The Impacts of COVID-19 on Poultry Producers and Consumers

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Keywords: COVID-19, poultry, supply, demand, price, producer, consumer, supply chain

Abstract

Following the outbreak of the COVID-19 pandemic, many laws and regulations were put in place to limit the spread of the disease. As a result, many industries were majorly affected by these regulations, including the poultry industry. This project studies the effects of the pandemic on both producers and consumers within the poultry industry to provide an understanding of the impacts to help prepare firms and individuals in case of future shocks. Based on producer case studies of Tyson Foods, Pilgrim's Pride, and Sanderson Farms, and consumer surveys, common themes were established to understand the impact throughout the poultry production process. Financial statements of Tyson Foods, Pilgrim's Pride, and Sanderson Farms were examined and the information gathered from the financial analysis matched what consumers shared via the consumer survey. Increased retail poultry prices, decreased quality, and limited availability of poultry products were the common themes noted.

Based on the results of this analysis, it is recommended that data from additional producers be analyzed, including poultry farmers who raise the birds for the poultry firms. Since the supply chain starts with the poultry producer, a better understanding of the pandemic's impact on this level will help prepare responses throughout the supply chain in the event of future shocks. Many consumers stated that they still notice impacts from COVID-19 within the poultry industry over two years later. This project provides insights specific to the poultry industry for those studying COVID-19's impact on food industries, and recommends best practices to consider in case of another major shock within the industry.

Keywords: COVID-19, poultry, producer, consumer, price

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Introduction

COVID-19 has affected everyone differently since the first United States case was confirmed in January of 2020. This study will measure the substantiality of it on a variety of individuals. COVID-19 led to extended lockdowns and regulations enacted to end the outbreak. These rules had direct impacts on the poultry industry. Within the United States, chicken consumption has more than doubled since 1970, making it the most consumed meat (Economic, 2022). The table in **Appendix A** details the steady rise of the U.S. per capita availability of meats, with chicken recently becoming the top meat. Due to the increased importance of poultry within the United States, this study will focus solely on the poultry industry from just before the outbreak of COVID-19 to the present.

Almost half of the United States poultry industry is covered by three main producers (in order starting with greatest market share): Tyson Foods with nearly 21%, Pilgrim's Pride with 17%, and Sanderson Farms with 9% (Maples et al., 2020). It is important to understand the structure of the poultry industry in the United States. There is a contract growing system in place, with 99% of broilers and broiler breeders grown under contract. It is a very complex system, between broiler breeding and grow-out. Broiler breeding begins with "genetic stock through primary breeders" and ends with "parent stock which supply the hatching eggs to be grown as broilers" (Maples et al., 2020). This can be very lengthy, as "the length of [broiler breeding] production varies from 60 to 80 weeks" (Maples et al., 2020). Given the length of the breeding and grow-out process, the industry could be impacted at various levels.

For the primary breeders, farmers are paid based on "breeder management and the

number of settable eggs supplied to the hatcheries" (Maples et al., 2020). This stage is known as broiler grow-out. This is the final stage in the production process, and it is when chicks are placed on farms to be grown to their desired age and size before harvest around four to eight weeks old (Maples et al., 2020). This stage begins with climate controlled houses for birds depending on their size, as younger, smaller birds need additional heat to stay warm. These "broiler houses are either tunnel ventilated or curtain-sided", which helps maintain proper airflow. The birds are then fed using age-specific feed until they reach their target age and size (Maples et al., 2020). They are then moved into slaughter facilities, where they are processed into ready-to-cook whole birds, chopped into parts, or sent for further processing. Within the contracts, farmers are paid based on total weights of the birds, sometimes including incentives for "flock uniformity" (Maples et al., 2020). Different types of birds are grown to different weights for processing. For example, Moyer's Chicks located in Quakertown, PA raises their broiler chicks to a live weight of over 4lbs by six weeks. This differs from their K-22 red broiler chicks, who are a slower growing bird. These birds grow to a live weight of 5lbs by eight weeks (Darre, 2021). These are just a couple ways how producers can be different from each other, and these differences in weight can directly affect their revenue.

The contract agreements can change, however, the total revenue can be equated pretty easily. To calculate the total revenue in most contract broiler arrangements, simply multiply the PMTR (payment rate per live pound delivered) by PROD (total live pounds of production) (Maples et al., 2020). With COVID-19 affecting the rates of production, farms' total revenue can be damaged in the contract industry. However, with set contract arrangements, farmers are able to easily calculate the immediate effects of COVID-19 on farm production and revenue.

At the beginning of the pandemic, demand for eggs and poultry meat increased, leading to a dramatic increase in egg prices and a minor increase in poultry meat prices (Hafez et al., 2021). Hafez et al. (2021) state that this is due to a change in consumer demand, which were mainly dietary changes. This study showed that "affordable animal protein supply" decreased throughout the pandemic, leading to a threat of food insecurity.

Other studies have been conducted with a focus on a certain region. For example, Pu & Zhong (2020) conducted research on agricultural problems throughout the first few months of COVID-19 pandemic in China. Part of their research highlighted the importance of government intervention. They detailed how China developed e-commerce enterprises to help match agricultural supply with demand (Pu & Zhong, 2020). The Chinese government also ensured the production of important agricultural products (Pu & Zhong, 2020). One of the main issues highlighted by this study was the "dumping" and forbiddance of poultry due to "the thinking that they might be potential epidemic transmission channels" (Pu & Zhong, 2020).

Both of these studies highlight impacts that the pandemic had on agricultural industries. However, there are some deficiencies in these studies that this project aims to overcome. First, these studies focus on quantitative issues such as decreased supply and increased prices. However, this study will focus on the qualitative aspects, such as how a poultry consumer may change his/her diet due to COVID-19's impact on poultry availability. Another deficiency in these studies is the geographical location that the studies focus on. Hafez (2021) looks at the poultry industry as a whole, while Pu & Zhong (2020) focus on China. A possible limitation from Pu & Zhong's study is that, with its focus on China, where COVID-19 began, inflated numbers might result in supply, demand, and prices. This could be due to the extreme number

of COVID-19 cases in China, which forced individuals to isolate and thus, drive the markets down due to limited social and economic interactions, which limited sales. This project highlights the impact of the pandemic on the poultry industry in the southeastern region of the United States. The map in **Appendix B** shows how the southeastern region leads the U.S. in broiler production, which is why this region was chosen for this study. This study will be more applicable to American producers and consumers because the qualitative and quantitative information provided will be more relatable, especially to those in the southeastern United States.

This project will measure the impact of COVID-19 on the poultry industry. Producers and consumers will both be studied to determine the level of impact on the poultry industry. It is important to measure the impact of the COVID-19 pandemic on the poultry industry in case of future shocks. This project will not only assess the impact, but will also serve as a detailed reference in the case of another disruption in the future. The project concludes with recommendations for producer and consumer response to future shocks. For example, with the recent emergence of the Monkeypox disease, producers and consumers can relate to this project to compare how the market shifted due to supply and demand changes.

Definition of Keywords (all definitions obtained from Merriam-Webster Online Dictionary):

Consumer- one that utilizes economic goods.

Coronavirus (COVID-19)- any of a family (*Coronaviridae*) of large single-stranded RNA viruses that have a lipid envelope studded with club-shaped spike proteins, infect birds and many mammals including humans, and include the causative agents of MERS, SARS, and

COVID-19.

Demand- willingness and ability to purchase a commodity or service; the quantity of a commodity or service wanted at a specified price and time.

Poultry- domesticated birds kept for eggs or meat.

Price- the amount of money given or set as consideration for the sale of a specified thing.

Producer- one that grows agricultural products or manufactures crude materials into articles of use. Note: In this project, "producer" refers to the poultry firm that contracts with individual farmers to raise the animals, rather than referring to the farmer him/herself.

Supply- the quantity or amount (as of a commodity) needed or available.

Supply Chain- the system of people and things that are involved in getting a product from the place where it is made to the person who buys it.

Review of Literature

The purpose of this project is to describe the impact of COVID-19 on the poultry industry and its producers and consumers. Even though chickens are not susceptible to the coronavirus, many outbreaks have occurred in employees of poultry farms and processing facilities, thus directly affecting the entire industry (Hafez et al., 2021). This is just one example of how COVID-19 directly impacted the poultry industry.

University of Wisconsin-Madison researcher, Michelle Miller (2021), stated that COVID-19 proved that managing risk in food supply chains requires policies be set to optimize goods and information flow for resilience. Information flow means that information is shared amongst all businesses and consumers (Airfocus, 2021). One of the problems that Miller discovered throughout the COVID-19 pandemic is "information asymmetry" (Miller, 2021): businesses would retain important information about the market and supply chain to have a competitive advantage over its competitors. Miller goes further and states that supply chain management is a major component of managing risk throughout disruptions such as COVID-19.

Limited Availability

In March of 2020, businesses and schools around the world closed and stay-at-home orders were put into force for an undisclosed time due to the rising cases of COVID-19. When this occurred, many people believed that food might become limited. In fact, according to Poudel et al., the impact of the pandemic on food supply and demand was believed to lead to food insecurity (Poudel et al., 2020). The poultry industry was affected by limited animal feed

and a labor shortage on farms and in processing facilities (Poudel et al., 2020). Having limited inputs and labor eventually led to a decrease in productivity within the poultry industry. Less processing capacity meant that farmers were required to store their birds over a longer period of time because they were not processing and selling at the same rate. Leaving these birds in storage eventually lessened the quality of the finished product and decreased overall processing capacity (Poudel et al., 2020). Limited supply drove the overall supply curve to the left, thus raising the price of poultry products throughout the industry.

How Lockdown Restrictions Impacted the Industry

When the COVID-19 pandemic first started, lockdown restrictions and advanced security measures were implemented. This prevented people from meeting and working, which severely damaged the agricultural industry (Barichello, 2020). Since agriculture is a labor intensive industry, the social distancing measures and other lockdown restrictions took a major toll on agribusiness (Sharma et. al, 2020). Imports and exports were heavily affected within major U.S. ports, as trade restrictions and limited labor supply congested the ports (Hey, 2020). As a result, shipments had to be redirected to smaller ports, which led to lost revenue for major international businesses (Hey, 2020).

COVID-19 restrictions included many measures to stop the spread of the disease, such as travel restrictions, border closures, and social distancing. **Appendix C** details how these lockdown restrictions disrupted the supply chain within the food industry (Poudel et al., 2020). The graphic details how travel restrictions impacted food production and processing, how border closures limited transportation and distribution, and how social distancing limited

interactions between the market, retailer, and the consumer.

Research shows that the first wave of COVID-19 lockdowns limited movement within and between countries (Biswal et al., 2020). As an example, India, which is the fourth largest poultry producer in the world, faced a "disruption of transport chains, perishability of the produce, closure of wholesale markets, and lack of sufficient storage facilities" following the COVID-19 lockdown (Biswal et al., 2020). These are all factors that ultimately led to a loss of revenue for poultry producers, limited supply, and decreased quality of poultry products in India. Connections in the poultry industry post-COVID-19 may be experienced between the United States and India.

Another way the poultry industry was directly affected by COVID-19 lockdowns was within the food service sector (Dorfman, 2020). Demand for poultry products that were served within restaurants, schools, and other cafeterias all drastically decreased, while the demand for poultry products meant to be prepared and consumed at home significantly increased. One of the variables for impact significance is the size of bird produced. Within the poultry industry, different sizes of birds are meant for different consumer markets (Maples et al., 2020). Also major broiler producers have different target markets. For example, Pilgrim's Pride sent roughly 47% of their production to grocery stores and 53% to food service, while Perdue was more dependent on grocery store markets. Perdue sent about 74% of their production volume to grocery stores and 19% to food service, while the remaining 7% was not listed (Maples et al., 2020). With initial COVID-19 lockdowns preventing individuals from eating out in restaurants and forcing them to purchase more from grocery stores, it is evident that major poultry producers were affected differently by the pandemic due to their target markets.

Project Methodology and Design

Targeted Population

The target population for this project is producers and consumers within the poultry industry in the southeastern region of the United States. The targeted producers were Tyson Foods, Pilgrim's Pride, and Sanderson Farms, while targeted consumers include farmer's market and grocery store poultry shoppers and restaurant-goers. The information obtained from these populations will determine the overall impact that COVID-19 had on the poultry industry.

Methodology

This project was conducted through a producer case study and a consumer survey. Tyson Foods' financial statements from 2020 and 2021 were studied to determine the financial impact that COVID-19 had on the company. This was also done with Pilgrim's Pride and Sanderson Farms. Following this step, a consumer survey was sent via email to 95 participants with 20 responses for a 21% response rate. Topics for the consumer survey included, but were not limited to production/consumption effects, dietary changes, and quality/quantity changes. This was done to compare and contrast the effects on producers versus consumers. Following analysis of survey data, responses were studied and divided into common themes of product price, product quality, and product availability. The financial statements for Tyson Foods can be found in **Appendix D**, Pilgrim's Pride in **Appendix E**, and Sanderson Farms in **Appendix F**,

while the survey questions for consumers can be found in **Appendix G**.

Summary of Outcomes, Discussions, and Recommendations

Project Outcomes and Results Analysis

Upon completion of the producer case studies and consumer-focused surveys, it was determined that COVID-19 did have major impacts on the poultry industry. For producers such as Tyson Foods, major differences in sales, income, and expenses were noticed between 2020 and 2021 (Tyson Foods, 2021). Tyson Foods had chicken sales in excess of $13.7 billion in 2021, up from $13.234 billion in 2020 and $13.300 billion in 2019. The $66 million dollar decrease from 2019 (pre-COVID) to 2020 was the result of a 0.1% increase in sales volume, and a 0.6% decrease in price. The $499 million increase in sales from 2020 to 2021, representing a 3.77% increase, was the result of an 11.2% increase in price that helped to offset the 3.3% decline in sales volume. According to Tyson Foods' financial statement, this is "because of the additional week in fiscal 2020, and increased retail volumes were almost completely offset by lower production numbers from COVID-19" (Tyson Foods, 2021).

COVID-19 had a major impact on operating income in fiscal 2021, resulting in a $625 million loss. This was due to increased supply chain costs, increased feed ingredient costs, and other "direct incremental expenses associated with COVID-19" (Tyson Foods, 2021). Tyson Foods experienced a $735 million expense with just the adjusted feed ingredient costs alone. The reported 11.2% increase in average sales price, due to a "favorable sales mix and inflationary market conditions," is corroborated by the consumer survey where respondents reported an increase in poultry prices.

When analyzing gross profit, data was not available specifically for Tyson's "chicken

segment". However, gross profit for the entire company increased by 7.2% from 2019 to 2020, followed by a 21.2% increase from 2020 to 2021 (Tyson Foods, 2021). Tyson Foods was able to avoid a negative profit as a result from COVID-19. This information is available in Tyson Foods' financial statements in **Appendix D**.

Pilgrim's Pride also experienced impacts from COVID-19. From 2019 to 2020, Pilgrim's Pride experienced a $140.7 million decrease in net sales within the United States, which equated to 1.8% loss. This was also due to shifts in the supply and demand for their poultry products. Such shifts include dietary and monetary changes between consumers, which impacted Pilgrim's Pride's demand for their products. Pilgrim's Pride also experienced a $233 million (31.8%) decrease in gross profit within the United States from 2019 to 2020. Then, from 2020 to 2021, Pilgrim's Pride gross profit increased by $425 million (85%), showing a rebound following a rough fiscal year prior (Pride, 2022). More data regarding their financial statement can be found in **Appendix E**.

For Sanderson Farms, net sales increased for every poultry product category. These categories can be found in **Appendix F**, along with the change in net sales from 2019 to 2020 to 2021. From fiscal 2019 to fiscal 2020, Sanderson Farms experienced a 3.6% increase in total net sales, while experiencing a 34.66% increase in total net sales from fiscal 2020 to 2021. These data show a recovery following the COVID-19 pandemic, and can be partially attributed to changing consumer demand, such as dietary and monetary changes. Also, when examining the Sanderson Farms' financial report, it was important to note the gross profit per quarter in fiscal 2020. During its first quarter, Sanderson Farms experienced a negative profit margin of $446,000 (Sanderson, 2022). Sanderson Farms then had a positive net profit of $12.4 million in

the second quarter, $90.5 million in the third quarter, and $91.7 million in the fourth quarter. COVID-19 became a global pandemic during the first quarter of fiscal 2020, further showing how it impacted Sanderson Farms' gross profits.

Survey Results

For consumers, there were common themes between individual experiences with COVID-19 and their poultry purchasing process. The first theme that stood out was the price of poultry products. According to the survey, 50% of the participants noticed a minor increase in purchase price of poultry products, while 35% noticed a major increase. In total, 85% of the survey respondents noticed an increase in poultry purchase price as a result of COVID-19. No respondents noticed a decrease in price.

The second theme from the consumer survey was the quality of the poultry products. No participants noticed a positive change in the quality of the products from grocery stores. Twenty-five percent noticed a little decrease in the quality, while 5% noticed a significant decrease in the quality. While a total of 30% of respondents noticed some level of decrease in the overall quality of poultry products as a result of the pandemic, 65% did not notice a change, and the remaining five percent reported they were unsure.

The third theme was the availability of poultry products following COVID-19. Fifty-five percent of survey respondents stated that many of the poultry products they purchase from grocery stores became hard to find once the pandemic started. Also, 40% of the respondents stated that restaurants frequently ran out of poultry dishes. This shows how supply chain and labor shocks impacted consumers.

An open ended question included in the survey asked respondents if they noticed any other effects that COVID-19 had on the poultry industry that was not asked. One specific response stood out, and that was "when ordering at restaurants, portion sizes became smaller too." This is important because as supply becomes more limited, it seems as if restaurants responded by limiting their portion sizes accordingly.

Earlier in the project, consumer dietary changes were highlighted. As a result of the survey, seven respondents stated that their diet changed throughout the COVID-19 pandemic. Five out of the seven respondents stated that they ate more poultry products as a result. When listing the reasons why their diets changed, the respondents were given an option to select multiple reasons. As a result, four respondents selected price changes, one selected quality changes, three selected limited availability, and two selected better health choices.

Also stated earlier, was the targeted consumers between farmer's market and grocery store poultry shoppers. However, after examining the survey results, only three of the 20 responses came from farmer's market shoppers, while 17 were grocery store shoppers. This is great when looking at how the pandemic impacted grocery stores. However, more responses will be needed from farmer's market shoppers to better understand how COVID-19 affected demand there.

Demographic questions revealed little diversity among respondents. Of the 20 respondents, 19 stated that they were "White/Caucasian", while one stated that they were "Hispanic/Latino". Also, there were two general states where respondents stated that they currently live in: Texas and Illinois. 8 respondents stated that they live in Texas, while 6 stated that they live in Illinois.

In terms of levels of education and pre-tax annual income, there was a great deal of variability. Ten of the twenty respondents reported that their highest level of education was a bachelor's degree, while the other results varied. In terms of income, it all varied, with no more than five respondents falling in the same category. More survey responses are needed to gather data from different segments of the population. A table with the demographic responses can be found in **Appendix H**.

Prior studies included in the review of literature indicated that COVID-19 led to limited availability of products within the poultry industry. The data from the consumer survey corroborates this finding. Prior studies also stated that COVID-19 indirectly lessened the quality of the finished product and decreased overall processing capacity (Poudel et al., 2020), points that are corroborated by the second and third themes from the consumer survey. The decreased processing capacity was also confirmed by the Tyson Foods, Pilgrim's Pride, and Sanderson Farms financial statements.

Implications, Impacts, and Recommendations

This project should help producers and consumers realize the importance and effects of laws and regulations on food industries. Many respondents stated that they were unsure of some changes because they simply did not keep track of the changes. However, the project should make them more aware of price and quality changes, along with availability of poultry products in grocery stores, farmers markets, and restaurants.

For producers, it is recommended that they study and learn how consumer habits changed as a result of COVID-19. This includes their diets and other purchasing habits.

Producers are recommended to essentially adjust their supply to equal the consumer demand in the case of future shocks. One way this can be done is by restaurant owners moving away "just-in-time" inventory. Instead of purchasing as they go, they can decide to store more products to serve the consumers. This will decrease overall profit, but it stabilizes income over time because they have a constant supply of food to sell to the consumers. By doing so, this will help producers know what type of product to produce more/less of, which will help drive up sales and revenue.

For consumers, it is recommended that consumers understand that in the case of future shocks, there will still be plenty of supply. At the beginning of the COVID-19 pandemic, consumers were rushing to the stores to buy endless supplies of toilet paper and other essential items. However, in preparation for future shocks, consumers are recommended to understand that prices and supply of goods may change. Consumers can expect to pay more, and if not, then they can expect to change their purchasing habits. That being said, it is recommended that consumers be willing to adjust their willingness to pay in the case of future shocks.

For future studies, it is recommended that more data be collected from the producers and processors within the poultry industry. Much of the information collected throughout the project was consumer-based. However, their experiences are shaped by what occurs on farms, in processing plants, and in other production facilities. To collect additional insights, a future project should be conducted with greater focus on the production side of the poultry industry.

It is also recommended that more consumer surveys be conducted due to the similarities in respondents' demographic information. This will help future studies learn more about how COVID-19 impacted individuals from different backgrounds.

Dissemination Plan

Although no dissemination plan has been determined, the data collected from this project could be publicly shared on scholarly websites and social media accounts. One possible outlet for project results is an extension publication pertaining to supply chain disruptions. It could help provide consumers with certain practices when preparing for the next supply chain disruption, whether it is another pandemic or not. Poultry consumers will then be more aware of the changes that occur within the industry due to implemented regulations. They will then hopefully be able to adjust their consumption with the changes in the market conditions.

If the consumer survey were expanded to gather additional responses and reach a more representative sample of consumers, then a potential dissemination outlet is the United States Department of Agriculture (USDA) website and social media accounts. With over 800,000 followers on Twitter alone, posting there would help get the information to consumers and make them aware of the effects of COVID-19 on the poultry industry. It would also help them be more prepared in case of other future shocks within the food industry, such as the recent Monkeypox outbreak. Although it is small-scale compared to COVID-19 in terms of number of cases, it can eventually serve as a future shock within food industries.

With these potential outlets, producers and consumers can utilize the insights from this study to have a better understanding and preparedness plan for managing future shocks within the food supply chain.

References

Airfocus. (2021). *What are information flows in product management? information flows in product management definition, benefits, & FAQ*. What Are Information Flows in Product Management? Information Flows in Product Management Definition, Benefits, & FAQ. Retrieved April 18, 2022, from https://airfocus.com/glossary/what-are-information-flows-in-product-management/

Barichello, R. (2020). The COVID‐19 pandemic: Anticipating its effects on Canada's agricultural trade. *Canadian Journal of Agricultural Economics/Revue canadienne d'agroeconomie*, *68*(2), 219-224.

Biswal, J., Vijayalakshmy, K., & Rahman, H. (2020). Impact of COVID-19 and associated lockdown on livestock and poultry sectors in India. *Veterinary World*, *13*(9), 1928.

Darre, M. J. (2021). *Everything You Need to Know About Raising Broiler Chickens*. Retrieved August 17, 2022, from https://www.uvm.edu/newfarmer/production/livestock/Growing%20Broilers-Darre.pdf

Dorfman, J. H. (2020). *Estimating Economic Losses by Contract Growers in the Poultry Sector due to COVID-19*. Impact Statement - Research | College of Agricultural & Environmental Sciences. Retrieved July 12, 2022, from

https://www.caes.uga.edu/research/impact/impact-statement/9639/estimating-economic-l osses-by-contract-growers-in-the-poultry-sector-due-to-covid-19.html

Economic Research Service - U.S. Department of Agriculture. (2022). *Per capita availability of chicken higher than that of beef*. USDA ERS - Chart Detail. Retrieved July 12, 2022, from https://www.ers.usda.gov/data-products/chart-gallery/gallery/chart-detail/?chartId=58312

Experimental Economics Center. (2006). *Factors affecting supply*. EconPort. Retrieved April 23, 2022, from http://www.econport.org/content/handbook/supply/changeSupply.html

Hafez, H. M., Attia, Y. A., Bovera, F., El-Hack, A., Mohamed, E., Khafaga, A. F., & de Oliveira, M. C. (2021). Influence of COVID-19 on the poultry production and environment. *Environmental Science and Pollution Research*, *28*(33), 44833-44844.

Hey, J. (2020, February 28). *Coronavirus: Measuring the market impact*. Home - Fruitnet.com. Retrieved February 4, 2022, from http://www.fruitnet.com/asiafruit/article/181021/coronavirus-measuring-the-market-impa ct.

Maples, Josh & Thompson, Jada & Anderson, John & Anderson, David & Gundersen, Craig. (2020). Estimating COVID-19 Impacts on the Broiler Industry. Applied Economic Perspectives and Policy. 43. 10.1002/aepp.13089.

Merriam-Webster. (2022). *Dictionary by Merriam-Webster: America's most-trusted online dictionary*. Merriam-Webster. Retrieved July 5, 2022, from https://www.merriam-webster.com/

Miller, M. (2021). Big data, information asymmetry, and food supply chain management for resilience. *Journal of Agriculture, Food Systems, and Community Development*, *11*(1), 171–182.

Pilgrim's Pride (2022). Form 10-K. https://ir.pilgrims.com/static-files/7b4dcb3d-4b50-4148-98c3-2ad410f5ca36

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

Pu, M., & Zhong, Y. (2020). Rising concerns over agricultural production as COVID-19 spreads: Lessons from China. *Global food security*, *26*, 100409.

Sanderson Farms (2022). Form 10-K. https://sec.report/Document/0000812128-21-000014/

Seidavi, A., Zaker‐Esteghamati, H., & Scanes, C. G. (2019). Poultry byproducts. *Byproducts from Agriculture and Fisheries: Adding Value for Food, Feed, Pharma, and Fuels*, 123-146.

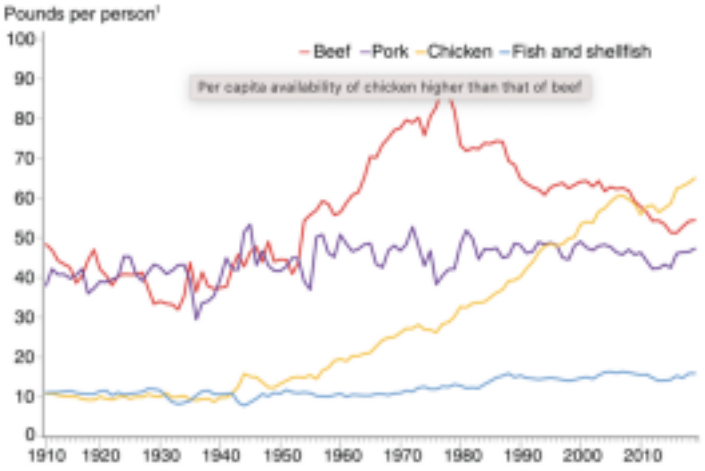
Sharma, R., Shishodia, A., Kamble, S., Gunasekaran, A., & Belhadi, A. (2020). Agriculture supply chain risks and COVID-19: mitigation strategies and implications for the practitioners. *International Journal of Logistics Research and Applications*, 1-27.

Tyson Foods (2022). Form 10-K. https://ir.tyson.com/reports/annual-reports/default.aspx

United States Department of Agriculture. (2022, April 28). *Broilers: Inventory by State, US*. USDA. Retrieved July 12, 2022, from https://www.nass.usda.gov/Charts_and_Maps/Poultry/brlmap.php

Appendices

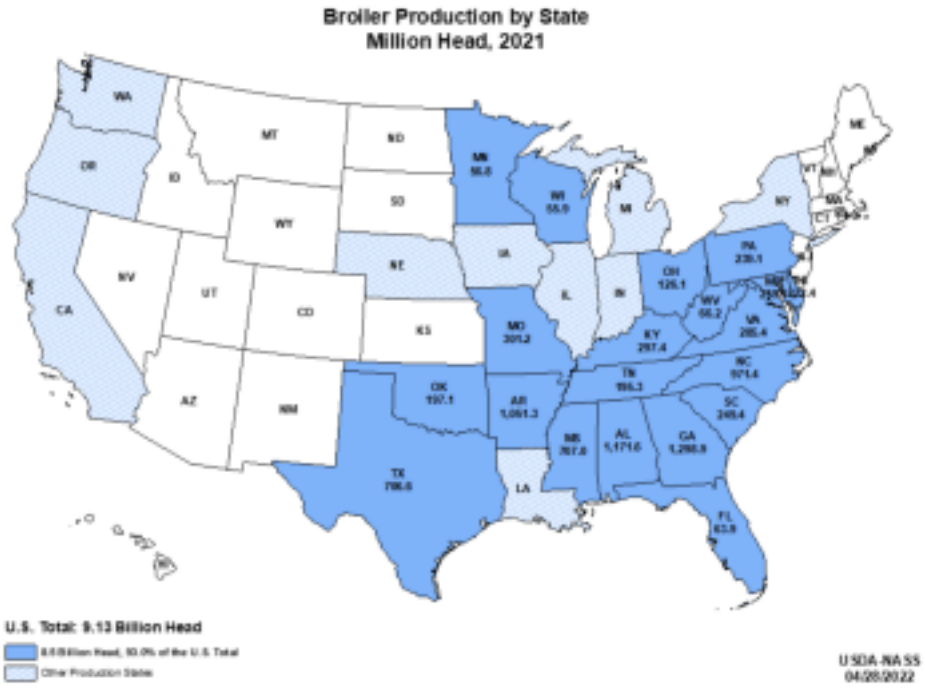
Appendix A: U.S. Per Capita Availability of Beef, Pork, Chicken, Fish/Shellfish Economic Research Service - U.S. Department of Agriculture. (2022). *Per capita availability of chicken higher than that of beef*. USDA ERS - Chart Detail. Retrieved July 12, 2022, from https://www.ers.usda.gov/data-products/chart-gallery/gallery/chart-detail/?chartId=5831



¹Calculated on the basis of raw and edible meat in boneless, trimmed (edible) weight. Excludes edible offals, bones, viscera, and game from red meat. Include skin, neck, and giblets from chicken. Excludes use of chicken for commercially prepared pet food.
Source: USDA, Economic Research Service, Food Availability Data.

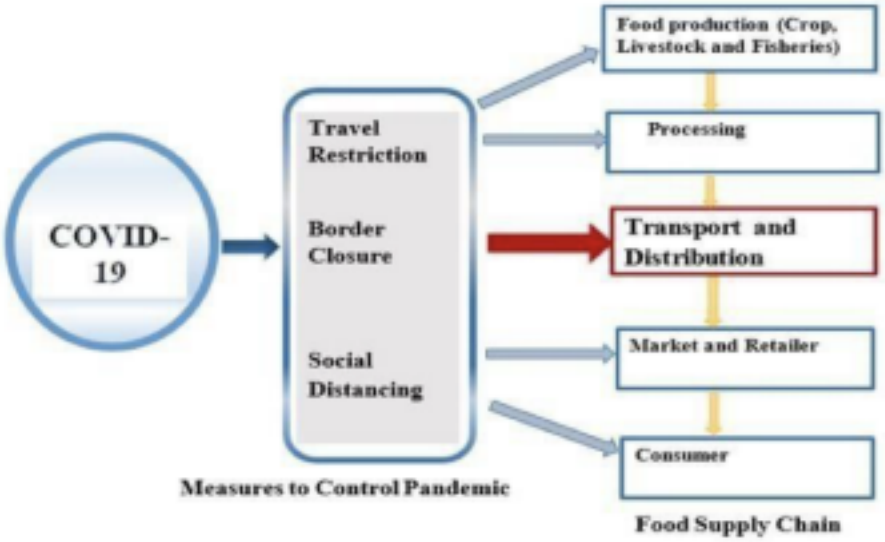
Appendix B: Broilers: Inventory by State, U.S.

United States Department of Agriculture. (2022, April 28). *Broilers: Inventory by State, US*. USDA. Retrieved July 12, 2022, from https://www.nass.usda.gov/Charts_and_Maps/Poultry/brlmap.php



Appendix C: COVID-19's Impact on the Food Supply Chain

Poudel et al., 2020.



Appendix D: Tyson Foods Financial Statement:

2021 Financial Statement:

Chicken Segment Results — in millions

	2021	2020	Change 2021 vs. 2020	2019	Change 2020 vs. 2019
Sales	$ 13,733	$ 13,234	$ 499	$ 13,300	$ (66)
Sales Volume Change			(3.3)%		0.1 %
Average Sales Price Change			11.2 %		(0.6)%
Operating Income (Loss)	$ (625)	$ 122	$ (747)	$ 621	$ (499)
Operating Margin	(4.6)%	0.9 %		4.7 %	

TYSON FOODS, INC.
CONSOLIDATED STATEMENTS OF INCOME

Three years ended October 2, 2021
in millions, except per share data

	2021	2020	2019
Sales	$ 47,049	$ 43,185	$ 42,405
Cost of Sales	40,523	37,801	37,383
Gross Profit	6,526	5,384	5,022
Selling, General and Administrative	2,130	2,376	2,252

Link to the entire financial statement:

https://s22.q4cdn.com/104708849/files/doc_financials/2021/q4/TSN-2021-10K-DRAFT-11.12.21.pdf

Appendix E: Pilgrim's Pride Financial Statement

From fiscal 2019 to fiscal 2020:

Sources of net sales	2020	Change from 2019 Amount	Change from 2019 Percent
		(In thousands, except percent data)	
U.S.	$ 7,496,017	$ (140,699)	(1.8)%
U.K. and Europe	3,274,292	890,499	37.4 %
Mexico	1,321,592	(67,118)	(4.8)%
Total net sales	$ 12,091,901	$ 682,682	6.0 %

Sources of gross profit	2020	Change from 2019 Amount	Change from 2019 Percent
		(In thousands, except percent data)	
U.S.	$ 500,465	$ (233,014)	(31.8)%
U.K. and Europe	218,327	46,576	27.1 %
Mexico	118,931	(46,137)	(28.0)%
Elimination	473	377	392.7 %
Total gross profit	$ 838,196	$ (232,198)	(21.7)%

From fiscal 2020 to fiscal 2021:

Sources of net sales	2021	Change from 2020 Amount	Change from 2020 Percent
		(In thousands, except percent data)	
U.S.	$ 9,113,879	$ 1,617,862	21.6 %
U.K. and Europe	3,934,062	659,770	20.2 %
Mexico	1,729,517	407,925	30.9 %
Total net sales	$ 14,777,458	$ 2,685,557	22.2 %

Sources of gross profit	2021	Change from 2020 Amount	Change from 2020 Percent
		(In thousands, except percent data)	
U.S.	$ 925,920	$ 425,455	85.0 %
U.K. and Europe	164,224	(54,103)	(24.8)%
Mexico	275,629	156,698	131.8 %
Elimination	54	(419)	(88.6)%
Total gross profit	$ 1,365,827	$ 527,631	62.9 %

Link to entire financial statement:

https://ir.pilgrims.com/static-files/7b4dcb3d-4b50-4148-98c3-2ad410f5ca36

Appendix F: Sanderson Farms Financial Statement: Net Sales by Poultry Category

Product Category	Fiscal Year 2021	Fiscal Year 2020	Fiscal Year 2019
		(in thousands)	
Fresh, vacuum-sealed chicken	$ 1,851,145	$ 1,200,343	$ 1,310,157
Fresh, chill-packed chicken	1,661,868	1,408,564	1,137,679
Fresh, ice-packed chicken	761,137	509,481	511,480
Frozen chicken	287,939	240,806	213,024
Prepared chicken	214,215	184,662	240,811
Other	23,349	20,411	27,107
Total net sales	**$ 4,799,653**	**$ 3,564,267**	**$ 3,440,258**

Gross Profits by Quarter in Fiscal 2020:

	Fiscal Year 2020			
	First Quarter	Second Quarter	Third Quarter	Fourth Quarter
	(In thousands, except per share data)			
	(unaudited)			
Net sales	$ 823,078	$ 844,711	$ 956,455	$ 940,023
Gross profit (loss)	(446)	12,428	90,458	91,716
Net income (loss)	(38,576)	6,118	32,810	27,922
Diluted earnings (loss) per share	$ (1.76)	$ 0.28	$ 1.48	$ 1.26

Link to entire financial statement:

https://sec.report/Document/0000812128-21-000014/

Appendix G: Consumer Survey

The entire consumer survey, as sent out via email and Google Forms:

https://docs.google.com/forms/d/1p66GL7Fxme8tKik15L4NBQV8s9C_pxSVwE2x9-wW4Dw/edit

COVID-19's Impact on Poultry Consumers

The COVID-19 pandemic affected everyone differently. Industries across the world were severely impacted by regulations, trade restrictions, and social distancing measures due to the pandemic. This short survey will help examine the impact that COVID-19 had on poultry consumers in the United States. Note: Your name will not be associated with your answers. Your answers will be combined with those of other respondents to assess the impacts of COVID-19 on poultry consumers.

* Required

COVID-19 Consumer Impact Questions

[The following set of questions will be used to measure the pandemic's impact on your everyday poultry consumption. These questions are based on your personal experiences following the COVID-19 impact, when regulations and social distancing went into effect. Note: poultry products include all poultry birds, most commonly chicken, turkey, duck, and goose.]

1. Did you notice any changes in the purchase price of poultry products in grocery stores?

* *Mark only one oval.*

- ☐ Major decrease in price
- ☐ Minor decrease in price
- ☐ No change
- ☐ Minor increase in price
- ☐ Major increase in price
- ☐ Unsure

2. Were there any differences in the quality of the poultry products you were purchasing/eating from grocery stores? This includes, but is not limited to, taste, texture, color, size, etc.

   Mark only one oval.

   - ☐ Much better quality
   - ☐ A little better quality
   - ☐ No change
   - ☐ A little worse quality
   - ☐ Much worse quality
   - ☐ Unsure

3. When shopping in grocery stores, did you have any trouble finding certain poultry products? * *Mark only one oval.*

   - ☐ Yes, many of the items I normally purchase were hard to find.
   - ☐ No, I had no trouble finding poultry items in the stores.
   - ☐ Unsure
   - ☐ I do not shop in grocery stores.

4. Did you shop at a farmer's market at any time during the pandemic? * *Mark only one*

oval.

- ☐ Yes, and I bought poultry products there.
- ☐ Yes, but I did not buy poultry products there.
- ☐ No
- ☐ Unsure

5. When eating at restaurants, what changes did you notice regarding poultry products?

   Check all that apply.

   - ☐ They were more expensive.
   - ☐ They were cheaper.
   - ☐ Restaurants frequently ran out of poultry dishes.
   - ☐ They were better quality than pre-pandemic.
   - ☐ They were worse quality than pre-pandemic.
   - ☐ No change
   - ☐ Unsure

6. Did your diet change throughout the COVID-19 pandemic? * *Mark only one oval.*

   - ☐ Yes, I ate more poultry products.
   - ☐ Yes, I ate less poultry products.
   - ☐ No
   - ☐ Unsure

7. If you answered yes to the previous question, why did it change?

   Check all that apply.

   - ☐ Price changes
   - ☐ Quality changes

- ☐ Poultry products became hard to find
- ☐ Other:

8. Roughly how long did it take for price/quality/quantity changes to return to its pre-COVID type?

Mark only one oval.

- ☐ 0-6 months
- ☐ 7-12 months
- ☐ 13-24 months
- ☐ It is still impacted
- ☐ Unsure

9. Did you notice any other effects that COVID-19 had on the poultry industry that I did not ask about? Please explain.

Post-Survey Demographic Questions:

The following set of questions will help categorize consumers into different groups for analysis of results. Remember, your name will not be associated with your answers.

10. What is your gender? *

Mark only one oval.

- [ ] Male
- [ ] Female
- [ ] Prefer not to answer
- [ ] Other:

11. What is your age? * *Mark only one oval.*

- [ ] Less than 26 years old
- [ ] Between 26-35 years old
- [ ] Between 36-45 years old
- [ ] Between 46-55 years old
- [ ] Between 56-65 years old
- [ ] Over 65 years old
- [ ] Prefer not to answer

12. Which race or ethnicity best describes you? Select all that apply: * *Check all that apply.*

- [ ] American Indian or Alaskan Native
- [ ] Asian/Pacific Islander
- [ ] Black or African American
- [ ] Hispanic or Latino
- [ ] White/Caucasian
- [ ] Prefer not to answer
- [ ] Other:

13. Which state do you currently live in? * *Mark only one oval.*

- [ ] Alabama
- [ ] Alaska

- [ ] Arizona
- [ ] Arkansas
- [ ] California
- [ ] Colorado
- [ ] Connecticut
- [ ] Delaware
- [ ] Florida
- [ ] Georgia
- [ ] Hawaii
- [ ] Idaho
- [ ] Illinois
- [ ] Indiana
- [ ] Iowa
- [ ] Kansas
- [ ] Kentucky
- [ ] Louisiana
- [ ] Maine
- [ ] Maryland
- [ ] Massachusetts
- [ ] Michigan
- [ ] Minnesota
- [ ] Mississippi
- [ ] Missouri

- [ ] Montana
- [ ] Nebraska
- [ ] Nevada
- [ ] New Hampshire
- [ ] New Jersey
- [ ] New Mexico
- [ ] New York
- [ ] North Carolina
- [ ] North Dakota
- [ ] Ohio
- [ ] Oklahoma
- [ ] Oregon
- [ ] Pennsylvania
- [ ] Rhode Island
- [ ] South Carolina
- [ ] South Dakota
- [ ] Tennessee
- [ ] Texas
- [ ] Utah
- [ ] Vermont
- [ ] Virginia
- [ ] Washington
- [ ] West Virginia

- [ ] Wisconsin
- [ ] Wyoming

14. What is your highest level of education? * *Mark only one oval.*

- [ ] Less than a high school degree
- [ ] High school degree
- [ ] Some college experience but no degree
- [ ] Associate's degree
- [ ] Bachelor's degree
- [ ] Master's degree
- [ ] Higher than a Master's degree
- [ ] Prefer not to answer

15. In which pre-tax annual income category do you fall under? * *Mark only one oval.*

- [ ] Less than $20,000
- [ ] $20,001-$40,000
- [ ] $40,001-$60,000
- [ ] $60,001-$100,000
- [ ] $100,001-$150,000
- [ ] $150,001-$200,000
- [ ] Greater than $200,000
- [ ] Prefer not to answer

Appendix H: Demographic Responses

Category	Responses	Number of Respondents
Gender	Male Female Prefer not to answer	9 11 0
Age	Less than 26 years old Between 26-35 years old Between 36-45 years old Between 46-55 years old Between 56-65 years old Over 65 years old Prefer not to answer	5 3 1 4 4 3 0
Race/Ethnicity	American Indian or Alaskan Native Asian/Pacific Islander Black or African American Hispanic or Latino White/Caucasian Prefer not to answer	0 0 0 1 19 0
State	Texas Illinois Arkansas New Jersey Virginia Oklahoma	8 6 2 2 1 1
Highest level of education	Less than a high school degree High school degree Some college experience but no degree Associate's degree Bachelor's degree Master's degree Higher than a Master's degree Prefer not to answer	0 3 3 1 10 2 1 0
Pre-tax annual income	Less than $20,000 $20,001-$40,000 $40,001-$60,000 $60,001-$100,000 $100,001-$150,000	5 1 3 3 2

	$150,001-$200,000 Greater than $200,000 Prefer not to answer	2 2 2