Vol 2 No 1 March 2021 Pages 117-124 e-ISSN 2708-5694

Journal of Agriculture, Food and Environment (JAFE)

Journal Homepage: http://journal.safebd.org/index.php/jafe

http://doi.org/10.47440/JAFE.2021.2120

Review

Impact of COVID-19 on livestock production and related industry

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Article History
Received: 3 March 2021
Revised: 26 March 2021
Accepted: 31 March 2021
Published online: 31 March 2021

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Keywords
COVID-19, economic, livestock, food.

A B S T R A C T

Livestock contributes significantly to rural and urban food security, offers a diverse range of products, generates jobs, increases demand for goods and services, and promotes economic value by contributing capital for finance and human. COVID-19 has had a significant influence on different sectors at regional, global and national levels, including livestock. It has a negative impact on animal production by limiting provision to animal inputs, feeds, markets, services and consumers as well as by limiting processing facility, storage capacity, conservation, and businesses opportunities and animal health problem by limiting the test and diagnostic facilities, surveillance, animal disease reporting problems, and stopping the animal disease prevention program nationally. We can not only stop any of the worst effects, but we can also endorse a transition to more humane livestock processing processes that are more in tune with nature which promote healthier diets and therefore improved health predictions for all. As a result, since no cases of COVID-19 transmission from livestock to humans have been recorded, farmers can continue to hold, rear, care for, and sustain their livestock by putting measures in place.

1. Introduction

On 31st December, 2019 in Wuhan city of China, a new contagious disease has been spread among the whole city which is now known as COVID-19 (WHO, 2020; Wang *et al.*, 2020). From that period of time, the corona virus has an influence on the chain of food supply which is confirmed as the most frightening way because we are involved in this food chain and it is reciprocally connected and breakable. We must develop the solutions together. Because of this pandemic situation, the economy of countries has shut down. This coronavirus is affecting our universal food systems by disturbing the value chain of agriculture regionally (Kurns, 2020). Livestock farming has a vital role in the distribution of food in urban and rural areas and it gives a vast diversity of goods that includes milk, wool, fiber, meat, feathers, eggs, hides and skin. This is also important because it generates employment, initiates with increased value for services and goods, enhances economic transformation in where human get benefits and financial capital in different economic sectors which are developing (FAO, 2018).

Coronavirus has a great influence on so many sectors at regional, national and global levels and livestock sector as well (G20, 2020; FAO, 2020a). In many countries important actions have been taken, for instance lockdown, stopping border pass and travel restrictions which have potentially adverse effects for livestock sector as border crossing has restricted labor access as well as professional services, also restricted the purchasing important input for production (FAO, 2020b). If an infectious disease spreads throughout a country, then hunger and malnutrition may occur (Sar *et al.*, 2010; Burgui, 2020). Processing efficiency became reduced for animal products because of this problems, market activity and sales also became vulnerable as well. Furthermore, this situation gets worse in accordance with the increase of diseases, strict movement restrictions causing labor shortage to harvest and troublesome for farmers to supply their goods to market.

The goal of this review is to narrate the impact of coronavirus on livestock production and effective management to alleviate this problem by providing effective suggestions and recommendations factor affecting the value chain to reduce this impact and enhance livestock production as well as the supply chain of livestock products.

2. COVID-19 and Livestock system

Livestock and poultry production in the industrialized era as well as in the developing world, is distinguished by its nature which is intensive and it is initially run by the policies of the

post-war government which tends to enhance production capacity and reduce cost, but it remains as customer need for food which is cheap in nature (Seleiman *et al.*, 2020). Farms are smaller in number but greater in size, with more cattle and birds per holding housed, climate-controlled structures, automation, and fewer stockpersons. Now it becomes common of vertical integration for one company which stands that one corporation owns the whole operation, from the feed mill to the manufacturing plant. Maximum output is desired from the production process, with all portions from hatch to slaughter always performing at full efficiency. If at any side of the chain is disturbed in flowing then immediate impacts may occur for animal welfare and for the environment as well as for human. The immediate consequences of COVID-19 were panic wave buying by people. Disappearing commodities from market shelves in the first few days were toilet rolls, sanitizers and disinfectants, pasta, flour, rice and yeast where in few nations' eggs, milk and cheese. Increased beef, egg, and dairy supermarket sales, with a higher rate when lockdowns were reported, but then sales continued as compared to the same period last year, from March to July, when panic was also emerged (Weersink *et al.*, 2020).

Countries like the United States have two separate supply chains: one for retail supply and another for the industry of food service. As a result, shortages on shelves did not indicate a lack of the product per se, but rather a shortage of the commodity in ways unsuitable for stores, exacerbated by logistics chains struggling to meet increased customer demand. When schools and restaurants closed, total needs for dairy in the United States fell by 12–15 percent, resulting in a milk surplus as well as dumping (Gibbens, 2020). Farm closures, the euthanasia of laying hens and contract cancellations resulted as whole egg production increased but liquid egg consumption, which accounts for about 30% of the US egg industry, declined. High-end beef, which is mostly sold in supermarkets, saw a drop in demand, and producers and processors failed to keep up with fluctuating amounts and forms of demand from various industries. The most significant influence of COVID-19 on the livestock commodity supply chain; though began with disease outbreaks within processing plant employees, which led to plant closures and ripple effects across the food chain.

3. COVID-19 and livestock production

3.1. Animal welfare at farm level and livestock farming

The abrupt restriction of human activities, as well as the economic downturn, are projected to have an effect on agriculture and veterinary care, and thus on animal welfare (Gortázar and de la Fuente, 2020). The COVID-19 epidemic wreaked havoc on animal welfare efforts. Farmers, staff, and veterinary practitioners were suddenly restricted in their practices, resulting in a lack of implementation of regular farming tasks. Such a condition makes it difficult to keep track of animal needs and welfare, preventing timely action to address any emerging issues. Many farmers have resorted to overstocking their livestock under such circumstances, which raises crowding-related suffering and reduces immune functions. As a result, the risk of animal disease is greatly elevated, posing a threat to the health and competitiveness of stocking livestock (Ghafouri-Fard *et al.*, 2020). To reduce the number of livestock on their farms and restrict the surplus supply of agricultural products, certain farmers have had to cull their animals or use methods that are incompatible with animal health, such as causing abortion and slaughtering (meat and milk). Owing to the short breeding-to-marketing time of these products and the drop in customer demand, some pig farmers were forced to destroy their animals (Vincent terBeek and McCullough, 2020). Thousands of pigs have been slaughtered by some farmers using cruel practices such as ventilation cutoff. This system relies on shutting down airflow sources as barn temperatures increase, lowering oxygen levels and causing suffocation. (Jones, 2020).

Furthermore, some organizations, like the Canadian Cattlemen's Association, have urged farmers to feed cattle maintenance rations without finishing rations to avoid feedlot practice, processing plant closures, and market capacity constraints. Owing to a lack of sufficient feed supplies and restrictions on animal mobility in pastures, some producers are forced to maintain livestock on a marginal maintenance feeding schedule or use substitute feed resources, posing yet another animal welfare dispute (Nielsen *et al.*, 2019). Veterinary facilities, such as routine health check-ins, medications, vaccines, and monitoring and diagnostic equipment, were in short supply for many growers. As a result, animal disease control has become a new problem that clashes with animal health concerns. Unfortunately, the impact of COVID-19 on animal healthcare practices is not limited to the farm level; there are also limitations at the national and international levels. Owing to financial constraints, several national and international animal health care programs have been postponed or suspended, limiting the effectiveness of disease prevention (Arnason, 2020). Gortázar and de la Fuente (2020) wrote in a recent commentary that the COVID-19 epidemic will have a negative effect on the management of diseases that are already present in Europe, mostly ASF. This prediction was based on the likelihood of expanded wildlife-livestock interaction as a result of human confinement, resulting in a rise in the number of wildlife reservoirs, destruction of ongoing endemic disease testing programs, and reduced disease surveillance program.

In general, grants and services aimed at controlling outbreaks of certain new transboundary animal diseases, such as foot and mouth disease, ASF, avian influenza, and other infectious animal diseases, have harmed around the world (Nielsen *et al.*, 2019 and Phelps, 2020). As for other zoonotic outbreaks, these cases are triggered by indirect impacts of the COVID-19 pandemic on livestock wellbeing and productivity (Phelps, 2020).

3.2. Animal production

3.2.1. Limitation of animal feed

Industrial feed businesses are losing productivity due to physical separation and the need for extra personal protective equipment. Labor shortage and a reduction in the availability of raw materials and other ingredients were the results of movement constraints and sickness. Transhumance is often hampered by movement limits, which makes it difficult for pastoralists to feed their animals and causes more delays in feed delivery (FAO, 2020c; FAO & WHO, 2020). Feeding of cattle takes some months to reach a satisfactory level of nutrition. The predicted loss in the feedlot sector indicates the lower valuation of animals put in feedlots before COVID-19 took effect.

3.2.2. Reduction of inputs and other services

Farmers' access to breeding materials and replacement stocks (e.g. semen, day-old chicks, heifers, piglet), as well as

milking machines and breeding materials (FAO, 2020d; Barrett, 2020; CDC, 2019), is being hampered by movement constraints and obstruction of national and foreign trade routes. This will jeopardize input providers' revenues. The interruption of public services, along with the delayed supply and use of vaccines and drugs is raising the risk of emerging epidemics, including animal diseases that cause significant agricultural deaths and outbreaks of diseases that can be transmitted to humans (e.g. Services for food safety monitoring and animal welfare extension). Export controls would have a larger effect on areas that depend on imports for processing or consumption, such as meat and dairy (e.g. Wide parts of Africa, as well as Small Island Emerging States).

3.2.3. Limited access to markets

Small-scale farmers are unable to export their animals due to the closure of live animal markets in many countries. Sales and rates are being lowered as a result of disruption of the logistics channel and a decrease in demand. Farmers are forced to hold their animals longer or destroy milk due to insufficient access to markets and slaughterhouses/processing plants, resulting in higher costs of production or significant losses. Women are the hardest hit by revenue disruptions from small ruminants or chickens, since it reduces their purchases of household commodities and nutrition. Intermediaries, who gather livestock or goods and combine them for fattening, packaging, or retailing, are also being hampered by movement limits (Galanakis, 2020). Farmers will lose their connection to a large buyer if intermediaries are disrupted, as previous epidemics have shown, particularly if there are no information systems connecting value chain actors. Many animal markets in West Africa have been closed, and cattle and small ruminant prices have fallen by half, forcing pastoralists to destock animals (FAO, 2020e). The misperception that livestock or livestock products are hosts or medium for the virus may lead to a further drop in demand for meat and other products, as well as export and import reductions and restrictions.

4. Processing of livestock products

4.1. Processing capacity limitation

Because of their labor-intensive existence, meat and dairy production sectors are being hampered by staff shortages as a result of lockdown policies. Overstocking or waste of animals and animal goods occurs as a result of their delivery. Animal movement restrictions will lead to overcrowding and more use of natural resource like water and pasture land. Reduced slaughter and process efficiency particularly in slaughterhouses and food processing plants will reduce meat production. Schools, retail stores, tea-coffee shop, public gatherings, and the travel industry are all losing regular clients to product manufacturers (Attwood, 2020; Huffstutter, 2020; Good, 2020; Hein, 2020, MoA, 2020).

4.2. Storage and conservation problems

Some collectors and processors are being forced to stock up due to transportation delays and improvements in retailing and usage patterns (Mishra *et al*., 2021).

4.3. Constrained in businesses activities

In developed countries, most of the meat and dairy production is done informally (i.e. up to 90 percent of volume). These companies are disrupted by COVID-19 prevention and response. Small-scale manufacturers, who also lack the capacity to export to organized markets, lose an outlet as a result of this instability (Gray, 2020).

5. Animal and animal products transportation

5.1. Obstacles in national transport

Transport is being hampered by movement limits, which is reducing the availability of cattle and livestock goods. Tight road traffic restrictions hindered milk production and transport, resulting in milk dumping and discarding (Mtimet *et al.*, 2021).

5.2. International transport problems

Exporters of livestock goods, as well as farmers whose livelihoods depend on exports, are affected by trade restrictions (Nižetić, 2020). Since they couldn't sell their animals or beef, livestock farmers, merchants, and butchers lost money. Live animal transport disruptions may also have a significant impact on product supply in the importing area.

6. Sales and consumption

6.1. Change in retailing and demand

Supermarkets and online outlets are reorienting retail, which is now increasing. More package, long-life, and refined meat and dairy products would be exported as a result (Roggeveen and Sethuraman, 2020).

6.2. Limitation in purchasing power

In countries with little to no social safety lines, quarantine and lockdowns are limiting buying power, especially for the informal worker (Xu *et al.*, 2020). Citizens, like millions of migrant workers in many countries, have already been left with little to no jobs as a result of the economic downturn and rising unemployment. Domestic animal income was limited during the 2014 Ebola crisis in West Africa due to a drop in buying power. Informal markets are being restricted across Africa as a result of the current crisis.

6.3. Limitation in demand and public procurement

In most countries, restaurant closures and decreased tourism have resulted in a significant drop in food demand by these industries. School feeding services have since been halted, depriving millions of children of their right to eat. Demand may also be influenced by fake news and rumor. In India, for example, chicken sales plummeted after social media posts spread the myth that eating chicken could cause humans to contract COVID-19 (FAO, 2020b).

7. Animal health

7.1. Prevalence of animal disease and weak immunity

According to the American Veterinary Medical Association (2020), there is less potential to focus on animal welfare practices such as biosecurity, vaccination, ill animal care, and treatment due to labor shortages. Animal overcrowding can raise stress and animal diseases prevalence, as well as jeopardize the standard of animal welfare. Farmers' access to basic medical facilities and animal health inputs, such as veterinary medicines, vaccinations, disinfectants, and equipment, is limited by movement limits and quarantine steps, which often make it difficult for veterinary and veterinary practitioners to enter the field (Herper and Branswell, 2020; Slabodkin, 2020).

- Lower rate of test and diagnostic facilities.
- Animal diseases reporting and surveillance disturbing (WHO, 2020).

- Suspension or reduced rate of animal disease prevention programs.
- National activities on outbreak investigations, animal disease surveillance.
- Animal disease disruption, as well as monitoring and reporting (WHO, 2020).
- National outbreak prevention efforts have been reduced or even suspended.
- National epidemic investigations, animal disease control, and vaccine efforts will not be carried out as scheduled.
- It's possible that a late or inadequate response to a trans-boundary animal disease epidemic will occur.
- Animal health initiatives and efforts at the global, federal, and national levels may be postponed or unable to be adopted as expected.

8. Production facilities and farming inputs

Farmers have been unable to obtain livestock production inputs due to restrictions on import/export operations and local trends, as well as insufficient marketing opportunities. Because of the restrictions on travel and the destruction of national and foreign trading channels, crucial livestock farming supplies and services, such as grain, replacement stocks (e.g., day-old chicks, piglets, gilts, heifers, and semen straws), medicines and vaccinations, feed additives, and other livestock farming resources, have significantly decreased (FAO, 2020). For example, Argentina, the world's largest soybean meal exporter, has cut its exports to feed manufacturing factories by about half, potentially affecting the supply of one of the most important feed ingredients in farm animal diets (Seleiman *et al.*, 2020). A similar problem arose in Brazil and the United States, where the COVID-19 pandemic halted soybean and corn shipments, resulting in a lack of animal feed ingredients (Seleiman *et al.*, 2020 and FAO, 2020). Movement constraints have restricted not only foreign trade, but also access to national/local production inputs; pastoralists in Africa's dry lands, for example, who depend on natural plants in pastures to feed their livestock, have lost this crucial natural production supply, and thus pastoralist livelihoods (FAO, 2020). Reduced fluidity and foreign exchange, according to several companies that sell vaccines, animal health supplies, feed additives, milk testing kits, and pasteurization equipment spare parts to small-scale meat and dairy farmers, are other significant factors influencing the viability of the livestock supply chain, especially in developing countries (AGRILINKs, 2020). There is little question that such cuts in output inputs and their trade will have a negative impact on animal productivity, livestock producers' profitability (particularly small-scale meat and dairy producers), and the profitability and commercial viability of these businesses.

9. Workforce from human activities

It is generally assumed that agricultural industries, such as meat and dairy production, are highly labor-intensive. The COVID-19 epidemic has resulted in a significant labor shortage in both developed and developing countries, which is particularly troublesome for countries that depend on imported labor, such as Europe. Several causes have been blamed for the lack of domestic, seasonal, and migrant laborers. Many employees have been poisoned and placed in isolation, while some have been unable to cross borders due to border controls and visa suspensions. Any workers have abandoned their jobs due to social factors such as family obligations or the need to stop spreading the disease. In some slaughterhouses in France, personnel shortages attributed to infection spillover among staff, quarantine, and childcare have reached 30%, with similar cases in Italy, Egypt, Tunisia, and Jordan (FAO, 2020). The shortage of laborers and human activities causes major disturbances in the global sustainability of livestock, poultry, and milk supply chains. In China, for example, the presence of several workers under quarantine has reduced the number of operational slaughterhouses in several provinces; even those that are operational are unable to operate at maximum capacity, resulting in a lack of meat supplies and drastic rises in meat prices in local Chinese meat markets, such as Beijing's largest wholesale market, the Xinfadi market. A shortage of laborers employed in meat processing farms and plants was also a major concern in Canada and the United States, particularly after the suspension of foreign worker visas (Attwood, 2020). Due to the COVID-19 spillover among workers in the United States, approximately 20% of pork production and 10% of beef production have been halted (Arnason, 2020 and Nielsen *et al.*, 2019). In Austria, the meat production industry is heavily reliant on foreign labor (80 percent) (migrants from eastern European countries). The processing chain is impacted by any limitations on free travel at borders (WFO, 2020). The same is true for dairy farmers, as trucking firms that distribute milk goods from dairy farms have experienced a driver crisis, as many of them have stopped operating to prevent the risk of contagion (Huffstutter, 2020).

10. Retail and distribution chain

Distribution and retail are critical components of the livestock supply chain; efficient distribution and retail ensure that suppliers and customers are linked, completing the production-demand chain. The COVID-19 epidemic has had a significant effect on this segment of the livestock supply chain, which has been hampered by several logistical challenges. Local car travel and road traffic regulation, as well as the lockout in large territories, have both become significant impediments to delivery and retail processes. In China, traffic bottlenecks on main roads have impacted local meat supplies, and family farmers are unable to sell hogs because vehicles are unable to reach villages due to the lockdown (Schmidhuber *et al.*, 2020). Before movement bans were lifted in the Philippines, shortages in vehicles carrying raw materials for processing meat threatened to spark a shortage. Similarly, strict road traffic restrictions interrupted milk distribution, resulting in milk dumping (FAO, 2020). In addition, a lack of manufacturing capability for meat and milk products has a negative effect on animal product distribution and retail. Since the beef production sector lacks sufficient ability for processing meat products (Arnason, 2020), the Beef Farmers of Ontario association has requested its representatives to postpone the selling of cull cows. Due to the closing of processing facilities in the United States and Canada, pig farmers have culled or aborted their pigs, creating an obstacle to the completion of sale and shipping operations (Vincent terBeek and McCullough, 2020). Another issue is the sharp rise in container transport costs, which has been followed by low commodity prices. The high shipping transport costs of live animals and frozen meat goods have been a source of complaint for some export companies. Due to declines in distribution and retail of milk processing sectors and refined milk goods for consumers, dairy farmers in the United States have faced high production costs and low raw milk prices (WFO, 2020).

11. Supply chain from livestock and consumers responsibility

In the production and completion of every food supply chain, consumers play a vital dual role. Any food supply chain's main and final goal is the customer, so the supply chain's final product must meet consumer demand and ambition. Around the same time, the food supply chain's continuation is contingent on customer appetite and buying power for the finished commodity. The consumer's attitudes toward livestock goods, poultry, and milk have been re-examined as a result of the COVID-19 pandemic, taking into account two major factors: purchase power and food staple preferences, and general knowledge of the welfare of agricultural products. When comparing meat and dairy staple demand to other food staples including rice, sugar, roots, and tubers, it becomes clear that meat and dairy staple demand is less elastic. This is primarily due to the high prices of animal product staples in comparison to other staples, especially those of carbohydrate origin, which are not appropriate for the market under pandemic conditions since many customers have lost their income or are on a tight budget. (Schmidhuber *et al.*, 2020 and FAO, 2020). Consumers' misconceptions about the potential of food, including livestock products (meat and milk), to be a vector for virus transmission play a critical role in sustaining demand for animal products, increasing demand-side shocks, regardless of the effect of consumer buying power on the viability of the livestock supply chain (Coronavirus, 2020).

12. Food security and global economy

The instability in the livestock supply chain, as well as the resulting imbalances between supply and demand, have had a significant effect on the livestock sector's economies. However, it is too early to draw a true picture of the severity of the economic downturn that would impact the livestock industry's bottom line (Laborde *et al*., 2020). Early forecasts indicate that the economic imbalance in the livestock sector will be long-term and will last until 2021. According to the National Cattleman's Beef Association, the cattle industry in the United States is forecast to lose around $13.6 billion over 2021 as a result of the COVID-19 spillover (NCBA, 2020). They estimated that this industry would lose $3.7 billion as a result of poor sales rates (low prices). The loss in value of the breeding stock, in addition to the loss in calf sales value, is expected to be $4.45 billion ($142 per mature breeding female). In the same way, the hog sector is forecast to lose $5 billion (Peel *et al.*, 2020). One of the effects of the COVID-19 outbreak was a major waste of food capital, especially meat and milk. Dairy producers, for example, have had to discard a million gallons of milk due to a drop in demand for milk and dairy products (Barrett, 2020). Such excess of food supplies, in addition to the health crisis, is a terrible new tragedy in the new global food security scenario. At the start of 2020, there were 27 million people in 35 countries that were acutely food poor and may-be on the verge of starvation as a result of the COVID-19 pandemic's overt and indirect effects. The Famine Early Warning Systems Network Global Food Security Alert issued in April 2020 cautioned that the COVID-19 pandemic could put populations in developing countries (such as those in northeastern Nigeria, South Sudan, and Yemen) at risk of famine. In view of this situation, finding interventions and unconventional ways to control the pandemic's detrimental effects on global food security is critical.

13. Alleviation measures with best practices

Dealing with the effects of the COVID-19 epidemic on the long-term viability of food supply chains has been a top priority for ensuring global food security. Using the livestock supply chain as an example, there are threats at each point in the supply chain that endanger its survival, as seen in this outline. Mitigation of these risks necessitates close cooperation among various agencies, including governments, politicians, non-governmental organizations and scientists.

Various steps have been taken on the legislative and structural levels to assist livestock farming programs in an effort to keep livestock supply chains running:

- Providing electronic marketing channels and facilitating direct delivery of animal/food goods to customers (Brazil, Italy, Ghana, and the Philippines) as well as platforms of electronics marketing (China and Morocco).
- Providing animal feeds, medications, and machinery to livestock producers [for example, the Italian government has purchased UHT milk (ultra-high-temperature) from the farmers who works in dairy farm].
- Assisting with the reopening of meat/milk production businesses (China).
- Developing extension services in agriculture, nursing, and animal disease control.
- Specific financial assistance to seasonal and casual staff (Egypt, Tunisia, and Morocco) (FAO, 2020).

Prospective alleviation techniques that may increase the stability of the livestock supply chain have been suggested by the science community. One of the proposed methods is to introduce new protein options to the food supply chain as alternatives to animal protein sources, such as algae, insects, and dairy-processing by-products (e.g., whey proteins) (Galanakis, 2020). Another ambitious choice is to use tissue culture biotechnology to produce animal muscle in vitro as an environmentally sustainable processing tool, reducing methane emissions from farm animals (Aleksandrowicz, 2016; Chriki and Hocquette, 2020).

However, these solutions do not seem to be long-term enough and could require ethical and social acceptance; other approaches to alleviation may be more practical. Farm animals, as the main component of this food supply chain, can be more adaptable to environmental pressures like viruses, inadequate management, and out-of-the-ordinary living conditions. Improving animal immunity and resistance to diseases and harsh environments while preserving sufficient output potentials should be one of the realistic applications in this term. Creating animals with a more effective immune system may indirectly lower production costs by reducing the use of medicines and drugs, including antibiotics (Hafez and Attia, 2020). By reducing veterinary medication contaminants in animal products, would also benefit patients and human wellbeing (Soltan *et al.*, 2018; Hashem *et al.*, 2019). Additionally, improving animal immune system function may aid in the preservation of farm animal biodiversity by removing the need to cull or kill infected or suspected animals during pandemic outbreaks (Pal and Kerorsa, 2020). Recent genetic advancements, such as CRISPR-Cas, and advanced transgenesis and genome editing technologies, such as CRISPR, can allow rapid genome modification in farm animals, resulting in animals that are better able to adapt to environmental and breeding challenges (Tait-Burkard *et al.*, 2018).

The scarcity of animal feed ingredients, whether foraging or concentrate ingredients, posed another threat to the livestock

supply chain's long-term viability. The failure of farmers to obtain animal feed was one of the main disruptors in the livestock supply chain, according to the data provided in our overview. Import/export restrictions have had a detrimental effect on the supply of key feed ingredients [soybean and corn] (Seleiman *et al.*, 2020 and FAO, 2020). As a result, one of the most important steps that will increase the food supply chain's stability is to enhance the livestock supply chain by alternate feed resources. A focus on using local feed supplies and/or incorporating agro-industrial by-products as alternate feed sources may be a viable option. Various feeding methods, such as raising the forage-to-concentrate ratio, using straw-based feed blocks, recycling human food waste and human-inedible food components to feed, and recycling agricultural wastes/byproducts, may be used to accomplish this. Reforming pastures by introducing permanent growing plant species can also lead to providing healthy feed supplies for grazing animals in regions where animal feeding relies on natural pastures (Flachowsky *et al.*, 2013).

By improving the link between suppliers, manufacturers, targeted markets, and customers, the expertise gained during the COVID-19 crisis can also lead to maximizing the portion of the livestock supply chain that involves manufacturing, retail, and marketing (Wesana *et al.*, 2019). Major waste of animal goods (milk and meat) has arisen from the inefficient interaction between these main factors, which could be eliminated by building online advertisement channels and internet technology facilities (Misra *et al.*, 2020). Unfortunately, there is no specific antidote or therapeutic protocol available to monitor the transmission of COVID-19, and estimates indicate that the pandemic will last for a long time. In this situation, livestock farmers must be mindful of various steps that they can take to ensure that their operations are secure and effective. Successful farmers should ensure farm biosafety (Poudel *et al.*, 2020 and FAO, 2020), worker/laborer protection (Pal and Kerorsa, 2020; Hafez and Attia, 2020), animal welfare conditions (Rodriguez-Morales *et al.*, 2020), access to production supplies (Lormore, 2020; Hafez and Attia, 2020), and, ultimately, adequate revenue for selling their goods.

14. Conclusion

The COVID-19 pandemic has had a significant effect on humanity's actions and practices, and agriculture is no exception. Owing to mobility constraints, limited purchasing power, and a larger effect on the most disadvantaged demographic groups, food consumption and therefore food security are significantly impacted. Millions of people, many of whom were already struggling, are threatened by the COVID-19 crisis, which challenges livestock production, food security, and nutrition. Many rural, medium, and large livestock farms and businesses are on the verge of going out of business. We should not only stop any of the worse consequences, but we should also encourage a shift to more sustainable livestock processing processes that are more in tune with nature and that promote healthier diets - and therefore enhanced health outcomes - for everyone. Since no cases of COVID-19 transmission from livestock animals to humans have been identified, farmers can continue to rear, hold, care for, and sustain their livestock by implementing best practices.

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