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Transportation barriers in local and regional food supply chains

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Abstract

Large-scale food supply chains in the U.S. are cost efficient but lack resilience to external shocks. One approach to increasing food system resilience is through regionalization, in which a large and distributed network of diverse and independent farms provides redundancy and spreads out risk. However, the decentralized structure of regional food supply chains (RFSCs) inhibits transportation efficiencies, which increases producers' costs and limits their market reach. Outsourcing transportation to commercial carriers and collaborating with other producers are two highly recommended strategies for improving RFSC transportation efficiency, but research on producers' perceptions of these strategies is limited. This paper describes research that seeks to understand the major transportation barriers that prevent RFSC pro-

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Statements and Declarations

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ducers from efficiently reaching broader markets and how these barriers might be overcome. Focus groups with RFSC producers throughout the U.S. state of Texas were administered, with results indicating that participants view transportation as a significant barrier to their businesses' growth and financial success. Outsourcing transportation to commercial carriers is viewed as a highly desirable alternative to self-delivery but is also considered to be expensive and insufficiently flexible. Nearly all participants were excited about the idea of collaborative transportation, but there were serious concerns about competition and logistical coordination. Despite these barriers, the results suggest that the formation of regional transportation cooperatives and/or the development of information and communication technology infrastructure to facilitate collaboration could provide a path forward. Moreover, the criticality of transportation for RFSCs underscores the need for public funding to support implementation of these strategies.

Keywords
local food logistics, regional food supply chains, resilient food system, small-scale farming, focus group research, horizontal collaboration, collaborative transportation, farmer perspectives on transportation, Texas, COVID-19, pandemic

Introduction

Uncertainties surrounding the ability of global food supply networks to withstand and rapidly recover from the impacts of adverse events have become a major concern (Béné, 2020; Rotz & Fraser, 2015). Under normal conditions, these networks can cost-efficiently produce and distribute large volumes of food (Food and Agriculture Organization of the United Nations [FAO], 2017). However, their efficient structures lack diversity and redundancy, making them vulnerable to a wide variety of potential shocks and stresses, including weather and climate-related disasters, pest infestation, disease outbreaks, contamination, trade or pricing shocks, and political instability or conflict (Fan et al., 2021). For example, the streamlining of operations and logistics to minimize inventory and excess production capacity has made food supply networks more cost-efficient (Hobbs, 2020), but as the COVID-19 emergency revealed, inadequate buffering against sudden shifts in demand and supply can lead to food price spikes and shortages during disasters (Simchi-Levi & Simchi-Levi, 2020). Global food supply networks are also characterized by relatively few large farms, with centralized production located in a few specific regions and distribution occurring along large-scale, vertically integrated networks of farmers, agribusinesses, wholesalers, retailers, and logistics providers (Hendrickson et al., 2020; Howard, 2021). While vertical integration facilitates tight connections between these actors, enabling efficient transactions, it also introduces vulnerability including cascading risks and series of shocks, in which problems can quickly spread and adversely impact multiple points across the network (Béné, 2020; Fan et al., 2021; Zurek et al., 2022). The risk of major disruptions to this tightly interconnected system is concerning for all participants, especially considering that food supply networks are increasingly exposed to shocks and stresses (Tendall et al., 2015), and their large scale and complexity can obscure the early warning signs of system failure (Campbell, 2009; Toth et al., 2015). As a result, there have been numerous calls from policymakers and food systems advocates for increased food system resilience (Oliver et al., 2018), including the ability to prepare for, respond to, and recover from disruptions.

Most discourse on increasing food system resilience has focused on how to return the supply network quickly and cost-effectively to the status quo after disruption (Zurek et al., 2022). However, system resilience is not intrinsically positive if the status quo is not delivering positive outcomes (Jacobi et al., 2018). Indeed, global food supply networks fail to meet the basic needs of many stakeholders and continue to fall short of meeting multiple United Nations (UN) Sustainable Development Goals (SDGs), including ending hunger, achieving food security and adequate nutrition for all, promoting sustainable agriculture, and providing meaningful livelihoods for producers (Oliver et al., 2018; Savary et al., 2020). It can be argued that increasing the resilience of this existing system,

while benefiting some powerful actors in the short term, would undermine long-term resilience and sustainability (Jacobi et al., 2018; Oliver et al., 2018). Rather than incremental adjustments for short-term harm reduction and mitigation, long-term food system resilience will require major structural changes to the global food supply system (i.e., a transformation) to promote the resilient delivery of the SDGs to benefit society (Oliver et al., 2018; Zurek et al., 2022).

What might such a transformation look like? One possibility is a network with increased regionalization of food production and distribution. Regionalized food supply chains (RFSCs) are characterized by many small-scale producers, with short distances and few or no intermediaries between producers and consumers, and a structure that is disaggregated and not vertically integrated (Woods et al., 2013). Compared with the prevailing global food supply network, the disaggregated structure of RFSCs tends to have lower interconnectivity, higher diversity, and greater redundancy at a system level, all of which have been identified as key principles for system resilience (Biggs et al., 2012; Hertel et al., 2021; Stein & Santini, 2022). Indeed, a large and distributed network of diverse and independent farms provides redundancy, spreads out risk, and increases the likelihood that at least some farms can continue producing in the event of a disruption (Oliver et al., 2018), thereby increasing regional self-reliance and mitigating the damaging effects of adverse events (Dahlberg, 2008; Garmestani et al., 2006; Rotz & Fraser, 2015). The autonomy and decision-making authority that characterizes most RFSC farms also increases their capacity for resourcefulness, adaptability, and flexibility, which is needed for rapid recovery from a disruption (Tendall et al., 2015). For these reasons, the COVID-19 crisis prompted calls by policymakers to improve food system resilience through greater functional diversification, decentralization, and regionalization (FAO, 2020; Rosenzweig et al., 2020; UN, 2020).

However, regionalization of the food supply does not guarantee resilient delivery of the SDGs. In particular, food system sustainability and resilience require individual producers to be economically viable (Toth et al., 2015; Stein & Santini, 2022. Economic viability is a major challenge for small and medium-sized RFSC producers for many reasons, including a lack of affordable land (Calo et al., 2021), high labor intensity (Bruce & Castellano, 2017), agricultural policies that benefit the large-scale global system (Spangler et al., 2020), and difficulty reaching profitable urban demand centers and broader regional markets (Stein & Santini, 2022. One barrier to reaching broader markets is transportation. Indeed, the very qualities that increase RFSC resilience also limit their ability to transport and distribute food efficiently. RFSC producers have high transportation costs because they lack the economies of scale achievable with high load factors and full truckloads (Day-Farnsworth & Miller, 2014). In fact, the low handling and fuel efficiency per unit of product hauled often outweighs the benefits of short transport distances (King et al., 2010; Mundler, 2012; VanWechel et al., 2007). As a result, transporting food from rural RFSC farms to distant urban demand centers can be cost-prohibitive, especially when refrigeration is required (Lindsey & Slama, 2012; Miller et al., 2016). Indeed, small-scale RFSC producers use a variety of different types of vehicles for deliveries, including light-duty trucks, cars, and vans (Pirog et al., 2001), thereby avoiding the costs associated with owning and operating a refrigerated truck (Rizet et al., 2012). However, a lack of temperature control risks product degradation and raises food safety concerns, especially as time in-transit increases (Day-Farnsworth & Miller, 2014). These transportation inefficiencies limit producers' ability to reach broader markets, especially for mid-sized RFSC producers—the so-called "agriculture of the middle"—with volumes that are too small to distribute through large, vertically integrated grocery chains but are too large for direct-to-consumer channels (Kirschennmann et al., 2008). Such barriers have led many small and midsize producers to give up on farming (Berti & Mulligan, 2016) and have limited the ability of RFSCs to contribute significantly to food system resilience, with 97% of U.S. food distributed through nationally and globally organized food supply chains (Woods et al., 2013).

One approach to overcoming transportation and distribution challenges is for producers to

scale up, such that the volumes they produce individually will allow them to participate in larger food systems. However, for many RFSC producers, scaling up production is neither possible nor desirable. Another possibility is for producers to adopt innovative transportation strategies (FAO, 2020), which can enable RFSCs to reduce transportation and inventory costs while continuing to provide benefits to the communities in which they are embedded (Marusak et al., 2021). A review of the literature on logistics best practices for RFSCs revealed two frequently recommended strategies: producer collaboration for transportation and outsourcing transportation to commercial carriers (Mittal et al., 2018). These strategies may be able to reduce producers' transportation costs, alleviate their logistics burden, and help them to access wholesale distribution and new, larger, and financially lucrative markets. However, examples in the literature of actual adoption and implementation of transportation collaboration and outsourcing by RFSC producers are relatively sparse and anecdotal, suggesting that producers may face significant barriers.

The questions addressed in this research are: What major transportation barriers prevent RFSC producers from efficiently reaching broader markets, and how might these barriers be overcome? As a starting point in answering these questions, we administered focus groups with RFSC producers in the state of Texas. Participants were asked about the transportation challenges they face, their views on outsourcing transportation to commercial carriers or independent crowdsourced drivers via an app, and their thoughts on collaborating with other RFSC producers for shared transportation. We then analyzed the transcripts from these focus groups to distill producers' perceptions of the potential benefits of these strategies, as well as barriers to adoption. This paper describes the results of this analysis, which emphasize the importance of solving transportation issues in RFSCs and suggest some potential approaches. The paper is organized as follows: first, the literature on transportation collaboration and outsourcing in both large-scale supply chains and RFSCs is reviewed, followed by a description of the research methods and the focus group results, and concluded with a discussion of results and practical implications for RFSCs.

Literature Review

This section provides an overview of the benefits and challenges associated with outsourcing transportation to third-party providers, for organizations participating in large-scale supply chains as well as producers who distribute their products via RFSCs. Then, the advantages and disadvantages of transportation collaboration are reviewed.

Outsourcing Transportation

Outsourcing transportation to commercial carriers has often been recommended by food systems researchers for RFSCs to improve their logistics efficiencies (Mittal et al., 2018). Because commercial carriers serve multiple shippers (i.e., farmers shipping products to buyers), they benefit from cost efficiencies via economies of scale, especially through load consolidation and increased vehicle capacity utilization (van Damme & Ploos van Amstel, 1996). These efficiencies can translate into lower transportation costs for the shipper, as well as potentially enabling them to operate with lower inventory levels (Stank & Goldsby, 2000). Increasingly, online freight and crowd-shipping platforms (e.g., uShip, Uber Freight) enable shippers to connect directly with independent carriers to outsource transportation, offering lower freight rates than traditional less-than-truckload (LTL) brokerages or courier services (Dolan, 2019). A dependable commercial carrier can provide quality service and flexibility and can even enhance a shipper's ability to meet customer requirements (e.g., just-in-time delivery), such that shippers need not invest in assets and new technology (Bardi & Tracey, 1991; Pani et al., 2022). Outsourcing transportation also allows shippers to leverage carriers' expertise so that they can focus on their own core competencies (Hsiao et al., 2010).

Some RFSC producers, especially producer cooperatives, have reported cost savings from outsourcing transportation to regional distributors (for example: Bittner et al., 2011; Clark et al., 2011; Matson et al., 2015; Nelson et al., 2013; Van Dis, 2012). Because these distributors are already transporting material for larger companies, they can al-

low RFSC producers to piggyback on those deliveries to increase vehicle utilization (Bittner et al., 2011). Some RFSC producers have also found that outsourcing transportation improves their on-time deliveries (Flaccavento, 2009) and facilitates cross-docking with other distributors to extend their market reach (Bittner et al., 2011). Other producers have been able to extend their market reach by using national carriers and third-party logistics providers (3PLs) (Matson et al., 2015; Muldoon et al., 2013; Stevenson, 2013). Another option is outsourcing transportation to a regional food hub, which can aggregate across multiple producers to achieve wholesale volumes, such that producers do not need to scale up production on an individual basis to sell to institutional and retail buyers (Berti et al., 2017).

However, outsourcing transportation is often challenging and can yield mixed results, even in large-scale supply chains. Indeed, LTL and standard parcel delivery services can be slow, expedited services are expensive, and commercial providers may increase their service fees over time (Ackerman, 1996). Insufficient responsiveness to customer needs can also be a problem (van Damme & Ploos van Amstel, 1996), requiring shippers to invest significant time and money into managing and monitoring carrier performance (Maltz & Ellram, 1997). Moreover, evaluating the cost savings of using these services can be difficult for the shipper (Selviaridis & Spring, 2007), and some shippers report that outsourcing limits their control over their transportation capabilities and reduces their contact with customers (Ellram & Cooper, 1990). The limited literature on RFSC transportation outsourcing provides some evidence that RFSCs struggle with many of the same challenges as large-scale supply chains. Indeed, some RFSC producers report that the benefits of outsourcing do not outweigh the costs (Berney et al., 2007). For example, RFSC producers often cease using a food hub's transportation services because they perceive the fees to be too high (Craven & Krejci, 2017. Furthermore, using a food hub or 3PL that commingles products can reduce food traceability and prevent producers from building their individual brands (Cantrell & Heuer, 2014).

Transportation Collaboration

Collaboration is another highly recommended strategy for RFSC transportation, wherein organizations share transportation resources and information with one another with the aim of collectively obtaining greater benefits than each organization can achieve individually (Audy et al., 2012). Successful transportation collaboration can help organizations to reduce costs (Cruijssen et al., 2007; Ergun et al., 2007), achieve better service levels and improved responsiveness (Chabot et al., 2018), and reduce greenhouse gas emissions through more efficient use of pooled resources, fewer empty truck runs, and reduced travel distances (Andriolo et al., 2015; Christ et al., 2017; Pérez-Bernabeu et al., 2015). Collaboration in supply chains can be either vertical or horizontal. Vertical collaboration occurs between different types of organizations located at different echelons in the same supply chain (i.e., upstream suppliers collaborating with downstream customers), with a goal of improving overall supply chain performance (Mason et al., 2007). By contrast, horizontal collaboration involves the sharing of assets or resources between two or more organizations that are fulfilling similar purposes at the same echelon of different supply chains (Barratt, 2004). These supply chains may be in the same or different industries and may be competitive or noncompetitive (Naesens et al., 2007).

Many transportation collaborations are maintained at an operational level, in which only transactional information is exchanged between partners to facilitate day-to-day business activities (Verstrepen et al., 2009). For example, partners might share information on delivery schedules to facilitate backhauling, in which trucks that would otherwise be empty on a return trip could be used to haul product for a partner (Guajardo & Rönnqvist, 2014). Longer-term and strategic collaborations are also possible, in which partners plan their logistics operations jointly according to shared objectives and performance indicators, as well as sharing infrastructure and sensitive information (e.g., demand data, forecasts, operational capacities) (Frisk et al., 2010). For example, two organizations distributing in the same regions might share vehicles and trucking routes to opti-

mize vehicle utilization and loaded traveling time, or they might split the cost of hiring a 3PL (Basso et al., 2019; Pan et al., 2019). Collaborators can also pool their loads and negotiate better rates from carriers (Chabot et al., 2018), extend their market coverage to include all partners' networks and help smaller organizations to participate in large contracts (Verstrepen et al., 2009).

To establish a transportation collaboration, participants must make a series of decisions. First, decisions regarding the size and constituency of a collaboration, often termed "partner selection" decisions, must be made. Having too few members may not yield significant benefits, but large coalitions are more likely to fail, as the potential for problems and challenges with coordination tend to increase as the number of collaborators increases (Audy et al., 2012; Christ et al., 2017). The objectives, goals, size, culture, and philosophy of the collaborating members should be similar; sharing a common vision is a strong predictor of a successful collaboration (Basso et al., 2019). Once the partners are established, they must decide on the appropriate level of collaborative intensity. This can be measured in terms of the amount of time and/or assets dedicated to maintaining the collaboration, the amount and type of information exchanged between collaborating organizations, the level of risk and potential benefits involved, and the range of activities performed (Verstrepen et al., 2009). Finally, the allocation of collaboration risks, costs, and benefits must be clearly defined and should be fair and acceptable to all participants according to their roles and responsibilities (Audy et al., 2012; Cruijssen et al., 2007). These terms can be formalized via contracts, which can help to encourage long-term relationships (Cygler et al., 2018), maintain a satisfactory balance of power, and facilitate negotiations between partners (Basso et al., 2019; Christ et al., 2017).

While the literature does not offer many examples of transportation collaboration in RFSCs, some RFSC producers have indicated that sharing and combining delivery routes has reduced their transportation costs and increased their logistics efficiency (Bittner et al., 2011; Diamond & Barham, 2012), as well as enabling them to deliver to customers more frequently (Van Dis, 2012). Other producers have reduced transportation costs by sharing vehicles for long hauls (Pirog et al., 2008). Some small-scale producers reported that transportation collaboration helped them to respond to the challenges and opportunities associated with the COVID-19 emergency (Marusak et al., 2021).

However, collaborative transportation partnerships are challenging to establish and maintain, they can be complex and costly to coordinate (Cygler et al., 2018; Martin et al., 2018), and insufficient trust between partners is a major issue (Barratt, 2004; Pomponi et al., 2015), particularly because they may also be competitors. To be successful, partners must commit to common objectives and a fair cost/benefit sharing mechanism (Audy et al., 2012; Cruijssen et al., 2007), but this is often a challenge, especially when there are power imbalances (Frisk et al., 2010). As partners become more interdependent, they may lose control over resources and autonomy in decision making (Basso et al., 2019; Cygler et al., 2018). Furthermore, to facilitate the information sharing needed to jointly plan, implement, and control the flow of materials, services, and information, collaborative partners must often adopt information and communications technologies (ICT), such as radio-frequency identification (RFID) or electronic data interchange (EDI) (Pan et al., 2019; Verstrepen et al., 2009). However, standardization of materials and information system interoperability is usually necessary (Montreuil, 2011), which can be a major challenge, especially if one or more partners lacks the resources to implement new systems.

Indeed, some RFSC producers have indicated that they view collaborating with other producers for transportation as risky, especially if it requires producers to share sensitive information with competitors. Some producers have expressed concerns about careless handling of their products by partners, which can damage customers' perceptions of their brand (Bloom & Hinrichs, 2011). Collaboration for backhauling in RFSCs has proved to be challenging because it increases routing complexity and requires significant planning and coordination (Bittner et al., 2011). Thus, collaborative transportation partnerships in RFSCs tend to be unstruc-

tured and informal and rely heavily on trust (Lutz et al., 2017).

Methods

The relative sparsity of the literature on RFSC transportation suggests that there are significant gaps in our understanding of how RFSC producers transport their products to buyers, the challenges they face, and their receptiveness to strategies like outsourcing and collaboration. In particular, producers' own views of these strategies and their experiences with them have not been sufficiently studied. This is a critically important gap to address because producers are definitive stakeholders in regional food systems. Therefore, attempting to increase transportation inefficiencies in RFSCs without understanding producers' requirements and objectives (i.e., what are the key problems and how do they prevent producers from achieving their version of "success"?) and their preferences (i.e., what are culturally and technologically appropriate methods for addressing the problems?) is likely to meet with failure.

To gain a greater understanding of RFSC producers' experiences, beliefs, and ideas with respect to transportation, producer focus groups were administered in the state of Texas. While focus groups have inherent limitations (i.e., the resulting data is likely to yield only tentative and geographically specific results), they have the advantage of being able to capture producers' knowledge and preferences in their own words.

Analysis was performed in three phases to follow a rigorous and systematic process that would increase the transferability of results: data collection, data consolidation, and data interpretation. The research design for each of the three phases is described below.

Data Collection

First, potential participants were identified and recruited. The Texas Center for Local Food (TCLF), a key partner on this research project, led the effort to recruit participants, sending individual and personalized emails to key organizations in its professional network and the networks of its partners, including Texas Small Farmers & Ranchers Community Based Organization, Texas Organic Farmers & Gardens Association, and the Growers Alliance of Central Texas. TCLF asked these organizations to extend the recruitment to their members and their own networks to maximize outreach, and they did so. In this way, TCLF leveraged its influence and long-standing relationships in the Texas regional food community to increase the quality and quantity of participants. Targeted participants were small and medium-sized farmers and ranchers with gross revenues of US$10,000-$4,000,000 with at least 80% of revenue derived from Texas buyers or buyers from the border states of Oklahoma, Louisiana, Arkansas, and New Mexico. The target focus group size was six participants each.

Existing literature and results from prior preliminary interviews with Texas farmers and ranchers informed the design of the focus group protocol used for data collection. The protocol was reviewed by project partners from the National Center for Appropriate Technology to ensure credibility. The protocol was divided into four parts to ask producers (1) about the transportation barriers ("pain points") preventing them from reaching urban buyers; (2) their own ideas on how to overcome these barriers; (3) their feelings on outsourcing transportation to independent individuals (i.e., crowd-shipping) or to commercial carriers and distributors, as well as the possibility of collaborating with other producers for transportation; and (4) the types of software that they are currently using for transportation and general farm management, and their feelings about using an app to connect with carriers and producers for transportation. The list of questions asked in each focus group is provided in the Appendix.

The data collection protocol was submitted to the University of Texas at Arlington Institutional Review Board (IRB) for review and was approved and assigned "exempt" status (protocol number 2021-0427.2). Upon IRB approval, virtual focus groups were conducted throughout the summer of 2021 using Zoom, due to restrictions in place for the COVID-19 pandemic. Six focus groups were conducted, with a total of 17 participants, including farmers and ranchers from five distinct geographic regions across Texas (see Table 1 for details).

The participants included 10 white males, 3 white females, 1 Black male, 1 Black female, 1

Hispanic male, and 1 Hispanic female. Table 2 summarizes key characteristics of the participants' operations, including items produced, total acres in crop production, total herd or flock size, and distance from the nearest major market (i.e., Dallas, Houston, Austin, San Antonio, or El Paso). None of the participants' farming or ranching businesses had a gross cash farm income of more than US$200,000. While this sample is biased toward relatively small producers and differs from our targeted sample (US$10,000-$4,000,000 gross), it should be noted that in Texas, 89% of farmers (representing 223,569 farms) gross less than US$50,000 on their farm or ranch operation (Texas State Small Producers Initiative, n.d.), which suggests that the data collected from our sample is likely to reflect the experiences of many Texas producers. Furthermore, while the small sample (17 producers out of a population of 223,569 producers in Texas) and geographic focus on Texas limit the generalizability of study results, we believe that, as one of the first to explore RFSC producer perspectives on transportation barriers and potential solutions, this study can nevertheless offer novel and valuable insights to food systems researchers, advocates, and practitioners. Transportation in RFSCs is not the focus of extensive research or extension efforts, nor is it a topic that often comes up among producers unless they are prompted. Indeed, when considering major barriers to their business' success, producers do not necessarily have transportation at the forefront of their minds: according to a 2019 needs assessment of 184 Texas small producers, the top five challenges they identified were access to capital, aversion to acquiring debt to finance their operation, financing, organic certification requirements, and costs of regulations and permits (Texas State Small Producers Initiative, n.d.). However, anecdotal evidence suggests that, when asked specifically and in person about their transportation and logistics challenges, RFSC producers will often acknowledge major frustrations with inefficiency and inadequate capacity. We believe that the use of focus groups specifically targeting the topic of transportation and facilitated by a trusted and familiar former producer (from TCLF) gave producers "permission" to open up and voice their opinions and ideas about an operational problem that does not always get much attention.

Table 1. Focus Group Descriptions

Focus group	Number of participants	Texas regions represented
1	4	Central
2	1	North
3	2	North, West
4	3	East, North, South
5	2	South
6	5	Central, West

Table 2. Participant Farm and Ranch Characteristics

Items Produced	Number of Participants
Fruits and Vegetables	11
Meat	7
Eggs and Dairy	3
Bees	0
Grains and Fiber	1
Other	1
Total Acres in Crop Production	**Mean (Range; Std. Dev.)**
# of acres	3.6 (.001-15; 4.7)
Total Herd or Flock Size	**Mean (Range; Std. Dev.)**
# of animals	122.5 (7-570; 200.9)
Distance from Nearest Major Market	**Mean (Range; Std. Dev.)**
miles	97.6 (15-257; 84.5)

Each focus group session lasted approximately 90 minutes, and participants were compensated US$100 for their time. For consistency, three research team members attended each focus group session, with one member (from TCLF) facilitating the meeting using the script described above, one member responsible for providing technical support and monitoring the chat, and one member taking notes. Prior to participation, research team members provided informed consent forms to all participants, explained participants' rights, risks, and benefits, collected a signed form from each

participant, and provided a copy of the form to participants to keep.

Data Consolidation and Interpretation

The focus group sessions were digitally recorded, and the research team transcribed the recordings verbatim, with participants' names redacted to provide anonymity. Four research team members were then responsible for data cleaning and consolidation. To maintain consistency across team members, each followed a systematic and iterative process that began with identifying relevant quotes from the transcripts and categorizing them according to the four sections of the protocol. To facilitate a common approach to categorizing quotes, the research team jointly designed a Microsoft Excel template for data entry and specified the following procedure: first, each researcher would independently read through a transcript and highlight relevant quotes; then they would identify the most appropriate category for each highlighted quote and enter it into their own copy of the Excel template. After everyone had completed this procedure for a particular transcript, one researcher compiled all four sets of categorized quotes into a single spreadsheet. The team then met to jointly review all the quotes, cleaning and organizing the material to remove redundant quotes and reach consensus on the most appropriate categorization for all quotes. This process was followed for each of the six transcripts. Upon completion, the extracted quotes from the entire data set were integrated and organized by category.

Next, each research team member independently reviewed all quotes in each category and grouped them according to self-generated subcategories. The team then met to discuss and compare everyone's subcategories, with a goal of eliminating redundancies and deciding on the most appropriate subcategories. If a researcher's proposed subcategory was determined to be too specific (i.e., it only contained one or two unique quotes and/or seemed very similar to another subcategory), the team combined it with another closely related subcategory. For example, under the category "transportation pain points," the researchers had originally proposed four subcategories ("lack of distribution services," "waiting on LTL service," "finding a delivery driver," "no one to collaborate with on transport"), and it was decided to consolidate them into a single subcategory ("lack of transportation outsourcing/collaboration opportunities"), which contained five unique quotes. In some cases, a researcher proposed a subcategory that was too general (e.g., "cost"), so the team would reassign its quotes to more specific subcategories generated by the other researchers (e.g., "challenges with cost estimation," "vehicle/fuel cost," "cold storage cost"). After multiple iterative sessions, the team reached consensus on the most relevant subcategories and the assignment of each quote to a subcategory. The number of independent quotes in each subcategory was then counted; this number was used as a proxy for the subcategory's relative importance; that is, more quotes indicated greater importance. While the number of quotes is an imperfect measure of a subcategory's importance, it provided a helpful first step in identifying the strongest and most frequently occurring focus group themes. Finally, the consolidated data set was interpreted to develop key themes and insights.

Results

This section describes the results of the focus groups in two sections: first, four overarching themes associated with producers' transportation pain points are described, followed by three themes that examine the potential of three different strategies to address these pain points.

Producers' Transportation "Pain Points"

The 11 subcategories of producers' quotes regarding transportation pain points were ranked according to the number of unique quotes associated with each, as shown in Table 3. This ranking helped to identify the most frequently recurring concepts, which were then organized according to four overarching themes that highlight the challenges RFSC producers face with respect to markets, temperature control, limited time, and being responsive to buyers' needs.

"Pain points" theme 1: Many RFSC producers struggle to reach markets

The "mismatched supply and demand" pain point was the most frequently mentioned across all focus

Table 3. Subcategories of Producer Transportation "Pain Points"

Subcategory name	Number of unique quotes
Mismatched supply and demand	17
Temperature control in transit	16
Long transportation distances	11
Lack of sufficient temperature-controlled on-farm storage capacity	9
Transportation takes too much time	7
Inadequate vehicle	7
Difficulty accommodating customer delivery schedule preferences	7
Lack of transportation outsourcing and/or collaboration opportunities	5
Difficulty setting customer minimum order size	5
Difficulty estimating transportation costs	4
Transportation costs are high	3

groups, and at first, it did not appear directly connected to transportation. Instead, it seemed to reflect well-known challenges associated with producing and selling food on a relatively small scale. While this apparent disconnect might seem surprising, since the participants were asked specifically to discuss their challenges in reaching urban buyers *with respect to transportation*, it aligns with what we know from previous research on RFSC transportation. Because transportation is not a core business or "value-adding" activity for most producers, they do not tend to view it as a key opportunity for cost reduction or strategic business growth (Marusak et al., 2021). Instead, they tend to focus on finding new markets and customers to increase their revenues. Therefore, it is perhaps unsurprising that perceived issues of mismatched supply and demand would inform producers' discussion of transportation challenges.

Some participants felt that local demand was lacking, while others believed that the demand was there but required increased marketing effort, as one producer explained:

> If I could just figure out how to get people to find me, we do create a good product. It's just how do I get people to find me that seems to be still a challenge.

Nearly all participants expressed strong interest in increasing their sales. One approach is to attend more farmers markets, but as several producers mentioned, this requires additional time and personnel, and there is already too much competition, according to this producer:

> There's so many pastured pork providers at all of the local markets now. I don't know how we would compete. I think we'd just be cannibalizing business, and that's not something I'm interested in doing.

Another approach to increasing sales is selling wholesale. However, wholesale buyers are typically looking for large volumes, which small farms are often unable to produce consistently. Several producers argued that they would struggle to achieve wholesale volumes even if they aggregated across multiple farms in their region, simply because there are not enough farms. One producer also commented on the lack of commitment from wholesale buyers:

> I have looked at some wholesale options but find it very difficult to get anything going there. There's a lot of people that talk a good talk, but then they never follow through and are very difficult to get ahold of and gain any commitment from.

By contrast, one producer pointed to potential solutions from other regions:

> I had worked with a bunch of Mennonite communities … up in Iowa, and they have a massive produce auction. … [But] small growers here in anywhere in Texas … just don't have things like that as a resource to help us move product when we have excess that needs to get moved.

Many producers were clearly frustrated by the limitations of selling only to their local markets.

However, when the idea of expanding distribution to reach wider regional markets was brought up, the challenges associated with transportation immediately became a focus of the discussion.

"Pain points" theme 2: Insufficient cold chain infrastructure limits RFSC distribution capacity

When participants focused their discussion on transportation, it became clear that maintaining temperature control in-transit in the Texas heat was a major concern, particularly for the producers who did not own refrigerated vehicles and were relying on coolers to protect their products. Many producers reported that their distribution range was severely limited by a lack of robust temperature control. This was an especially serious problem for meat producers, as one rancher noted:

> If I didn't have frozen items, the game changes, because I don't have to worry about the heat. In winter, I don't have much problems at all. So, it limits me to where I can only basically do local deliveries.

Ranchers also expressed concerns about risks to food safety and quality when transporting live animals and frozen meat to and from processing plants in the summer. With so few processors willing to work with small-scale producers, the closest available options are often one to two hours away. Three of the eleven participants growing fresh vegetables also noted that a lack of on-farm cold storage made scheduling deliveries challenging. Without sufficient refrigerated storage capacity, their deliveries must be made shortly after harvest. Alternatively, to give themselves greater flexibility, they may be forced to rely on cost-inefficient workarounds, as exemplified by this producer:

> Our biggest problem is we don't have onsite cold storage right now due to local policy issues and zoning … so, what we've been doing is using our refrigerated truck for storage. We were able to get this refrigerated truck through a USDA microloan … so now we can make deliveries, but the biggest struggle is keeping it on while we're harvesting, and sometimes, if [the customer] wants it on a certain day, we'll have to keep it on overnight to deliver on the next day. So, there's cost involved in not having cold storage.

"Pain points" theme 3: Time spent on transportation takes away from time spent managing the farm

With so many demands on a producer's time, transportation was viewed as a major burden, and nearly all participants expressed significant interest in reallocating the time spent on transportation to on-farm activities and management. Time spent on transportation was mainly viewed as a consequence of long transport distances from rural farm locations to urban markets, as well as traffic in and around cities. Even when transportation is outsourced, it can take producers a significant amount of time to get their products to the carrier, with one rancher noting that the nearest United Parcel Service (UPS) store was 45 minutes away from their ranch.

Not having enough time to distribute to distant urban markets was perceived by several producers as a major barrier to their business's growth. Although they have sufficient production capacity to sell to larger markets, two producers noted:

> If I wanted to drive to Austin, I could have a lot bigger markets. But it takes me an hour to get to Austin. … That eats up a huge portion of my day when you're also in charge of the production side of things, and wanting to have a life as well.

> I'm sure we can sell way more in different parts of Texas, but we don't have the transportation to San Antonio or Austin. … That's like 9 to 10 hours from El Paso.

However, transportation time was not always described as a function of distance; sometimes it was a consequence of having to make a large number of delivery stops, or in the case of this producer, time spent coordinating and packing product for deliveries:

> My freezer has gotten so disorganized that it takes me probably an extra 30 to 45 minutes, maybe even an hour, to pack orders sometimes

> because I can't find what I need. But I literally cannot stop to organize my freezers because I do not have the time to stop and do it without not doing something else. [It would probably] take four to six hours [to have somebody else do it] … and if you pay someone 20 bucks an hour, and it saves you that much time every time, why wouldn't you just pay someone? Well, that's a great idea, but I could look at 30 other things I need done on my farm that I could say the same thing about, and at some point, I'm out of money.

"Pain points" theme 4: Transportation limits RFSC producers' ability to meet buyers' needs

Many customers expect frequent and flexible deliveries of small volumes, which is a frustration for many producers, who observed that low-value orders are often not worth the time and fuel required to make a long-distance trip. One producer described the tradeoff between responsiveness and efficiency:

> I have heard from a few customers that they … wish my delivery day was Monday instead of Wednesday, or Thursday instead of Wednesday, or Friday … any day but Wednesday, right? And they're so accustomed to being able to go and order groceries and get them tomorrow or the next day. I can't go to town every day. It's two hours round trip for me to do that and a lot of people are not placing big enough orders. … I keep trying to get them to get a whole hog, so I'm not driving to San Antonio for a half, but they don't have the freezer space for it. … It would be great if there was somebody else who's going to be in Antonio that I could say, hey, could you take this?

However, this producer felt uncomfortable insisting on minimum order quantities, based on the assumption that they would lose sales, which would affect their cash flow:

> The one day a week that I currently do delivery, I might have a $25 order in Round Rock and a $30 partial box order is really far South Austin. People will say, well, why don't you just set a $50 order minimum? Well, yes, except if somebody is not going to order because they can't spend $50, then I either have $25 or I have no dollars, and which do I pick? I'm going to spend $50 worth of my time and gas money to take $30 worth of stuff to Round Rock because it gives me $30 I didn't have and it gets the product out of my freezer.

Other producers also expressed concerns about losing sales because of transportation limitations. One producer described their frustrations in meeting a large wholesale customer's delivery requirements:

> The biggest struggle I've had with wholesale is finding [transportation] going, for example, to Austin, on the same day that the buyer wants the product. Sometimes I have product ready and they'll say, oh, I need a Monday delivery, but the shipping company that I'm using—I'm piggybacking on someone else's order—will say, well, we're not gonna ship out until Tuesday. I've had orders canceled because they're not gonna get there at the time that the buyer wants it.

Another producer had been discouraged from scaling up their production, knowing that a lack of transportation would prevent them from being able to meet wholesale customers' requirements:

> It's a little difficult for me to think about getting any bigger than what I have right now in production, just because of delivering. … I would need somebody to come and pick it up, to ship it out to where it would go to. For example, if I wanted to get into H-E-B or to Sprouts or Whole Foods, who is going to take that for me?

Addressing the Pain Points

After analyzing the producers' transportation "pain points," the five subcategories describing producers' ideas about how to mitigate the pain points were ranked according to the number of unique quotes, as shown in Table 4.

Table 4. Subcategories of Potential Approaches to Addressing Transportation "Pain Points"

Subcategory name	Number of unique quotes
Collaboration with other producers	16
Outsourcing transportation or logistics to a food hub	13
Outsourcing transportation to a commercial carrier	11
Changing marketing or distribution strategy	11
Networking with other producers	3

The two most frequently mentioned ideas for addressing transportation challenges were outsourcing and producer collaboration. The 11 unique quotes in the subcategory "Changing marketing or distribution strategy" covered a wide variety of ideas on how to reach more customers or make deliveries more efficient. For example, several producers described how they plan their delivery routes and schedule strategically to reduce travel time. Others discussed the strategy of offering a home delivery service, which provides highly valued convenience to customers. One producer emphasized the importance of critically evaluating what the "optimal" distribution radius for a farm ought to be. Depending on the locations of the farm and its customer base, as well as the size and density of the customer base, increasing the farm's distribution radius is not always an appropriate goal and may result in diminishing returns.

Because most of the producer-generated ideas on how to address transportation pain points were related to outsourcing and collaboration, these ideas were integrated with their responses to the follow-on questions regarding who producers feel comfortable outsourcing to, according to three themes: (1) hiring independent crowdsourced drivers, (2) outsourcing to commercial third-party carriers or food hubs, and (3) collaborating with other producers.

"Addressing the pain points" theme 1: Hiring crowdsourced drivers for transportation is too risky

The research team had hypothesized that farmers might find the flexibility and low cost of outsourcing transportation via "crowd-shipping" to be appealing, and indeed, some participants acknowledged that it would likely save them time. However, most were strongly opposed to the idea. The issue of trust was paramount, with concerns about a lack of service reliability, and more prominently, drivers' lack of knowledge on how to handle products appropriately, especially regarding temperature control. One producer's comment exemplified these concerns:

> I don't know how I feel about a stranger. Having an Uber delivery guy do it. I don't know that I could do that. I don't think there would be the understanding of how vegetables needed to be treated. That would seem a little iffy one to me. I think there have to be some kind of training about how to handle food and how to store food? All of those things that we have to know. I don't know.

Other producers believed that direct interaction with customers helps build and maintain relationships, and a crowdsourced driver would not do this adequately:

> I would not want to just like literally call Favor or Uber Eats or something and have them deliver my produce to a customer. I think that there are some values to that faced visionary interaction between the supplier and the customer.

In one focus group, there was discussion about risk to personal safety, as one rancher explained:

> I'm at the end of a dead-end road and I have 100 acres and with my house being in the front, if I'm working in the back, you can easily get up to my house and I would not know it. … I don't let people know where our physical address is just because security is just a huge issue. The first year I think I got robbed like four times. … They brought a vehicle into my property and took a whole bunch of tools. … So yeah, we take issues of security very high.

Participants agreed that it would be necessary to have strong mechanisms for monitoring and accountability, such as customer feedback, user reviews, and temperature control monitoring, as well as risk mitigation strategies, like packing products in disposable coolers. In general the option of hiring a crowdsourced driver was quickly dismissed due to major concerns about trust. No one brought up the potential of cost savings associated with this option. In fact, one producer viewed it as being both risky and expensive:

> As for the third parties like Uber and all those other companies, [they] are not financially viable, they're just backed by either Wall Street or they eventually get bought up…Those numbers just don't work either. They charge too much. I know some of the breweries who use that service. Those guys take like a 30–40% cut to do that and that just hurts your bottom line.

"Addressing the pain points" theme 2: Commercial carriers are trustworthy, but this comes at a cost

Outsourcing transportation to a commercial carrier appealed to most producers, as it takes the transportation burden completely off their plate. It was viewed as a way to reallocate time to more important strategic tasks that would help to grow their businesses, as exemplified by this producer:

> That would be the dream, right? That someone is going to [make my] deliveries, and then that's going to free up my time to do the marketing that brings me … more orders.

Most producers indicated that they would trust commercial drivers with their products. They could see value in hiring carriers offering refrigerated transport and other convenient services, such as product tracking and delivery confirmation, as well as driver screening and training. Other participants trusted that transportation companies would be held liable for any missing, damaged, or unsafe products, as this producer commented:

> Most third-party companies are going to be bonded. If product gets contaminated …[and] they served it to somebody and somebody got sick, the lawsuits come back on me. [But] that logistics company is bonded, and they would be able to carry the burden of any out of spec product while it was in their custody.

However, several producers were concerned about reduced flexibility and high costs. A producer who had explored using a commercial delivery service said:

> Third-party companies … want anywhere between $4 to $7 per delivery. They'll be here, whenever I tell them to, but it's going to come at a cost, and we tend to work with small quantities, but a lot of [orders], so, a lot of different delivery stops.

A rancher commented on the cost of temperature control:

> With UPS 3-day shipping, I can deliver to San Antonio … [but] I can't sell to Houston, for example, because people there just don't want to pay for the for the dry ice that it takes.

Another producer found commercial services to be not only cost-prohibitive but also unable to cover their market territory:

> I've looked into Favor, but they only work within like a 10-mile radius. And that's not enough reach for us … and they charge $15 and other fees per delivery.

By contrast, one participant noted that the value of time savings could outweigh the cost of the service:

> I did use [a] third party, which I thought was really good and very trusted. They delivered on time. … They did take a slight percentage of what we had made, but it was a nominal cost whenever I weighted out having to drive in traffic and use all of that time.

Another producer suggested that a group of producers could jointly pursue third-party trans-

portation and take advantage of lower bundled costs:

> I could see where a group of farmers could share in … some sort of a delivery service that comes around and picks up and takes everyone's stuff at one time … taking that [burden] off of all of the farmers. … If we've got enough farmers who are using [the service] then … there'd be a cluster, which would give you a lower rate.

Other farmers suggested creating a farmer-run aggregation point that would enable them to leverage commercial carriers' underutilized truck capacity on existing transportation routes:

> This is where FedEx and UPS and even the local post office … you could go to these existing delivery services and say, [you'll] be our drop-off point, and then use their current distribution mechanisms to deliver to those end customers, because they're already going to those customers' regions.

While some farmers viewed food hubs positively, others noted that they require relatively large volumes and only offer wholesale prices. One farmer commented that a food hub that is appropriately scaled for small producers is needed:

> I think if someone would really step up to the plate, like Common Market, and focus more on the small farm, I think that would definitely help all of us. I mean, on two acres … you can produce a heck of a lot of produce if you do it right.

"Addressing the Pain Points" Theme 3: Collaborating with other producers is appealing but challenging

The idea of collaborating with other producers for transportation was met with enthusiasm and generated significant discussion. Several participants mentioned that they would appreciate the opportunity to connect and build relationships with other like-minded producers in their communities. Many also said that they would be comfortable collaborating with other producers because they understand the business and could be trusted to handle products. Several participants pointed to the time and cost savings achieved by sharing the burden of transportation, as these two producers' comments exemplified:

> We had another farmer within half an hour of us and we are kind of on their way. So, they would swing by and pick up our product. … I would pay them half the gas plus some for doing the actual deliveries. … And I was very comfortable with that. … It certainly cut everybody's cost down to be able to do deliveries together.

> We had the experience of working with farmer friends to make deliveries. We take turns to deliver to 12 to 15 different restaurants in El Paso. … [When we work together] we invest like 3 to 4 hours per month each in delivery, and if we do it by ourselves, is going to be like 12 to 15 hours per month.

Several producers welcomed the opportunity to aggregate products with other producers, and a few mentioned the idea of pooling inventory and jointly marketing their products to leverage complementary offerings (e.g., vegetables and meat) and to fill gaps in offerings during low-productivity seasons to maintain continuity with customers. One producer took this concept a step further, suggesting that producers could work together to establish a virtual food hub:

> The thought that's exciting about this to me is the opportunity for identifying new customers, right? It almost kind of creates like a crowdsourced food hub or distribution network, where like I've got a bunch of X and you've got a bunch of Y and your customer wants X and my customer wants Y. So, I could see it being to everyone kind of a mutual benefit.

However, one producer had concerns about relying on another person to make timely and safe deliveries:

> I would never do that unless I absolutely trust them. … I can invest all this money into growing X amount of dollars per pound, and then we drop the ball or we fumble on the delivery, and there goes potentially a $300 invoice. … And if that accumulates across the year, you're talking five figures.

Another producer worried about losing connection with their customers:

> I think … the face of the farm changes if you have another farmer making the delivery, and it's a personal relationship with that chef. I mean, if you're just delivering it to the stocking boy and he doesn't know Adam from me, then it's not as big of a thing, but as we all know in this smaller farm situation, it's a lot more relationship driven than just the product.

The biggest and most frequently mentioned concern was competition. Several farmers stated that they would never share transportation with another producer, while others said that they would only collaborate with trusted friends. Their concerns were exemplified by this farmer's comment:

> If I hand my product over to another producer that has a friend that produces the same thing that I produce now, all of a sudden they know who my customers are and they can then share my customers with their friend, or they can … take that customer away from me … or they may go … find somebody down the road that has the same product and come in and undercut me. So you gotta have some way to protect yourself …

Indeed, one producer described their prior experience of a transportation collaboration failing due to competitiveness between farmers:

> We did have a what we thought was going to be a partnership … where we were going to take advantage of one member's cold storage and vehicle, but what we've kind of found out was that there's a lot of politics between the different growers and not as much collaboration as what you might see in some other regions. … I think it boils down to just our socioeconomic situation that we have here. … We don't have the amount of customer base locally for what we're all trying to do—making higher quality product than what you can get at the grocery store and making that extra money to where our farms are self-sufficient.

Others emphasized the importance of having structures in place to support accountability, even when collaborating with trusted partners. Another producer who had successfully shared transportation with a small group of producers in their community pointed to the importance of choosing partners strategically. When asked about issues of competitiveness and mistrust, they responded:

> I guess that was not my experience. Granted I knew the farmers really well and we sold slightly different products, so it wasn't like we were both competing to sell the same person tomatoes, you know? And we had different restaurants we were selling to for the most part.

However, even when competition is not an issue, producers face the challenge of farms' geographic remoteness and distance from one another, as well as the complexity of coordinating multiple harvest and delivery schedules, as in this producer's experience:

> The coordination of getting [multiple farmers' products] there at the same time [for] third-party shipping [was stressful]. … We would be waiting for product [and be] rearranging it on the pallet, trying to make everything fit. … We would have to use our staff and time, and we weren't really compensated for … fixing up the pallet and keeping it at a cold temperature, if [the farmer dropped off product] to us at 12 and the pallet wasn't leaving until 8 or 9.

This comment also points to an issue that came up repeatedly: how to share costs, and how to fairly compensate producers for the time spent

making deliveries for other producers. Moreover, a broader concern emerged regarding which producers would actually be willing to take on the task of transportation and how it could be made profitable for them. Producers who had collaborated for transportation in the past described informal arrangements where partners would take turns making deliveries, or they would split the cost of fuel. However, without proper incentives in place, a well-intentioned collaboration can fall apart in the face of self-interest. One producer gave such an example:

> Our original plan was a rotating farmer program. Each week it would be one farmer's turn to go out and pick up and deliver to the restaurants … [but] if it became their week to do the delivery, and they didn't have much [of their own] harvest, then it wasn't worth their while to … take their turn and drive around. … So, [it] didn't work.

None of the participants viewed transporting other producers' products as a way of making money. Most indicated that they would only collaborate if it was convenient, as explained by this producer:

> I would want to help another farmer if they asked me to take their stuff for them, but if it wasn't fairly easy and convenient for me to do it, it would just add more burden to my day that I don't need. … What are the odds that I'm getting paid to deliver someone else's stuff in a way that is actually gonna make me money?

Indeed, another participant gave an example of a transportation collaboration that never got off the ground because making deliveries for other producers was not cost-efficient:

> [One] farmer got a very large grant which allowed them to buy some refrigerated warehouse space and refrigerated trucks, [but] they ran into the problem of only delivering their own produce because it was less profitable for them to go pick up other people's produce, despite being paid for that delivery.

To overcome these issues, several producers suggested a cooperative model, either regionally or across the entire state. One producer described how this structure and its shared goals had helped to successfully maintain their current collaboration:

> I'm a part of a farmers' co-op and we [collaborate for transportation] all the time on an informal basis. We all pretty much trust each other and have this vested interest in making the business be successful so I think that's motivating for people …

Another producer pointed to the practical benefits of forming a cooperative to facilitate shared storage and transportation:

> A valley-wide cooperative can be formed, and part of the training involved with that, and even a requirement as a member, is that you use a certain box, and do things a specific way when you're doing your packing and everything, so that there is a specific way everything is coming into that one cold storage unit.

This comment also points to the role of aggregation and shared cold storage in supporting transportation collaboration, which was mentioned by multiple participants. One producer shared their experience:

> We did hire an aggregator who would go to each farm and pick up the product, and it would be stored at one farmer's farm in their cold storage, and if everything was gathered together, she would go and do the deliveries. … The key was having that reliable person that didn't miss a delivery.

To support a larger transportation collaboration, some producers suggested renting cold storage space at a centralized location for producer drop-off (e.g., using underutilized refrigerator space at a restaurant or convenience store). One producer emphasized the criticality of

this type of infrastructure:

> [We need a] facility where people could come from the rural areas, bring it to outside the city, and have it as a jumping off point to being sold to the urban population. That type of infrastructure is what we are sorely missing. … Until we build our own infrastructure, it's very hard to stay competitive with the stores.

Finally, when the idea of using information and communications technology (ICT) was suggested to participants, such as an app to connect producers to one another to facilitate coordination, scheduling, and payment. Nearly all the participants responded positively and indicated that they would be very happy to have technology to help them collaborate and alleviate their transportation burden. However, one producer anticipated barriers to adoption:

> Early adopters … I think that's what that would take. Because the 50, 60, 70 year-old men and women that I work with aren't gonna do that. Some of the newer, younger kids are getting into that.

Discussion of Results

The results of this study indicate that RFSC producers in Texas view transportation as a significant barrier to their businesses' growth and financial success. Long distances and high temperatures, especially in summer, make transportation costly, in terms of time, energy, and fuel, and in terms of the investment in refrigerated vehicles and cold storage. These costs limit producers' distribution range and their ability to reach large urban markets. Moreover, RFSC producers recognize that increased transportation efficiency would free up time and energy to focus on their core competency: managing production operations on their farm. While RFSC producers could potentially compete with grocery stores by offering a high level of service and responsiveness to customers (e.g., frequent and home deliveries), they lack the transportation capacity to do so. Investing in refrigerated vehicles and on-farm cold storage could yield significant returns, in terms of new market opportunities, but this is cost-prohibitive for most producers.

Focus group participants viewed outsourcing transportation to commercial carriers as a highly desirable alternative to self-delivery, but it was also considered to be expensive and lacking the necessary flexibility. Nearly all participants were excited about the idea of collaborative transportation; however, concerns about the risks involved with cooperating with competitors (also known as coopetition) were frequently mentioned. Practicalities like coordinating harvest schedules and the long travel distances between farms were also viewed as barriers. To address this, the idea of aggregating product in a shared storage location for predelivery staging held strong appeal among many participants. However, few participants had a clear idea of how vehicles and storage spaces could be jointly operated in a cost-effective way. Rules governing cost/benefit allocation and accountability would be needed, but it was unclear to producers how to define these rules. Producers who were currently or previously engaged in transportation collaborations typically managed them informally via reciprocity. In the face of these challenges, few participants were actively collaborating.

While these findings have practical value for Texas RFSCs and provide a foundation for future research on RFSC transportation, this study does have limitations. The use of focus groups limits the generalizability of this study's findings. In particular, all participants are located in Texas, which has characteristics that are distinct from other geographic regions. For example, producers located in regions that do not experience extreme summer heat might not emphasize the role of temperature control as heavily, and producers located in more densely populated regions, or regions having more established RFSCs with greater productive capacity, might face different challenges or prioritize them differently. Additionally, with 17 total participants, some of the resulting subcategories (in Tables 3 and 4) contained relatively few unique quotes, such that their generalizability to other producers and regions is uncertain. Furthermore, all 17 participants were producing at a small scale, so the perspectives of midsized farms were not captured.

However, as the larger subcategories indicate, there were clear recurring themes that emerged

across multiple participants' responses, irrespective of their farm's characteristics (e.g., size, location, product types). Interestingly, these themes are reflective of some of the most frustrating and persistent transportation challenges cited in the broader supply-chain literature. Specifically, similar perceived costs and risks associated with outsourcing, especially for small and medium-sized enterprises, have been identified as significant barriers to improved transportation efficiency (Holter et al., 2008). Furthermore, the supply-chain literature repeatedly illuminates that the complexity and cost of coordination (Cygler et al., 2018; Martin et al., 2018), insufficient trust between partners (Barratt, 2004; Pomponi et al., 2015), and difficulty in creating fair cost/benefit sharing mechanisms (Audy et al., 2012; Cruijssen et al., 2007) are major barriers to horizontal collaboration.

The commonalities between the results of this study and major themes in the broader supply-chain literature suggest that, while a larger-scale study is needed for generalizability, it is likely that these same themes will emerge in other regions and among other types of RFSC producers. This also suggests that implementing adapted versions of transportation best practices in conventional supply chains to RFSCs may offer potential. Specifically, the establishment of strategic clusters for logistics collaboration, as well as the adoption of shared ICT infrastructure to facilitate fast, efficient, and secure transactions, have been recommended in the supply-chain literature to overcome transportation challenges (Cruijssen, 2020; Sheffi et al., 2019). While RFSCs may not be able or willing to adopt these solutions in the same way as other supply chains, the concept of strategic clustering (e.g., establishing cooperatives) or implementing cost-effective ICT infrastructure (i.e., an online transportation collaboration app) could provide a path forward.

Transportation Cooperatives

Multiple focus group participants indicated that for producer transportation collaboration to work, a cooperative model would be needed to facilitate trust, establish common objectives, establish a fair cost/benefit sharing mechanism, and ensure conformity in packaging and labeling. A cooperative is a formalized legal structure for a business that is owned and controlled by its members and returns profits back to those members based on their level of participation (Cooperative Development Institute [CDI], 2023). Cooperatives can help small-scale producers increase market reach and sales and reduce their risk through pooled resources and jointly achieved scale (South Carolina Center for Cooperative and Enterprise Development [SC CEED], 2023). Cooperatives' formalized structure, including mechanisms to ensure accountability, may be able to address common challenges in collaboration, including insufficient trust between partners. Indeed, Saulters et al. (2018) found that successful RFSC cooperatives rely on trust-based relationships, where members view each other as strategic partners and work collectively to support the overall reputation of the cooperative's brand. Furthermore, successful cooperatives often focus on shared values, such as social justice, environmentally sustainable production practices, or fairness to farmer members (e.g., receiving the same transportation rates irrespective of production volume) (Saulters et al., 2018).

Despite their potential, however, cooperatives among RFSC producers often fail (Beratan et al., 2014). Common pitfalls for new cooperatives include not having a clearly defined common mission, a lack of leadership, a lack of member commitment, and inadequate business plans, risk assessment, and financing (University of Wisconsin Center for Cooperatives, 2024). Perhaps more problematically, cooperatives may require standardization of product, leading to a loss of an individual producer's farm identity (Gray, 2014). Indeed, in their study on civic food networks, Anderson et al. (2014) emphasized the importance of a farm's identity as a brand in direct marketing, finding that producers tend to strongly oppose participating in any venture that is perceived as undermining their individual autonomy and farm identity.

Nevertheless, there are some examples of successful RFSC cooperatives that focus on providing transportation services to their producer members while preserving producers' brand identity. La

Montanita Co-op[1] is a food hub that aggregates products from regional producers and provides transportation throughout New Mexico. The Wisconsin Food Hub Cooperative[2] operates a trucking LLC to distribute members' products throughout Wisconsin, Minneapolis, and Chicago. The LLC operates at cost and transports other items in the farming off-season, to ensure that drivers are retained (Freedman 2023). Regional cooperatives can also jointly form federations, which can further extend producers' geographic reach (Sumner et al., 2014). For example, the Northwest Food Hub Network[3] is a network of farmer-owned cooperative food hubs that has the collective scale to distribute to large institutional buyers located across multiple states in the Pacific Northwest.

However, a producer cooperative need not necessarily establish a full-scale food hub to reap the benefits of collaborative transportation. A more modest approach could be the creation of micro-aggregation nodes at convenient peri-urban locations, where producers could independently drop off products and then collaboratively outsource the outbound transportation from the node to urban buyers. In this way, producers' travel distances are reduced, issues of coordinating pickups and drop-offs with multiple producers are less problematic, and concerns about competitors coming into direct contact with a producer's customers and luring away business could be mitigated.

Transportation ICT

Another possibility, which could complement or replace the idea of a formal transportation cooperative, is the implementation of an online transportation platform, designed for a specific regional food community. While participants in this study consistently rejected the idea of hiring independent crowdsourced carriers, the concept of using an online platform (i.e., an app) to connect with trusted members of their communities (e.g., other producers, neighbors, friends) for transportation was appealing. Similar to a crowd-shipping app, producers with items to ship could post their delivery requirements on the platform, and other community members could then bid to serve as carriers for that job. The shipper could then choose their preferred bid (according to the price and carrier characteristics) and work with the carrier to schedule the pickup and delivery (Kulkarni et al., 2023).

However, there are challenges with this approach. Mittal et al. (2022) determined that there are no existing commercial online transportation platforms suitable for meeting the needs of small-scale RFSC producers. While there have been efforts to design platforms to facilitate transportation collaboration between producers, food hubs, and buyers, these proposals are all still in the research stage (e.g., Doshi et al., 2015; Matson et al., 2013; Mittal et al., 2017). Even if a suitable platform could be designed for an RFSC, there is no guarantee that producers would use it, and without active participation, it would fail (Frehe et al., 2017). Indeed, the supply-chain literature indicates that ICT for collaborative transportation faces many challenges, particularly with respect to process standardization and data governance and privacy policies (Pan et al., 2019). Furthermore, requiring large up-front investment in ICT would be a major barrier for small-scale RFSC businesses.

Public Funding to Support RFSC Transportation

While forming transportation cooperatives and utilizing a collaborative transportation app have potential to help RFSC producers with transportation outsourcing and collaboration, actual implementation faces many barriers. As noted previously, many producer cooperatives fail due to insufficient resources—both financial and human (e.g., time and energy). Furthermore, the design, development, and implementation of an online transportation platform requires technical capabilities (or hiring of consultants or software developers), and most RFSC producers lack the necessary funds, time, and technical or organizational know-how. Grant funding and technical assistance provided by university researchers or extension per-

[1] https://coopdistribution.coop/
[2] https://wifoodhub.com/trucking/
[3] http://www.nwfoodhubnetwork.com/

sonnel could help. For example, a simple online transportation platform could be developed at low cost, particularly if the app were to be managed and maintained regionally, rather than becoming a for-profit commercial venture. However, an efficient transportation system that operates successfully and supports RFSCs in the long term cannot rely solely on grant funding, nor should it rely on a single organization or individual to champion and sustain it.

The results of this study point to the criticality of transportation in regional food systems and, more broadly, food system resilience (FAO, 2020). It is therefore in the public interest to improve regional food distribution systems, suggesting a rationale for public funding. Similar to public transit systems, cities could subsidize these costs, or even set up their own secure and professionally run transportation systems for bringing perishable local and regional foods into the city.

Conclusion

The research described in this paper sought to reveal the major transportation barriers that prevent RFSC producers from efficiently reaching broader markets and how these barriers could be overcome. The use of Texas-based focus groups, as well as the relatively small operational scale of the participants (i.e., all had gross cash farm incomes less than US$200,000) may limit the generalizability of this study's findings to other regions and other types of RFSC producers. Self-selection bias is another potential issue: the nature of the study may have attracted participants who are keen to address their transportation problems, while those producers who have already found solutions to these problems may have been underrepresented. Because of these limitations, it was expected that the main contribution of this study would be to provide a foundation for future research. Surprisingly, however, the strength of the recurring themes that emerged from the focus group data, as well as their clear parallels with the broader supply chain literature, offered insights and promising strategies that are likely transferable and actionable. Nevertheless, the findings from this study indicate the more research on RFSC transportation is needed, in terms of understanding major barriers and appropriate solutions for different regions and producer types and sizes, as well as the suitability of conventional supply chain best practices and solutions for RFSCs.

Increasing RFSC transportation capacity and capabilities is critically important. Infrastructure to facilitate efficient transportation can help producers who want to scale up their production to access larger wholesale markets, and it can also help producers who wish to maintain their current scale by allowing them to reduce their time and resources invested in transportation while increasing flexibility and responsiveness to buyers. This has significant implications for helping regional food systems to reach their potential to transform the prevailing global food supply system. If regionally produced food can reach more buyers and fill more demand, regional food systems can grow and strengthen, making them sufficiently resilient to withstand and recover from the impacts of adverse events and serve as a sustainable and reliable source of food security for communities.

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Appendix: Focus Group Playbook

Questions: [Facilitator and team cues in square brackets.]

1. Let's talk about barriers that are preventing you from reaching urban buyers.
    a. What are your top 3 challenges or "pain points" with respect to *transportation*?
    b. Describe your current *storage and transportation equipment*. How does the current equipment you have impact your transportation?
    c. Other barriers (including non-transportation barriers)?
    d. What, if anything, would help you reach urban markets better?

    [Show video introducing delivery sharing notion] https://vimeo.com/506299026

2. How do you feel about collaborating/outsourcing for transportation?
    a. How do you feel about outsourcing your transportation to other farmers? What would it take to make you feel good/better about collaborating with other farmers?
    b. How do you feel about outsourcing your transportation to private distribution companies? [privacy, reliability, trust…?]
    c. How do you feel about outsourcing your transportation to other individuals?
    d. Other ideas and thoughts?

    [Show video about app possibilities] https://vimeo.com/506300649

3. What software/apps are you using?
    a. Do you use routing software? Which one? Mobile?
    b. What other software do you use on your farm? Storage, field management, sales, food safety tracking?

4. What other ideas do you have on how transportation problems could be solved?
    a. [Present them with possible solutions/scenarios for a regional food transportation system and ask them to react.] Feasible? Doomed from the start? And why?
    b. How prepared are we as an industry to meet the growing demand?
    c. Other ideas?

Facilitator close: Any final thoughts? Thank you for coming. After we have analyzed the transcript from this focus group, we may need clarification on some points. If you are willing, we may contact you in the next few weeks to ask you some follow-up questions. When our analysis is complete, we will share the results with you.