**Journal of Food Technology Research**
*2022 Vol. 9, No. 3, pp. 160-175.*
*ISSN(e): 2312-3796*
*ISSN(p): 2312-6426*
*DOI: 10.18488/jftr.v9i3.3228*


# THE IMPACT OF COVID-19 ON FOOD SECURITY: GHANA IN REVIEW

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**Article History**
Received: 22 September 2022
Revised: 3 November 2022
Accepted: 22 November 2022
Published: 9 December 2022

**Keywords**
COVID 19
Food security
Food system
Ghana
Poverty
Socioeconomic crisis.

## *ABSTRACT*

Since the outbreak of the COVID-19 pandemic, Ghana has recorded a total of 130, 727 confirmed cases with 1,207 deaths at the time of writing this article. The COVID-19 pandemic has had a significant influence on nations and regions all around the world since it started and Ghana is no exception. This systematic review discusses COVID-19 measures in Ghana, the impact of COVID-19 on the import and export of Agricultural inputs and food, as well as the impact of COVID-19 on local food system actors. In the second part, measures to prevent food insecurity in Ghana during the outbreak of the pandemic, emerging lessons, and building resilience have also been presented. In several production regions, the Ghanaian food system experienced disturbances that resulted in reduced output due to limited labor mobility; nevertheless, these disruptions were minor and did not appear to have a significant impact on production. The COVID-19 epidemic has disrupted food supplies, putting billions of people's food security in jeopardy. According to some estimates, global hunger might treble as a result of food supply disruptions, especially in poor countries around the world. Ghana's economy is beginning to recover from the effects of the COVID-19 pandemic, and in order to maintain this recovery, the government will need to continue to support both the productive and vulnerable sectors of the economy. Finally, there has never been a better time to eat more of what we grow and to grow more of what we eat than right now.

**Contribution/Originality:** This review contributes to the existing literature on the magnitude of disruptions, consequences, and measures taken to establish a more resilient food system to achieve food security due to the outbreak of COVID-19 in Ghana. There is little or no literature on the impact of COVID-19 on food systems in Ghana, hence the need for this review.

## 1. INTRODUCTION

The COVID-19 pandemic, which began at the end of December 2019 in Wuhan, China, and was caused by a new strain of virus known as severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) (Lai et al., 2020). The outbreak of the COVID-19 disease has impacted major cities the hardest. Cities have become epicenters of the COVID-19 disease, as they serve as entrance sites for most foreign tourists. The COVID-19 pandemic has had a direct impact on food systems by affecting the food supply-demand system, as well as an indirect impact by lowering purchasing power, reducing food distribution and marketing capacity, and increasing healthcare chores (Poudel et al., 2020). The global economic lockdown enforced by countries to deal with the health difficulties caused by the spread of the disease has posed significant challenges and had a severe impact on all sectors of the global economy. The slowdown in agricultural and other related economic activities, which were nearly grounded to a halt during the peak of the pandemic, is the best way to understand COVID-19's impact on food security. Farmers were unable to access their farmlands due to various governments' restrictions on movement/lockdown policies. This had a significant impact on local and national food production. Despite being endowed with a diversified set of human and natural resources, food security is already one of the key difficulties confronting Africa's rapidly growing population (Ejeromedoghene et al., 2020).

On March 12, 2020, Ghana verified its first case of COVID-19 (Nimako-Aidoo & Eric, 2020). Following this, the president of the Republic of Ghana, frightened by the rising number of reported cases in the country, imposed various limitations on the movement of products and services in Ghana's two largest cities (Accra and Greater Kumasi). Ghana's unique strategy included measures such as the suspension of public meetings, the disinfection of market facilities, the severe enforcement of social distancing and personal hygiene, the closing of all land, sea, and air borders to human travel, and the lockdown of disease epicenters. These were in addition to the World Health Organization's COVID-19 protocols, which were designed to help stop the virus from spreading. The food system in Ghana has been severely disrupted, with ramifications at numerous levels and across supply chains. It is vital to assess the magnitude of disruptions, consequences, and range of actions following the outbreak of COVID- 19 in order for Ghana to establish a more resilient food system capable of achieving food security. The rationale of this article is to explore the impact of COVID-19 on the agricultural sector and food security in general, as well as the socio-economic impact on the living standard of the people.

## 2. COVID-19 MEASURES IN GHANA

Unlike the 1918–19 H1N1 influenza pandemic, where there were no medications or vaccines to cure or prevent the disease, a variety of non-pharmaceutical interventions such as travel bans and limitations, school and workplace closures, isolation of ill persons, quarantine of exposed people, social distancing, and cancellation of major gathering events were implemented in the early stages of the epidemic and were proven to be effective (Ayouni et al., 2021). With the advancement in knowledge and technology, the current epidemic has seen the implementation of various strategies both pharmaceutical and non-pharmaceutical to minimize SARS-CoV-2 transmission. World Health Organization (WHO) published guidelines in 2019 for non-pharmaceutical public health strategies to reduce the risk and effects of the epidemic and pandemic influenza (Burns et al., 2020). Many countries have implemented preventative methods to prevent or reduce COVID-19 infection (Al-Tawfiq & Memish, 2020; Hasnain, Pasha, & Ghani, 2020). Ghana introduced public health interventions such as public education and physical separation to prevent coronavirus illness transmission (COVID-19). Again, instead of a total lockdown, Ghana maintained various parts of the country and critical services open in lockdown regions and advised people to wear face masks on a regular basis. Lockdowns have been reported (Basu et al., 2020; Salvatore et al., 2020) to have a strong correlation with a reduction in the spread and the number of reported cases of the virus. Nonetheless, some authors have reported on its partial effectiveness due to state-level variations and have suggested its implementation with other interventions such as social distancing and community-wide face mask-wearing to make it more effective

(Meo et al., 2020; Thu, Ngoc, & Hai, 2020). Some scholars (Bo et al., 2021; Hossain et al., 2020; Lai et al., 2020; Nunan & Brassey, 2020; Suh, Meehan, Blaisdell, & Browne, 2021) have reported on these interventions and have ascertained their effectiveness in response to the outbreak when implemented earlier in the epidemic. Other measure put in place included social distancing, in-land transportation restrictions, ban on travels by sea and air, quarantine of infested individuals, ban on social gathering, compulsory washing of hands and wearing of face masks at public places Figure 1.

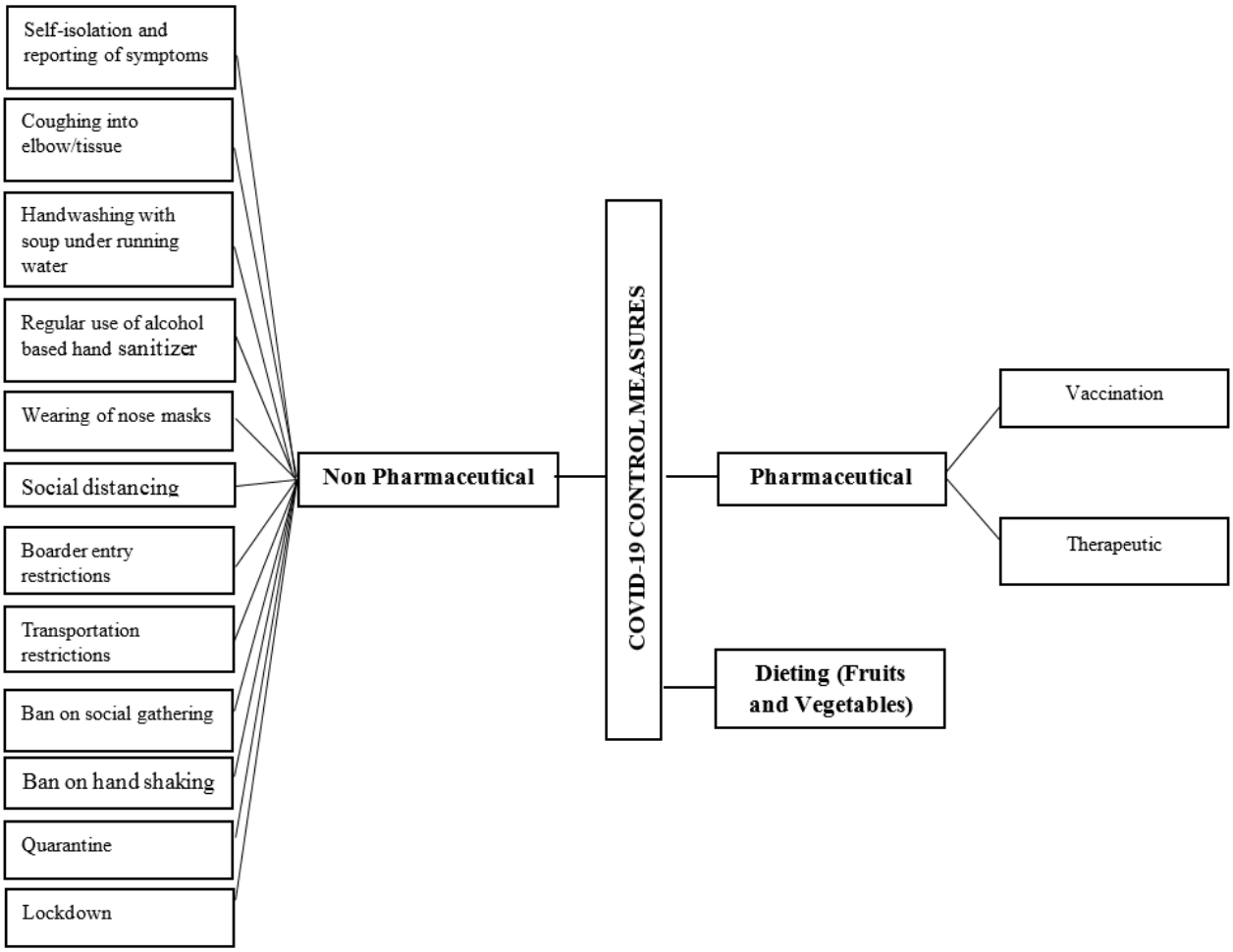


**Figure 1.** COVID-19 measures introduced in Ghana.

Implementation of these measures in Ghana was faced with countless challenges. For instance, like other developing countries, Ghana is facing economic challenges with regard to the purchase of diagnostic kits and equipment, and the training of the medical staff on biosafety and biosecurity, thus relying on both local and international donors' supports to curtail the epidemic. Handwashing was also reported to be efficient in controlling the spread of the virus. To ensure the availability of sufficient quantities of safe water and handwashing supplies throughout the outbreak response, critical measures such as hand hygiene in the community and healthcare settings were implemented by supplying water free to all homes in the country. Since some of the interventions have been reported not to be effective when used alone and cannot contain the outbreak, there is a need to use numerous interventions in concert to bring the outbreak under control in Ghana.

Again, for the preventive measures to be effective, recommended public health and social measures were tailored to the context and resources made available. To determine the most efficient preventive measures, the Ghana Health Services used routine sentinel surveillance data from a national network of primary healthcare facilities to examine the effect of these COVID-19 measures on reported and recovery cases as a proxy to determine

the overall potential reduction in the virus transmission. In addition to this, the government of Ghana resorted to giving periodic updates on the pandemic through the minister of information and the president of the Republic of Ghana. The public is kept informed about important developments such as testing, treatment, recoveries, and other announcements through this medium. These regular updates have improved Ghanaians' awareness of the pandemic and alleviated their anxieties. Figure 2

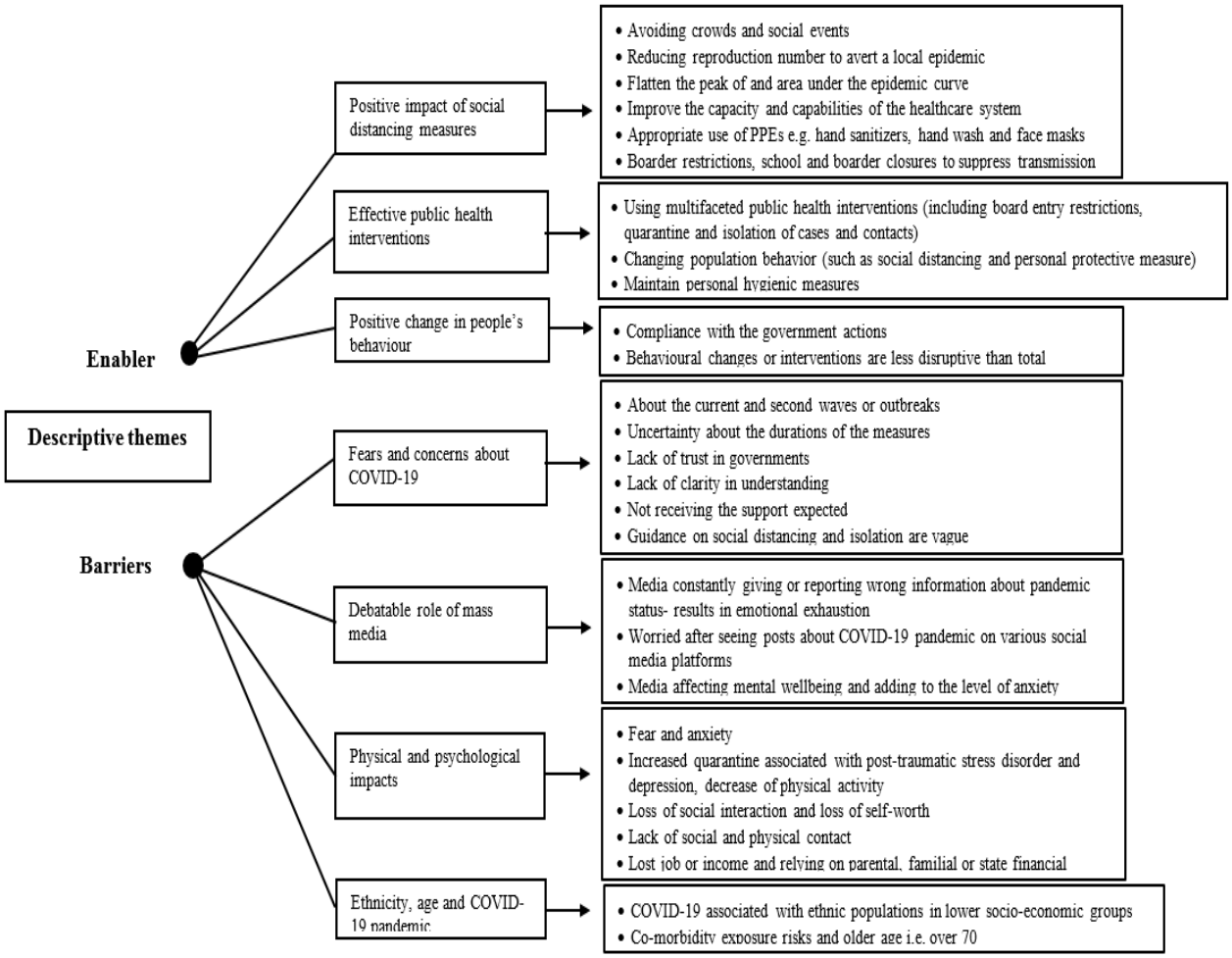


**Figure 2**. Themes identified across studies (Regmi & Lwin, 2021).

## 3. IMPACT OF COVID-19 ON THE IMPORT AND EXPORT OF AGRICULTURAL INPUTS AND FOOD

The impacts of COVID-19 on imports and exports of agricultural produce have been direct and indirect. The direct effects are on production, trade, and investments within Ghana and the rest of the world (especially China, Europe, and the United States), on global commodity (cocoa) prices, and on human life especially the health and life of the vulnerable. Indirectly, the effect of the pandemic has been through the slowing down of global economic growth, supply chain disruptions and by extension, the negative impact on Ghana's own growth. The coronavirus outbreak stopped all shipments at a point in time. Companies lost new business contacts and saw export deals fall apart due to lockdowns brought on by the coronavirus spread in Europe. The spread of the coronavirus forced the world's largest importers of crops such as cashew to cut orders as their processing factories were closed down due to lockdowns imposed to slow the spread of the virus. This caused a glut, forcing the international market price of the commodities to slump. According to Cullen (2020) chief economist at the United Nations Food and Agriculture Organization, "a protracted pandemic crisis could quickly put a strain on food supply chains; a complex web of interactions involving farmers, agricultural inputs, processing plants, transportation, retailers and more.

COVID-19 slowed down growth in agriculture because of disruptions in the supply chain and lower demand activities (Bonadio, Huo, Levchenko, & Pandalai-Nayar, 2021). Disruptions limited farmers' access to inputs, such as seeds, fertilizers, insecticides, day-old chicks, animal feed, and drugs. Uncertainty and fear negatively impacted planting and purchasing decisions and also a reduction in the volume of main agricultural exports, as a result of the general downturn in global economic activity due to the pandemic. Prior to the breakout of COVID-19, the status of food security and nutrition was already a concern, and it is likely to worsen (HLPE, 2020). A general shortage in the food supply is anticipated if the pandemic intensifies. This could lead to inflation in food prices especially rice, vegetables, sugar, bread, poultry, and other meat products.

Most countries depend heavily on imported foods to meet their local demands. In Sub-Saharan Africa, the supply chain failed due to border closures. Ghana's market trading relies primarily on imported items from neighboring nations such as Burkina Faso and Nigeria, as well as countries such as China, India, and Vietnam. Food prices in urban markets across the country have risen sharply as a result of the global surge of COVID-19 cases, which has generated a lack of supply. Ghana imports a huge volume of agricultural products, such as rice, from other countries to meet domestic needs. In 2019, Ghana was estimated to have imported $2 billion worth of food products. The import of food in Ghana will continue to increase due to the inability of the agricultural sector to meet demand (Kuusaana & Eledi, 2015). Movement across national borders was almost impossible. This caused the export of services to decline by more than 60% between April and June 2020, and almost by half in July and August compared to the same months in 2019 (Larik & Ponzio, 2021). Restricted movement of people means limited movement of products, which has an impact on food availability in food-insecure communities that rely heavily on imports like Ghana.

Food security exists when all people have physical and economic access to enough, safe, and nutritious food to suit their dietary needs and food choices to live an active and healthy life (Bastos, Pereira, & Vilhena, 2021). There are four dimensions to food security: availability, access, stability, and usage. All four dimensions must be met at the same time. Food security is a primary concern in all these endeavors, as it is a basic human necessity (Eftimov, Popovski, Petković, Seljak, & Kocev, 2020; Gibson, 2012). Food security has been affected by the lockdown and restrictions on movements within and across countries as logistical services related to food and food supply chains are disrupted (Ingram, 2020). Ill health, social distancing, constraints on movements, and inadequate labor have greatly affected agricultural producers, processors, traders, and logistics companies in food supply chains. Canned, frozen, or dried foods are largely imported instead of perishable food. It has been affected by restrictions on movement and restrictions on food exports by some food exporting companies. Some countries placed export restrictions on certain food items to preserve local supply and to defend the local market from excessive demand. The closure of eateries and food outlets affected the demand for fresh produce (Ingram, 2020). Food wastage and loss were increased due to the blockage of transport routes used in the fresh foods supply chain. Farmers complained that their crops and fruits were rotting due to the unavailability of delivery trucks in adhering to lockdown orders. Imported food items were so expensive due to high demand.

The pandemic has also affected the prices of food leading to food price surges. The pandemic has increased the price of staple food in Ghana severely. Availability and affordability of food were affected by the pandemic due to inadequacies in production and distribution. In addition, the pandemic has destroyed businesses, especially small and medium enterprises with a severe impact on owners and their workforce. A survey conducted by regular exporters revealed that the most important factor responsible for the drop in exports during the second quarter of 2020 was a drop in foreign demand (Larik & Ponzio, 2021).

## 4. IMPACT OF COVID-19 ON THE ACTORS OF LOCAL FOOD SYSTEMS

The COVID-19 pandemic has had an unparalleled impact on the entire world, and Ghana is no exception (Nandi, Nedumaran, Selvaraj, Mazumdar, & Kumar, 2021). Researchers from a variety of disciplines struggled to

assess and comprehend the impacts of the pandemic on food, nutrition, health, and overall lives, particularly in low- and middle-income nations. The pandemic is threatening livelihoods and lives, and it has turned into not only a health but also an economic problem (Poudel et al., 2020; Rizou, Galanakis, Aldawoud, & Galanakis, 2020). The impacts of the pandemic on Ghana's agriculture industry have been severe, disrupting entire agricultural value chains from farmer to end consumer. Lack of transportation, market limitations, labor constraints, insufficient supply of quality inputs, opportunistic behavior of intermediaries to maintain high margins, and fear of infection from COVID-19 have all put a burden on Ghana's food supply (De Paulo Farias & Dos Santos Gomes, 2020). On the other hand, expenditures on food, health, cleanliness, and other vital services have increased. Despite the fact that life is gradually returning to normal, the impacts of COVID-19 continue to ripple across industries, including agriculture and the food value chain.

### *4.1. Farmers*

The COVID-19 pandemic has had a double impact on smallholder, marginal farmers, and farm laborers. Farm activities were delayed, postharvest losses increased, and production costs increased significantly due to high labor costs and input prices, all of which have resulted in a major drop in household income (Quayson, Bai, & Osei, 2020). The COVID-19 pandemic, according to Nandi et al. (2021) imposed a twofold burden on farmers by interrupting farm production on the one hand and reducing diet diversity on the other. Farm output disruptions led to lower household income and higher consumer food costs. The impact on farmers soared to other actors in the value chain, with varying degrees of impact on each. During the pandemic, the availability of storage infrastructure would have saved the farmer's household income to some extent. Farm operations were hampered at the production level due to a lack of transportation, local government limitations, market closures, and a lack of labor for farm activities. Planting was delayed for close to two weeks in some farming communities due to delayed rains aggravated by COVID-19 and others reduced their total area under cultivation due to uncertainties about the future demand (Agyei-Holmes, Ankrah, & Boakye, 2021).

The lockdown introduced by the government of Ghana did not only impact the affected areas but other regions. For instance, farmhands who wanted to travel from Kwame Danso to Ejura and neighboring comminutes to offer farm services could not do so. Similarly, Farmers who wanted to travel to the lockdown cities to purchase farm implements and other inputs could not do so. This unavoidably affected production levels and consequently overall output for the 2020 planting season. The lack of labor is due not only to local government constraints but also to the rural community's dread of COVID-19 infection. Due to a lack of or inadequate transportation infrastructure, massive post-harvest losses have been documented (Hodey & Dzanku, 2020). These postharvest losses occur in most of the food basket regions, particularly in the Ahafo Region, Bono Region, Bono East Region, Northern Region, and some parts of the Ashanti Region. Furthermore, due to border closures, farm-level Aggregators ceased buying farm produce, resulting in a lack of demand for the commodity from large customers such as local marketplaces, urban dealers, and main processors.

### *4.2. Aggregators*

The COVID-19 pandemic will continue to wreak havoc on many sectors of the economy, including agriculture, which serves as the backbone of Ghana's economy (Ibn-Mohammed et al., 2021). Aggregators, mainly women who are retailers of farm produce in towns and cities benefit greatly from the food supply chain. The activities of this food supply chain actors were directly affected when the government imposed movement restrictions and deployed the military into towns and cities to enforce the partial lockdown. Few aggregators traveled to farming areas to buy farm produce and this puts a strain on the already fragile rural-urban food network. The decline in the number of fresh food vendors in our markets, as well as the closure of restaurants, hotels, and other local eateries, has dramatically reduced the purchase of fresh food (Agyei-Holmes et al., 2021).

As a result of the slower pace in obtaining fresh foods due to the lockdown measures, a large number of aggregators ceased the carting of foods from rural communities. Low-income individuals stayed at home to observe the government's directive and this adversely impacted families' income and purchasing power (Agyei-Holmes et al., 2021). All these factors adversely affected food supply chains. Consequently, the majority of individuals could not afford to buy fresh produce. For instance, consumers frequently purchase tomato paste, which remained relatively cheaper compared to fresh tomatoes.

### *4.3. Processors*

Food security is determined not only by the availability of food but also by its accessibility and consumption. The COVID-19 pandemic has affected the processing industry in different ways such as increasing consumer awareness of the hygiene and safety of processing of various food products. These processes include packaging materials, digital printing, and packaging for e-commerce shipments, as well as rethinking the materials and design requirements of sustainable processing techniques and packaging (Boyact-Gündüz, Ibrahim, Wei, & Galanakis, 2021). COVID-19 impacted negatively on processors such as price spikes, lack of innovation owing to lack of investment, demand collapsed due to lockdowns, low income, and unemployment (Hailu, 2020). Food shortages and price hikes were linked to a shortage in the supply of raw materials due to border restrictions, as well as inadequate labor available for production and harvesting. For example, highly perishable commodities like fruits, vegetables, and fisheries need a lot of possessing (Batool, Imran, & Tanweer, 2020; Cullen, 2020).

### *4.4. Traders*

The Impact of the COVID-19 pandemic on local marketers in Ghana was evident due to the rapid development of e-commerce and direct connection of farmers with consumers, reduced local availability, and disruption of transportation flows. For instance, traders in Accra and Kumasi central markets complained of low sales because security agents refused to let shoppers inside the market unless they showed proof that they lived a few meters away. Furthermore, traders in Accra and Kumasi who were ordered to remain at home during the three-week partial shutdown were in a more vulnerable financial condition. Shoppers avoided purchases in the neighborhood markets, causing similar concerns. Poor sales have been demonstrated in studies to have economic (capital loss, insufficient savings, and inability to satisfy immediate family duties) and socio-psychological consequences for merchants (Asante & Helbrecht, 2020).

### *4.5. Consumers*

A study conducted by Janssen (2021) on the changes in food consumption of three countries during the COVID-19 pandemic revealed that some people decreased and others increased their consumption frequencies, demonstrating that the pandemic had different impacts on people's lifestyles and food consumption patterns. Food is essential for personal health as well as the health of the world, given that present food production and consumption practices have significant environmental consequences. Disasters like the COVID-19 pandemic disrupted our food system and altered our relationship with food and with ramifications at numerous levels and across supply chains Figure 3.

For example, in order to reduce the spread of the pandemic, the restriction on the movement of logistics and the flow of commodities has greatly resulted in food shortages. Additionally, partial or total lockdown measures implemented at regional and national levels, such as the closure of schools, workplaces, non-essential shops, and restaurants, and a ban on events, changed how people obtained and prepared food. Some of these restrictions have made getting food to individuals in need more difficult (Janssen, 2021). During this period, the government and other philanthropists donated food to the vulnerable.

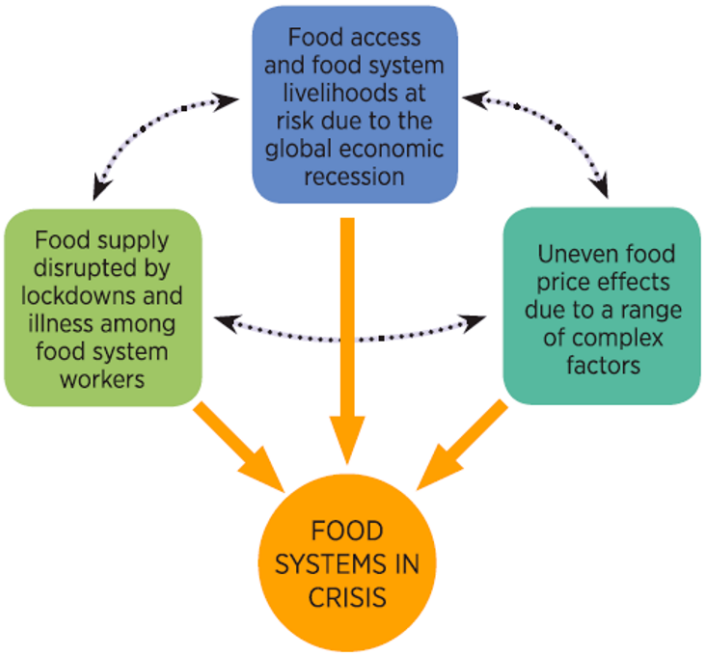


**Figure 3**. The impact of COVID-19 on the food system (Clapp & Moseley, 2020).

## 5. IMPACT OF COVID-19 ON THE POULTRY AND LIVESTOCK FARMING SYSTEMS

Globally, many sectors including the poultry, livestock, and aqua farming sectors have suffered significant losses as a result of the COVID-19 pandemic. The lockdown and other restrictive measures introduced to minimise the spread of the disease compounded the effects of the Pandemic on the poultry, livestock, and aqua farming systems in Ghana. The consequences on the health, livelihoods and income among others resulting from the influence of the Pandemic on poultry, livestock, and aqua sectors are unimaginable. This is because chicken, eggs, meat, and fish contribute a lot to the food basket and nutrition security in the country. Farm animals for instance are noted to provide around 13% of calories and 28% of protein demand globally. They contribute to crop production and productivity by serving as a source of transportation and manure respectively (FAO, 2011). Consumption of foods from animal sources such as meat, dairy, eggs, and fish is substantially linked to lower rates of stunted growth in children and other signs of malnutrition (Headey, Hirvonen, & Hoddinott, 2018).

### *5.1. Poultry Farming*

Even though, poultry production is mainly a rural activity accounting for 60-80% of total production (FAO, 2017) the sector has not been spared of the effects of COVID and the restrictive measures introduced globally in the country. An analysis of the effects of the Pandemic on the poultry sector revealed effects, including limited access to raw materials for the industry, low productivity due to inadequate attention to the welfare of the birds, and low sales of poultry products. All these have resulted in an increased demand for locally based raw materials. Most countries in Africa, including Ghana, depend on importation for the supply of feed ingredients and breeding materials, including parent stock and grand-parent stock (Uyanga, Onagbesan, Onwuka, Emmanuel, & Lin, 2021). In Ghana, day-old chicks, poultry feed, medication, and other logistics are largely imported, and therefore negatively affected by the restrictions on the movement and imports of goods during the pandemic. The international poultry Council, for instance, cautioned that if the bans on travelling are prolonged, the stock for breeding and eggs for hatching will be unavailable for most developing countries (Vorotnikov, 2020). The FaAOotU (2020) also observed that farmers' access to breeding materials such as semen and replacement stocks such as chicks was hampered by movement restrictions and interruption of national and international trade network systems (FaAOotU, 2020). Low sales of poultry products were a key finding of the effect of COVID-19 on the poultry sector. As reported by the Ghana Statistical Service (2020), low sales and increased pressure from financial

institutions to repay borrowed loans have harmed the majority of poultry farmers in the country. The partial lockdown slowed down demand for poultry because of the lockdown of restaurants, pubs, and drinking bars.

Another negative area of influence of the Pandemic on the poultry industry is the low productivity of the sector. The restriction on the movement of people and social distancing affected the welfare of the birds. This was because routine activities such as feeding, watering, cleaning of pens, egg collection, vaccination, and drug administration were seriously hampered. The positive finding of the Pandemic on the sector is that it created a demand for locally based raw materials. In the absence of imported stocks, farmers were forced to rely on local sources of stocks for their businesses. This created market for local suppliers of poultry feeds and other materials. As reported by Obese, Osei-Amponsah, Timpong-Jones, and Bekoe (2021), before the outbreak of the pandemic, our local farmers imported the day-old chicks instead of patronizing the local hatcheries. However, due to the closure of land and marine borders, farmers were not able to import the day-old chicks and this led to an increased demand for day-old chicks from our local hatcheries.'

### *5.2. Livestock Farming*

Animal production in Ghana, like that of other countries in Africa, has been affected by the negative impacts on stakeholders' activities in the livestock value chain. Feed production and supply, communal grazing, sustainable use and conservation, and provisions of veterinary services, such as artificial insemination, livestock trade, transport, slaughtering, processing, and marketing of livestock products have been hindered by the Pandemic (Obese et al., 2021). As a consequence of the restrictions on gatherings and movements, many social and religious celebrations such as Easter could not be held and this affected the demand for livestock products negatively (Aduhene & Osei-Assibey, 2021). The lockdown led to reduced access to animal feed and pasture which impacted livestock production negatively, particularly in weight gain, production of milk, reproduction, and many others. Due to decongestion and the close down of some markets, some food materials for making livestock feeds such as maize, wheat, soybean, and fishmeal, were in low supply, resulting in price hikes (Asante & Mills, 2020). Global price trends also obscure the wide variation in the extent to which prices have fluctuated at the local level as a result of the pandemic, with some countries experiencing relatively stable or only moderately increased prices, while others have experienced massive food price increases, as shown in Table 1.

**Table 1.** Examples of the wide variation in local food price changes in the context of COVID-19.

| Country | Local food price % change from 02/14/20 to 07/09/20 |
|---|---|
| Switzerland | +0.7 |
| Kenya | +2.6 |
| United Kingdom | +2.9 |
| Canada | +3.6 |
| USA | +4.5 |
| Indonesia | +4.9 |
| India | +5.3 |
| Brazil | +6.3 |
| Nigeria | +6.2 |
| Mexico | +6.5 |
| South Africa | +7.8 |
| Tanzania | +14.1 |
| Botswana | +16.5 |
| Haiti | +16.5 |
| Ghana | +20.0 |
| Sudan | +21.8 |
| Zambia | +29.0 |
| Venezuela | 47.0 |
| Guyana | +49.8 |

The number of animals in livestock markets and cross-border animal movements both declined substantially (Bisson, 2020). Ghana imports live animals from the neighboring West African countries in order to supplement the protein needs of the country. The closing of the land border significantly hampered livestock traffic into the country, especially from the Sahel regions of West Africa (Asante & Mills, 2020). This affected the number of animals that were available for slaughter each day in the abattoir. Few weeks leading up to the lockdown at the Paga animal entry point, a total of 3,579 cattle, 1,985 sheep, and 3,978 goats were imported, but the numbers were cut to 1,525 (57 percent), 780 (61 percent), and 1,423 (64 percent), respectively, during the lockdown period (Obese et al., 2021). The COVID-19 pandemic had a significant impact on the quantity of meat that was produced in a day and the supply chain and this led to an increase in the price of meat. In the Kumasi abattoir, for instance, production of meat reduced drastically during the lockdown which led to an increase in the price of meat (Obese et al., 2021). The partial lockdown also slowed down the activities of hotels, restaurants, pubs, and drinking bars.

The aforementioned places have a great demand for livestock products. For instance, before the restrictions on drinking pubs and bars in Ghana, kebab sellers roasted and sold meat almost every evening in bars and pubs. The partial lockdown during the pandemic also affected the purchasing power of consumers because they stayed at home adhering to precautionary measures (Dickson & Yao, 2020). This led to low affordability and affected the quantity of meat that could be purchased by households.

The restrictions have also had a detrimental impact on the services offered by veterinarians to livestock farmers. In general, most livestock farmers in Ghana do not patronize veterinary services for their animals due to a scarcity of veterinarians and the high cost of services and drugs. Unfortunately, the COVID-19 pandemic has made matters worse, as the few available services have become more expensive and difficult to access (Obese et al., 2021). Observation of social distancing, and staying at home to avoid the transmission of the virus from one person to another, also affected the availability of labor in farms.

### *5.3. Aquaculture*

The habitats of aquatic species include seas, lakes, rivers, lagoons, ponds, dams, etc. The novel COVID- 19 affected every sector of which the aqua farming was not spared. In Ghana, the fishing industry generated more than $1 billion in 2015 (Ameyaw, Tsamenyi, McIlgorm, & Aheto, 2021). Fish is the primary source of low-cost protein in Ghana, accounting for roughly 60% of animal protein in the local diet (N'Souvi, Sun, Zhang, Broohm, & Okey, 2021). Fish contributes significantly to the supply of critical micronutrients, with per capita consumption of fish (24 kg) in Ghana significantly greater than the world average (16 kg) (Hicks et al., 2019). The fishing sector in Ghana employs approximately 10% of the people and is a major contributor to livelihoods in coastal areas (N'Souvi et al., 2021). Ghana's aquaculture has seen great development in production over the last decade, contributing to improved incomes and livelihoods (Ragasa et al., 2022). Ghana is now the second-largest tilapia grower in Sub-Saharan Africa (SSA), trailing only Egypt on the African continent (Ragasa et al., 2022).

## 6. MEASURES TO PREVENT FOOD INSECURITY IN GHANA DURING COVID-19 OUTBREAK

Ghana is known for being self-sufficient in root and tuber production (Agyei-Holmes et al., 2021). Prior to the emergence of COVID-19, the majority of roots and tubers were produced in enormous amounts to suit Ghanaian demand. These crops (yam, cocoyam, and cassava) lasted all year in 2020 (Nkegbe, Abu, & Issahaku, 2017).

Ghana's government imposed a three-week lockdown in several sections of the country (Greater Accra and Greater Kumasi Metropolitan Areas). To help strengthen the agricultural sector's resilience and lessen the threat to Ghana's food security, the sector was exempted from the limitations, with specific exemptions made for important production to be carried out (Agyei-Holmes et al., 2021). This meant that (a) all farmers could proceed to farm as usual; (b) input suppliers and retailers could continue to distribute and sell farm inputs; (c) farm input

transportation within lockdown zones and throughout the country could continue uninterrupted; and (d) food processing companies could continue to produce and distribute their products (Amewu, Asante, Pauw, & Thurlow, 2020). Agriculture and fishing were both recognized as essential services, hence this exemption was granted (Okyere et al., 2020).

Another significant effort in the government's reaction to the pandemic was the food distribution drive to serve food packages and hot meals to roughly a million poor people in places facing lockdown restrictions (Dzigbede & Pathak, 2020). People were only allowed to go out to get essential commodities like food, medications, and water, as well as to conduct banking transactions and use public restrooms. Private cars and aircraft that provide critical services or transport freight were permitted to operate. This was done to ensure that market traders have access to fresh products on a regular basis. Market traders who provide critical services such as the manufacture, distribution, and marketing of food, beverages, pharmaceuticals, medication, plastic packages, and paper were spared from the partial lockdown, while all other traders were ordered to stay at home (Asante & Mills, 2020). Aside from government assistance, a number of generous individuals and organizations gave food to those in need (Salifu Yendork & James, 2020).

Finally, as part of ways to mitigate COVID-19, Ghana implemented a three-and-a-half-year 100 billion Ghana COVID-19 Alleviation and Revitalization of Enterprises Support (CARES) Obaatanpa Program from November 2020. The program is divided into two phases, the first of which aims to alleviate Ghanaians' hardships by lowering the cost of basic services, ensuring food security, protecting enterprises and workers, and enhancing the health system. The government of Ghana took the following steps to achieve food security: (a) Broaden support from 1.2 million to 1.5 million farmers under the Planting for Food and Jobs Program (PFJ); (b) Aid farmers through the Rearing for Food and Jobs Program (RFJ); (c) Arrange financing facilities for rice millers and poultry farmers; and (d) Give financial support for the National Food Buffer Stock Company and the National Food Buffer Stock Company. The government is working to extend the buffer stock system, which is a platform for managing food stock such as legumes and grains with the goal of providing meals to Ghana's Senior High Schools (SHS) and other pre-secondary school feeding programs. When schools in Ghana were closed due to COVID-19 in May 2020, the Ghana Education Service worked with the National Food Buffer Stock Company to collect unsold foods from various SHS and transfer them to the Ghana Prisons Service to feed disadvantaged convicts. The Ghana Commodity Exchange also supported grain and legume marketing. This helped to ensure the availability and accessibility of grains in Ghanaian communities (Agyei-Holmes et al., 2021).

## 7. EMERGING LESSONS AND BUILDING RESILIENCE

There is no doubt that the world will have to cope with one or more issues from time to time. If it is not extreme poverty and hunger, then it is a financial meltdown. If it is not climate change, it may be a pandemic like the one that is currently affecting us (COVID-19). Most of the time, humanity has risen to the occasion by putting various resources together to combat our common ills. COVID-19's outbreak and reaction in Ghana demonstrate the continuation of major urban sustainability challenges. The COVID-19 outbreak revealed significant structural issues in the housing, transportation, health, sanitation, water, and hygiene sectors. These structural flaws reduce the efficiency of urban networks while also reducing policymakers' ability to deal effectively with COVID-19. Even though reported cases in Ghana were not that many, health facilities to contain the pandemic became topical issues as there were no adequate accommodations to house infected persons in some areas. As a result of the informal sector's dominance (economic), the fast expansion of slums in urban areas (social), and poor social structures and support systems, Ghana was unable to lock down for more than three weeks. In fact, metropolitan areas, rather than rural areas, are more vulnerable to the COVID-19 pandemic's rapid spread, raising doubts about the resilience of urban populations.

The government of Ghana, through the Ministry of Food and Agriculture, is undertaking the "COVID-19 Alleviation and Revitalization of Enterprises Support (GHANA CARES)" program as part of attempts to mitigate the impact of the COVID-19 pandemic on Ghanaians' lives and livelihoods. Agriculture was regarded as a critical component of this program, with the potential to revitalize and change Ghana's economy. In support of the government's import substitution program, one of the interventions is to provide interest rate subsidies (IRS) to private actors in the rice, soya bean, tomato, and chicken value chains to make access to inexpensive finance easier. Another measure toward strengthening resilience in this COVID-19 era, according to Ankrah, Agyei-Holmes, and Boakye (2021) is the necessity for key policy actions to consolidate advances gained in Ghana's planting for food and jobs, as well as investments in storage facilities to store additional grains. Furthermore, the Ghanaian government has asked all metropolitan, municipal, and district assemblies (MMDAs) to make sure that all COVID-19 expenditures are budgeted for and included in their sector in the years 2022-2025. Effective collaboration between the private, academic, and public sectors should serve as the strategic foundation for enhancing Ghana's health sector and other sections of the economy in response to the COVID-19 pandemic.

## 8. CONCLUSION

The food system in Ghana has been severely disrupted, with ramifications at numerous levels and across supply chains. Price instability, market manipulation, and stockpiling are all having an impact on food costs in some parts of the country with negative consequences for the nutrition of the most vulnerable. Hunger was projected to kill more vulnerable individuals in Ghana than the COVID-19 disease if the government did not act immediately. One of the main considerations in Ghana's President's decision to release the lockdown on April 21, much to the astonishment of many world leaders, was the terrible impact of the lockdown on marketers and traders, as well as the urban poor. Ghana's government recognizes the importance of being at the forefront of efforts to develop the foundations for an inclusive and long-term recovery following the COVID-19 disease. Food supply and availability will be affected in the future if agricultural production is not strengthened and productivity-boosting methods are not developed. Understanding and assessing the pandemic's ongoing influence on food security is a topic of research that needs to be pursued further.

**Funding:** This study received no specific financial support.
**Competing Interests:** The authors declare that they have no competing interests.
**Authors' Contributions:** All authors contributed equally to the conception and design of the study.

## REFERENCES

Aduhene, D. T., & Osei-Assibey, E. (2021). Socio-economic impact of COVID-19 on Ghana's economy: Challenges and prospects. *International Journal of Social Economics*, *48*(4), 543-556.

Agyei-Holmes, A., Ankrah, D. A., & Boakye, A. A. (2021). COVID-19 and Ghana's agri-food system: An assessment of resilience. *African Geographical Review*, 1-22.Available at: https://doi.org/10.1080/19376812.2021.1971096.

Al-Tawfiq, J. A., & Memish, Z. A. (2020). COVID-19 in the Eastern mediterranean region and Saudi Arabia: Prevention and therapeutic strategies. *International Journal of Antimicrobial Agents*, *55*(5), 105968.Available at: https://doi.org/10.1016/j.ijantimicag.2020.105968.

Amewu, S., Asante, S., Pauw, K., & Thurlow, J. (2020). The economic costs of COVID-19 in sub-Saharan Africa: Insights from a simulation exercise for Ghana. *The European Journal of Development Research*, *32*(5), 1353-1378.Available at: https://doi.org/10.1057/s41287-020-00332-6.

Ameyaw, G. A., Tsamenyi, M., McIlgorm, A., & Aheto, D. W. (2021). Challenges in the management of small-scale marine fisheries conflicts in Ghana. *Ocean & Coastal Management*, *211*, 105791.Available at: https://doi.org/10.1016/j.ocecoaman.2021.105791.

Ankrah, D. A., Agyei-Holmes, A., & Boakye, A. A. (2021). Ghana's rice value chain resilience in the context of COVID-19. *Social Sciences & Humanities Open*, *4*(1), 100210.Available at: https://doi.org/10.1016/j.ssaho.2021.100210.

Asante, L. A., & Helbrecht, I. (2020). Urban governance and its implications for the micro-geographies of market trading in Ghana: A case of the Kotokuraba market project in Cape Coast. *Geo Journal*, *85*(5), 1203-1225.Available at: https://doi.org/10.1007/s10708-019-10018-0.

Asante, L. A., & Mills, R. O. (2020). Exploring the socio-economic impact of COVID-19 pandemic in marketplaces in urban Ghana. *Africa Spectrum*, *55*(2), 170-181.Available at: https://doi.org/10.1177/0002039720943612.

Ayouni, I., Maatoug, J., Dhouib, W., Zammit, N., Fredj, S. B., Ghammam, R., & Ghannem, H. (2021). Effective public health measures to mitigate the spread of COVID-19: A systematic review. *BMC public health*, *21*(1), 1-14.Available at: https://doi.org/10.1186/s12889-021-11111-1.

Bastos, D., Pereira, M., & Vilhena, E. (2021). *Sustainability and food safety: Challenges and impacts*. Paper presented at the 1st Symposium of Applied Science.

Basu, D., Salvatore, M., Ray, D., Kleinsasser, M., Purkayastha, S., Bhattacharyya, R., & Mukherjee, B. (2020). A comprehensive public health evaluation of lockdown as a non-pharmaceutical intervention on COVID-19 spread in India: National trends masking state level variations. *medRxiv*, 1-25.Available at: https://doi.org/10.1101/2020.05.25.20113043.

Batool, A., Imran, S., & Tanweer, A. (2020). Relative nutritional and phytochemical composition of citrus fruit compartments- a case against wasting citrus peels. *Nurture*, *14*(1), 6–11.Available at: https://doi.org/10.55951/nurture.v14i1.8.

Bisson, L. (2020). COVID-19 impact on West African value chains. Clingendael Institute. Retrieved from: https://www.jstor.org/stable/pdf/resrep25675. [Accessed 01/02/2022].

Bo, Y., Guo, C., Lin, C., Zeng, Y., Li, H. B., Zhang, Y., . . . Kwok, K. O. (2021). Effectiveness of non-pharmaceutical interventions on COVID-19 transmission in 190 countries from 23 January to 13 April 2020. *International Journal of Infectious Diseases*, *102*, 247-253.Available at: https://doi.org/10.1016/j.ijid.2020.10.066.

Bonadio, B., Huo, Z., Levchenko, A. A., & Pandalai-Nayar, N. (2021). Global supply chains in the pandemic. *Journal of International Economics*, *133*, 103534.

Boyacı-Gündüz, C. P., Ibrahim, S. A., Wei, O. C., & Galanakis, C. M. (2021). Transformation of the food sector: Security and resilience during the COVID-19 pandemic. *Foods*, *10*(3), 497.Available at: https://doi.org/10.3390/foods10030497.

Burns, J., Movsisyan, A., Stratil, J. M., Coenen, M., Emmert-Fees, K. M., Geffert, K., & Rehfuess, E. (2020). Travel-related control measures to contain the COVID-19 pandemic: A rapid review. *Cochrane Database of Systematic Reviews*, *9*, 1-165.Available at: https://doi.org/10.1002/14651858.CD013717.

Clapp, J., & Moseley, W. G. (2020). This food crisis is different: COVID-19 and the fragility of the neoliberal food security order. *The Journal of Peasant Studies*, *47*(7), 1393-1417.Available at: https://doi.org/10.1080/03066150.2020.1823838.

Cullen, M. T. J. F. R. (2020). Italy, COVID-19 and the risk to food supply chains: How to respond.

Cullen, M. T. (2020). Coronavirus food supply chain under strain what to do. What to Do, Food and Agriculture Organization, 1-39. Retrieved from: https://www.fao.org/3/ca8308en/ca8308en.pdf [Accessed 15/06/2021].

De Paulo Farias, D., & Dos Santos Gomes, M. (2020). COVID-19 outbreak: What should be done to avoid food shortages? *Trends in Fod Science & Technology*, *102*, 291-292.Available at: https://doi.org/10.1016/j.tifs.2020.06.007.

Dickson, R. S., & Yao, D. (2020). The impact and opportunities of COVID-19 in Ghana. *Open Journal of Social Sciences*, *8*(10), 71.Available at: https://doi.org/10.4236/jss.2020.810006.

Dzigbede, K. D., & Pathak, R. (2020). COVID-19 economic shocks and fiscal policy options for Ghana. *Management*, *32*(5), 903-917.Available at: https://doi.org/10.1108/jpbafm-07-2020-0127.

Eftimov, T., Popovski, G., Petković, M., Seljak, B. K., & Kocev, D. (2020). COVID-19 pandemic changes the food consumption patterns. *Trends in Food Science & Technology*, *104*, 268-272.Available at: https://doi.org/10.1016/j.tifs.2020.08.017.

Ejeromedoghene, O., Tesi, J., Uyanga, V., Adebayo, A., Nwosisi, M., Tesi, G., & Akinyeye, R. (2020). Food security and safety concerns in animal production and public health issues in Africa: A perspective of COVID-19 pandemic era. *Ethics, Medicine and Public Health*, *15*, 100600.Available at: https://doi.org/10.1016/j.jemep.2020.100600.

FaAOotU, N. (2020). Guidelines to mitigate the impact of the COVID-19 pandemic on livestock production and animal health. *Rome. [Google Scholar]*, 1-20.Available at: https://doi.org/10.4060/ca9177en.

FAO. (2011). World livestock 2011 – livestock in food security. Rome, FA. Retrieved from: https://www.fao.org/3/i2373e/i2373e.pdf. [Accessed 02/02/2020].

FAO. (2017). Report of the workshop on climate proofing aquaculture in sub-Saharan Africa: Review of policies and production systems for climate change resilience. Retrieved from: https://www.fao.org/3/i6907e/i6907e.pdf.

Ghana Statistical Service. (2020). Mobility analysis to support the government of Ghana in responding to the COVID-19 outbreak. Retrieved from: https://statsghana.gov.gh/gsspublications.php?category=MTkwMDE4MjI2Ny4xMDg=/webstats. [Accessed 02/05/2022].

Gibson, M. (2012). *The feeding of nations: Redefining food security for the 21st century* (1st ed.). Boca Raton, Fl. USA: CRC Press; Taylor and Francis Group.

Hailu, G. (2020). Economic thoughts on COVID-19 for Canadian food processors. *Canadian Journal of Agricultural Economics*, *68*(2), 163-169.Available at: https://doi.org/10.1111/cjag.12241.

Hasnain, M., Pasha, M. F., & Ghani, I. (2020). Combined measures to control the COVID-19 pandemic in Wuhan, Hubei, China: A narrative review. *Journal of Biosafety and Biosecurity*, *2*(2), 51-57.Available at: https://doi.org/10.1016/j.jobb.2020.10.001.

Headey, D., Hirvonen, K., & Hoddinott, J. (2018). Animal sourced foods and child stunting. *American Journal of Agricultural Economics*, *100*(5), 1302–1319.Available at: https://doi.org/10.1093/ajae/aay053.

Hicks, C. C., Cohen, P. J., Graham, N. A., Nash, K. L., Allison, E. H., D'Lima, C., . . . Thorne-Lyman, A. L. (2019). Harnessing global fisheries to tackle micronutrient deficiencies. *Nature*, *574*(7776), 95-98.Available at: https://doi.org/10.1038/s41586-019-1592-6.

HLPE. (2020). *Interim issues paper on the impact of COVID-19 on food security and nutrition (FSN) by the high-level panel of experts on food security and nutrition (HLPE)*. Italy: FAO Rome.

Hodey, L. S., & Dzanku, F. M. (2020). Impact of COVID-19 on food systems and rural livelihoods in Ghana. APRA COVID-19 Country Report, Brighton: Future Agricultures Consortium.

Hossain, M. P., Junus, A., Zhu, X., Jia, P., Wen, T.-H., Pfeiffer, D., & Yuan, H.-Y. (2020). The effects of border control and quarantine measures on the spread of COVID-19. *Epidemics*, *32*, 100397.Available at: https://doi.org/10.1016/j.epidem.2020.100397.

Ibn-Mohammed, T., Mustapha, K., Godsell, J., Adamu, Z., Babatunde, K., Akintade, D., . . . Yamoah, F. (2021). A critical analysis of the impacts of COVID-19 on the global economy and ecosystems and opportunities for circular economy strategies. *Resources, Conservation and Recycling*, *164*, 105169.Available at: https://doi.org/10.1016/j.resconrec.2020.105169.

Ingram, J. (2020). Nutrition security is more than food security. *Nature Food*, *1*(1), 2-2.Available at: https://doi.org/10.1038/s43016-019-0002-4.

Janssen, M., et al. (2021). Changes in food consumption during the COVID-19 pandemic: analysis of consumer survey data from the first lockdown period in Denmark (Vol. 8, pp. 60). Germany, and Slovenia.

Kuusaana, E. D., & Eledi, J. A. (2015). *As the city grows, where do the farmers go? Understanding Peri-urbanization and food systems in Ghana-evidence from the Tamale Metropolis*. Paper presented at the Urban Forum.

Lai, S., Ruktanonchai, N. W., Zhou, L., Prosper, O., Luo, W., Floyd, J. R., . . . Du, X. (2020). Effect of non-pharmaceutical interventions to contain COVID-19 in China. *Nature*, *585*(7825), 410-413.Available at: https://doi.org/10.1038/s41586-020-2293-x.

Larik, J., & Ponzio, R. (2021). Global governance beyond COVID-19: Recovery and institutional revitalisation. *Irish Studies in International Affairs*, *32*(1), 35-51.Available at: https://doi.org/10.1353/isia.2021.0054.

Meo, S. A., Abukhalaf, A. A., Alomar, A. A., AlMutairi, F. J., Usmani, A. M., & Klonoff, D. C. (2020). Impact of lockdown on COVID-19 prevalence and mortality during 2020 pandemic: observational analysis of 27 countries. *European Journal of Medical Research*, *25*(1), 1-7.Available at: https://doi.org/10.1186/s40001-020-00456-9.

N'Souvi, K., Sun, C., Zhang, H., Broohm, D. A., & Okey, M. K. N. (2021). Fisheries and aquaculture in Togo: Overview, performance, fisheries policy, challenges and comparative study with Ghana, Mali, Niger and Senegal fisheries and aquaculture. *Marine Policy*, *132*, 104681.Available at: https://doi.org/10.1016/j.marpol.2021.104681.

Nandi, R., Nedumaran, S., Selvaraj, A., Mazumdar, S. D., & Kumar, S. (2021). The COVID-19 induced disruptions across groundnut value chain: Empirical evidence from South India. *Sustainability*, *13*(4), 1-21.Available at: https://doi.org/10.3390/su13041707.

Nimako-Aidoo, E. D.-G. J., & Eric, O.-A. A. O. A. (2020). Data driven modeling of projected mitigation and suppressing strategy interventions for SARS-COV 2 in Ghana. *ArXiv Preprint ArXiv:2004.09009*, 1-21.Available at: https://doi.org/10.48550/arXiv.2004.09009.

Nkegbe, P. K., Abu, B. M., & Issahaku, H. (2017). Food security in the savannah accelerated development authority zone of Ghana: An ordered probit with household hunger scale approach. *Agriculture & Food Security*, *6*(1), 1-11.Available at: https://doi.org/10.1186/s40066-017-0111-y.

Nunan, D., & Brassey, J. (2020). *What is the evidence for mass gatherings during global pandemics? A rapid summary of best-available evidence*. Oxford (UK): The Centre for Evidence-Based Medicine: Oxford COVID-19.

Obese, F. Y., Osei-Amponsah, R., Timpong-Jones, E., & Bekoe, E. (2021). Impact of COVID-19 on animal production in Ghana. *Animal Frontiers*, *11*(1), 43-46.Available at: https://doi.org/10.1093/af/vfaa056.

Okyere, I., Chuku, E. O., Ekumah, B., Angnuureng, D. B., Boakye-Appiah, J. K., Mills, D. J., . . . Crawford, B. (2020). Physical distancing and risk of COVID-19 in small-scale fisheries: A remote sensing assessment in coastal Ghana. *Scientific Reports*, *10*(1), 1-13.Available at: https://doi.org/10.1038/s41598-020-79898-4.

Poudel, P. B., Poudel, M. R., Gautam, A., Phuyal, S., Tiwari, C. K., Bashyal, N., & Bashyal, S. (2020). COVID-19 and its global impact on food and agriculture. *Journal of Biology and Today's World*, *9*(5), 221-225.

Quayson, M., Bai, C., & Osei, V. (2020). Digital inclusion for resilient post-COVID-19 supply chains: Smallholder farmer perspectives. *IEEE Engineering Management Review*, *48*(3), 104-110.Available at: https://doi.org/10.1109/emr.2020.3006259.

Ragasa, C., Agyakwah, S. K., Asmah, R., Mensah, E. T.-D., Amewu, S., & Oyih, M. (2022). Accelerating pond aquaculture development and resilience beyond COVID: Ensuring food and jobs in Ghana. *Aquaculture*, *547*, 737476.Available at: https://doi.org/10.1016/j.aquaculture.2021.737476.

Regmi, K., & Lwin, C. M. (2021). Factors associated with the implementation of non-pharmaceutical interventions for reducing coronavirus disease 2019 (COVID-19): a systematic review. *International Journal of Environmental Research and Public Health*, *18*(8), 4274.Available at: https://doi.org/10.3390/ijerph18084274.

Rizou, M., Galanakis, I. M., Aldawoud, T. M., & Galanakis, C. M. (2020). Safety of foods, food supply chain and environment within the COVID-19 pandemic. *Trends in Food Science & Technology*, *102*, 293-299.Available at: https://doi.org/10.1016/j.tifs.2020.06.008.

Salifu Yendork, J., & James, S. (2020). COVID-19 in Ghana: Changes and the way forward. *Journal of Comparative Family Studies*, *51*(3-4), 369-384.Available at: https://doi.org/10.3138/jcfs.51.3-4.012.

Salvatore, M., Basu, D., Ray, D., Kleinsasser, M., Purkayastha, S., Bhattacharyya, R., & Mukherjee, B. (2020). Comprehensive public health evaluation of lockdown as a non-pharmaceutical intervention on COVID-19 spread in India: national trends masking state-level variations. *BMJ Open*, *10*(12), e041778.Available at: https://doi.org/10.1136/bmjopen-2020-041778.

Suh, H. H., Meehan, J., Blaisdell, L., & Browne, L. (2021). Effectiveness of non-pharmaceutical interventions on child and staff COVID-19 cases in US summer camps. *MedRxiv*, 1-16.Available at: https://doi.org/10.1101/2021.02.18.21250271.

Thu, T. P. B., Ngoc, P. N. H., & Hai, N. M. (2020). Effect of the social distancing measures on the spread of COVID-19 in 10 highly infected countries. *Science of the Total Environment*, *742*, 140430.Available at: https://doi.org/10.1016/j.scitotenv.2020.140430.

Uyanga, V. A., Onagbesan, O. M., Onwuka, C., Emmanuel, B., & Lin, H. (2021). Coronavirus disease 2019 (COVID-19) and poultry production: Emerging issues in African countries. *World's Poultry Science Journal*, *77*(1), 153-174.Available at: https://doi.org/10.1080/00439339.2021.1874848.

Vorotnikov, V. (2020). Coronavirus could disrupt poultry production. Retrieved from: https://www.poultryworld.net/poultry/coronavirus-could-disrupt-poultry-production. [Accessed 02/05/2022].