



## Article

# Identifying Critical Issues in the Horticulture Industry: A Delphi Analysis during the COVID-19 Pandemic

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**Abstract:** The horticulture industry provides significant contributions to society, including healthy foods, economic development, recreation and leisure activities, among others. However, there are critical issues facing the horticulture industry which should be illuminated to ensure ongoing vitality and relevance, particularly within the COVID-19 pandemic context. The present study used the Delphi Technique to identify the most critical issues facing the horticulture industry as perceived by a panel of industry experts. Data were collected from February to October 2020 and thus preceded the initial declaration of COVID-19 as a global pandemic through the lifting of stay-at-home orders in most states. The expert panel arrived at a consensus on 34 specific issues, five of which were specifically related to the COVID-19 pandemic. Using the Constant Comparative Method, the issues were thematically analyzed and grouped into five primary categories, including (alphabetically ordered): (1) disease and pest management, (2) education, research, and recruitment, (3) environmental conditions and natural resource availability, (4) labor challenges and considerations, and (5) production challenges and innovations. The results of the study provide a framework for both academic and practitioner audiences to identify critical focus areas for the industry within a COVID-19 context.

**Keywords:** horticulture; critical issues; labor shortage; environmental conditions; horticultural production; pest management

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## 1. Introduction

The horticulture industry provides significant contributions to society, including the provision of healthy foods [1], economic development [2], the provision of essential vitamins and minerals [1], and contributions to recreation and leisure activities [2]. However, the horticulture industry is facing critical challenges globally, which affect the production and processing of and research into horticultural crops [3]. Consumer demands for an affordable, year-round supply of produce are increasing [4], particularly among higher socioeconomic classes [5]. Additionally, climate change, the loss of productive soils, increased cost of land, lack of water, and loss of low-cost labor all pose significant threats to the development of the horticulture industry. Immediate action is necessary to rectify these threats and continue providing a sufficient supply of nutritious foods [6].

Fresh produce provides individuals with essential vitamins and nutrients and is considered an integral aspect of a healthy lifestyle [7]. As a result, governmental and non-profit public health agencies encourage the consumption of fresh produce, most notably through the “five-a-day” campaign [3,7]. Fresh produce consumption further increases within the higher income stratum [8,9]. Consumers in higher-income households seek increased variety and novelty of produce and have a higher proportion of fruits and vegetables in their diets [3]. Additionally, there has been a concerted effort to increase

produce consumption within low-income areas that are historically nutrient-deficient [9]. However, the per capita availability of fresh produce has been insufficient to meet the recommended consumption levels [9]. Therefore, the horticulture industry must be able to innovate to meet the increasing demand and recommendations for consumption.

In addition to the consumption of horticultural products, ornamentals, and aesthetic products also represent a vital sector of the horticulture industry. The outbreak of COVID-19 precipitated significant changes in the production and purchase of these products [10,11]. Stringent lockdown mandates negatively affected floral shops by forcing them to alter operating hours, reducing customers and sales [10,12]. Additionally, the canceling or postponement of public social events (e.g., weddings, funerals) led to a decrease in demand for luxury perishable ornamental items, such as cut flowers, forcing many producers to destroy unsold supplies [11]. Conversely, as the time spent in social isolation increased, individuals recognized the value of horticulture as a leisure activity [11]. Interest in hobbies, such as gardening or foraging, has increased, and web-based gardening forums have experienced an increase in interest and engagement [11].

As demand for edible and ornamental horticultural products increases, the sustainability of horticultural production will be challenged [13]. In particular, the availability of water is one of the largest issues facing horticultural production [3,14]. As a result, new innovations in precision agriculture technologies may represent a viable solution [15,16]. However, there are several barriers to the adoption of precision agriculture, including a low knowledge base [17] and a lack of implementation of mechanized production operations [18,19]. Further research related to the sustainability of horticultural production and education on the use of precision agriculture technologies is necessary to meet the growing demand for horticultural production and ensure food security.

Additional challenges facing the horticulture industry include immigration policies, labor shortages, and disruptions to the supply chain [11,20]. Most horticultural producers rely on seasonal and migrant labor to grow, harvest, process, transport, and distribute horticultural commodities [21]. Restrictions in the mobility of migrant workers across borders have decreased the availability of low-cost migrant labor [20,22]. Labor shortages significantly impact the quality and potential profit of the product [23] and contribute to increased labor and transport prices [20]. In addition to decreasing the availability of labor, the COVID-19 pandemic has significantly impacted the provision of key intermediate products for horticultural producers and delayed the transport of products to market [20]. As a result, global food and ornamental retail systems have been destabilized [20]. Horticulture producers will be faced with increased labor shortages and breaks in the supply chain with the development of the Delta variant of COVID-19 and will need to turn to alternative labor and distribution mechanisms to ensure the security of the global horticultural system [11].

While several studies have been recently published regarding issues facing the horticulture industry as a result of COVID-19, there is a lack of research pertaining to the identification and discussion of the critical issues facing the horticulture industry not only precipitated by the COVID-19 pandemic. The present study fills this gap in the literature and provides horticultural professionals, both academics and practitioners, with a comprehensive list of present or near-present challenges to the industry. Identifying these issues will help to inform future outreach, communication, and education efforts. Specifically, the present study was driven by the following research objectives:

1. Create a comprehensive list of potential critical issues facing the horticulture industry;
2. Generate a consensus on the specific critical issues facing the horticulture industry;
3. Develop a heuristic thematic grouping of critical issues facing the horticulture industry.

## 2. Materials and Methods

### 2.1. Delphi Technique

First developed in the 1950s by the Rand Corporation [24], the Delphi technique is useful to “gain consensus using a series of questionnaires and the provision of feedback to participants who have expertise in key areas” [25] (p. 12). While the Delphi technique has traditionally been used for forecasting, communication improvements, and policy analysis, there is precedent for using the Delphi technique to identify critical issues within various industries, for example, recent publications have successfully used the Delphi technique within other agricultural industries, including food systems [26,27], animal and food production [28], agronomy [29], agricultural education [30], and extension education [31,32].

### 2.2. Expert Panel

Data for the Delphi process are collected by a panel of individuals who are experts in the area of interest [25]. The validity of Delphi studies is dependent on the competence and knowledge of panel members; therefore, a heterogeneous group of experts who possess a wide understanding of the desired subject matter should be selected [25,33]. For the current study, individuals from academic and industry backgrounds in horticulture were selected for the expert panel. The expert panel was composed of 35 individuals from a variety of backgrounds and focus areas, including greenhouses, nurseries, florals, state department of agriculture, commodity groups, organic farming, and so forth. Panelists' titles included Owner, CEO, Executive Director, Commodity Commissioner, Consultant, Research Coordinator, President, Center Director. The academic panelists included 70 faculty and staff members from a single southern department of Horticulture.

### 2.3. Data Collection

The current study implemented a three-round Delphi, which was deemed adequate to generate consensus [34]. Data were collected from February to October 2020. The survey was distributed via the Qualtrics online survey platform. During round one, which was conducted in February 2020, panel members were asked to respond to the following question: “In your opinion, what are the most critical issues facing industries related to horticulture?” Panelists were encouraged to provide a word or short phrase to briefly describe up to five of the top critical issues. Data from round one were collated, and a comprehensive list of potential critical issues was presented to panelists in the second round. Responses from both the academic and industry panelists were combined following round one of the process. The inclusion of both practitioner and academic perspectives was intended to ensure a comprehensive set of potential issues for consideration in subsequent rounds of the process. Any items generated from the academic panel members are noted in the results section. Only industry panel members completed rounds two and three of the process.

During round two, industry respondents were asked to review the list of issues generated in round one and respond to the following prompt: “Please indicate the level of importance you associated with each of the following issues facing industries related to horticulture.” Panel members rated level of importance using a five-point, Likert-type scale (1 = Not at all important, 2 = Somewhat important, 3 = Important, 4 = Very important, 5 = Extremely important).

Between rounds one and two, the COVID-19 pandemic began and fundamentally impacted many industries related to horticulture, agriculture, and natural resources. As such, there were two adjustments to the round two survey. First, the research team included two new items for panelists to respond to given the nature of the COVID-19 environment, specifically, “Remaining economically viable during the COVID-19 pandemic” and “Remaining relevant during the COVID-19 pandemic”. The researcher included items are noted in the results.

The second adjustment provided panelists an additional opportunity in round two to respond to the following prompt: “Given the significant COVID-19 related changes and impacts experienced in the past six months, are there any additional critical issues that were not included in the previous list, but you would like to identify? If so, please feel free to use the space below to provide a short description of the issue.” Panel members were asked to use a word or short phrase to briefly describe up to three critical issues facing industries related to horticulture as a result of the COVID-19 pandemic. Items generated from the COVID-19 related open-ended questions were included in the third and final round of the process. Respondent-generated COVID-19 related items are identified in the results section. Data from round two were collated and presented to participants in round three.

During round three, panel members were asked to create a final list of critical issues facing industries related to horticulture. Panelists were given the opportunity to respond to the following prompt: “Please indicate whether or not the following issues facing industries related to horticulture should be retained.” Using a dichotomous scale with possible answer choices *Yes* or *No*, panel members indicated which critical issues they felt should be retained for the final list.

Response rates were calculated for each round of the Delphi and are displayed in Table 1. Recommendations within the literature indicate individual round response rates greater than 70% are acceptable [35].

**Table 1.** Delphi expert panel response rates.

Delphi Round	Academic Faculty Panel (n, Invited)	Academic Faculty Panel Response Rate	External Panel (n, Invited)	External Panel Response Rate
Round 1	70	84.3%	35	88.6%
Round 2	n/a	n/a	35	77.1%
Round 3	n/a	n/a	35	77.1%

#### 2.4. Data Analysis

Data were analyzed using the SPSS v25 statistical software. Items generated during round one were consolidated, with duplicate items removed. During round two, expert panel members indicated the level of importance they associated with each issue generated during round one. Mean importance scores were calculated for each issue [36,37], and a mean threshold value of 3.50 was established a priori [38]. Items with mean importance scores greater than or equivalent to 3.50 were retained. Additionally, panelists were given the opportunity to add additional issues that may be facing the horticultural industry as a result of the COVID-19 pandemic. Fourteen issues were generated from this additional prompt. During round three, expert panelists indicated the level of consensus they associated with each issue. A consensus threshold of 65% was determined a priori based on recommendations in the literature [39]. A final list of 34 unique issues was retained from the Delphi process.

Following the conclusion of the Delphi process, the final list of critical issues was analyzed using the constant comparative method [40]. This method of analysis allows researchers to generate a heuristic thematic grouping of items through repeated comparison. Initially, each item or data point is reviewed and coded into “as many categories of analysis as possible” [40] (p. 439). As each item is coded, the researcher compares the item with previous items coded into the same category to generate themes [40]. Through these repeated comparisons, higher-order categories emerge, lending the researcher greater insight into the theoretical ideas the data might inform [40]. For the present study, codes, themes, and categories were analyzed manually by hand prior to being transferred to an electronic format. Peer debriefing and member checking among

the research team were used to reduce bias and improve the trustworthiness of the proposed analysis [41].

### 3. Results

The initial round of the Delphi resulted in 59 unique responses concerning critical issues in horticulture-related industries. During round two, expert panelists rated the level of importance they associated with each issue. Table 2 displays the results of round two, including frequency counts and mean scores for each issue.

**Table 2.** Delphi round two results: level of importance for critical issues facing industries related to horticulture (1 = least important; 5 = most important) ( $n = 59$ ).

Issue	1	2	3	4	5	Mean
Rising costs of production not matched with rising prices people are willing to pay	0	0	3	13	11	4.30
Machine harvest of produce and production automation	0	2	3	7	15	4.30
Immigrant labor need	0	1	6	5	15	4.26
Shortage of skilled labor <sup>a</sup>	0	0	7	6	14	4.26
Shortage of manual labor <sup>a</sup>	0	1	4	10	12	4.22
Labor costs for growers	0	0	3	15	9	4.22
Need for education public to value of horticultural products	1	0	4	10	12	4.19
Disease and pest management resistance issues	0	0	4	15	8	4.15
Public perception of pesticides	1	1	5	9	11	4.04
Decreasing number of horticultural majors/graduates <sup>a</sup>	0	0	7	13	7	4.00
Difficulty in producing crops profitability (input costs, operational costs, market price)	0	3	4	9	10	4.00
Changing environmental conditions and issues (weather, growing season, etc.)	0	2	6	9	10	4.00
Water quantity	0	2	6	9	10	4.00
Emerging pests/pathogens (globalization, etc.)	0	1	3	18	5	4.00
Water quality	0	1	6	13	7	3.96
Sustainable pest control <sup>a</sup>	0	0	7	14	6	3.96
Need to embrace technology and precision agriculture more	0	2	6	12	7	3.89
Need for competitive pay vs other professions	0	0	9	13	5	3.85
Product quality <sup>a</sup>	0	1	8	12	6	3.85
Decline of university floral and horticulture programs	1	2	7	8	9	3.81
Need for more market development and market—having a home for products	0	4	5	9	8	3.81
Competition from cheaper and/or less regulated horticultural products imported from other countries	1	6	4	3	13	3.78
Environmental impacts of industry	0	4	6	8	8	3.77
Economic impact due to diseases, pathogens <sup>a</sup>	0	3	8	9	7	3.74
Lack of economic impact data for specialty crops <sup>a</sup>	0	4	7	8	8	3.74
Changing demographics and associated consumer preferences <sup>a</sup>	0	1	11	9	6	3.74
Viral diseases—need for resistant plants	0	1	9	13	4	3.74
Remaining economically viable during the COVID-19 pandemic <sup>b</sup>	2	3	5	7	10	3.74
Need for recognition within the larger agriculture community	0	4	9	5	9	3.70
Need for sustainable practices	0	3	10	7	7	3.67
Food safety/quality and lack of standard practices in operations, management, and postharvest issues in the industry	0	2	9	10	4	3.64
Student debt alongside low-paying agriculture jobs <sup>a</sup>	0	1	12	10	4	3.63
Uncertainty of international trade policy	2	5	3	8	9	3.63
Remaining relevant during the COVID-19 pandemic <sup>b</sup>	3	3	5	6	10	3.63

Lack of public investment in long-term, high-risk investment (even universities focus on short ROIs)	3	2	6	8	8	3.59
Negative public opinion of agriculture	1	4	8	8	6	3.52
Increasing ecosystem concerns	0	5	7	11	4	3.52
Need for more communication of research results to the industry	2	3	5	13	4	3.52
Continuing to develop commercially viable varieties for blueberries	0	5	7	11	4	3.48
Need for more consistent cropping and yielding	1	1	14	6	5	3.48
Trucking/shipping costs	1	2	13	8	3	3.37
Lack of respect for industry in government/private	0	7	7	10	3	3.33
Stress management affecting all agriculture industries trying to stay viable in agriculture today	1	5	11	4	6	3.33
Restriction of chemical control measures <sup>a</sup>	2	3	12	5	5	3.30
Energy costs	0	6	11	9	1	3.19
Not enough growers/entrepreneurs	3	4	11	4	5	3.15
Government/environmental regulations and certifications	1	5	13	5	3	3.15
Health hazards of industry	0	6	15	3	3	3.11
Diversity in the industry	2	7	9	5	4	3.07
Invasive plants still propagated and sold in the trade <sup>a</sup>	4	5	7	8	3	3.04
Institutionalizing more support for small, local, and organic farms feeding our communities	1	9	9	5	3	3.00
Emerging crops like citrus	1	8	9	6	2	3.00
Limited diversity in crops (need for more new crops)	3	5	9	8	1	2.96
Diverse markets: ornamental, houseplants, and vegetables <sup>a</sup>	4	5	11	4	3	2.89
Shortage of floral industry researchers	5	6	7	6	3	2.85
Over production	4	12	1	9	1	2.67
Organic horticulture vs. production	2	11	9	5	0	2.63
Review and analyze existing varietal plantings to determine if we have imploding DNA issues on mature plants	5	10	9	3	0	2.37

<sup>a</sup> Academic sourced item; <sup>b</sup> Researcher included COVID-19 response item.

Following round two of the Delphi, 55 unique issues were retained. In round three, expert panelists were asked to indicate their level of agreement regarding each issue. The results of round three are presented in Table 3.

**Table 3.** Delphi round three results: level of consensus for critical issues facing industries related to horticulture ( $n = 55$ ).

Issue	Consensus (%)
Sustainable pest control <sup>a</sup>	96.30
Disease and pest management resistance issues	96.30
Water quantity	96.30
Water quality	96.30
Shortage of skilled labor <sup>a</sup>	96.30
Need for sustainable practices	96.30
Emerging pests/pathogens (globalization, etc.)	96.30
Shortage of manual labor <sup>a</sup>	92.59
Rising costs of production not matched with rising prices people are willing to pay	92.59
Labor costs for growers	92.59
Decreasing number of horticulture majors/graduates <sup>a</sup>	92.59
Machine harvest of produce and production automation	88.89
Need to embrace technology and precision agriculture more	84.61
Changing environmental conditions and issues (weather, growing season, etc.)	84.61
Need for competitive pay vs. other professions	84.61

Changing demographics and associated consumer preferences <sup>a</sup>	84.61
Immigrant labor need	81.48
Difficulty in producing crops profitability (input costs, operational costs, market price)	81.48
Safety and protection of horticultural laborers	80.00
Decline of university floral and horticulture programs	77.78
Need for education public to value of horticultural products	77.78
Viral diseases—need for resistant plants	76.92
Supply chain issues, ensuring crops to market **	76.92
Continuity of long-term research functions **	76.00
Environmental impacts of industry	72.00
Need for more market development and marketing—having a home for products	70.37
Public perception of pesticides	70.37
Economic impact due to diseases, pathogens <sup>a</sup>	70.37
Lack of economic impact data for specialty crops <sup>a</sup>	69.23
Lack of robust distance education programs in horticulture **	69.23
Ensuring no delays on migrant workforces, specifically H2A **	68.00
Product quality <sup>a</sup>	68.00
Food safety/quality and lack of standard practices in operations, management, and postharvest issues in the industry	68.00
Interest in home gardening **	65.38
Negative public opinion of agriculture	62.96
Speculative production issues and crop forecasting—i.e., will first-time gardeners do so again next spring? **	61.54
Need for recognition within the larger agricultural community	59.26
Lack of public investment in long-term, high-risk investment (even universities focus on short ROIs)	59.26
Increasing ecosystem concerns	57.69
Demand for local produce **	57.69
Need for more communication of research results to the industry	57.69
Lack of value-added processing of Georgia produce such as IQF or canning **	56.00
Increased demand for horticultural products during/due to COVID-19 **	53.85
Horticultural products for contributions to mental health **	50.00
Competition from cheaper and/or less regulated horticultural products imported from other countries	50.00
Remaining economically viable during the COVID-19 pandemic <sup>b</sup>	48.15
Student debt alongside low-paying agriculture jobs <sup>a</sup>	48.15
Maintaining a healthy and confident workforce during the uncertainty of COVID-19 **	48.15
Uncertainty of international trade policy	44.44
Potential labor issues surrounding COVID-19, i.e., parents not being able to work due to virtual school for children **	40.00
Testing worker, the cost making sure we keep them safe **	38.46
Remaining relevant during the COVID-19 pandemic <sup>b</sup>	37.04
Potential plant shortages in ornamental due to banner sales during COVID-19 **	26.92
Feeding worker cost while they are in quarantine	26.92

<sup>a</sup> Academic sourced items; <sup>b</sup> Researcher included COVID-19 response item from round 2; \*\* COVID-19 open-ended response sourced items from round 2.

Following the third round of the Delphi, 34 unique issues were retained. These issues were analyzed thematically using the constant comparative method. Five heuristic themes resulted from the constant comparative method analysis. These themes and their associated issues are presented in Table 4.

**Table 4.** Constant Comparative Method Thematic Analysis Results ( $n = 34$ ).

Issue	Number of Issues	Number of Issues with 90–100% Agreement
<i>Production Challenges and Innovations</i>	11	2
Need for sustainable practices		
Rising costs of production not matched with rising prices people are willing to pay		
Machine harvest of produce and production automation		
Need to embrace technology and precision agriculture more		
Changing demographics and associated consumer preferences <sup>a</sup>		
Difficulty in producing crops profitability (input costs, operational costs, market price)		
Supply chain issues, ensuring crops to market <sup>**</sup>		
Need for more market development and marketing—having a home for products		
Product quality <sup>a</sup>		
Food safety/quality and lack of standard practices in operations, management, and postharvest issues in industry		
Interest in home gardening <sup>**</sup>		
<i>Education, Research, and Recruitment</i>	7	1
Decreasing number of horticultural majors/graduates <sup>a</sup>		
Need for competitive pay vs. other professions		
Decline of university floral and horticulture programs		
Need for education public to value of horticultural products		
Continuity of long-term research functions <sup>**</sup>		
Lack of economic impact data for specialty crops <sup>a</sup>		
Lack of robust distance education programs in horticulture <sup>**</sup>		
<i>Disease and Pest Management</i>	6	3
Sustainable pest control		
Disease and pest management resistance issues		
Emerging pests/pathogens (globalization, etc.)		
Viral diseases—need for resistant plants		
Public perception of pesticides		
Economic impact due to diseases, pathogens <sup>a</sup>		
<i>Labor Challenges and Considerations</i>	6	3
Shortage of skilled labor <sup>a</sup>		
Shortage of manual labor <sup>a</sup>		
Labor costs for growers		
Immigrant labor need		
Safety and protection of horticultural laborers		
Ensuring no delays on migrant workforces, specifically H2A <sup>**</sup>		
<i>Environmental Conditions and Natural Resource Availability</i>	4	2
Water quantity		
Water quality		
Changing environmental conditions and issues (weather, growing season, etc.)		
Environmental impacts of industry		

<sup>a</sup> Academic sourced items; <sup>\*\*</sup> COVID-19 open-ended response sourced items from round 2.

#### 4. Discussion

The purpose of this study was to generate consensus among horticultural experts regarding critical issues facing horticulture-related industries. A novel contribution of the work is the timeframe within which data were collected. Specifically, the process was initiated prior to the COVID-19 outbreak being declared a global pandemic by the World Health Organization [42] and was completed after most states within the United States lifted stay-at-home orders [43]. Thematic analysis of these issues enables us to heuristically summarize the major problems facing the horticulture industry and provides a starting point for action. In total, 34 unique issues resulted from the Delphi process and



were categorized into five overarching themes. Based on the nature of the data collection process, COVID-19 related items were generated and included in rounds two and three. However, of the 34 retained issues, only five were specifically related to COVID-19.

Some of the top issues identified within this study are contained within the *Disease and Pest Management* theme. Emerging pests and pathogens and increasing resistance to current pest management practices were indicated as significant areas of need. The *Production Challenges and Innovations* theme contained the highest number of issues, indicating a need for reform in horticultural production practices. Several issues in this category highlight the need for more sustainable practices as well as increased adoption of automated processes and precision agriculture. Additionally, unreliable supply chains, changing consumer preferences, increasing profitability of horticultural products were identified as areas needing further attention. The improvement of formal horticultural education programs, through distance or traditional formats, was a key issue that arose in the *Education, Research, and Recruitment* theme. Additionally, there is a need for stronger recruitment and retention efforts within university programs and the workforce. Within the *Labor Challenges and Considerations* theme, it is overwhelmingly apparent that the shortage of skilled, manual, and migrant workers is a serious threat to the horticulture industry. Finally, the *Environmental Conditions and Natural Resource Availability* theme illustrates how changing environmental conditions will impact horticultural production and the availability of necessary resources [44].

While it would be beneficial to address all critical issues, immediate action should be directed towards addressing issues that generated the most agreement. There were 11 issues that generated a very high level of agreement (i.e., issues with 90–100% agreement in round three of the Delphi process). Based on the distribution of these 11 issues, addressing needs within the *Disease and Pest Management* and *Labor Challenges and Consideration* issues is a critical starting point. Subsequent efforts should be directed towards addressing the issues identified within the *Production Challenges and Innovations*, *Environmental Conditions and Natural Resource Availability*, and *Education, Research, and Recruitment* themes.

#### 4.1. Impacts of COVID-19

The results of the study underscore previous findings regarding the impacts of COVID-19 on the horticulture industry [11]. When given the opportunity to identify issues in the horticulture industry precipitated by the COVID-19 pandemic, expert panelists identified and reached a consensus on 14 issues. Five issues related to COVID-19 were included in the final list following the Delphi process. Two issues were associated with *Production Challenges and Innovations*, including “supply chain issues, ensuring crops to market” and “interest in home gardening”. As the pandemic continues and supply chain disruptions persist, it is imperative to develop contingency plans that ensure horticultural products reach the market. For example, opportunities for local buyers or increased efficiency of long-term storage should be explored [11]. Two issues were associated with *Education, Research, and Recruitment*, including “continuity of long-term research functions” and “lack of robust distance education programs in horticulture”. To adapt to the changing nature of education and research, provisions should be made to ensure continuity of research functions in nontraditional or virtual settings. Additionally, higher education institutions should continue to offer flexibility regarding online instruction and devote resources towards developing robust distance education programs and support systems. Finally, one issue was associated with *Labor Challenges and Considerations*, including “ensuring no delays on migrant workforces, specifically H2A”. The findings of the study indicate there were critical issues that surfaced specifically related to the COVID-19 pandemic.

#### 4.2. Contributions to Literature

The present study provides several contributions to the literature regarding the horticulture industry. First, the study updates previous research related to challenges and opportunities for the horticulture industry in the 21st century. With the exception of Warrington [3], no study has examined critical issues and opportunities for growth facing the horticulture industry as a whole. The results of this study provide critical insight regarding the current challenges facing the horticulture industry (e.g., labor shortage, need for sustainable practices, and changing consumer preferences) and should be used as a guide to increase resiliency. Additionally, the themes generated address opportunities for growth (i.e., local partnerships, distance education programs for horticulture, and communication of pesticide benefits) and should be used to ensure longevity within the horticulture industry. Second, the present study extends the literature regarding the impacts of COVID-19 on the horticulture industry. Additionally, the current study provides a set of mutually agreed issue focus areas among a panel of experts. The results of this study may serve as a guide for future research and investigation. A recommendation would be to use the results of the present study and analyze whether different specialty areas within the horticultural industry are facing similar or differing challenges. For example, using the current results as a starting point, future research could examine whether producers in ornamentals are experiencing differing levels of challenges across the identified issue areas compared to producers in nurseries more generally. Accordingly, a consistent set of critical issue focus areas may help to harmonize future research discourse within the discipline.

#### 4.3. Contributions to Practice

There are several practical contributions of the present study to the horticulture industry and academic profession. Specifically, the overall themes represent a heuristic guide concerning research, educational programs, and resource allocation. Regarding the *Disease and Pest Management* category, steps should be taken to identify sustainable pest management practices that combat new diseases and pests while protecting from existing pests and pathogens resistant to current practices. In particular, participatory-based approaches may be used to develop solutions in conjunction with local horticultural producers. To alleviate the challenges discussed in the *Labor Challenges and Considerations* theme, horticulture professionals can work with producers to offer recruiting incentives that attract manual and migrant laborers. Additionally, horticultural producers can partner with the Cooperative Extension Service to offer educational training that increases the availability of skilled laborers.

#### 4.4. Limitations

While the results of the present study hold significant promise for the continued development of the horticulture industry, there are a few limitations that must be addressed. Primarily, with the use of the Delphi technique, the issues generated are limited to the insights of the expert panel members. Although measures were taken to reduce bias and assemble a heterogeneous panel, the results may not be generalizable to all contexts. Furthermore, the specific demographic and professional expertise of the expert panelists were not included in the data collection process. A recommendation is for future research using expert panelists to include contextual details of panel members to aid in the interpretability of results. Additionally, the perspectives and backgrounds of the authors may affect the interpretation and generation of themes within the constant comparative method. Therefore, we disclose these limitations for increased clarity and interpretation of results.

### 5. Conclusions

Identification of critical issues is an important tool for assessing the resiliency and capacity of an industry [28,29]. Awareness of the challenges and opportunities associated

with the horticulture industry can guide resource allocation and inform research and educational opportunities. The current study identified an expansive list of the most critical issues currently facing the horticulture industry prior to and during the COVID-19 pandemic. The results of this study provide updated information about the challenges facing the horticulture industry in the 21st century. Additionally, the current study makes meaningful contributions to the literature concerning the impact of COVID-19 on horticultural operations. Finally, the results of this study can be used to guide future research and practice, specifically related to pest/disease management, labor supply, and production practices.

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## References

1. Suman, M. Urban Horticulture Prospective to Secure Food Provisions in Urban and Peri-Urban Environments. *Int. J. Pure Appl. Biosci.* **2019**, *7*, 133–140, doi:10.18782/2320-7051.7469.
2. Bradley, L.K.; Behe, B.K.; Bumgarner, N.; Glen, C.D.; Donaldson, J.L.; Bauske, E.M.; Dorn, S.; Langellotto, G. Assessing the Economic Contributions and Benefits of Consumer Horticulture. *HortTechnology* **2017**, *27*, 591–598, doi:10.21273/horttech03784-17.
3. Warrington, I. Challenges and opportunities for horticulture and priorities for horticultural research at the start of the twenty-first century. *Acta Hort.* **2011**, *916*, 59–68, doi:10.17660/actahortic.2011.916.6.
4. Kyriacou, M.C.; Roupheal, Y. Towards a new definition of quality for fresh fruits and vegetables. *Sci. Hort.* **2018**, *234*, 463–469, <https://doi.org/10.1016/j.scienta.2017.09.046>.
5. Sharma, A.A.V. Current Trends and Emerging trends in Horticulture. *J. Hort.* **2013**, *1*, e101, doi:10.4172/2376-0354.1000e101.
6. Food and Agriculture Organization of the United Nations [UN-FAO]. Fruit and Vegetables: Your Dietary Essentials. 2021. Available online: <http://www.fao.org/3/cb2395en/online/cb2395en.html> (accessed on 8 September 2021).
7. Chatziprodromidou, I.P.; Bellou, M.; Vantarakis, G.; Vantarakis, A. Viral outbreaks linked to fresh produce consumption: A systematic review. *J. Appl. Microbiol.* **2018**, *124*, 932–942, doi:10.1111/jam.13747.
8. Lallukka, T.; Pitkaniemi, J.; Rahkonen, O.; Roos, E.; Laaksonen, M.; Lahelma, E. The association of income with fresh fruit and vegetable consumption at different levels of education. *Eur. J. Clin. Nutr.* **2010**, *64*, 324–327, doi:10.1038/ejcn.2009.155.
9. Mason-D’Croz, D.; Bogard, J.R.; Sulser, T.B.; Cenacchi, N.; Dunston, S.; Herrero, M.; Wiebe, K. Gaps between fruit and vegetable production, demand, and recommended consumption at global and national levels: An integrated modelling study. *Lancet Planet. Health* **2019**, *3*, e318–e329, doi:10.1016/s2542-5196(19)30095-6.
10. Anacleto, A.; Bornancin, A.P.D.A.; Mendes, S.H.C.; Scheuer, L. Between flowers and fears: The new coronavirus pandemic (COVID-19) and the flower retail trade. *Ornam. Hort.* **2021**, *27*, 26–32, doi:10.1590/2447-536x.v27i1.2232.
11. Bulgari, R.; Petrini, A.; Cocetta, G.; Nicoletto, C.; Ertani, A.; Sambo, P.; Ferrante, A.; Nicola, S. The Impact of COVID-19 on Horticulture: Critical Issues and Opportunities Derived from an Unexpected Occurrence. *Horticulturae* **2021**, *7*, 124, doi:10.3390/horticulturae7060124.
12. Biazoti, A.; Nakamura, A.; Nagib, G.; Leão, V.; Giacchè, G.; Mauad, T. The Impact of COVID-19 on Urban Agriculture in São Paulo, Brazil. *Sustainability* **2021**, *13*, 6185, doi:10.3390/su13116185.
13. Davies, F.; Bowman, J. Horticulture, food security, and the challenge of feeding the world. *Acta Hort.* **2016**, *1128*, 1–6, doi:10.17660/actahortic.2016.1128.1.

14. Lillywhite, R. Horticulture and The Environment. In *Horticulture: Plants for People and Places*; Dixon, G., Aldous, D., Eds.; Springer: Berlin/Heidelberg, Germany, 2014; Volume 2, pp. 603–617.
15. Gautam, D.; Pagay, V. A Review of Current and Potential Applications of Remote Sensing to Study the Water Status of Horticultural Crops. *Agronomy* **2020**, *10*, 140, doi:10.3390/agronomy10010140.
16. Alvino, A.; Marino, S. Remote Sensing for Irrigation of Horticultural Crops. *Horticulturae* **2017**, *3*, 40, doi:10.3390/horticulturae3020040.
17. Layden, I.; O'Halloran, J. *Adoption of Precision Systems Technology in Vegetable Production*; Department of Agriculture and Fisheries Queensland: Brisbane, Australia, 2020. Available online: <http://era.daf.qld.gov.au/id/eprint/7802/1/vg16009-final-report-complete.pdf> (accessed on 8 September 2021).
18. Cai, Y.; Takeda, F.; Foote, B.; DeVetter, L.W. Effects of Machine-Harvest Interval on Fruit Quality of Fresh Market Northern Highbush Blueberry. *Horticulturae* **2021**, *7*, 245, doi:10.3390/horticulturae7080245.
19. Lowenberg-DeBoer, J.; Erickson, B. Setting the Record Straight on Precision Agriculture Adoption. *Agron. J.* **2019**, *111*, 1552–1569, doi:10.2134/agronj2018.12.0779.
20. Bochtis, D.; Benos, L.; Lampridi, M.; Marinoudi, V.; Pearson, S.; Sørensen, C. Agricultural Workforce Crisis in Light of the COVID-19 Pandemic. *Sustainability* **2020**, *12*, 8212, doi:10.3390/su12198212.
21. Cassey, A.J.; Lee, K.; Sage, J.; Tozer, P.R. Assessing post-harvest labor shortages, wages, and welfare. *Agric. Food Econ.* **2018**, *6*, 17, doi:10.1186/s40100-018-0112-6.
22. Neef, A. Legal and social protection for migrant farm workers: Lessons from COVID-19. *Agric. Hum. Values* **2020**, *37*, 641–642, doi:10.1007/s10460-020-10086-w.
23. Calvin, L.; Martin, P. Labor-intensive U.S. fruit and vegetable industry competes in a global market. USDA Economic Research Service: Washington, DC, USA, 1 December 2010; Available online: <https://www.ers.usda.gov/amber-waves/2010/december/labor-intensive-us-fruit-and-vegetable-industry-competes-in-a-global-market/> (accessed on 8 September 2021).
24. Turoff, M.; Linstone, H. *The Delphi Method: Techniques and Applications*; New Jersey Institute of Technology: Newark, NJ, USA, 2002.
25. Habibi, A.; Sarafazi, A.; Izadyar, S. Delphi technique: Theoretical framework in qualitative research. *Int. J. Eng. Sci.* **2014**, *3*, 8–13.
26. Lamm, K.W.; Randall, N.L.; Diez-Gonzalez, F. Critical Food Safety Issues Facing the Food Industry: A Delphi Analysis. *J. Food Prot.* **2020**, *84*, 680–687, doi:10.4315/jfp-20-372.
27. Allen, T.; Prospero, P.; Cogill, B.; Padilla, M.; Peri, I. A Delphi Approach to Develop Sustainable Food System Metrics. *Soc. Indic. Res.* **2018**, *141*, 1307–1339, doi:10.1007/s11205-018-1865-8.
28. Lamm, K.W.; Randall, N.L.; Fluharty, F.L. Critical issues facing the animal and food industry: A Delphi analysis. *Transl. Anim. Sci.* **2021**, *5*, txa213, doi:10.1093/tas/txaa213.
29. Lamm, K.W.; Randall, N.L.; Sherrier, J. Agriculture leaders identify critical issues facing crop production. *Agron. J.* **2021**, doi:10.1002/agj2.20835.
30. Agricultural Technical Skills Needed by Entry Level Agriculture Teachers: A Modified Delphi Study. *J. Agric. Educ.* **2020**, *61*, 140–151, doi:10.5032/jae.2020.01140.
31. Powell, A.; Scaduto, J.; Lamm, K.W. Perceived strengths of the Georgia 4-H program: A delphi analysis. *J. Hum. Sci. Ext.* In press.
32. Powell, A.; Bennett, N.; Lamm, K.W. Expanding 4-H alumni life perspectives: An experiential and pro-grammatic evaluation. *J. Agric. Educ.* **2021**, *62*, 185–200. <https://doi.org/10.5032/jae.2021.28415>.
33. Vernon, W. The Delphi technique: A review. *Int. J. Ther. Rehabilitation* **2009**, *16*, 69–76, doi:10.12968/ijtr.2009.16.2.38892.
34. Fan, C.K.; Cheng, C.L. A study to identify the training needs of life insurance sales representatives in Tai-wan using the Delphi approach. *Int. J. Train. Dev.* **2006**, *10*, 212–226.
35. Keeney, S.; Hasson, F.; McKenna, H. *The Delphi Technique in Nursing and Health Research*; Wiley-Blackwell: Chichester, UK, 2011.
36. Hasson, F.; Keeney, S.; McKenna, H. Research guidelines for the Delphi survey technique. *J. Adv. Nurs.* **2000**, *32*, 1008–1015, doi:10.1046/j.1365-2648.2000.t01-1-01567.x.
37. Murray, W.F.; Jarman, B.O. Predicting Future Trends in Adult Fitness Using the Delphi Approach. *Res. Q. Exerc. Sport* **1987**, *58*, 124–131, doi:10.1080/02701367.1987.10605436.
38. Garson, G.D. *The Delphi Method in Quantitative Research*; Statistical Associated Publishing: Asheboro, NC, USA, 2014.
39. Williams, P.L.; Webb, C. The Delphi technique: A methodological discussion. *J. Adv. Nurs.* **1994**, *19*, 180–186, doi:10.1111/j.1365-2648.1994.tb01066.x.
40. Glaser, B.G. The Constant Comparative Method of Qualitative Analysis. *Soc. Probl.* **1965**, *12*, 436–445, doi:10.2307/798843.
41. Lincoln, Y.; Guba, E.G. *Naturalistic Inquiry*; Sage: Thousand Oaks, CA, USA, 1985.
42. World Health Organization. WHO Director-General's Opening Remarks at the Media Briefing on COVID-19. Available online: <https://www.who.int/director-general/speeches/detail/who-director-general-s-opening-remarks-at-the-media-briefing-on-covid-19---11-March-2020> (accessed on 11 March 2020).
43. Stoddart, M.; Osborne, M.; Cruz, A. When Each State's Stay-at-Home Order Lifts. *ABC News*, 12 May 2020. Available online: <https://abcnews.go.com/US/list-states-stay-home-order-lifts/story?id=70317035a> (accessed on 8 September 2021).

44. Fitton, N.; Alexander, P.; Arnell, N.; Bajzelj, B.; Calvin, K.; Doelman, J.; Gerber, J.; Havlik, P.; Hasegawa, T.; Herrero, M.; et al. The vulnerabilities of agricultural land and food production to future water scarcity. *Glob. Environ. Chang.* **2019**, *58*, 101944, doi:10.1016/j.gloenvcha.2019.101944.