Swette Center for Sustainable Food Systems
Arizona State University

Harnessing the Power of Digitalization to Advance Local and Regional Agriculture

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Swette Center for Sustainable Food Systems, Arizona State University
September 2021

This publication is a Capstone Report by the Graduate Certificate in Food Policy and Sustainability Leadership class of 2020-2021 and MS in Sustainable Food Systems class of 2021. This report was partially funded by TMG Think Tank for Sustainability.

Suggested Citation:
Swette Center for Sustainable Food Systems. *Harnessing the Power of Digitalization to Advance Local and Regional Agriculture*. September, 2021. (Swette Center, 2021)

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Table of Contents

Executive Summary

With the increasing presence of digital tools in the food production and distribution system of the United States, it is important to understand the various pitfalls and advantages that food system stakeholders have encountered regarding these technologies. In the wake of COVID-19, climate change, and technological development, many models of agriculture and processing have been disrupted, thus requiring both the producers and consumers to reconfigure their interactions with the food system. Analyses were conducted under four different “topics” that ASU researchers examined within the changes of digitalization and regional agriculture: (1) the digital divide, (2) urban food systems, (3) data for ecosystem services, and (4) impacts of COVID-19. The main methodology for all research questions involved literature reviews, interviews with food system stakeholders, data analysis, and reflection.

The case studies presented here highlight the challenges and opportunities of digitalization in regional food systems. The digital divide (Topic 1), has become exacerbated by the irregular and inequitable accessibility of broadband for rural food producers and communities, creating a need for more broadband resources and expertise. For urban food systems (Topic 2), the future of urban planning and geospatial technology will involve a greater need for quantitative skills as well as community involvement in order to address the increasing need for urban agriculture and tools to fight food insecurity within urban environments. The usage of online data tools (Topic 3) has the power to simplify data management processes, and can open access to new markets and more education/training opportunities. However it can also make it difficult to determine ownership rights. These data tools can also help to manage natural resources, such as marine fisheries, in a more sustainable way. The impacts of the COVID-19 pandemic (Topic 4), have drastically shifted business models and practices by farmers and food distribution methods through online community and consumer interactions. The implications of relying on online resources are still unknown, and the need for further research across all areas will need to be addressed as we head into the future of agriculture.

Introduction

Food systems in the U.S. are fluid and constantly changing structures. The food system of today is far different from the system that existed before the widespread adoption of the internet. The USDA reports that 70% of US farms have at least minimal internet access either through broadband or cellular service (USDA, 2021). This has impacted what was once a more or less linear path from farm to plate that is now a complex system where producers are reaching consumers in numerous new ways. Because of the increased connectivity of both producers and consumers, technology will have an increasing role in agriculture (King, 2017). Digitalization of food systems can lead to increased market access for farmers, additional efficiency along the supply chain, further traceability of food sources, and the strengthening of rural financial markets (Schroeder, 2021). However, all of these improvements operate under the expectations that data is collected smoothly from farms, farmers have equal access to broadband, farms can use geospatial and other digital tools available, and farms can bounce back from COVID-19. Currently, these expectations are not being fully met, thus creating challenges within the efforts towards equitable digitalization of food.

This report is in partnership with TMG, Think Tank for Sustainability. This paper investigates the big question, “How does the digitalization of agriculture and agrifood systems affect local and regional food systems?” This is done through the culmination of seven interrelated research projects looking into different challenges and opportunities in digitalization across the food system in the United States.

This paper acts as a snapshot of some of the happenings in the food system in 2021. To create this picture of the food system, eight Arizona State University graduate students investigated four areas of the food system: (1) the digital divide, (2) urban food systems, (3) data for ecosystems services, and (4) COVID-19’s impact on the digitalization of food. These questions were answered through data collection and interviews, resulting in the following case studies and analyses.

This research presents insight into data management, new ways of selling, marketing and communicating, equity in access to digital tools, and COVID-19’s impact on the digitalization of agriculture. The food system is an ever-changing environment and this research answers questions about this moment in time and provides a roadmap of additional questions for researchers in the future. Because of the changing nature of this field of inquiry, research should be done frequently to gauge changes, innovations, and challenges as they occur.

Table 1: Table outlining the research questions in the four topic areas asked in this project.

Topic Areas	Research Questions
1. Digital Divide	*1.A How does lack of reliable broadband internet access impact farmers' viability and participation in e-commerce?*
	1.B How does the lack of reliable broadband internet access affect the success of small farms in the Southeast?
2. Urban Food Systems	*2.A What are the most useful geospatial tools for influencing food system resilience in Phoenix?*
3. Data for Ecosystem Services	*3.A How can local fisheries use fish tracking to promote more sustainable fishing practices?*
	3.B What hurdles to sharing on-farm data with consumers currently exist, and what factors would encourage farmers/ build trust in sharing their farm-level data?
4. COVID-19's Impact on the Digitalization of Food	*4.A What new digital tools did local and regional farmers in Colorado begin to use for the first time due to the COVID-19 pandemic, and will they continue use of them beyond the pandemic?*
	4.B How have direct to consumer Facebook Groups in Minnesota and Wisconsin changed the agriculture market for producers and consumers?

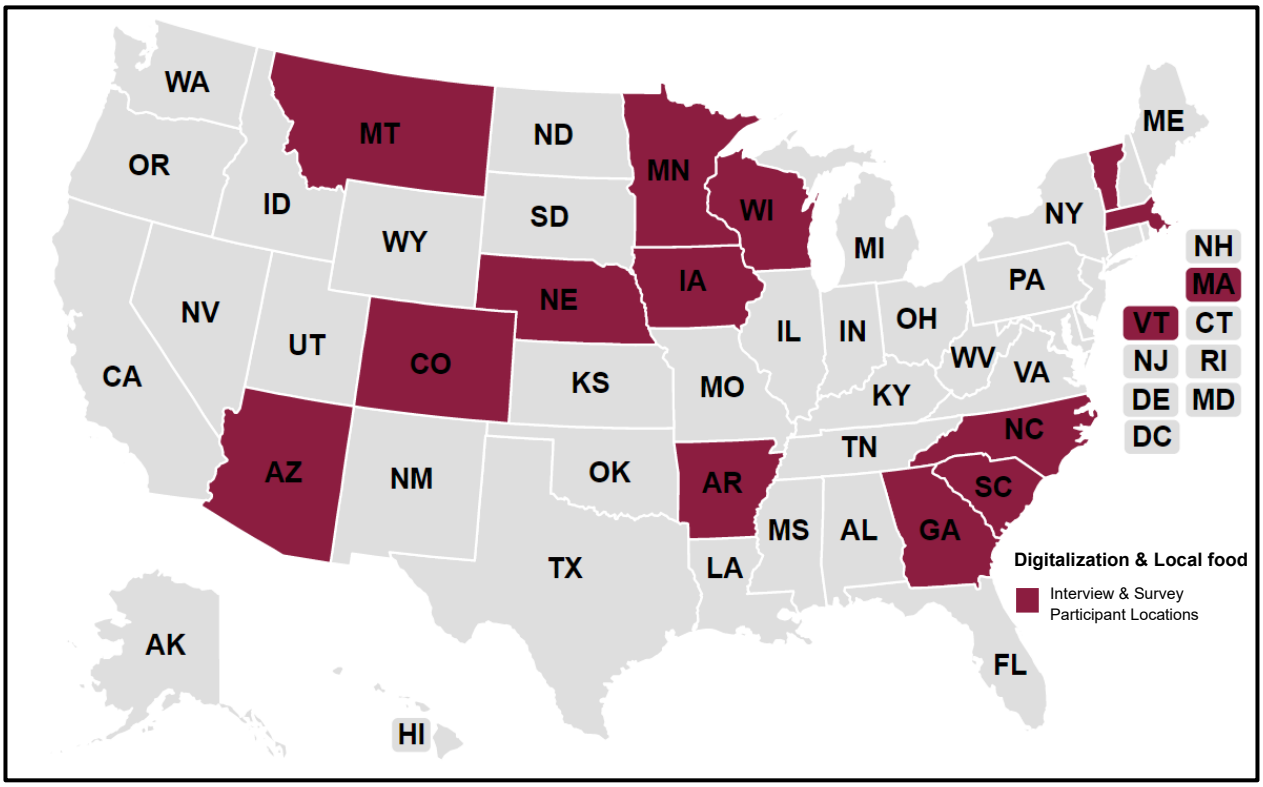

Figure 1: Map of the United States indicating states where research was conducted.

Topic 1: The Digital Divide

Case 1.A: How lack of reliable broadband internet access impacts farmers' viability and participation in e-commerce

Summary

The “digital divide” - those who have computer and internet access and those who do not - has been well documented for several decades, however the literature surrounding its connection to local and regional agriculture within the United States (US) is limited. Governments often endorse broadband for all, particularly for businesses, with the goal of establishing high-speed internet access to remain competitive in today's global market. A common belief is that technology has the potential to improve economic development in rural areas. Increased internet speeds can lead to increased business productivity and can improve sales and even foster job creation and retention in rural communities. However, many rural areas still lack the technological infrastructure to support the current volume of data transfer and do not have the economy of scale to independently support broadband markets (Galloway, 2007).

During the COVID-19 pandemic, markets, restaurants, and other food distribution channels closed or reduced operations. Farms across the US began using software platforms that support direct to consumer sales. There are resources that have been developed to support farmers in choosing between the numerous product options and sales models – but how does internet access affect business development and farm viability for small to mid-sized farms? This research discusses who is being left out of the quickly growing agriculture e-commerce market.

The digital divide caused many challenges and frustrations for farmers in rural areas. They were required to adapt to online markets and e-commerce without the internet bandwidth to easily manage this change. Farmers from four states (Arizona, Nebraska, Arkansas, Vermont) were interviewed to contextualize the current landscape of rural broadband and e-commerce participation as it relates to small to mid-sized farms. Overall, lack of affordable and reliable internet access was found to have a significant impact on farmers’ ability to participate in e-commerce and farmers from all four states agreed that high-speed internet access is a must to maintain viable farming operations moving forward.

Background

Broadband and the Digital Divide

Approximately one quarter of the U.S. population does not have access to broadband internet at home. This lack of access to is commonly referred to as the 'digital divide'. Internet access within the home is particularly necessary during the COVID-19 pandemic as school, work, and social interaction depend on it. This digital inclusion is incorporated in several of the United Nations (UN) Sustainable Development Goals, as numerous countries are experiencing the digital divide, which has been exacerbated during the COVID-19 pandemic. Not only rural areas, but cities are also facing challenges closing the digital divide quickly enough to address the impacts that it could have on health, education and the economy within communities. This is particularly apparent in low-income areas, demonstrating the exclusion of marginalized groups from accessible affordable broadband internet (Reddick et al, 2020)

There are several types of technologies that can be referred to as broadband including cable, fiber optic, wireless, DSL (Digital Subscriber Lines), satellite and broadband over power lines (BPL). The Federal Communications Commission (FCC) is the agency that sets standards and defines broadband. The current FCC definition of broadband is a connection with download speeds of 25 megabits per second (Mbps) and upload speeds of 3 Mbps (Bauerly et al, 2019). Mergers of several large-scale internet providers over the years means that only a small handful of firms hold the vast control of the market (Oyana, 2011). There are also often tensions around adoption of broadband in rural communities. Sometimes even when access is available, adoption from the community has lagged behind adoption in urban areas (LaRose et al, 2007).

Internet access helps to shrink geographic isolation within rural communities. Many argue that it is as important as other common goods and utilities, such as roadways, sewer and water. Some believe that it is the keystone of the new economy; with employment in the agriculture sector shrinking, internet is critical to maintaining the rural population (Hambly & Rajabiun, 2021) While a significant factor, others pointed out that broadband is certainly necessary, however it is not the singular answer to rural development (Pant & Odame, 2016).

The digital divide remains a challenge in Tribal communities, with a significant proportion of Native Americans lacking access to affordable and reliable telecommunications services. The FCC's Office of Native Affairs and Policy states that approximately 1.4 million Americans living on Tribal Lands are impacted by the digital divide (Bauerly et al, 2019). No more than 10% and possibly as little as 5% of people on

reservations have access to reliable broadband. This is further complicated by the fact that as recent as the year 2000, approximately 14% of people on reservations did not have electricity. This number was as high as 40% on some reservations. (Kemper, 2013).

Recent literature argues that broadband internet access should be recognized as a social determinant of health. Reduced broadband, especially during the COVID-19 pandemic, exacerbated existing health disparities in the U.S., particularly with already vulnerable populations, including elderly, racial and ethnic minorities, poor, and rural communities. Lack of broadband limits access to healthcare, job opportunities and unemployment benefits. Food pantries and soup kitchens are updating their inventory online, making it difficult for food insecure people who lack internet to access food when they need it most. There are recommendations for modeling programs like the Broadband Technology Opportunities Program, which estimates a fivefold return on investment into the local economy with support for broadband. Similar programs should be incorporated into recovery legislation, but would need ample funding to be successful (Benda et al, 2020).

The call for more reliable broadband has resulted in a number of initiatives that are directing investment into regional and rural broadband networks, which often are owned by private companies. There continues to be a lack of appropriate data, particularly focused on creating successful strategies for managing public investment (Hambly & Rajabiun, 2021). One tool that could help alleviate this gap in data is a recent release from the Commerce Department's National Telecommunications and Information Administration (NTIA) that uses aggregated data to highlight the current landscape of broadband access across all of the US (Figure 1; Federal Communications Commission 2020).

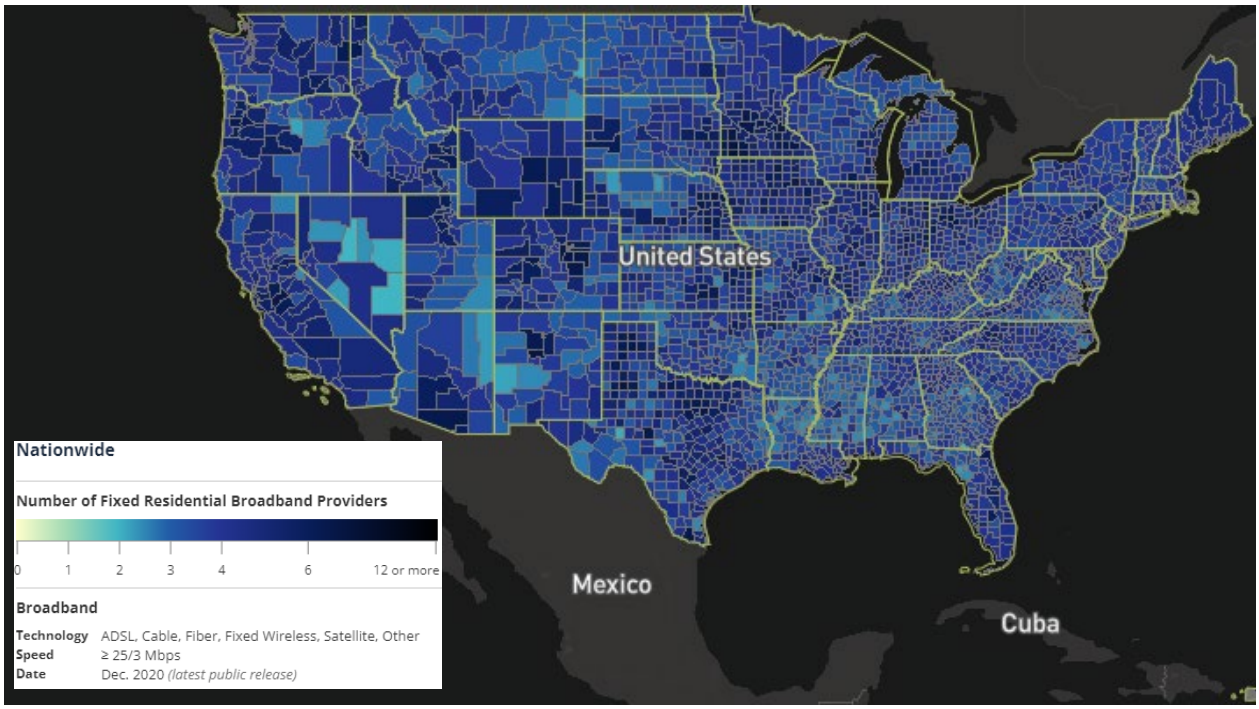

Figure 1.A.1: Digital map shows the number of broadband providers, by county. However, interviews with farmers reflect that presence of broadband providers does not always mean that broadband speeds are available. (Federal Communications Commission 2020)

How Farmers and Producers Utilize Broadband

There is significant push for rural connectivity with the increase in data-based precision agriculture and natural resource management in rural areas (Hambly & Rajabiun, 2021). As it currently exists, precision agriculture technology is mostly focused towards large-scale farms that are equipped with advanced equipment and agricultural companies that supply those tools (Kosior, 2018). However, the focus of this research is primarily geared towards small to mid-sized farming operations.

Because the level of data transmission requirements within agriculture has increased so drastically, access to high-speed internet has become significantly more important because dial-up services simply cannot handle the increased data transfer. Broadband can provide farmers with better price comparison, marketing, weather reports, information for general management, access to new markets and increased sales. Additionally, today most farm management tools and resources such as Cooperative Extension and United State Department of Agriculture (USDA) services are mainly accessed online (Jeffcoat et al, 2012).

Internet and technology are also key to facilitating communication across the agriculture sector. Farmer to farmer networks allow for accessible knowledge-sharing, problem-solving and innovation using social media or other platforms such as YouTube. These digital networks are integral to farmers, particularly those who aim to farm sustainably. These networks allow for farmers who would otherwise be unlikely to meet in person to engage in dialogue and learning (Burbi & Hartless Rose, 2016). Technologies such as mobile apps and e-commerce platforms are not only changing farmers' experience, but consumer experience as well. Streams of farm data and digital technology and tools do offer promising new ways for farms to increase productivity, profitability and sustainability (Kosior, 2018).

E-commerce in Agriculture

E-commerce (electronic commerce) can provide benefits like support in facilitating transactions, understanding available inventory and accessing websites and platforms. This research utilized the broadest definition from Soegoto & Nugraha (2020) as follows: “e- commerce includes all aspects of business processes and markets that are activated using internet technology and websites”. E-commerce within agriculture can be useful for marketing products and expanding distribution areas, which can in turn benefit producers by attracting more customers and purchases (Soegoto & Nugraha, 2020).

E-commerce can allow for accurate data around point-of-sale (POS) so that farmers can better forecast market demand and manage inventory and distribution. Benefits include convenience, market access, savings in transaction costs, market transparency, and increased productivity. Key requirements for adoption and participation of e-commerce within the food system include a critical mass of consumers connected to the internet, that agricultural producers have enhanced internet access, and support for public and private cooperation for infrastructure and funding. Compared to other sectors, little research has been conducted on e-commerce application within agriculture (Vrana, 2003).

Zeng et al. (2017) recommends that more focus should be placed on regional development models of agricultural e-commerce. There could also be a role for the government in developing regional e-commerce centers, or public information platforms and databases. This could also be established by cooperative-driven models within the agriculture sector, where the cooperative manages the buying and selling of producers' products via their own e-commerce platforms (Zeng et al, 2017).

Local and regional food systems exhibited high levels of innovation during the COVID-19 pandemic to respond to market and policy shifts. Short supply chains allowed local

markets to leverage relationships and access buyers. E-commerce platforms and online food sales saw a significant increase with 33% of US households buying groceries online in May of 2020, versus 13% the year prior. Companies such as Instacart saw an increase in order volume of 500%. Small and regional food operations also turned to e-commerce. This was made possible thanks to resources like access to reliable broadband internet, e-commerce education opportunities, and technical assistance. Data shows that 73% of farmers have access to a computer, and 75% have access to some form of internet, but pre-pandemic, only 19% used their devices for marketing activities, sales, auctions, or price tracking. During COVID-19 there was an increase in producers that were first-time e-commerce users. While e-commerce was previously limited, the increase allowed farmers to restore sales online relatively quickly and they were able to expand their inventory sold through these channels and foster new collaborations with online marketplaces (Thilmany et al. 2020).

As noted, at the start of the COVID-19 pandemic, farms across the U.S. began using software platforms that support direct to consumer sales. There are several resources that have been developed to support farmers in choosing between the numerous product options and sales models such as the Farmer's Guide to Direct Sales Software Platforms, produced by the National Young Farmers Coalition (2020). However, there is limited research on how the digital divide has impacted rural farmers' participation in e-commerce markets, or their utilization of e-commerce tools and platforms.

Policy Landscape

Federal support for broadband has been a policy priority for a number of years. In 2009 the American Recovery and Reinvestment Act (ARRA) delegated the FCC to create a national plan for improving internet access and provided $4.7 billion to the National Telecom and Information Administration (NTIA) for broadband initiatives, along with $2.5 billion to the Rural Utility Service which is housed within the United States Department of Agriculture (USDA) for installation and support. The FCC's goal was to reach 100 million homes with affordable access and speeds of 100/50 Mbps. More recently the FCC announced a $20.4 billion program in January, 2020 that would subsidize broadband infrastructure construction over the next decade. Providers such as phone, satellite, telecom companies and cooperatives are eligible to apply for funding. Groups that apply must agree to offer 25/4 Mbps minimum speed and agree to cost share provisions with a monthly customer rate not exceeding $60. Approximately thirteen state governments host some type of statewide broadband program that aims to improve internet access in underserved communities and 30 states have appropriated funding in support of broadband expansion. (Schmit & Severson 2020).

More recently, the American Rescue Plan Act of 2021, which was a $1.9 trillion economic stimulus bill passed by the 117th United States Congress and signed into law by President Joe Biden on March 11, 2021, is meant to support the U.S.'s recovery from the economic and health effects of the COVID-19 pandemic and ongoing recession. In addition to the American Rescue Plan, James Clyburn (D-SC) and Sen. Amy Klobuchar (D-MN) reintroduced the Accessible, Affordable Internet for All Act. This $94 billion proposal would expand broadband service to areas where it doesn't exist, improve speeds in places with low connectivity, and help families who are struggling to afford monthly bills. This piece of legislation is seen as the broadband portion of a much larger push for infrastructure improvements expected now that the American Rescue Plan has been enacted (Benton Institute for Broadband & Society, 2021). The USDA states the American Rescue Plan will fund broadband to schools and hospitals and other community facilities (USDA, 2021). An example of this not yet passed, is the American Jobs Plan which promises to create jobs and rebuild our country's infrastructure. One way it plans to achieve that goal is by bringing broadband to all Americans that is affordable, reliable, and high-speed, especially the 35% of rural Americans who lack access to broadband at minimally acceptable speeds (The White House, 2021). At this time, it is unclear what this type of legislation means specifically for farmers.

At the more local level, some U.S. states have laws that can create barriers to the expansion of broadband initiatives and access, while other states, such as Minnesota's innovative laws around "dig once" efforts requiring broadband to be installed in combination with other infrastructure plans have been implemented (Bauerly et al, 2019).

Innovative Broadband Models

While grant funding and initial investments are key, it is also important to consider the long-term annual operation and maintenance costs to support broadband infrastructure. Most see broadband as necessary as other utilities such as power and telephone services, for society to thrive. With internet service providers frequently being investor-owned firms, they are typically less likely to provide services to less-populated rural areas because of the lack of return on investment. Member-owner broadband cooperatives may be a possible option for long term sustainability. Cooperatives already have a proven history of success providing other utilities, such as electricity and telephone services in rural areas. While rural telecoms and electric cooperatives are already beginning to support broadband initiatives, across the country there are still many places in rural America where these types of cooperatives do not exist (Schmit & Severson 2020). One study also noted that multi-stakeholder or public-private partnerships could be possible and successful paths moving forward (Oyana, 2011).

Research Methodology

Materials and data for this analysis came from two activities - a literature review and results from a series of interviews with producers and industry experts in related fields.

The relevant literature review and interview guide that was developed[1] aimed to answer the question: How does lack of reliable broadband internet access impact farmers' viability and participation in e-commerce? The literature search was conducted through the following electronic databases: Google Scholar, ASU's research library and related websites, press releases and grey literature written by experts in the field. The search terms that were utilized included: broadband access and food; broadband access and local food; Tribal broadband access; e-commerce and agriculture; and rural broadband.

The interviews allowed for gathering in-depth perspectives on rural broadband access within local food systems and farmers access to and participation in e-commerce activities. Eight interviews were conducted with a variety of rural producers and agricultural experts from communities across the country. The goals of the interviews were to:

1. Identify what internet access and reliability looks like for rural farmers;
2. Understand producer's overall engagement and participation in e-commerce;
3. Identify how lack of reliable internet access inhibits, or creates obstacles for producers and farm viability;
4. Recognize any other key factors that may impact or influence participation in e-commerce.

The three-page interview guide[1] contained open-ended questions divided into four sections including (i) background farm information, (ii) broadband access, (iii) e-commerce, and (iv) challenges, solutions, and closing thoughts.

A total of eight interviews were conducted:

- Six interviews with a diverse group of small to midscale farmers operating in Arizona, Nebraska, Arkansas and Vermont
- One interview with a procurement and supply-chain specialist that worked with rural farmers
- One interview with staff from a public power district that was involved in developing a public-private partnership for rural broadband expansion in Nebraska.

[1]See Appendix A for the full interview guide used in the interviews

Interviewees from small to mid-sized rural farming operations were recruited via connections and recommendations from the research team, as well as email outreach support from Arizona State University (ASU) partners.

The student researcher began each interview with a brief introduction and overview of the research project, asked interviewee for confirmation to participate in the study and to record the interview. Questions were asked following the interview guide, with exceptions for relevant improvisations and modification of questions for non-producer experts, or follow-up questions for clarity. All interviews were conducted via Zoom audio (dial-in extension) and lasted from 30-60 minutes. The student researcher took notes manually and recorded the interview. Interview transcripts were compiled and qualitatively reviewed to identify key themes, commonalities and recommendations.

Study Limitations

The research methods for this study have specific limitations, both inherent to the methods themselves and related to the research objectives. Here we discuss two main limitations.

Selection and desirability bias

For interviews, the primary limitation was selection bias. People interviewed do not represent a random sample of viewpoints because they were recruited and recommended based on connections to the research team. Therefore, interviewees perspective and opinions may skew towards those of the research team and partners. Furthermore, all outreach and interviews were conducted at the height of the growing season in many places throughout the U.S., which was a limitation to interviewee recruitment during this process. Finally, because this research focused on the digital divide, there was an inherent lack of ability for the student researcher to reach producers that do not have any access to the internet, since outreach was conducted via email. This research intentionally did not place a focus on large-scale farming operations. While these farms are most likely to utilize precision agriculture which requires rural broadband, the desired focus for this study was local and regional food systems. An additional challenge when conducting interviews is desirability bias, in which an interviewee answers questions in a way that they perceive to be desirable in the eyes of the researcher. In this case, this could involve responding in a way that is not favorable to existing broadband infrastructure and e-commerce platforms. To steer away from this type of bias, the interviewer aimed to hold a position of neutrality.

Minimal Tribal representation

Another limitation to this research overall is that Native American and Tribal communities were only represented through one interview, while Tribal communities

face the digital divide at disproportionate rates compared to other populations. A separate study should be conducted that specifically focuses on the perspective and experiences of Native American communities as it relates to broadband access and local food systems.

Findings

Summary of interviews

The types of farming operations represented in the interviews are presented in Table 1.A.1.

Table 1.A.1: Overview of farms represented in interviews and broadband access status

Farm Overview	Broadband Access
Tribal-owned and operated 1-acre market-style vegetable farm with a CSA program	Yes
34-acre goat dairy/creamery and CSA vegetable operation	Yes
35-acre farm with 1.5 acres under market-style vegetable, herb and flower production	Yes
80-acre grass-fed sheep and hog operation that also offers on-farm stays, rentals and events	Yes
Multigenerational certified organic grass-based dairy farm	Yes

Farmers ranged in experience from first growing season to farmers that have been actively farming for 45 years. Most farms experienced some level of change over the years, ranging from moving locations multiple times, to adjusting the size of herds, or shifting to different varieties of crops. Most farms had a limited amount of staff and were primarily family-owned and operated. Two of the farms utilize on-farm apprenticeship or volunteer programs. Marketing and sales practices included direct to consumer sales via farmers markets, online storefronts, social media and community supported agriculture (CSA) memberships, wholesale sales to local shops and grocers, and exclusively selling through a cooperative.

All six farmers subscribed to high-speed internet services (Table 1.A.1). The types of internet services represented included wireless, satellite, cable, and DSL. Internet was purchased from several types of service suppliers including major cable providers, phone companies, and more local telecommunications providers. None of the farmers interviewed currently had access to only dial-up, however some of them had only recently up-graded from dial-up in the past year, and one farmer had only started internet services in their home in the past year. Internet access across different areas of the farm varied as well. Most farmers noted that they could not receive internet access in their packing sheds, coolers and other areas where they might need to upload inventory or utilize various sensors. Most interviewees acknowledged that regardless of the farming operation, they would still require internet access at home because of outside employment for themselves or family members, or access for school-aged children. Of those who revealed how much they paid for internet services, it ranged from $80-$120 per month. When purchased through a phone company, it required purchasing a phone line in conjunction with the internet.

There was an extensive number of e-commerce and management practices that farmers implemented requiring internet access:

- Email and communicating to customers, or other business-related communications.
- Training, professional development and external engagement within the farming and food system community.
- Expense administration, such as processing, billing, tracking and taxes.
- Supply shopping, price comparison shopping and interacting with suppliers.
- Research for farm management issues, like soil or pest challenges.
- Website management and maintenance.
- Online marketing and promotion, including social media management.

Interviewees highlighted a number of benefits and barriers to participating in e-commerce. While Table 1.A.2 does not represent every benefit and barrier mentioned, it showcases some common themes.

Table 1.A.2: Farmer identified benefits and barriers to participation in e-commerce.

Benefits and Barrier to Participating in E-commerce	
Benefits	**Barriers**
Better access to expanded customer-base, particularly younger customers.	Some websites are too complex to load with limited bandwidths.
Customers tend to spend more money when they can pay electronically via credit card.	Being timed out of online banking sessions while waiting for the web page to load can lead to frustration on the customer's end.
Improvement in marketing and promotion of your farm and products.	Learning curve without the support of technical assistance or training makes leveraging these tools challenging.
Not spending as much time talking with customers over the phone.	For older generations, whether farmers or customers, e-commerce is still new and unfamiliar.
Ability to conduct various business management on own time, not just during regular 9-5 business hours.	A website cannot always eliminate every question, or inquiry a customer might have.
Improves all around customer service and communication.	Some customers do not have reliable internet access, or cell phone service themselves.
Saves a lot of time that would normally be spent traveling to the bank.	Customers that don't want to, or are not able to participate in e-commerce, because they can only pay by cash or check, or need technical assistance with things like navigating a website or platform.

The results from the remaining two interviews (non-farmers) are discussed in the Key Themes section.

Key Themes

After compiling and reviewing all interviews, the key findings that surfaced are as follows:

All farmers interviewed had access to "high-speed" internet, but actual speed, coverage and reliability varied greatly.

> "If you get up at two in the morning it's pretty good but who wants to be on the internet a two in the morning."

While all six farmers interviewed had some access to high-speed internet at their farms and at home, there were significant differences in speeds, consistency and dependability. Most conversations exposed frustrations related to both upload and download speeds, despite ostensibly having high-speed internet. Reliability could be significantly impaired by multiple users utilizing internet within the community at certain times of the day, and weather could affect speeds. A farmer in Vermont shared: "If you get up at two in the morning it's pretty good, but who wants to be on the internet at two in the morning".

The most frequently noticed times when connection slowed down or shut off were during the morning office hours and the late afternoon and evening when kids are arriving home from school, or when it was raining, storming or windy. Several interviewees highlighted that when more than one person was utilizing the internet at their own home it would be far less functional. A grower in Arkansas described: "If multiple people are watching videos on Instagram or YouTube they'll buffer for quite some time, or I'll get kicked off Zoom. So, it's good for one person, but it's not ideal for multiple people at once."

Most interviewees were paying for much higher speeds than they were actually receiving. One farmer stated: "When you test the speed, we're getting between 10% and 30% of what we're paying for."

It is also important to note that three of the six farmers interviewed had little to no cell phone service on their farms and/or community. This created challenges for farmers trying to receive calls about their business when they were not connected to Wi-Fi, while trying to run SNAP-EBT cards and credit cards on cell-operated reader machines at farmers markets, and when trying to be able to log into an account with a two-factor authentication system, such as an online banking platform. In one case, a farmer had to frequently utilize a personal cell phone hotspot to access

> "When you test the speed, we're getting between 10% and 30% of what we're paying for."

the internet in the field to manage inventory: “Our workaround is to use a hotspot on my phone when we really need it; that's the backup since I have unlimited data with US Cellular. Certain parts of the field probably wouldn't do well, but in the packing shed I can get it decently and otherwise we have to walk a quarter block up the hill to go to the farm store and that's usually a place that we can get connection speed again, but it’s a hit or miss depending on usage of someone else or what our neighbors are doing.”

Satellite internet and cell service can also be significantly impacted by air quality or cloud cover. Another interviewee described past experience with satellite-based internet services, and said that it simply was not worth subscribing in their area due to either using up the data package too quickly, or it being too dependent on having ideal weather conditions.

Community access points are important, but not a feasible solution for farmers.

Types and availability of community internet access points varied widely. Several farms were more than 20 minutes driving time from the closest town-center. A few farmers had coffee shops or other businesses that have internet access, but they would need to drive to town or be at the farmers market to reach them. Libraries were available to most farmers, however distance was often a limiting factor. Library internet speeds and availability varied as well. Some had high-speed fiber optic Wi-Fi, which could even work in the parking lot. Others only had a single desktop computer with minimal bandwidth. Farmers that sold at farmers markets mentioned that often the cell reception was not reliable enough to manage sales via their electronic point of sale (POS) system and that they would need to wait until there was a better connection to process an order. This also applied to being able to process credit cards and SNAP-EBT cards. There were minimal examples of public hotspots, but some were available in towns via local phone companies to provide access for children doing remote learning during COVID-19. One interviewee mentioned there was conversation about the community offering backpack hotspots, but that if it wasn’t heavily subsidized, the cost would be prohibitive for their farming operation.

Slow internet severely inhibits farming operations.

While farming is already more than a full-time job for most producers, when they experience lack of access to reliable and high-speed internet, it eats up large amounts of precious time in their day. One farmer contextualized this situation with an example: “There are times that it is time consuming because I will be needing to learn something, for example, if we have machinery breakdown and I’m trying to research online what I need to fix it and the internet is being uncooperative, then I sometimes have to go

someplace and do something different, and come back again and try again an hour or two later and see if I can be successful, and you can imagine how frustrating that can be."

Slow internet can cause farmers to feel cut off and disconnected from their local communities and broader farming networks. One farmer described: "In my ideal world, your farm could become like some type of interface with your community. We are trying to think about ways that we can produce some different things that could tie more into the local community, and so, then you get a whole other issue of, if you're in a rural community where internet is really limited, how do you get the word out? How do you reach people to help them understand where your product is? How do you make it accessible equitably? The internet is in a lot of ways, a really efficient way to do that, but if neither your consumers nor you as a business have the ability to do that, then that makes it really difficult."

"There are times that it is time consuming because I will be needing to learn something, for example, if we have machinery breakdown and I'm trying to research online what I need to fix it and the internet is being uncooperative, then I sometimes have to go someplace and do something different, and come back again and try again an hour or two later and see if I can be successful, and you can imagine how frustrating that can be."

Several of the interviewees noted that they were like many farmers that had to shift to online sales during the COVID-19 pandemic and that they did not feel like they had reliable enough internet access to manage that process. The same applied to their customer base, particularly in this Tribal farmer's community: "One of the things I do want to say is with our customers, a barrier is that a lot of them are low-income and they have what is called a free phone for life, where they get a phone which is connected to some level of data, and it is not a lot of data. I remember, there was a time where I think Facebook was free to all of those customers and so that's was the reason why we did a lot of our sales, or tried to do our advertising just with Facebook, because that service is free to those customers. I don't think they use a lot of their data to look at websites or to purchase things. I think they kind of save that [their data] for emergency or personal use or something important. So it's kind of hard to figure out where and how much we should be advertising to our SNAP customers. So that's one of the things that I know is a barrier for us is that the customers don't have the ability to pay for full service internet because the cost is too high."

Reliable and high-speed internet access does allow for farmers to participate more easily in e-commerce.

There are a vast number of management practices that farmers implement, including e-commerce, that require internet access. When farmers have more reliable access, it streamlines their operations. All farmers that were interviewed agreed that having more reliable and higher speed internet would improve their farming operations. For those farmers interviewed that recently received access to more reliable internet, they could name multiple areas of improvement. One farmer that recently moved to a new farm shared: “This always felt like a real limitation before when we didn't have good internet. When you have a high-speed option, everything is faster, so everything is easier. You can get things done more quickly and be able to be a better customer service person. And so, I feel like I am much more responsive to my customers than I was a few years ago and part of that comes from the fact that I can be proactive with my website.”

As noted, there are several benefits for farmers to participate in e-commerce, all of which are made more beneficial when paired with reliable high-speed internet. Farmers noted reliable internet coverage and speeds help to more easily manage inventory and sales, whether that be on the farm, or at the market. Similarly, it improves production records and data management, since it allows for increased accuracy and timeliness of inputting data (moving from entering data manually by first writing it down to being able to upload it directly). It could allow for use of field sensors for soil health and water usage, or for farmers to install sensors in their coolers to notify them if there is a temperature issue, helping to prevent profit-loss and food waste. One farm was already utilizing a calf-monitoring system that required internet, however it was a hassle to install, since it needed significant infrastructure to beam the Wi-Fi signal to the barn. They would have liked to utilize similar technology on other parts of the farm, but the access to the internet was a limiting factor.

Some farmers noted that a stronger internet connection would allow them to communicate via video calls while out in the field. This could be helpful to share visual information with groups like seed suppliers, extension services, or to offer virtual farm tours for business, or education. It would also allow them to watch or share videos for professional development, research and learning opportunities. Farmers shared that having access to the internet could help them to better be able to share the stories of their farms, whether that be through their website, social media, regular newsletters or other forms of communication. Multiple farmers noted that they believe it helps them greatly improve their customer service and experience.

Several interviewees highlighted that their farms simply would not be able to survive in today's market without the internet. The farmers also wanted to acknowledge that they feel very privileged to have the internet services that they do. They understand and

often know other farmers in their community that have either no internet access or very slow and outdated dial-up services.

E-commerce platforms are often too complex to be utilized by farmers with limited internet access.

Of the farmers that were interviewed, none of them were utilizing agriculture-specific e-commerce platforms to manage their operations. Even if they had considered using these types of tools, there were three main reasons why they were not able to access these resources:

- The software was too complex for what they needed to successfully manage their operations
- They did not have the necessary internet bandwidth or cell phone coverage to run the programs
- The costs to purchase, or pay subscription fees was too high to justify as a small operation.

The most common management tools farmers were using were Quickbooks or Freshbooks for bookkeeping and more general e-commerce management tools, such as WooCommerce, Squarespace, GoDaddy, and Square. Other free management tools included email, Google Suite, online banking, and Canva.

Some farmers interviewed had such limited internet speeds that even common websites were often too intricate to load. For example, one farmer often purchased replacement parts for equipment online and faced difficulty having a page as common as Tractor Supply Company's (2021) website load.

Costs of both broadband access and e-commerce digital tools are the most prohibitive aspects of participation in e-commerce.

The farms interviewed for this research were all small to mid-scale, family-run, sustainability-focused operations. They mostly shared that it would be difficult to justify the extra expense of higher-speed internet or state-of-the-art management tools. "Cost is certainly a massive factor." Most expressed that they felt they were too small to get the most out of these tools. Some farmers explained that even if there was a higher-speed option for internet currently available in their area that they would likely not be able to afford it: "If we had the option to upgrade at any point, cost would be a barrier to doing so. I mean it could currently be that we have an option to upgrade and we're not based on how tight our finances are here at the

"Cost is certainly a massive factor."

“Cost has been the biggest reason why we haven't been able to get this [internet] earlier.

farm. So, I would say if we're paying $80 bucks now and it went up to $100, that would be significant… Anything that we can control we try to. We try to keep it simple on the cost side as much as possible.” Some interviewees explained how even when new providers become available, installation can be out of reach: “I will see the occasional other options, but it would be like $500 for installation alone, which is kind of pricey.” Another farmer shared “Cost has been the biggest reason why we haven't been able to get this [internet] earlier. Luckily, we have applied for some grants for small business to be able to help us to pay for the installation and also the fees for our internet services. And that's just right there at home, we're not able to take something elsewhere, to be able to like run a tablet in the field...” One interviewee provided an extreme example: “At our previous farm location it was going to be $30,000 per household to install internet services 6 miles from the nearest provider.”

The Tribal farmer interviewee felt they were too small to take advantage of many types of tools and that because they were still trying to identify their own customers, they did not believe a company from outside of their local community would be able to achieve this goal: “We did have two different groups come to us and they were telling us oh we're going to create your Facebook page and we'll do all of this and it sounded good, but again for me I'm too small. I don't feel like it's going to be worth my time and I didn't think they know my customer. If I don't know my customer that well, how will they know my customers they're not even from the reservation. So why would I be paying somebody else for this extra service if I can't really fully tell them what I want. Because to be quite frank, that's always the issue is that somebody else is coming in saying: *Oh, I can help you with that!* But then they can't really fully understand the bigger picture of what's happening [within Tribal communities].”

Most interviewees expressed that they believe it is not only crucial for them to have access to reliable internet, but it’s also key that community members do as well - particularly when they have low-income, or SNAP customer bases. If customers can’t find the farmer or purchase something online because they cannot afford internet, then that ultimately impacts the farmer’s bottom-line.

Public-private partnerships and federal investment could be a path forward.

Service provider monopolies or simply a lack of providers were a major concern for interviewees. Oftentimes, for some farmers, there was only a singular provider that was able to service their area: “I remember three years ago [when they first installed internet] that was our only option!” Or in some places the service is too weak: “They had

to come in from Show Low. We tried to get one local company, but when they came out to try to install, the service was just too weak; it wouldn't pick up anything, and so we had to go with them [the other provider]."

In speaking with the representative from the public power district in Nebraska, the largest wholesale power provider in the state, they shared that they own a fiber optic network that they utilize to operate their grid. The interviewee stated: "That situation enables an interesting possibility for partnerships. In our case partnerships with private sector companies that may be the provider of internet service." They went on to explain: "Well the essence of our effort from my perspective, is why build two networks. It's already difficult and costly to build networks especially in a rural part of the state, so it just makes a lot of sense for us to say wow if you could understand our needs we could look at the needs we have down the road then let's build one network with a partner in a footprint area that could then serve both the rural broadband needs, as well as provide the connectivity and the security issues and things that we have to face so that's kind of the essence of the why."

"I remember three years ago [when they first installed internet] that was our only option!" Or in some places the service is too weak: "They had to come in from Show Low. We tried to get one local company, but when they came out to try to install, the service was just too weak; it wouldn't pick up anything, and so we had to go with them [the other provider]."

However, there are some limiting factors: "So it sounds really logical and you say: *Let's just do that everywhere!* But there are politics and issues involved in everything." When working within public-private partnerships, or various collaborations it can become a challenge to balance priorities: "How do you get those kind of conversations started? You're coming from two different worlds; what can be the basis for discussions? For this particular initiative, the first logical step was to connect with a group that could carry out initial feasibility studies and preliminary network designs to establish a baseline for discussion around this future collaboration in order to apply for grants and funding. They are in a place now where after facilitating numerous conversations, they are nearing a full partnership to pilot this type of model in a small footprint within the state hoping to replicate this public-private partnership with the public power utilities to create a blueprint for other communities and states."

"Well, the essence of our effort from my perspective, is why build two networks?"

Similarly, the procurement and supply-chain specialist interviewee explained that they have seen success in supporting rural farmers through collaborations between farmer

cooperatives and food hubs. If a rural farmer does not have access to reliable internet, they could be a member of a cooperative or food hub that could run the inventory and sales processes that require the internet for data management. This type of partnership could be an interim solution for farmers without high-speed internet, but also a sustainable path for local and regional supply chains long-term.

Both of these interviewees noted that for any of these types of partnerships that the parties involved must be open to new ideas and perspectives.

Reflections

The goal of this research was to better understand how lack of reliable broadband internet access can impact farmers' viability and participation in e-commerce. Overall, it was found that lack of reliable, affordable and high-speed internet access significantly inhibits modern-day farm viability and hinders participation in e-commerce. All farmers interviewed were already engaging in e-commerce and viewed it as a necessary tool to maintain farm success. However, farmers who were still facing access and reliability issues around high-speed internet voiced frustrations around how it was a limiting factor for their farm. Not only is reliable internet access a challenge for the farmers themselves, but for their surrounding communities and customers as well. Farmers were adamant that full community internet access was necessary for their farms to survive because local customers need to be able to successfully find local farms and place orders Cell phone service coverage was also a significant challenge for rural farming communities and it can be an additional layer of limitation when farms are located in an area with both lack of access to high-speed internet and cell phone service. Additionally, lack of access is not the only limiting factor when it comes to the internet, but affordability is also a significant barrier, exacerbated during the COVID-19 pandemic lockdown which limited in-person sales options.

> “That’s how radical that change, that step in the wrong direction, was. If you had never had DSL you might not have thought too much about it, but we had had it for like four years. And so it was a huge step backwards and it just pains me to think that there are still people that that's how they have to access the internet.”

In addition to helping farmers more easily participate in e-commerce, better internet would allow more farmers to connect across the nation and create more learning opportunities: “There are actually farmers who still the only internet they can access is dial-up. And I can tell you, when we moved in 2013 from the house where we had lived for 34 years to the house where I grew up, which is only three quarters of a mile apart, but the phone lines come from opposite direction – even though those houses are on

the same road. We had relatively good internet at the previous location and when we moved up here the technology that the phone company had at the time didn't allow us to have DSL. So, we went from DSL at the old house back to dial-up internet and I tell people that was like going from an airplane to a horse and buggy. That's how radical that change, that step in the wrong direction, was. If you had never had DSL you might not have thought too much about it, but we had had it for like four years. And so it was a huge step backwards and it just pains me to think that there are still people that that's how they have to access the internet."

Recommendations

The farmer and industry experts had several recommendations to note. First, in terms of simplifying farmers participation in e-commerce, it is key to ensure that e-commerce software and tools are affordable – making the investment worth the added costs associated with a product or service. Similarly, making sure the investment in time is worth it and is tied to a direct benefit, such as increased sales. For e-commerce platforms themselves, involving farmers at the development stage of any new tool or platform, whether it be through feedback or more direct involvement would be beneficial. However, farmers would need to be compensated for this work. If you are a company or organization that partners with farmers on e-commerce, try not to frequently change systems and platforms; this can become a barrier for farmers. For people or groups who might be developing websites for which rural farmers will be a primary customer or audience, it would be helpful to make websites more accessible for those without reliable internet. One farmer inquired if there is a way to simplify the webpages to access them in pieces, or allow only certain segments to load at a time, to not slow down the process.

Interviews also showcased how farmer cooperatives and food hubs seem to be a successful model to support small-scale farmers, especially those that do not have capacity or market access to sell directly to consumers, whether that be due to lack of reliable internet, or otherwise. This can be a temporary solution while broadband infrastructure is installed, but can also be a successful model into the future. Farmers also noted that it is important for there to be access to either reliable Wi-Fi or cell phone coverage at farmers markets to be able to process payments electronically via credit cards or SNAP-EBT cards.

Further recommendations included merging internet service with other existing public power utilities – the public-private partnership in Nebraska is an example of what this could look like. Additionally, have energy, utility and internet service providers go to agriculture and farming conferences, particularly sustainable and locally-focused

conferences, to hear concerns and needs directly from farmers and be able to engage with them and inform their models.

Overall, just supporting rural communities generally with affordable and reliable internet services would improve the situation. If customers do not have access to the internet, farmers have no reason to participate in e-commerce. As one farmer put it: “It is all interrelated.”

Closing Thoughts

Time is very precious for producers – any time saved is incredibly valuable to a small-scale farmer. This makes having access to high-speed and reliable internet service integral to their success. This research also reiterated that access to communication should be a common good. In today’s digital world, the internet provides a key way to stay in touch with customers and the farming community. While monetary support for Extension services at the national level has been dwindling over recent years, farmer-to-farmer networks have become increasingly important. In addition, with the aging generation of farmers, high-speed internet access has become critical to attracting and retaining young populations in rural communities, including farmers.

Policies to support rural broadband infrastructure and expansion continue to be needed. While this is a timely topic with various recovery legislation being put in place to support these efforts, funding is not only needed to offset installation costs, but it is imperative that it also supports ongoing affordability and maintenance in the years to come. It is also key that this legislation acknowledges and supports populations that have been most impacted by the digital divide including Tribal communities and other communities of color.

With much of this new recovery legislation coming into play, it means that electric cooperatives, phone companies, satellite and telecom providers are going to be eligible for funding to support these broadband initiatives. However, the challenge is that companies often need large teams of people to apply for and manage these funds. This is often not ideal for small rural companies with limited staff, capacity and funding. One farmer suggested non-rural populations need to understand the situation around internet access that many farmers are facing and the impact that it has: “The thing is that I need people to understand what an impact it has. And that in our society, right now, as a farmer and as a working parent, I can't do – I literally cannot do what I need to do, given the internet access that we have.” They went on to

> Farmers are producing food to feed the nation. They should have equal access to urban and suburban counterparts, without having to foot the bill themselves.

say: “This is an equity issue. Farmers are producing food to feed the nation. They should have equal access as urban and suburban counterparts, without having to foot the bill themselves. There needs to be local, state and federal support. We need support for rural communities from legislators. A farm, in my opinion, should be a business and therefore should have the capability to or needs the ability to exist in the marketplace, as any other business and if they're compromised in that way, then they can't and then their viability as a business is compromised.”

Case 1.B: The Digital Divide: How lack of reliable broadband internet access affects the success of small farms in the Southeast

Summary

For small and mid-sized producers within local and regional food systems, digital tools have become increasingly significant for farm business management. Social media, websites, and online stores are increasing the web presence for these smaller producers and building their customer relations. Despite these tools becoming streamlined in business management, the digital divide in the United States has left certain producers behind. Although many producers can access an internet connection, the quality and usability vary greatly. As new technologies and marketing strategies become available for farms with high-speed broadband internet, producers existing within the digital divide are forced to adapt in order to remain viable. This deep dive examines the impact broadband access has, both positively and negatively, on the success of small farms in the Southeastern United States.

Background

The digital age is rapidly growing and evolving on a global scale, particularly in the United States (US). Every industry has been impacted by the digital age and agriculture is no exception. While advancements in agricultural-based technology are constantly working to improve the way people grow, produce, and manage food and natural resources, there are inherent benefits and disadvantages (House of Representatives, 2017). These benefits and disadvantages became especially clear during the pandemic when the entire globe was forced to form connections and conduct business virtually. The digital divide became undeniable, leaving the majority of the US reeling in an attempt to address this issue (Lai & Widmar, 2020). For local and regional food systems, many innovative responses have evolved out of the pandemic, but many communities are still limited by lacking infrastructure, broadband access, and new technologies. A 2021 report from the US Department of Agriculture's (USDA) National Agricultural Statistics Service (NASS) revealed that while 50% of farms accessed the internet through a broadband connection, 70% of farms were only able to access the internet through a cellular data plan (USDA, 2021).

The Federal Communications Commission (FCC) defines broadband as high-speed transmission technologies, such as a Digital Subscriber Line (DSL), cable modem, fiber, wireless, and satellite (FCC, 2014). High-speed internet is faster than traditional dial-up

access; the FCC defines broadband speeds as at least 25 megabits per second (Mbps) for downloads and 3 mbps for uploads (FCC, 2015). The digital divide is when “certain cohorts of society are deprived of information and services because of their lack of access to computers and the Internet” (Hennessy et al., 2016, p. 475). Data from 2018 portrays how the digital divide impacts rural areas compared to urban areas in the United States; only 52% of rural residents had broadband internet access compared to 94% of urban residents (Lai & Widmar, 2020). It is also important to note the difference between accessing the internet with broadband versus a cellular data plan. While both provide access to the internet, the speed and functionality can vary greatly.

The pandemic revealed what rural communities already knew; society today is dependent on high-speed broadband internet access despite it not being readily available to all. The digital divide became an even more apparent and urgent issue in healthcare, education, information dissemination, and agriculture. Supply chain interruptions caused by the pandemic simultaneously wreaked havoc on some parts of our industrial food system while uplifting local and regional food systems. Reports of small farms thriving under unprecedented attention and demand shared headlines with devastating stories of the family farm livelihood under threat (White, 2021, CFSA, 2020). Agricultural advancements in digitalization will always be limited if certain populations continue to face significant barriers to information and services accessed through the internet (Hennessy et al., 2016).

With limited in-person engagement or events since early in 2020 and the majority of daily life being conducted virtually, examining the impacts of the digital divide on local and regional food systems is crucial. Understanding the numerous ways local and regional producers benefit from and rely on the internet and, subsequently, the barriers to fully harnessing digital tools, will greatly impact resilient solutions moving forward.

Research Methodology

In order to explore the relationship between the digital divide and digitization of local and regional food systems, the question, “How does the lack of reliable broadband internet access affect the success of small farms in the Southeast?” was asked by the researcher. To conduct initial research, literature was reviewed to identify current gaps in knowledge, related to the digital divide’s impact on agriculture and more specifically, local and regional food systems. Various terms were searched on Google Scholar, Arizona State University’s digital library, and specifically in the *Journal of Agriculture, Food Systems, and Community Development*. Terms included: “digital divide & agrifood”, “digital divide & agrifood United States”, “rural technology development”, “COVID-19 pandemic & digital divide”, “digitalization food”, and “online local food".

In addition, interviews were conducted with small and mid-sized producers located throughout North Carolina, South Carolina, and Georgia. Interviewees were recruited through connections from a Georgia-based branch of a national conservation organization and a regionally based community land trust, also located in Georgia. Additional interviewee outreach was conducted with the use of a listserv network, hosted by a farmer-driven non-profit organization based in North and South Carolina. An email, which included a brief explanation of the research project, was sent out on eight different listservs within this network.

In order to conduct the interviews consistently, a two-page interview guide containing open-ended questions was used[2]. The interview was divided into four sections described below:

- *Background*: The background section asked questions related to the interviewee's farming operation, marketing, and distribution processes.
- *Broadband Access:* The broadband access section established a baseline for each interviewee's ability to access broadband internet. Interviewees were asked to describe the reliability, functionality, and speed of their broadband, if applicable. This section also included questions about the ways in which broadband access has either inhibited or improved their farming operations.
- *Multi-generational Farms:* The multi-generational farm section was originally intended for use with interviewees that came from family farms, as this was initially within the scope of the research. However, the majority of the interviewees recruited were first-generation farmers, making this section of the interview less relevant.
- *Challenges and Solutions:* The challenges and solutions section, asked about challenges presented by COVID-19 and provided interviewees an opportunity to offer up solutions or recommendations based on their experience.

Once interviewees were selected, the student researcher contacted each interviewee individually to schedule a phone interview, which was conducted using Zoom. At the beginning of every interview, the researcher provided a brief personal introduction and description of the research project and asked for consent to record the interview audio. Once consent to participation and recording was granted, the researcher began asking questions according to the interview guide. Throughout the interview, any additional questions asked that were not included on the interview guide were relevant and following up on the interviewee's response. At the end of the interview, participants were given the opportunity to ask any questions of the interviewer, were thanked for their time, and promised a copy of the final report.

[2] See Appendix A for the full interview guide used in the interviews

Interview limitations

The biggest limitation of this interview process was selection bias. Personal connections and recommendations were leveraged to assist with the recruitment process, which could have influenced the type of person interested in participating. The non-profit organization that manages the listserv network serves North and South Carolina but has a significantly larger presence in North Carolina, particularly in the Raleigh-Durham-Chapel Hill metropolitan area. The majority of interviewees were recruited through this listserv network, resulting in underrepresentation in the voices of South Carolina and Georgia-based producers. This listserv is also email-based and therefore required any possible interview subjects to have an email address and regular internet access in order to have been notified of this opportunity. As a result, the experience of producers that do not have broadband internet access and/or do not have an email address was excluded from this research. Their voices are perhaps the most significant and most likely to be excluded from conversations on the digital divide and broadband access within agricultural and rural communities.

Findings

To answer the research question and gain a better understanding of the current state of broadband access for small farmers, seven interviews were conducted with small-to-mid-sized producers, located throughout North Carolina, South Carolina, and Georgia. These interviews provided an in-depth look into the experiences of farmers with varied access to broadband internet. The interviews specifically examined the way broadband access has inhibited or improved the participant's farming operation. An analysis of the interviews as a whole revealed the following key findings.

The seven farms interviewed included the following farm types:

- 320 square foot shipping container for growing microgreens, located on the site of a ¼ acre community garden
- 40-acre pasture-raised meat operation and agritourism venture
- 30-acre pasture-raised, regenerative agriculture livestock farm and processing facility
- 5.5 acre medicinal and culinary organic herb farm
- third-generation pecan and citrus farmer on 108 acres
- 50-acre free-range chicken and poultry farm
- 2-acre educational eco preserve and farm.

The initial research question hoped to explore an additional dynamic between producers and broadband internet access by interviewing multi-generational, family farmers. However, interview outreach did not elicit a significant response from multi-generational, family farms and as a result, this part of the research was abandoned. The majority of

the farmers interviewed were first-generation farmers, with farm experience ranging from 6 to 35 years. Some of the farmers had experience working on other farms prior to owning their own. With the exception of the third-generation farmer and the farmer with 35 years of experience, the remaining have owned and managed their farms for less than 15 years.

All farmers interviewed had varying degrees of access to the internet, though not all had broadband access. For those with broadband internet access, the reliability and speeds vary greatly.

Each interviewee was asked to describe the type, speed, and reliability of their internet access. While all interviewees had some form of internet access, not all had broadband internet. The majority of interviewees relied on cable, satellite, or DSL connections. Three of the interviewees relied on mobile hotspots or cellular services, which were cost-prohibitive based on the individual's data plan, thus limiting their internet use. While the type of internet service varied, all of the interviewees shared a similar sentiment that their service was undesirable. Interviewees described their internet as "unreliable", "outdated", "frustrating" and "miserable". One farmer expressed a feeling like his internet, "goes back to the early 2000's."

Interviewees described their internet as "unreliable", "outdated", "frustrating" and "miserable".

The farmers interviewed relied on multiple devices in order to maintain the backend operations and web presence of their farms. For those interviewed with internet access, the use of both a smartphone and desktop or laptop computer was most common. For those who did not have internet access and were reliant solely on cellular service, all computer-based work (i.e. record keeping, finances, emails, website management, social media, etc.) was completed using a smartphone. Only three of the interviewees also use a tablet, though the tablet was not described as the main device. One farmer, who despite mainly using a desktop computer for his paperwork and farm business management, described his smartphone as a "lifeline in the tractor".

Farmers living in rural communities stated that the lack of competition in broadband internet service providers was an issue.

Of the seven farmers interviewed, six are currently living on their farms in rural communities while the seventh had recently moved her microgreen operation back to an urban area. For those living in rural areas, the majority stated that there is limited competition for broadband service providers in their community. Without any competition, the farmers are limited to only one option for internet access, regardless of

the type, speed, or price. Interviewees in North and South Carolina suggested that state laws, which limit or restrict municipal broadband networks, were part of the problem. Both states have passed legislation over the last decade, which heavily restricts the ability of municipalities and county governments to provide their own internet service. As a result, these laws have created a dependence on major telecommunication companies to provide service. These laws were a part of a nationwide effort to pass restrictive legislation in 18 states, in favor of large telecommunication companies, thereby limiting local control (Cooper, 2021).

For the two farmers who had other broadband providers available, cost became the limiting factor. One farmer described a conversation she had with a large telecommunications company, where she was informed it would cost “ten thousand dollars” to install internet for her and four other households. In contrast, her current internet service provider told her, “they didn’t have the capacity” and that she “got the best [internet service] that we’ve got”.

Farmers are adapting their farming operations, in some cases becoming less efficient, because certain activities can’t be consistently accomplished to their satisfaction due to inadequate internet connections.

All of the farmers experienced some form of limitation or felt inhibited by their internet access. As a result, the farmers described various ways they had adapted to their situations, changing elements of their operations to accommodate these limitations. From some of the interviewees, this meant making small changes to their daily tasks and habits. For others, this meant adapting to more significant shifts in their operations, often resulting in less efficiency.

> “I’ve resigned myself to slow internet speeds and not being able to keep up with certain websites.”

Many of the farmers mentioned that before the pandemic, they would often spend time working in coffee shops, at the public library, or at the homes of friends and family, to access high-speed internet. While the pandemic has ceased this activity for all the interviewees, it was stated that working in public spaces has its benefits but ultimately is not ideal. The availability of high-speed internet access made website and online store updates easier, marketing and social media engagement quicker, and allowed others to send emails containing attachments. Despite the benefits, most found this to be “inconvenient” and a “nuisance”. One farmer in particular, who recently transitioned from a mobile hotspot to satellite internet, explained how she felt uncomfortable working in public places. She said, “I’m really uncomfortable accessing any of the public sites, because of security...I’m always very

cautious about what I do there." Another farmer shared that instead of working in town, "I've resigned myself to slow internet speeds and not being able to keep up with certain websites." This sentiment of resigning to slow internet speeds and adapting accordingly was shared by many throughout the interview process.

Other farmers described more drastic adjustments and operational shifts. For one farmer, who started her business growing microgreens, lack of broadband internet access impacts her farming operation directly. She grows microgreens in a retrofitted shipping container, which has a Crop Box™ computer system installed inside. The computer system stores data, planting calendars and programs automatic irrigation and lights. In years past, the farm and shipping container was located in a large city with internet access. At that time, the farmer states, "I didn't even have to be on the farm. I could be on vacation and [my employees] could see what I had told them to do on the screen, in the Crop Box." Unfortunately, in order for these features to be used, the Crop Box must be connected to the internet. For the farmer who recently upgraded from a hotspot to satellite internet, she is working to change her mindset around web-based tasks and activities. Relying on the hotspot forced her to develop habits like, "saving her data" for "special" web-based tasks, such as updating her website or checking her financial records. With satellite internet now, she is "slowly getting out of that habit."

Despite internet access barriers, many farmers turned to digital tools during the pandemic, including launching online stores, which have been successful.

Forced to maintain their sales and customer relations, without the ease and benefit of in-person interactions, interviewees created online stores for the first time, dedicated more time and energy to maintaining an engaging web presence, and upgraded their distribution methods. Social media pages, websites, electronic newsletters, and regular email correspondence were all digital tools used by the farmers interviewed. One farmer explained that the pandemic led her to increase her use of electronic newsletters; "I've had MailChimp for years, for probably about 10 years, but I've only ever sent like three newsletters a year. Whereas now it's like every single week since March of 2020...it's been good, because it really has allowed me to connect with a whole group of people that I wouldn't have normally connected with."

> "Being able to run an online store, that probably has the biggest potential to help any farm."

Despite challenges caused by unreliable or slow broadband internet, interviewees found ways to increase their time spent online, resulting in the successful cultivation of customer satisfaction. The reasons for enduring their undesirable internet connections were quite simple; "The only way [the customer] is going to get to know you is through

what you present online," said one farmer. Another farmer said "Being able to run an online store, that probably has the biggest potential to help any farm." Multiple farmers credited the creation of online stores as key to their success during the pandemic. A third-generation pecan and citrus farmer, who was working on transitioning his family's farm from a large commercial operation into a smaller, and hopefully organically grown pecan farm, explained, "[The pandemic] was really a good springboard for us to get into the online sales. We didn't have an online store until June or July of last year."

Many farmers stated that the pandemic created better business for their farms, including increased consumer demand for reliable sources of locally raised meat.

> "The best thing, I think, that happened to our business was the pandemic. And that is such a weird and horrible thing to say, but it really is.

When interviewees were asked to describe their experiences during the pandemic, the vast majority stated that to some degree, the pandemic created a better environment for their business. One farmer, who raises pasture-raised hogs, cattle, turkeys, sheep, and laying hens, stated: "The best thing, I think, that happened to our business was the pandemic. And that is such a weird and horrible thing to say, but it really is. [Customers] didn't want to go to the grocery store so they were willing to give farmers markets a try and they realized…it tastes so much better and it's better quality." Other interviewees expressed similar sentiments, sharing that the pandemic caused consumers to change their purchasing habits for the better. Of the three livestock farmers interviewed, each witnessed their customers' preferences and habits shift towards the reliability found when purchasing meat directly from the source. As another pasture-raised chicken and hog farmer stated, "There were several people who were thrilled to find somebody who would ship meat right to their own home so they didn't have to go out shopping." Simply put, "People wanted a guaranteed supply of meat" confirmed another pasture-raised chicken and hog farmer.

> "You look more professional online, you look more trustworthy, you're more interactive. All those things that customers want to see if they're going to make the decision to pay a *crapload* more money for your meat versus the grocery store."

While the pandemic caused a tremendous amount of disruption, grief, and loss, there was also a seeming unanimous turn towards the community. For consumers, there was an appeal and desire to support farmers in their community, who they could trust to provide high-quality fresh produce and meat, while also knowing their purchase was supporting someone else's livelihood. One farmer credited a well-

maintained web presence with her ability to form trusting relationships with her customers. She stated; “You look more professional online, you look more trustworthy, you’re more interactive. All those things that customers want to see if they’re going to make the decision to pay a *crapload* more money for your meat versus the grocery store.”

Reflections

As local and regional food systems continue to build more resiliency and become a viable alternative to the conventional, industrial food system, it is vital that producers know how to engage consumers effectively. Small to mid-sized producers, that are focused on sustainable, organic, and/or regenerative agricultural practices, need to be able to connect with their customers. By continuing to identify engaging and innovative ways for producers to tell their stories, the customer is able to have an increased understanding of the quality and care that went into their products. Educating customers on the rationale behind their pricing and production methods can increase awareness and value of locally produced foods. The USDA’s Know Your Farmer, Know Your Food (KYF2) Initiative is an excellent example of how strengthening connections between producers and consumers can affect the entire local and regional food system (USDA, 2021). While there are already robust efforts in place to educate farmers to harness social media, more awareness around these programs is needed. In addition, without adequate broadband internet, these tools become less useful.

In order to make high-speed broadband internet more accessible, there needs to be an increase in long term funding for infrastructure, including installation and maintenance, particularly in rural areas and tribal nations. The proposed Infrastructure Investment and Jobs Act would invest $65 billion for broadband deployment (The White House, 2021). If passed, this funding would support the necessary infrastructure to ensure every American has access to reliable high-speed internet, offer lost-cost affordable plans, boost competition, and foster greater digital inclusion. The passage of this legislation would create significant progress toward closing the digital divide, however, there are other efforts needed to ensure that the digital divide is closed in agriculture.

As mentioned in the key findings, the lack of broadband service provider competition is a major factor limiting farmers’ ability to access more reliable, high-speed internet. Without adequate competition, those living in rural areas, including farmers, have no choice but to pay for substandard broadband service. Unfortunately, both North and South Carolina have restrictive legislation in place that prohibit municipal broadband projects (Cooper, 2021). These laws need to be reversed and legislative action needs to be taken to support the ability for local municipalities to create and provide their

broadband networks. The community of Wilson, North Carolina provides an excellent success story and case study in support of this recommendation. Wilson is a small community, located in the eastern part of North Carolina. In 2008, the city created Greenlight, which is a city owned “Fiber-to-Home" network. Greenlight has successfully provided broadband access throughout the community and demonstrates the success of local investments, driven by community need (Marcattilio-McCraken, 2020).

In addition to increased infrastructure investments and legislation that supports competition, the FCC needs to broaden its definition of broadband internet speeds. The current definition sets speed rates as low as 25 mbps, which are not fast enough to reliably perform many of the tasks farmers need to accomplish online. The definition should increase speeds to 100 mbps, in order to qualify as high-speed broadband internet (Bennett et al., 2021). These recommendations combined can help to close the digital divide and create far more accessible broadband internet access. These changes are needed in order to ensure that rural and farming communities, particularly those within local and regional food systems, can maintain viable livelihoods and remain relevant in an ever changing technological world.

This deep dive indicates that greater research is needed to fully understand the impact that the disparity in broadband access, as a result of the digital divide, has on small to mid-sized producers. Based on the key findings, additional research needs to intentionally focus on and include specific populations that have been significantly impacted by the digital divide, such as, Native American tribal nations and those who do not have any form of internet access and/or reliable cellular service. Considerations when conducting future research should also highlight the disparities with gender and race, socioeconomic status, technological literacy; health and age, as it relates to the digital divide’s impact on agriculture.

Topic 2: Urban food systems

How geospatial tools affect development of a resilient food system in Phoenix, Arizona

Summary

With the emergence of geospatial technology becoming a widespread tool for data collecting and information, it's more important than ever that food policy experts examine the potential of geospatial technology in urban food systems. The city of Phoenix, Arizona, has undergone massive shifts in food production and distribution in the face of climate change and urbanization, bringing issues surrounding food insecurity and farmland loss to the forefront. While traditional uses for geospatial mapping and layering of data have addressed urban heat island effect (UHI) and water usage for the Phoenix Metropolitan (Phoenix Metro) area, researchers are interested in the possibilities for using this technology to create more sustainable changes to the food system as the city looks to the future. Through interviews with food policy stakeholders in Phoenix, researchers can examine the potential impacts of geospatial technologies and look towards further research that incorporates community participation and farmland preservation.

Background

Many cities across the country are facing a widespread problem when it comes to the sourcing and distribution of food. As farmland decreases and urbanization increases, the production of food will eventually be outweighed by demand from the population of citizens (Satterthwaite, D, et.al., 2010).Technology has become a crucial tool for policymakers in the food systems space, and the need for relevant data to inform decision-making regarding local food systems is more apparent than ever in the face of climate change.

Over the years, the city of Phoenix has become a prime case study in natural resources conservation and the need for geospatial tools and data to examine trends in food insecurity, land availability, and community involvement in addressing food issues (Climate Action Plan Framework for Public Input, 2019). Within the existing research of food systems mapping and database resources in Phoenix, past uses of geospatial technologies have been centered around water usage (Larson, et. al, 2012) and urban heat mapping (Buyantuyev, et. al, 2010); Chow, et al., 2012). However, when it comes

to examining food distribution and layering databases to identify opportunities for urban food production, the lack of resources underscores the need for new technologies to support a more resilient local food system. Researchers for this project explored case studies in the literature that have created programs for urban food production and the technologies that aided them in policymaking.

Relevant case studies from across the globe

In Boston, Massachusetts, a study was conducted to assess the city's vacant and underutilized parcels for the use of urban agriculture and serve as a model for other cities. Public datasets were used to identify viable ground level and rooftop surfaces using geospatial tools, layering and remote sensing data. Additionally, food yield calculations were employed. Findings highlighted the city's ability to provide enough fruits and vegetables for all residents utilizing parcels identified in this study, accounting for 7.4 and 10 percent of the city's land surface, respectively (Saha and Eckelmen, 2017).

Another case of building food system-resiliency comes from Singapore, where 95% of all vegetables are imported, leaving the city vulnerable to price fluctuations and a reliable food supply (Agri-food & Veterinary Authority of Singapore, 2008). The Urban Redevelopment Authority (URA) and National Parks Board (NPA) launched the "LUSH" project, Landscaping for Urban Spaces and High Rises, in an attempt to build large-scale infrastructure for food production with limited agricultural land. This policy framework is intended to encourage developers to incorporate greenery into building projects (Chong, T.T, n.d.) to meet Singapore's Sustainable Development Blueprint target of 50 hectares of sky-rise greenery by 2030 (Housing and Development Board, 2008). Additionally, a related study determined that if this initiative were applied across public housing estates, local food production would increase by 35.5% (Astee L.Y. & Kishnani L.T., 2010). Researchers also estimated growing viability and rainwater exposure by calculating food miles and surface areas of public housing to address food security and climate smart practices.

Lastly, a study in Providence, Rhode Island examined the shortcomings of spatialized food injustices by employing alternative methods, such as participatory mapping, that could better reflect modern food access techniques (De Master, K.T. et al., 2019). Researchers found that traditional "food desert" mapping didn't adequately represent community resources and access to healthy food. They found pitfalls with GIS mapping in terms of limited user-friendly formatting and lack of "nuanced narrative" to reflect Providence's community. This, in addition to the previously mentioned studies, led to questions about the mapping approach used in initiatives and planning within the Phoenix Metro area.

Focus on Phoenix

For this study, researchers examine the case of Phoenix, Arizona as a city that will be faced with similar challenges of accessibility and resiliency for the urban food system in the near future. The city of Phoenix is home to approximately 1.7 million people and covers approximately 518 square miles, making it the 5th most populous city in the United States. It ranks as one of the fastest growing cities in the United States; and its population is expected to double by 2040 (Weatherhead, 2020).

The Phoenix metro area is divided into 15 urban villages with a total population of approximately 4.9 million people. Rapid urbanization over the last few decades has contributed to the urban heat island effect (UHI), indicative of higher temperatures concentrated in urban areas with less greenery and vegetation (Wang, et. al, 2016). Rising temperatures have caused "hot drought" which has reduced the availability of surface water; and scientists project the flow of the Colorado River Basin to decrease by 25% in the coming years (Climate Action Plan Framework for Public Input, 2019). Additionally, agricultural lands have been reduced by 36% over the past twenty years, posing a significant threat to the availability of farmland for food production. If this pattern of development continues, the city of Phoenix will have no viable farmland within thirty-five years (Hill, 2020) .

The city of Phoenix has a vested interest in building a resilient local food system as evidenced by their Local Food Action Plan 2025 with goals embedded in the proposed Climate Action Plan Framework (City of Phoenix Food Action Plan, 2020). Maricopa County has identified 55 "food deserts", of which 43 reside in Phoenix, spanning approximately half the city. Nearly 14% of county residents are food insecure, while 17% live in poverty and long distances from grocery stores (FACT, 2019).

In 2017, Smith et. al., conducted a study using tax assessor cadastral data, National Agriculture Image Program (NAIP), and US Geology elevation data across 22 cities in the Phoenix Metro area to determine available vacant parcels for potential greening (VPPG). VPPG were defined as land viable for increased ground cover or agriculture and was limited to privately owned land. The authors assert greening plays a role in reducing daytime UHI effect and larger, more concentrated spaces have a more significant cooling effect. Additionally, VPPG have the potential to reduce food deserts, and therefore, relevant to this study. ArcGIS cluster technology was utilized to conduct a hot spot analysis and categorized vacant land into seven categories. Three categories were viable for greening; bare soil, scrub vegetation and grass/trees. The study identified hot spots with extreme land surface temperatures (LST) concentrated in South Phoenix, a high poverty community. There were 7800 vacant lots for potential greening identified in this neighborhood alone. The map below reflects the identification of VPPG

and demonstrates how geospatial maps can be used to support the local food system. (Smith, et. al, 2017).

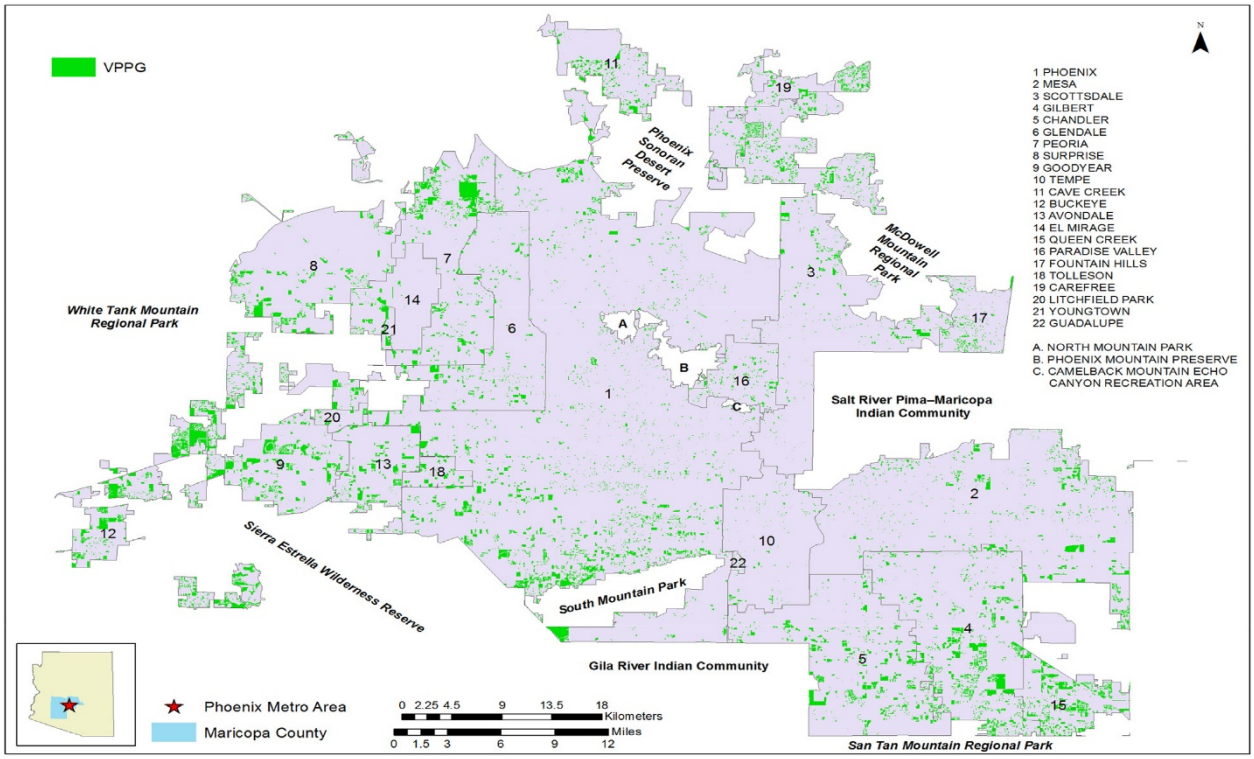

Figure 2.1: Vacant Parcel for Potential Greening (VPPG) in the Phoenix metropolitan area indicated by green coloring. Source: J.P. Smith et al. / Applied Geography 85 (2017) 139-151

For this study, researchers were interested in examining the role of geospatial tools to address food insecurity, health and land viability, with a particular focus on data layering and mapping that could better inform policy making in the face of climate change.

Research Methodology

Researchers used a two-pronged approach for this study, which included a literature review and individual interviews. The literature review informed the research question and interview guide. Search terms via Google Scholar included; Digitalization & urban agriculture, urban agriculture & technology, GIS mapping and urban agriculture, Phoenix and geospatial, Singapore and agriculture, urban food systems and food security, climate impacts and food systems and climate change and urban agriculture.

This study asks the question: *How could geospatial tools influence food system resilience in Phoenix, Arizona?*

A total of three interviews were conducted with key food systems stakeholders in Phoenix. The goal was to assess the current state of knowledge and use of geospatial tools and data to inform the resilience of the local food system. Interviewees were recruited by existing networks. The interviews started with a brief introduction about the research and interviewees were asked to provide verbal consent to participate and be recorded. Once consented, Interviewees were asked a series of set questions developed by student researchers in the Urban Food Systems group. Questions were modified slightly to accommodate the specific type of food systems work of the interviewee, as well as unscripted, relevant follow up questions related to the natural flow of the conversation. Interviews were approximately 30-60 minutes in length and conducted via Zoom conferencing technology. The interviews concluded by thanking the participants and offering to share the report after it was finalized. All interviews were audio recorded and transcribed. Interview questions focused on the following areas:

1. Background and expertise
2. Knowledge and use of geospatial technologies, tools and data
3. Challenges facing the local food system
5. Strengths and opportunities in the local food system

Background and expertise included questions about the interviewees' current and/or past relevant work related to the food system. Knowledge and use of geospatial tools included the interviewees' level of knowledge and use of geospatial tools, whether personally or indirectly. This included specific technologies, frequency of use of the technology itself, as well as the use of data garnered from technology. In the case where the technology was not familiar, it also included discussion about the type of tools that may be most useful for informing the local food system. Challenges facing the local food system included both current and future challenges. Strengths and opportunities focused on the potential of current strengths to bring future opportunities to support local food system resilience. Limitations of this study include selection bias due to recruitment of participants from existing networks, as well as the limited number of interviews conducted.

Findings

Interviews were conducted with three food systems stakeholders holding expertise in policy and advocacy, conservation and farmland preservation and healthy food and communities. The goals of the interviews were to gauge the level of knowledge of geospatial technologies within the local food system landscape, determine how these tools and data are currently being used and how food systems stakeholders see them

being used in the future to support local food system resilience in Phoenix. Common themes that developed from interviews are detailed below:

Farmland loss is the greatest threat to the local food system in Phoenix.

> "It is very tempting when the developer comes with millions of dollars to buy your farm, to sell it."

All interviews identified farmland loss as the single greatest challenge facing the local food system now and in the future. One interviewee reported, "This year alone, we've had four farms contact us about losing land and how and they're having to leave Phoenix." Additionally, an interviewee with expertise in conservation stated "We are not understanding this is going to negatively impact us because we are starting to lose the ability to feed ourselves." Rapid urbanization due to population growth has increased demand for land, which has resulted in skyrocketing values and land being sold off to development. Unfortunately, farmers that rent land are being displaced at an alarming rate and food production in the Phoenix metro area is becoming scarce. In fact, two interviewees specifically noted that we are twenty years too late to save larger plots, which was defined as twenty or more acres of farmland. Additionally, one policy expert noted a missed opportunity to include policy in the general city plan, which could have stipulated that a portion of all land purchased for future development be preserved for food production. However, all interviewees believe focusing on smaller plots ranging from three to ten acres may still be possible to set aside for food production in the Phoenix metro area. Therefore, geospatial tools to support the preservation of farmland ranked as the top priority for all interviewees.

Food systems' stakeholders are familiar with traditional geospatial technologies, but have limited use due to barriers with ease of use.

Overall, food systems' stakeholders interviewed are familiar with geospatial technologies and think they would be useful in influencing local food system resilience. However, all interviewees reported that widespread use is not actualized in their work, due to barriers with ease of use. Additionally, they believe navigating the technology requires specialized training and, for that reason, all the potential uses are unknown. An interviewee with expertise in policy referred to the technology platforms most widely used in the local food system as "GIS-esque", a term coined to describe current mapping experiences in local collaborations. The extent of use includes basic mapping tools utilizing neighborhood, city, county, state level zip code and census tract data to draw various maps. For example, to find a food outlet, farmer's markets or double up food bucks' locations. Uncertainty was noted as to whether this type of mapping technically counted as geospatial use. Furthermore, an interviewee with expertise in

land conservation is currently tasked with purchasing GIS technology for the purpose of identifying land for conservation and agricultural uses. It is anticipated an expert will navigate the technology, while conservation experts will use the data. Finally, a policy expert and former city planner reported geospatial data mapping to identify agricultural land in Phoenix is emerging, and the most credible land use data available is city assessor records.

The ability to share data amongst food systems stakeholders is essential in strengthening the local food system.

All stakeholders interviewed underscored the importance of shared data for collaboration and coalition building within the local food system. Since food systems stakeholders represent the entire supply chain and bring different experiences, agreements on shared data "are important to understanding who is doing what across the state and identifying gaps and resources." Additionally, being informed leads to a deeper understanding of what other food systems actors are doing; and this alone facilitates collaboration by simply understanding how different groups can work together. One such practice often used in coalition work is called a "data walk", which is a shared space for collective food data, available to food system's actors in coalition work. The technology platform most widely used is "my sidewalk" software. Agreed upon and shared data reduces duplication of efforts and increases efficiency amongst stakeholders in collaborative work.

Community engagement is a critical component to ensuring local food system resilience and food security.

> "We can have all the data in the world telling us to do something, but at the end of the day, if it is not what the community wants, it doesn't matter"

All Interviewees believe the traditional ways in which we look at solving food insecurity need to be reframed. Most notably, limitations in data points are barriers to community engagement. For example, putting a farmer's market or grocery store on every corner isn't always the solution. One interviewee reported, "It's like the idea of if you build it, they will come. No, they won't if it's not with community and not from community." It is most important to listen to the voices of the community, understand what they want and balance the need for technology to make data driven decisions with community engagement. The importance of understanding how close the people are to their farms and how integrated those farms are with their local communities and food systems was underscored as being the key to access. In addition to a top-down policy approach, taking a "grass tops, grass roots" approach to initiate hyper local change may drive

change more quickly than policy alone. This can be achieved by highlighting community engagement through best practices and success stories. For example, one such project, Spaces of Opportunity, rents land from the Roosevelt school district for a dollar per year. “Engaging the community to interact with plots of land, if that is what they want”, is another access point to food that meet the needs of the growers and consumers living in the community.

There is an interest in exploring geospatial tools in new ways to improve the local economy and address food security, equity and access to healthy food.

> “I drive past six farms on my way to work and we don’t get any food from those farms...that food has to go to California for processing....”

Overall, Interviewees think the way USDA traditionally defines food access in terms of food deserts is limited and doesn’t get to the heart of addressing equity and access to healthy food. Mapping does not account for the quality of food. Additionally, distance from outlet alone doesn’t address neighborhood disparities. Those interviewed also believe that the pandemic revealed challenges in the food supply chain. One interviewee stated “I think the pandemic made people more aware of the importance of growing local food, so I hope that local interest continues.” Using geospatial tools to layer asset maps that identify farms and supply chain services (processing, packaging, cold storage, distribution, food hubs) to “map how food moves through our food system” is another priority to address current limitations. This would strengthen the local system. Food leaves for these services and doesn’t return, which impacts the local economy. Additionally, although land is being lost to development in Maricopa county, there is a lot of agricultural land. One interviewee suggested another potential solution to address food security and access to healthy food is to utilize geospatial tools to identify opportunities to grow different crops that feed people, as opposed to cotton and animal feed.

Layering geospatial maps to identify viable land for food production will contribute to food system resilience.

As land continues to be lost to development, there is a growing interest in using geospatial tools to identify viable land for food production. “It is going to be important to find opportunities where food can be grown,” Additionally, interviewees think when farmers are displaced to development, viable land options to relocate should be available to them. For example, it may take five years to build healthy soil and it is not as simple as moving to any available vacant plot. Priorities include layering maps to

determine soil health, water quality and water availability, as well as identifying existing spaces, not traditionally considered growing spaces, for food production.

For example, one policy expert interviewed suggested... “A Walmart parking lot or a rooftop building, or schools, churches where they have excess land and streets rights of way.” Further stating, “Why not change from whatever landscape they are using now to plant food producing trees and really become an edible landscape.” Furthermore, another interviewee suggested identifying unusual configurations of land that are “pretty unusable other than for growing food.” Interviewees seemed to agree, the most complex food policy issue is preserving agricultural land due to nuances in navigating federal, state and local policy, which often includes all three, due to the extensive amount of federal trust land Arizona holds. Therefore, identifying both viable private and public land and exploring alternative uses on existing land is important; as it is not likely large acreage will be obtained as quickly as it is being lost for food production.

Policy will need to adapt to reflect the changing ways food is grown to sustain the local food system.

> *“*Growing crops in a field, I would guess that in 10 years, it’s going to be more the exception than the rule.”

Interviewees agree that policy to support urban food production is essential to building a resilient food system. One policy expert noted the extent to which language in favor of urban development is integrated into the general city plan in Phoenix is in direct conflict with urban food production. This provides insight into how policy experts navigate the system to include food friendly policy. For example, zoning codes are generally amended by issue, rather than universally when it comes to food production. One such example is an amendment to city zoning code in 2012 to permit community gardens in Phoenix. This seems to be an important consideration for the future of the local food system when looking at new and different ways of growing food, such as retrofitting buildings, growing on rooftops or vertical gardens that will require amendments to the zoning codes. Another interviewee stated, “food is a bi-partisan issue” and something that most people can get behind.” Statewide policy is another avenue to support local food. This includes programs like double up food bucks, which address food access and keeps money circulating in the local economy. Geospatial data can potentially be the conduit to facilitate the direction of policy. Additionally, the common strengths all interviewees noted were the growing interest in local food and the level of support and collaboration happening across organizations. This is hopeful in terms of support for future policy changes.

Reflection

The literature review and interviews in this study revealed challenges and opportunities for geospatial tools to influence local food system resilience in Phoenix. Case studies from across the globe serve as potential frameworks to guide food systems work in Phoenix as stakeholders address the city's needs now and in the future.

Interviews with food system actors made clear that population growth and rapid urbanization are accelerating farmland loss at a pace faster than it can be preserved for food production. Additionally, the pandemic exposed weaknesses in the food supply chain and underscored the critical role local food systems play in providing access to healthy food and meeting the needs of their communities. Geospatial tools most certainly have a place in navigating challenges the city will face to sustain the local food system in the future. These tools can also act as a conduit for shared data across the food system to strengthen the supply chain and facilitate collaboration amongst stakeholders.

First and foremost, barriers, such as the expertise needed to access geospatial tools, must be addressed. One solution to consider is research partnerships. For example, experts at Arizona State University Geospatial Map and Hub could potentially support local food systems stakeholders in tackling challenges that are not possible in the absence of geospatial technologies.

Additionally, the city's Food Action Plan 2025 and Climate Action Plan Framework have goals to identify public vacant parcels for food production. Therefore, utilizing geospatial tools to identify vacant land seems like a logical first step in addressing farmland loss and both traditional and non-traditional options for local food production. Furthermore, the interviews revealed a growing interest in layering maps for soil viability and water quality, as well as asset maps to identify farm locations across the state that offer supply chain services. If asset maps were widely available, this could prevent food from leaving Arizona, which would build the economy and create new jobs by keeping dollars in circulation locally.

Although not widely mentioned in the interviews, layering maps for natural resources is a potential opportunity to mitigate climate impacts and meet the city's climate resiliency goals, while addressing local urban food production. The city's Climate Action Plan proposal includes a climate hazard assessment, which forecasts future impacts such as drought, wildfire risks, water availability, extreme heat and flooding - the basis for the climate resiliency goals to specifically focus on the City's needs- in addition to the global GHG emissions targets (Climate Action Plan for Public Input, 2019). Additionally, the Smith, et. al, study referenced in the literature review demonstrates the use of

geospatial layering to identify private vacant parcels for potential greening to reduce urban heat island effect and food deserts. Layering maps to include future climate scenarios on top of vacant parcels could target land most viable for specific types of food production. For example, areas identified in extreme drought zones may be more viable for dryland farming or native indigenous crops that require low water usage. This type of layering may also determine, for example, that planting edible trees is a priority in neighborhoods identified as extreme hotspots with a low tree shade canopy. Geospatial tools show promise for creating a roadmap to target the most pressing issues Phoenix will face in regard to both food production and climate impacts to build a resilient food system.

Beyond that, geospatial maps may help guide the city in data driven decision making when considering incentive programs for residents to increase financial security, equitable access to healthy food and reduce climate impacts. Such programs may include low-cost urban plots or incentives for growers to integrate climate smart practices (no/low till, crop rotations, cover cropping, practices to increase water holding capacity, rainwater capture and carbon storage) as well as incentives that motivate private landowners to use existing land, i.e. churches, schools, and businesses, for food production.

Another key interest from the interviews is the need for technology to address community involvement that is limited by current GIS-mapping systems to accurately account for food equity and distribution patterns. A recent article from the Brookings Institute highlighted the importance of tracking modern-day food distribution patterns in the context of digital technology and census data to resolve the pitfalls of food mapping to address food security (George and Tumer, 2021). With the emergence of the SNAP Online Purchasing Pilot and the effects of COVID-19 on food delivery systems, the way communities are accessing food goes beyond the traditional assessment of food deserts. This is an important consideration in addressing the sustainability of the local food system.

The city of Phoenix and food systems stakeholders could explore the use of participatory maps in conjunction with community voices from the15 villages in Phoenix to accurately assess and resolve gaps in the data. Additionally, layering assets (supply chain services) with census data to support local food distributors in offering more accurate and timely information, may contribute to the local food system and economy. Such participatory mapping shows promise for GIS mapping and layering to become more “user-friendly”, (De Master, K.T. et al. 2019). These are important considerations for policymakers when advocating for sustainable changes to the local food system of

Phoenix. Policy will be instrumental to the local food system’s resilience as Phoenix looks towards the future of food in a growing and ever-changing landscape.

Topic 3: Data for Ecosystem Services

Case 3.A: How local fisheries use fish tracking to promote more sustainable fishing practices

Summary

Fishing has been a part of the human diet for a suspected 40,000 years (Bejcek, 2014). As the population has grown, fishing practices have adapted and evolved to harvest a higher quantity of fish more quickly and efficiently. Practices such as aquaculture have given farmers the ability to "farm" fish much like a cattle farmer, rather than relying on the open ocean for their catch. As technology increases, so does the potential for automations and more precise fishing methods. This research aims to understand how data and digitalization may help promote more sustainable fishing practices from harvesting to the consumer's table.

Background

Studies have shown that fish consumption has doubled over the last fifty years (Hang et al., 2020). Over half of this consumption is wild caught fish with the rest coming from aquaculture farms. The Living Planet Index has shown that since the 1970's, the population of wild fish in our oceans has declined by approximately 68% (WWF (2020). Size selective harvesting, specifically large sized fish (fish higher on the food chain), is common in fish markets and can shape the population of fish whether they are wild caught or farmed (Reddy et al., 2013).

With the rise of automation in fishing methods, data security concerns have rightfully been brought to the table. Using technology such as blockchain, a digital ledger, may be able to decrease the likelihood of human error through farm sensor technology and other automated systems (Hang et al., 2020). Because this ledger cannot be altered once inputted, the data is secured and as accurate as possible. Blockchain technology is currently being used to help create a more transparent supply-chain in large scale tuna fishing (Visser & Hanich, 2018). These operations are using blockchain technology to track the tuna from the moment it is caught until it is purchased by the consumer. There are some difficulties in maintaining this log once the fish is fileted, but with the whole fish a QR (quick response) code is physically attached to the tuna (Visser & Hanich, 2018). Now that this technology is being used on a large scale, the question of how it can be transferred to small local and regional fisheries remains to be answered.

While precision agriculture can help predict crop production in plant-based farms, predicting yields in fishing, whether it be wild caught or aquaculture, has proven to be extremely complex (Torky & Hassanein, 2020). Some fishermen have begun using electronic monitoring systems to record the fish caught, size, weight quantity, types of equipment used and bycatch (NOAA, 2021). This electronic data collection method validates the logbooks and catches potential errors, while ensuring compliance and recording crucial data for monitoring. This data can then be used to monitor the fish stocks and human's impact on fish population and ecosystems (NOAA, 2021). Electronic monitoring systems differ from blockchain in that they must undergo data review and analysis either by a person or artificial intelligence (AI) technology before the data can be stored in an online data system.

Research Methodology

This research was conducted by a literature review and zoom/ in-person interviews across Martha's Vineyard and Cape Cod. The literature review was conducted by searching terms associated with fishing and tracking practices in ASU journal library and Google Scholar. Terms included: "fish tracking", "small-scale fishing + blockchain", "small-scale fishing + data collection", "fishing and QR codes", "Fishing data transformation".

The interview participants were found using local fishing connections and by word of mouth. The interviews were conducted using IRB approved question prompts and interviewed individuals from the aquaculture, oyster farming, wild-caught and wholesale buyers industries.

The findings and inputs only represent a small fraction of the people involved in the seafood community and there are many other stakeholders who should be contacted such as kelp famers, freshwater fishermen, deep-sea fishermen, and/or fishermen using other fishing methods such as trawling. This study was conducted in a small local area focused on coastal waters around Cape Cod. The information gathered here is specific to this area but may be similar to other areas around the country or globe.

Limitations

This study was conducted during the summer months which is a very busy time for the fishing industry. This impacted who was available for interviews and how long the interview could last. There was also a quick turnaround time for this project that did not allow for extensive interviewing which could have yielded different findings.

Findings

All fishing operations interviewed used some form of online data collection combined with manual data collection and storage.

Aquaculture

Humans have been using aquaculture, sometimes referred to as aquafarming, for millennia (Hunt & Isabella, 2020). The ability to farm fish has the potential to reduce the stress on open ocean ecosystems and allow people to consume the fish that they demand without as many potential consequences. However, sourcing from aquaculture farms that are environmentally responsible is key. Some common areas of technological improvements include efficient heating systems, fish purging systems, water sanitation and disinfection systems, anaerobic digesters, and the overall husbandry systems and operations. There are specific data management points in aquaculture that differ from wild caught fishers, therefore many farms use aquaculture specific data management systems. One specific system referenced in farm interviews is AquaManager. This system uses an online and mobile platform to allow farmers to have real time production control, run production plans, and access this data from anywhere they have internet connection (Aquamanager, 2018).

Massachusetts has specific guidelines and regulations regarding aquaculture (MassGov). This program allows farmers to compile the regulatory data in one place for ease of submission. Along with this they are also able to track the individual fish rather than the entire tank. This helps with tracing health notes or any other data that the farmer would like to move with that specific fish. The aquaculture farmer interviewed specified that "[AquaManager] can pinpoint every lot of feed that comes in. It is recorded so if we have a fish health problem we can go back and look at that feed, pull up the records of that feed and see if we had that feed sent out to be tested for any possible contaminants that may cause fish health issues." Fish are being constantly graded as they grow on a bell curve with some fish progressing faster or slower than others. AquaManager allows this progression to be easily tracked and the specific feed ratios for the fish can be updated accordingly. Even with the ease of use that AquaManager allows, a specific person is dedicated to updating the information within the system. In addition to AquaManager, at this specific farm, an estimated ten hours a week is spent using a separate forecasting system to track inventory and sales. This is important because like most farms there is a very small profit margin. "We sell our fish at wholesale and really

"We sell our fish at wholesale and really what he's watching between AquaManager and our forecaster is how we can dial in costs."

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Potential improvement also lies in the makeup of the food fed to the farmed fish. The current ratio has approximately 10% of fish-based products incorporated into the food. Reducing the amount of marine-caught fish into the feed is their overall goal. With the technology that they use they can design the ratios in the specific feed for the type of fish as well as the life stage of that fish. Certain fish do not like some ingredients so being able to track what is in the feed, where the feed is going and at what stage helps to increase the overall efficiency of the growing process.

Online data management could help aquaculture operations hone in their feeding rates to create the most ideal and profitable processes available.

AquaManager was extremely helpful during the height of the COVID-19 shut down. The aquaculture farm sells wholesale to restaurants and small markets, which were dramatically impacted by closure. Using this management system, they were able to change the water temperature and feed ratios to slow the growth of fish in their indoor tanks to keep their losses to a minimum. An area for potential sustainability growth is the transformation of waste products. There is also potential to track the shipment path of fish. Shipping across the country is a high carbon emissary as the refrigeration necessary for the fish takes substantial energy. Using the data manager to track the lowest shipping methods or other local markets may be able to lower this output.

Wild-Caught

Blockchain technology has made a significant impact in the traceability with large scale tuna fisheries in the Pacific (Visser & Hanich, 2018). Transferring this technology to small scale fishing operations runs into efficiency issues. To make this technology useful on a small scale there would need to be demand from the consumer. On a local level many people assume that the fish they are purchasing from fish markets are caught locally. However, when these markets run out of local fish, they may supplement with shipped in catches. Finding the right technology that is worth the cost investment is critical. Potential technology options include drones, at sea weighing systems, eco-labels, blockchain and other monitoring technologies. The fishermen interviewed were wary of introducing new technologies specifically concerning user friendliness, longevity, learning curve and overall usefulness. To offset the chance of mislabeling, many wild caught fishermen on a large-scale use data tracking methods, such as blockchain. Many onboard monitoring systems were suspended during COVID-19 (Long, 2020). Systems have had to change to AI or camera tracking to conduct regulatory checks without having to place staff onto vessels.

Data collection strategies on-vessels have many barriers, but can be helpful to reduce the overall paperwork load.

There are many barriers to collecting and storing data while onboard a fishing vessel including weather, internet access, electricity sources, budgetary restrictions, and desire to learn new technologies (FAO & WorldFish, 2020). During COVID-19 some of the larger buyers of locally caught seafood, such as restaurants and catering companies, were shut down or reduced their number of units purchased. Fishermen started selling directly from the dock to the consumer. While doing this they were able to create a line of communication directly to the consumer to showcase how their fishing methods were different from other shipped in fish options. Stories like these and the technology to maintain traceability throughout the supply line will allow fishermen and consumers to make the most sustainable choices possible.

Oyster Farming

Oyster farming is one of the most sustainable sources of protein for human consumption as well as potentially restoring certain ecosystem areas (Ray & Fulweiler, 2020). A local farm mentioned trials being conducted to determine the changes that adding oyster gear will have on the ecosystem using eDNA to determine marine life and its specific locations. This introduction of oyster gear and its influences on the environment is important because areas with already diverse systems are not allowed to be converted to aquaculture. The oyster farmer put it this way: "They want to take a dead area that has no commercial value whatsoever and allow aquaculture to derive value from that by growing in this area." Using data collection methods to measure the influence oyster farming has on the marine ecosystem can influence the decisions towards the growth of the oyster industry.

"They want to take a dead area that has no commercial value whatsoever and allow aquaculture to derive value from that by growing in this area."

Simplifying the tagging process and promoting the benefits of oyster farming via online data management would be favorable among many oyster farmers.

"[there] would be a lot of transparency that I think would help with accountability, which would help the consumer more than anything."

Currently, tracking oysters is a tedious process. There are paper tags that travel with the oyster bags and are updated by the farmers, wholesalers, and other branches of the food chain until it reaches the consumer. When updating these tags, the time of harvest, date, and quantity all must be updated and manually inputted. The farmer then

must report his catch to the Massachusetts online database. All oyster farmers must also hold their written tags for approximately seven months in case of any need to look at past sales. Many oyster farmers work as both the farmer and wholesaler which means that they must keep twice as many tags. This results in a large amount of paperwork pileup and the potential for lost or mismatched data. Having this system automated would help with accountability. Regarding online data collection the farmer mentioned. “[there] would be a lot of transparency that I think would help with accountability, which would help the consumer more than anything.”

Wholesalers

One of the most difficult aspects about wholesale purchasing from wild caught fishermen is the lack of predictability. It can be difficult to track fish and on some days the catch yields vary greatly. This is especially difficult for local fish buyers because they do not ship fish from other places to fill in the product gaps. If the local fishermen do not bring in the fish, there is simply no fish to sell. Other fish markets, who are not focused on buying from only local fishermen, would order fish from other sellers to have this product available to consumers regardless of where it is being landed. The seafood collaborative is trying to “create local demand” for their fish rather than the other way around. They have brainstormed the idea of a fish CSA style program but are worried about the repercussions of unpredictable fish catches. Some weeks there could be no fish to put out on pickup day, so that style may not be a suitable answer.” We kind of have reactionary sales rather than proactive sales.” mentioned the owner. Reframing the consumer’s mindset from actively seeking out the fish that they prefer to buying the fish that is available could dramatically change the landscape of fishing. “We want to support the local fishermen and create the demand for the local product. Instead of fulfilling people's needs for non- local stuff that they're used to getting all the time at the drop of a hat.” When asked about whether the way fish are being caught is being tracked, he replied, “We do tell people what species are caught by certain methods. We go to our oysters and we talk about cage grown and certain depths with black sea bass we talk about how it's rod and reel. I think part of it within blockchain is that you're getting in the educational part of where it's coming from. I think learning how they're being caught is a great thing.”

“We want to support the local fishermen and create the demand for the local product. Instead of fulfilling people's needs for non-local stuff that they're used to getting all the time at the drop of a hat.”

The ability for wholesalers to guide consumer purchases towards locally caught in season fish may be helped by an increase in information about the fish themselves.

With the location on the coast of Massachusetts, finding local fish is not difficult but determining what has been locally caught or important can be a challenge. “I think [local labeling is] important for things being shipped around the country and to know what you're getting, here people assume it's just coming right off the dock.” Currently some wholesalers have a QR code on their product tags that takes the consumer to a website or downloads specific information. While some larger operations such as Red’s Best attach QR codes to their fish that can track back to the exact vessel that caught the fish, it is more difficult for small operations to achieve this level of detail. This becomes even more difficult when selling products to restaurants. Determining a method to produce concise data delivery to the consumer on a restaurant scale would allow consumers to see more freely and unencumbered where their fish was caught. Living in a coastal region with easy access to fish shops allows for a premise of assumption when buying fish from fish markets. It can be assumed that certain species of fish are caught locally, but that is not always the case. It can be very difficult to determine the validity of fish labeled as locally caught.

Reflections

Simplifications

Solutions to paperwork simplification include blockchain technology, applications that organize data in one location (ex AquaManager), online codes and other similar technology. A combination of any of these would lift the heavy paperwork burden that many farmers/fishers face.

There is also potential to change the tracking system from manually inputted paper tags to an online database that would automatically track the necessary information. This would allow more concise tracking systems and lift the burden of record keeping from the farmer’s plate. Encouraging fishermen to track and digitalize their fish records would automatically assign a record of where this fish was caught, thus reducing mislabeling. Blue Trace is a company that created an online printing system to help streamline the tracking process. With their technology the tagging can be done online and printed at the final stages. This system has the potential to be linked up to any spreadsheet or online database. Reframing how this is tracked could also increase transparency and garner more accountability in real time. This is especially important in cases of foodborne illnesses, which when dealing with shellfish is extremely pertinent.

Another area for growth would be a real time menu updating service. This system would use the QR code system that restaurants are using for their online menus to enable the approximation of the batch of oysters that are being served on the menu at that

moment. The menu then could be updated online and have other important information about the catch embedded in the information on the menu. When asked about this idea the wholesaler responded: “I think the best method, just from my experience, is actually somebody physically talking about the product. If the wait staff and the employees know where stuff is coming from that knowledge [will be] passed along to make the second step.” While this system has many barriers before it is developed, it could directly link the restaurant and consumer to the fisherman.

Stories

An overarching theme appeared over the course of the interviews: stories. Farmers, fishers and wholesalers all mentioned the importance of storytelling. Showing the public the stories and truth behind the fishing industry will increase transparency and allow the consumer to make the most informed decision. While there was no consensus on the best way to get these stories to the consumer there was a sense that face to face conversations are the most impactful way to relay the messages. While this is not feasible for communities that live hundreds of miles away from the fishers who are raising or catching their fish, technology provides an opportunity to connect the consumer to their fisher.

Final Thoughts

Creating a system of digitalization within the small-scale fishing industry will take the efforts of many different people. From the fishermen, wholesale purchasers, restaurant owners all the way to the consumer. Changing how people determine which fish they choose, how those fish are harvested, caught, or raised and the importance that is given to sustainable methods is a first step. Reducing the paperwork and filing loads on farm owners and fishermen will hopefully encourage more new farms to begin and allow more time to be diverted to other beneficial opportunities. Enhancing these opportunities for small-scale and local fishing operations is crucial to keep large operations from overtaking the market.

Case 3.B: Building Clarity around Data Usage in Food Supply Chains

Summary

As food systems become further digitalized, it is vital that secure and thorough data networks are put into place. Technology advances in agriculture have led to more data collection, and establishing channels to get this data to consumers, thus increasing transparency throughout the system, is met with challenges that must be faced. Supply chains are complex, and communicating data from the producers all the way to consumers is a task that will require coordination at every step along the chain, increasing costs and leading to shifting practices. The following deep dive asks: What hurdles to sharing on-farm data with consumers currently exist, and what factors would encourage farmers/ build trust in sharing their farm-level data? Farmers face a lack of access to resources to effectively collect and manage their data and a lack of transparency around how their data is being used once it leaves their farm. Increasing education around data usage in the food supply chain, along with establishing resources and financial incentives that encourage farmers to engage in this data sharing, are clear steps in the right direction at the farm-level.

Background

When looking at the impact that digitalization in agriculture will have on local food systems, it's important to consider the influx of data available to collect and analyze to help improve food systems. As increasing amounts of data are available through digitalization of agricultural processes, potential benefits and challenges arise. Big data and precision agriculture can improve sustainability in food systems through climate-smart practices, and increasing exposure to these through transparent supply chains is vital.

Benefits in Data-Sharing in the Food Supply Chain

According to Ingram and Maye, digital agriculture "offers the ability to utilize technology to convert precise data into actionable knowledge to drive and support complex decision-making on-farm and along the value chain." (Ingram, 2020, p. 2) Smart farm tech can provide specific and localized data to farmers, which drives a shift towards data-driven management. Accessing data allows for further innovation in digital agriculture: more efficiency, equity, accountability in supply chains, and sustainability. Data collection and analysis from farmers can promote food safety and sustainable production and better land use, and also encourage innovation. (Schroeder, 2021)

Brewer et al suggest that a data trust framework must be built to help govern the sharing of data throughout food supply chains. (Brewer, 2021) When considering transparency within food supply chains, we often think of further clarity for the consumer on where their food comes from, what practices the producer of their food is engaging in, and how their food got from point A in the supply chain to their shopping basket. Consumer advocates speak of scenarios in which, at the grocery store or local market, you can attain data on any food item you wish to purchase, thus making a consumer-smart decision around the food you choose to buy and eat.

On-farm sustainability initiatives must take environmental impacts into account, and data-driven efforts help ensure this. Precision agriculture can "decrease fertilizer, pesticide, and water inputs while increasing conservation effectiveness to maintain sustainable ag at a field level and sustainability across a watershed." (Delgado, 2019, p. 2) To effectively promote precision agriculture, there is a need for site-specific ag management and spatially-managed data.(Schroeder, 2021) Precision Conservation and Precision Ag both will be data-driven and provide major benefits to existing system— this data collection can integrate scientific and farming communities on regional and global scales. These processes require human capital and training in farming to process data, but this data will allow farmers to manage nutrients and other inputs and outputs more effectively at a farm level. Agricultural science moving directly to the farm could reduce external costs, as farms could serve as the data generators themselves. (Delgado, 2019)

Challenges in Data-Sharing

This idea and others like it, and the ability to enact them on a large scale, are far easier said than done. In order to attain transparency in the food supply chain and attain other goals of digitalization of food systems, there must be reliable systems in which data can flow from the producer level to the consumer level. This will take monetary and time investments that must be rewarded with concrete value added to producer-level operations. Usually, regulation of factors in the food supply chain requires actors to trace their products to just one step prior in the supply chain, creating fragmentation. Fluid data exchanges can be severed by distrust between different supply chain members, financial and human capital barriers, and the complexity of managing data ownership. In most cases, private companies make their own agreements on data governance when exchanging data, sometimes having to take local data protection regulations into account. Because these agreements are often made in the short-term and there is no industry consensus around data sharing, inequalities and inefficiencies can emerge in the long-run. If food systems are to become further digitalized, further clarity on data governance and exchange must be established to “secure a wider public

purpose and facilitate the necessary trust to stimulate data exchanges across the whole food sector." (Brewer et. al, 2021, p. 543)

Increasing the usage of data in ecosystem services also faces the challenge of building trust when collecting data from farmers. Agriculture is very relationship-based, and often farmers are hesitant to take on new technologies without fully understanding how they'll change their day-to-day operations. Digital networks between farmers and other actors can both formalize knowledge transfers but also undermine interpersonal relationships and networks. Once data is collected, to conduct a thorough analysis of the complexities on farms, a human-centered approach is needed. Experiential knowledge must be incorporated into the technological processes that produce data for farm management. (Ingram, 2020) To build trust in using data ecosystems, Wiseman (2019) and other scholars call for the creation and implementation of data-sharing laws around agricultural data collection. "If smart farming is going to realize its potential, then the broader legal and regulatory issues must not be ignored." (Wiseman, 2019, p. 10)

There cannot be one single approach to data collection and sharing as it differs among types of agricultural operations. Farmers fear that their data will be used against them in the marketplace and from a political standpoint. When farmers begin to use smart farming technology, it is not always transparent how much of their data they are giving away; the majority of farmers do not know about the terms and conditions of data collection when they agree to tech service providers. Ownership and agency around data will only come if law is written to protect the data and transparently communicated with farmers and all stakeholders. While tech providers call for the importance of open data, farmers must be given a clear opportunity to consent to their privacy settings and data usage; this means defining what farm data is considered personal vs. farm-level. It's also important to consider that all of this legal and trust-building work takes human capital and energy.

Farmers are hesitant to share data because they believe other organizations downstream will reap the profit and benefit from this data sharing. 49% of farmers do not believe their customer has a right to know how they manage their farm. However, according to the Farm Journal, 71% of farmers report that their primary agricultural advisor or consultant did not suggest increasing data collection and reporting on the farm. (Farm Journal, 2020) Farms are complex systems that require networks of relationships, including those between the farmer and their agricultural advisor. Sharing of some farm data could increase asymmetries of access to knowledge in the supply chain and could compromise smaller farming operations. Agricultural operations may be more willing to commit to data sharing with financial incentives involved, but remain

concerned with third party interests accessing their data. These concerns around trust highlight the need for open dialogue around data usage.

It is complicated to determine how to share financial benefits of collecting agricultural data with farmers themselves, but without these boundaries clarified, digitalization of agriculture could create imbalance wherein some poorer farms have to sell their data and bigger farms maintain control over theirs. (Schroeder, 2021) There exists an inequality of bargaining power in who has to contribute their data versus who can control and share their data at their own means, and this inequality often targets vulnerable and smaller agricultural operations. For digitalization of agriculture to be beneficial to both public and private sectors, entities have emphasized the importance of data being open under public domain with minimal restrictions. If data is equitably accessible, then this access to data can help bridge the gap between smaller and larger farms, making them comparably profitable. However, data collection technologies and human capital for analyzing this data are far more doable in larger industrial agriculture ventures. There exists uncertainty on who can own, access, and control data, and how to keep value chains balanced. In the face of these challenges, farmers are not eager to share data and digitalize.

Another challenge is adapting to different needs for data collection on different types of farms. How much does/should the farmer be a part of the data collection process? How do you use technology to effectively specialize data for different farm types? How does data collection differ? What does each farm need? Agricultural systems are complex--large farms have different organizational structures than smaller family farms, and the type of agricultural activity and use of farmland on a farm calls for different methods and approaches to data collection. Data that relies on sampling cannot be consistent across the board and difficult to cooperate with different-sized operations in collecting applicable information, and sometimes farmers just do not have the existing reporting tools in place to gather data and are not too concerned with setting these up. Depending on whether farming operations are vertically or horizontally integrated, data can be tricky and expensive to maintain. (Vrolijk, 2013)

Research Methodology

In order to engage in this deep dive, research into existing literature was conducted. This research honed in on the benefits of data exchange in digitalized food systems, and the challenges that the food system is currently facing in collecting and putting this data to use. The following phrases were searched via the ASU resources and Google Scholar: “data usage in agriculture,” “challenges of data sharing in food systems,” “trust in data sharing in agriculture,” “increased transparency in food supply chains.”

After gathering preliminary data from online sources, feedback was then collected through a series of interviews with farmers. The farmers interviewed for this research are based in Iowa, Nebraska, and Arizona, on varying sizes of agricultural operations. One farmer, a seventh-generation farmer in Iowa, runs Continuum Ag, a soil health company that has one of the largest private collections of soil biological data, and they work with thousands of farmers. Another farmer operates on less than 4 acres of land and belongs to a cooperative in Phoenix, Arizona. The third interviewee runs a mid-sized farm in Nebraska. The feedback from farmer interviews was then analyzed in the context of the preliminary online research.

If given more time on this project, more farmer interviews would have been conducted. Each interview contributed immensely valuable feedback to the findings of this report.

Findings

In interviews with farmers around data collection and usage on their farms, a few common threads emerged.

The first is this: most farmers have complex systems of data collection built into their machinery. Two farmers spoke of the software installed into their machinery that automatically collects yield, input, and harvest data via monitors and GPS systems within the machinery. The farmer with the smallest operations of 3.75 acres spoke of manual data collection, and creating logs of inputs on their farm and of their sales. In the case of the small farmer, they collected data to share with their organic certification agency, but otherwise, they kept most of their data logs to themselves. When mid- to large- sized farmers buy improving machinery, it often comes with built-in software that gathers precision data on their farming practices and collects it in a database via this machinery software. One farmer cited that this machinery collects “more data than people will use,” mostly because they do not know how to nor do they have employees designated to this task, so the ability to use this data productively becomes more overwhelming than anything.

However, farmers cited a lack of clarity with the software providers on how they protect and utilize farmer data. Equipment manufacturers, in building advanced software into their machinery, have been able to “build a moat around their business,” as farmers are required to buy into newly released software that pairs with the machinery they own. This puts farmers in a tricky spot where they don’t often have the capacity to make decisions around what data is being collected. As one farmer stated, in reference to equipment manufacturers accessing farmer data through their equipment, “I think there's a lot of times where farmers would like to unplug or turn off somebody's ability to

go take [data] from them." Even though the new technology can be extremely helpful for farmers, they lack the resources and time to do appropriate education on the data sharing implications of implementing these technologies, and feel as though organizations using their data are intentionally obscure about how it gets used. There are also a variety of different databases that collect different types of farmer data. This lack of cohesion around data collection and management makes it difficult for data to flow through the supply chain from the farmer.

> "I think there's a lot of times where farmers would like to unplug or turn off somebody's ability to go take data from them."

Next, farmers agreed with the importance of building transparency along the supply chain, and they believe that using and sharing data is a powerful tool to do so. However, building seamless data flows throughout the supply chain is pricey, and even though consumers are demanding more and more transparency, it is unclear whether consumers are willing to absorb this cost. Farmers emphasized that they need to understand what data they need to collect that will actually drive value, because right now, it's an additional cost to collect all the data needed. One farmer asked, "Right now we don't thoroughly understand what a consumer actually wants to see at the end of the day, and is it robust enough to actually be able to drive any real outcomes?" It then becomes a question of who is going to pay for these processes to be implemented, and whether it'll be more expensive to build and create a new label than what a consumer is willing to pay to have it on there. When farmers are told they need to implement new practices and there's no money coming to support this, it can run smaller family farms out of business, as they're not able to participate unless they can guarantee improved profits in the long-run. One farmer expressed how "everyone wants transparency and no one wants to pay for it," stating that the moment he states the cost of implementing new data transparency initiatives, the need and opportunity for it goes away. "There's enough work in farming already," shares one farmer, "and the layering of more work without being economically beneficial is sometimes hard to justify."

> "Everyone wants transparency and no one wants to pay for it."

Another issue that arises here is how to standardize and measure sustainability practices all along the supply chain. More standards-setting organizations are emerging to streamline this effort, but at this point, it's still messy and farmers have not received a clear message on what standards deserve attention. One farmer spoke of the different sustainability practices that farmers can enact and communicate, and how there is a need for standardized verification and data collection, so that sustainability approvals are meaningful. As these standards of sustainability and best practice become clearly defined, farmers will require more support on-farm to help collect and share the data

that is being asked of them. This is just the beginning of the challenge in coordinating the transfer of data through the supply chain, but it shows the monetary and time-based investment that farmers will need to make to set this in motion. For data to travel from the farm-level, through complex supply chains, to the consumer, there need to be systems set in place that carry this data and maintain its integrity from point A to point B, without expecting farmers to absorb extra costs.

When looking at the issue of data protection, policymakers may lean into the need for clearer and increased regulation around data protection and usage. Most farmers, however, were pretty turned off by the idea of having to deal with more regulation and did not see this as a solution. Instead, they focused the conversation around education and incentivizing data sharing and transparency. If farmers can ensure that data-sharing and instilling the procedures that come with it will increase their return on investment on their farm, they will eagerly find a way to get on board in a way that works for them. To this point, farmers emphasized the importance of letting the farmers respond to market forces on their own, without regulation. Additionally, farmers spoke of the potential of acquiring resources to start up some of these data collection and management procedures.

Farmers spoke to the importance of education all along the supply chain in increasing data usage. One interviewee emphasized how education needed to happen at the consumer level. Stating how “as consumers, we do not have connection to our start-to-finish processes. And being able to relate to how your food is grown, where it comes from, and how we treat the worker is a vital educational process,” they highlighted that consumers must demand transparency around environmental effects of farming, fair treatment of farmworkers, health and nutrition matters of the food they consume, etc. This consumer education can then put pressure on the food value chain to improve its practices and be transparent about them too. Other interviewees cited the importance of extending education resources to *farmers*, getting them all to understand what increased data transparency would mean for them and their farms. This education would help mitigate some of the fear and hesitancy that farmers have around sharing data. Emphasizing how regulation creates more headaches and costs for farmers with less means. They discussed how there will always be individuals who bend regulations. “What I'd rather see is instead of the government putting a bunch of much money into regulation,” the

“What I'd rather see is instead of the government putting a bunch of much money into regulation is for the government to put money towards education and to financing some of these programs that allow people to test and try stuff and that will reward those that are increasing transparency.”

farmer stated, “is for the government to put money towards education and to financing some of these programs that allow people to test and try stuff and that will reward those that are increasing transparency.” One farmer called for increasing communication between farmers and other supply chain actors, so that they can offer their voice to these conversations around data transparency and get the funding they need.

Reflection

In interviewing farmers, a few differences came to the surface in the research done prior and via the conversations had with farmers. Most of the academic research conducted centered around the need for building frameworks and further regulation to protect farmers’ data. However, farmers spoke of the current overregulation of their operations and the importance of keeping markets as free as possible as farmers adjust to more sustainable practices and share these via transparent supply chains. Additionally, most farmers are willing to share their data on the basis of financial incentives above all else. Farmers would like to increase open conversations around data sharing in supply chains, and look towards education initiatives to help ease hesitation around data sharing.

It was interesting to hear the different extents to which they had thought about data in connection to their operations based on the size of their farms, how long they/their families had been in the farming business, how they sold and marketed their goods, and so on. Though the small farmer likely had the most sustainable practices and most connection to the consumer, they seemed to have thought the least about data usage. It’s important to consider the implications of this. When agriculture is localized and exists on a small scale, it’s much easier for the processes involved to be transparent and clear to the consumer, but if consumers demand data sharing of their products, this could create a barrier for farmers of smaller operations who do not have the capital and money to implement data collection and management on their farms. However, farmers of all sizes spoke of the barriers to entry in data transparency. The farmers with larger operations thought often about data, and had many remaining questions around its usage and risks, and where their data is currently being managed and held.

The founder of Continuum Ag elaborated on their data-sharing policies for farmers who are clients of their services, and their work sets a good model for building strong data networks from the farm level. Continuum Ag built Topsoil, the first soil health data platform that connects with an array of different data tools that farmers use to quantify, map, and create actionable recommendations around soil. Their founder recounted that they have had good luck getting farmers onboard with their services. They show

farmers the value model, how their profits and yields will increase as they manage their soil health more carefully and farmers own their own data. While this data ownership is not a major part of their marketing model, it's clear, in writing, as soon as a user creates an account on Topsoil, that they own their data. Beyond this, there's no further regulation on the farmers' data in the system. He highlighted that whenever someone other than a farmer begins to own a farmers' data, they will find ways to profit off it, thus it's important to keep all data in the hands of a farmer and allow them to share it with the supply chain via value incentives. A major challenge the company faces is that "farmers have tons of data, but it's spread right now into lots of different platforms, and these platforms don't typically talk to the other ones, leaving the data fragmented." Topsoil is working to bring this data together so that it can communicate and flow more readily along transparent supply chains.

"Farmers have tons of data, but it's spread right now into lots of different platforms, and these platforms don't typically talk to the other ones, leaving the data fragmented."

Key Recommendations:

After speaking with farmers and gathering academic research, the following recommendations were formed:

1. Create a cost/benefit analysis for farmers of different sizes and operations in collecting and storing data. Quantify what value this increased data management will bring to their farm, and highlight the risks as well.
2. Establish exactly what data consumers are looking for from farmers, and the most efficient tactics to share this data. Standardize sustainability tactics and set clear metrics on how farmers will present this data across the board.
3. Conduct a system wide approach to the uptake of data usage in farming by building conversations and increased education around data collection. Bring producers, machinery companies, manufacturers, consumers, government regulators, AgTech companies, and Think Tanks into this conversation. Start with an education-based approach, build in financial incentives, and then consider the role that government regulation has to play as a last step.
4. Encourage education over regulation to increase trust in data collection and data sharing. In order to set the groundwork for further data collection in the industry, education and transparency around data usage must start with agricultural advisors and individuals who work with farmers, so that they can set a precedent for best practices in data collection and management.
5. Encourage machinery companies to be clearer about the data they collect. These companies should work together to pull agricultural data into a unified platform where farmers own their data.

Topic 4: The impact of COVID-19 on local and regional farmer's use of digital tools

Case 4.A: How COVID-19 impacted adoption of digital tools for local and regional farmers in Colorado

Summary

COVID-19 impacted the way that many different types of businesses and industries operate. For many local and regional farmers, their businesses were impacted by a decrease in customers at in-person farmers' markets and, for some, an increased opportunity to capture the growing number of online sales. This project sought to explore the impact that these market forces may have had on the adoption of digital tools by local and regional producers, as well as a forward-looking question into how the use of digital tools may be impacted by the pandemic into the future.

Background

Shifts in Consumer Purchasing Habits due to COVID-19

The COVID-19 pandemic shifted consumers to purchase their groceries online, more than they ever have before. Specifically, 33% of households purchased their groceries online in May 2020, while in 2019 only 13% of households did (Thilmany, 2020). This increased demand speaks to the safety concerns consumers experienced, especially during the initial "lockdown" periods in the first few months of the pandemic. This created a new opportunity for grocery retailers, grocery delivery services, and online marketplaces as well as local and regional producers who were able to sell their produce online, either through their own website or through a partner or third-party.

Consumer Motivation for Buying Local Food Before and During the COVID-19 Pandemic

In 2018, 55 percent of consumers made a conscious effort to buy locally grown food, according to a survey conducted and released by *The Packer* (Kresin, 2019*).* The motivations that consumers listed for making local purchases included supporting small farms; supporting the local economy; interest in freshness, taste, health, food safety; and concern for the environment (Martinez, 2021).

During the first few months of the COVID-19 pandemic, when it began to impact consumers in the U.S., online sales of local food increased 360% in the second quarter of 2020 (Thilmany, 2020). These increased sales reflected both an increase in the number of orders as well as the amount spent per order. Research has indicated that consumer motivation during this timeframe was driven by supply chain issues that led to a lack of stock in regular grocery stores, leading consumers to seek out local suppliers of fresh produce (Hobbs, 2020).

Research Methodology

The analysis for this deep dive was driven by two methods of research: Individual interviews with local and regional farmers and ranchers in Colorado and Montana, as well as a literature review, to gain background information about existing information and studies on the topic.

Both methods of research were conducted in pursuit of answering the question: *Did local and regional farmers begin to use new digital tools for the first time due to the COVID-19 pandemic, and will they continue the use of them beyond the pandemic?*

Interview Process

Before starting the interview, participants were required to verbally agree to participate after listening to an IRB-approved consent form being read aloud. Interview participants were identified through existing relationships and with the assistance of the Boulder County Farmers Market nonprofit group. The interview objectives were to obtain in-depth perspectives from several farmers on the question topic.

Interview questions consisted of the following areas:

- Background information on the farm (size, type of products, rural vs urban location, amount of years in farming, primary format for selling).
- Use of digital tools before the pandemic, during the start of the pandemic, current use, and projected future use.
- Impact of the pandemic on sales and format for sales (e.g. digital vs in-person at farmer's market).

Interviews were conducted via Zoom and only the audio recording and transcripts were saved for use in this research project. Interviews were 30-60 minutes in length. Transcripts and detailed notes were used to support research analysis and to identify common themes and experiences.

Literature Review Process

The search for relevant research, studies, and literature were conducted through the ASU Research Library, Google Scholar, reputable news outlets, and academic journals. Search terms included: technology used by farmers in COVID-19, farmer digital tools in COVID-19 pandemic, local farm e-commerce COVID-19, agriculture digital marketing tools COVID-19.

Limitations

The number of producer interviews was limited due to their lack of time available in late July and August. This is one of the busiest times in the farming season for farmers in the Western United States, so the amount of conducted interviews was limited to three even though there was interest and willingness from many more farmers who were unable to devote the time needed for an interview.

Additionally, this project was limited geographically to two U.S. states, Colorado and Montana. Conducting interviews with producers from additional parts of the country, including a mix of urban and rural could yield interesting different results and possibly also identify trends specific and tied to geographic regions.

Findings

Common themes

Producers interviewed, for the most part, did not begin to use a lot of new digital tools due to the pandemic. However, they did increase the frequency and intensity of use of digital tools that they were already using before the pandemic.

The producers interviewed said that while the types of digital tools they used did not change, they did increase their frequency and intensity of use.

One producer who is located rurally, about a 4-hour drive from the major metropolitan area in his state, said that due to the rural location of his business, he was used to conducting business through digital tools like social media marketing, an e-commerce platform on his website and partner/third party websites.

> "In the first years of our business we used in-person farmers markets as a primary way to reach customers and build a presence in the community. In 2020 when they stopped doing in-person farmers' markets due to the pandemic, we shifted to using social media more as our primary way to reach customers."

A separate producer also credits her rural location to (pre-pandemic) early adoption of many digital tools that enabled her to connect with customers and drum up sales while not located near where the majority of her customers reside in the state.

Many producers said the digital tools became crucial elements of their business's success during the pandemic to adapt to fewer in-person sales and marketing opportunities.

One producer said that if he hadn't already had an e-commerce platform set up ahead of the pandemic, his business would not have seen the sharp increase of sales that occurred with COVID-19. His sales increased dramatically to the point where he was running into bottlenecks with processing plants in order to get his product to customers.

A separate producer said, "In the first years of our business we used in-person farmers markets as a primary way to reach customers and build a presence in the community. In 2020 when they stopped doing in-person farmers' markets due to the pandemic, we shifted to using social media more as our primary way to reach customers."

"We started communicating more on social media as the pandemic went on - just as a way to reach out to the community when we didn't really know how else to do it."

The most valued tools were social media marketing and e-commerce.

"We started communicating more on social media as the pandemic went on -- just as a way to reach out to the community when we didn't really know how else to do it," says one producer. She credits her business's presence on Facebook and Instagram as crucial avenues for customers to discover their products and then click through to either purchase through their website or to register for an upcoming event at the farm.

"We had a large volume increase (in sales) … we were using the same tools, but doing more volume overall, on the website sales in particular. We saw that happen in correlation with the pandemic absolutely -- when the grocery store shelves were emptied, they came to me."

Another producer cites their e-commerce platform on their website as his most valuable tool during the pandemic to capture online sales. "We had a large volume increase (in sales) … we were using the same tools, but doing more volume overall, on the website sales in particular. We saw that happen in correlation with the pandemic absolutely -- when the grocery store shelves were emptied, they came to me."

Many producers leaned heavily on their existing digital tools in new ways that they had not before the pandemic.

In-app social media shopping

While there were not many new digital tools being used by the farmers interviewed, several of them spoke of ways they expanded the use of digital tools that had already been in use before the pandemic.

One urban farmer started using the “Instagram Store” feature which allows business owners to directly integrate the catalog of their e-commerce store into their Instagram profile, allowing consumers to make purchases without leaving the Instagram application. The farmer attributed a large share of sales from new customers through this newly activated channel. While they had used the Instagram app previously, they had used it as a marketing and communications tool and not for direct-to-consumer sales.

While outside research and data on in-app social media shopping is still developing, Instagram has shared that 130 million Instagram accounts click through a shopping post to learn more about products every month (Instagram Internal Data, 2019). Additionally, a 2020 survey showed that 44% of users use Instagram to shop weekly (Instagram Internal Data, 2020)

Experimentation with social media and Google ads to boost online sales

Additionally, a separate producer who had used social media platforms to market their products and connect with customers began trailing a small budget of paid ads on social media and Google Ads to expand their reach. They said it was too early to tell if this new effort was resulting in increased customers and plan to continue spending small amounts on social media as well as exploring Google Ads. Overall in 2020, digital advertising increased by 12.2% according to a report from the Interactive Advertising Bureau (Graham, 2021).

Reflections

There is value in further exploring this question with a larger sample size of farmers, with a focus on multigenerational farmers. This project interviewed two millennial and one boomer farmers. Seeking out information from additional generations of farmers would be insightful, as well as increasing the overall sample size to gain additional insights into trends across local and regional producers.

Additionally, conducting this research in 1-2 years may prove fruitful to see if farmers are able to reflect on their experiences during the pandemic with digital tools and better understand how they may have informed the way their businesses proceeded thereafter.

Closing Thoughts

Overall, the implications of COVID-19 did not make a sizable impact in shifting which digital tools were used by the producers interviewed. However, the pandemic cemented the producers' need and dependence on these tools in a way that did not exist before COVID-19. Due to consumer demand and public health restrictions, producers leaned heavily into the use of these tools and explored new ways to use them to digitally conduct their business, sales, and marketing when in-person options decreased.

Further research on this topic would be valuable to best understand the ways that local and regional producers continue to use digital tools to adapt their business methods based on the impacts of the COVID-19 pandemic.

Case 4.B: The Impact of Direct-to-Consumer Facebook Groups in Minnesota and Wisconsin

Summary

The 2020 COVID-19 Pandemic changed the way consumers in the United States access food. In a world with interrupted supply chains, producers were forced to find new and alternative access points to buyers. Two of these access points were Farm Direct Facebook groups based out of Minnesota and Wisconsin. These groups, with over 60,000 members each, connect producers to a new market and give consumers a way to connect digitally with growers in their area. These groups not only act as a marketplace, but as an information exchange for peer-to-peer learning. This case study examines the interactions and data generated by these two groups over the past 16 months. Facebook groups like Farm Direct Minnesota and Farm Direct Wisconsin present new opportunities for commerce as well as new challenges.

Background

The impact of COVID-19 on the food and agriculture sector is still playing out and thus literature on the topic is limited. Preliminary research on the pandemic began as early as April 2020, with additional studies and publications continuing to be published. One widely studied topic is how the meat industry was dramatically impacted. COVID-19 exposed longstanding food system issues that are often ignored in the meat industry (Campuzano et al., 2020). Consolidation of meat processing plants has lengthened the path from farm to consumer and weakened local processing capabilities (Schaffer & Ray, 2020).

The meat industry was not the only sector of the food agriculture world impacted by COVID-19. The theory of ecological resilience has recently been applied to the food system (Worstell, 2020). This theory refers to the degree of disturbance the system can buffer before entering the collapse/release and reorganization phase (Worstell, 2020). COVID-19 has created a major disturbance to the food system and has led to reorganization. Grocery stores have been resilient during the pandemic, while restaurants have struggled (Worstell, 2020). A movement towards direct delivery of foods and smaller supply chains has been invigorated over the course of the last year (Worstell, 2020). The shortcomings of a large and connected food system have been exacerbated and now some communities are looking to increase resilience through independent, but interconnected networks (Worstell, 2020).The COVID-19 pandemic

"An upcoming trend in the United States is direct to consumer services provided via social media platforms like Facebook."

has tested the resilience of the food system and highlighted areas for adaptation (Worstell, 2020). However, as discussed on the Food Navigator Podcast, Julian Mellentin, a consultant for the food and beverage industry, states, "It is far too easy for people to come along and say the coronavirus will change everything. But that is not what history shows. History shows that there are pre-existing trends… and crises accelerate those changes." (2020). Direct-to-consumer services have rapidly increased, while many traditional grocery brands try to develop an easy route to market and become online first brands (Galanakis et al., 2021). In Eastern Europe, the COVID-19 disruption invigorated online platforms and built new relations between producers and consumers (Darnhofer, 2020). An upcoming trend in the United States is direct to consumer services provided via social media platforms like Facebook.

Facebook allows individuals to form "Groups", which act as a digital meeting place for people with similar interests (Facebook Groups, 2021). Groups have been a part of Facebook since 2010 and studies have shown that interactions in these communities encourage sharing knowledge and connecting across the platform (Morse & Brown, 2021) (Pi et al, 2013). Two direct-to-consumer food groups of interest are Farm Direct Minnesota and Farm Direct Wisconsin. According to a news article interview with a member of Farm Direct Minnesota, one farmer in the group, "...has never been busier." (Young, 2020).

Although not a new concept, Facebook Groups have been reinvigorated during the pandemic. The disturbance has forced consumers and producers to find new ways to connect and one of those ways is through social media platforms.

Research Methodology

The researchers set out to investigate: "How has the COIVD-19 pandemic impacted producer to consumer relations?". The main research question being, "How have direct to consumer Facebook Groups in Minnesota and Wisconsin (Farm Direct Minnesota and Farm Direct Wisconsin) changed the agriculture market for producers and consumers?" To answer this question, researchers spent time exploring the structure and interactions within these groups. Time was spent examining group rules and the connected websites of each group. Using the search function within the two groups, key terms were searched including the terms: question, meat, sale, GMO, marketing, connecting, and vegetable. Key posts within the groups were identified, interactions on different types of posts were analyzed, and the number of likes different types of posts

garnered were documented. Additionally, the number of “topics” hashtagged in each group was recorded and sorted into three categories: location, product for sale, and other. Once data was collected, the groups were compared and contrasted. The significant posts were sorted into categories based on content.

Research Limitations

Multiple barriers were encountered when trying to answer this research question. The initial plan for the study included a survey that was going to be shared on the Facebook Pages. A survey was developed with specific questions for the producers and separate questions for consumers. The intent was to get consent from the admins of the groups before posting the survey However, after over a month of trying to get the survey posted, researchers were unsuccessful in coming to an agreement with the admins. Additionally, without backend analytics data only available to admins of the groups, data collection was limited in scope. This data includes: posts per day, interactions on posts, member joining activity, daily visitors to the page, and age of members. The final barrier to research was the way Facebook sorted information within the groups. It is not always apparent how discussion posts are being displayed. Are they displayed by popularity, top comments, most recent, or default (an order that encourages participation in the group)? These three factors changed the depth of the study, but valuable information was still gathered.

Findings

Farm Direct Wisconsin

Farm Direct Wisconsin was the first of the two groups to start and was created on April 23, 2020. The page description states:

Farmers are hurting in Wisconsin. I know there are a lot of people who would love to buy products directly from a farm, but don't know how or where to look. If you are a farmer and have products to sell, list your city and what you have to offer. (Farm Direct Wisconsin)

At of the beginning of September, the group had just over 61,000 members that had joined the private group over the last 19 months. From September 8-15, 2021, 82 new members joined the group. Current public metrics state that there are about 190 posts per month, not including comments, this equates to roughly six posts per day. The group operates with the following set of six rules:

1. Check the Topic for vendors near you; Please go to "Topics" at the top of the page under Invites on mobile devices or to the right of the posts under the picture on desktop, and find your location. All vendors are sorted by location. Please do not post "looking" until you do.
2. Vendor Rules; Your post must begin with your city first, products then contact info. Website/Facebook link/email or phone number. You must make an actual Post to be placed in the appropriate location.
3. Do not post for others; Please do not make a post for someone else's business. You do not know their situation. Please instead send them a link and ask if they would like to offer their products. I will remove posts if I find out they are not the actual vendor. Thanks!
4. No political posts; Any post which is perceived to be political in nature may be removed at the Administrator's discretion.
5. Be Kind and Courteous; We're all in this together to create a welcoming environment. Let's treat everyone with respect. Healthy debates are natural, but kindness is required.
6. This is not a live animal or equip Buy/Sell Group; No buy/sell for live animals, equipment or supplies.

The group is managed by four Admins. The Admins must approve any new post in the group and verify that the posts do not violate the group rules.

If a producer wants to post what they have available, they would create a discussion post with their location listed at the beginning of the post, they would then list their product availability, contact information, and any appropriate hashtags so the post would be grouped with similar topics. If a consumer is looking for a product, they could search the topics, search the whole group using keywords, or if they do not find the product, they can post an ISO post (in search of).

The “Topics” in the group can be seen in the following figures.

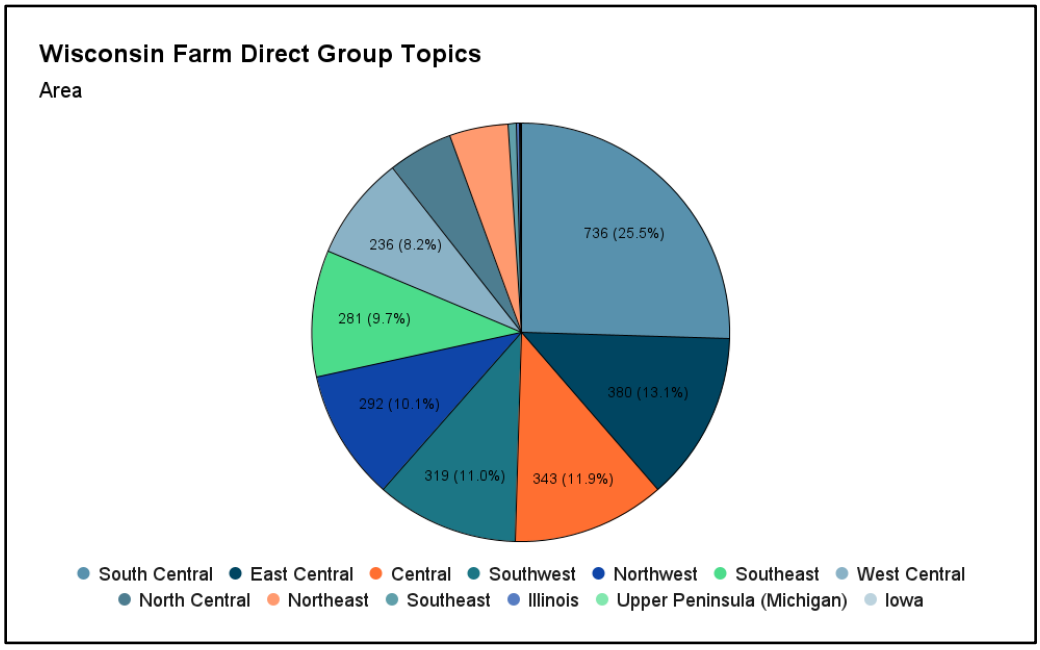

Figure 4.B.1: Shows the areas producers are tagging the most in their discussion posts. The legend is ordered from most mentions to least. Just over half of the area topics are in the central area of Wisconsin. (Farm Direct Wisconsin)

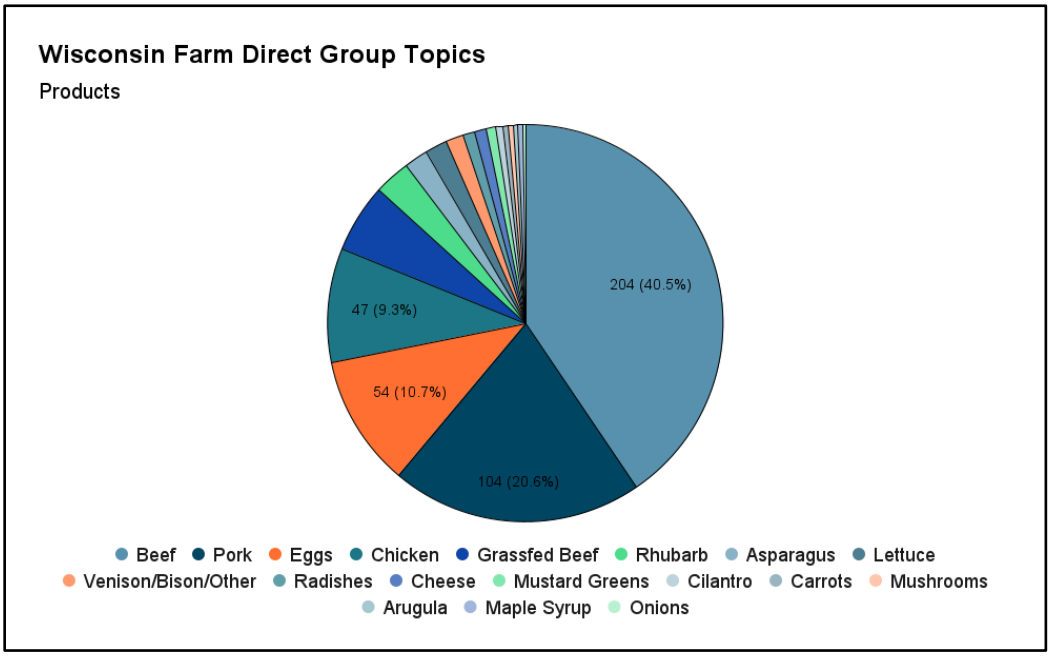

Figure 4.B.2: Highlights the most common products tagged in discussion posts on Farm Direct Wisconsin. The legend is ordered from most mentions to least. The vast majority of topics related to food items are meat, while less than a quarter of the topics are vegetables. (Farm Direct Wisconsin, n.d.)

In addition to the Facebook Group there is also a website that lists vendors in Wisconsin registered with Farm Direct (2021). A vendor can register for the directory by filling out a Google Form. The highlight of the website is a map that features vendors and includes contact information, region, website/Facebook links, store hours, payment methods accepted, shipping methods, and products offered. Potential customers can find farms on one or both of the platforms.

Significant Posts

When searching for questions that were asked in the group, only four significant posts were identified. Selected posts had over 15 comments or reactions. All of these questions were asked in the group between May and June 2020. After the group was started questions appeared to drop off significantly. Questions were sometimes hard to search for within the group because question marks cannot be searched. This narrowed the methodology to searching manually through all posts or searching the word “question”. Although few posts with high engagement were found, the group still averages 190 posts per month. Most posts have a few comments or likes. These posts could still garner interactions between consumers and producers through direct messages on Facebook, email, or phone.

Although few posts with high engagement were found, the group still averages 190 posts per month.

The first question with a significant amount of participation was asked on May 9, 2020. The group member appeared to be a dairy farmer and posted a question that they frequently are asked and a response to it (Eick, 2020). This post received a large 593 reactions and 284 comments. The poster wanted to let consumers know that individual farms produced a large amount of milk each day and that this milk needed to be processed and pasteurized in order to be sold. The original poster also shared an article from a local newspaper that highlighted an example of a producer in New York giving away free raw milk and being fined by the New York Agriculture Department. The comments focused on thoughts of what to do with extra milk and how to change regulations to diminish waste.

A post on May 11, 2020 asked the group if producers state-wide were having difficulty finding butchers and if this was a new issue (Isaccson, 2020). The original poster appeared to be an Angus farmer. This survey question received 82 comments. Most commenters agreed that this has been an issue for years and was greatly exacerbated by the pandemic.

The next question appeared to be from a consumer and was posted on May 2, 2020. This person wondered why grocery store eggs were always white and if this was natural

(Axeman, 2020). This discussion post received 173 comments from a wide range of folks. Respondents stated that the egg color varied by genetics and that commercial eggs needed to be washed because of the conditions that they are produced under.

The final post on June 3, 2020 appeared to be asked by a part time duck egg and meat producer. They wondered if there was a demand in their area for Peking duck meat and eggs (Skarda, 2020). This post received 93 comments and respondents were very excited about the prospect of these products. Researchers searched the Facebook group for other posts by the original poster and found a post from December 15, 2020 where the poster was selling duck eggs and meat. They used the platform to conduct market research and then followed through with the information that was obtained and were able to make sales.

Farm Direct Minnesota

Farm Direct Minnesota was formed on May 5, 2020, shortly after Farm Direct Wisconsin. The page description is much shorter and states, “Connecting Farmers Direct to Customers.” Unlike the Wisconsin group, the Minnesota page is a public group on Facebook. This means that you do not have to be a member in order to view the posts in the group. As of September 2021, the group has just over 60,000 members, and from September 8-15, 2021, 195 members joined the group. Over the last month, 550 discussions were posted, this means on average 18 posts are created a day. Farm Direct Minnesota and Farm Direct Wisconsin share many rules.
The ten rules of Farm Direct Minnesota are as follows:

1. Understanding in Joining this Group
2. No Live Animals
3. All Sellers - Must Post Location
4. All Sellers - Limit Multiple Posts - Bump Posts
5. No Undercutting Prices - by Private Message
6. Customers - Search for Products First
7. All - It is assumed if you are selling any goods or services in this group you are legally allowed to do so & meet any required regulations & licenses. You assume all liability for any such sales/services.
8. No hate Speech, Bullying, Insults, Profanity
9. No Political Posts
10. All Members - Be aware, there are many posts about animal meat here, if you have a known sensitivity to this feel free to keep scrolling or leave the group. We do ask that no videos of butchering be posted.

The group is managed by one admin and two moderators. New discussion posts must be approved by this group before they appear in the group. If a producer has something

to sell, they create discussion posts with their location and any products they are selling. They can add any appropriate topics to the post with the use of hashtags. Once the discussion is created it must be approved by the admin or moderators before it is posted. When a seller has a new product or wants to edit their post, they should delete the old post and create a new one. A producer should only have one active post and then bump or comment on the post to refresh it. If a consumer finds this group and wants to find out what is available in their area or purchase a specific product, they are asked to input the product they are looking to purchase or their area into the search bar and see what is available. Customers can also use the topics function to search availability. If someone cannot find what they are looking for, they can post an ISO (in search of) containing what they are looking for and their region. This post must then be approved by the moderators or admin.

The “Topics” in the group can be seen in the following figures.

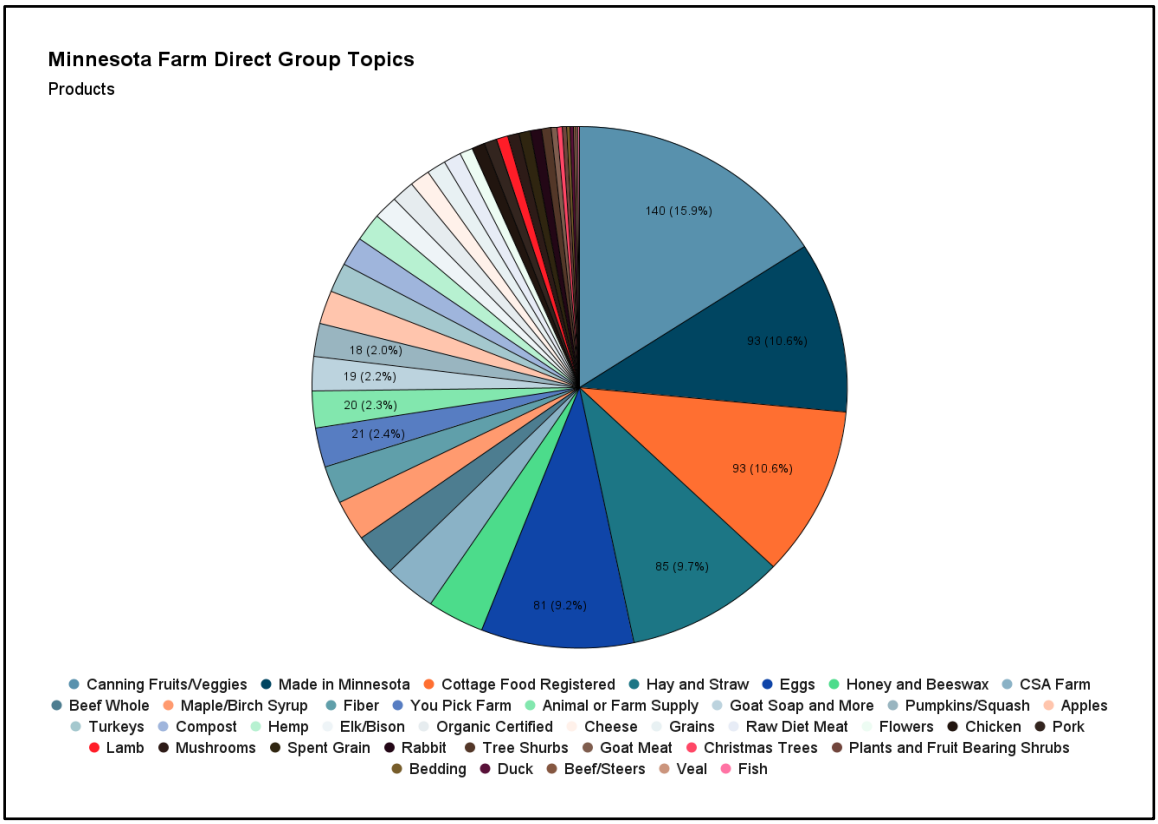

Figure 4.B.3: Shows the topics that can be categorized as products. The legend is ordered from most mentions to least. There is a wide variety of products highlighted under Topics, but Can Fruits/Veggies have a large margin over others. (Farm Direct Minnesota).

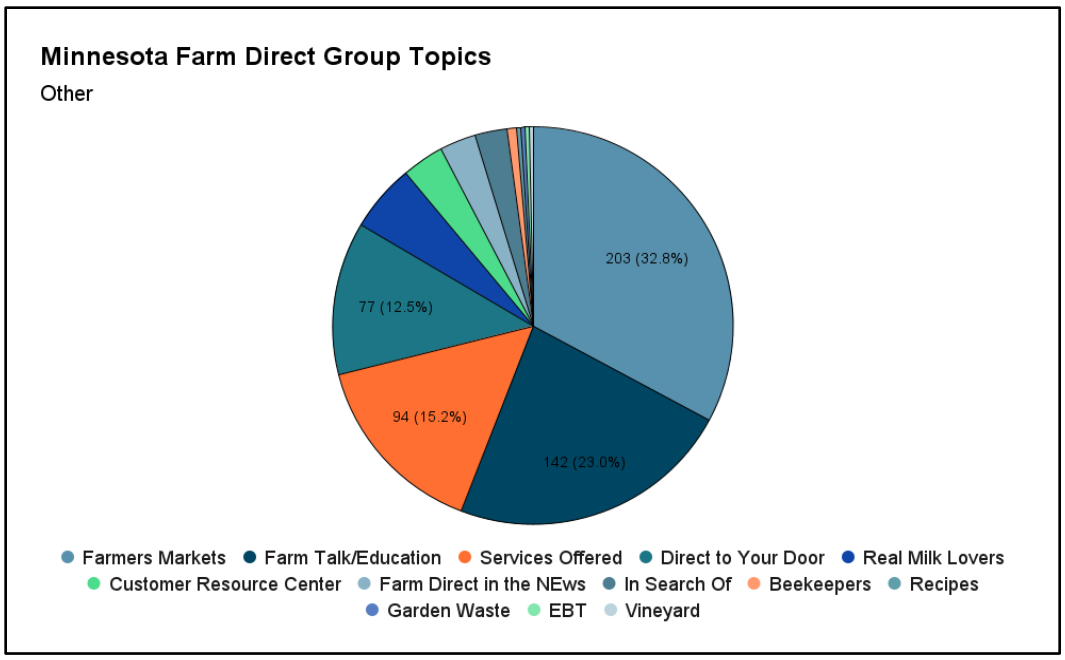

Figure 4.B.4: Shows the topics in Farm Direct Minnesota that could not be categorized as “Area” or “Products”. “Farmers Markets” and “Farmer Talk/Education” are two of the topics that account for most of the questions asked within the group. The legend is ordered from most mentions to least. (Farm Direct Minnesota)

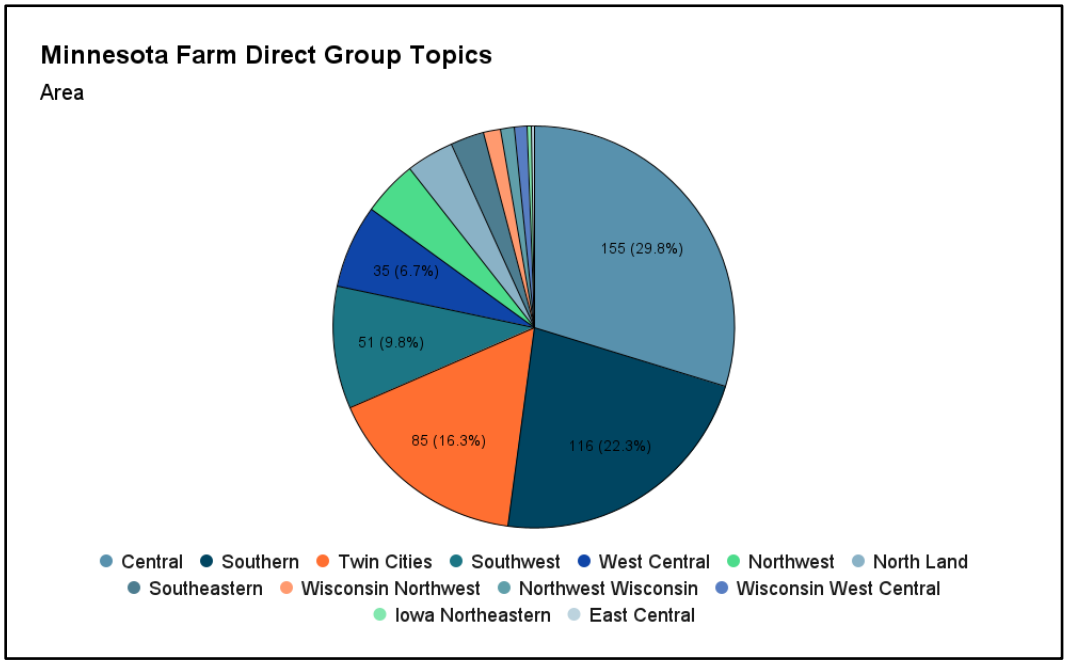

Figure 4.B.5: Shows the areas producers are tagging the most in their discussion posts. The legend is ordered from most mentions to least. Around two thirds of the areas tagged in discussion posts are around the central and southern region, including the Twin Cities. (Farm Direct Minnesota)

Much like Farm Direct Wisconsin, Farm Direct Minnesota also has a traditional website. The Farm Direct Minnesota Website features a map of vendors and supplemental information about the group (2021).

Significant Posts

Search methods were similar to find significant posts in both groups. Farm Direct Minnesota had more recent posts and easily searchable questions. Discussion posts with questions are notable because they receive the most interaction in the group. This is followed by posts by consumers looking for products and then producers posting product availability.

On May 17, 2020 a producer asked if folks with hog and cattle would continue selling to the general public when meat processors returned to full capacity (Murply, 2020). This question received 41 comments. A commenter brought up the issue of some farmers not owning the cattle, but just raising them. Others noted that a positive consequence of the pandemic was a move towards more local foods.

On July 20, 2020 a consumer asked why beef is always $2 to $3 more expensive on the page than in the grocery store (Breyer, 2020). This post received 225 comments with varying explanations. Commenters noted that the products in the store are generally very different and not comparable to what is usually sold on Farm Direct. Another member noted the high cost of processing local versus processing on a large scale. Everyone was very civil and folks cordially explained the difference to someone who seemed genuinely curious.

On August 24, 2020, the group admin posted a poll asking how members found products in the Facebook group (Varga, 2020). 159 people used the magnifying glass search function, 93 used the topics section by product, 86 used the topics section by region, 12 people waited to see a product they were interested in, 10 just scrolled through the group.

On November 14, 2020 an egg producer posted a reactionary post to another member's post. The original post came from a member who did not know the difference between farm fresh and commercial egg pricing (Lowry, 2020). It appeared the person asking about egg pricing came off as ignorant. Lowry created a post to highlight that the group was about teaching others how food is produced locally. Lowry took the time to call the original poster and explain the differences. Members commented on this post and said the eggs were too expensive and there was much debate in the comments. So, the original poster closed the comments. This represents the single found example of unpleasant behavior between group members.

On February 13, 2021 a member asked a question about GMOs and generally wanted to know members' thoughts on the subject (Connors, 2021). This post received 190 comments, most of which were very civil. Folks posted their opinions, facts, and resources without shaming others. Sources provided varied from news articles, documentaries, university articles, and various other websites.

On February 14, 2021 a local butcher posted about an idea they had to create a mobile slaughter operation. They stated the benefits of this model and what would need to be done to accomplish this project. At the end of the post, they posed a question to the group wondering if there is demand for this service (Erickson, 2021). This post received an astounding 313 comments. Commenters were generally supportive and liked the idea, but advised the poster to look at financing and zoning issues. Additionally, commenters noted that the big players lobby for laws that make it harder for mobile operations to operate. There were a fever savory comments, but those were quickly shutdown by other members in the group.

On April 7, 2021 someone asked a question of small hobby farmers, wondering if 5 acres was large enough for a small farm (Peoples, 2021). This post received 153 comments with various opinions on what is needed for a small hobby farm. Additionally, group members offered to give tours of their homesteads so the original poster could get an idea of what can be done on different acreage. Others suggested that they check with local zoning laws to ensure a homestead could legally be established.

On May 13, 2021 the group creator and admin posted a question for farmers and growers. She wondered if folks could make changes to how things work in Minnesota in regards to selling goods, what would they change? She had an upcoming meeting and wanted to share the collective knowledge of the group (Varga, 2021). This post received 90 comments from producers. Folks had a wide range of suggestions including: having materials available in other languages, increased education for consumers on the food system, a percentage of sales contributing to the cost of running the Facebook page, limiting overhead costs, and more independence from regulation.

On June 28, 2021 a home vegetable gardener had a question about growing tomato plants. They discussed how they cared for the potted tomato and the issues they were having (Todaro, 2021). The question received 32 answers in a short period of time. The replies were a mix of folks having the same issue. The group proposed the issue could be bugs, heat, water, or pruning, but ultimately decided the issue was the heat.

On July 24, 2021 a member asked a question to canners in the group. They wanted to know what others were doing to acquire lids (Wold, 2021). This question received 57

responses and seemed to very successfully answer the question. Folks provided online sources, local supplies, and there was a discussion on the quality of different lids.

On August 4, 2021 a member asked if others joined to learn about agriculture from farmers or if they joined to purchase directly from farmers (Braun, 2021). This question received 228 responses. Based on the responses most members joined to purchase directly from farmers and many already had completed a purchase. Others joined to purchase and have also learned. Based on comments a majority of folks had purchased some sort of meat product. Some stated that they can almost exclusively purchase food from the group and that Farm Direct Minnesota is the first place they check for products.

On August 17, 2021 a person whose children were planning on selling canned goods at market to raise money for a local charity asked what others charged for various canned products at farmers markets (Tulibaski, 2021). The query received 19 comments and respondents were happy to share what they were charging and noted that the region and canning shortage needed to be taken into account. Two commenters noted that it would be helpful to register as a cottage food producer. They provided a link to the Minnesota Department of Agriculture website where the information is posted.

Similarities and Differences

Questions asked in Farm Direct Wisconsin had the most interaction as well as a post where a producer was market testing. Although these posts do not represent most of content in the group, they highlight interesting interactions. Again, Farm Direct Minnesota, questions received the most interactions, but there was engagement of the larger group with broader asked, and the use of Facebook's Polling function. In Minnesota, the group also had more interaction from the main group admin.

Both Farm Direct Minnesota and Farm Direct Wisconsin share many similarities. The groups each have similar rules, membership, origin, sense of community, and interactions. The rules focus around keeping the groups welcoming and focused on education and getting food from producers to consumers. The rules also touch on how buyers and sellers should go about searching for and posting products. Both groups started around the same time, end of April/beginning of May and have achieved roughly the same membership around 61,000 members as of September 17, 2021. The interactions in both groups are also very similar and give a sense of community and accountability.

The groups differ in the number of topic areas, discussion posts per month, and the privacy of the group. Members of Farm Direct Wisconsin use "Topics" more often especially when tagging the area of the state. Nearly three times as many posts in Farm

Direct Wisconsin are tagged with topics than in Farm Direct Wisconsin. Although tagging “Topics” is more common among the Wisconsin group, the Minnesota Group has over three times as many monthly discussion posts. As highlighted in figures two and three, the most commonly tagged products in the groups are significantly different. Farm Direct Wisconsin’s top three products are beef, pork, and egg. While Farm Direct Minnesota’s are canning fruits/veggies, made in Minnesota, and cottage registered foods. Finally, Farm Direct Wisconsin is a private group while Farm Direct Minnesota is a public group, both require admin approval to join. The only difference is that non-group members cannot see the posts or members of private groups.

Reflections

Education

One of the most interesting themes that was found while collecting data is the education that happens within both of the groups. These online communities have gone beyond simply being a platform like Facebook Marketplace or a dedicated producer website, but have become a place to ask questions and learn how food is produced. The online environment creates a place where folks feel comfortable asking about topics like GMOs. The ability to ask questions also allows producers to do market research before putting too much and money into the development of the product. A producer can simply post in the group and gauge interest of a new product, like duck eggs (Sharda, 2020).

This ability of the platform adds value for both producers and consumers. Consumers can voice their opinion on what products they would like to purchase, and producers can identify the capitalize on this want. However, when information is presented, it is not always clear who is presenting the information or if it is accurate. Initial discussions in each group have to be approved by admins or group moderators and this may affect what questions are posted. A member of the group may be able to see the profile of someone else, but they might not be able to tell if the poster has expertise in the area. Some members of the group cited sources from extension services or other reputable sources, but this was not common. There is undoubtedly a wealth of knowledge in these groups, but sorting through it is not always the easiest task. For the most part these conversations and education seem very civil, but it is difficult to say whether this is due to moderation or if it naturally happens.

These online communities have gone beyond simply being a platform like Facebook Marketplace or a dedicated producer website, but have become a place to ask questions and learn how food is produced.

Discussion Post Interactions

Farm Direct Wisconsin sees around 180 posts per month and Farm Direct Minnesota sees about 580 posts per month. Both these numbers represent a significant and consistent amount of group engagement. Most posts are short and simply list what a farmer is available or what a consumer is looking to purchase. These posts see little interaction in the comments or likes, but this does not mean these posts are not gaining traction. Consumers and producers could still communicate through direct messages on Facebook, email, or phone. While searching through posts, researchers noticed that the interactions on posts with few comments were mostly from producers reaching out to consumers about product availability. This indicates an extra effort by producers who have many other aspects of production management that need their attention.

Lower post interaction could also be contributed to how posts are presented to group members. Are members specifically seeking out the page to interact, or are they seeing posts in their Facebook News Feed? When visiting one of the groups, there are a few ways to sort posts. Researchers found that it was not always clear how posts were being sorted, this could be impacting what posts get interaction. More data about posts interactions and views are available to Facebook Group admins through backend analytics and would be useful information to have.

Recommendations

The growth and number of posts in these groups is a clear sign that Farm Direct Facebook Groups are changing how producers and consumers connect. They have successfully tapped into a platform where there appears to be a large overlap of producers and consumers. With improvements to the functionality of Facebook Groups, the impact to direct producer to consumer food, could be even greater. Facebook Groups are not yet optimized for this type of peer-to-peer interaction, but yet these two groups have made an existing platform fit their needs. Meaningful improvements that could be made include: more filters for search results, optimization of sorted discussion posts, ability to search by posting month and day, ability to search for poster location, creation of verified posters or “content experts", integrating Facebook Marketplace into agriculture sales, and the ability to sort by both product and location simultaneously. Increasing search filter options would allow consumers to more easily find products accessible to them. The ability to search for a specific product and a specific location would also be beneficial. Currently, posts can only be chronologically narrowed by year, but if they could be sorted by date or month recent items would be

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easier to find. Currently, “Topics' 'functions as a way to sort posts by region, a better version of this ability would be the option to search within a certain radius. Currently certain posts engage many group members and offer the opportunity for education, but there is not a way to verify accuracy of the information. The creation of “content experts' ' or “verified posters' ' would allow admins to appoint certain members these titles based on their experience. This could help build trust of the information that is shared. Although not yet a perfect marketplace, this form of direct-to-consumer availability and education is connecting consumers to local food.

Closing Thoughts

Farm Direct Minnesota and Farm Direct Wisconsin are both less than twenty months old and were both formed out of a desire to help regional agriculture. The rapid increase of membership and the connections made are promising for the future of the groups. There is plenty of room for Facebook to optimize Groups to function as a better platform for communities of this nature, but these groups are fitting into pre-existing systems. It is difficult to tell what will happen to Farm Direct as we move towards the tail end of the pandemic. Will consumers and producers drift back to their old ways or will e-commerce through social media platforms continue to be a viable marketing platform. Either way, the past 20 months have highlighted the adaptability of agriculture systems.

Conclusion

In exploring the impact of digitalization on local and regional food systems, focus was given to the seven research projects detailed above under the research buckets of (1) the digital divide, (2) urban food systems, (3) data for ecosystems services, and (4) COVID-19. Though the projects were conducted with distinct research questions, common themes emerged throughout the case studies/explorations. Looking at digitalization of food systems, the case studies and analysis done highlighted recurring themes: inequitable access to digital tools and resources, rapidly transforming business methods, significant impact from the COVID-19 pandemic, and limitations of small and mid-sized producers to keep up with the rapidly changing environment.

Inequitable access to digital tools and resources

Larger-scale, commercial operations typically sell through a wholesaler or broker and have little interaction with the consumer, whereas small to mid-sized producers often rely heavily on connections with their consumers in order to make a profit. As such, the ability for local and regional food systems to maintain a vibrant marketplace, full of a diverse offering of producers and products, is reliant on accessible digital tools and resources, such as, broadband internet, geospatial tools or blockchain supply chain tracking. However, the research analysis revealed that these tools are not readily available or accessible to those within local and regional food systems. For some, the digital divide is the starting and ending point for accessing digital tools and resources. Without access to high-speed broadband internet, producers and other food system stakeholders are forced to rely on substandard internet access or cellular service, limiting their available resources. In other cases, mapping and managing data using geospatial tools, precision agriculture, or blockchain supply chain tracking are inaccessible due to limited capacity, funding, and training.

The management of smaller farms and fisheries can be grueling, often requiring the farmer to take on multiple roles within the business. As the internet becomes host to even more technology, digital tools, e-commerce, marketing, and communications, producers will be presented with a new challenge to remain proficient in the newest technologies. Without reliable, equitable, and affordable access to high-speed broadband internet and digital tools, local and regional food systems will be negatively impacted by digitalization.

Rapidly transforming business methods

There are new ways of doing business in agriculture - using digital tools for communication, marketing and sales has dramatically transformed the business model for many small to midsize farms. E-commerce allows for business processes to be digitalized, which allows producers to reach their consumer audience more efficiently and thus distribute their goods to consumers in smarter ways. Farmers are creating online storefronts, social media pages, utilizing e-newsletters, and digitalizing much of their commerce transactions. On the farm level, processes such as precision agriculture through enhanced machinery and data collection are becoming more common, and as more data is collected, practices at the start of the supply chain are becoming more transparent. Additionally, using digital tools to conduct research about farm-related business tactics has allowed smaller farmers to enhance their models and become more competitive. Case studies explored how farmers could likely not keep up with the market today without access to these transforming digital systems of commerce.

Present challenges in digitalization

There are existing pitfalls to using new digital tools in addition to the benefits, and these must be addressed as digitalization pushes forward. Access to and education on digital resources are not necessarily distributed equally, leaving some producers behind, depending on their geographic location, tech-abilities or access to technical training and resources. In the case of some technologies, such as geospatial technologies, individuals in the food supply chain may be familiar with them, but they have not been given the appropriate resources and training to fully understand and implement these technologies. Farmers whose machinery and on-site practices collect increasingly more data face uncertainty on how this data is being collected and managed outside of their operations, and they do not always own their data, thus they worry that it can be used against them. Through data sharing channels, it’s impossible to verify and protect information.

Small to midsize producers in particular often have limitations of time, money and technical education required to implement the use of some digital tools like e-commerce platforms, sophisticated social media marketing, geospatial tools and blockchain supply chain tracking. Sharing and understanding data is essential to strengthening local food systems, however food system stakeholders aren’t always able to feasibly integrate data management into their operations. Simply providing access to digital tools like geospatial tools, blockchain supply chain software, e-commerce platforms, or social media isn’t enough to guarantee regular implementation. Additionally, as discussed prior, farmers in rural areas without reliable access to broadband internet cannot

engage with these digital resources at the same rate as other members of the supply chain, thus leaving them at a disadvantage.

The COVID-19 pandemic's unprecedented impacts on agriculture

The impact of the COVID-19 pandemic on local and regional food systems can not be understated. Local and regional producers were hit with an unprecedented loss of markets when lockdowns went into place, with farmers markets and restaurants shutting down within a matter of days. In the weeks following, an equally unparalleled demand for local and regional food products sent sales skyrocketing for many within the local food supply chain. Producers, ranging from small-scale fishing operations to organic vegetable growers and sustainable livestock farmers, quickly pivoted their operations and focused on direct-to-consumer sales and significantly relied on digital tools to expand their markets. Other stakeholders along the local food supply chain were also forced to rely on digital tools, from production and e-commerce to regulatory checks and community food asset mapping.

As the pandemic continues to affect many aspects of daily life, future researchers should continue to evaluate its impact on local and regional food systems, particularly as it relates to this new reliance on digital tools and resources. Additionally, it is important to note the consequential effect the pandemic had on food insecurity. The divide between those that have access to affordable, healthy, culturally relevant, and regularly accessible food and those that do not was made more significant. Building climate resilience, food security and health equity in all communities, urban or rural, will require strong local and regional food systems, capable of keeping up with modern times.

Closing Reflection

The implications that digitalizing the food system will have on individuals all along the supply chain are complex and require sustained research. The individual deep dives conducted explore only a small bit of the full picture of digitalization of agricultural systems, but these research questions should continue to be explored. Future research should bring in stakeholders all along the food and agriculture supply chain and should take into account the long-term impacts of the new technologies and digitalizations that are being implemented today.

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Appendix

Appendix A: Interview Guide

The Digital Divide Interview Questions

Background

1. Can you provide a brief overview of your farm?
2. What kind of farming do you engage in, livestock, crop, mixed, etc.?
3. How long have you been farming?
    a. For multigenerational farms:
        i. How long has the family been farming?
        ii. Has the farm gone through any significant changes over the years?
4. How do you market the farm and sell your products?
5. What is your average acreage under production?
6. What are your typical marketing, sales and distribution processes?

Broadband Access

1. Do you currently have internet access at home and/or on your farm?
    a. If yes, how would you describe the type, speed and reliability of your internet access?
    b. If not, do you have any other access to the internet in your community, i.e., library, public hotspot, local businesses?
2. Are there times of the day/year that you have less reliable connection?
3. Are there any outside factors that affect your ability to access reliable broadband, i.e., weather, cost, etc.?
4. As it relates to your farm, do you use the internet in your day -to -day operations?
    a. If yes, please describe the management practices that require the internet?
5. Do you currently own a computer, tablet or smartphone?
    a. If yes, which is the primary device you use for your farming operations?
6. Do other people rely on these devices for personal or business-related activities?
7. Does access to reliable broadband internet inhibit any aspects of your farming operation?

8. What challenges have you faced in running your farm operation/business as it relates to broadband internet access?
9. Has access to broadband internet created any new opportunities for the farm?
10. In what ways has internet access attributed to greater success on the farm (on either the production or business end)?

E-commerce Markets

1. Are you currently participating in e-commerce markets?
2. Are you currently using any e-commerce software or management tools, such as FarmBrite, Food4All or 1000EcoFarms, etc.?
    a. If yes, did you participate in these markets prior to the COVID-19 pandemic?
3. What do you see as the primary benefits of participating in e-commerce markets?
4. What do you see as the primary barriers to participating in e-commerce markets?
5. If not participating in e-commerce markets, do you currently have demand to do so?
6. What are the key factors that would sway your decision to participate in an e-commerce market? Or what would make it worth it?

Multi-generational Farms

1. Have the family's farm operations changed, based on the availability of broadband access or as the availability of web- based technologies have increased?
2. How are young(er) farmers using the internet differently than their parents and/or older generations?
3. Have younger generations introduced new web-based tools or technologies to the farm's daily operations (i.e., e-commerce, online marketing, farm management, etc.)

Challenges And Solutions

1. How would you describe the ease (or lack thereof) of participation in e-commerce markets?
2. For you as a producer, what do you see as ways of simplifying your participation in e-commerce markets?
3. Did the COVID-19 pandemic impact your farming operation, particularly as it relates to your use of the internet to conduct business?

4. Do you have any recommendations around improving farmers' access to broadband or supporting participation in e-commerce markets?

Urban Food Systems Interview Questions

1. What area of the food system do you represent?
2. Tell me about the work you do within the food system.
3. Do you use geospatial technologies in your food system's work?
    a. If so, which technologies are most useful in your work? Or what information in regard to food systems would be most useful to support your work?
4. In what ways are geospatial technologies limited? What would you change to meet your needs?
5. What are the greatest challenges facing your local food systems now and in the future?
6. What are the strengths in your local food system? Opportunities?
7. If you could wave a magic wand and have access to data in one location, what data is most important to developing and sustaining a local food system?
8. If geospatial technologies could forecast information years from now, what would be most useful to know about the local food system?

Data for Ecosystem Services Interview Questions

1. What does your fishery currently look like? [Location, size, number of staff, number of inputs/outputs.
2. How has your business/practices changed over the last 10 (15, 20?) years?
3. Are you familiar with blockchain technology?
4. Do you currently use a system to record your transactions? If you don't already use blockchain, what do you use?
5. How would/does blockchain technology change (or not change) the way that you currently fish?
6. Do you think blockchain technology will be able to help promote more sustainable fishing efforts?
7. There is a lot of data on blockchain with tuna fishing. How do you see blockchain technology transferring to a smaller fishing scale? OR How can we transfer the successes of high commodity fish (i.e., tuna) to other local fish?
8. Do you have any concerns about data security and/or data accuracy?
9. Are there any other technologies that you feel are critical to ensuring sustainability in fishing?
10. What is one thing you want people to know about your business?

11. Did you fill out the National Ag Census? Why or why not?
    a. If yes, did you fill out particular sub-censuses?
    b. How did you hear about the Ag Census?
12. Were there elements of the census you did not have the capacity to answer due to tech limitations?
13. “Farm-level data collection and sharing has the potential to strengthen environmental impact and add transparency into the food value chain.” What does transparency in the food value chain mean to you?
14. Do you currently have tools in place to collect and manage data on your farm?
15. If yes, what do you collect data on of the following:
    a. Yields
    b. Productivity
    c. Profitability
    d. field entry dates
    e. Emissions
    f. crop location
    g. nutrient use
    h. seed selection
16. Which groups would you feel comfortable sharing farm-level data with?
    i. Landowners
    j. Government officials providing resources
    k. Consumers - through marketing
    l. Fellow farmers to share tactics of land stewardship
    m. Ag Tech companies with enhanced ag practices for your farm
    n. Think tanks
17. Do you believe that if you share data and information on your conservation practices, you will gain new access in consumer markets?
18. Do you know of any existing regulations in place to protect your data when you share it?
19. Do you share the data you routinely collect with any larger cooperative or other organization?

4. **Covid-19 Interview Questions**

1. How many years have you been farming?
2. Are you a first -generation farmer or did you have another career prior to farming?
3. What type of products do you grow?
4. What type of digital tools did you use *before* the start of the pandemic (Mid-March 2020)? (Options include; Third party e-commerce, E-commerce through

our own website/platform, Social media marketing, Email marketing, Inventory management system, Accounting software (like Quickbooks)

5. What type of digital tools did you use *during* the pandemic (Mid-March 2020-present). (Options to include are the same as above.)
6. Which types of digital tools do you foresee yourself using beyond the pandemic? (Options to include are the same as above.)
7. Which digital tools were most useful to you during the pandemic and why? How did they impact your sales and why?

About the Authors

Wesley Conner
Wesley is a regional food and hospitality specialist based in Denmark, where she is currently launching a restaurant and connecting sustainable food production practices to hospitality. Her past work with regenerative agriculture, food policy councils, and working for world-ranking restaurants encompasses her passion for building resilient food systems through community and local businesses. Wesley spent three years at Blue Hill at Stone Barns working in the farm and restaurant, and previously graduated from Connecticut College with a focus on literature and psychology.

Brandee Kitzmiller
Brandee is the garden coordinator for the nonprofit Island Grown Schools on Martha's Vineyard, Massachusetts. She strives to teach and empower children to make healthy eating choices, learn to grow food and connect with local farms. She also works with schools, local farms and nonprofits to create a more equitable food system across the island. Before working with Island Grown Schools Brandee served as a service member with FoodCorps for two years in New London, Connecticut. Brandee grew up in the Shenandoah Valley of Virginia and has a BS in public health and nutrition from George Mason University.

Kana Miller
Kana Miller is the Local Food Distribution Coordinator at Carolina Farm Stewardship Association (CFSA), where her work focuses on supporting local and organic agriculture, advocating for food and farm policy and providing technical assistance to producers across North and South Carolina. In this role, Kana works with food hubs to help increase their organizational capacity and food safety. In addition, she is building a network of food hubs, farmers, and community partners interested in increasing food security and addressing chronic health issues with local food box programs. Kana's interest in sustainable and equitable food systems deepened after serving as a FoodCorps service member, working with youth to strengthen their relationships to food, farming, and entrepreneurship. Prior to joining CFSA, she worked at Second Harvest Food Bank of NWNC, where she was focused on building connections between hunger and health. She is committed to racial equity and food justice, and shares an excitement for growing, cooking, and sharing food. Originally from Atlanta, Georgia, Kana has called North Carolina home for six years. She received a bachelor's in environmental studies from Skidmore College. Based out of Winston-Salem, she and her partner have a small farm growing mixed seasonal vegetables.

Paige Mollen
Paige Mollen is a life-long educator who has dedicated her career to making quality education accessible to all learners and empowering students to become leaders in their communities. She is co-founder and president of the Mollen Foundation, a nonprofit organization dedicated to the prevention of childhood obesity. In her role she focuses on integrating food education and physical activity into core curriculum in schools. Prior to starting the Mollen Foundation in 2008, Paige spent 22 years as an educator, national consultant and strategist, facilitating innovative solutions for students with learning and behavioral challenges to learn and thrive in public schools. She currently serves as the education chair for the Arizona Farm to School Network. Paige holds a bachelor's degree in special education from Arizona State University and a master's degree in education from Northern Arizona University.

Mary Rochelle
Mary Rochelle is the Program and Grants Coordinator for the School Food Project, the food services department of Boulder Valley School District. She oversees farm-to-school programs and leads communication for the healthy and sustainable school food program. This includes fundraising and developing programs that center health promotion, local food, food waste reduction, garden education, and hands-on cooking experiences. Mary got started in the good food and sustainability industry right out of college with a public relations internship that developed into a long-term Account Executive position at an agency in the organic food industry. Subsequently, Mary served as an AmeriCorps member and then a staff member at FoodCorps, a national nonprofit that works to connect kids to healthy food in school through hands-on garden and cooking lessons. Mary received her bachelor's degree from the University of Colorado - Boulder where she studied journalism and philosophy. Along the way, Mary has also worked for several organic farms and food systems organizations.

Joe Snowaert
Joe Snowaert is a school and local food systems specialist in the Washington, D.C. area. His work has included being a Program Specialist with Fairfax County Public Schools Office of Food and Nutrition Services, where he worked on integrating salad bars into the elementary school cafeterias, training food service professionals, and managing FNS data collection and usage. Previously he completed two years of FoodCorps service. Joe first served in his home state of Michigan with the Crim Fitness Foundation in Flint and then as one of the first service members in Fairfax County, Virginia. Joe grew up in the Upper Peninsula of Michigan surrounded by water and a diversity of agricultural crops. He holds a BS in horticulture from Michigan State University where he concentrated on sustainable and organic growing practices.

Annalise VanVranken
Annalise VanVranken is a Project Manager at FoodCorps, a national non-profit and AmeriCorps program working to connect kids to healthy food in school, so they can lead healthier lives and reach their full potential. Annalise's work is focused on supporting FoodCorps' policy, government and strategic partnerships work, along with supply chain and school meals initiatives. Annalise was brought to this role after two years of FoodCorps service in New Jersey and three years as the Massachusetts Program Coordinator, leading a cohort of twenty-two service members, along with their schools and sites, to create direct impact and leverage farm-to-school and food equity initiatives across the state. Annalise holds a BA in Environmental Studies and Sociology with a minor in Sustainability from Wells College. While currently residing in Brooklyn, New York, Annalise was born and raised in southern New Jersey, where the Garden State inspired her love of food and the people that produce it.

Isabel Yoder
Isabel Yoder works as a Research Analyst at the Farm Credit Funding Corporation in the New York region. In her role on the Risk & Research team, her current research focuses on how ESG investment priorities and policies will affect the Farm Credit System. Her past work experience includes working as a Policy Research Analyst for the Mexican American Legislative Caucus in Austin, Texas, as an intern for ECOM Agroindustrial Corp. in Switzerland, and she has done project work for Crop to Cup Coffee Importers and with Buena Tierra in central Mexico. Isabel received her BA from the University of Virginia where she studied Political and Social Thought and Mathematics. While at UVA, she conducted research on the implications of NAFTA on smallholder farmers in Mexico, and her existing research interests revolve around using sustainable agricultural methods to encourage local food sovereignty.

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