

COVID-19 pandemic impacts public health and food security of animal industry

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Objective: This study aimed to highlight the negative impact of the COVID-19 pandemic on the worldwide animal industry with special attention to public health and food security of animal industry.

Methods: Two E-surveys were designed and conducted. The first E-survey was prepared to measure the impact of COVID-19 on the animal industry by getting the responses of randomly selected 140 farmers. The second was prepared to measure the impact of COVID-19 on the policy level by getting responses from animal industry experts who preselected based on their national and international records in the field. The surveys were executed during the period from 15/4/2020 to 15/6/2020 and the data were subjected to different statistical analyses considering the demographic characteristics of both farmers and experts.

Findings: The results showed those farmers' demographic characteristics influenced the response towards COVID-19 impacts on the industry. The farmers of the age class of 35-45 years who lived in the South region of Jordan and raising their animals under the intensive production system had more awareness and knowledge about COVID-19, and the best management and hygienic practices required. Other farmers who had limited knowledge and minimum awareness reported a more negative impact on their businesses. On the other hand, the experts' demographic characteristics did not show any relation with their responses towards COVID-19 impacts on the industry. The farmers of various demographic characteristics were facing financial risks ranged from debt to bankruptcy.

Conclusion: The experts stated that the world and Jordan are able to mitigate the COVID-19 devastating socioeconomic and health impacts considering timely, targeted and prioritized policies and strategies. A recommendation was suggested for applying digital technologies in anticipating problems and mitigating temporary shortages, in addition to building food chain resilience to avoid similar situations in the future at global and country levels.

Keywords: COVID-19, Coronavirus, Livestock products chain, Jordan.

Introduction

The globe on daily basis continues to actively monitor and assess the dynamic COVID-19 situation in every single field. It is known that the dynamic of the COVID-19 virus is due to transmission between people even though the virus emerged from an animal source (WHO, 2020). It is for sure, up to this moment, no evidence of transmission of the virus from farm animals to the people. Although, the COVID-19 impacts on short- and long-term food security and the global economy are already being reported (FAO, 2020).

COVID-19 has negative impacts on the lives and livelihoods of the global. We are, in this research work, focusing on studying its impact on livelihood and food security of the animal industry and the farmers/owners. In particular, we also know, for sure, that this pandemic negatively affects significant elements of both food supply and demand as results of road, market and border closures, supply chain and trade disruptions and quarantines. These elements restrict people's access to sufficient food, especially poor and vulnerable people. The pandemic's impacts across the food system might be investigated but there is so far the need for more studies in countries of vulnerable people, refugees and like Jordan. Globally, there is enough food for some countries but Jordan is a resource-poor, food-deficit country with limited agricultural land, no oil resources and scarce water supply (WFP, 2020). Food security policymakers of Jordan need to be careful not to repeat the mistakes made during the food crisis, such as the 2007-2008 food crisis, and thus to avoid this pandemic negative impact on food supply (FAO). On the other hand, the effects might be similar during the Ebola virus disease (EVD) epidemic when the restriction measures adopted to limit the propagation of the EVD epidemic by closing weekly markets and closing borders in countries where infected (FAO, 2016 ; De la Fuente, et al., 2019).

The animal industry has faced the pandemic following emerged regulations reported by WHO and/or local health authority in its own country (WHO, 2020). However, animal owners and industry have practiced the precautionary measures differently in applying good hygiene and biosecurity practices. They were, in general, exposed to the pandemic with no plan, including any alternative arrangements for the care of animals, their needs, and biosecurity hygiene practices. This includes applying the same rules of prevention between people and animals; for instance, applying social distance, avoiding face-to-face contact, avoiding sharing food and close sleeping arrangements with animals. The rules also include washing hands before and after contact with animals and consulting veterinary for a medication of animals by online tools. On the other hand, workers of the animal industry might have

better scientific knowledge regards diseases assuming they deal with them as animals become frequently sick. However, they might face unplanned circumstances such as no alternative plan about how animals will have cared when lockdown placed or the owner/worker gets infected with COVID-19. Besides, when feed and medications may be needed and products may be marketed. A successful decision making requires a scientifically based study where related scientific knowledge and design applied. Therefore, this was aimed at understanding how the corvid-19 pandemic may affect the animal and livestock industry, and the supply chain of the products. Such study may assist policymakers in taking suitable decisions and measures to avoid severe negative impacts on food security and mitigate the impacts of the COVID-19 pandemic on the animal industry and food supply chain of the globe with attention to the animal industry in Jordan.

Materials and Methods

Selection of the survey region and subjects

There were two E-surveys made for achieving the aim of this study. The surveys(E-survey) (online) were conducted in all 12 governorates of the three regions in Jordan which are the northern region (NR) of Irbid, Jerash and Ajloun and Mafraq governorates, the middle region (MR) of Amman, BalqaMadaba and Zarqa governorates, and the south region (SR) of Karak, Tafilah, Maan and Aqaba governorates (Fig. 1). The first E-survey (In Arabic) (<https://forms.gle/g4VYb6aobp4QMDcx7>) was prepared to measure the impact of COVID-19 on the animal farm level. A total of 140 farmers were interviewed from all regions. These farmers selected randomly based on farm records provided by Jordan Ministry of Agriculture (MoA) and they possessed different business characteristics and different types of animal industry.

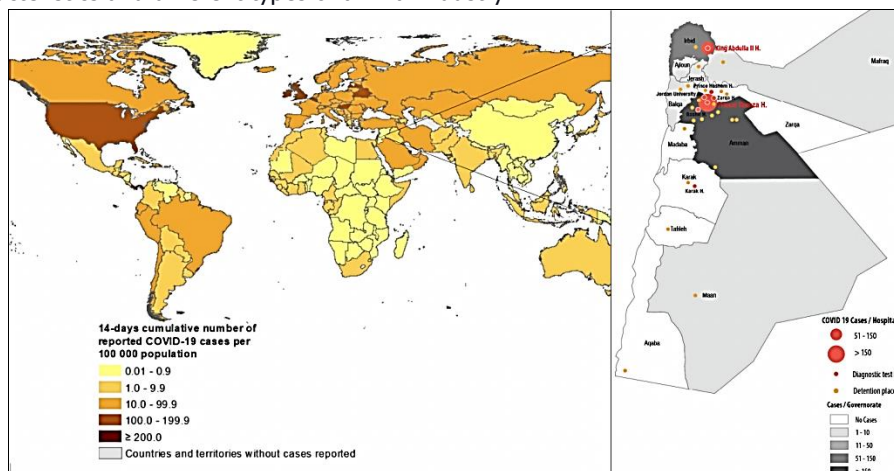


Fig. 1. Map of Word and Jordan related to COVID-19 pandemic on 30/4/2020 (survey period from 15/4-14/5/2020) indicating infected cases in each governorate based on 14-days cumulative reported cases (Sources:Red Cross-<http://www.icrc.org/>).

The second (In Arabic) (<https://forms.gle/UNfH7gtSMdxBWR366>) was prepared to measure the impact of COVID-19 on the policymaker level. Animal production specialists including policymakers and national and international consultants were interviewed for taking their feedback on policy management of the animal industry in Jordan during COVID-19 pandemic. The surveys were executed during the period from 15/4/2020 to 15/6/2020. The participant of the research were asked to be involved following ethical principles declared and stated ahead.

Statistical analysis

Statistical analysis was performed in several steps. First: survey data were subjected to simple descriptive statistics using the Chi-square test of the FREQ procedure. Then, the effects of the different demographic characteristics of animal farmers and experts on their response to questions were measured. These include age, region, animal sector type, education level, annual income and years of experience.

Results

Farmers' demographic characteristics and their responses to the pandemic

Many agricultural studies have observed a relationship between demographic characteristics and farmers responses and actions taken. The study aimed at considering participating farmers' and experts' demographic characteristics as part of comprehensive descriptive analyses. This study addresses few demographic characteristics; age, education, livestock industry type and production system, geographical region and annual income. Farmers who participated in the study have various proportions in the demographic characteristics (Fig. 2).

Results showed evidence to achieve the assumption which was demographic characteristics influenced (to varying extents) the response towards COVID-19 impacts on the industry. For example, the farmers of different ages were significantly responded differently to three questions measuring the common knowledge of COVID-19 spread, animal product features and best management practices during the crisis.

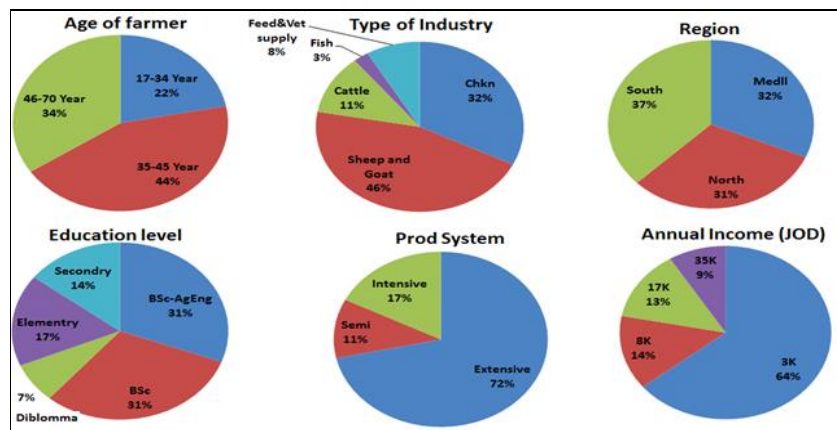


Fig. 2. Demographic characteristics of participated farmers.

The class age 17-34 showed less positive responses towards these questions indicating they had less awareness and knowledge than other farmers. Furthermore, most farmers of the South region were drying themselves after washing with cloth towels as a hygienic practice, whereas more farmers of the Middle region were drying themselves with a paper towel (Table 1).

Table 1. Significant positive responses of farmers of different age classes and regions.

Question	P-value	Age classes		
		17-34	35-45	46-70
Did you know that the World Health Organization confirmed that there is no evidence that pets or farm animals have spread COVID-19 among humans?	0.02	21	47	44
Do you think that animal products have special and rapidly perishable preservation and storage conditions, which leads to increased levels of food loss and waste if they do not reach the market in the right time?	0.04	30	55	47
Did this crisis increase your ability to face future crises and follow a crisis management plan within routine management?	0.02	28	45	43
Region		Middle	North	South
Would you dry with a cloth towel?	<0.0001	26	34	50
Wipe dry with a paper towel?	0.01	28	18	16

*Middle (Amman, Balqa, Zarqa), North (Irbid, Ajloun, Mafraq), South (Karak, Aqaba)

The farmers of different production systems had basic knowledge about COVID-19 transmission mode. However, farmers under the semi-intensive system were doing good personal and animal hygienic practices and better than farmers under other systems (Table 2). Also, most of them were hopeful that the coming month after the first COVID-19 wave will be bringing the current situation into normal like before. However, all farmers agreed in a significant proportion that their animal industry businesses might suffer financial losses presented either as bankruptcy, a debt, big and unbearable worse, potentially worse to limited and endurable worse. It seems that many of them will borrow money to keep their business running and to cover their financial losses.

Table 2. Significantly different responses of farmers of different production systems.

Question	P-value	Production Systems		
		Semi-intensive	Extensive	Intensive
Did you know that the current spread of the Coronavirus is due to its transmission between humans?	0.02	94	12	24
Would you dry with a cloth towel?	0.01	83	13	14
Wipe dry with a paper towel?	0.03	41	6	17
If your animal becomes sick, have you contacted a veterinarian to obtain health advice during the Coronavirus?	0.01	85	9	23
Do you think that starting next month (June), food supply chains will return to work as normal as they were before the pandemic?	0.04	66	7	10
Do you think that the financial losses, if any, have an effect as follow :	0.09			
It led to bankruptcy?		11	0	1
Led to a debt?		43	9	10
Large and potentially worse?		11	2	2

Limited and endurable worse	13	0	0
Big and unbearable worse	20	4	11

With regards to animal industry business types, similar results were reported (Table 3). Regardless of the industry type, they will borrow money to keep their business running and to cover their financial loss. These results were indicating that the chicken, sheep and goat rearing industry faced financial troubles as a result of the COVID-19 crisis. Both industries were providing daily valuable food in terms of broiler meat, eggs, milk and red meat to Jordanian people. In particular, the farmers of the chicken industry were practicing hygienic measures for their own and workers' health and following prevention and biosecurity measures at their farms. The chicken farmers were positively responded to hygienic practices and future management and they were optimistic about getting back the food supply chains to normal or near-normal operation as they were before the pandemic.

Table 3. Significantly different responses of farmers of different animal industry types.

Question	P-value	Chicken	P-value	Sheep and goat	P-value	Cattle	P-value	Fish	P-value	Feed and Vet
Do you take precautions to take care of yourself, workers and animals periodically?	0.03	48								
Did you take the precautions to take care of yourself, workers and animals during the Corona pandemic?	0.02	49								
Would you dry with a cloth towel?			0.01	68	0.04	12				
Wipe dry with a paper towel?			0.01	28	0.04	13	0.03	4		
Are you trying not to touch your eyes, nose, or mouth?	0.01	39								
If you have corona, and you must take care of your animals, will you continue to practice hygiene and take care of your health and prevention (biosecurity) such as washing your hands before and after contact with animals and wearing masks	0.03	48								
Did this crisis increase your ability to face future crises and follow a crisis management plan within routine management?	0.01	40			0.03	13				
Do you think that as of May (this month) food supply chains have returned to normal or near normal operation as they were before the pandemic?	0.02	24					0.02	0	0.02	12
Do you think that starting next month (June) food supply chains will return to work as normal as they were before the pandemic?	0.01	25	0.01			9	0.01	0		
Do you think that the financial losses, if any, have an effect as follow	0.01	1	0.04	1				1		
It led to bankruptcy		7		5		1		0		1
Led to a debt		28		31		8		1		6
Large and potentially worse		6		7		3		0		1
Limited and endurable worse		1		12		0		0		0
Big and unbearable worse		12		21		7		3		6

The level of education was investigated as a factor that might differentiate responses towards the pandemic (Table 4). The results showed that farmers who were university-educated (Bachelor degree in agriculture or otherwise) had positively responded to correct scientific knowledge and management practices during the pandemic.

Table 4. Significantly different responses of farmers of different education levels.

Question	P-value	Education level				
		Agriculture Certificate	BSc	Diploma	Secondary	Primary
Did you know that the current spread of the Coronavirus is due to its transmission between humans?	0.04	41	41	9	20	19
Did you know that the genetic analysis (DNA sequence) of the virus that causes Corona appeared from an animal source (bat)?	0.02	40	38	10	18	16
Did you know that there is currently no evidence of the virus being transmitted from pets - whether domestic animals or livestock - to humans?	0.02	42	39	9	16	18
Did you know that the cause of corona is a coronavirus, and that there are many types of coronavirus that can infect animals and may cause disease in animals and they are different from the Coronavirus?	0.01	40	38	8	16	13
Did you know that coronaviruses are a large family of viruses that can cause disease in animals or humans? And only some of these can be transferred from animals to humans?	0.02	39	33	8	15	11
Did you know that there are reports of isolated cases of pets abroad that were positive for Coronavirus, after their close contact with breeders infected with Corona?	0.03	32	18	3	8	9
Do you wash your hands after touching animals, food, or equipment, or after washing food and water containers?	0.07	42	40	10	20	20
Do you think that animal products have special and rapidly perishable preservation and storage conditions, which leads to increased levels of food loss and waste if they do not reach the market in the right time?	0.02	42	41	8	20	21
Do you think that during the pandemic (from mid-March to April) there were disturbances in the food supply chain, such as restrictions imposed on your movement and the movement of your workers that led to obstacles in the production and processing of animal products and consequently financial losses?	0.02	42	41	10	19	19

Nevertheless, farmers of non-university education showed limited scientific knowledge about the pandemic and its adverse consequences on the businesses. The annual business income as a factor considered for investigation its effect on the farmers' responses towards the pandemic was significant only for hygienic measures practiced for personal and animal health (Table 5).

Table 5. Significantly different responses of farmers of different annual income (3 K, 8 K, 17 K, 35 K).

Question	P-value	3 K	8 K	17 K	35 K
Do you cover your nose and mouth with masks or a tissue when working with animals during the crisis?	0.01	59	17	13	12
If your animals sick, would you call a vet for consultation?	0.03	70	19	17	11
If you have a disease you should not contact animals, and you should arrange with someone to take care of the situations and care of the animals	0.04	77	18	18	11
Wipe dry with a paper towel?	0.01	35	9	15	5

Experts' demographic characteristics and their responses to the pandemic

On the other hand, the participated experts in the study have various demographic characteristics (Fig. 3). The age classes were two classes (34-45 and 47-68 years) with almost equal proportion (52 and 48%). Most of them had experience exceeded 10 years and hold a Ph.D. certificate. Furthermore, half of them located in the Middle region of Jordan and worked at universities as academics and consultants. In general, the experts were agreed on a negative impact of the pandemic on global food security. Their opinions are listed in Table 6 showing animal products supply chain had negatively impacted the farm, market, and home level. They indicated that global animal products supply and demand were negatively affected as a result of border closures, quarantines, and disruptions in the market (Table 6). Furthermore, people have been restricted from accessing adequate and varied nutritious food sources in the world. On the other hand, they indicated that the blockage of transport routes has particularly hampered the supply chains of fresh food from animal products and may also lead to an increase in global food spoilage and waste levels. As a consequence, the world has seen that the countries that followed the quarantine and panic during the outbreak of the Corona disease exacerbated the food suffering in them, as the restrictions on the movement led to shortage of workers at harvest time and thus stopped food chain supply (Table 6).

Table 6. Significantly different responses of experts on impact of COVID-19 on food security in the globe.

Question	Agree %	P-value
Overall N	33	
Do you think COVID-19 will have a negative impact on global food security from animal source products?	90.9	<0.0001
Do you think that the negative impacts will affect important elements of both food supply and demand?	87.9	<0.0001
Do you think that border closures, quarantines, and disruptions in the market and in the supply chain and trade have restricted people's access to adequate/varied and nutritious food sources in the world?	93.9	<0.0001
Do you think the blockage of transport routes has particularly hampered the supply chains of fresh food from animal products and may also lead to an increase in global food spoilage and waste levels?	84.9	<0.0001
Do you think that the countries that followed the quarantine and panic during the outbreak of the Corona disease exacerbated the food suffering in them, as the restrictions on movement led to a shortage of workers at harvest time	75.8	0.0031
Do you think that policymakers around the world should take care not to repeat the mistakes made during the food crisis of 2007-08, and to turn this health crisis into a food crisis that can be completely avoided?	100	
Do you agree that the impact of the epidemic on food and nutrition will be mitigated by the continued flow of global food trade?	90.9	<0.0001
Do you believe that global food supply chains should be kept alive and the effects of the epidemic on the food system mitigated?	97.0	<0.0001
Do you think there are ways to test and stress the global diet in the coming weeks and months?	87.9	<0.0001
Do you think that the disturbances so far are minimal as the food supply is adequate? (Are markets stable?)	84.9	<0.0001
Do you think that countries experiencing prolonged crises of under-investment in public health will increasingly suffer from the	97.0	<0.0001

effects of the epidemic?

Do you think that quick measures should be taken to protect the most vulnerable groups to provide them with food?	94.0	<0.0001
Do you think that countries with high levels of poverty (including migrants, internally displaced persons and conflict-affected people) will increasingly suffer from the effects of the epidemic?	94.0	<0.0001
Do you think the hardest hit could be forced back to negative coping strategies - such as selling productive assets and a less diversified diet - to compensate for lower income?	79.0	<0.0009
Do you think that the COVID-19 outbreak will make the demand for food generally inelastic and its impact on overall consumption is likely to be limited, although dietary patterns may change?	81.8	0.0003
Do you think that the demand for food in poor countries is closely related to income, and here it can affect the loss of income earning opportunities on consumption?	97.0	<0.0001
Do you think fear of contagion could translate into reduced traffic to food markets, and we expect to see a shift in how people buy and consume food - fewer visits to restaurants, increased home eating?	84.9	<0.0001
Do you think Countries should inject money into the agricultural sectors, for example through the grant facility, it can help small and medium-sized businesses and wage-earners who cannot work to temporarily survive	93.9	<0.0001
Do you think that countries should provide supplemental benefits to compensate for loss of income by small-scale producers, for example; If food insecurity becomes too severe	87.9	<0.0001
Do you think that countries should temporarily reduce VAT and other taxes; If necessary, review tax policy on imported goods to compensate for potential cost increases (due to lower exchange values) and assess the potential effects of devaluation.	87.9	<0.0001
Do you think that countries that depend heavily on importing food, such as developing countries, small islands, and countries that depend on exports of raw materials such as oil, could have severe consequences of COVID-19 for them?	84.9	<0.0001
Do you think markets will face supply shocks due to disease and containment efforts that restrict mobility and rising costs of doing business due to restrictive supply restrictions and tightening of credit that lead to lower economic growth or economic recession?	75.8	<0.0031
Do you think that COVID-19 is likely to be a deflationary shock to the global economy, the true cost of a healthy diet may rise due to the increase in the cost of perishable goods,	93.4	<0.0001
Do you think countries should generally avoid any trade restrictions to keep food and feed supplies, as well as those for agricultural inputs, from exacerbating tense local conditions?	84.9	<0.0001
Do you think that after the spread of the virus, countries around the world began to implement a number of policy measures aimed at avoiding further spread of the disease with the risk of exposing commodities such as animal and fish products to damage and that there is a possibility of exporting spoiled products to Jordan?	81.2	<0.0003

The majority of experts agreed on policymakers around the world supposed to take care not to repeat the mistakes made during the food crisis of 2007-2008 and avoid turn this health crisis into a food crisis. They agreed that the impact of the epidemic on food and nutrition can be mitigated by the continuousflow of global food supply chains and be kept alive. They suggest that policymakers should apply ways to test and stress the global diet in the coming weeks and months to ensure that the disturbances so far are minimal, the food supply is adequate and markets are stable.

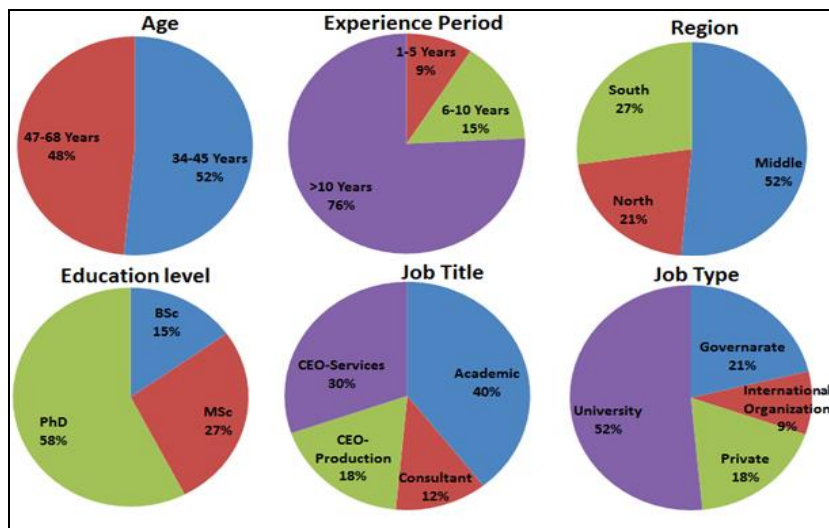


Fig. 3. Demographic characteristics of participated experts.

In detail, the experts emphasized on the fact that countries experiencing prolonged crises of COVID-19 will increasingly suffer from the effects of the pandemic on both health and food sectors. Therefore, they suggest quick measures should be taken to protect the most vulnerable groups (including poor, migrants, internally displaced persons, and conflict-affected people) and to provide them with food. Nevertheless, the countries with high levels of poverty will increasingly suffer from the effects of the epidemic resulting in applying negative coping strategies. The coping strategies include changing dietary patterns towards a less diversified diet to compensate for lower-income and selling productive assets. It is worthy to note that food in poor countries is closely related to income, and the loss of income can affect getting food consumption and make the demand for food generally. Most of the experts raise a point that fear of contamination with COVID-19 could translate into reduced traffic to food markets, and they expected to see a shift in how people buy and consume food, for example, fewer visits to restaurants and increased home eating.

They suggest strategies and policies be followed to overcome the impact of the pandemic on people's livelihood in all global countries (Table 6). The first strategy was injecting money into the agricultural sectors, for example through the grant facility which can help small and medium-sized businesses and wage-earners who cannot work to temporarily survive. The second, suggested strategy was providing supplemental benefits to compensate for the loss of income by small-scale animal producers. The third one was the temporary reducing taxes; if necessary, or review tax policy to compensate for potential negative impacts on the animal industry. With regards to policies, the majority of experts suggested policies based on each country's status. For instance, countries that depend heavily on importing food, such as developing countries, small islands, and countries that depend on exports of raw materials such as oil, could have severe consequences of COVID-19 for them. In general, they suggest that effective policy should face supply shocks due to disease and containment efforts that restrict mobility and rising costs of doing business due to restrictive supply restrictions and tightening of credit that leads to lower economic growth or economic recession. The shock is likely to be a deflationary shock to the global economy; the true cost of a healthy diet may rise due to the increase in the cost of fresh food. Besides, the suggested effective policy should generally avoid any trade restrictions to keep animal feed and its food products supply, as well as those for agricultural and animal industry inputs. Finally, the policy might consider implementing several measures aimed at avoiding further spread of the disease with the risk of exposing animal and fish products to damage and that there is a possibility of exporting spoiled products to importing countries such as Jordan.

On the other hand, animal industry experts in Jordan reported their views on how COVID-19 was impacting the industry (Table 7). They had a significant view that the COVID-19 harmed Jordanian food security in general and on food from animal sources. Generally, their view was described as the impact on the livestock sector was harmful due to the low access to fodder, slaughterhouses, and other supplies, lack of veterinary services, medicines and other inputs for livestock production. They indicated that for food supply, the partial or total closure of the food market and restaurants and the lack of grocery shopping reduced the demand for animal products, which affected producers and suppliers. They suggested overcoming this problem and reducing the impact of the epidemic on food and nutrition by following strategies such as supporting small farmers to increase production in Jordan and meeting the food needs of vulnerable (poor) communities in Jordan under the umbrella of the continuity of the preservation and health protection in Jordan.

Table 7. Significantly different responses of experts on impact of COVID-19 on food security in Jordan.

Question	Agree %	P-value
Overall N	33	
Do you think that COVID-19 has had or will have a negative impact on Jordanian food security in general and on food from animal sources?	78.79	<0.0009
Do you think that the impact of the epidemic on the livestock sector is bad due to the low access to fodder, slaughterhouses and other supplies in Jordan?	93.94	<0.0001
Do you think that the lack of veterinary services, medicines and	96.97	<0.0001

other inputs could affect livestock production?		
Do you think that the partial or total closure of restaurants (as it was weeks ago) and the lack of grocery shopping reduced the demand for animal products, which affected producers and suppliers	90.91	<0.0001
Do you agree to reduce the impact of the epidemic on food and nutrition by supporting small farmers to increase production in Jordan?	93.94	<0.0001
Do you agree to reduce the impact of the epidemic on food and nutrition by meeting the food needs of vulnerable (poor) communities in Jordan?	93.94	<0.0001
Do you agree that reducing the impact of the epidemic on food and nutrition through all the above points and under the umbrella of the continuity of the preservation and health protection in Jordan?	87.88	<0.0001
Do you think that the people most affected are the poorest people in Jordan (including migrants, internally displaced people, and conflict-affected people)	90.91	<0.0001
Do you think these (poorer) people in Jordan could not stand any other possible disruptions to their livelihoods or access to food after COVID-19?	93.94	<0.0001
Do you think that the social and health restrictions and protections due to COVID-19 that exist in Jordan now will increase the suffering of people who already suffer from acute food insecurity?	81.82	0.0003
Do you think that the people most affected are also vulnerable groups of small farmers whose work or care for their livestock may be hindered in accessing markets to sell their products or buy basic inputs?	90.91	<0.0001
Do you think the reason small farmers suffer due to COVID-19 is that they will face high food prices and low purchasing power?	87.88	<0.0001
Do you think that the day laborers in the livestock sector in Jordan were more affected by the loss of jobs and income?	93.94	<0.0001
Do you think that the measures taken with regard to expatriate workers may affect food production from animal sources and thus affect market prices in Jordan?	78.79	0.0009
Do you think that the negative impact on low-income families has increased the cost of progressing towards the sustainable development goals in Jordan?	87.88	<0.0001
Do you think that because of lower income and uncertainty people spend less and lead to reduced demand, lower sales and also production?	90.91	<0.0001
Do you think that Jordan should use food banks as an option, reduce food waste, and activate solidarity networks and NGOs to provide food?	84.85	<0.0001
Do you think that Jordan should amend and expand social protection programs by increasing food support and tax exemption on basic food for families with school-age children, especially for workers in the most affected economic sectors?	90.91	<0.0001
Do you think that after the spread of the virus, there is risk of exposing commodities such as animal and fish products to damage and that there is a possibility of exporting spoiled products to Jordan?	81.82	0.0003
Do you think that the logistical problems associated with transport restrictions, border closures, and reduced demand in restaurants and hotels could lead to major changes in international food suppliers to the Jordanian market - thus affecting prices?	87.88	<0.0001
Do you think that demand by Jordanian traders will also decrease due to higher uncertainty, increased prudential behavior,	81.82	0.0003

containment efforts, and higher financial costs of importing?

Do you think that countries including Jordan should use digital tools (apps) to improve communication on food chains and measures to reduce the risk of COVID?	96.97	<0.0001
Do you think that policymakers in Jordan and the world should monitor trends and pay attention to avoiding tightening food supply conditions, making feedback, and activating the role of digital technologies in anticipating problems and mitigating temporary shortages, in addition to building food chain resilience to avoid similar situations in the future?	90.91	<0.0001

Indeed, the people most affected are the poorest in Jordan including migrants, internally displaced people, and conflict-affected people. There was general agreement that these (poorer) people in Jordan could not stand any other possible disruptions to their livelihoods or access to food after COVID-19. Furthermore, the social and health restrictions and protections due to COVID-19 that exist in Jordan will increase the suffering of these people who already suffer from acute food insecurity. There was an emphasis on vulnerable groups of small farmers, whose work or care for their livestock may be hindered in accessing markets to sell their products or buy basic inputs, facing high food prices and low purchasing power. Furthermore, the experts indicated that the day laborers and expatriate workers in the livestock sector in Jordan were more affected by the loss of jobs and income. Similarly, they stated that the closure (lockout or curfew) measures taken affected food production from animal sources and thus affect market prices in Jordan. The people spent less and lead to reduced demand, lower sales and also production because of lower-income and uncertainty in the food supply. Consequently, the negative impact on low-income families has increased the cost of progressing towards sustainable development goals in Jordan. Therefore, the experts recommend using food banks as an option, to reduce food waste and activate solidarity networks of stakeholders of governmental and non-governmental organizations. Overall, they suggest that Jordan should amend and expand social protection programs by increasing food support and tax exemption on basic food for families, especially for workers in the most affected economic sectors.

Considering word trading of food of animal sources, the experts agreed on the logistical problems associated with transport restrictions, border closures, and reduced demand in restaurants and hotels could lead to major changes in international food suppliers to the Jordanian market-thus affecting prices. They also noted that the demand for the food by Jordanian traders decreased due to higher uncertainty, increased prudential behavior, containment efforts, and higher financial costs of importing. Another note was pointed that after the spread of the virus, there was the risk of exposing commodities of animal and fish products to damage and that there was a possibility of exporting spoiled animal products to Jordan. As a precaution measure, the experts suggest that Jordan should use digital tools to improve communication on food chains and measures to reduce the risk of COVID-19. The policymakers in Jordan and the world should monitor trends and pay attention to avoiding tightening food supply conditions, making feedback, and activating the role of digital technologies in anticipating problems and mitigating temporary shortages, in addition to building food chain resilience to avoid similar situations in the future.

Discussion

The current study outlines the socioeconomic response of farmers and experts of the animal industry towards COVID-19 impacts on food security in Jordan. The study outcomes provide requirements with what needs to be done to support Jordan and word food security considering the multiple social and economic challenges that the pandemic has brought. The result has also helped us reflect on what sustainable solutions suggested by Jordanian experts of the animal industry can be applied, notwithstanding the impact of the crisis on the livelihood of farmers and families. Overall, authorities stated that Jordan's response to contain the spread of the virus has so far, been very effective, particularly given the scale and scope of the crisis (Jørgen, 2020). As of the time of execution of this study, early June 2020, the health statistics stated there have only been 9 deaths in a population of 9.456 million (WHO, 2020). But the negative impact of the pandemic on the animal industry will be with us for the foreseeable future as described in the result section. The results showed those farmers' and experts' demographic characteristics influenced the response towards COVID-19 impacts on the industry. In similar, Liu et al., reported the importance of considering demographic factors such as age, experience, education, and measuring response taken by livestock farmers, owners and experts. The farmers of the class age of 35-45 years, the South region and the intensive production system had more awareness and knowledge about COVID-19, and best management and hygienic practices. Other farmers who had limited knowledge and minimum awareness reported a more negative impact on higher businesses. Similarly, a recent study reported the impacts to be more severe for livestock products, which are often produced by smallholder farmers (FAO 2020). In general, farmers worldwide in the livestock industry play a crucial role in global food security and the economy. The ability of the industry to overcome the negative impacts of the COVID-19 virus on animal welfare and the livestock supply chain is related to the ability of farmers to do so (Hashem, 2020). Here we found that some categories of Jordan farmers were able to acclimatize and implement adequate management tools during the negative impacts of the COVID-19 virus regards their level of education, business type and production system. For example, in Jordan, during COVID-19, road and market blocks prevented animal industry producers from selling products or buying inputs, which resulted in a loss of income, loss of production and it had negatively affected and thus threatened the existence of their businesses. As a consequence, the majority of farmers were facing financial losses as a result of the COVID-19. Similar findings were reported in China, Italy,

Egypt, Kenya, and other countries (Hashem, et al., 2020; Zhang, 2020; Luedi, et al., 2020; Barcaccia, et al., 2020; FAO, 2020). The financial losses were physically cut off, delays due to required sanitary checks, roadblocks and closing slaughterhouses. Besides, many street markets and farmers' markets were closed to limit public gatherings. This prevented smallholder producers from selling directly to consumers resulting in a loss in quality or to complete damage of their perishable products and to the accumulation of non-perishable products.

On the other hand, the participated experts' responses considering their various demographic characteristics were reported the negative impact of the pandemic on global and Jordan food security. Similar responses were reported by the Food and Agriculture Organization (Zurayk, 2020). In general, the four dimensions of food security of availability, access, utilization, and stability have fallen negatively under the stress of the COVID-19 pandemic (FAO, 2020). The experts indicated that global animal products supply and demand were negatively affected as a result of border closures, quarantines, and disruptions in the market. They also indicated that reasons for negative impact at Jordan level were due to restriction from accessing adequate and varied nutritious food sources, the blockage of transport routes, and the limited amount of fresh animal products. To avoid global and thus local food crisis, the majority of experts agreed on policymakers of around the world should play a pivot role to avoid turn this health crisis into a food crisis. The suggested role to be played might include various mitigated strategies and policies. The strategies can be the continuous flow of global food supply chains and be kept alive, sustainable food supply chain, adequate and stable markets, protect the most vulnerable people groups (including poor, migrants, internally displaced persons and conflict-affected people). In agreement, it was suggested monitoring the negative impacts of the COVID-19 pandemic may help in creating resilience management tools, contribute to ensuring a sustainable food supply chain of livestock products, alleviating losses and posing lessons for future duty of action (Hashem, 2020).

The experts emphasized applying some more useful strategies such as change dietary patterns towards a healthy diet, injecting money into the agricultural sectors, providing supplemental benefits to compensate for the loss of income by small-scale animal producers and temporarily reducing taxes. It was noteworthy to get attention to different coping strategies and a shift in consumption patterns practiced by producers and consumers during the pandemic time. In the past, we have observed a similar shift in consumption patterns by applying less balanced and diversified diets by poor households during the financial crises of 2008 (FAO, 2020). Similar consumer behavior changes were observed in many value chains during the EVD epidemic in 2014 (FAO, 2016).

On the other hand, the suggested policies were country status based on which countries that depend heavily on importing food and developing countries. In general, they stated that the effective policy should face supply shocks of food containment, restrict mobility, rising costs, economic growth and economic recession. Overall, the policymakers might consider implementing some measures aimed at avoiding the further spread of the disease and discontinuation of fresh animal products chain supply on a global basis and amend and expand social protection programs by increasing food support and tax exemption on basic food for families, especially for local and expatriates workers in the most affected economic sectors. It is for sure, crucial to maintaining the agriculture operation process during lockdown to ensure the continuation of production and the protection of rural workers. However, there were successful strategies made by countries. For instance, Italy has extended the residence permits for non-European Union citizens already living in the country in response to the shortage in the agricultural workforce during COVID-19 (ANSA, 2020). Furthermore, online (electronic) commerce sites have also facilitated the trade of agricultural products to sustain market demand for smallholder producers and create mechanisms to support the sales of accumulated products (Zhu, 2020). Therefore, we find based on the COVID-19 crisis that it is important to establish safe trade corridors considering digital technologies and based on public health mitigation measures along market chains.

Conclusion

Animal Industry had negatively impacted by the COVID-19 pandemic in the world. Likewise, in Jordan, the impact was measured as responses and actions practiced by farmers and experts. The farmers of various demographic characteristics and various management and hygienic practices indicated that their businesses have faced financial risks ranged from financial debt to bankruptcy during the first wave of pandemic (March-June). The experts stated that Jordan and similar countries importing most of their food and their residents are vulnerable families can able to mitigate the COVID-19 devastating socioeconomic impacts considering timely, targeted, and prioritized policies and strategies. A recommendation was suggested for applying digital technologies in anticipating problems and mitigating temporary shortages, in addition to building food chain resilience to avoid similar situations in the future at global and country levels. In other words, it is recommended to utilize the digital transformation in establishing safe trade corridors of animal products during any plausible future crisis. Finally, the negative impacts of the COVID-19 pandemic that threatens the animal industry can be minimized when the animal products supply chain kept globally and locally sustainable considering resilience management tools, alleviating current losses and producing more food by applying green and sustainable practices.

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Author Contributions

R.M. Al-Atiyat designed the structure of the electronic questionnaire, literature review paper, and wrote the paper. M.J. Tabbaa collected and compiled the literature analyzed the data, synthesized the results and reviewed the paper drafts.

Conflicts of Interest

The authors declare no conflict of interest.

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