical, and social impact but also caused disruptions in the food supply chain and the fragility of food systems in some regions asynchronously. Theoretically and practically, agriculture and food supply chain paradigm-shifting using the Internet of things (IoT) and Agroecology paradigm application, by providing food security, shortening the food supply chain, and improving food security, is considered a proper response to COVID-19 shock.

***Keywords**: COVID-19, Food Supply Chain, Food Security, Agroecology, Internet of Things (IoT)*

1 Introduction

With the emergence of COVID-19 in Wuhan, China, in December 2019, and its rapid spread to the world, this epidemic became a pandemic. Its pathology with different degrees caused the occurrence of complications in various countries. Despite the emerging nature of this virus, concerns and questions have been raised about its effects on various sectors, including agriculture and food. A glance at decisions made by governments showed that the focus of policymakers in exposed communities is concentrated more on health and economics and less on agriculture and food security. At present, in some developing countries, there are evidences showing the direct and indirect effects of Covid-19 on the four pillars of food security, i.e., availability, access, use, and stability, as well as fragility and social inequality in global food systems and challenges in agriculture and the food supply chain (FSC). As such, the poorest populations have been more exposed to vulnerability. This event would hinder global attempts to attain sustainable development goals (Altieri & Nichols, 2020; Cullen, 2020; FSN, 2020; IPES-Food, 2020). The more dependence on international food trade the more threatened the food system. Indeed, these impacts have not been identified entirely, and most estimations have been referred to the rate of supply, demand, trade, and logistics in agriculture (Schmidhuber et al., 2020). Now, the following questions are being addressed. What have been the impacts of this virus on agriculture, food supply chain (FSC), Labour, Rural Economy and Trade, Social Tensions and Conflicts, and Human and Health Hazards? In this paper, in addition to addressing the questions mentioned above, the goal is to address what should be done in the face of these challenges. Main COVID-19 impacts on the food supply chain (FSC), agriculture, and rural are included:

2 Impact on Agriculture

Although the conventional industrial and intensive agriculture model has been able to produce a large amount of food, it has caused the increasing and uncontrolled expansion of agriculture, extensive deforestation, loss of biodiversity, emission of greenhouse gases, rapid increase in obesity and diet-related diseases, and the exploitation of wild species that has created the basis for the spread of all kinds of diseases in human societies. In Iran, due to the perishability of most agricultural products, especially summer crops, greenhouse products, flowers and ornamental plants, and the decrease in buyers due to the Corona crisis, many of them are not sold and lost. Presently, decorative flowers, and plants have been regarded as unnecessary; consequently, their production has decreased significantly (ICPRA, 2020). With the closure of various stores, including clothing stores, the demand for cotton has decreased (Outlaw et al., 2020). Quarantine regulations and travel restrictions between countries, cities, and provinces led to the closure of ports, airports and reduced transportation. This caused delays or shortages in the supply of production inputs such as seeds, fertilizers, and chemical pesticides, veterinary drugs, and Labour shortages in some areas, and after that, the prices of inputs increased to some extent, and this caused an increase in damage caused by pests and plant diseases, and livestock as well as disruption in the production process, including the planting of spring crops in some areas. Therefore, with export restrictions, some countries attempted to preserve food products inside their borders and enforce policies to control price increases (Benton, 2020). In another example, in Liberia, 47% of farmers reported that, because of the incidence of corona disease, they were not able to plant their lands. Also, occurred restrictions caused problems in the harvesting of fall-season products. These cases will increase production costs and product prices in some areas. In some regions, disruption in the transportation system caused honeybee shortage and pollination crisis. This condition would impact the extent of production of some agricultural and horticultural products. The probable impacts of this pandemic on food production, especially in major importing and exporting countries, including the U.S.A, China, and the European Union, may have severe consequences for access to food products and their price at the international level. This situation imposed severe challenges for food security and nutrition globally (Paola, 2020; FAO, 2020; IPES-Food, 2020; Martin, 2020; Schmidhuber et al., 2020). As farmers and producers couldn't supply their products to the market, it is expected that animal- source food value chains such as milk, meat, poultry, and fish would be faced with a more challenging situation. As a result of transport restrictions, some manufacturing units have experienced animal and poultry food shortages, and problems delivering milk, egg, and live animals to slaughterhouse, dairy companies, markets, and stores. With forbidding fishing activity and the closure of the fish supply market, a domino effect was observed on the whole fishery value chain (IPES-Food, 2020; Martin, 2020).

3 Disruption in Food Supply Chain

Many countries have implemented quarantine regulations, border closures, and traffic restrictions to slow down the spread of the coronavirus. The closure of most enterprises caused revenue reduction or loss; as the demand or consumption of most food products has reduced, and consumer relationship was interrupted with the market. This pandemic disease directly affected the food system and caused deviation from geographical and seasonal patterns and indirectly by reducing the purchasing power and affecting the capacity of food production and distribution more to the

poor and vulnerable people (Paola, 2020; FAO, 2020; IPES-Food, 2020). This is a symmetrical shock but influenced national food systems asynchronously. Over time the impact of the asynchronous shock on supply and demand channels has been observed in various locations. In the case of continuity of this crisis, this epidemic disease would rapidly influence system elements and FSC links from production, processing, and national and international logistic systems to intermediate and final demands. As such, the market experienced increasing demand for canned foods, and the demand increase in electronic trade was fivefold. In Iran, food products would cover 24% of household costs; because of the economic recession, households faced problems paying food costs (ICPRA, 2020). In the United States of America, less than %50 of consumer costs are spent on purchasing a homemade meal and about 50% on an outdoor meal. Consumer fear of reclosing of retail stores brought roughly increased demand for food products, consequently increasing some product prices. Price increases and instability are not only due to increasing demand but also due to business behavior. Indeed, food availability and accessibility depend on the duration of COVID-19 incidence and the intensity of the disease controlling the action. (Paola, 2020; Cullen, 2020; Martin, 2020; Schmidhuber et al., 2020). Of course, in the United States, since the start of the Covid-19 pandemic, the price of some goods has decreased by 20-30%, and if this situation continues, it can lead to losses for producers (Outlaw et al., 2020). So, to prevent interruption in national and international food systems and disruption in the food supply chain (FSC), the countries couldn't decelerate or interrupt the movement of FSC gearwheels. World Trade Organization (WTO) has emphasized this subject (WTO, 2020).

4 Impact on Labour

After the incidence of coronavirus and disruption in the food supply chain, including restaurant closure, food system workers have experienced job and income loss. As a result, it was increased malnutrition, food insecurity, and rural poverty. A primary assessment of the International Labour Organization (ILO) suggests a 2-8% reduction in Gross Domestic Product (GDP) resulted in 2/3-24/7 job loss. This condition imposed a significant income loss of around 860 million to 3/44 billion us dollars to workers (ILO, 2020). The Labour shortage has influenced agricultural and food production chains to some extent. As a result, some agricultural products were not harvested, remained in fields, and finally, they were decayed. Labour shortage would disrupt food production and its processing to some extent an investigation suggested. In some regions, regardless of the risk of infection, agriculture and food workers have continued work due to the necessity of continuity of global food supply (Cullen, 2020; FAO, 2020; IPES-Food, 2020; Schmidhuber et al., 2020).

5 Impact on Rural Economy and Trade

Corona crisis has established chain reactions in the rural economy. At first, the animal and poultry sectors felt the impact of transport restrictions on food distribution, migrant farmworkers' employment, and agricultural trade. The closure of local and regional markets and stores has reduced the food supply. The loss of one of the primary revenue sources for rural resulted in increasing poverty in rural areas. Closure of repair stations and spare parts stores has faced problems. So, some rural were not able to deliver their products, such as vegetables, eggs, and milk, to the market (Food Security Information Network and Global Network against Food Crises , 2021). In Iran, because of the fear of carrying COVID-19 by local poultry purchasing has decreased significantly. Because of traffic restrictions, many fresh products were not exported. Because of the non-issuance of rural mobility permission, some sheep species remained in tropical regions (winter quarters), and their low, warm tolerance caused their death, sometimes abortion. Also, due to the ban on the migration of nomads to the colder region and the impossibility of using newly grown pastures, the cost of nomads has increased due to being forced to use manual feeding. This cost is heavier in the case of larger herds and leads to an increase in the price of live animals and meat (IPRC, 2020a). The application of quarantine regulations and traffic bans have caused restrictions on the export and import of food, which has led to the formation of an unpredictable business environment, and these conditions can have negative effects on the availability and access to food in some areas. International trade-dependent food systems were more threatened. Continuing these trading restrictions caused food insecurity, especially for vulnerable groups (Paola, 2020; WTO, 2020). For example, China's food exports have been damaged by enforced trading restrictions, which in turn, impact agricultural production in other countries. Whereas in Qana, the price of main foods has increased by 20-30% (IPES-Food, 2020; Martin, 2020).

6 Intensification of Social Tensions and Conflicts

Totally, in countries with limited resources, also weak management of COVID-19, the competition between healthcare and food security priorities has created tensions at the community level. For example, in Iran, the prohibition of migrant rural mobility has forced this population has remained in tropical or summer quarters. Their herds have consumed

regional pastures. As a result of this compulsory habitation, it occurred conflicts with local or indigenous habitats. At the same time, the pastures of their cold areas are also used by other herders and cause conflicts between tribes. Therefore, this disease has disrupted the order of tribes' departure and caused disputes among tribes of different regions (IPRC, 2020b). Price changes, economic instability, and fear of disease spread have created social conflicts at various levels. Food scarcity in refugee camps will increase tensions in such situations (Food Security Information Network and Global Network against Food Crises , 2021). Mental stress due to this disease, disruption in markets, shortage and inequality in food availability and accessibility, the fear of purchasing, and increasing food price has raised concerns, increasing deprivation feeling, dissatisfaction, and also rising tensions, and violent conflicts. Increasing conflicts and struggles together with such crises as natural disasters, and attacks of pests (e.g., locusts) will endanger food security and corona disease control in some regions (Paola, 2020; FAO, 2020).

7 Human and Health Hazards

Endangerment of food security of vulnerable rural households could lead them toward negative coping strategies. This behavior would have permanent impacts on their livelihood. School closure in more than 160 countries has deprived more than 87% of students of main meals. Free school meals are considered the primary source of children's nutrition in vulnerable households. Income loss and purchasing power reduction resulted in reducing the quality and quantity of meals, malnutrition, increasing dropouts also, and reducing healthcare and sanitary facilities (Cullen, 2020; FAO, 2020). The coronavirus outbreak in some regions suggested some urban households have sojourned in rural areas temporarily. Shortage of prevention and therapeutic facilities in rural regions caused the emergence of a crisis in health systems (IPRC, 2020b). On the other side, more concentration on urban areas has increased rural and urban inequalities and appeared to have respective weaknesses. With the economic downturn, marginalized groups such as smallholder farmers, and landless women, and vulnerable groups such as immigrants have less access to health facilities and needed food due to lack of income, and with the increase in the level of food insecurity and Malnutrition, their body's immune system is weakened, and the possibility of contracting the Covid-19 virus increases. (Food Security Information Network and Global Network against Food Crises, 2021).

8 What Must Be Done?

Whereas the COVID-19 pandemic is considered a significant health crisis, current industrial agriculture systems have burdened significant pressures. Therefore, in the current situation, to attain sustainable development and food security, it is essential to renovate agriculture and, re-engineer food systems with an emphasis on a flexible, responsive, and resilient local food supply chain. In other words, a change in theory and practice in agriculture and the food supply chain is a logical answer to this new challenge. This paradigm change requested by the stakeholders of agriculture and food systems has been proposed at different levels (IPES-Food, 2020).

The agroecology paradigm has an essential capacity to respond to such challenges. Besides high diversity and resilience, these agroecology systems could have a logical function and deliver ecosystem services. This approach, by eliminating the inadequacies and problems of the industrial agriculture model, tries to reduce the risks and threats caused by natural diseases by reviving the ecosystem and agriculture by reviving biodiversity at different levels, and preserving and strengthening pathogens. Therefore, agroecology is considered a powerful systemic approach to discovering more links between agriculture and health. Today, scientists have understood species living in destroyed habitats contain more pathogenic viruses causing human infection. Agroecology approaches have been considered an essential part of solving this problem. Transition to sustainable food and agriculture system involves the collective transfer to planned ecosystems such as agroecology, urban agriculture, and permaculture. All of these ecosystems have been diverse, sustainable, and flexible both industrially and economically. Nowadays, it is proven these ecosystems would protect the economy and health. In other words, economies couldn't protect ecosystems (Altieri et al., 2020; Altieri & Nicholls, 2020; Benton, 2020).

Also, through producer empowerment and environmental protection, agroecology approaches to the current challenges will provide sustainable and healthy local foods for the whole population. By providing local solutions and empowering farmers in the field, agroecology helps to improve their livelihood and quality of life and maintains local economies and markets. Besides agroecology, other urban agriculture model and community-supported agriculture (CSA) may help to attain this goal (Altieri et al., 2020; Altieri & Nicholls, 2020; FAO, 2020; Nyssens et al., 2020). For this reason, the tendency to develop the application of urban agriculture and community-supported agriculture has recently expanded. Food production through urban agriculture has not only cut the food supply chain and reduced the probability of food contamination but also provided an opportunity for urban households to design a proper solution and cooperate in food production. Following the outbreak of the Covid-19 crisis, the increasing tendency of people to use the mentioned paradigm has increased. Therefore, urban agriculture can play a significant role in increasing urban

food sovereignty and increasing food justice in domestic food systems. According to the surveys, Internet searches for urban agriculture and community-supported agriculture have increased over the past months (Loker & Francies, 2020). In the IT era, the Internet of Things (IoT) application in agriculture and the food supply chain is considered a proper response to COVID-19 shock and most food security problems during recent years. On this basis, we will face more secure, functional, and sustainable FSC connecting fields to this device. IoT is a new emergent technology full of sensors, machine learning, artificial intelligence, and analysis. This technology will change global ideology about food. In present critical conditions, the necessity of paying more attention to FSC tracing is felt more than ever. Therefore, with the application of IoT, we could identify different risks and infections in 5 main stages of the FSC chain, i.e., production, process, transport, storage, and selling, then perform necessary actions to reduce or remove these risks. In such a case, the problem of food security will be removed. e.g., RFID labels as developed barcodes make it possible to trace agricultural products. In a new decade, it is expected that the smart agriculture market will experience fourfold growth. Accordingly, it is expected the value of this market will become 40 billion dollars in 2026 for applications of electronic agriculture (Gu et al., 2012; Xiaorong et al., 2015; Zhang, 2018).

IT applications, including IoT, gave FSC flexibility and the ability to face such unexpected events as the COVID-19 pandemic. In China, the use of big data platforms is used to obtain information and monitor the slow-moving of food products across the country and the fast link between the main elements of the agricultural and food supply chain. It is predicted that by 2050, the use of the Internet of Things in agriculture will increase food production by 70% and provide food for more than 9.6 billion people, and this shows the undeniable role of smart agriculture and the effect of Internet of the Things in increasing the performance of agricultural products (Accorsi et al., 2017; Cullen 2020).

In current critical circumstances, in addition to tracing food health, the personal hygiene of FSC Labour is a significant concern. Temperature monitoring with face recognition and other biometric identifiers is being collected, processed, and alarmed using IoT. In the case of early diagnosis, early treatment is possible, and more virus outbreaks will be prevented. Therefore, food security and health are remarkably secure for consumers. But there is a concern about data privacy. Consequently, it is necessary to regard some considerations in this respective. Nevertheless, if this technology is properly designed and applied, different jobs in the whole FSC will enjoy time-saving, economy, cost-effectiveness, and improved customer satisfaction (Lyons, 2019). Therefore, it seems that during the COVID-19 pandemic, food systems would develop their resilience using ICT and IoT applications. In such circumstances, FSC would evolve its flexibility and deliver services.

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