Global Sustainability Research
https://doi.org/10.56556/gssr.v2i2.447
ISSN: 2833-986X

RESEARCH ARTICLE

# Global impact of COVID-19 on the sustainability of livestock production

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Received: 24 February, 2023, Accepted: 28 March, 2023, Published: 30 March, 2023

**Abstract**
Global transmission of the 2019 coronavirus illness (COVID-19), caused by the coronavirus 2 strain associated with severe acute respiratory syndrome, has started (SARS-CoV-2). The pandemic has had far-reaching, devastating effects on human society, the natural world, and the environment on a global scale. The many links in the food production chain, particularly agriculture and cattle, are also badly impacted in terms of product sustainability and monetary losses. There has been a considerable drop in meat, milk, and egg production because of the global epidemic. National and international movement limitations enacted as part of public health sector control efforts have impacted the accessibility of inputs for livestock producers and farm outputs, veterinary services, farmworkers, and animal care businesses. As COVID-19 impacted the global livestock sector which is continuing, understanding and implementing sustainable approaches in livestock production is needed for both academia and industry. To respond to this need, this study carried out a systematic review of the existing literature on the impact of COVID-19 on the sustainability of livestock performance and welfare on a global scale. Significant consequences on livestock performance sustainability, worldwide animal welfare, and mitigation methods are discussed in this paper in light of the recent outbreak of COVID-19.

**Keywords:** Livestock production; COVID-19; Supply chain; Animal welfare; Sustainability

## Introduction

Worldwide anarchy in 2019 can be traced back to the pandemic Coronavirus epidemic that began that year. The disease has had such a terrible effect on people's health, economies, and social life all across the world that the World Health Organization (WHO) has declared it a pandemic (Zhou et al., 2020). A contributing element to the virus's virulence is the fact that COVID-19 was initially identified in zoo specimens (Tazerji et al., 2020). The virus destroyed all of the towns and ended life as it had been known before in a relatively short length of time. Although lockdown was an essential measure to halt the pandemic's spread, it had devastating unintended consequences for human and animal health and caused a financial disaster on a scale never previously witnessed. The inability of the populace to leave their homes has these results (Shehata et al., 2021).

COVID-19 has also had a significant negative impact on agricultural sectors worldwide (Rahman et al., 2021). This has had an obvious effect on the long-term viability of animal production systems, especially those that produce meat and milk, as well as supply chains, trade, and consumers' purchasing patterns (Bekuma, 2020). Global food insecurity is a big issue, especially because of the pandemic's effect on cattle production systems. The situation has worsened as a result of organizational shifts in animal care. As COVID-19 impacted the global livestock sector which is continuing, understanding and implementing sustainable approaches in livestock production is needed for both academia and industry. However, there is a research gap between COVID-19's impact on livestock production and the sustainability of livestock performance. To fill up this research gap, this study carried out a systematic review of the existing literature on the impact of COVID-19 on the sustainability of livestock performance and welfare on a global scale. The key concerns of this study are the long-term viability of livestock production and the impact that COVID-19 has had on the health and well-being of animals.

This review accumulates information from various organizational reports, cited observations, and scientific papers in order to illustrate how the outbreak of COVID-19 has affected livestock production all over the world, including the dairy, beef, and poultry industries, as well as their respective management systems. This kind of information and data might be helpful in making substantial efforts to improve the current situation and to assert learning for our future, with a particular emphasis on food security through sustainable livestock

production. Moreover, this study highlights COVID-19's effects on animal welfare and health which could be helpful to achieve sustainability of farming operations. Furthermore, this article provides recommendations for improved animal husbandry during the COVID-19 pandemic and the sustainability of livestock production.

**Methodology**

To provide a complete understanding of the sustainability of livestock performance and welfare on a global scale, this study conducted a systematic literature review to summarize the results and discussions on studies that cover the impact of COVID-19 on the sustainability of livestock production. A systematic review of the scientific literature leads to the selection of 44 documents published between 2020 to 2022. The documents were collected from Web of Science (WOS), Scopus, and Google Scholar databases. Figure 1 presents the development of criteria for document selection to conduct the review. This work presents an overview of the impact of COVID-19 on the sustainability of livestock performance and welfare on a global scale. To ensure the quality of the present study's findings, the development of a relevant agenda for future research, and provide appropriate recommendations for sustainable livestock production, this study included the research articles only from peer-reviewed journals. These papers were further analyzed to assess if the focus of their study was related to the present study's objective.

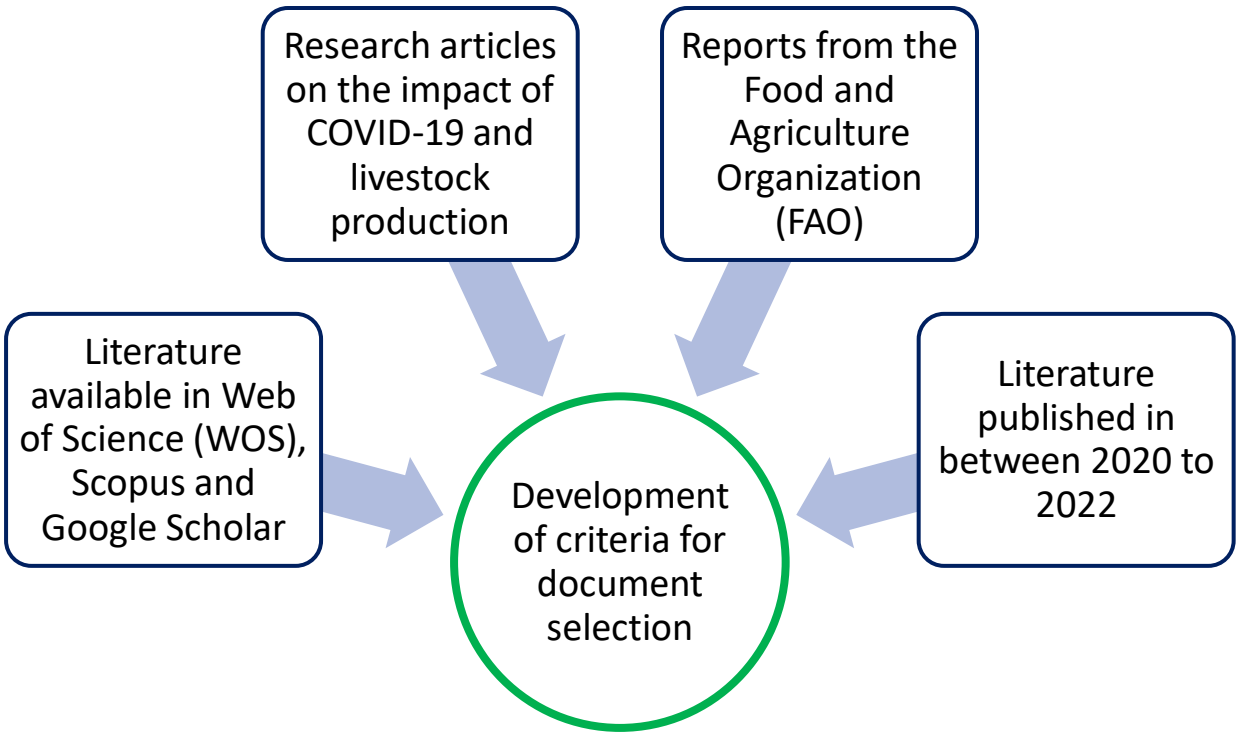


**Figure 1.** The development of criteria for document selection

**COVID-19's impact on livestock production**

Economy, food distribution networks, and people's standard of living are only few of the many spheres of influence that are intricately linked to livestock production systems (FAO, 2020a). The COVID-19 pandemic has had a devastating effect on the whole animal-rearing industry,

including its processing, transportation, sales, and consumer behavior (FAO, 2020b). Processing facility closures, travel restrictions, and quarantine/isolation practices all contributed to a scarcity of workers and/or the elimination of some jobs in the food supply chain. Hence, many countries' agricultural systems are under danger (FAO, 2020b). Backlogs have developed in the majority of Austria's animal production systems due to the labor issue. Eighty percent of Austria's meat processing industry workers are immigrants from Eastern European countries (Hashem et al., 2020). Between 60%-70% of Chinese dairy farms reported a lack of workers in February 2020. (Qingbin et al., 2020). In addition to other essential imported feed and feed ingredients, such as soybeans, wheat, and corn, a number of countries have said that they do not possess this commodity (Rahimi et al., 2022).

Developing countries have also suffered as a result of their reliance on international trade (Galanakis, 2020; Raihan, 2023a). Due to trade and movement limitations, several countries experienced a lack of veterinary services, production tools, vaccines, disinfectants, feed additives, and medications on the farm level (FAO, 2020b). The animals' health and well-being suffered as a result of this (Hashem et al., 2021). The global market for animals and animal products has also suffered severe harm as a result of the closure of a large number of retailers and restaurants, the implementation of a stringent lockdown, and the restriction of transit options. Twelve to fifteen percent less milk and cheese were consumed in the US (Gibbens, 2020). Sales of meat, eggs, and milk all dropped drastically in the United States, Southeast Asia, the Middle East, and Latin America during the COVID-19 pandemic (Galanakis, 2020). The lack of farmland has also contributed to an increase in the price of animal feed around the world (FAO, 2021a). The impact of COVID-19 on the long-term viability of cattle production systems is shown in Figure 2.

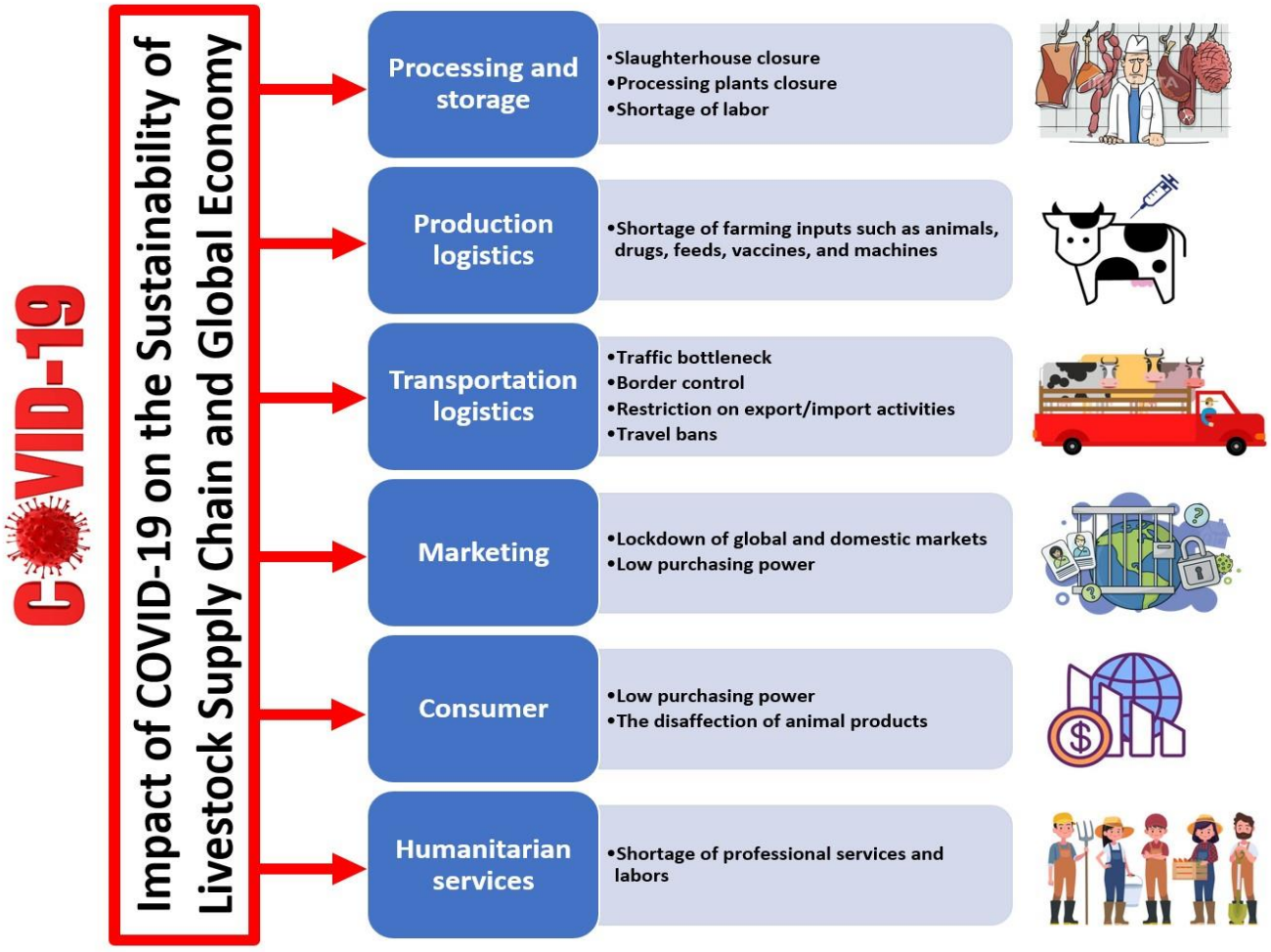


**Figure 2.** COVID-19 pandemic's effect on the sustainability of the livestock supply chain and the worldwide economy
**Source:** Adapted from FAO (2020b)

**COVID-19's impact on animal products**

This pandemic has generated significant secondary health concerns (for both humans and animals) and economic loss, despite the fact that social isolation and lockdown are necessary to limit and delay the spread of the virus (Shehata et al., 2021). This article explores how factors like lockdowns, isolation, panic, and employee illness affect livestock productivity.

**Meat**

Some specialists speculated at the outset of the pandemic that SARS-CoV-2 could be spread from humans in China to pangolins (WHO, 2021). The rising global population has resulted in a higher demand for meat and other foods (Raihan et al., 2021; Raihan et al., 2022a; Raihan and Said, 2022; Raihan, 2023b). The great bulk of the meat that is consumed by humans comes from livestock raised in intensive farming operations. The main components of worldwide animal production, imports, and meat exports are broken down into thousand tonnes of carcass weight equivalent and presented in Table 1 for the years 2019 and 2020 (before and during the COVID-19 pandemic). Since the beginning of the pandemic in 2019, there has been a decline in bovine meat output as well as decreases in imports and exports, whereas pig meat has shown the opposite trend (FAO, 2021b). In countries with a low income and a food deficit, production, imports, and exports of meat have all fallen. On the other hand, in developed countries, the output of meat has climbed while imports and exports of meat have decreased. In general, the findings indicate that the influence of COVID-19 on the production, imports, and exports of meat differs according to the kind of meat, with poultry meat being unaffected in comparison to other types of animal meat. In addition, the stages of development that countries are now in have a direct bearing on how output, imports, and exports shift through time.

**Table 1.** The livestock production, imports, and exports of meat (measured in thousand tons of carcass weight equivalent) worldwide before and after the COVID-19 pandemic

| Meat classifications | Production | | Imports | | Exports | |
|---|---|---|---|---|---|---|
| | 2019 | 2020 | 2019 | 2020 | 2019 | 2020 |
| Poultry | 131,562 | 133,266 | 12,451 | 12,501 | 14,241 | 14,226 |
| Pigs | 110,095 | 109,200 | 9,101 | 11,574 | 9,553 | 11,889 |
| Bovine | 72,410 | 71,408 | 10,627 | 10,650 | 11,335 | 11,193 |
| Ovine | 16,214 | 16,276 | 1,045 | 977 | 1,049 | 981 |
| Worldwide production of meat | 337,209 | 337,182 | 33,630 | 35,999 | 36,611 | 38,694 |
| Low-income nations with food deficits | 27,272 | 26,558 | 2,452 | 2,134 | 1,741 | 1,579 |
| Less developed nations | 14,448 | 14,570 | 1,483 | 1,393 | 56 | 50 |

Source: FAO (2021b)

Although there are no statistics available about the effects of the COVID-19 pandemic on the production of small ruminants, there has been claimed to be a short-term economic impact of COVID-19 on the small ruminant flocks in Spain. When compared to the pricing in March 2020, milk prices for dairy goat flocks experienced a decline of approximately 4.5 cents per liter in April 2020. On the other hand, the cost of one month's supply of sheep milk remained practically unchanged throughout this time period, with some sources indicating a rise of more than 6 cents per liter in comparison to the previous year. In addition, the worldwide data collected from 2,750 Spanish flocks revealed a decrease in the price of lamb ranging from 16.8 to 26.9%. This information was obtained. In a similar fashion, the prices of goat kid meat fell by 12.5% per kilogram. (Vidaurreta et al., 2020).

**Eggs**

Currently, there is no proof that eggs or other poultry products can transmit SARS-CoV-2 to humans (Suárez-Garca et al., 2020). In contrast to the 2006 avian flu pandemic, which only affected a tiny portion of the chicken processing business, COVID-19 has had far-reaching consequences for the whole industry (Das and Samanta, 2021). Market closures and restrictions on egg sales were direct results of the COVID-19 epidemic. Because they couldn't sell their eggs to nearby supermarkets or eateries, farmers took a major financial hit (Hafez et al., 2021). Restrictions on farmer travel, disruptions in the food supply chain, and containment efforts conducted during the COVID-19 pandemic led to a drop in the value of global egg imports and exports in 2020 compared to 2019.

**Processed food**

Eating ill animals or foods that have been contaminated by other foods, diseased food handlers, or contaminated food contact materials is one way that SARS-CoV-2 could potentially be disseminated. Another way is by the consumption of foods that have been contaminated by other foods (Oakenfull and Wilson, 2020). The Centers for

Disease Control and Prevention (CDC) have so far pinpointed processed foods, packaging, and handlers as potential vectors for the spread of SARS-CoV-2 (FAO, 2021c). Depending on the surface, the virus can live for a few hours up to a few days (Van Doremalen et al., 2020). The Centers for Disease Control and Prevention (CDC) advises washing and sanitizing a variety of surfaces to reduce the risk of spreading germs (Seymour et al., 2020). At present time, there is no proof that the SARS-CoV-2 virus can be spread through eating contaminated food. Considering how crucial food is to our life, we can't rule out the potential that it could also serve as a vector for the spread of disease (Duda-Chodak et al., 2020).

**Effects of COVID-19 on the economy of animal production**

The spread of COVID-19 has had far-reaching consequences for the world economy, especially in the areas of animal production and trade in related goods. Hence, global economic growth has slowed from 2.9% to 2.4%. Rates are expected to drop to 1.5% if the outbreak continues (Hussain et al., 2020). Likewise, individuals who depend on agriculture (about 60% of the global population) have suffered as a direct result of the COVID-19 pandemic (Lenzen et al., 2020). The results of COVID-19 on the world economy are shown in Figure 2.

**Effects on the dairy industry's economy**

The dairy industry around the world has felt the effects of COVID-19. Even though milk production has decreased because of the epidemic, the daily demand for milk is increasing. As a result, there was a significant chasm between demand and potential supply. Producers of dairy products in the United States lost millions of dollars when they had to dump 4 million gallons of fresh milk in the trash during the first week of April 2020 because they couldn't get it to market (Newman and Bunge, 2020). Canadian dairy farmers were forced to give up producing fresh milk because of a shortage of markets, the inability to safely store their product at home, and a dearth of processing plants (Weersink et al., 2020). As a result of the market closure caused by the COVID-19 outbreak, dairy farmers in Bangladesh were severely impacted financially (Zabir et al., 2020). Milk prices have dropped drastically during COVID-19 as well. As a result of COVID-19, fresh milk in Bangladesh has been dumped, costing the country 67 million dollars (Begum et al., 2020).

Nepal has also lost $17 million in dairy product sales (Poudel et al., 2020). As a direct result of the COVID-19 epidemic, Pakistan experienced a drop in revenue equivalent to 57.3 billion liters worth of milk and other dairy products (such as yogurt, butter, and ghee, amongst others) (Ghafar et al., 2020). Indian milk sales have dropped by 50 percent, while milk consumption has dropped by 25 percent to 30 percent (Bajwa, 2020). The Chinese dairy industry has suffered economically due to problems with production and transportation, a shortage of inputs, and an increase in input prices. Milk from approximately 6.25 percent of farms was not accepted by processors, and 27.34 percent of farmers were unable to sell their whole milk production due to a lack of buyers. Moreover, 12.50% of farms had to throw out some milk because of the sickness epidemic (Qingbin et al., 2020). Losses in economic output for the dairy industry can be traced back to the global spread of the COVID-19 pandemic, as seen in Figure 3.

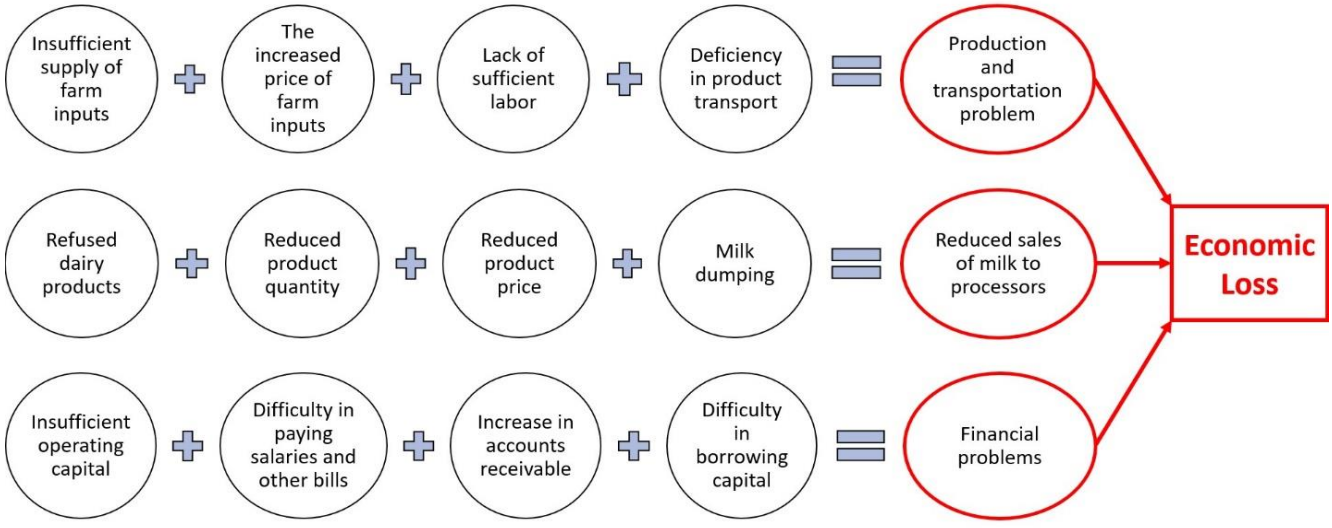


**Figure 3.** The major causes of the economic losses in the dairy industry as a consequence of the COVID-19 pandemic
**Source:** Adapted from FAO (2020b)

The major causes of the economic losses in the dairy industry due to the COVID-19 pandemic consists of production and transportation problems; reduced sales of milk to processors; and financial problems. Insufficient supply of farm inputs, the increased price of farm inputs, lack of sufficient labor, and deficiency in product transport, all lead to production and transportation problem. Moreover, reduced sales of milk to processors are caused by refused dairy products, reduced product quality, reduced product price, and milk dumping. Furthermore, the financial problems in the dairy industry created because of the COVID-19 pandemic are insufficient operating capital, difficulty in paying salaries and other bills, an increase in accounts receivable, and difficulty in borrowing capital.

**Effects on the economy of the meat industry**

COVID-19 has had an effect on the beef industry all over the world as a result of restrictions placed on imports and exports, a fall in the market, and issues in the processing business (Ijaz et al., 2021). The output of beef in the world is projected to decrease by 1.7%, falling from 338.9 million tons in 2019 to 333 million tons in 2020. (FAO, 2020a). The United States' 2020 pork output forecast is down 8.9 million tons, or 8 percent, from 2019's projections. Beef production decreased by 1% in 2020, compared to 2019 (72.6 mmt) (FAO, 2020a). There will be a 7% drop in market pork sales compared to 2019 because 10 million pigs will be removed from the supply chain of pig markets between April and September 2020, causing an economic catastrophe (loss of 2 billion pounds of pork) (Ijaz et al., 2021). Because of farm and slaughterhouse closures in the United States, beef production dropped by 25% and 43%, respectively (Hashem et al., 2020). U.S. economic losses from the beef business are estimated at $13.6 billion (Peel et al., 2020). The price of ovine meat fell by 8.6 percent during the COVID-19 pandemic, and the prices of other types of meat followed suit (poultry > hog > beef) (Pal and Kerorsa, 2020).

**Effects on the poultry industry's economy**

Chicken producers felt the effects of the COVID-19 pandemic, in part because of emergency pandemic marketing measures (Sattar et al., 2021). By the end of April 2020, it is anticipated that COVID-19 will have caused record losses for India's poultry business in the amount of 370 million United States dollars. (Biswal et al., 2020). There have been observations of comparable tendencies in other South Asian nations, such as Bangladesh and Pakistan. The catastrophic economic crisis that has gripped China has also had a detrimental influence on the export of chicken and other items derived from poultry in that country. Turkey temporarily restricted Chinese poultry imports (Pan et al., 2020). The majority of countries have instituted bans or quotas on some animal imports, including chicken and poultry products. This includes the United States, India, and Russia (Pan et al., 2020).

In addition, six million Bangladeshis have direct or indirect connections to the poultry industry (Hamid et al., 2016). The commercial poultry industry in Bangladesh is growing about 15% annually (Mahmud, 2020). Not only that, but a great deal of the nation's economy relies on the industry (Hamid et al., 2016). Nonetheless, chicken farms experienced significant financial losses as a result of the COVID-19 pandemic. Around $1 billion in lost revenue has been incurred by the Bangladeshi government as a direct result of the COVID-19 outbreak, which has caused a 35% drop in commercial output of day-old chicks, eggs, and meat (BPICC, 2020). In addition, the industry has lost almost 29% per farm egg (production cost of $0.07 versus selling price of $0.046 to $0.065), even though the price per farm egg was between $0.08 and $0.09 before the epidemic. Chicken producers lost 32-40% of their original investment since they could only sell broiler meat for $0.77-$0.80 per kilogram, despite spending $1.17-1.18 per kilogram on manufacturing (Mahmud, 2020).

**COVID-19's effects on animal welfare and health**

Global animal health and wellbeing have suffered as a result of the COVID-19 limits on farming and veterinary services. Quarantine measures taken in response to the COVID-19 pandemic may also make it more difficult to conduct regular zoonotic disease surveillance. Furthermore, because of these movement restrictions, efforts to monitor and control wild animals and diseases including foot-and-mouth disease, African swine fever, and exotic transboundary diseases have been put on hold (lumpy skin disease, pox virus diseases, Japanese encephalitis, and Rift Valley fever). The global spread of the COVID-19 pandemic had a terrible impact on the well-being of animals. In addition, global warming and climate change has negative consequences on human and animal health (Raihan et al., 2022b; Raihan et al., 2022c; Isfat and Raihan, 2022; Raihan, 2023c). Animals are more likely to contract various diseases due to their prolonged confinement on farms. As a corollary, the global economic crisis and associated restrictions on human mobility and procedures have had a major impact on the health of animals, as have the suspension of farming activities and veterinary services (Hashem et al., 2021; Raihan, 2023d; Raihan et al., 2023a; Raihan et al., 2023b). Because farmers have less access to animals (particularly cattle, sheep, and goats) and animal products, they are forced to kill or induce abortions in order to control animal populations and prevent overproduction. Pig farmers are aborting sows and killing them inhumanely by methods including suffocation, burning, and shutting off air since consumer demand has dropped and the marketing mechanism has been disrupted (Jones, 2020).

The effects of COVID-19 on animal healthcare on farms, in communities, and around the world are already apparent, and they are not good news. As a result, many national and international organizations have had to put off or postpone important activities, initiatives, and projects until they can secure more money. Several animal and zoonotic disease prevention, control, and eradication efforts have stalled as a result (FAO, 2020a). The following effects on animal health and welfare (Deeh et al., 2020) were noted as a worldwide result of the COVID-19 pandemic:

**Farming activities**

One of the drawbacks of COVID-19 is that it makes it difficult to keep up with normal animal health tasks like disease diagnosis, routine immunization, and effective treatment of sick animals. Prolonged durations of animal lodging on farms lead to stress, immunosuppression, growing stocking density, and multifactorial diseases as a result of decreased movement, higher mortality, lower productivity, and diminishing economic benefits. Animal producers were unable to get advice, therefore their animals didn't get veterinary care, because of a shortage of veterinarians and the frequency with which they could see them. The lack and erratic supply of inputs such animal feed additives led to an increase in illnesses as a result of import and export restrictions (vitamins, minerals, antibiotics, and others). For instance, the COVID-19 epidemic has caused a kink in the supply chain for animal pharmaceuticals traveling between China (home to multiple pharmaceutical firms) and the United States (Hashem et al., 2021). Figure 4 shows how the spread of COVID-19 threatens the viability of farms.

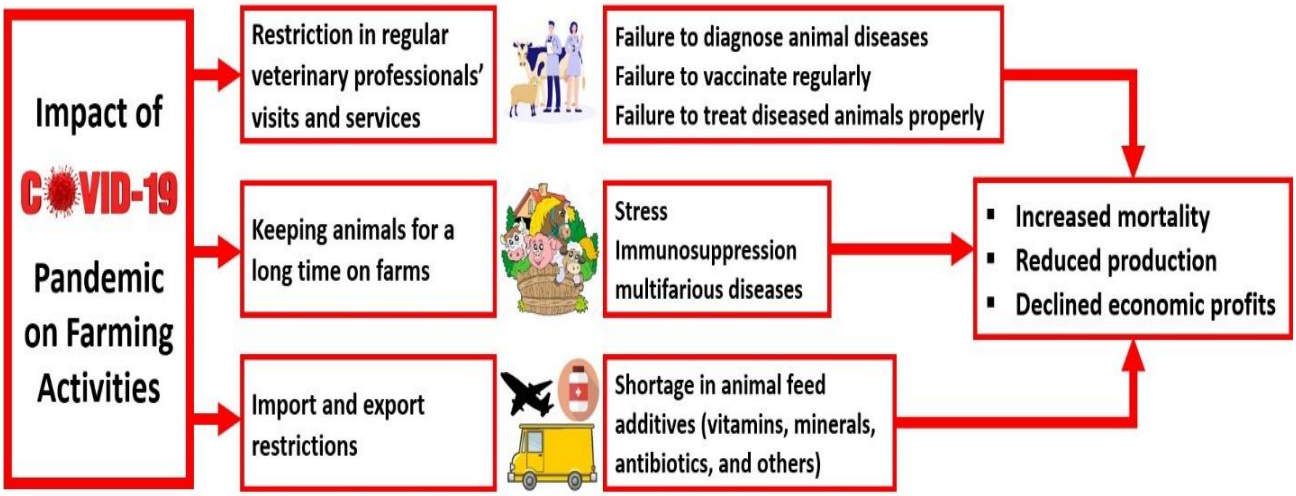


**Figure 4.** The effect of the COVID-19 outbreaks on the sustainability of farming operations

**Lab operations and veterinary services**

It was challenging to import laboratory agents and equipment due to import/export restrictions. Because of the social lockdown, veterinary experts in the lab were unable to conduct their jobs because they couldn't get to work. Issues with transporting samples from animal farms to labs and a lack of personal protective equipment (PPE) were also factors. Often there were no on-call veterinarians or open laboratories. Lack of safety precautions, PPE, sample collection gear, laboratory agents, and PCR materials also contributed to an increase in the transmission of animal diseases.

**Local animal health efforts**

The COVID-19 pandemic has caused considerable economic disruption, which has had a substantial impact on a variety of approaches to the prevention and treatment of disease in animals. Mobility restrictions hampered efforts to vaccinate, diagnose, and treat many different types of animals and animal diseases. The lockdown impeded the Papua New Guinea National Agricultural Quarantine and Inspection Authority's (NAQIA) ability to visit affected areas, despite the agency's use of stringent control measures to battle COVID-19 (FAO, 2020a).

**Animal health activities worldwide during COVID-19**

Famous multinational organizations have delayed or canceled their global animal health initiatives due to a lack of financial and logistical assistance. As a corollary, trade and transportation barriers have impeded global animal health initiatives.

**Recommendations for improved animal husbandry during the COVID-19 pandemic**

In order to effectively deal with the COVID-19 pandemic, animal husbandry techniques must be improved both during and after the outbreak. Protecting the well-being of those who care for animals is a top priority. This includes giving out vaccines when it's safe to do so, encouraging people to eat healthier, and decreasing stress levels. Despite this, public confidence in immunization is low because of worries about the safety of the current COVID-19 vaccines. Many people believe untrue statements about the COVID-19 vaccine, such as the following: the vaccine is ineffective and causes severe side effects; vaccine material can integrate into human chromosomes; fetal tissue is used in the vaccine's development; and the vaccine contains a microchip or nano-transducer (Shehata et al., 2021). Achieving high rates of immunization among workers while alleviating their anxiety is strongly encouraged. Helping the public understand the need of vaccinations, setting realistic expectations, and using motivational tactics to dispel misinformation about them is a key responsibility of health professionals (Verger et al., 2021).

A wide variety of animals, both domestic and wild, have been found to have spontaneously contracted SARS-CoV-2 infections. All of these animals are included in this category: canines, felines, minks, ferrets, lions, tigers, pumas, snow leopards, and gorillas. Despite the fact that poultry and cattle are resistant to the virus and only moderately vulnerable to it, respectively, these animals may nevertheless impede the progression of the virus and its ability to propagate (Shehata et al., 2022). Therefore, it is absolutely necessary to utilize the One Health approach. Furthermore, climate change adaptation and mitigation strategies (Begum et al., 2020; Ali et al., 2022; Raihan, 2023e; Raihan et al., 2023c) should be taken for the sustainable development in the the livestock sector. It has been suggested that a number of actions be taken in order to guarantee the production of livestock for the long term: (i) the strict hygienic processing of animal products during marketing and handling; (ii) the improvement of social distance and hand washing hygiene practices in production facilities; (iii) the strict regulations of animal farms regarding biosecurity, isolation, care, visitors, and animal workers; and (iv) the improvement of animal housing and hygiene.

**Conclusion**

This study presents an overview of the global impact of COVID-19 on the sustainability of livestock performance and welfare. The systematic literature review method was used to conduct this study which includes 44 documents published between 2020 to 2022. The fulfillment of the nutritional requirements of human beings is significantly aided by the production of meat from livestock and poultry. They are absolutely necessary for the achievement of global food security, the Sustainable Development Goals, as well as the economic prosperity and GDP of many agricultural countries. A significant amount of damage has been done to human civilization as well as to ecosystems and the economy as a result of the COVID-19 pandemic. The findings of this study revealed that the impact of the pandemic has threatened the sustainability of businesses related to livestock and poultry, which has led to workers in those industries losing their jobs. In light of the effects of the ongoing pandemic and the knowledge gained from it, it is time to rethink the strategies currently in place for the control of pandemics and infectious diseases in animals, particularly those involving significant zoonotic infectious agents.

The findings of this study suggest that progressive methods of animal husbandry and agricultural production, which take into account the welfare of animals, should be implemented. In order to identify newly emerging diseases and pandemics, the authors of this study suggest placing a greater emphasis on coordinated efforts directed toward developing a disease surveillance and monitoring system based on the One Health approach. It is absolutely necessary to have a robust network on all three levels (local, national, and international) in order to be adequately prepared to stop any further pandemic outbreaks. This study could be useful for making major efforts to improve the existing situation and acquiring knowledge for the future, with a focus on food security through sustainable livestock farming. In addition, this study reveals COVID-19's impacts on animal welfare and health, which could aid in achieving sustainability in farming activities. In addition, this article provides ideas for enhanced animal husbandry and sustainable livestock production during the COVID-19 pandemic.

**Acknowledgement:** None

**Funding:** None

**Conflict of interest:** The authors declare no conflict of interest.

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