



THE UNIVERSITY OF ARIZONA

Cooperative Extension

az1867

March 2021

---

## COVID-19 EFFECTS ON FARMING ACTIVITIES IN ARIZONA AND HOW FARMERS AND RANCHERS RESPONDED

---

Isaac K. Mpanga, Russell Tronstad, Jeff Schalau, Ursula K. Schuch, Hope Wilson, Christy Stuth, and Hattie Braun

## Table of Contents

Executive Summary .....	2
Introduction .....	2
Materials and Methods.....	3
Survey Data Collection .....	3
Demographics of Farmers: .....	3
Results .....	6
Effects of COVID-19 on Farm Operating Costs in Arizona .....	6
Effects of COVID-19 on Farm Sales in Arizona.....	6
Forms of Support Received by Farmers and Ranchers and the Need for More Information on Programs:.....	7
Farmers and Ranchers Opinion on How Consumers Could Support Farms and Local Food Systems:.....	8
Effects of COVID-19 on farmers source of education and extension programs:.....	9
Food Safety Practices by Farmers and Ranchers Before and After the COVID-19 Outbreak in Arizona:10	
Conclusions .....	10
Appendix: Questions used for the survey .....	11

## Executive Summary

The unprecedented outbreak of COVID-19 impacted agricultural activities in Arizona, and, like many other activities, there was a need for a better understanding of these impacts to support current and future decision making. An online survey was conducted to provide insights on how COVID-19 affected farm operation costs, sales, food safety practices, transfer of information, support received by farmers, and farmers' opinions on how consumers could support local food systems in Arizona during and after the pandemic. Fifty-four percent of farmers and ranchers who participated in the online survey reported no change in their operating cost, while 5% reported a decrease, and 40% reported an increase. Concerning sales, 70% of farmers and ranchers said their sales were reduced due to the COVID-19 outbreak, likely due to decreased sales to retail shops, restaurants, farmer's markets, roadside stands, and food bank outlets, all of which declined after the outbreak. The remaining 30% of farmers who reported no change or had an increase in sales sold their products through Community Support Agriculture (CSA) or on-farm pick-up. Support received as a result of the crisis was in government loans (29%). Farmers and ranchers identified the need for more information on COVID-19 small business loans (39%) and USDA loan programs (28%). The opinion of farmers and ranchers on how consumers can better support local food systems were diverse, ranging from shopping at the local farmer's market (31%), buying from an on-farm site (18%), ordering online (14%), and joining Community Supported Agriculture (11%). For educational information delivery to producers, in-person meetings were reduced drastically (down by 34%) while factsheets, online courses, and telephone/email increased by 9 to 15% following the outbreak of COVID-19. Interestingly, the farmers and ranchers prefer email/telephone calls (39%) and online courses (25%) during and after the pandemic, with 28% wanting to return to in-person meetings. Finally, an increase in food safety and communicable disease prevention practices have been reported after the COVID-19 outbreak. Respondents reported an increase in produce washing (31%), produce packaging (34%), using recommended gloves (12%), social distancing (44%), and cleaning contact surfaces (12%). Remarkably, frequent handwashing with soap declined (-14%), which could be a result of the increased use of recommended gloves.

## Introduction

The unprecedented outbreak of the novel COVID-19 pandemic has stalled or critically stifled most of the world's economies. The United States (US) reported a 9.8% drop in gross domestic product by the end of June. The devastating impact of the pandemic can be readily recognized by surveillance data, but these numbers fail to recognize the complexities, barriers and constraints placed on the US agricultural system, especially at the local and state levels. Farmers and ranchers that supply the nation with food and fiber may be disproportionately impacted. The intent of this survey was to understand the effects of COVID-19 on Arizona's agricultural production operations and how farmers and ranchers responded to the crisis. This data will inform policymakers, industry, researchers, extension agents, and consumers on how to support local farmers and ranchers for a continual distribution of agricultural products and services without disruptions.

## Materials and Methods

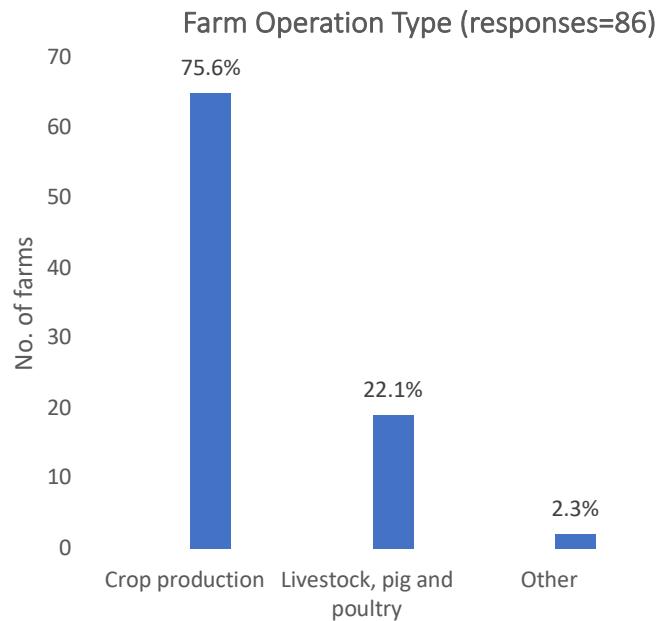
### Survey Data Collection

This survey was conducted using Qualtrics, an online platform. The survey questions were approved by the Institutional Review Board (IRB) prior to distribution and are listed in the Appendix of this report. A link to the survey was sent out to farmers and ranchers through the University of Arizona listservs, posted in newsletters, and farmer social media platforms. The survey was open for responses from April 1st, 2020, to July 1st, 2020 with seventy-seven farmers and ranchers participating in the survey. This is a very low number of responses when compared to the total number of farmers and ranchers in the state (approximately 19,000)

### Demographics of Farmers:

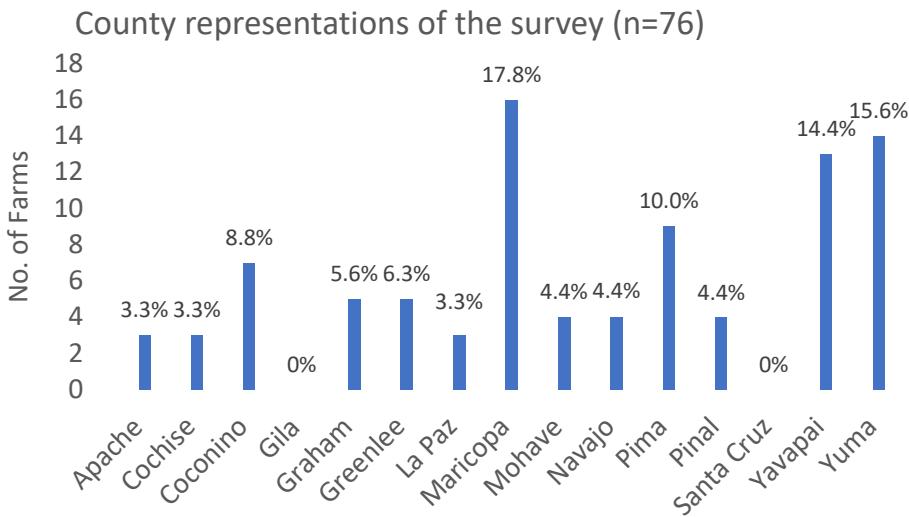
This includes types of operations, counties, age, farm size, ethnicity, and veterans.

*Farm operation type:* The total number of responses received varied by the type of operation and some farms engaged in more than one type of operation. Concerning the main type of farm operation, 76% were primarily crop producers, 22% livestock, and 2% were from other sectors such as education and sales (Fig. 1).



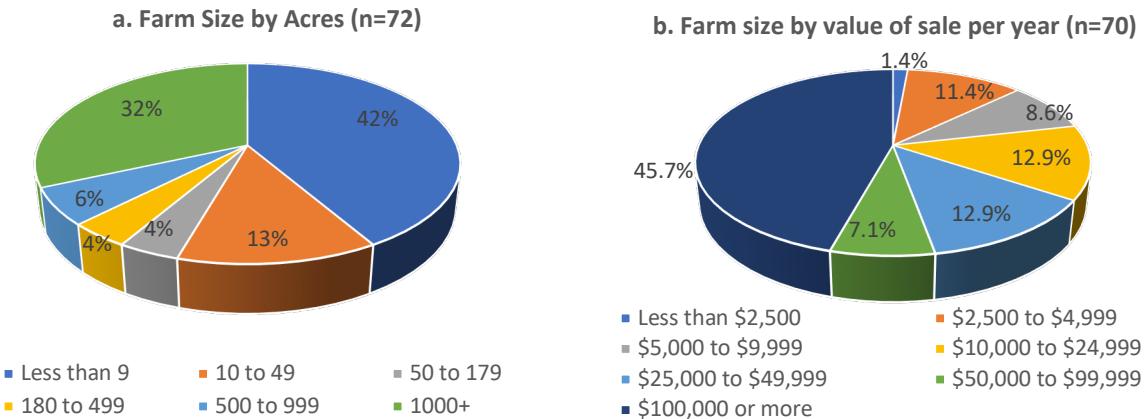
**Figure 1:** Type of farm operation

*Respondents based on county of operation:* Of Arizona's 15 counties, the majority (58%) of respondents operate in Maricopa (18%), Yavapai (14%), Yuma (16%), or Pima (10%) counties. The remaining counties made up 41% of the respondents, with each county making up 8% or less individually. There were no respondents from either Gila or Santa Cruz counties (Fig. 2).



**Figure 2:** Number of respondents based on the county of operation

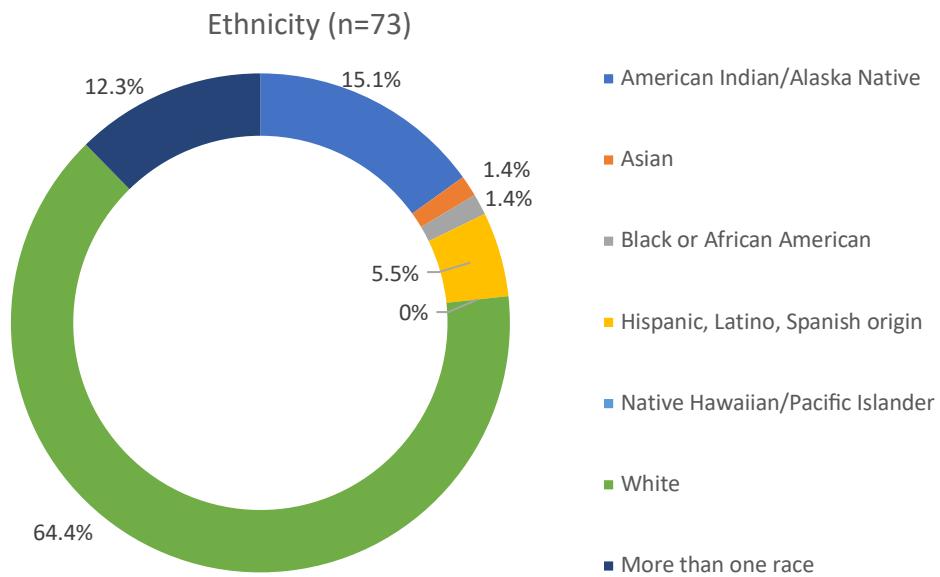
*Respondents based on farm size by acreage and value of sales:* Based on acreage size of the farm or ranch operation, most of the respondents are from operations with less than 9 acres (42%) or with more than 1,000 acres (32%) (Fig 3a) and make up about 67% of farmers and ranchers population in Arizona (USDA, 2018). Farm sizes between 10 and 1,000 acres had representation ranging from 4% to 13% (Fig. 3a). Based on sales per year, farmers who earned more than \$100,000 were the majority (46%) followed by farms with sales ranging from \$10,000 to \$49,900 (26%, Fig. 3b). Farm size by sales (Fig. 3b) looks somewhat similar to farm size by acres (Fig. 3a). In terms of farm size by acres, the survey has a similar trend to the United States Department of Agriculture census data for 2017, with most of the farms being small-scale (Figure 3a). In Arizona, about 50% of farms operate on 1 to 9 acres (USDA, 2018).



**Figure 3:** Representation of survey responses using farm size by acreage and value of sales

*Respondents based on ethnicity:* White farmers comprised the majority of respondents (64.4%) followed by Native Americans (15.1%), those with more than one ethnicity (12.3%), Asian (1.4%), Black (1.4%), and Hispanic, Latino, and Spanish (5.5%). There was no representation from Native Hawaiian and Pacific Islanders (see Fig. 4). The ethnicity data trend in this survey differs from the

2017 USDA agriculture census data, where native Americans are 60%, 38% white, and 2% for the other ethnicities (USDA, 2018).



**Figure 4:** Ethnicity of survey respondents

*Age and other characteristics of the survey respondents:* From this survey data, most of the respondents were within the 35 to 64 age range (62.7%), followed by above 64 years of age (24.0%), and those less than 35 years (13.3%) (Table 1), which is similar to the USDA census data report (USDA, 2018). New farmers and ranchers in this study made up 25.3% of respondents, while veterans made up 9.3% (Table 1).

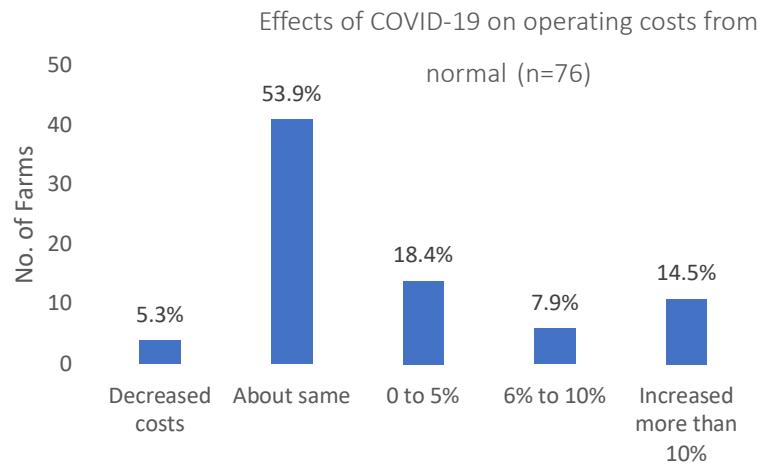
**Table 1:** Age and other characteristics of the survey respondents

Age (n=75)	No. of farmers	Percentages
Less than 35	10	13.3%
35 to 64	47	62.7%
65 and older	18	24.0%
<hr/>		
Other characteristics (n=75)		
Veteran	7	9.3%
New and beginning farmers	19	25.3%
Not specified as a veteran or beginner farmer	49	65.3%

## Results

### Effects of COVID-19 on Farm Operating Costs in Arizona

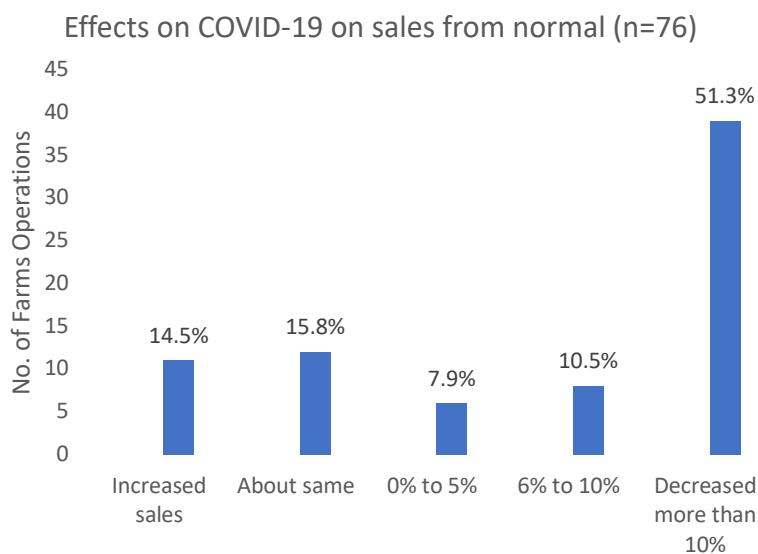
Most farmers and ranchers reported that their operating costs did not change (53.9%), 5.5% reported a decrease, 18.4% a 0 to 5% increase, 7.9% a 6 to 10% increase, and 14.5% reported more than a 10% increase (Fig. 5).



**Figure 5:** Effects of COVID-19 on farm operating costs from normal

### Effects of COVID-19 on Farm Sales in Arizona

Regarding the impact of COVID-19 on sales, 51.3% reported a 10% or greater decrease, 18.4% reported a decline between 0 and 10%, 15.8% reported no changes in sales, and only 14.5% reported an increase in sales (Fig. 6). Of all producers, 69.7% reported a decline in farm sales. These declines could be due to less products sold through retail shops, restaurants, farmer's markets, roadside stands, and food banks outlet, after the COVID-19 outbreak (Table 2).



**Figure 6:** Effects of COVID-19 on-farm sales in Arizona

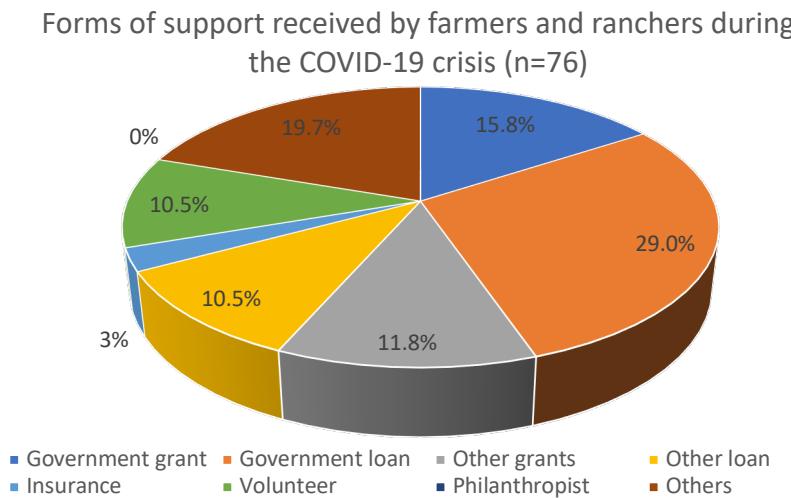
The remaining 30.3% who either had no change or an increase in their sales are those that probably sell their goods and services through outlets such as online, community supported agriculture (CSA), on-farm sales and pick-up, and other markets that recorded an increase in their services (Table 2).

**Table 2:** Changes in farm sales to outlets before (responses=131) and after (responses=108) the COVID-19 pandemic outbreak (n=77 with multiple choice options). The numbers beside the percentages are the absolute number of responses for each marketing outlet, and the change (% change= ((After – Before)/n) x 100)

Producer Marketing Outlet	Before % (responses)	After % (responses)	% change
CSA	7.8% (6)	14.3% (11)	6.5%
Farmer's market	40.3% (31)	18.2% (14)	-22.1%
Food bank	6.5% (5)	2.6% (2)	-3.9%
Roadside stand	6.5% (5)	5.2% (4)	-1.3%
On-farm sales and pick-ups	26.0% (20)	28.6% (22)	2.6%
Restaurants	19.5% (15)	3.9% (3)	-15.6%
Wholesale to broker or retail outlet	37.7% (29)	31.2% (24)	-6.5%
Online	6.5% (5)	7.8% (6)	1.3%
Other	19.5% (15)	28.6% (22)	9.1%

#### Forms of Support Received by Farmers and Ranchers and the Need for More Information on Programs:

Sources of support received by farmers and ranchers were in the form of government loans (29.0%), government grants (15.8%), other grants (11.8%), other loans (10.5%), volunteer assistance (10.5%), and insurance at (3.0%). Other sources of financial support included unemployment benefits, industry support, or no support at all and applied to 19.7% of our respondents (Fig. 7).



**Figure 7:** Forms of program support received by farmers and rancher.

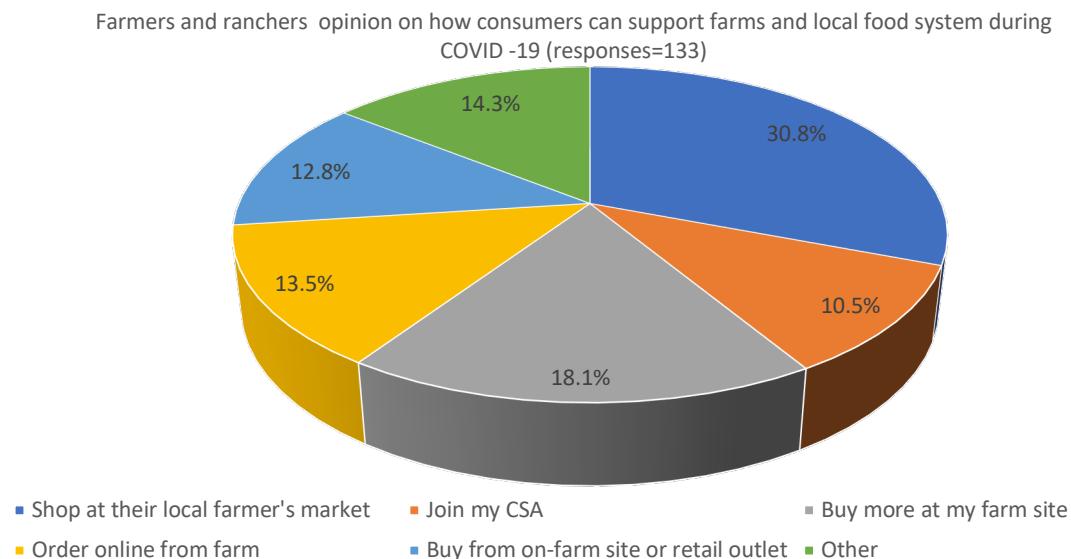
With regard to receiving educational information on different subjects, respondents ranked the COVID-19 Small Business Relief Program relatively high (39% rated as very important), followed by USDA insurance programs (29%), and USDA loan programs (28%) (Table 3).

**Table 3:** Farmers and ranchers ranking of programs in terms of a need for more information to understand the program benefits (Rate from 1 to 5; 1 = very important and 5 = not important).

	Ranking				
	1	2	3	4	5
Captive insurance (n=52)	21%	10%	23%	13%	33%
USDA insurance program (n=51)	29%	10%	16%	10%	35%
USDA loan programs (n=50)	28%	12%	22%	12%	26%
Labor programs (n=57)	18%	21%	21%	16%	25%
Connecting products left in the field to food bank (n=53)	21%	23%	15%	9%	32%
COVID-19 small business programs available (n=59)	39%	14%	22%	5%	20%
Other (n=9)	33%	22%	11%	0%	33%

### Farmers and Ranchers Opinion on How Consumers Could Support Farms and Local Food Systems:

Farmers and ranchers expressed diverse opinions on the kind of support they need from customers was diverse. The majority reported they would like their customers to shop at their local farmer's market (30.8%), buy from their farm site (18.1%), order online (13.5%), join their CSA (10.5%), or buy from an on-farm or retail outlet (12.8%) (Fig. 8).



**Figure 8:** Farmer's opinion on how consumers could support farms and local food systems during and after the COVID-19 pandemic.

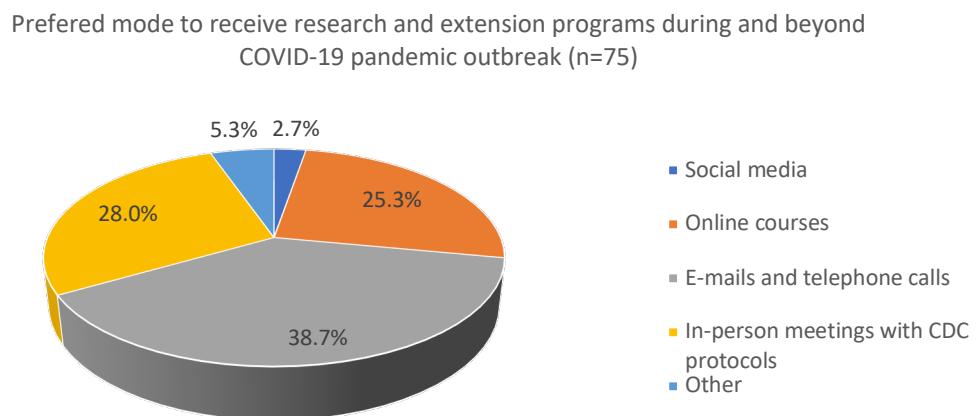
## Effects of COVID-19 on farmers source of education and extension programs:

Before the COVID-19 pandemic outbreak, farmers received more of their education, research, consultation, and extension information through in-person meetings than any other means; this was reduced drastically after the outbreak. Sources of information for farmers and ranchers that increased dramatically after the outbreak included factsheets, online courses, and telephone and emails (Table 4).

**Table 4:** Effects of COVID-19 on farmers and ranchers' sources of research, education, and extension programs (% change=  $((\text{After} - \text{Before})/n) \times 100$ ). Respondent only chose one primary source for both before and after (n=76). The numbers by the percentages are the absolute number of responses for each method of delivery for education

Delivery Method for Education	Before (n=75)	After (n=76)	% change
	% (responses)	% (responses)	
Online courses	14.5% (11)	28.9% (22)	14.4%
In-person contact	42.1% (32)	7.9% (6)	-34.2%
Telephone calls and emails	9.2% (7)	18.4% (14)	9.2%
Social media	5.3% (4)	5.3% (4)	0%
Fact sheet/publication	13.2% (10)	25% (19)	11.8%
Other	14.5% (11)	14.5% (11)	0%

Interestingly, 39% and 25% of the farmers and ranchers prefer emails and telephone calls, and online courses during and after the pandemic, respectively. In comparison, 28% want to return to in-person meetings with CDC protocols (Fig. 9). The preference and increase in the use of emails and telephone calls could be related to only online survey solicitation. Only farmers and ranchers with email access participated in the survey, which must be noted when drawing conclusions for this study.



**Figure 9:** Farmers and ranchers preferred mode to receive education, research, extension, and consultation programs during and after the COVID-19.

## Food Safety Practices by Farmers and Ranchers Before and After the COVID-19 Outbreak in Arizona:

Our results suggest that farmers and ranchers in Arizona took food safety practices seriously even before the COVID-19 outbreak. However, increases in many food safety practices were reported after the COVID-19 outbreak. Increases were reported for produce washing (31%), produce packaging (34%), using recommended hand gloves (12%), social distancing (44%), and cleaning contact surfaces (12%). Frequent handwashing with soap declined by 14%, which may be explained by the increased use of recommended gloves (Table. 5).

**Table 5:** Food safety practices by farmers and ranchers before (response=121) and after (responses=309) the COVID-19 outbreak in Arizona (% change=  $((\text{After} - \text{Before})/n) \times 100$ ). The number of total individual respondents for this question were. The numbers in parentheses are the absolute counts for each food safety practice.

Food Safety Practice	Before	After	% Change
Produce washing	54.5% (42)	85.7% (66)	31.2%
Frequent handwashing with soap	68.8% (53)	54.5% (42)	-14.3%
Produce packaging	38.9% (30)	72.7% (56)	33.8%
Using recommended gloves	35.1% (27)	46.8% (36)	11.7%
Social distancing (6 feet apart)	11.7% (9)	55.8% (43)	44.2%
Cleaning and disinfecting food contact surfaces	57.1% (44)	68.8% (53)	11.7%
Other	9.1% (7)	116.9% (3)	7.8%

## Conclusions

This study provides information on the effects of COVID-19 on-farm operations in Arizona. While operating costs remained steady, sales of farm produce and products declined in most cases. Though some farmers and ranchers benefited from government loans and grants, a good number reported that they would need more information on government support programs they could benefit from. Also, extension programs noted a shift from in-person to online delivery with farmers and ranchers giving preference to emails and telephone calls after COVID-19. Food safety practices increased after the COVID-19 outbreak. Farmers and ranchers indicated consumers could support their agricultural activities by buying local goods and produce, including purchasing through CSA's or farm pick-up.

Unfortunately, the survey was not able to capture the views of farmers and ranchers who had no online access due to COVID-19 restrictions, which limited in-person meeting at the time of the survey. Compared to the number of farmers and ranchers in the state (about 19,000), seventy-seven responses represent only 0.4% of the population. However, our sample population does align with Agricultural Census data and it represents a broad sample of producers across the State. While it would be very interesting to contrast the results of respondents with no online access to the results presented here with more responses, the results presented here remain relevant to extension agents, policymakers, and private institutions interested in farming activities in the State and could guide decision making during this pandemic.

## References

1. USDA (2018). 2017 census of agriculture  
[https://www.nass.usda.gov/Publications/AgCensus/2017/Full\\_Report/Volume\\_1,\\_Chapter\\_1\\_State\\_Level/Arizona/](https://www.nass.usda.gov/Publications/AgCensus/2017/Full_Report/Volume_1,_Chapter_1_State_Level/Arizona/) (accessed in December 2020)

## Appendix: Questions used for the survey

Q1 What primary effects did COVID-19 have on your farm operations? (Please check only one)

- Limited operations due to inadequate workers
- Unable to sell products as usual with limited buyers
- Lower market prices than before COVID-19
- Not able to plan for the season
- Not able to obtain all inputs
- Higher input costs
- Other? Please list \_\_\_\_\_

(The list provided in the survey are: access due to curfews, Higher demand for seed and agriculture related information, PFM closed, Increased demand for local products, limited ability to market juice fruit as the plant closed, and I direct market lamb. Initially, there were fewer opportunities to send my lambs to slaughter, but that has subsided. I am seeing increased sales because of fear of shortages)

Q2 Looking forward from today, what is the number one concern for your farm regarding COVID-19? (Please check only one)

- Access to markets
- Financial devastation
- Health and safety of workers, family, and self
- Already implemented changes in response to COVID-19 and have no concerns

Q3 How much did COVID-19 change or reduce your sales from normal? (Please check only one)

- Increased sales
- About same
- 0% to 5%
- 6% to 10%
- Decreased more than 10%

Q4 How much did COVID-19 change or increase your costs of operation? (Please check only one)

- Decreased costs
- About same
- 0 to 5%
- 6% to 10%
- Increased more than 10%

Q5 What primary venue(s) did you sell your farm products *before* the COVID-19 outbreak? (Please check all that apply)

- CSA
- Farmer's market

- Food bank
- Roadside stand
- On-farm sales and pick-ups
- Restaurants
- Wholesale to broker or retail outlet
- Online

Other? Please list \_\_\_\_\_

(List of others provided in the survey responses: Auction, Festivals, Wine Festivals, you pick, Alfalfa, Cotton broker, cattle Auctions, Wine & Food Festivals, Livestock Auction, forward contract, Other non-profits in our town, Cooperative, Processor)

Q6 What primary venue(s) did you sell your farm products *during* the COVID-19 outbreak? (Please check all that apply)

- CSA
- Farmer's market
- Food bank
- Roadside stand
- On-farm sales and pick-ups
- Restaurants
- Wholesale to broker or retail outlet

Online

Other? Please list \_\_\_\_\_

(List of others provided in the survey responses: word of mouth, closed, auction, relief efforts, deliver by hand, too hot to ship, bars are closed, DTC, you pick, cotton broker, home deliveries, livestock auction, no CSA, no sales, non-profits In our town, no sales, none shut down, co-op, the market was disrupted because of safety concerns but sales continued, and processor)

Q7 What can consumers do to better support farms and local food systems during COVID-19? (Please check all that apply)

Shop at their local farmer's market and follow social distancing rules

Join my CSA

Buy more at my farm site

Order from farm online

Buy my products from an on-farm site retail outlet

Other? Please list \_\_\_\_\_

(List of others provided in the survey responses: buy US beef, order your beef directly from a rancher, open business, buy locally grown/made, buy farmer grown products not made synthetics, NA, live their life to the fullest, support ag in any way, buy American produced, grocery store, just buy as usual in store, buy local, buy fresh produce, buy local, buy from local home delivery service, buy product produced and processed in the United States, contact their congressmen and women about smaller and more small to medium scale processing facilities, more direct farm to consumer chains that diversify away from huge warehouses, buy fruits and veggies anywhere, and continue to buy produce in grocery stores)

Q8 Where did you **primarily** obtain research information, Cooperative Extension educational programs, and consultation *before* the COVID-19 outbreak? (Please check only one)

Online courses

In-person contact (farm visits and workshops)

- Telephone calls and emails
- Social media
- Other? Please list \_\_\_\_\_

(List of others provided in the survey responses: come from a farm family, that plus 60 years of “book learning”, FSA, online resources, research on web, the UA cooperative extension are largely cowering at home and of no help, internet websites, myself, Yavapai College, online, books, and in person training provided by industry or industry support groups)

Q9 Where do you **primarily** find research information, Cooperative Extension educational programs, and consultation *after* the COVID-19 outbreak? (Please check only one)

- Online courses
- In-person contact (farm visits and workshops)
- Telephone calls and emails
- Social media
- Other? Please list \_\_\_\_\_

(List of others provided in the survey responses: online resources, farm bureau, web, the UA cooperative extension are largely cowering at home and of no help, internet websites, myself, from vendors/suppliers & industry resources, online, print and online newspapers, U of A, and books)

Q10 What is your preferred method to receive research and extension programs by the University of Arizona Cooperative Extension? (Please check only one)

- Social media
- Online courses
- Emails and telephone calls
- In-person meetings that respect social distancing protocols
- Other? Please list \_\_\_\_\_

(List of others provided in the survey responses: in person AFTER covid, currently email/phone, but in-person meetings much preferred pending the nature of exposure & the pandemic's course, interactive webinars and regionally located in-person w/ social distancing, webinars, and zoom)

Q11 What food safety measures did you practice *before* the COVID-19 outbreak? (Please check only what you practiced)

- Produce washing
- Frequent handwashing with soap
- Produce packaging
- Using recommended gloves
- Social distancing (6 feet apart)
- Cleaning and disinfecting food contact surfaces
- Other? Please list \_\_\_\_\_
- Other? Please list \_\_\_\_\_

(List of others provided in the survey responses: way more than any choices here - cleaning->sanitation is 80%+ of what we do (farm winery), gloves in fields and packing, thorough sanitation, clean harvesting tools, gap, water sampling, the packages of meat are only touched by my sister and myself, and the customer points to the one they want).

Q12 What safety measure so you now follow *after* the COVID-19 outbreak? (Please check only what you practice)

- Frequent handwashing with soap
- Produce washing

- Social distancing (6 feet apart)
- Produce packaging
- Disinfecting surfaces touched by produce
- Using recommended gloves
- Cleaning and disinfecting food contact surfaces
- Other? Please list \_\_\_\_\_

(List of others provided in the survey responses: don't work when you are sick, way more than any choices here - cleaning->sanitation is 80+% of what we, do (farm winery), hand sanitizer, masks @ markets & home delivery, thorough sanitation = no change, masks, cleaning tool. Less contact. Packaging produce away from donated foods and areas where more people are working, gap, water sampling, mask use and we are the only people who touch the packages of meat)

Q13 What main category below describes your farm operation? (Please check all that apply)

- Crops production
- Livestock, pig and poultry
- Other? Please list \_\_\_\_\_

(List of others provided in the survey responses: eggs, native milkweeds, wine grapes, farm winery, fruit/you pick, alfalfa grower, farm winery, orchard, education program for elementary students, citrus, hydroponic microgreens, and writer about agriculture)

Q14 County of operation (Please check all that apply)

- Apache
- Cochise
- Coconino
- Gila
- Graham
- Greenlee
- La Paz
- Maricopa
- Mohave
- Navajo
- Pima
- Pinal
- Santa Cruz
- Yavapai
- Yuma

Q15 What is your farm size (acres)?

- 1 to 9
- 10 to 49
- 50 to 179
- 180 to 499
- 500 to 999
- 1000+

Q16 Farm size by value of sales per year

- Less than \$2,500
- \$2,500 to \$4,999
- \$5,000 to \$9,999
- \$10,000 to \$24,999
- \$25,000 to \$49,999
- \$50,000 to \$99,999
- \$100,000 or more

Q17 Did you receive or do you expect any form of support to enhance your operation during this crisis? If so, who provided the support? (Please check all that apply)

- Government grant
- Government loan
- Other grants

- Other loan
- Insurance
- Volunteer
- Philanthropist
- Other? Please list \_\_\_\_\_

(List of others provided in the survey responses: FSA, small grant by non-profit, SBA EIDL loan -> applied 1st day - still waiting, none, USDA, nothing, Increased CSA, unemployment Insurance benefits, self-employed, unemployment, industry organizations, none, and maybe direct payments)

Q18 Please rate what areas, if any, you need the most help in terms of understanding (Rate from 1 to 5; 1 = very important and 5 = not important)

	1	2	3	4	5
Captive insurance	<input type="radio"/>				
USDA insurance program	<input type="radio"/>				
USDA loan programs	<input type="radio"/>				
Labor programs	<input type="radio"/>				
Connecting products left in the field to food banks	<input type="radio"/>				
COVID-19 small business programs available for farms	<input type="radio"/>				
Other?	<input type="radio"/>				

(List of others provided in the survey responses:

**Please complete the demographics below**

Q19 Ethnicity:

- American Indian/Alaska Native
- Asian
- Black or African American
- Hispanic, Latino, Spanish origin
- Native Hawaiian/Pacific Islander
- White
- More than one race

Q20 Gender:

- Female
- Male

Q21 Age:

- Less than 35
- 35 to 64
- 65 and older

Q22 Other characteristics:

- With military service
- New and beginning farmers



THE UNIVERSITY OF ARIZONA

**Cooperative Extension**

**THE UNIVERSITY OF ARIZONA**

**COLLEGE OF AGRICULTURE AND LIFE SCIENCES**

**TUCSON, ARIZONA 85721**

**AUTHOR**

**ISAAC K. MPANGA**

*Associate Area Agent Commercial Horticulture and Small  
Acreage Yavapai and Coconino Counties*

**RUSSELL TRONSTAD**

*Specialist, Agriculture-Resource Economics*

**JEFF SCHALAU**

*Yavapai County Director*

**URSULA K. SCHUCH**

*Professor and Specialist, Environmental Horticulture*

**HOPE WILSON**

*Associate Agent - Family, Consumer and Health Sciences*

**CHRISTY STUTH**

*Area Associate Agent, Family, Consumer and Health Sciences*

**HATTIE BRAUN**

*Director, County Extension*

**CONTACT**

**ISAAC K. MPANGA**

**[mpangai@arizona.edu](mailto:mpangai@arizona.edu)**

This information has been reviewed by University faculty.  
**[extension.arizona.edu/pubs/az1867-2021.pdf](http://extension.arizona.edu/pubs/az1867-2021.pdf)**

Other titles from Arizona Cooperative Extension can be found at:  
**[extension.arizona.edu/pubs](http://extension.arizona.edu/pubs)**

Any products, services or organizations that are mentioned, shown or indirectly implied in this publication do not imply endorsement by The University of Arizona.

Issued in furtherance of Cooperative Extension work, acts of May 8 and June 30, 1914, in cooperation with the U.S. Department of Agriculture, Jeffrey C. Silvertooth, Associate Dean & Director, Extension & Economic Development, Division of Agriculture, Life and Veterinary Sciences, and Cooperative Extension, The University of Arizona.

The University of Arizona is an equal opportunity, affirmative action institution. The University does not discriminate on the basis of race, color, religion, sex, national origin, age, disability, veteran status, sexual orientation, gender identity, or genetic information in its programs and activities.