Assessment of COVID-19 Impacts

Using the Immediate Impact Model of Local Agricultural Production (IMLAP)

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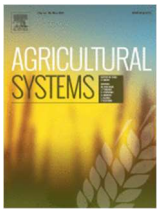
Selected Poster prepared for presentation at the 2021 Agricultural & Applied Economics Association Annual Meeting, Austin, Texas
August 1-3, 2021



Haqiqi, Iman & Bahalou Horeh, Marziyeh, 2021. "Assessment of COVID-19 impacts on U.S. counties using the immediate impact model of local agricultural production (IMLAP)," *Agricultural Systems, 190*:103132.
doi:10.1016/j.agsy.2021.103132

Assessment of COVID-19 Impacts Using the Immediate Impact Model of Local Agricultural Production (IMLAP)

Highlights

- COVID-19 racial and ethnic health disparities require attention to food production impacts linked to the most vulnerable communities.
- Novel local modeling is introduced for immediate impact assessments of COVID-19 on labor productivity and agricultural production.
- The COVID-19 burden on agricultural production is estimated to be around 2.63% of total farm outputs in the United States.
- Continued productivity growth, yield improvement, and boosted exports can eliminate the negative impacts of COVID-19 on agricultural production.
- The impacts are heterogeneous across communities suggesting community-specific supportive policy.

Keywords: COVID-19 impacts; labor productivity; livestock production; crop production; farmworkers.

Context

The COVID-19 pandemic has resulted in immediate and wide impacts on human and agricultural systems. While some of the positive and negative impacts of COVID-19 on the environment and economies are emerging, there is not a comprehensive understanding of the potential impacts of COVID-19 on the most vulnerable farmers.

Objective

The purpose of this study is to evaluate the immediate impacts of COVID-19 on agricultural and food systems in the United States. Our aim is to quantify the impacts on labor productivity in crops and livestock production considering the heterogenous vulnerability of different labor types. We are interested in measuring the production that is not realized due to COVID-19.

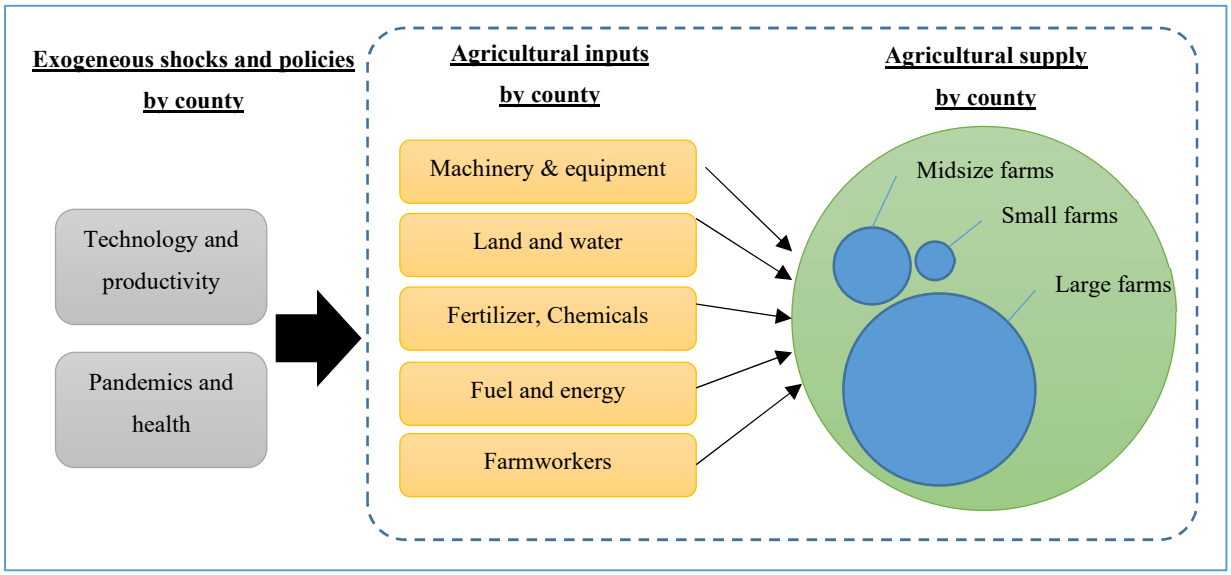


Figure 1: Graphical summary of major factors affecting agricultural supply in IMLAP.

Significance

The proposed quantitative framework of this study is a simple yet novel model that empowers diverse research communities to provide a quick analysis of the impacts of unprecedented events. It offers a holistic framework to evaluate the response of agricultural production to changes in availability and productivity of labor, machinery & equipment, land, fertilizer, seeds, and other inputs. This study presents new foundations for agricultural research communities to provide solutions to agricultural resilience challenges and highlights the significance of demand drivers, technological growth, and international trade in strengthening the food system.

Methods

In this paper, we introduce IMLAP, Immediate impact Model of Local Agricultural Production. This model is an economic framework considering short-term agricultural production responses to economic, environmental, and policy changes. We investigate the potential impacts of COVID-19 on the farmers in the U.S. for each county with a special focus on female, Hispanic, black and African American, and small-scale producers. The production function is a Nested Constant Elasticity of Substitution system as shown in Figure (2). This is a standard framework widely used in agricultural economics for the assessment of agricultural shocks and policies like in SIMPLE-G (Baldos et al., 2020), GTAP (Corong et al., 2017), GCAM (Calvin et al., 2019), IMPACT (Rosegrant et al., 2012), AIM (Fujimori et al., 2017), ENVISAGE (Van Der Mensbrugghe, 2018), MAGNET (van Meijl et al., 2006), and EPPA (Jacoby et al., 2006). The Technical Appendix provides more details about the production function and its components.

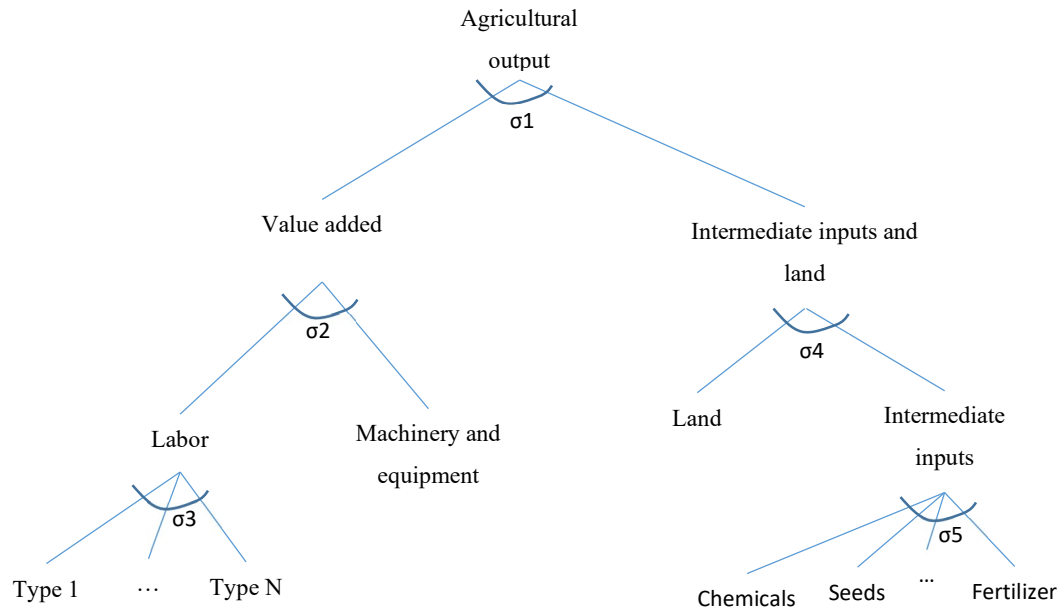


Figure 2: Structure of local agricultural production.

Results and conclusions

Considering the impacts of COVID-19 on labor, the findings of this study suggest a decline in agricultural output in all the U.S. counties ranging from 1.18% to 7.14% of total production. Our simulation results show that counties with a higher number of small-scale farms, non-white farmers, and female-operated farms are the most vulnerable to COVID-19. Also, we argue that the stimulus policies and support packages must target these communities of producers to ensure that their livelihood is protected. The findings suggest that productivity growth (technological improvements) and international trade can eliminate the negative impacts of pandemics. Figure (3) summarizes the results by farm size in terms of the potential production not realized.

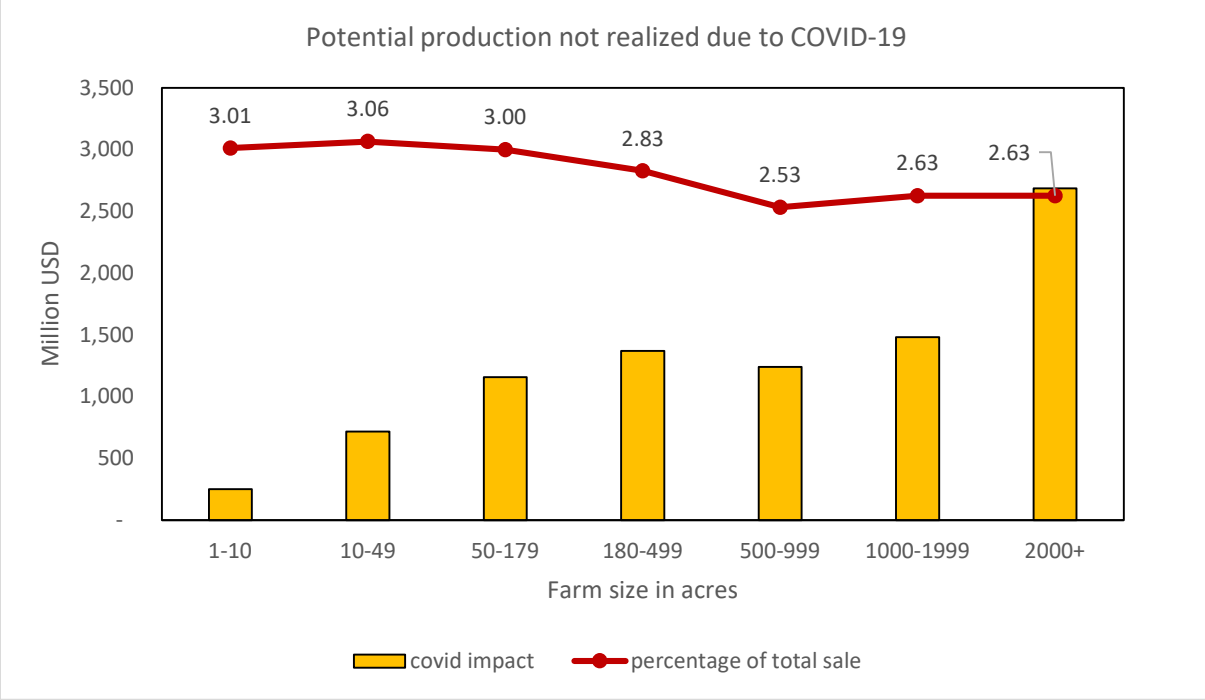


Figure 3: Estimated share of production not realized due to COVID-19 by farm size.

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1) HIGHLIGHTS

- COVID-19 racial and ethnic health disparities require attention to food production impacts linked to the most vulnerable communities.
- Novel local modeling is introduced for immediate impact assessments of COVID-19 on labor productivity and agricultural production.
- The COVID-19 burden on agricultural production is estimated to be around 2.63% of total farm outputs in the United States.
- Continued productivity growth, yield improvement, and boosted exports can eliminate the negative impacts of COVID-19 on agricultural production.
- The impacts are heterogeneous across communities suggesting community-specific supportive policy.

2) RESEARCH GAP AND GOALS

- There is not a comprehensive understanding of the potential impacts of a pandemic on the most vulnerable farmers in the US.
- Our aim is to quantify the impacts of COVID-19 through reduced labor productivity in crops and livestock production considering the heterogenous vulnerability of different farmworkers.
- We are interested in measuring the production that is not realized due to COVID-19.

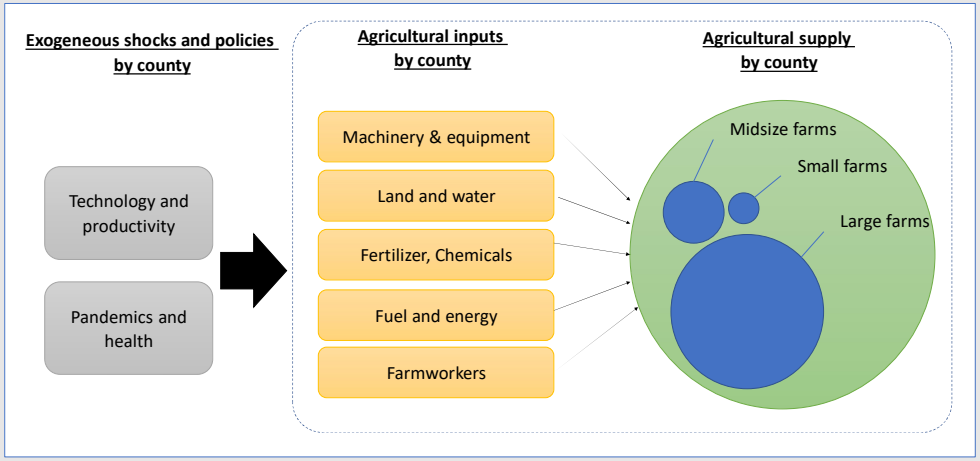
3) SIGNIFICANCE

- The proposed quantitative framework of this study is a simple yet novel model that empowers diverse research communities to provide a quick analysis of the impacts of unprecedented events.
- It offers a holistic framework to evaluate the response of agricultural production to changes in availability and productivity of labor, machinery & equipment, land, fertilizer, seeds, and other inputs.
- This study presents a framework to provide solutions to agricultural resilience challenges and highlights the significance of demand drivers, technological growth, and international trade.

4) METHODS (LOOK AT THE PAPER FOR MORE DETAILS)

Model: IMLAP, Immediate impact Model of Local Agricultural Production.

- This model is an economic framework considering short-term agricultural production responses to economic, environmental, and policy changes.
- Production functions are nested CES (constant elasticity of substitution) at the county level.
- Production functions are calibrated based on the US Census of Agriculture.
- We investigate the potential impacts of COVID-19 on the farmers in the U.S. for each county with a special focus on female, Hispanic, black and African American,



5) EXPERIMENT DESIGN

- We consider three changes during 2020:
  - Labor productivity loss due to COVID-19 by ethnicity as reported by the US CDC (the Centers for Disease Control and Prevention).
  - Change in agricultural exports (USDA forecasts the volume of U.S. exports increased in 2020)
  - Continued productivity growth and yield improvements

6) MAIN LINEARIZED EQUATION

$$q^{y}_{j,c} = \sum_{i} \theta^{i}_{j,c}\left(q^{i}_{j,c} + a^{i}_{j,c}\right) + \sum_{l} \theta^{l}_{j,c}\left(q^{l}_{j,c} + a^{l}_{j,c}\right) + \sum_{n} \theta^{n}_{j,c}\left(q^{n}_{j,c} + a^{n}_{j,c}\right) + \sum_{k} \theta^{k}_{j,c}\left(q^{k}_{j,c} + a^{k}_{j,c}\right) + a^{y}_{j,c}$$

Here, q shows the percentage change in the quantities, θ is the CES parameter, and α is the percentage change productivity parameter.

While i, j, k, l, n, show intermediate inputs, farm types, capital, labor, and land, respectively.

For example, $q^{y}_{j,c}$ is the percentage change in the production of output y (crop/livestock), by farm type j in county c.

This equation shows an increase in the quantity of any input (q^{i}, q^{l}, q^{k}, q^{n}) can increase production given no reduction in other inputs and productivity.

7) RESULTS

- We estimate that COVID-19 could be responsible for 1.18% to 7.14% lower agricultural production in various US counties.
- While all the states will have lower agricultural production, California's agriculture suffers more from COVID-19 by around $1.5 billion agricultural outputs not realized due to COVID-19.
- At the national level, the COVID-19 damage on the agricultural in the U.S. is estimated to be around 2.63% of total production.

8) RESULTS AND CONCLUSIONS

- We show that counties with a higher number of small-scale farms, non-white farmers, and female-operated farms are the most vulnerable to COVID-19.
- Also, we argue that the stimulus policies and support packages must target these communities of producers to ensure that their livelihood is protected.
- The findings suggest that productivity growth (technological improvements) and international trade can eliminate the negative impacts of pandemics.

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The authors acknowledge support from the United States Department of Agriculture AFRI grant #2019-67023-29679; and the National Science Foundation INFEWS grant #1855937.