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
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## **Research Report: Innovation among Businesses Across the Agri-Food Supply Chain during COVID-19**

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### **Abstract**

Innovation contributes critically to business recovery following major crises. Traditionally, business innovation is characterized by a series of choices and actions over time. During COVID-19, however, businesses throughout the agri-food supply chain were forced to innovate rapidly due to sudden unforeseen policy changes. To understand innovation induced by COVID-19, we analyze 297 usable responses from a survey of agri-food supply chain businesses in two distinct study regions (California and the two-state region of Minnesota-Wisconsin). Results indicate that larger agri-food businesses managed by younger owner-operators were more likely to innovate and adapt during the COVID-19 crisis.

**Keywords:** innovation, COVID-19, business size, agri-food supply chain

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## **Introduction**

Innovation is considered imperative for businesses to recover following major crises. During the COVID-19 pandemic, movement toward new business models, technologies, and niche products occurred in many industries but were particularly visible in the agri-food sector (de Lucas Ancillo et al., 2020; Galankis et al., 2020; Bellemare and Dusoruth, 2021; Benedek et al., 2021; Gavrilla et al., 2021; Reardon et al., 2021). For example, farmers shifted markets and delivery channels (Richards and Rickard, 2020), food manufacturers reformulated recipes and re-purposed production lines (Nakat and Bou-Mitri, 2021), retail grocers launched or expanded online ordering and home-delivery services (Melton, 2020; Walmart, 2020), and restaurants pivoted to take-out offerings, delivery, and virtual dining (Norris, Taylor Jr., and Taylor, 2021). During the first year of the pandemic, innovation among agri-food businesses were rapid and complex, compressing the traditional innovation and diffusion processes described by Schumpeter (1943) and Rogers (2003), respectively. There was little time for business owners to develop, tool, and test new ideas or for these new ideas to be subsequently adopted by other businesses. Consequently, researchers suggest that a better understanding of innovation among agri-food businesses during the COVID-19 pandemic is needed (Reardon et al., 2021; Charlebois et al., 2022;). Our study explores the impact of COVID-19 on innovation across segments of the agri-food sector.

## **Background**

Innovation is defined as the introduction of new goods, services, or ways of doing business (Wojan and Parker, 2017). Business innovation plays a vital role in short-term recovery and long-term resilience following significant market uncertainty, economic recession, and major crises (Wojan and Paker, 2017; Ulvenblad et al., 2018; Galankis et al., 2021; Ozanne et al., 2022; Wang et al., 2022).

Studies have reported an association between innovation and business size with mixed findings, some suggesting that relative advantages accrue to large firms while others identify small firm advantages (Tether, 1998; Camisón-Zornoza et al., 2004; Verhees and Meulenbergh, 2004; Damanpour and Schneider, 2008; Vossen, 2012). According to Vossen (2012), large businesses have the advantage of being able to invest more into research and development (R&D); spread risk over a portfolio of products; hire and train specialized labor; lean on greater economies of scale, market bargaining power, and access to external capital; and erect barriers to entry. On the other hand, small businesses typically benefit from advantages such as limited decision-making bureaucracy, rapid decision making, motivated and committed owner-operator management, rapid and effective communication, quick reaction to changing market requirements, and the ability to learn quickly and adapt routines as needed. We hypothesized that greater innovation during COVID-19 occurred among smaller scale businesses, as their flexibility would allow them to pivot more easily.

The Organization for Economic Cooperation and Development (OECD) developed guidelines for enterprises in the manufacturing sector to measure business size by the number of employees (2022). According to OECD guidelines, the majority of businesses throughout the U.S. agri-food

supply chain (including agricultural production, food wholesaling, food retailing segments) are classified as “micro” and “small” (U.S. Census Bureau, 2019); the only exception is the processing/manufacturing segment, which has an average of 55 employees per business, putting it in the OECD’s “medium”-size category. Agri-food businesses in this study represent micro (ag production), small (wholesale grocery and restaurants), and medium (manufacturing and retail grocery) OECD business size categories.

In addition to size, previous research has found that innovation within the agri-food supply chain is statistically associated with business and operator characteristics, such as geographic location, population density, transaction cost, and owner age, gender, and industry experience (King et al., 2010; O’Hara and Low, 2016; Wojan and Parker, 2017; O’Hara and Lin, 2019; Nosratabadi, Mosavi, and Lakner, 2020).

## Methods

In this paper, we use an empirical approach to test the hypothesis that innovation throughout the food supply chain differed by business size and type during the COVID-19 pandemic. First, linear regression is used to evaluate the relationship between innovation and business characteristics, such as supply chain segment, business size, operator gender, and operator age. Next, descriptive statistics are applied to determine whether pandemic-related innovations were in line with long-term business strategies.

Data for the regression analysis came from 297 survey responses to 11 questions collected electronically from businesses in the agri-food supply chains in California and the two-state region of Minnesota-Wisconsin. Survey distribution lists (email addresses) were compiled from Data Axel/Reference Solutions and from private and nonprofit membership organizations representing the agri-food supply chain segments included in this study (agricultural production, food manufacturing, wholesale grocery, retail grocery, and restaurants). The survey was fielded electronically using the Qualtrics platform from February 2021–April 2021. Follow-up reminders were emailed every 2 weeks throughout the survey period.

Survey participants were asked about business and operator characteristics as well as adaptations made during the first year of COVID-19. There were 14 possible innovation responses for questions related to business and operator characteristics to determine the innovations and adaptations made during COVID-19 (see Table 1). The 14 innovation responses identified by researchers were based on previous research and anecdotal evidence of changes businesses were making during the pandemic across the United States. For each possible innovation item, a value of 1 was recorded if selected and 0 otherwise if not selected. Researchers originally categorized these 14 items into three categories; however, in post hoc analysis the items were more reliable in a two-category structure. Response choices to the adaptation question included 8 questions in operational innovations ( $M = 2.08$ ,  $SD = 1.94$ ,  $\alpha = .69$ ) and 6 in marketing innovations ( $M = 1.76$ ,  $SD = 1.65$ ,  $\alpha = .70$ ) (see Table 1). Following Camisón-Zornoza et al. (2004), who found there was no statistical reason to distinguish between different types of innovation and because this study was not concerned with indicator rank as with Kamalipoor et al. (2022), the operational and

marketing responses were summed to create a single-dimension innovation score (INS) for each respondent business. Innovation scores ranged from 0 to 14.

**Table 1. Summary of responses to the question, “Since the coronavirus situation began to affect your business, how has your business changed? (Check all that apply.)” ( $n = 229$ )**

Innovation Items	Number of Responses % ( $n$ )
Business Operations	
Changing delivery/shipping practices including packaging	50% (114)
Lay-offs/furloughs	43% (98)
Offering training/education to employees	36% (83)
Hiring new people	34% (79)
Sourcing inputs/products from different suppliers	33% (76)
Changing inventory management practices	32% (74)
Investing in own equipment/facility	19% (44)
Increasing the number of input/product suppliers	17% (38)
Marketing	
Changing marketing strategies/practices	56% (129)
Changing products/services offered	54% (124)
Selling through different sales channels	45% (104)
Changing payment methods	32% (74)
Increasing the number of sales channels	28% (65)
Obtaining new certifications/licenses	7% (15)

Multiple linear regression (IBM SPSS, Version 27) was used to study the relationship between a dependent INS variable and 9 independent variables, which included each of the five supply chain segments (ag production, manufacturing, wholesaling, grocery retailing, and restaurants), as well as the logarithmic transformation of 2019 employee numbers (LG10SIZE), logarithmic transformation of 2019 sales revenue (LG10REV), operator age (AGE), and operator gender (GEN). The supply chain segments (AGPRD, MNF, WHL, RET, and REST) equaled 1 if the business reported any portion of their sales revenue generated from the segment; that is, they are not defined exclusively for each business. For the GEN variable, responses from women-owned businesses were coded 1 and 0 otherwise.

Descriptive statistics were used to further inform our understanding of business decisions made during COVID-19. A second innovation-related question asked, “Which of the changes were in line with the long-term direction of your business and were helped by the coronavirus situation to bring them about?” (see Table 2). There were 175 responses to this question from the business operators whose responses were included in the regression analysis. In the paired responses, we computed the proportion of innovations that were in line with the long-term direction for each item.

**Table 2. Summary of responses to the question, “Which of the changes were in line with the long-term direction of your business and were helped by the coronavirus situation to bring them about? (Check all that apply.)” ( $n = 175$ )**

Innovation Items	Number of Responses % ( $n$ )
Business Operations	
Investing in own equipment/facility	75% (33)
Offering training/education to employees	71% (59)
Hiring new people	67% (53)
Changing inventory management practices	62% (46)
Sourcing inputs/products from different suppliers	53% (40)
Lay-offs/furloughs	50% (49)
Changing delivery/shipping practices including packaging	49% (56)
Increasing the number of input/product suppliers	47% (18)
Marketing	
Selling through different sales channels	91% (95)
Increasing the number of sales channels	89% (58)
Changing marketing strategies/practices	80% (103)
Obtaining new certifications/licenses	73% (11)
Changing products/services offered	68% (84)
Changing payment methods	62% (46)

## Results

The linear regression model explained 15.9% of variance for the innovation score (see Table 3). The model was significant overall, indicating statistically significant explanatory power for operator age and business size. Through linear regression, we find that all else equal, younger business operators tended to make innovative changes during the COVID-19 crisis ( $\beta = -0.47$ ,  $p = .011$ ). The results also indicated that business size, measured by employment, was positively correlated with the extent of innovation along the agri-food supply chain. Larger businesses with more employees were more likely to innovate during COVID-19 than smaller businesses ( $\beta = 1.471$ ,  $p = .002$ ). We did not find a significant relationship between innovation and the following factors: supply chain segments, sales revenue, and gender. Moreover, regional difference was found to be statistically insignificant in preliminary analysis. Descriptive statistics suggest that innovations made during COVID-19 were in line with long-term strategies for 59% of businesses throughout the agri-food supply chain ( $n = 175$ ) (see Table 3).

**Table 3. Linear Regression Results**

Variables	<i>B</i>	<i>SE</i>	<i>t</i>	<i>p</i>
Production_Agriculture	-0.882	-1.493	-1.493	0.137
Manufacturing	0.158	0.273	0.273	0.785
Wholesaling	-0.352	-0.551	-0.551	0.582
Grocery_Retailing	-0.251	-0.524	-0.524	0.601
Restaurants	0.389	0.836	0.836	0.404
Gender	0.684	1.458	1.458	0.146
Age	-0.470	-2.560	-2.560	0.011**
Log_Revenue	0.216	0.643	0.643	0.521
Log_Size	1.471	3.125	3.125	0.002**
R <sup>2</sup>	.194			
Adjusted R <sup>2</sup>	.159			
F statistic	5.541***			

Note: Single, double, and triple asterisks (\*, \*\*, \*\*\*) indicate statistical significance at the 10%, 5%, and 1% levels.

## Implications

Innovation and adaptation occurred rapidly within the agri-food supply chain during the COVID-19 pandemic, allowing businesses to not only “bounce back but to bounce forward” (Ameen et al., 2022). This rapid innovation is perhaps one of the positive outcomes of the crisis. However, innovation did not occur equally across businesses throughout the agri-food supply chain. Our study suggests that during the first year of the pandemic, only larger businesses and those with relatively young owner operators adopted operational and marketing innovations.

The results challenge our hypothesis that smaller scale businesses would be more flexible than larger businesses and thus able to rapidly innovate during the COVID-19 crisis. The results may be explained by the fact that a large percentage of businesses in our study can be classified as “service oriented.” An extensive meta-study by Camisón-Zornoza et al. (2004) explains that size is more positively correlated with innovation among service-oriented businesses compared to manufacturing businesses. The majority of the respondents in our study (65%), representing the upstream supply chain segments of wholesaling, grocery retailing, and restaurants, are classified as service oriented. We suggest that the traditional benefits accruing to larger businesses, such as investments in R&D as well as economies of scale and greater bargaining power, may have better prepared the relatively large, service-oriented agri-food businesses for the COVID-19 pandemic. Moreover, the descriptive statistics comparing innovation with long-term business strategies further support the concepts of strategic and contingency planning afforded by significant R&D investment.

Our original findings make new contributions to the innovation literature while offering insights for policy makers and business owners within the agri-food supply chain. Business owners do not have control over firm size and operator age in the short term. Therefore, policy considerations should include incentive payments for business owners well in advance of crises to support innovative R&D and strategic planning among sectors of the agri-food supply chain that represent

critical foodstuffs. Future research should focus on the relationship between R&D spending and innovation among small and large firms within the agri-food supply chain.

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