Title: Resilient Regional Food Supply Chains and Rethinking the Way Forward: Key Takeaways from the COVID-19 Pandemic

Published in *Agricultural Systems*; available online: https://doi.org/10.1016/j.agsy.2021.103101

Amy Marusak[1], Narjes Sadeghiamirshahidi[1], Caroline C. Krejci[1], Anuj Mittal[2], Sue Beckwith[3], Jaime Cantu[1], Mike Morris[4], and Jason Grimm[5]

[1]Department of Industrial, Manufacturing, and Systems Engineering, The University of Texas at Arlington, Box 19017, Arlington, TX 76019, USA

[2]Department of Industrial Engineering Technology, School of Engineering, Dunwoody College of Technology, 818 Dunwoody Blvd, Minneapolis, MN 55403, USA

[3]Texas Center for Local Food, 310 North Main St., Elgin, TX, 78621, USA

[4]The National Center for Appropriate Technology, 118 Broadway, Suite 524, San Antonio, TX 78205, USA

[5]Iowa Valley Resource Conservation & Development, 920 48th Avenue, Amana, IA 52203, USA

Abstract

Context

The U.S. food supply system relies heavily on vertically-integrated food supply chains (FSCs), which leverage large-scale production, streamlined operations, and centralized planning and control to provide consumers with a consistent supply of food. However, these FSCs were seriously disrupted upon the outbreak of the COVID-19 pandemic in spring 2020. During the height of the crisis, they were slow to respond to production system failures and sudden and widespread changes in consumer demand. By contrast, many regionalized food supply chains (RFSCs) proved to be adaptive and responsive to changes in demand and delivery requirements, quickly pivoting to distribute products directly to consumers safely.

Objective

The objective of this research is to explore how RFSCs can improve the resilience of the U.S. food supply system in the face of large-scale disruptions like the COVID-19 crisis. In particular, this research seeks to gain a greater understanding of how RFSCs can leverage logistics best practices for efficient and reliable distribution to consumers in normal times and during disasters.

Methods

This study presents seven case studies of RFSCs in Texas and Iowa that adopted logistics best practices to enable them to provide their customers with convenient and safe purchasing mechanisms during the COVID-19 emergency. A description of how the strategies adopted by each participant promote the achievement of the United Nations Sustainability Development goals is provided.

Results and Conclusions

The successes experienced by these farmers and distributors at the height of the COVID-19 pandemic were a consequence of their willingness to adopt new distribution and logistics strategies. Collaboration among RFSC actors was a particularly effective strategy, as well as the adoption of scale-appropriate information and communication technologies, which helped to facilitate collaboration. Further, these RFSCs demonstrated how improving their logistics performance allowed them to contribute to the health and well-being of their communities in a time of need.

Significance

These case studies demonstrate the potential of RFSCs to support a resilient and socially-sustainable food system that communities can rely on, even in the face of a major disruption like COVID-19. The adoption of logistics best practices helped these RFSCs to develop new organizational strengths that will likely support sustainable development in their communities after the crisis ends.

Keywords

Sustainable development goals, regional food supply chains, resilience, COVID-19, logistics best practices, consumer convenience

Highlights

- Case studies demonstrate regional food system resilience during the COVID-19 crisis
- Regional food system alignment with U.N. Sustainable Development Goals is described
- Farmers rapidly pivoted to new market channels using logistics best practices
- The importance of offering consumers convenient delivery options is emphasized
- Recommendations for maintaining sustainability in the long term are discussed

1. Introduction

Most U.S. cities and regions are generally unable to supply their resource needs for food; thus consumers are almost entirely dependent on distant food sources (Goldstein et al., 2017; Pirog et al., 2001; Ramaswami et al., 2017). They are connected to these sources by supply chains that are characterized

by significant horizontal and vertical integration and consolidation throughout, such that a few large and powerful actors control production, processing, distribution, and retailing (Howard, 2016; Hendrickson and Heffernan, 2020). This structure allows for streamlined operations and cost efficiencies; in particular, just-in-time fulfillment enables continuous product flows and small localized inventories (Hobbs, 2020). However, this lean and efficient structure has also received criticism for being inflexible and vulnerable to supply disruptions (Clancy and Ruhf, 2010; Dahlberg, 2008; United Nations, 2006). Lacking inventory and capacity buffers, modern food supply chains are unable to respond rapidly to sudden and widespread demand increases or supply shortages and are vulnerable to bottleneck failures (Hobbs, 2020; Simchi-Levi and Simchi-Levi, 2020).

The COVID-19 pandemic has illuminated the fragility of the prevailing food supply system. Prior to the pandemic, the amount of food consumed at home and away from home in the U.S. was roughly equal (USDA-ERS, 2018). At the height of the COVID-19 emergency, however, wholesale markets rapidly diminished when restaurants, hotels, and schools closed (Yaffe-Bellany and Corkery, 2020). Consequently, grocery retail demand increased significantly, with consumer panic-buying and more meals prepared at home (Hall et al., 2020; Morgan, 2020; Venuto, 2020). Conventional food supply chains, with package sizes and infrastructure intended for wholesale buyers, struggled to adapt for retail sales, and large concentrated meat and dairy processors and long-haul transportation networks were disrupted by labor shortages as workers became ill (Hobbs, 2020). As a result, many consumers experienced increased food prices and shortages at the grocery store.

Regionalized food supply chains (RFSCs), in which food is sourced in geographic proximity to the consumer, have demonstrated a viable alternative. RFSCs are characterized by short-distance transportation, seasonal and regional production, and few intermediaries between producers and consumers. With the shift in consumer demand and retail shortages, the demand for regionally-produced food has surged, with farm stands and farmers' markets reporting tremendous increases in sales (Kolodinsky et al., 2020). Moreover, RFSCs have proved to be quite nimble in their response to demand shifts during the pandemic. For example, as farm-to-table restaurant demand disappeared, many small-scale producers and distributors have been able to rapidly pivot to sell directly to consumers, increasing their staff and acquiring additional delivery vehicles to provide contact-free home deliveries and curbside pickups (Broyles, 2020; Heil, 2020).

To improve the resilience of food supply systems in the face of large-scale disruptions like the COVID-19 crisis, the Food and Agriculture Organization of the United Nations has emphasized the importance of

short supply chains and stronger rural-urban linkages (FAO, 2020; Rosenzweig, 2020). The decentralized structure of RFSCs allows risk to be spread among many diverse food producers, thereby increasing regional self-reliance and mitigating the adverse effects of a food supply disruption (Dahlberg, 2008). In fact, greater regionalization may be an appropriate strategy to continue after the pandemic (Elbein, 2020; FAO, 2020). The COVID-19 emergency may be viewed as an opportunity to rethink existing policies and practices to reshape existing food systems, transitioning to new kinds of systems that support rural development and healthy diets for all of society, protect the environment, and better align food production and consumption to the principles of sustainable development (Mollenkopf et al., 2020; United Nations, 2020).

However, to fulfill these long-term aims toward greater food system sustainability and resilience, the ability of RFSCs to consistently deliver food efficiently and effectively must be enhanced. For RFSCs to be scaled up sufficiently to meet consumer demand, innovative transportation and distribution strategies are needed (FAO, 2020). Transporting food from rural and geographically dispersed farm locations to distant urban demand centers, especially when refrigerated/frozen goods are involved, is often cost-prohibitive (Miller et al., 2016). Most small and mid-sized farmers do not have the necessary logistics infrastructure to support efficient transportation to reach demand centers, and they often lack the expertise, capital, and access to credit to acquire and implement such systems (Jensen, 2010). Therefore, their distribution networks tend to be fragmented and less efficient than the centralized distribution networks of conventional food supply chains (Gebresenbet and Bosona, 2012), making regionally-produced food more expensive (Ohberg, 2012). To sustain the increased level of demand that they have experienced during the COVID-19 emergency, RFSCs must adopt efficiency-enhancing logistics best practices from conventional food supply chains. Increased efficiency will bring down the overall cost of food and increase access of regionally produced food, especially in regions lacking access to supermarkets. Logistical cost savings will help RFSCs utilize resources in upscaling their operations to provide increased variety and continuous supply of food to the consumers.

While conventional food supply chains source their products globally to ensure a consistent, year-round supply of a wide variety of products (Ohberg, 2012) at low cost (Bakos, 2017), RFSCs are often limited by regional climates and seasonality. Furthermore, post-pandemic, it is likely that consumers will once more be attracted to the convenience of one-stop-shopping, home delivery, and value-added products (Hobbs, 2020). Even consumers with flexible budgets will be unlikely to prioritize buying regionally-produced food over other uses of their time and money (Ohberg, 2012). In addition, RFSCs should

consider providing features such as online ordering and home delivery to be on par with conventional food supply chains.

This paper describes seven case studies in which RFSCs found opportunity in adversity during the COVID-19 crisis. These farmers and regional distributors rapidly and successfully pivoted their operations to meet their communities' needs by adopting logistics best practices and providing their customers with convenient and safe purchasing mechanisms. These successes suggest ways that RFSCs can continue to support more resilient food systems and achieve sustainable development goals after the crisis is over. The structure of the paper is as follows: Section 2 provides background on the potential of RFSCs to support greater sustainability, the challenges that RFSCs face in terms of logistics and delivery convenience, and potential solutions to these challenges; Section 3 describes the seven case studies, emphasizing the RFSC actors' implementation of logistics best practices in support of Sustainable Development goals; Section 4 discusses the implications of this research; Section 5 concludes the paper and discusses ongoing and future work.

2. Background

2.1 Regional food supply systems and the United Nations Sustainable Development Goals

The potential of RFSCs to bring the principles of sustainable development to food production and consumption is based on the idea that regionally-produced food can be more economically, environmentally, and socially sustainable than conventionally-produced food (Berti and Mulligan, 2016). Indeed, many consumers seek out RFSCs for perceived benefits that include fresher, safer, and/or more nutritious food, reduced reliance on fossil fuel consumption, and the ability to support the local economy (Feldmann and Hamm, 2015; Martinez et al., 2010; Schnell, 2013). As such, RFSCs have the potential to support several UN Sustainable Development Goals (SDGs), principally: zero hunger (SDG 2), good health and well-being (SDG 3), decent work and economic growth (SDG 8), sustainable cities and communities (SDG 11), and responsible consumption and production (SDG 12).

With fewer intermediaries and shorter distribution times than conventional food supply chains, RFSCs are often capable of providing consumers with fresher and more nutritious food (Ackerman et al., 2014; Galli and Brunori, 2013). However, the ability of RFSCs to promote good health and well-being for all people could be hindered by economic concerns; regionally-produced food is often perceived as being entirely unaffordable for vulnerable populations (Allen, 2010). However, some studies indicate that this perception may not be accurate (Donaher and Lynes, 2017; Pirog and McCann, 2009), and markets served by RFSCs can be (and often are) supported by public food assistance programs to improve access

(Guthman et al., 2006). Furthermore, many RFSC participants view SDGs 2 and 3 as core to their personal values and organizational missions. In fact, several of the case studies in this paper describe RFSC organizations that promoted food access to food-insecure families during the COVID-19 pandemic as unemployment and food shortages spiked.

RFSCs can also promote decent work and economic growth (SDG 8), particularly in rural communities. Small and midsize farms, which account for 96 percent of U.S. farms (MacDonald and Hoppe, 2017), struggle to market their products through conventional food supply chains because they lack the necessary scale to satisfy large-scale distributor volume and price point requirements (Perrett, 2007). Finding appropriately-scaled market channels is particularly challenging for midsize farms – they are too small to distribute their products economically through large, vertically-integrated grocery chains, but their volumes are too large for direct-to-consumer channels, such as farmers' markets (Kirschennmann et al., 2008). Consequently, these midsize farms, which comprise an "agriculture of the middle", often must limit their distribution to a small segment of niche wholesale customers, such as independent restaurants and college/university foodservice. Unlike small-scale farmers, who typically have supplemental off-farm income, midsize farmers often rely primarily on their farm's income to support themselves and their families (Kirschennmann et al., 2008) – if the farm is not profitable, they lose their livelihood. As a result, many small and midsize farmers have left the farming profession and moved to urban areas, leading either to overall increased farm sizes and/or land abandonment and damaging the rural economy as a whole (Berti and Mulligan, 2016). By contrast, RFSCs typically aim to provide fair prices to small-scale farmers and treat them as strategic business partners (Stevenson and Pirog, 2013), enabling them to scale up their businesses, increase their market reach, and make their region less dependent on food from outside the region, as well as creating new employment opportunities in intermediary businesses (e.g., processing, distribution) (Pinchot, 2014).

Because RFSCs require less transport, cold storage, processing, and packaging than conventional food supply chains (Ackerman et al., 2014), they may offer a better alternative for responsible consumption and production (SDG 12). According to the USDA Agriculture Transportation Open Data Platform, produce in conventional supply chains travels 1500 to 1700 miles on average from farm to table (USDA, 2020). RFSCs can potentially reduce the energy and ecological costs of long-distance transportation (Bloom and Hinrichs, 2011; Low et al., 2015) by requiring less cold storage, wasting less food, and generating fewer carbon emissions (Coley et al., 2009; Galli and Brunori, 2013; Kiss et al., 2019). By increasing farmers' and consumers' proximity, RFSCs may also enable consumers to demand greater farmer accountability for ecological degradation (Iles, 2005).

All of these characteristics of RFSCs suggest that they can serve as a key element of sustainable cities and communities (SDG 11). However, in the U.S., 97% of food still travels through nationally and globally organized food supply chains (Woods et al., 2013). To achieve their potential to support sustainable development, RFSCs must address multiple challenges. This paper focuses on the challenge of efficient RFSC logistics.

2.2 Logistics best practices for RFSCs

The long-term sustainability, viability, and resilience of RFSCs can be significantly improved by selectively employing some transportation, warehousing, and inventory management best practices that make conventional food supply chains efficient and effective (Rogoff, 2014). Faced with the COVID-19 crisis, the regional food producers and distributors in the case studies presented in this paper have variously adopted one or more of eight recommended logistics best practices. These best practices are extracted from the comprehensive literature review on logistics for regional food systems conducted by Mittal et al. (2018):

- *Efficient vehicle utilization*: Increasing vehicle load rates via optimized routing and scheduling and consolidating delivery routes can help an organization to increase its logistics efficiency and reduce transportation costs.
- *Vehicle selection*: Selecting appropriate vehicle types and sizes to meet supply chain objectives is critical for transportation efficiency; large and refrigerated vehicles can improve product freshness and facilitate longer delivery routes, but they also tend to have very low fuel efficiency.
- *On-time and frequent deliveries*: Customers with busy schedules tend to highly value on-time deliveries; they also typically prefer more frequent deliveries, which reduce the amount of inventory that they must carry while increasing product availability and freshness.
- *Outsourced transportation*: Hiring the services of third-party logistics providers can reduce overall transportation costs; however, finding scale-appropriate providers can be challenging for small-scale shippers (Niemi and Pekkanen, 2016) and for making home deliveries through e-commerce (Chen et al., 2014).
- *Horizontal collaboration*: Organizations in different supply chains work together to cluster their logistics activities and assets (e.g., through shared transportation and processing facilities) for greater efficiency and reduced logistics costs (Pomponi, 2015).
- *Facility location*: Determining the optimum number and locations of warehouses is critical for logistics efficiency, with implications for labor, transportation, inventory, and indirect costs; proximity to suppliers and/or customers is another important consideration.

- *Inventory management*: Implementing warehouse inventory management systems, using inventory tracking systems, and matching supply with demand through demand forecasting can reduce logistics costs and improve service levels.
- *Improved supplier reliability*: Reducing supply uncertainty can help organizations to match supply and demand, thereby increasing inventory availability and supply chain responsiveness.

The case studies presented in this paper demonstrate the importance of logistics for RFSC success. When faced with the challenges and opportunities that presented themselves at the onset of the COVID-19 emergency, the RFSC participants in these case studies were able to implement logistics best practices in their distribution operations that not only allowed their organizations to survive but also thrive.

2.3 Convenience

Consumers highly value convenience in their food purchasing decisions (Morganosky and Cude, 2000). For example, online shopping, door-step home deliveries, and drive-through pick-ups are some ways conventional grocery stores (e.g., Walmart and Kroger) have offered convenient delivery to their consumers (Raison and Jones, 2020). By contrast, RFSCs tend to offer relatively infrequent opportunities to make purchases and receive deliveries. For example, many regional food distributors offer their customers semi-monthly or weekly distribution, and most farmers' markets are held weekly, on weekends. Although consumers may be motivated to buy regionally-produced food, the appeal of 24-hour grocery stores that offer one-stop shopping and enormous product variety is strong. Consumers have also demonstrated that they are willing to pay a nominal fee (e.g., for home delivery) for more convenient delivery options (Anesbury et al., 2016). Therefore, for RFSCs to continue to take advantage of the increased demand for regionally-produced food that stemmed from the COVID-19 pandemic, they will need to find ways to provide convenient food delivery options, which consumers have come to expect from the conventional food supply system. The case studies discussed in this paper demonstrate how some RFSCs were able to rapidly pivot from wholesale to direct-to-consumer distribution and also efficiently provide their new customers with highly valued convenience.

3. Case studies

Over the course of three months (May-July 2020), twenty-five RFSC participants (farmers, ranchers, distributors, and community leaders) located in the states of Texas and Iowa were interviewed over the phone or via online conference to gain an understanding of their logistics operations, the challenges they faced with respect to logistics, and the approaches that they had implemented to overcome these challenges. Of these case studies, seven of them demonstrated the application of logistics best practices to

not only overcome pandemic-related challenges but also develop new organizational strengths that could help these RFSCs to promote post-pandemic sustainable development in their communities. Six of the seven case studies presented in this section are based on RFSCs in Texas (including the north, central, and eastern regions of the state), and one case study is from Iowa (see Figure 1). Each case study describes how the RFSCs responded to changes in demand at the height of the COVID-19 emergency. The connection to logistics best practices is established, and the relationship to relevant Sustainable Development Goals is examined.

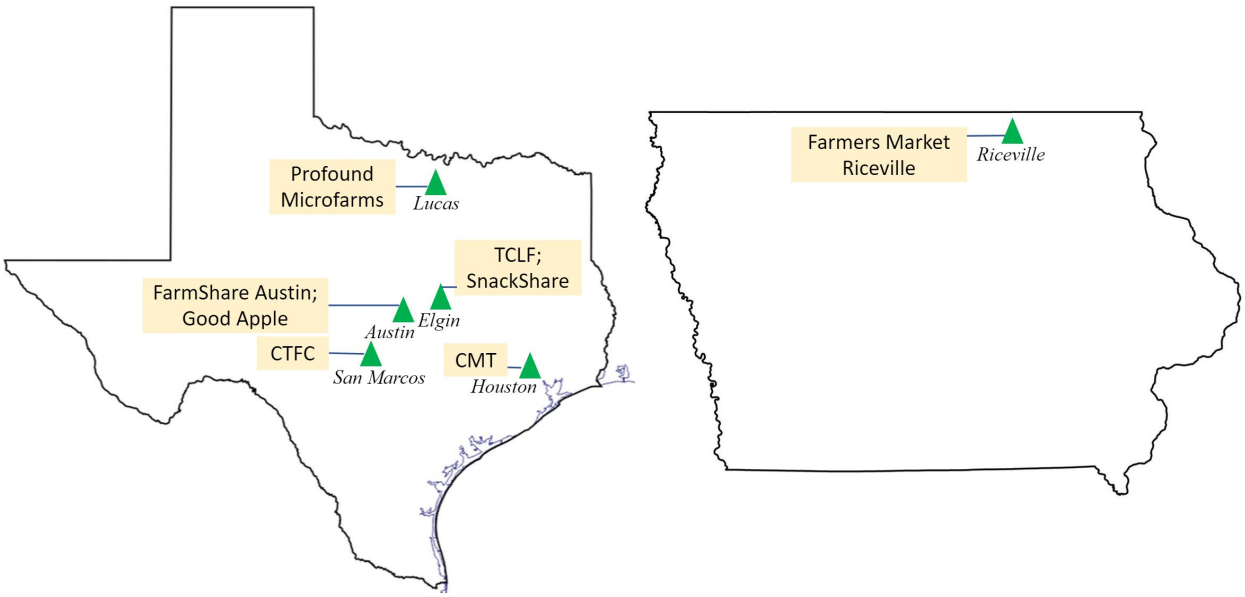

Figure 1. Case study locations in Texas (left) and Iowa (right)

3.1 Texas Center for Local Food and Common Market Texas

Logistics best practice implemented: horizontal collaboration

Sustainable Development Goals supported: 2 & 3

Texas Center for Local Food (TCLF), located in Elgin, Texas, is a nonprofit organization founded by Texas farmers to increase the consumption of locally grown foods in Texas. TCLF provides education, research, and technical assistance to create regional food systems in Texas that support prosperous family farms, healthy consumers, and vibrant rural economies. The city of Elgin has a total population of around 10,000 and is home to the first commercial organic feed mill in Texas, a large certified organic pastured egg farm, and the Sustainable Agriculture program of Austin Community College. As such, Elgin has the potential to become a model in Texas for local food as a driver of economic activity, including jobs that are healthy for the environment and provide healthy food statewide. However, many Elgin residents struggle with food security: 19% of children under age 18 live in poverty, and 80% of students in the

Elgin Independent School District qualify for free and reduced lunch. It is estimated that the median annual household for a family in Elgin is $50,000, and as a result of the pandemic, many citizens experienced food shortages, and many families who would not have ordinarily done so turned to local food banks for support.

The Common Market is a nonprofit regional food distributor with operations in Atlanta, Philadelphia, and Houston. The Common Market Texas (CMT) sources and provides solely Texas-grown food. Their core mission is to connect communities with healthy food from sustainable family farms and to improve food security, farm viability, and community and ecological health. Prior to the COVID-19 pandemic, CMT distributed regionally-produced food to wholesale buyers, servicing many restaurants and institutions throughout Central and South East Texas, predominately surrounding the Houston and Austin areas. However, with the closure of schools and restaurants at the onset of the pandemic in mid-March, CMT's wholesale operation immediately lost 70-80% of its sales. To avoid wasting large volumes of food, they realized that they needed to find a way to quickly pivot to serve new market channels.

In response to these challenges, TCLF partnered with CMT and rapidly launched the Texas Farms Veggie Box Program for direct-to-consumer distribution in Elgin. Each week TCLF purchased family-size boxes of Texas-grown fresh vegetables from CMT, and over the course of eleven weeks, they distributed 1,665 boxes to 486 families and individuals, through online sales to the public, donations to food insecure families, and distribution to Elgin schoolchildren and their families. TCLF estimates that the program contributed $36,742 directly to the Texas local food economy.

Several factors contributed to the success of this program. Operating without chains of command and intermediaries allowed TCLF and CMT to rapidly react and transition to a new direct-to-consumer distribution model without having to wait on authorization from above. CMT already had relationships in place with local farmers, packing and distribution capacity, and an existing customer base in Austin that regularly brought their delivery truck through Elgin. TCLF leveraged these resources to provide food to those in need, while CMT benefited from additional cash flow generated by veggie box sales to the general public. CMT supplemented the veggie boxes with pamphlets describing the farms that produced each item and provided weekly updates of the boxes' contents via social media outlets. Furthermore, a local Elgin restaurant allowed TCLF to safely distribute the pre-ordered boxes to customers via a contact-free drive-through in their parking lot each week and allocated the necessary on-site cold storage in their walk-in cooler during distribution.

3.2 Profound Microfarms/Profound Foods

Logistics best practices implemented: horizontal collaboration; efficient vehicle utilization; on-time and frequent deliveries; improved supplier reliability

Sustainable Development Goals supported: 8 & 12

Profound Microfarms is a farm located in Lucas, Texas, that specializes in greenhouse grown microgreens. Prior to the COVID-19 pandemic, Profound Microfarms serviced over 100 restaurants throughout North Texas with biweekly deliveries. In 2018, Profound Microfarms launched Profound Foods, which operated as a regional food hub, aggregating products from 30 North Texas farmers and distributing these products to area restaurants. A convenient online marketplace allowed restaurants to customize their orders with products from any of the participating farmers. This collaborative method of aggregation reduced participating farmers' time and capital spent on transportation and enabled them to reach more customers. Facing evaporating restaurant demand with the onset of the pandemic, Profound Foods immediately decided to shift to a direct-to-consumer distribution model, marketing their products to consumers through social media, email, and news platforms and leveraging their existing online marketplace to enable customizable orders. They now offer free home delivery to customers within 50 miles of their aggregation facility, as well as three contactless pick-up locations congruent to zip codes with the highest demand. As sales continue to soar, Profound Foods plans to maintain their focus on online direct-to-consumer distribution.

Throughout this transition, Profound Foods improved their supplier reliability by expanding their producer network. Since the onset of the pandemic, they have consistently distributed approximately 200 orders each week, equating to an increase of 250% over their pre-pandemic sales, and they have on-boarded 18 new farmers, increasing product variety and availability. Moreover, they have further extended their product offerings with the addition of value-added items. They are presently collaborating with executive chefs in the region to create value-added products that will complement their fresh product selection and consume excess and imperfect inventory that could not be sold directly to customers. They are currently utilizing an off-site commercial kitchen to prepare these products but plan to construct an on-site commercial kitchen in the near future.

Operating at nearly maximum capacity on each of their biweekly delivery routes, Profound Foods has taken advantage of efficient vehicle utilization. Using two refrigerated vans, 120 home deliveries are made each week on average on Friday and Saturday, at a rate of approximately 10 deliveries per hour, while pick-up locations are serviced each week on Thursday and Friday. Furthermore, they encourage producers located in the same vicinity to work together to jointly haul their products to Profound's aggregation center each week, thereby reducing transportation costs and less-than-full shipments. Three

producers in East Texas have adopted this practice, rotating transportation among the three of them each week.

Another logistics best practice adopted by Profound Foods is on-time and frequent deliveries. Based on conversations with other farmers and distributors, it was determined that most have a single weekly delivery/pick-up day scheduled. By contrast, Profound Foods has scheduled three days each week for deliveries and pick-ups, thereby assuring on-time and frequent deliveries to their customers, who value the degree of choice and convenience that this schedule provides.

By enabling 48 small-scale North Texas farmers to efficiently distribute their products to hundreds of urban consumers, Profound Foods has demonstrated how implementing multiple logistics best practices can provide a path to economic sustainability for regional food systems. Their expansion into value-added products also addresses issues of food waste, by providing farmers with a profitable way to absorb excess or cosmetically-imperfect inventory.

3.3 Central Texas Farmers' Cooperative

Logistics best practices implemented: horizontal collaboration; vehicle selection

Sustainable Development Goal supported: 8

The Central Texas Farmers Co-op (CTFC) is a jointly owned and democratically controlled cooperative of small and beginning farmers located between San Antonio and Austin, with a mission to consistently provide guaranteed sales to small sustainable farms. CTFC originated in September of 2016 as a group of young farmers and advocates who wanted to explore the opportunities that could evolve for them by working together, rather than in competition. One year later, they launched a 25-member community supported agriculture (CSA) program, which provides subscribing consumers with weekly boxes of regionally-produced vegetables and meats. To fulfill their weekly CSA orders, CTFC purchases products in bulk from its farmer members at a price stationed between wholesale and retail market prices. Currently, the co-op consists of 17 owner-members who are bound by a formal membership agreement and make decisions via consensus management.

Prior to the pandemic, the co-op distributed products to customers through a farmers' market-style pick-up, where customers were permitted to hand-select items by the pound and exchange items from the standard box supplied by the co-op. This format differs from traditional CSAs, where shares are prepacked, items are predetermined, and all boxes are identical. The parking lot of a neighborhood restaurant in San Marcos provided a collocated drop-off and pick-up site for farmers and consumers, respectively, such that the co-op was not required to provide transportation.

With their CSA model in place, CTFC did not face the challenge of pivoting from wholesale to direct-to-consumer distribution, as with Common Market Texas and Profound Foods. However, due to mandated safety protocols and social distancing, the co-op was forced to employ new distribution strategies to continue to serve their CSA members for the Spring 2020 season. Although the co-op was able to continue using the parking lot of the neighborhood restaurant for distribution, they could no longer offer customers on-site customization of their boxes. The co-op had to develop a process for pre-packing the boxes and delivering to customers via contactless curbside pick-up.

One of CTFC's farmer members owned an on-farm wash and pack facility, which was made available to the co-op to prepare the CSA boxes prior to distribution. Thirteen farmers dropped off their products at this centrally-located farm each week, where co-op members would then prepare customers' boxes. CTFC implemented new procedures for aggregating and packing, adopting pandemic-related and food safety best practices. Although access to the packing facility facilitated this pre-packing process, it also created a new challenge: the co-op would need to find a cost-effective way to transport the boxes from the packing facility to the restaurant for distribution to customers each week.

To address this challenge, CTFC decided to purchase a used trailer, equipped with insulation, air conditioning, and a CoolBot, which is a device that allows a window air conditioning unit to maintain temperatures as low as 35 degrees, i.e., providing refrigeration (Munzer, 2012). The co-op did not own a vehicle that was capable of towing the trailer, but they were able to hire a member to pull the trailer on a weekly basis. This investment has provided CTFC with temperature-controlled storage throughout their entire distribution operation.

Thus, collaboration among co-op members not only allowed CTFC to meet the safety requirements of direct-to-consumer distribution during the pandemic, but also enabled them to rapidly increase their logistics capacity to fulfill new demand for regionally-produced food that arose in response to the pandemic. By investing in an insulated trailer and equipping it with a CoolBot, CTFC was able to cost-effectively increase their hauling capacity and acquire short-term storage for distribution. As a result, CTFC achieved their long-term goal of distributing 200 CSA shares in spring 2020. They also decided to extend the duration of their spring CSA program by several weeks, and they are considering expanding to a second distribution location for fall 2020. These factors have promoted economic growth via improved market opportunities for CTFC farmer members.

3.4 Good Apple

Logistics best practices implemented: horizontal collaboration; outsourced transportation

Sustainable Development Goals supported: 2, 3, & 12

Good Apple is an Austin-based local and organic food distributor that delivers boxes of mixed fresh produce to subscribers' homes throughout Travis County on a weekly, biweekly, or monthly basis. For every box that is sold to subscribers, Good Apple delivers another box to a family facing food insecurity in the Austin area, free of charge, with an aim of increasing access to fresh and nutritious food for those in need. Products are regularly procured from 4 to 12 farms located within a 180-mile radius of Travis County, along with seasonal fruit from the Rio Grande Valley in South Texas. Good Apple works with the farmers to rescue imperfect or overproduced items that would otherwise go unsold, thereby addressing food waste issues, reducing their procurement costs, and working collaboratively with farmers, rather than requiring specific products for their boxes each week. The farmers deliver products directly to the warehouse of a central Austin food pantry, which is collaborating with Good Apple to provide them with short-term cold storage, as well as packing and cross-docking capabilities. In turn, Good Apple supplies the pantry with fresh produce, and the pantry provides supplemental grocery staples for the donated boxes.

Since the onset of the pandemic, Good Apple has seen their demand increase tremendously, forcing them to increase their transportation and delivery capacity in response. They previously had hired contract drivers to make deliveries, but the surge in demand required them to begin outsourcing transportation to a national commercial carrier (Dropoff). Although Dropoff's six-dollar delivery charge was significantly less cost-efficient than employing contract drivers, outsourcing deliveries provided Good Apple with instant logistics flexibility and scalability. This strategy has enabled them to rapidly grow their company to deliver 375 to 400 boxes each week.

3.5 Farmshare Austin

Logistics best practices implemented: outsourced transportation; efficient vehicle utilization

Sustainable Development Goals supported: 2, 3, & 11

Farmshare Austin is a nonprofit organization that produces vegetables on their 10-acre farm located in Eastern Travis County, with a mission to grow a healthy local food community by increasing food access, providing training to new farmers, and preserving farmland. Prior to the pandemic, Farmshare Austin sold their vegetables to underprivileged consumers in multiple locations throughout Austin via weekly mobile markets. Their goal was to provide a farmers' market experience with top-quality items to those who would have otherwise lacked access to them. When Farmshare Austin has excess inventory, they also distribute their products to wholesalers and restaurants, but the mobile markets are their priority.

During the pandemic, Farmshare Austin was no longer able to distribute food via the mobile market, due to safety concerns. As an alternative, they decided to offer curbside home deliveries two days per week, sourcing products that they could not produce themselves from other local farms to expand the volume and variety of their product offerings, while continuing to accept Supplemental Nutrition Assistance Program (SNAP) dollars as payment. However, home delivery required a radical adjustment to their transportation methods: their fleet consists of two transit vans and one refrigerated box truck, which would not provide them with sufficient capacity. To rapidly increase their transportation capacity, Farmshare Austin partnered with Cap Metro, a local public transportation provider, to make their deliveries. Any deliveries outside Cap Metro's service area were performed by Farmshare Austin's fleet. By piggybacking on Cap Metro's existing routes to make their deliveries, Farmshare Austin was also able to minimize their carbon footprint.

In addition to providing vehicles and drivers free of charge through the end of August, Cap Metro also offered Farmshare Austin use of their route-optimization software, which helps drivers find the shortest route to a customer's location and avoid traffic jams, as well as helping them to consolidate deliveries and reduce the number of trips they make. This enables them to decrease their transportation cost and time. Based on this experience, Farmshare Austin determined that route optimization software is a worthwhile investment for them, and they plan to continue using it to facilitate weekly home when their contract with Cap Metro ends, in addition to reestablishing their mobile markets.

3.6 SnackShare

Logistics best practices implemented: outsourced transportation; improved supplier reliability; facility location

Sustainable Development Goal supported: 11

SnackShare is a regional food aggregator that allows consumers to place weekly orders via an online marketplace and then provides home and office delivery. Since January 2019, they have operated out of a 57,000 square foot warehouse located in Elgin, Texas, that was strategically chosen to facilitate farmer deliveries, rather than locating in Austin, near their predominantly urban customers. Prior to the pandemic, SnackShare focused on the challenge of growing their new business to enable them to support more small-scale local producers.

To take advantage of the spike in demand for regionally-produced food that coincided with the onset of the COVID-19 crisis, SnackShare had to quickly find new suppliers. According to their organizational mission, they had been working predominantly with small-scale farmers, but they decided to begin purchasing products from larger operations, as well, to maintain consistent and reliable service to their

customers. Transportation also became an issue: SnackShare owns two refrigerated vans, but these vans only had capacity to service 60 to 70 percent of the 200 weekly home deliveries. To address this, SnackShare outsourced the remaining deliveries to contract drivers from the Austin area, employing former food service industry workers that had been laid off due to the pandemic. The use of contract delivery drivers allowed SnackShare to scale up their delivery capacity quickly and affordably. However, in the long term, they intend to add new refrigerated vehicles to their fleet and employ drivers.

3.7 Riceville Farmers' Market

Logistics best practices implemented: inventory management system

Sustainable Development Goals supported: 2 & 3

The Riceville Farmers' Market operates in Riceville, Iowa, a small town located in northeast Iowa with a total population of 783 people (Data USA, 2020). The farmers' market is the town's primary source of fresh produce and bakery items, as there are no local stores or supermarkets. The farmers' market typically begins operating every year in the month of May. However, with the onset of pandemic and due to vulnerable elderly population in the city (median age of 45.9 years (Data USA, 2020)), the farmers' market could not have customers visit farm stands at a physical location. Therefore, a virtual solution was required, such that customers could visit a vendor's shop online to view available products, place their orders, and pick up the orders in a contactless manner, thereby avoiding any potential exposure.

Thus, the Riceville Farmers' Market adopted an online ordering platform, which operates on a weekly cycle, in which the farmers provide information on product availability to the market manager by Saturday at noon. The online shopping cart opens every Saturday by 4:00 pm, and customers can add products to their carts until the following Wednesday at noon. Upon receiving the customer orders, the market manager sends the list of products that farmers need to bring to the market on Saturday morning. The customers pick up their orders on Saturday morning via curbside delivery. The online platform serves as an inventory management system that facilitates supplier-buyer coordination, particularly with e-sourcing, through which inventory level can be monitored and updated precisely. This results in improved crop management and planning for the participating farmers. In addition, by allowing farmers to continuously monitor their inventory levels, the platform helped to prevent them from selling beyond their capacities and stocking out.

As with the program established by TCLF and CMT, the Riceville Farmers' Market continued to provide consumers with access to fresh local food during the pandemic. Post-pandemic, the market manager envisions using the online platform in conjunction with the physical market option, to provide more consumers with access to local and fresh food.

Table 1 summarizes all seven case studies, describing their operations before and during the pandemic, logistics best practices adopted, consumer convenience features offered, and which sustainable development goals they align with.

Table 1. Summary of seven case studies on regional food systems in Texas and Iowa

Name of the organization	Operations before pandemic	Operations during pandemic	Logistics best practices adopted during pandemic	Convenience options offered during pandemic	Sustainable development goals addressed
Texas Center for Local Food (TCLF); Common Market Texas (CMT)	TCLF: provides farm to school education programs and local food system development CMT: Regional food distributor that sources Texas-grown food, primarily sells to restaurants and institutions	TCLF and CMT jointly initiated the Texas Farms Veggie Box program to retail customers and food insecure youth	Horizontal Collaboration	Provided customers an option of drive through pick-ups at a local restaurant	SDG 2; SDG 3
Profound Microfarms	Profound Microfarms launched Profound Foods in 2018 to operate as a regional food hub aggregating for 30 producers and making bi-weekly deliveries to over 100 restaurants	Transitioned to a direct-to-consumer retail model offering a variety of products via an online platform. Distribution occurs through three pick-up locations and home deliveries dispersed among three delivery days. Utilizing off-site commercial kitchen to produce value-added goods	Horizontal Collaboration; Efficient Vehicle Utilization; On-time & Frequent Deliveries; Improved Supplier Reliability	Provided consumers an online ordering platform to build customized orders and offered the choice of pick-up or home delivery.	SDG 8; SDG12
Central Texas Farmers Cooperative (CTFC)	Provided a farmer's market style CSA where customers could hand select their items of choice from the current week's harvest and exchange items from the standard box. The farmer drop-off location and consumer pick-up location were collocated at a local restaurant	Offered pre-packaged CSA shares. Customer pick-up location and aggregation and packaging facility were located at different sites. Purchased an insulated trailer to transport the shares from the packing facility to customer pick-up location	Horizontal Collaboration; Vehicle Selection	Offered consistent CSA shares on a weekly basis at the local restaurant prior to the pandemic	SDG 8

Name of the organization	Operations before pandemic	Operations during pandemic	Logistics best practices adopted during pandemic	Convenience options offered during pandemic	Sustainable development goals addressed
Good Apple	Offered fresh "rescued" organic produced sourced from local farms and other grocery staples via an online ordering platform, delivered to homes on a weekly, biweekly, or monthly subscription basis. For every box sold, they donate a box free of charge to food insecure families. Collaborated with a local food panty to aggregate and pack boxes: Good Apple provides fresh produce to the pantry, while the pantry supplements the boxes with grocery staples	Due to increased demand, employed more contract drivers as well as outsourcing deliveries to the national carrier, Dropoff, to continue fulfilling orders to their prior delivery schedule.	Outsourcing Transportation; Horizontal Collaboration	Offered evening home delivery to customers through an online ordering platform, with flexible delivery options available multiple days per week	SDG 2; SDG 3; SDG 12
Farmshare Austin	Operate as a 10-acre farm and provide training to farmers who would like to learn how to operate a sustainable farm. Their food access program makes top-quality produce accessible to the general public and food insecure families through mobile markets throughout the city. They accept Supplemental Nutrition Assistance Program (SNAP) as payment at mobile markets to further increase accessibility to food insecure families	Transitioned from their mobile market operation to curb side deliveries for safety concerns brought upon by the pandemic, however continued to accept SNAP as payment for curb side deliveries. They expanded the selections available for home deliveries with other commodities from local farms that could not be grown on their farm. They also extended their distribution capacity by leveraging transit services through local public transportation provider, Cap Metro	Efficient Vehicle Utilization; Outsourcing Transportation	Provided free home delivery to customers and expanded the selection of items offered. Also, continued to accept SNAP as payment to continue to make fresh locally grown products accessible to food insecure families	SDG 2; SDG 3; SDG 11

Name of the organization	Operations before pandemic	Operations during pandemic	Logistics best practices adopted during pandemic	Convenience options offered during pandemic	Sustainable development goals addressed
SnackShare	Operate as an online marketplace that allows customers to place online orders, aggregates products from local farmers at their warehouse and deliver them to the customers	Added new farm vendors and maintained consistent supply of their products to meet the increased local food demand during the pandemic. Also, employed new contract drivers to satisfy their deliveries, as their existing vans did not contain enough capacity for delivery fulfilment	Outsourcing Transportation; Improved Supplier Reliability; Facility Location	Offered customers to place orders through an online marketplace and provided free home delivery	SDG 11
Farmers Market Riceville	Operated as a traditional farmers market where vendors gather at a physical location and set up their respective stands, and customers visit farm stand(s) of their choice to purchase desired products	Transitioned to a virtual marketplace where the farmers provide information on the product availability to the customers over an online portal, customers can place order online within a four-day time window, farmers prepare customer orders and bring them to an aggregation location, and finally, customers pick-up their products using a drive through option	Inventory Management System	Provided customers an option to pre-order products from different farmers market vendors and drive through pick-up option	SDG 2; SDG 3

4. Research implications

The case studies presented in this paper suggest three key implications for RFSCs moving forward, including adopting innovative distribution and logistics methods, leveraging information and communication technologies, and reevaluating the supply chain performance criteria, as described below.

Adopt innovative distribution and logistics methods

While the growth of some RFSCs during the COVID-19 pandemic was driven by increased consumer demand for regionally-produced food, the overarching reason that the case study farmers and distributors were able to benefit from these circumstances was their willingness to take the necessary risk of adopting new distribution and logistics strategies. It could be argued that, in many cases, they did not have much choice – if they had not pivoted immediately to serve direct-to-consumer channels and provide safe, contact-free delivery options, their businesses simply would not have survived. However, the case studies presented in this paper suggest that their actions were more than just survival mechanisms; rather, these RFSC actors viewed the change in consumer demand patterns as an opportunity to innovate with new distribution methods and logistics practices that could help them to grow their businesses in the long term. For example, several case study participants mentioned that direct-to-consumer distribution via home delivery was a strategy that they had been considering even prior to the pandemic.

During the pandemic, necessity was perhaps truly the proverbial mother of invention, and these innovations might not have succeeded without the pandemic-driven increase in consumer demand for regionally-produced food. However, the successes experienced by these farmers and distributors suggest that a more proactive approach to distribution and logistics innovation could benefit RFSCs beyond the pandemic. The logistics best practices described in Mittal et al. (2018) have long been recommended to RFSC practitioners; however, adoption has been slow. Hopefully, the successful outcomes described in this paper will help to encourage other RFSC actors to seriously consider the adoption of logistics best practices, with an eye toward not just the risks but also the potential benefits. In particular, these case studies demonstrated that collaboration among RFSC actors is a long-term investment that can potentially reduce or eliminate the costs and risks associated with trying out other logistics strategies.

Leverage information and communication technologies (ICT)

Adoption of scale-appropriate ICT solutions can facilitate the implementation of other logistics best practices in RFSCs. In some cases, purchasing off-the-shelf software can be a cost-effective and convenient solution. For example, Farmshare Austin is taking advantage of commercial route optimization software to support more efficient vehicle utilization when planning and scheduling their

deliveries. Leveraging third-party logistics providers' ICT is another potentially useful strategy, such as Good Apple's use of the Dropoff app to outsource transportation for their deliveries. However, ICT solutions that cater specifically to the requirements and scale of RFSCs are often necessary: they need to be affordable (Craven, Mittal and Krejci, 2016), easy to use and understand, and customized to meet farmers' needs. The Riceville Farmers' Market inventory management system is an example of ICT that was designed specifically to meet the needs of RFSC stakeholders (Mittal and Grimm, 2020). The ICT solution was developed by a nonprofit organization in Iowa with a very low initial and no running cost, as any incremental cost could be a burden on farmers and, thus, customers. Thus, collaboration between academic institutions, nonprofit organizations, and the local agricultural community can facilitate the development of ICT solutions that support more efficient and effective RFSC logistics.

Reevaluate supply chain performance criteria

Implementing logistics best practices can enable RFSCs to improve their performance with respect to traditional supply chain metrics, including reduced transportation and inventory costs and increased capacity management, delivery, and information sharing capabilities. However, if food supply systems are to be held to the standards of the UN Sustainable Development Goals, their contributions to societal well-being must also be considered. This necessitates the inclusion of metrics that capture a food supply system's contribution to community development and public health. Socially-focused food supply system objectives include reducing food waste and carbon footprint, improving consumer access to healthy food (especially underserved populations), increasing the number of job opportunities for rural and underdeveloped communities, and maintaining food dollars within the local economy. The RFSCs described in this paper demonstrate how efficient logistics systems can be leveraged to provide such public benefits. Good Apple and Profound Foods are reducing food waste by purchasing and making use of cosmetically imperfect produce. Farmshare Austin has reduced its carbon footprint by partnering with a local public transportation provider. Many of these organizations (TCLF, Common Market, Good Apple, Farmshare Austin, and Riceville Farmers Market) are focused on increasing low-resource consumers' access to healthy local food. All of the RFSC actors described in these case studies (especially CTFC and TCLF) have made it their mission to increase opportunities for small and mid-size regional food producers to earn sufficient income to support themselves and their families.

These case studies suggest that food producers and distributors that are embedded within the communities they serve are best-suited to contributing to the sustainable development of those communities' health and well-being. Facilitating collaboration between these organizations (e.g., via ICT solutions) can help them to take advantage of logistics and operational efficiencies that would be difficult or impossible to implement on their own, thereby increasing their capacity to contribute to their communities.

5. Conclusion

This paper presented seven case studies from Texas and Iowa that exemplified the flexibility, responsiveness, and community-oriented focus of regional food supply chains, which allowed them to continue to supply food to their communities in the face of the logistics challenges presented by the COVID-19 pandemic. In contrast with conventional food supply chains, these RFSCs were able to rapidly pivot their operations to distribute products directly to consumers, whose demand for regionally-produced eat-at-home items increased even as restaurant and wholesale demand diminished. This rapid response was facilitated by the adoption of logistics best practices, many of which relied on the creation of new collaborative partnerships and the use of information and communication technologies. These practices have helped the RFSCs to develop new organizational strengths that will likely support sustainable development in their communities, even after the pandemic is over.

It is unlikely that RFSCs are capable of replacing conventional food supply systems entirely, at least in the near term. In many regions (including Texas and Iowa), there is currently insufficient productive capacity to meet regional demand requirements for food, especially in food processing. Furthermore, it will be difficult for RFSCs to match the level of convenience offered by large grocery conglomerates, which provide one-stop-shopping and an extraordinary variety of foods year-round, all at a low price. However, these case studies demonstrate the potential of RFSCs to support a resilient and socially-sustainable food system that communities can rely on, even in the face of a major disruption like COVID-19. Hopefully, these success stories will encourage RFSC practitioners and stakeholders to proactively invest in collaborative ventures and other logistics-enhancing practices, allowing them to take advantage of increased efficiencies and new market opportunities in the long term.

Acknowledgments

This work was supported by the Southern Sustainable Agriculture Research and Education program [project number LS19-312]. The authors would like to thank the anonymous reviewer for critically reading the manuscript and suggesting substantial improvements.

References

Ackerman, K., Conard, M., Culligan, P., Plunz, R., Sutto, M.P., Whittinghill, L., 2014. Sustainable food systems for future cities: The potential of urban agriculture. Econ. Soc. Rev. (Irel). 45, 189–206.

Allen, P., 2010. Realizing justice in local food systems. Cambridge J. Reg. Econ. Soc. 3, 295–308. https://doi.org/10.1093/cjres/rsq015

Anesbury, Z., Nenycz-Thiel, M., Dawes, J., Kennedy, R., 2016. How do shoppers behave online? An observational study of online grocery shopping. J. Consum. Behav. 15, 261–270. https://doi.org/10.1002/cb.1566

Bakos, I.M., 2017. Local food systems supported by communities nationally and internationally. DETUROPE 9, 59–79.

Berti, G., Mulligan, C., 2016. Competitiveness of small farms and innovative food supply chains: The role of food hubs in creating sustainable regional and local food systems. Sustain. (United States) 8, 616. https://doi.org/10.3390/su8070616

Bloom, J.D., Hinrichs, C.C., 2011. Moving local food through conventional food system infrastructure: Value chain framework comparisons and insights. Renew. Agric. Food Syst. 26, 13–23. https://doi.org/10.1017/S1742170510000384

Broyles, A., 2020. Coronavirus kicks local food delivery companies into overdrive. Retrieved from: [WWW Document]. URL https://www.statesman.com/foodanddining/20200327/coronavirus-kicks-local-food-delivery-companies-into-overdrive (accessed 9.10.20).

Chen, M.C., Hsu, C.L., Hsu, C.M., Lee, Y.Y., 2014. Ensuring the quality of e-shopping specialty foods through efficient logistics service. Trends Food Sci. Technol. https://doi.org/10.1016/j.tifs.2013.10.011

Clancy, K., Ruhf, K., 2010. Is Local Enough? Some Arguments for Regional Food Systems. Choices Mag. Food, Farm Resour. Issues 25, 36–40.

Coley, D., Howard, M., Winter, M., 2009. Local food, food miles and carbon emissions: A comparison of farm shop and mass distribution approaches. Food Policy 34, 150–155. https://doi.org/10.1016/j.foodpol.2008.11.001

Craven, T., Mittal, A., Krejci, C.C. 2016. Effective Coordination in Regional Food Supply Chains. In Proceedings of the Industrial and Systems Engineering Research Conference, Anaheim, CA, USA, 21–24 May 2016.

Dahlberg, K.A., 2008. Pursuing Long-Term Food and Agricultural Security in the United States: Decentralization, Diversification, and Reduction of Resource Intensity, in: Food and the Mid-Level Farm. pp. 23–34. https://doi.org/10.7551/mitpress/9780262122993.003.0002

Data USA, 2020. Retrieved from: https://datausa.io/profile/geo/riceville-ia#demographics [WWW Document]. URL https://datausa.io/profile/geo/riceville-ia#demographics (accessed 9.5.20).

Donaher, E., Lynes, J., 2017. Is local produce more expensive? Challenging perceptions of price in local food systems. Local Environ. 22, 746–763. https://doi.org/10.1080/13549839.2016.1263940

Elbein, S., 2020. The pandemic could actually strengthen the U.S. food system. Retrieved from: https://www.nationalgeographic.com/science/2020/07/pandemic-could-strengthen-us-food-system/.

Natl. Geogr. Mag.
FAO, 2020. Urban food systems and COVID-19: The role of cities and local governments in responding to the emergency. Policy brief. Retrieved from: [WWW Document]. URL http://www.fao.org/3/ca8600en/CA8600EN.pdf (accessed 8.14.20).
Feldmann, C., Hamm, U., 2015. Consumers' perceptions and preferences for local food: A review. Food Qual. Prefer. 40, 152–164. https://doi.org/10.1016/j.foodqual.2014.09.014
Galli, F., Brunori, G., 2013. Short food supply chains as drivers of sustainable development, Evidence Document. Document Developed in the Framework of the FP7 Project FOODLINKS; (GA No. 265287).
Gebresenbet, G., Bosona, T., 2012. Logistics and Supply Chains in Agriculture and Food, in: Pathways to Supply Chain Excellence. InTech, pp. 125–146. https://doi.org/10.5772/25907
Goldstein, B., Birkved, M., Fernández, J., Hauschild, M., 2017. Surveying the Environmental Footprint of Urban Food Consumption. J. Ind. Ecol. 21, 151–165. https://doi.org/10.1111/jiec.12384
Greenberg, L.S.Z., 2007. Innovative Strategies for Meeting New Markets. Retrieved from: http://ngfn.org/resources/ngfn-database/knowledge/Meeting New Markets l greenberg.pdf.
Guthman, J., Morris, A.W., Allen, P., 2006. Squaring farm security and food security in two types of alternative food institutions. Rural Sociol. 71, 662–684. https://doi.org/10.1526/003601106781262034
Hall, M.C., Prayag, G., Fieger, P., Dyason, D., 2020. Beyond panic buying: consumption displacement and COVID-19. J. Serv. Manag. https://doi.org/10.1108/JOSM-05-2020-0151
Heil, E., 2020. Facing devastating losses, small farmers pivot to sell directly to consumers. The Washington Post. Retrieved from: [WWW Document]. URL https://www.washingtonpost.com/news/voraciously/wp/2020/04/01/facing-devastating-losses-small-farmers-pivot-to-sell-directly-to-consumers/ (accessed 8.14.20).
Hendrickson, M.K., Howard, P.H., Miller, E.M., Constance, D.H., 2020. THE FOOD SYSTEM: CONCENTRATION AND ITS IMPACTS, Family Farm Action Alliance.
Howard, P.H. 2016. Concentration and Power in the Food System: Who controls what we eat? Bloom. Publ. Inc., London New York, 216 p. https://doi.org/10.1007/s41130-017-0039-4
Hobbs, J.E., 2020. Food supply chains during the COVID-19 pandemic. Can. J. Agric. Econ. 68, 171–176. https://doi.org/10.1111/cjag.12237
Iles, A., 2005. Learning in sustainable agriculture: Food miles and missing objects. Environ. Values 14, 163–183. https://doi.org/10.3197/0963271054084894
Jensen, J., 2010. Local and Regional Food Systems for Rural Futures. Retrieved from: http://www.rupri.org/Forms/RUPRI_Rural-Futures-

Lab_2010_Food_Systems_for_Rural_Futures.pdf.
Kirschennmann, F., Stevenson, G. W., Buttel, F., Lyson, T.A., Duffy, M., 2008. Agriculture of the Middle: Why Farm Structure Matters. In *Food and the Mid-Level Farm: Renewing an Agriculture of the Middle*. Lyson, T. A., Stevenson, G. W., & Welsh, R. (Eds.). MIT Press.
Kiss, K., Ruszkai, C., Takács-György, K., 2019. Examination of short supply chains based on circular economy and sustainability aspects. Resources. https://doi.org/10.3390/resources8040161
Kolodinsky, J., Sitaker, M., Chase, L., Smith, D., Wang, W., 2020. Food Systems Disruptions: Turning a Threat into an Opportunity for Local Food Systems. J. Agric. Food Syst. Community Dev. 9, 1–4. https://doi.org/10.5304/jafscd.2020.093.013
Low, S.A., Adalja, A., Beaulieu, E., Key, N., Martinez, S., Melton, A., Perez, A., Ralston, K., Stewart, H., Suttles, S., Vogel, S., 2015. Trends in U.S. Local and Regional Food Systems: Report to Congress; United States Department of Agriculture: Washington, DC, USA.
MacDonald, J.M., Hoppe, R.A., 2017. Large Family Farms Continue To Dominate U.S. Agricultural Production. USDA Economic Research Service. Retrieved from: https://www.ers.usda.gov/amber-waves/2017/march/large-family-farms-continue-to-dominate-us-agricultural-production/.
Martinez, S., Hand, M., da Pra, M., Pollack, S., Ralston, K., Smith, T., Vogel, S., Clark, S., Lohr, L., Low, S., Newman, C., 2010. Local food systems: Concepts, impacts, and issues. Retrieved from: https://www.ers.usda.gov/webdocs/publications/46393/7054_err97_1_.pdf?v=4226.
Miller, M., Holloway, W., Perry, E., Zietlow, B., Kokjohn, S., Lukszys, P., Chacula, N., Reynolds, A., Morales, A., 2016. Regional Food Freight: Lessons from the Chicago Region. Retrieved from: https://localfoodeconomics.com/wp-content/uploads/2018/02/miller-et-al-2016-Regional-food-freight-final-2.pdf.
Mittal, A., Krejci, C.C., Craven, T.J., 2018. Logistics best practices for regional food systems: A review. Sustain. https://doi.org/10.3390/su10010168
Mittal, A., & Grimm, J. 2020. ICT solutions to support local food supply chains during the COVID-19 pandemic. *Journal of Agriculture, Food Systems, and Community Development*, *10*(1), 1-5.
Mollenkopf, D.A., Ozanne, L.K., Stolze, H.J., 2020. A transformative supply chain response to COVID-19. J. Serv. Manag. https://doi.org/10.1108/JOSM-05-2020-0143
Morgan, T., 2020. Some Growers Plow Under Fields As Fruit, Vegetable Demand Disappears - AgWeb. Retrieved from: [WWW Document]. URL https://www.agweb.com/article/some-growers-plow-under-fields-fruit-vegetable-demand-disappears (accessed 9.1.20).
Morganosky, M.A., Cude, B.J., 2000. Consumer response to online grocery shopping. Int. J. Retail Distrib. Manag. 28, 17–26. https://doi.org/10.1108/09590550010306737
Munzer, A., 2012. CoolBot Enables Small Farmers to Build Do-it-Yourself Coolers - Cornell Small

Farms. Retrieved from: [WWW Document]. URL https://smallfarms.cornell.edu/2012/06/coolbot-enables-small-farmers-to-build-do-it-yourself-coolers/ (accessed 9.10.20).

Niemi, P., Pekkanen, P., 2016. Estimating the business potential for operators in a local food supply chain. Br. Food J. 118, 2815–2827. https://doi.org/10.1108/BFJ-03-2016-0086

Ohberg, L.A., 2012. What ' s Stopping Us ? Identifying Barriers to the Local Food Movement Using Ontario , Canada as a Case Study by Movement Using Ontario , Canada as a Case Study (Doctoral dissertation). Retrieved from: https://tspace.library.utoronto.ca/bitstream/1807/334.

Perrett, A., 2007. The Infrastructure of Food Procurement and Distribution: Implications for Farmers in Western North Carolina," report for Appalachian Sustainable Agriculture Project. Retrieved from: http://asapconnections.org/downloads/growing-local-implications-for-weste.

Peters, C.J., Bills, N.L., Lembo, A.J., Wilkins, J.L., Fick, G.W., 2009. Mapping potential foodsheds in New York State: A spatial model for evaluating the capacity to localize food production. Renew. Agric. Food Syst. 24, 72–84. https://doi.org/10.1017/S1742170508002457

Pinchot, A., 2014. The economics of local food: A Literature Review of the Production, Distribution, and Consumption of Local Food. University of Minnesota Extension Center for Community Vitality. p.12. Retrieved from: https://conservancy.umn.edu/bitstream/handle/11299/1716.

Pirog, R., Van Pelt, T., Enshayan, K., Cook, E., 2001. Food , Fuel , and Freeways : An Iowa perspective on how far food travels, fuel usage, and greenhouse gas emissions. Leopold Cent. Sustain. Agric. 37.

Pirog, R.S., McCann, N.W., 2009. Is Local Food More Expensive? A Consumer Price Perspective on Local and Non-local Foods Purchased in Iowa. Leopold Cent. Pubs Pap. 1–20.

Pomponi, F., Fratocchi, L., Tafuri, S.R., 2015. Trust development and horizontal collaboration in logistics: A theory based evolutionary framework. Supply Chain Manag. 20, 83–97. https://doi.org/10.1108/SCM-02-2014-0078

Raison, B., Jones, J., 2020. Virtual Farmers Markets: A Reflective Essay on a Rural Ohio Project. J. Agric. Food Syst. Community Dev. 9, 1–12. https://doi.org/10.5304/jafscd.2020.094.020

Ramaswami, A., Boyer, D., Nagpure, A.S., Fang, A., Bogra, S., Bakshi, B., Cohen, E., Rao-Ghorpade, A., 2017. An urban systems framework to assess the trans-boundary food-energy-water nexus: Implementation in Delhi, India. Environ. Res. Lett. 12, 025008. https://doi.org/10.1088/1748-9326/aa5556

Rogoff, J., 2014. Improving Systems of Distribution and Logistics for Regional Food Hubs:The Central Appalachian Network: Abingdon, VA, USA; The Department of Urban Studies and Planning, Massachusetts Institute of Technology: Cambridge, MA, USA.

Rosenzweig, C., Mbow, C., Barioni, L.G., Benton, T.G., Herrero, M., Krishnapillai, M., Liwenga, E.T.,

Pradhan, P., Rivera-Ferre, M.G., Sapkota, T., Tubiello, F.N., Xu, Y., Mencos Contreras, E., Portugal-Pereira, J., 2020. Climate change responses benefit from a global food system approach. Nat. Food 1, 94–97. https://doi.org/10.1038/s43016-020-0031-z

Sadeghiamirshahidi, N., Mittal, A., Krejci, C.C., 2020. An agent-based model of digitally-mediated farmer transportation collaboration,"under review", in: Computational Social Science Annual Conference.

Schnell, S.M., 2013. Food miles, local eating, and community supported agriculture: Putting local food in its place. Agric. Human Values 30, 615–628. https://doi.org/10.1007/s10460-013-9436-8

Simchi-Levi, D., Simchi-Levi, E., 2020. Building resilient supply chains won't be easy. Harvard Business Review. Retrieved from: https://hbr.org/2020/06/building-resilient-supply-chains-wont-be-easy.

Stevenson, G.W., Pirog, R., 2013. Values-based food supply chains: Strategies for agri-food enterprises-of-the-middle Definitions and distinctions. Retrieved from: https://asapconnections.org/downloads/growing-local-implications-for-western-north-carolina.pdf/.

United Nations, 2020. The Impact of COVID-19 on Food Security and Nutrition. Retrieved from: https://www.un.org/sites/un2.un.org/files/sg_policy_brief_on_covid_impact_on_food_security.pdf.

United Nations, 2006. Tracking the trend towards market concentration: the case of agricultural input industry. Study prepared by the UNCTAD secretariat. Retrieved from: http://www.unctad.org/en/docs/ditccom200516_en.pdf.

USDA-ERS, 2018. America's Eating Habits: Food Away From Home, Economic Information Bulletin No. 196.

USDA, 2020. | Open Ag Transport Data [WWW Document]. URL https://agtransport.usda.gov/d/acar-e3r8/visualization (accessed 12.30.20).

Venuto, D., 2020. Covid-19 coronavirus lockdown: Your panic buying is putting other Kiwis at risk. Retrieved from: https://www.nzherald.co.nz/business/news/article.cfm?c_id53&objectid512319171 (accessed 9.3.20). NZ Her.

Woods, T., Velandia, M., Holcomb, R., Dunning, R., Bendfeldt, E., 2013. Local Food Systems Markets and Supply Chains. Choices Mag. Food, Farm Resour. Issues 28, 1–4.

Yaffe-Bellany, D., Corkery, M., 2020. Dumped Milk, Smashed Eggs, Plowed Vegetables: Food Waste of the Pandemic. The New York Times. Retrieved from: [WWW Document]. URL https://www.nytimes.com/2020/04/11/business/coronavirus-destroying-food.html (accessed 9.1.20).