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An overview of agri-food supply chains in the covid-19 pandemic period

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Abstract

Due to the global pandemic, which has recently spread all over the world, supply chain resilience and flexibility of industries became more important than ever. Due to the COVID-19 outbreak, both the in increase in consumption and the occasional halt in production have led to a focus on agricultural food supply chains. With this pandemic, new challenges, threats and different opportunities have emerged for agri-food supply chains. In this study, the effects of COVID-19 on agri-food sector which has an important place in Turkey's economy has been discussed and the results have been compared with the world leader United States. The basis of the study will be to compare the agri-food supply chains of both countries on the basis of real data. A roadmap will be presented to identify the impacts in both countries and to see how they are dealing with a pandemic.

1. Introduction

Coronavirus disease, also known as COVID-19, is an infectious respiratory disease. The world has met with this virus on 31 December 2019, when Wuhan Municipal Health Commission has reported several cases that later identified as a coronavirus (World Health Organization, 2020). Before long, the virus has spread along with all world. OECD (2020) presented that according to OECD's latest Economic Outlook, "The Covid-19 pandemic has triggered the most severe recession in nearly a century and is causing enormous damage to people's health, jobs, and well-being." As of 31st December 2020, total corona cases in the world reached 84 million and the number of deaths is 1.8 million. Even though, Turkey's first case appeared 3 months after the first case in Wuhan, government authorities immediately took some precaution to prevent bigger consequences like other countries. Still, the coronavirus continues to spread all over the world and continues to affect many lives, jobs and industries. Consequently, people have been affected by the virus, regardless of their profession. Therefore, setbacks, limitations, disruptions occurred on the global supply chains, including agriculture sector. Due to fact that agriculture is the oldest livelihood, it is one of the essential sectors for the governments. Kayabaşı, (2020) stated that several exemptions were applied to farmers and farm workers due to the pandemic limitations in order not to break supply chain. Additionally, she emphasized supply shortages of agricultural crops in the next period may be occur, in spite of this privileges.

When this is the case, people started to pay more attention to their health, and started to be more careful than ever, about what they are buying, how the product has been developed and delivered, etc. It leads people to want more information about supply chains' steps like food procurement, food safety, production methods, hygiene, and the use of genetically modified feed when they purchase (Wognum et al., 2011; Zavvar Sabegh et al. 2016). Especially,

the agricultural supply chain has become more important than other sectors because the food sector has infectiousness risks more than others. For example, in the past, beginning of the SARS-CoV-2 virus, many restaurants and cafeterias stopped selling steaks and meat products in central Europe (Rizou et al., 2020). Similarly, countries such as Turkey, United States of America and so on imposed quarantine from time to time and brought several restrictions to several entertainment venues, for instance; restaurants, bars, coffee shops.

The possibility of a pandemic is considered by scientists for many years. In this case, quarantines will continue from time to time around the world. Therefore, disruptions are expected, especially in the food supply chain. This study consists of three important contributions. First, studies on food supply chains affected by pandemics will be examined in the literature. Then, using real statistical data related to COVID-19 pandemic, agri-food supply chains in Turkey and the United States are to be analysed to understand the impact. the general situation of the food supply chain. Lastly, a roadmap will be presented to determine how both countries should deal with the pandemic, by consulting experts on the agri-food supply chain.

The paper consists of four sections. The next section will discuss a detailed literature review of the topic. Data to be used in analysis is presented in Section 3. Section 4 consists of discussions and managerial implications. Lastly, the conclusion of the study is provided.

2. Food Supply Chain in the Pandemic

In this section, the literature review for supply chain and pandemic is investigated.

There are numerous researches related to supply chains and pandemic in the world. While the articles reviewed COVID-19 pandemic are predominant, there are other studies investigating the disruption of supply chains during avian influenza Kumar and Chandra (2010) and other pandemics also exist. Kumar and Chandra (2010) analyzed a drop in sales, inventory shortages, and fewer workers caused by the avian flu pandemic in the global supply chain of a US Computer Company. To overcome these issues, they made recommendations to enhance supply chain operations and communication such as developing a strategic business continuity plan. Majority of papers in this literature review are about food supply chains, agri-food supply chains during pandemic periods (Hobbs, 2020; Rowan & Galanakis, 2020; Luckstead et al., 2020; Rizou et al., 2020; Elleby et al., 2020; Chowdhury et al., 2020; Abiral & Atalan-Helicke, 2020; Seleiman et al., 2020; Orden, 2020).

On the other hand, papers such as Nikolopoulos et al. (2020), Zhu et al. (2020) focused broader effects of COVID-19 in the supply chain disruptions. In more detail, Nikolopoulos et al. (2020) studied a new hybrid forecasting model which is based on the nearest neighbourhood and clustering to predict growth rates of coronavirus at the country level. They underlined that it is essential to forecast during the pandemic, especially when demand suddenly arises and much greater effect is observed on the supply side, the well-known Bullwhip Effect. Another study that mentions the bullwhip effect belongs to Zhu et al. (2020). They demonstrated a relationship between medical shortages and supply chain problems through to COVID-19. Despite the businesses are aware of the increasing demand, the bullwhip effect still applies. Hence, to cope with it, they suggest mainly two things; nationalize the source of medical supply and diversify their suppliers. Similarly, Hobbs, (2020), Abiral & Atalan-Helicke (2020), and Seleiman et al. (2020) got the same or similar result which consumers/governments and so on can benefit from the localization of supplier. In other words, COVID-19 impact can be decreased by a local producer or supplier option.

Other researchers focused on the market dynamics during the COVID-19 pandemic (Orden, 2020). He exposed the economic value of the North American food sector has decreased by 12-18 billion dollars and it result with a huge amount of unearned revenue. Additionally, Elleby et al. (2020) conducted a scenario-based analysis of IMF economic growth forecasts for 2020 and 2021 using a global multi-commodity agricultural market model. They figured out that agricultural food product's prices are below the baseline. However, in the following years' picture will become more mix and some prices of such items will increase. One another issue that COVID-19 brought the agenda is food safety. Food safety refers to the discipline of collecting, handling, sorting, distributing, and stocking foods to prevent foodborne illness. Thus, the safety of food became a more important issue in supply chain management, especially on pandemic days. Rizou et al. (2020) summarized how the COVID-19 can spread through different surfaces and environments including food supply chains. While arguing the safety of food, it is also essential to talk about the safety of the environment, too. Rowan & Galanakis (2020) reviewed setbacks, challenges, and potential solutions for post-COVID19 and provided green deal innovation, while meeting the demand. Last but not least, Luckstead et al. (2020) surveyed coronavirus impact on labour throughout the food supply chain. Without a doubt, human resources, labour component of supply chains are the most indispensable parts. Unfortunately due to breakdowns during the pandemic, a lot of places like schools, restaurants, bars, and so

on have been shut down. For that reason, countless people were unemployed. Within this study, surveys showed participants' ideas shifted to food being a national security issue.

Table 1. Literature Review of Supply Chain and Pandemic Source: own research

Author(s)	Title	Purpose of The Study	Findings
Hobbs, (2020)	Food supply chains during the COVID-19 pandemic	An early assessment of the implications of the COVID-19 pandemic for food supply chains and supply chain resilience	COVID-19 pandemic will have longer-lasting effects on the nature of food supply chains. Two aspects come to mind: the growth of the online grocery delivery sector and the extent to which consumers prioritize "local" food supply chains. Attention should give to keeping cross-border supply chains open and unencumbered by new regulation, mitigate panic buying and stockpiling behaviour by consumers in the event of future crises also deserve consideration.
Rowan & Galanakis (2020)	Unlocking challenges and opportunities presented by COVID-19 pandemic for cross-cutting disruption in agri-food and green deal innovations: Quo Vadis?	To review challenges, opportunities, and potential solutions for the post-COVID-19 era that focuses on intensive sustaining of agri-food supply chain in tandem with meeting the high demand for new green deal innovation	Future disruptive technologies will be shaped by increased demand to produce more safe foods and attitudes towards climate change and digitization. Such as Peatlands-based Freshwater Aquaculture process.
Luckstead et al. (2020)	Labour Issues in the Food Supply Chain Amid the COVID-19 Pandemic	Explain the impacts of the COVID-19 pandemic on labour throughout the food supply chain via survey before and during the spread of COVID-19.	Results showed that participants' thoughts are shifted to idea that food being a national security issue and a higher degree of empathy for H-2A guest workers.
Kumar & Chandra (2010)	Supply chain disruption by avian flu pandemic for US companies: a case study	To measure effects of avian flu in global supply chain of an computer company and develop an decision framework using system dynamics, using Closed-Loop and Stock Flow Diagram.	Some suggestions made to managers such as; developing a strategic business continuity plan, review their insurance policy, communicate with their supply chain partners on the issue of sustainability.
Rizou et al. (2020)	Safety of foods, food supply chain and environment within	Summarize the ways of infection of COVID-19 through the foods, food	More safety measures are needed, the need for developing respective bioanalytical protocols for food

	the COVID-19 pandemic	supply chain, surfaces, and environment.	and environmental safety applications to adapt in the post-lockdown period is also highlighted.
Elleby et al. (2020)	Impacts of the COVID-19 Pandemic on the Global Agricultural Markets	Determine price change for every type of products using Aglink-Cosimo model.	In covid-19 pandemic' process agricultural markets spending decreased sharply like other products market.
Chowdhury et al. (2020)	A case study on strategies to deal with the impacts of COVID-19 pandemic in the food and beverage industry	Researched the food sectors for COVID-19 effect on short term and medium term impacts in Bangladesh.	Causes of effect about short and medium term impacts for food industry.
Abiral & Atalan-Helicke (2020)	Trusting food supply chains during the pandemic: reflections from Turkey and the U.S.	Analysis consumer behaviour in food supply chain in Turkey and US.	Turkish consumer chose more trustworthy short supply chains like local farmer market beside new routines options.
Seleiman et al. (2020)	Will novel coronavirus (Covid-19) pandemic impact agriculture, food security and animal sectors?	Compare food sector export data with after pandemic process data for each country.	Covid-19 impact can reduce with local producer and short supply chain.
Orden (2020)	Resilience and Vulnerabilities of the North American Food System during the Covid-19 Pandemic	This paper explains pandemic impact on American food sector with economic value.	USA corn and soybean market decrease 12-18 billion dollars in pre-pandemic process so this drop effect to revenue like 8 -11 billion dollars for USA income.
Nikolopoulos et al. (2020)	Forecasting and planning during a pandemic: COVID-19 growth rates, supply chain disruptions, and governmental decisions	To predict COVID-19 growth rates in country level with a new hybrid forecasting model based on nearest neighbour and clustering, further excess demands to help decision—makers.	Even though trustable data are not available right now, using Google Trends data, they figure it out that earlier a lockdown is imposed, the higher the excess demand will be for groceries. And thus, government can imply policies according to it.
Zhu et al. (2020)	Lessons Learned from the COVID-19 Pandemic Exposing the Shortcomings of Current Supply Chain Operations: A Long-Term Prescriptive Offering	To address supply shortages and supply chain issues derived from COVID-19.Thus, to mitigate the effects of these issues and protect supply chain operation.	Proposed some recommendations, such as nationalizing the medical supply chains, adopting a plus one diversification approach, and increasing safety stock.

When the literature is examined, with the COVID-19 pandemic that emerged at the end of 2019 and affected the whole world, the supply chain issue was studied in different sectors. However, it has been found that there are very

limited studies on the agricultural food supply chain. There has been no study that deals with each link of the chain as a whole, especially in order to prevent the food flow from being interrupted.

3. Data Collection

3.1 Coronavirus Data

In this part of the study, the number of cases and deaths of both US and Turkey will be compared and how they are affected by the pandemic will be analysed. The number of cases and deaths in both countries until 31 December 2020 is shown in Table 2.

Table 2. Cumulative Total Cases and Deaths (Source: (Source World Meters, 2021)

Country	Cases- Cumulative Total	Deaths - Cumulative Total
United States of America	20,555,134	361,948
Turkey	2,208,652	20,881

As shown in the Table 2, the number of cumulative cases total is over of 20.6 million in the US. In parallel, total number of deaths in the US is 362 thousand. However, Turkey has reached 2.2 million cases, while total number of deaths is nearly 20.9 thousand. When the numbers are analyzed, the death rate in United States is approximately 1.77%, while Turkey death rate is 0.95%. When population of these countries are considered, US has a population of 320 million and 6.42% had been infected; where in Turkey with a population of 83 million, only 2.66% of it had been infected. Despite the fact that US population is approximately four-fold Turkey population, the rate of cases is not consistent with these numbers.

Table 3 and Table 4 show the monthly number of cases and deaths during 2020, which is considered the beginning of the pandemic in both countries. With the official start of the pandemic being accepted as March, it is seen that the cases are increasing irregularly every month.

Table 3. Coronavirus Cases and Deaths of US per Month (Source World Meters, 2021)

Country Month	United States of America	
	Cases	Deaths
January	0	0
February	68	1
March	197776	5209
April	910603	60030
May	755292	43865
June	884162	21343
July	2018419	26944
August	1524731	30727
September	1222029	23969
October	1948104	24333
November	4504509	37878
December	3717639	44624

In March, there were 0.06% (197.776) cases in the US compared to the population (320m) and 0,04% (36.806) cases in Turkey compared to the population (83m). In September 2020, there were 2.34% (7.503.080) cases in the US compared to the population (320m) and 1.05% (866.776) cases in Turkey compared to the population (83m).

According to Table 3 and Table 4, in the 2020, COVID-19 impacted US population more due to rapid spread. The higher the number of cases and deaths, the longer the lockdown in that country. The lockdown period can cause problems in terms of both production and consumption. This means that the US agri-food supply chain should have been further damaged.

Table 4. Coronavirus Cases and Deaths of Turkey per Month (Source World Meters, 2021) https://www.worldometers.info/coronavirus/

Country Month	Turkey	
	Cases	Deaths
January	0	0
February	0	0
March	36.806	214
April	290.156	2960
May	118.969	1366
June	97.822	591
July	84.230	560
August	106.788	679
September	132.005	1825
October	154.239	2057
November	410.633	3494
December	550.442	3864

3.2 Agricultural Data

The value of agricultural land use in Turkey is decreasing day by day due to various reasons. Figure 1 presents the total used agricultural land values in thousand hectares in Turkey between the years 2004-2019. As can be seen in the table that this decrease will continue throughout the pandemic period. In particular, it is thought that the value of this downward trend in 2020 due to COVID-19 could be greater than the past 5 years.

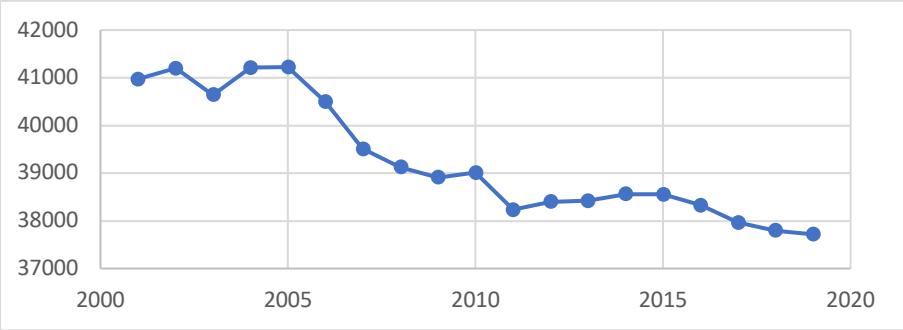

Figure 1. Total Agricultural Land in Turkey (Source: TUIK, 2020)

Figure 2 shows the basic agricultural food products per hectare of area sown with wheat in Turkey.

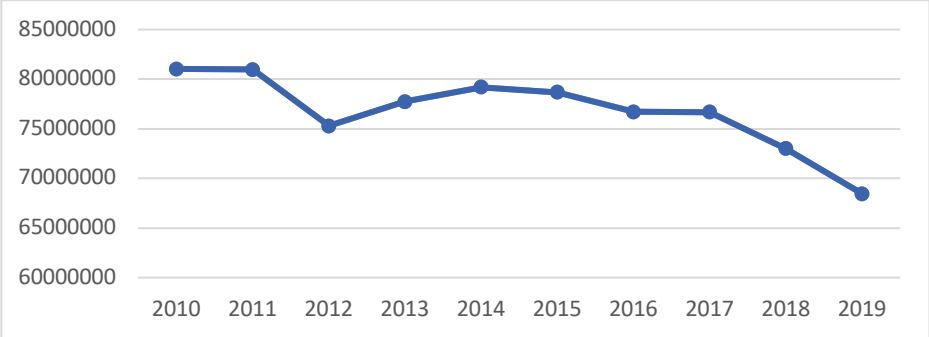

Figure 2. Sown Area of Wheat (Source: TUIK, 2020)

Both cultivation areas and production are significantly reduced due to political, economic and different reasons.

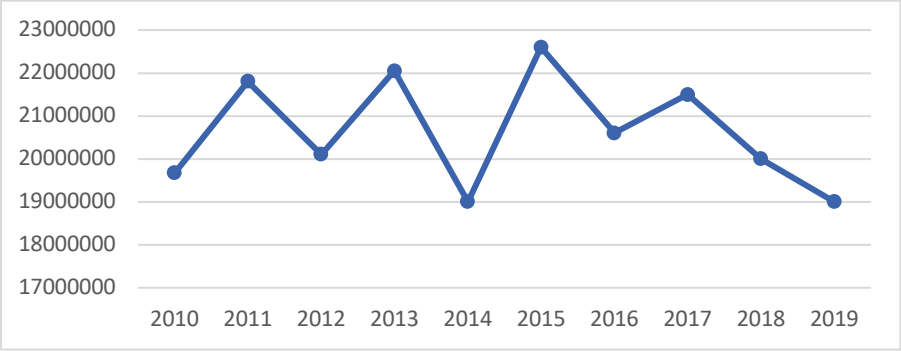

Figure 3. Total Wheat Production (Source: TUIK, 2020)

In contrast to Turkey, US' Agriculture process more stable than Turkey' Agriculture. Figure 4 and 5 show the Wheat plant and production value. Each table telling wheat productivity not affected by corona so we can understand US' Agriculture system stronger and flexible than Turkish side. If US' Agriculture system was like Figure 2 and 3, we can say US supply chain take damage from pandemic. This damage probably will be on production and sale process but Figure 4 shows us this damage bearable in these pandemic times.

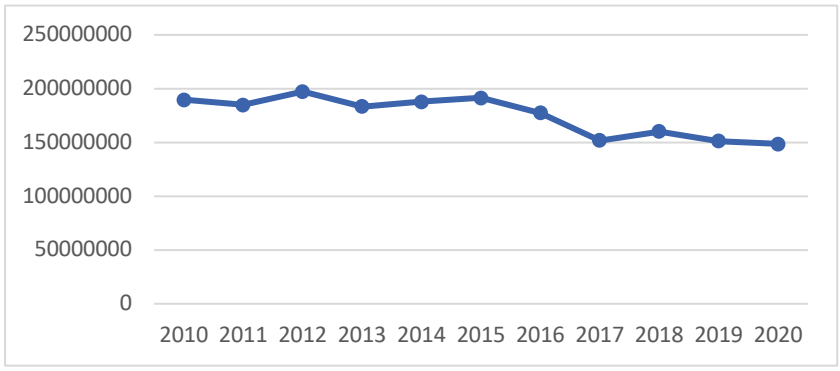

Figure 4. Sown Area of Wheat (Source: US Depart. of Agriculture, 2021)

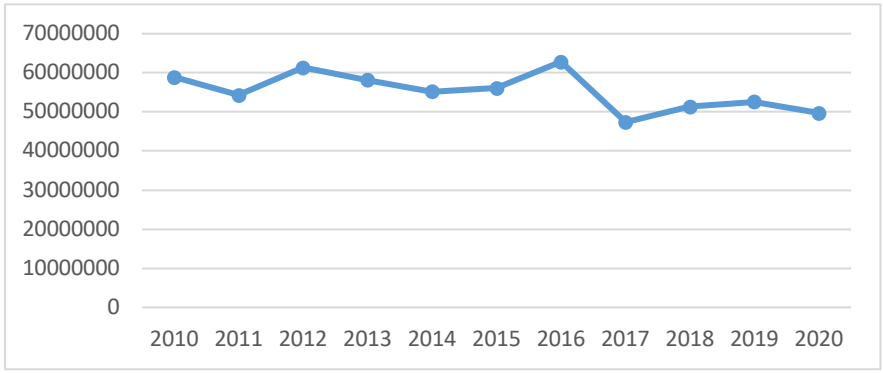

Figure 5. Sown Area of Wheat (Source: US Depart. of Agriculture, 2021)

In times of lockdown, people start to stock up and wheats product have an important share in this stock as pasta and flour. People started making homemade food products in order to reduce dependency on outside. These issues increased wheat consumption value; therefore, US wheat stock value decreased in 2020. Figure 6 shows this decrease with numbers. Wheat ending stock value dropped nearly 15 percent.

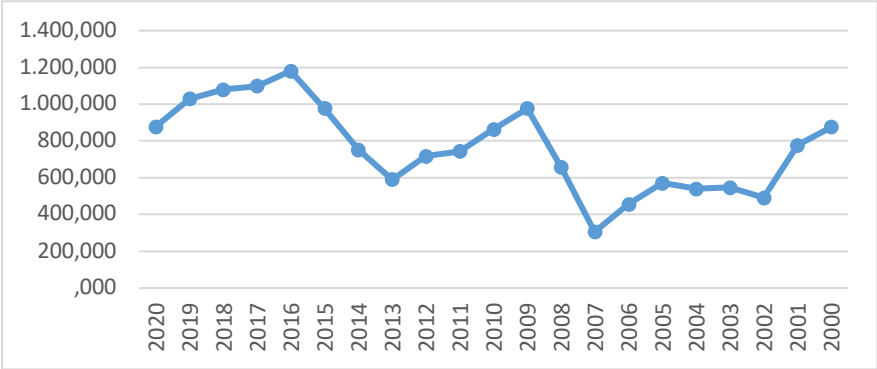

Figure 6. Ending stocks value for Wheat (Source: US Depart. of Agriculture, 2021)

Increased use of wheat, increased the need for wheat so US government increase wheat import value for people. Normally, Export-Import balance is on the positive side but in lockdown time (2020 March, April, May, June, and July) this balance turned negative sharply. Figure 7 shows how big this rotation is in Dollar value.

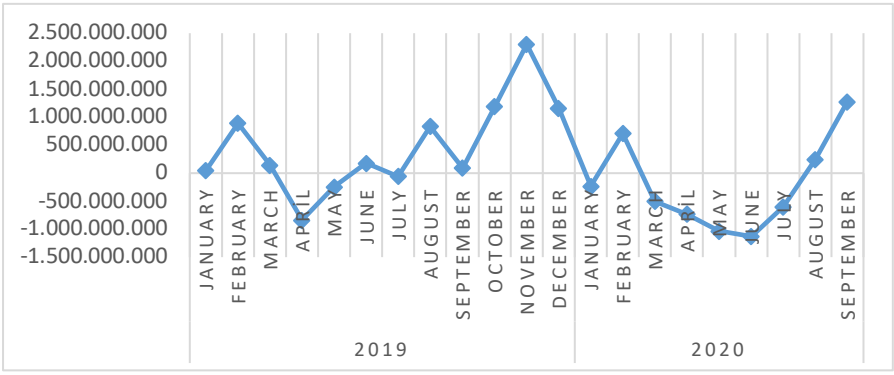

Figure 7. Export – Import value for Wheat (Source: US Depart. of Agriculture, 2021)

4. Discussion and Managerial Implications

With COVID-19, which affected the whole world, there has been an unexpected demand, especially in food and hygiene products, in many countries. With the distress in the supply chains and the decrease in supply, there has been panic buying and hoarding behaviour. Especially during the quarantine periods, there was a shortage of staple food, canned goods and flour in the markets.

A roadmap will be presented to identify the impacts in both countries and to see how they are dealing with a pandemic. For this purpose, five experts from different companies with at least ten years of work experience in the food sector and three academicians working on the subject were chosen. The detailed information about experts is given in Table 5.

Table 5. Information about Experts

Expert	Position	Experience	Gender
1	Food Engineer	11	Male
2	Supply Chain Department Manager	18	Male
3	Logistics Manager	10	Female
4	Food Engineer	12	Male
5	Logistics Manager	15	Female

Open-ended questions were asked to experts working in different departments of the agricultural food sector. Experts were asked to evaluate the current situation in terms of suppliers, producers and consumers. Again, in case the pandemic continues, the same experts have been asked for possible problems and solutions to be encountered in the future.

Current problems identified in line with the answers and comments from experts;

- The measures taken during the isolation periods had negative effects on the labour supply, especially in the food sector. Although the continuity of the sector is mandatory, unfortunately it is not possible to work from home.

- The stopping or slowing down of production in the food sector creates two important problems. If the production factory closes or employees seek unpaid leave, the people working in the factories suffer economic hardship. However, the real problem is that if the place of production is infected, all people are at risk.

- Factories producing agricultural food are the first to protect the health of the employee. In this way, both the permanent source of production income and sufficient workforce are provided. During the pandemic period, it is important to protect and maintain the health of people working in the food supply chain.

- Incentives should be organized in order to increase production by keeping employees at work.

- It is necessary to work with multiple and new suppliers to meet the demand arising from the sudden increase and fluctuations in demand.

- Changing consumption habits during the pandemic period should review the product change decision of many farmers and producers.

- In addition to production, it is another important issue to ensure the flow of all logistics channels throughout the food supply chain. All stakeholders must be equally careful in order to maintain the flow of food throughout the supply chain and to meet consumer demands.

- Many agricultural products in Turkey is due to seasonal workers living in different regions. Concerns continue due to the pandemic, and finding workers can be more and more difficult. As workers' wages are already a major cost factor for agriculture and food wages, COVID-19 will further strain the agri-food economy.

- Manufacturing companies will need to restructure their production lines with flexible and agile models suitable for the pandemic instead of existing static optimization models.

- With COVID-19, a great increase has been observed in e-commerce purchases in the food sector. Manufacturer and retail companies should definitely focus on in e-commerce strategies.

5. Conclusion

The COVID-19 pandemic, which has affected the world, has had positive and negative effects at different stages of production supply chains. However, the difference of the agricultural food sector from other sectors is that it produces products that are necessary for daily life. During the COVID-19 pandemic, which has affected the whole world, especially the supply chains of the agriculture and consequently the food sectors have deeply affected. The measures taken against the pandemic caused changes in the supply chain structures and changes in consumer demand led to major demand shocks.

This study consists of three important contributions. First, studies on food supply chains affected by pandemics will be examined in the literature. Then, using real statistical data related to COVID-19 process, Turkey and the

United States, is to analyse the general situation of the food supply chain. Lastly, a roadmap will be presented to determine how both countries should deal with the pandemic, by consulting experts on the agri-food supply chain.

Although vaccines are being introduced, the exact end date of the pandemic is uncertain. The impact of this uncertainty on the food supply chain can take many years. In addition, with the end of the pandemic, the possibility that the demand will never return to pre-pandemic levels should be considered.

This pandemic with an uncertain end date showed us that no model used in the past is suitable for the new situation. Therefore, taking into account that the pandemic will continue for many years, the company needs to remodel all the supply chain stages according to the new order, more flexible, agile and. We should not forget that in pandemic times, consumers' access to healthy food is as important as access to food.

Contribution of Researchers

Both Esra Ekinci and Yucel Ozturkoglu designed and gave contribution the Introduction, Conclusion, Discussion

Conflict of Interest

The authors declared that there is no conflict of interest.

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