



The Impact of COVID-19 on the Food Supply Chain and the Effects on Consumer Habits

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A pandemic is not a new event encountered in the history of humanity because humanity has faced various pandemics in history.

The common point of pandemics is their severe adverse effects on the global economy. Considering the food supply chain, one of the most critical sectors of the economy, it has been seen that COVID-19 impacts the whole process from the field to the consumer.

In the light of recent challenges in the food supply chain, there is now considerable concern about food production, processing, distribution, and demand.

COVID-19 resulted in the movement restrictions of workers, changes in demand of consumers, closure of food production facilities, restricted food trade policies, and financial pressures in the food supply chain.

Therefore, governments should facilitate the movement of workers and agri-food products. In addition, small farmers or vulnerable people should be supported financially. Facilities should change the working conditions and maintain the health and safety of employees by altering safety measures. The supply chain also should be flexible enough to respond to the challenges in the food supply chain.

The purpose of this review is to evaluate the impact of COVID-19 on the supply chain and the effects on the demand.

In this next slides we'll see

- **The effects and posterior consequences of Covid-19**
- **Impact categories**
- **Casual Loop Diagram**



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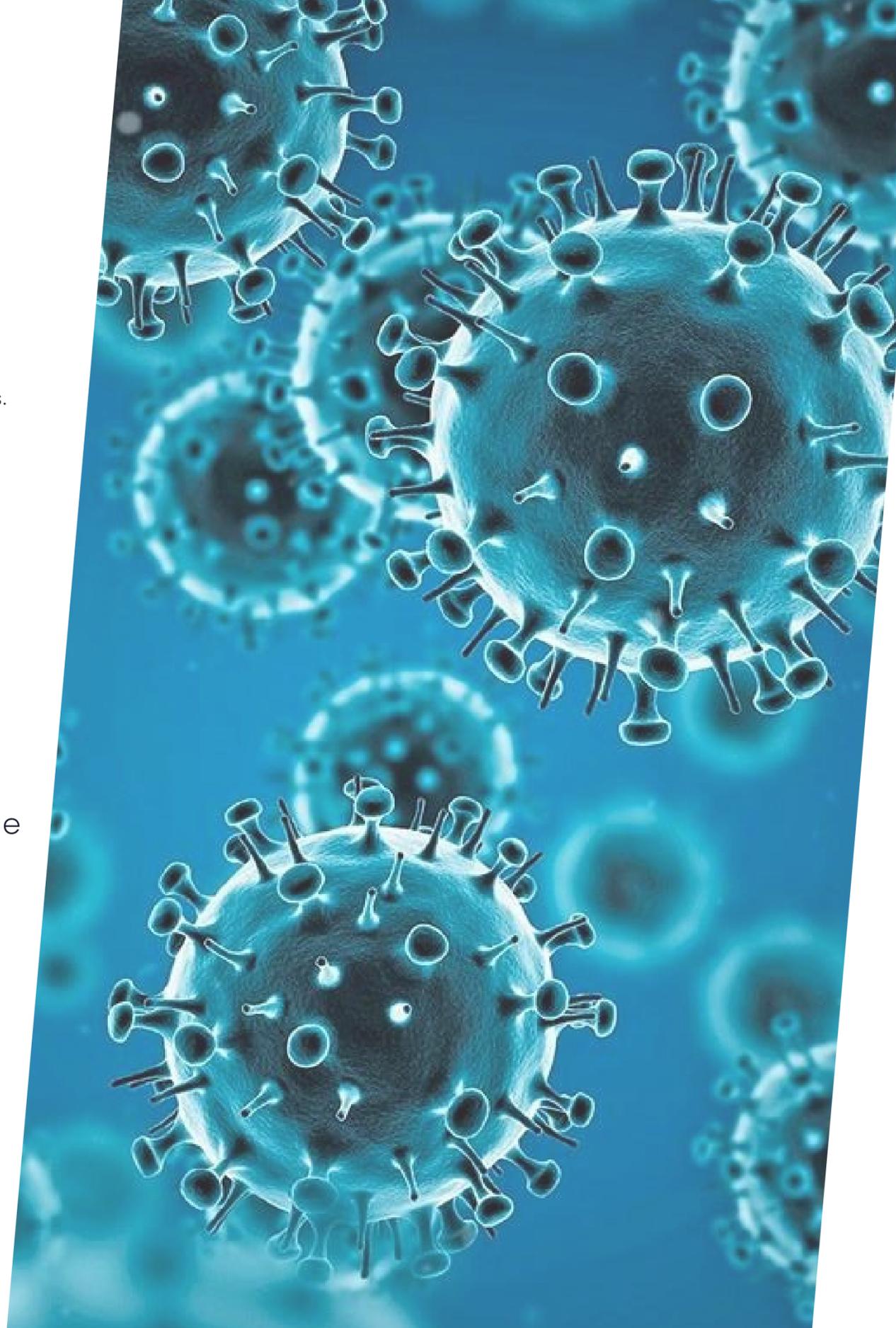
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The effects and posterior consequences of Covid-19

The consumer markets took a massive hit during the peak of the coronavirus pandemic, but they are also a dynamic sector, constantly innovating to provide Americans with food and necessities.

There is no doubt that corporations have been pouring resources into security, production, and supply to keep sustaining the economy. However, companies have faced several challenges in terms of their production processes, resulting in increased production and logistics costs, which in turn is reflected in increased consumer prices. Some of these barriers include:

- The rising price of raw materials
- High logistics costs
- The need to transform and build valuable products
- Ensure sanitary conditions, and reassure the consumer that the product is sustainable and safe.
- Human resources constraints
- SC instability
- Financial and economic constraints
- Logistics Disruption
- Infrastructure disruption
- Relationships between stakeholders
- Difficulty accessing services and materials
- Consumer behavior
- Unemployment and reduce income.



Businesses should seek to:

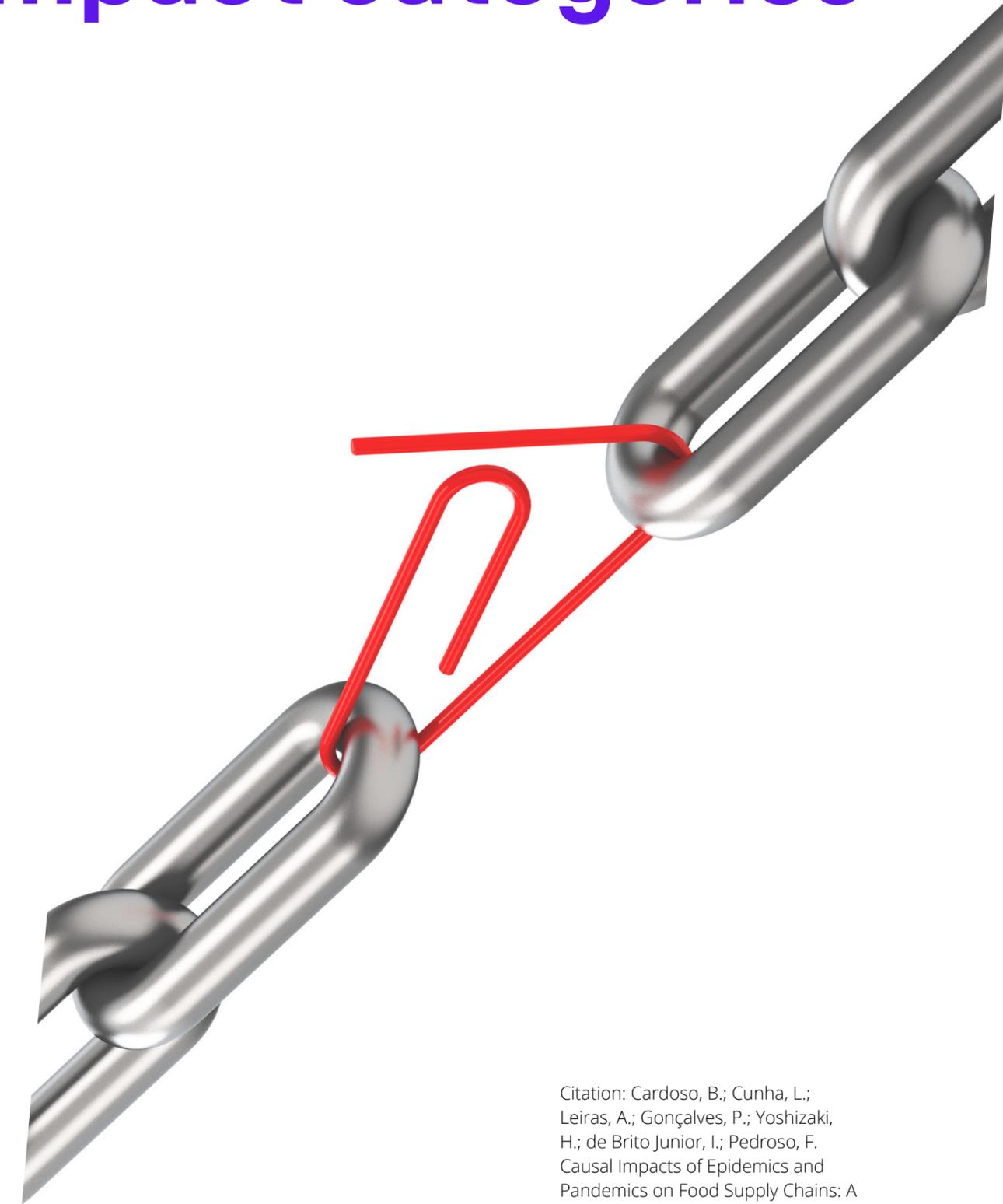
- Develop an end-to-end resilience strategy within its supply chain, identifying crisis scenarios and evaluating existing gaps between the current model and the potential crisis situation.
- Invest in developing capacities (example: digital transformation) that encourage closing the identified gaps, evaluating different alternatives, suppliers, and sourcing strategies, and conducting a cost/benefit analysis, among others.
- Businesses must also be able to measure and monitor changes in their supply chain: to establish response plans for certain situations: Define a 'Plan B' for certain events; develop specific procedures on how to act; disseminate communication protocols; clarify responsibilities and delegations of autonomy.

Other crucial things for businesses to keep in mind:

- Technological platforms can also be used to continuously monitor the performance of suppliers.
- Continue to promote, more than ever, a collaborative supply chain between all involved actors, which allows for traceability and accountability throughout the whole chain.
- In the case of manufacturers or builders, review the location map of factories, distribution hubs and logistics warehouses.
- Most supermarket chains have had to demonstrate the adaptability and flexibility of their logistics operations by changing their daily delivery frequency at their points of sale due to the uncontrolled increase in demand. Likewise, logistics operators whose the main activity is based on providing services to food industry or high-consumption food platforms are also experiencing a notable increase in activity.

Impact categories

Impact Category	SC Link				Policy Category
	Supply-Side	Demand-Side	Logistics and Infrastructure	Management and Operation	
Human resources constraints	X		X	X	Workforce assessment and monitoring Workforce adjustment Activities automation Health safety protocols
SC instability	X	X	X	X	Stability and business continuity plans Government financial assistance for companies Cooperation and collaboration Online infrastructures Decision and communication support tools
Financial and economic constraints	X		X	X	Economic and cost reduction plans Government awareness of economic impacts
Logistics disruption	X		X	X	Decision and communication support tools Government financial assistance for companies Online infrastructures Transportation and distribution plans
Infrastructure disruption	X		X	X	Restructuring plans Online infrastructures Workforce adjustment
Relationships between stakeholders	X		X	X	Communication technologies Cooperation and collaboration
Difficulty accessing services and materials	X		X	X	Government financial assistance for companies Contingency plans Cooperation and collaboration
Consumer behavior	X	X		X	Demand analysis plans Information-sharing tools
Unemployment and reduced income		X			Social support programs Food security plans Government financial assistance for population Workforce adjustment



Citation: Cardoso, B.; Cunha, L.; Leiras, A.; Gonçalves, P.; Yoshizaki, H.; de Brito Junior, I.; Pedroso, F. Causal Impacts of Epidemics and Pandemics on Food Supply Chains: A Systematic Review. Sustainability 2021, 13, 9799. <https://doi.org/10.3390/su13179799>

Causal Loop Diagram

Given the context of the COVID-19 pandemic, the CLD captures a simple SIR (Susceptible, Infected, Recovered) model in the top right of the image. The SIR is widely employed to model epidemics, such as Ebola, MERS, SARS, and Malaria.

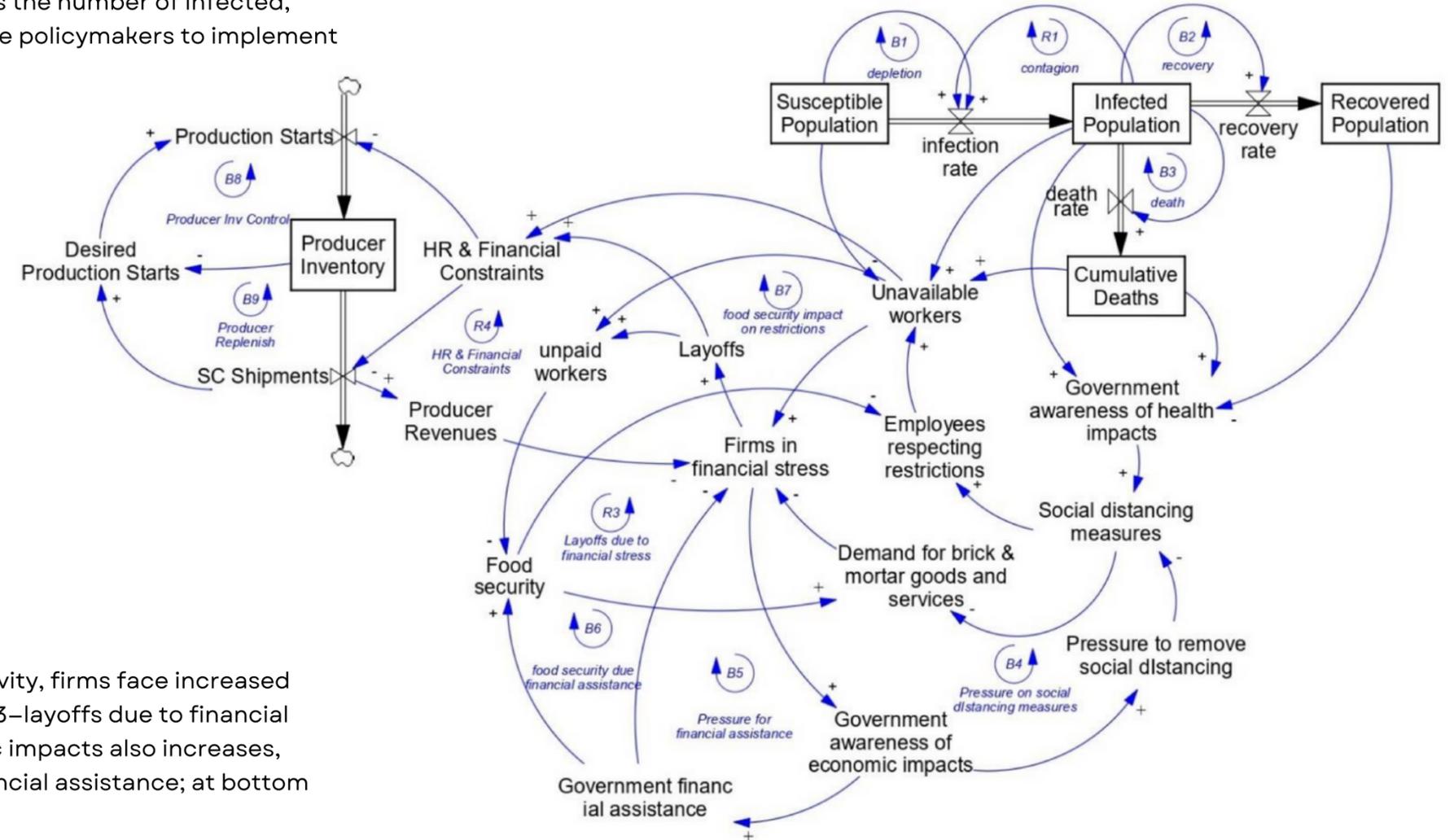
The reinforcing loop R1 captures the contagion process that diffuses the epidemic. As the disease progresses, it infects healthy individuals closing the balancing loop B1 (depletion). Some infected individuals recover (e.g., balancing loop B2–recovery), and some die (e.g., balancing loop B3–death). The larger the infected and dead populations, the more significant the impact on economically active individuals, and the smaller the number of active workers. As the number of infected, deceased, and hospitalized increase, heightened awareness and critical public opinion pressure policymakers to implement public health policies that can curb the diffusion of the epidemic (closing a balancing loop that implements social distancing measures).

Social distancing measures, quarantines, and mobility restrictions to avoid contact and reduce the infection rate prevent workers (e.g., susceptible and at-risk populations) from going to work, reducing the number of available workers and increasing the number of employees receive salaries. An additional impact to the number of active workers includes the infected, hospitalized, and dead. As the number of people out of work increases, more households face income loss, and more families are exposed to food insecurity. Furthermore, food price rises and food shortages increase food insecurity in vulnerable families.

Balancing loop B7 (food security impact on restrictions) captures this effect (center). Families that cannot afford to buy food without a steady stream of wages must return to work even if social distancing measures may still be in effect. Balancing loop B6 (food security due to financial assistance) captures the need for government to implement public policies to assist the vulnerable population and prevent them from facing unprecedented problems (bottom center, Figure 3).

As quarantines and social distancing measures reduce overall consumption and economic activity, firms face increased financial stress. Firms with no means to retain employees must lay them off (reinforcing loop R3–layoffs due to financial stress). As more firms struggle and layoffs increase, government awareness of these economic impacts also increases, leading policy-makers to provide financial assistance to enterprises (loop B5–pressure for financial assistance; at bottom center). Finally, unavailable workers and firms’ stress also affects the food supply chain (FSC) productivity, captured by reinforcing loop R4 (HR & Financial Constraints; center-left). Thus, producer inventories will likely face a series of disruptions mentioned in the literature, encompassing disruptions in production, transportation, distribution, storage, among others (captured by loops B8 and B9; left).

All variables presented in the CLD come directly from the SLR. In addition to the variables directly related to the SLR findings (e.g., HR & Financial Constraints), the CLD also captures variables (e.g., social distancing measures included in the health and safety protocols category) identified in the broader epidemiological and public policy literature systemically and consistently.



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The Effects on Consumer Habits

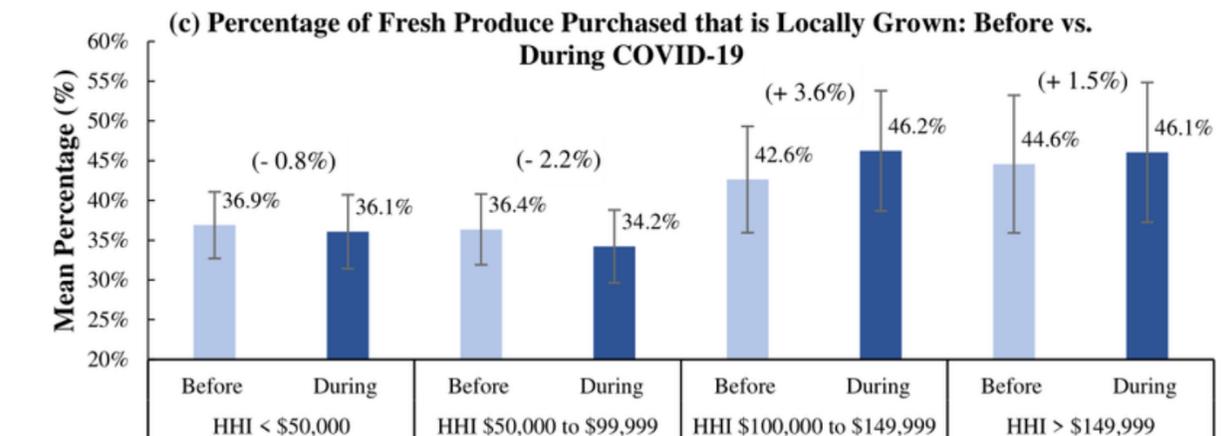
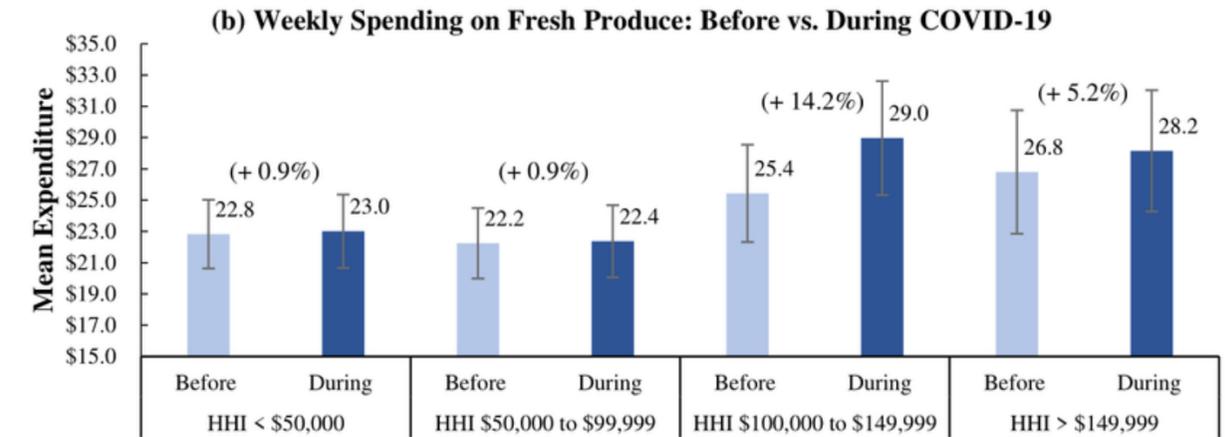
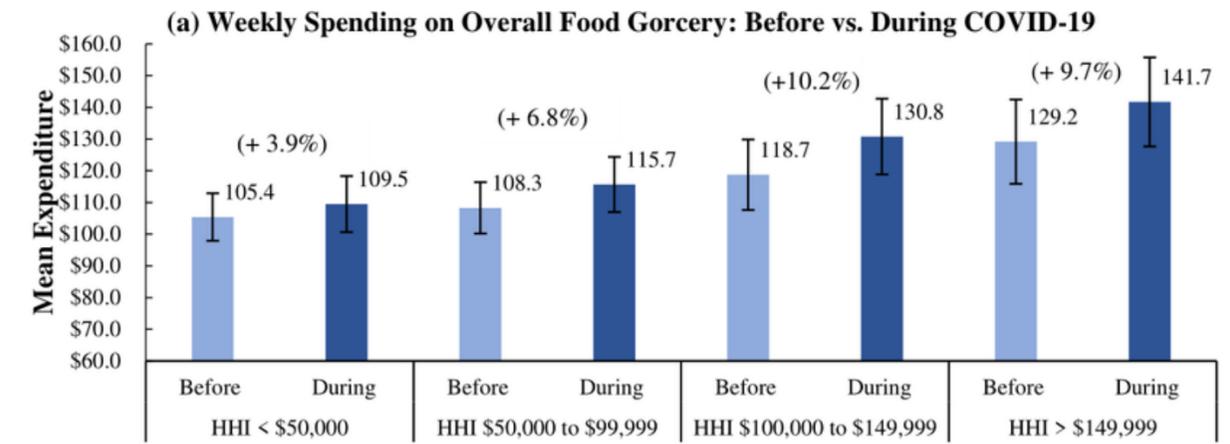
Variable definitions	Obs.	%	Variable definitions	Obs.	%
Household income			Age of primary food shopper		
< \$50,000	212	41.25%	18 to 24 = 1	51	9.92%
\$50,000-\$99,999	159	30.93%	25 to 34 = 2	106	20.62%
\$100,000-\$149,999	77	14.98%	35 to 44 = 3	122	23.74%
\$150,000 or more	66	12.84%	45 to 54 = 4	47	9.14%
SNAP Participant	142	27.63%	55 to 64 = 5	97	18.87%
Education of primary shopper	514		65 or above = 6	91	17.70%
Less than high school	60	11.67%	Employed (full/ part time/ self-employed)	243	47.28%
High school	144	28.02%	With at least one kid under 18	216	42.22%
Some college (no degree)	115	22.37%	With at least one member > 64	154	29.96%
Associate's degree	48	9.34%	Metropolitan area = 1	437	85.02%
Bachelor's degree	95	18.48%	Owns garden = 1	215	41.83%
Graduate/prof. degree	52	10.12%	Male = 1	166	32.30%
Variable definitions				Mean	Std.
Self-report health level, min (extremely bad) = 1; max = 5				3.76	0.88
Safe practice level, min (not following any food safety procedures) = 0; max = 15				12.27	3.05
Household family size, min = 1; max = 12				3.14	1.86
# of FM selling fresh produce per 10,000 pop, min = 0; max = 4.8				0.18	0.3
# of grocery stores & supercenters per 10,000 pop, min = 0.7; max = 9.4				2.34	1.47
# of Covid-19 cases per 100 pop, min = 0.05; max = 5.13				1.53	0.82

<https://doi.org/10.1371/journal.pone.0256921.t001>

The Effects on Consumer Habits

To understand how household grocery expenditure has changed due to Covid-19, a recent research asked primary grocery shoppers to answer the following questions for periods both before Covid-19 and during the Covid-19:

- What was/has been your (or your household's) typical weekly expenses for food purchased during grocery shopping?
- What was/has been your (or your household's) typical weekly expenses for fresh vegetables and fruits?
- Of the fresh fruits and vegetables you purchased, approximately what percentage was locally grown?



Note 1: Responses are recorded in ranges. Interval censored regressions are used to calculate the mean numbers. The range of a bar indicates the 95% confidence interval of the mean based on the censored regression.

Note 2: The numbers in parenthesis indicate the percentage changes of the means between the two periods.

Note 3: The U.S. Bureau of Labor Statistics reported the August 2020 food at home and vegetable and fruits price indexes increased 3.7% and 3% respectively in comparison to January 2020.

The Effects on Consumer Habits

Results

Using a nationwide survey, we investigate how Covid-19 has affected US household grocery spending behavior, in particular fresh produce and local food purchase, and the factors driving such changes.

- Out of 514 responses, about 40% and 30% of the households reported increased overall food grocery and fresh produce expenditures, respectively, while about 20% of the households decreased their spending on these two categories. About a quarter of the households reduced the share of locally grown fresh produce over the total fresh produce purchase, while more than half of the sample reported no change in local fresh produce shopping behavior.
- Interval regression results show that average food grocery spending of the two higher household groups increased by 10.2% and 9.7%, respectively, while for the base and middle-income groups, average food grocery expenditures only increased by 3.9% and 6.8%, respectively (Fig 1).
- Results show those higher-income households are between 9 and 9.6 percentage points more likely to increase their spending compared to the base income group (<\$50,000). The fact that higher-income groups have a higher probability of increasing their spending compared to lower-income groups should not come as a surprise. The Global Alliance for Improved Nutrition [28] reports that households with lower income faced greater financial constraints, limiting how much they can increase spending to cover inflated food prices. This may force them to compromise for lower food quality/or quantity [28] or substituting canned goods for fresh produce.
- Recent studies also show that many households suffered from food hardship and insecurity during the pandemic. The interval regression results show that average fresh produce spending of the two higher household groups increased 14.2% and 5.2%, respectively, while for both the base and middle-income groups, average food grocery expenditures only increased by less than 1%. W
- All else equal, households with kids or elderly are significantly more likely to increase their expenditure on food groceries during the pandemic than other households. This could be due to the higher nutrition and quality demand of kids and older adults. The presence of kids has positively impacted household spending on fresh produce, a highly nutritious type of food during Covid-19. However, having an elderly at home does not significantly affect household fresh produce spending. One possible explanation is that the elderly may take vitamin or fiber supplements to fulfill the needs of these key nutrition supplied by fresh produce, while parents may prefer to offer kids fresh produce over nutrition supplements.
- Although having an elderly in the family does not significantly affect fresh produce expenditures, households are 6.8 percentage points more likely to increase, and 7.1 percentage points less likely to decrease, the share of local fresh produce purchased than other households during the pandemic. This may be due to: 1) the stronger bond older population may have with the local business and food suppliers, preferring to buy from people they know and trusting how they handle food, and; 2) elderly and seniors may have had more difficulty shifting to online shopping [44], preferring to keep buying from local vendors. Although many farmer's markets operating with reduced hours and more operating restrictions, the older population may still prefer purchasing local fresh produce. The support of local businesses from households with elderlies during the pandemic is essential for the survival of these operations. Many local businesses, including the local fresh produce suppliers, have faced extremely severe adverse shocks and suffered long-term or permanent loss of business and customers. Our result would suggest that campaigns aiming to promote local and small businesses by providing local/small business maps, statement credits, or coupons may have a greater effect when targeted towards the older population.
- On the retail side, the preference for online shopping may create severe financial difficulties for local farmers and businesses who do not have experience setting up online stores or even access to the Internet, adversely affecting the local economy. Some local farmers started agritourism businesses and/or on-site stores that may help offset the financial losses due to restricted farmer's market operations. However, not every farm has the resource and knowledge to operate and prompt their own agritourism business. It is essential for the policymakers to develop programs to increase broadband access and to train local farmers on developing alternative sales channels and innovative approaches such as 1) providing farm-to-home delivery; 2) offering online purchasing options, 3) diversifying retail outlets, 4) following social distancing measures at farmers markets.