SCALING UP PRODUCTION OF LOCAL SALAD MIX FOR RETAIL GROCERY MARKETS:
A FEASIBILITY STUDY IN SOUTHEAST MICHIGAN

By

Jennifer A. Gerhart

A THESIS

Submitted to
Michigan State University
in partial fulfillment of the requirements
for the degree of

Community Sustainability – Master of Science

2021

ABSTRACT

SCALING UP PRODUCTION OF LOCAL SALAD MIX FOR RETAIL GROCERY MARKETS:
A FEASIBILITY STUDY IN SOUTHEAST MICHIGAN

By

Jennifer A. Gerhart

Changes to the supermarket supply chain over the last few decades have “squeezed out” local and small farmers in place of more consolidated and global suppliers. As a result, local farmers have turned to more direct to consumer markets for farm sales, which capture a higher price point but also bear higher marketing costs. Previous research has revealed saturation and lack of profitability in this market type. As a result, researchers have explored strategies for “scaling up” local farmers into intermediary supply chains, such as grocery retail, and have tested the profitability of hybrid marketing strategies with positive results. However, none of this research has used production costs to test market feasibility and this component is critical for a small farmer’s willingness to “scale up” into intermediary markets. Using salad mix as a test crop and Southeast Michigan as a sample region, this research uses farmer-generated production costs for four production methods to examine the feasibility of previously identified strategies for scaling up into intermediary supply chains. The data reveal that central processing has the greatest impact on lowering both the farmgate cost of production and the output price for the buyer. In addition, the minimal costs of organic certification for small farmers justifies the price premium received in grocery retail markets. Lastly, hydroponic production was found to be infeasible at a small scale but could potentially meet retailers price preferences at larger scales. Based on these findings, further research on the realistic costs for centralized processing, distribution, and marketing for this crop type to be sold to grocers is recommended.

ACKNOWLEDGMENTS

This thesis would not have been possible without the support of Michigan State University Extension's Educational Assistance Program and the flexibility I was permitted to continue to work full time while pursuing this degree. My MSU Extension leadership team – Dave Ivan, Matt Shane, and Abby Harper – were extremely supportive through this process, and I am grateful for their encouragement and interest in my academic development.

This thesis would also not have been possible without the steadfast support from my advisor, Dr. Phil Howard. His creative approach to research as well as the relevance of his research interests critical to my work with small food and farm viability. I gained a deeper understanding of the role consolidation plays in the larger food system and this helped frame my own research. My committee, Dr. Phil Warsaw and Dr. Thomas Reardon also provided invaluable support and thoughtful comments throughout this process. I enjoyed conversing with them about supply chain issues in the local and mainstream food systems. Kathryn Colasanti, while not an official committee member by the end of this defense, provided invaluable support early on in framing this thesis.

I began this Master's degree in order to better serve the farmers and food entrepreneurs I work with as the Washtenaw County Local Foods Coordinator. This thesis reflects my desire to use research to help small farmers thrive in the local marketplace. The research skills acquired and knowledge gained through this Master's degree program will be used to serve the small food and farm businesses of Michigan who aim to build a local food system that is more just, economically viable, and community focused. Post-graduation, I plan to continue in my role with MSU Extension but with a deeper working knowledge of topics related to small farm viability, market development, and local food systems.

TABLE OF CONTENTS

LIST OF TABLES

CHAPTER 1

INTRODUCTION

Demand for "local food" is a growing trend among U.S. consumers and consumers are often willing to pay a premium price for it (Fan, Gómez, and Coles 2019; Feldmann and Hamm 2015). Triggered by the economic and environmental impacts of increasingly global supply chains, consumers seek local food for its better quality, embeddedness to place, local economic development, and democratic values (Goodman, DuPuis, and Goodman 2010). Though "local food" or "local food system" lack an official definition, they generally represent a more direct connection between producers and consumers (Martinez 2010) and include both direct-to-consumer markets (farm stands, farmers markets and community supported agriculture [CSA]) and intermediary markets (direct-to-grocery, institution, or restaurant) (Low and Vogel 2011).

In response to this growing consumer trend, U.S. supermarket retailers have demonstrated increased interest in procuring local foods for their customers (Bloom and Hinrichs 2017; Dunning 2016; Gupta and Jablonski 2016; Guptill and Wilkins 2002; Robinson et al. 2017). This interest in sourcing local food reveals a departure from the "supermarket revolution" trends of the 1990s in which advances in wholesaling and processing specialized supermarket supply chains and procurement systems around the world (Reardon et al. 2009). While examples of both the inclusion and exclusion of local and small farmers are demonstrated in these supply chains (Reardon et al. 2009), increasingly consolidated supply chains in the U.S. put greater emphasis on global imports rather than regional spot markets, and demand for larger suppliers increased (Konefal et al. 2007). This has shifted procurement away from regional supply chains in which local farmers could participate and towards more centralized, consolidated, and global procurement systems. Increased consolidation among top producers, distributors, and retailers continues to limit small actor participation in the grocery retail sector (Howard 2016).

In response, local governments and non-governmental agencies have pursued a variety of strategies to link small farmers to supermarkets. Examples include the use of "hubs" or "parks" in Asia (Reardon, Timmer, and Minten 2012); food hubs in North America (Barham et al. 2012; Blay-Palmer et al. 2013; Fischer, Pirog, and Hamm 2015); contracts in Ghana, India, Madagascar, Mozambique, and Nicaragua (Barrett et al. 2012); or producer cooperatives in South Africa (Chibanda, Ortmann, and Lyne 2009). In the U.S., some researchers have worked directly with supermarkets to increase small and local farm inclusion in the supply chain (Bloom and Hinrichs 2017; Dunning 2016; Robinson et al. 2017), thereby both studying and dismantling the barriers to small farm participation in the grocery supply chain.

Ultimately, the "squeezing out" of small farmers from the mainstream grocery sector has shifted retailing opportunities for small farmers to more direct markets such as farmers markets, farm stands, and CSAs (Guptill and Wilkins 2002). These direct-market retail channels provide higher price points for lower volumes, as well as flexibility in terms of grades and standards for the producer (Low and Vogel 2011). Direct market sales capture a larger portion of the consumer dollar, which can increase the overall income of a farm operation (Detre, Uematsu, and Mishra 2011). However, the marketing labor costs associated with direct markets are quite high and significantly impact the producers' overall profitability (LeRoux et al. 2010).

Opportunities for conducting retail sales through direct markets have been increasing in the U.S. Nationwide, the number of farmers markets increased 180% between 2006 and 2014 (Low et al. 2015), and in Michigan, the number of farmers markets more than doubled during the same time period (Michigan Municipal League 2014). However, despite the growth in direct retail outlets, direct market sales plateaued between 2007 and 2012 (Low et al. 2015), indicating potential market saturation in this sector. Though the number of marketing opportunities has increased, the question of the profitability in these market types remains.

Evidence of low profitability in direct markets presents concerns for the viability of small farmers in the U.S. Farm-gate profitability is important for small farmers who are not subsidized by governments to the same extent as they are in Norway, Iceland, Switzerland, Japan or Korea (Organisation for Economic Co-operation and Development 2020), nor do buyers commonly participate in resource-providing contracts with small farmers as in the palm oil industry in Ghana (Ruml and Qaim 2020) or the dairy industry in Poland (Dries and Swinnen 2004). Overall, profitability in direct market sales are more associated with short-term financial gains rather than long-term viability (Ahearn, Liang, and Goetz 2018), and farms selling in direct markets tend to experience smaller increases in sales over time than other farm types (Low et al. 2015). Park (2015) found that increases in direct markets actually have a negative impact on overall farm sales, and sellers in direct-to-consumer markets tended to be less satisfied with their profitability than those selling to intermediary market channels (Silva et al. 2015).

In response to both potential market saturation and poor profitability in direct-to-consumer markets, researchers and practitioners have explored the idea of "scaling up" small producers into larger, more mainstream markets (Farnsworth et al. 2009; Friedmann 2007) including into the retail-distributor infrastructure (Bloom and Hinrichs 2017; Clark and Inwood 2016). One technique is to "piggy-back" on mainstream distributor infrastructure but these strategies have yielded mixed results. Challenges include lack of trust between the producer and the distributor to manage product quality, low prices offered by the distributors that are not feasible for the small producer (Bloom and Hinrichs 2011), high transaction costs when working with local producers (Givens and Dunning 2018), and loss of identity when local product is supplemented with traditional warehouse stock keeping units (SKU) (Guptill and Wilkins 2002). Trust-based relationships between supply chain actors are critical when integrating local food into the mainstream distributor infrastructure (Abatekassa and Peterson 2011; Clark and Inwood 2016) but take significant time to establish and manage (Dunning 2016).

Another option is to vertically build new supply chains that focus specifically on small farm viability. Better known as “value-chains,” supply chain actors work strategically to ensure equitable profit distribution across the supply chain while moving larger volumes of products to larger buyers (Lev and Stevenson 2011; Stevenson and Pirog 2008). Strong public and private support for the development of local and regional food systems in the U.S. has fostered the emergence of food hubs, which provide the infrastructure for value-chains to operate effectively (Berti and Mulligan 2016; Fischer et al. 2015). While each food hub is unique in their individual goals and objects, a focus on local farmer and supplier support is common (Bielaczyc et al. 2020).

A third method for scaling up local suppliers into mainstream or wholesale markets is through horizontal producer collaboration. Cooperatives, as formal collaborative structures, can reduce transaction costs, improve farmgate prices, and improve market access for smallholder farmers (Hoken and Su 2018; Ito, Bao, and Su 2012; Verhofstadt and Maertens 2013). However, the level of collaboration in farmer cooperatives depends on the marginal costs and benefits to the participants, and if a farm is highly diversified, the benefits of working with the group may be low (Fischer and Qaim 2014). Though small diversified farmers tend to have less of an incentive to invest in a cooperative (Grashuis and Ye 2019), even in heterogeneous grower groups, all members tend to benefit from the cooperative’s functions (Agbo et al. 2014; Biggeri et al. 2018). One example of cooperative development in “scaling up” literature is at Tuskegee University, where researchers and practitioners worked to develop a supply chain between local smallholders and a local supermarket, which then evolved into a producer-managed cooperative (Robinson et al. 2017).

At the farm level, small farm profitability may be increased by developing a hybrid marketing strategy that includes both direct and intermediated markets. Bauman et al. (2018) found that top-performing direct market producers had lower rates of profitability (measured in returns on assets) than top-performing producers with intermediated sales, thus demonstrating the importance of intermediated sales on profitability. In a proof-of-concept project intended to evaluate the economic feasibility of shifting from a diversified direct-market cropping system to one tailored for wholesale accounts (fewer crops and more mechanization), Thompson and Gaskin (2018) demonstrated that it is possible for small growers to feasibly produce for a wholesale market on small acreage and without sacrificing environmental production values. On a more qualitative level, Silva et al. (2015) found that farmers selling into intermediated markets are more satisfied with their profitability than those selling into direct market channels.

However, a significant challenge to both “scaling up” small producers and hybridizing their market channels is the small farmers’ willingness to participate in intermediary markets. Small farmers’ report concerns with “lost sales” due to the lower price point expected in intermediated markets (Thompson and Gaskin 2018). LeRoux et al. (2010) and Hardesty and Leff (2010) address this by evaluating the marketing costs in both intermediary and direct markets in a case-study setting. While their findings support the profitability of hybrid marketing plans that include intermediated or wholesale sales, their studies omit production costs from the analysis. It is important to use production figures to more precisely determine feasibility in this market sector as they are a substantial component of overall viability for small farmers. To my knowledge, no research has analyzed cost-of-production figures in relation to wholesale price points to assess whether this market type is feasible for the small farmer. Therefore, this thesis uses cost-of-production figures to perform a feasibility study on small farm transactions in the grocery retail sector.

Defining the Sample Product

Larger Southeast Michigan growers produce a wide variety of specialty crops for the local retail grocery market, however, locally produced salad mix is relatively absent. Minimal competition for a differentiated local brand of salad mix makes it an interesting produce type on which to perform a small farm feasibility analysis. Currently, one Michigan salad mix brand is distributed throughout the region by a specialty distributor, but demand for this product currently exceeds supply[1]. The salad mix industry differs from other commodities in that the technology required to efficiently harvest, process, package, and ship is more specialized than for other crops, and this limits competition in the wholesale sector (Cook 2011). Additionally, foodborne illness outbreaks in bagged spinach and romaine lettuce have contributed to stricter food safety regulations (HACCP particularly) which dissuades new entrants (Community Involved in Sustaining Agriculture 2009). That said, in a supply chain case study on direct, intermediated, and mainstream salad mix supply chains, growers received a premium even in the intermediary market for salad mix (King et al. 2010).

Bagged salad mix for foodservice and retail grocery entered the market in the 1970s when TransFRESH worked with Whirlpool Corporation to adapt controlled atmosphere

[1] Heather Ratliff, Cherry Capital Foods Sales Representative, interview by author, December 10, 2019.

technology for bagged salad transport (Lugg, Shim, and Zilberman 2017). This technological innovation spurred the emergence of two lettuce-shippers in the bagged salad industry: Fresh Express and Dole (Cook 2011). By 2011, Fresh Express (now owned by Chiquita) and Dole made up 54.4% of the total market share for bagged salad (Howard 2016). However, if factoring for private label sales, which could account for as much as one quarter of all bagged salad mix sales, the combined Chiquita and Dole market shares are likely much higher (Cook 2011). While the bagged salad market for foodservice was developing, Earthbound Farm began supplying organic salad mixes to a high-end restaurant, Chez Panisse (Guthman 2003), and by 2010, Earthbound Farm products were being produced at volumes of nearly 1 million pounds per day (King et al. 2010). The rapid growth of this market sector due to both technological advancements and market consolidation has resulted in a limited number of suppliers within the mainstream supply chain. Yet, opportunities in a more localized, differentiated supply chain are poorly understood.

Overview of Thesis Chapters

This thesis expands on previous research for "scaling up" local food systems by assessing whether small farmers who have traditionally focused on direct market sales for salad mix can feasibly sell this crop into the retail grocery sector. In Chapter 2, a literature review covers the strategies identified in previous research on scaling up small famers and local food systems. This chapter also reviews agricultural feasibility studies and salad mix production methods, which provide a context for the data collection methods used in this research.

Chapter 3 describes the methods used for collecting data on small farm cost of production figures, as well as on grocer standards for salad mix products in this market sector. Using

Southeast Michigan as a sample region, three focus groups of small farmers created enterprise budgets for three different production methods: two field-grown production styles (mechanical and no-till) and a third for hydroponic production. Hoop house production for season extension was analyzed using production figures developed by the two field production focus groups. Wholesale pricing and logistics data was gathered via interviews from produce buyers or managers in twelve independent and cooperative retail grocers. Distribution, product specifications, a willingness to pay scenario, and qualitative responses to local purchasing were collected in these interviews.

The data analysis in Chapter 4 begins with a detailed description of each production method as defined by the focus groups. The associated enterprise budgets show the variable and fixed costs associated with the four methods, and a break-even analysis (Dillon 1993) is used to determine the farmgate output price for each. The enterprise budgets are then adjusted in the following ways based on the "scaling up" strategies identified in the literature review: improved harvest technology, centralized post-harvest processing, and doubled production. A description of the qualitative and quantitative market data collected from the retail grocers rounds out the chapter. In Chapter 5, the break-even output prices along with the market data are combined to assess the feasibility of four "scaling up" strategies for small farmers: technological advances, centralized packing and distribution, organic certification, and collaborative strategies between producers and the grocers.

CHAPTER 2
LITERATURE REVIEW

In order to address barriers to small farm viability particularly in terms of market access and profitability, this chapter analyzes the literature for "scaling up" small farmers into intermediary markets. Three central themes emerge from the literature which all play a key role in "scaling up": increased collaboration, technology innovation, and centralized marketing. In addition, this chapter reviews previous research that utilized cost of production to test either production feasibility or market accessibility. An overview of production standards for salad mix field, hoop house, and hydroponic production round out the literature review and provides context for the data collection and analysis described in the following chapters.

Strategies for "Scaling Up" Small Farmers

Vertical Collaboration

As identified in Chapter 1, the globalization and consolidation of supermarket supply chains has drastically reduced procurement costs for grocery retailers (Konefal et al. 2007). Labor costs for managing inventory, placing orders, and processing invoices are lower when working with fewer, larger distributors. In produce sourcing, a trend towards purchasing directly from increasingly consolidated shippers has eliminated intermediaries such as local brokers or the use of spot markets (Martinez and Davis 2002). Sourcing directly from local suppliers, on the other hand, results in greater labor costs, and consequently, the motivation to work with local producers is lower (Guptill and Wilkins 2002). Grocers as large as Walmart are willing to take on this additional cost due to increasing consumer demand for local food products, but still face significant barriers when integrating local suppliers into their lean and centralized business model (Bloom and Hinrichs 2017). Furthermore, retailers' broad definition of "local" may still exclude smallholders, as they tend to view it in a larger geographical framework than consumers (Colloredo-Mansfeld et al. 2014).

Researchers and practitioners with interests in increased local food procurement have engaged directly in supply chain development to better understand the components necessary to overcome cost-related barriers to working with small local producers. In a Tuskegee University project, researchers and specialists fostered a relationship between small farmers in Southern Alabama and the regional Walmart supermarket (Robinson et al. 2017). The project demonstrated the high level of planning, communication, and logistics necessary to supply just a few key produce items to the local store. In a longitudinal study of a 100-store regional supermarket chain in the U.S., Dunning (2016) worked with store management to increase local purchasing, which included the development of a local vendor application and the coordination of regular grower meetings. The research sought to better understand how relationships between producers and buyers can be created and maintained, and while the store demonstrated interest in local sourcing, university-sponsored support was critical.

Both of the aforementioned studies identify the need to establish trust between local suppliers and buyers in order to build viable local supply chains. Local supply chain research in other sectors of the food distribution system including from farm to wholesaler (Abatekassa and Peterson 2011), farm to distributor (Bloom and Hinrichs 2011), and farm to institution (Buckley et al. 2013) corroborate these findings. Once trust is established between two parties, the formation of long-term commitments can follow, and if successful, a mutually dependent relationship can exist (Holm, Eriksson, and Johanson 1999; Kwon and Suh 2004). Mutual dependency, or at least long-term commitments, are critical for small growers to remain viable suppliers in the grocery retail sector, but this type of relationship requires significant time to establish (Dunning 2016; Guptill and Wilkins 2002)

While relationship building takes time and sometimes external support, one practical strategy for increasing local farm products in a mutually beneficial way is through the direct store delivery (DSD) model. DSD transfers the labor of stocking shelves and managing inventory from the grocer to the local vendor, which presents a potential win-win scenario for both parties if the vendor has the resources to take on these tasks (Guptill and Wilkins 2002). By stocking shelves on a regular basis, the vendor can regularly assess the competition, fine-tune product selection, and collaborate with the grocer on in-store marketing campaigns while the grocer saves on the additional labor required for working with local vendors (Dunning 2016). This method is found to be superior to the common practice of substituting SKUs in the warehouse for local product when available. Therefore, this thesis will assess the possibility of integrating aspects of DSD into the break-even analysis as a potential strategy for small farm sales to retail grocers.

Technology Innovation

In the U.S., technological innovations in seed genetics, fertilizers, planting, harvest, and post-harvest technologies have increased the size and prevalence of monocrop production systems (MacDonald, Korb, and Hoppe 2013). Local food production, on the other hand, tends to be more labor-intensive and highly diversified (Janssen 2018). The cost of labor in both the production and marketing of local food are significant limiting factors for small farm profitability (Hardesty and Leff 2010; LeRoux et al. 2010). One of the key strategies to improving the productivity and profitability of small, diversified farming systems is technological innovation (Bowman and Zilberman 2013). Advancements in small-scale agriculture technologies to plant and harvest more efficiently reduces labor costs and improves economic outcomes of the small farm operation. For mainstream salad mix, though, the major improvements in technology have been for large-scale systems.

Technological innovation in bagged salad mix through adapted controlled atmosphere technology revolutionized the market for mixed greens (see Chapter 1). Another technological advancement, this time in harvest technology, expedited the growth of Earthbound Farms as a major player in the salad mix industry. According to the company's website[2], a partner-grower created a prototype of an industrial-scale greens harvester that could withstand year-round use and harvest thousands of acres in its lifetime. The harvester decreased the labor needed to produce the greens from 50 people to just 8-10, which decreased the price and improved the company's competitiveness in the salad mix industry. Earthbound now operates a fleet of 18 harvesters, which collect 1 million pounds per day.

Though Earthbound Farm's accelerated adoption of harvest technology catapulted them into the mainstream salad mix market, this type of rapid adoption is relatively rare on small farms. The adoption of small farm technology is dependent on incremental rather than accelerated advancements to the farming system, as well as on its usability and connection to profitability (Kitinoja 2013). In an ethnographic study of diversified small farms in Iowa, Janssen (2018) observed a number of small farmers use technological innovations to improve efficiencies and reduce labor costs. Incremental investments in such tools as transplanters, tractor-drawn harvesting equipment, post-harvest equipment and cold storage were illustrated in her descriptions. These tools, she argues, help the small farmer move towards "mid-level" farm status without adding acreage. Specialization and mechanization are common in small farmers

[2] https://www.earthboundfarm.com/about/our-farmers/meet-farmer-stan-pura/

“scaling up” to serve intermediary markets such as schools and grocers (Janssen 2018; Thompson and Gaskin 2018).

In this study, the farmers were asked about their knowledge and experience with more advanced harvest technology and the applicability of those tools on their farms. These tools were then assessed for their potential to reduce production costs in order to inform the overall feasibility recommendations for small farm salad mix production.

Centralized Marketing

Farmers who sell product into intermediary markets are challenged to compete with mainstream suppliers on price and efficiencies. Consolidated and vertically integrated supply chains can offer lower prices and increased purchasing convenience for buyers (Konefal et al. 2007; Richards and Patterson 2003). Value-chains, which utilize strategic partnerships to capture a premium for suppliers and reduce procurement costs for buyers, are a strategy for farmers to effectively compete in intermediary markets (Stevenson and Pirog 2008). The value-chain benefits farmers by improving transparency across the supply chain and providing higher prices (Feenstra and Hardesty 2016).

The “food hub” is a value-chain structure for moving local food into traditional mainstream markets to increase small and midsized growers’ market access (Low et al. 2015). Similar to the traditional wholesale food company or packer, food hubs are designed to aggregate product from regional, source identified farms for distribution to intermediary markets (Barham et al. 2012; Fischer et al. 2015). In addition, they often provide a wide range of wrap-around services including quality control, education, and food safety certification for producers. They differ from the mainstream wholesale system in that they often grounded in social, environmental, or economic objectives (Barham et al. 2012).

Food hub business structures, financial health, and customer types are quite heterogenous. Their business structures range from nonprofits to cooperatives to for-profit companies, and their financial health is just as varied. According to the 2019 National Food Hub Survey, two-thirds of U.S. food hubs were breaking even or better, but the range of operating expense ratio[3] varied dramatically from 0.02 to 9.76. About one-third of the food hubs surveyed self-identified as highly dependent on grant funding and half reported non-sales revenue sources (Bielaczyc et al. 2020). In terms of customer or market types, food hubs serve a variety of customers from direct consumers to wholesale buyers in institutional food service, retail grocery, and restaurants. Of those that focus on wholesale, the markets with the largest predicted increase in sales in the future are small retailers (Bielaczyc et al. 2020).

While the findings of the 2019 National Food Hub Survey are generally optimistic about current and future growth for the industry, it is impractical to use these findings as a tool for assessing the feasibility of a regional food hub specifically for aggregating and distributing locally-grown salad mix. Rather, the optimistic growth projections and federally supported infrastructure indicate their overall potential to provide market access for small farmers in Southeast Michigan. Therefore, this research assessed changes in farmgate profitability given the presence of a food hub type operation to manage sales and marketing to the retail grocery market.

[3] Operating Expense Ratio: (total operating expenses divided by gross revenue) is a tool to measure financial health. 1.00 is breaking even. Anything less than 1.00 indicates positive profit margin and greater than 1.00 indicates negative profit margin.

Testing the “Scaling Up” Strategies

Rather than seek novel “scaling-up” strategies, this research will test the influence of vertical collaboration, technology innovation, and centralized marketing on producer feasibility for a given geographic market of small farmers and grocery retailers. To perform this type of analysis, cost-of-production figures are required which can then be manipulated and evaluated based on the above-mentioned strategies. Researchers most commonly gather cost-of-production data using enterprise budgets as demonstrated in research on hydroponic lettuce (Barbosa et al. 2015), high-tunnel tomatoes and lettuce (Galinato and Miles 2013), aquaponic tilapia and lettuce (Rakocy et al. 1997), muskoxen (Starr, Greenberg, and Rowell 2017), blueberries (Fonsah et al. 2011) and more. These studies are helpful in testing feasibility because they identify a common metric for analysis. Individual farmers can exhibit a wide range of cost of production figures, and true cost-of-production figures are often laborious for farmers to gather themselves. These studies use data gathered from national survey statistics (Barbosa et al. 2015; Malaiyandi, Bayite-kasule, and Mugarura 2010), demonstration trials (Rakocy et al. 1997; Starr et al. 2017), and farmer focus groups (Estes et al. 2003; Galinato and Miles 2013) to create a single enterprise budget for analysis.

Within the breadth of research on this topic, I could not identify any studies that compared salad mix production types; nor any that looked at the potential for a single crop to *expand* into local intermediary markets. The above-mentioned studies focus primarily on cost of production figures rather than market feasibility. King et al. (2010) provides the best case-study example of salad mix market research but the cost of production figures are calculated for direct and intermediary markets by adding the estimated cost of processing activities to the farmgate price in the mainstream market. This type of estimation misses any nuances inherent in small farm production and is not an exact representation of small farm production figures.

In a study on high-tunnel tomatoes and lettuce, Galinato and Miles (2015) assemble farmer focus groups to create a single enterprise budget each for four types of production methods. Farmers work together to estimate the figures for direct and indirect costs in a sample enterprise budget. Lacking access to demonstration trials or national survey statistics as stated above, this research follows similar focus-group type methods. While the farmers' practical knowledge provides the basis for these figures, cooperative extension bulletins, factsheets, and publications verify the predicted production costs for small farms. Farmers in Southeast Michigan utilize cooperative extension services in addition to books from Chelsea Green Publishing, such as *The New Organic Grower* and *Lean Farm*, farmer-based podcasts, and social media to educate themselves about farming methods (Gerhart and Schuh 2018).

Salad Mix Production Standards

In Southeast Michigan, salad mix is most commonly produced in open fields via mechanical or no-till methods, under hoop houses, or hydroponically. Salad mixes can also be produced in greenhouses on bench-tops[4], but no growers in Southeast Michigan currently produce the crop this way. Field production of salad mix is described in numerous cooperative extension bulletins and websites including the New England Vegetable Management Guide,[5] University of Wisconsin Extension,[6] and Penn State Extension.[7] Common production characteristics in northern climates include planting dates spanning April through September and

[4] https://ag.umass.edu/greenhouse-floriculture/fact-sheets/greenhouse-greens-resources
[5] https://nevegetable.org/crops/salad-mix
[6] https://fyi.extension.wisc.edu/danecountyag/files/2016/10/2017-OVPC-Salad-Mix-FINAL.pdf
[7] https://extension.psu.edu/growing-edible-greens

variety selection (lettuce or mustard mix) depending on the season. Seeds are sown using hand or tractor-mounted seeders in rows on a prepared seed bed. Pests are controlled with row cover or sprays, and weeds are managed using both hand and tractor-mounted implements such as basket-weavers. Harvest can be performed by hand with knives, with mechanical hand tools, or tractor mounted harvesters. In addition to the methods described in Extension materials, technical guides published by small farm seed companies such as Johnny's Selected Seeds[8] provide variety recommendations and seeding rates to small producers.

In the last few decades, research in season extension techniques for small farms has increased. Season extension can take the form of row covers (Rhoads 2002) or high tunnels, also known as hoop houses (Kaiser and Ernst 2012; Nennich and Wold-Burkness 2012). These controlled environments allow farmers to plant earlier and harvest later, including year-round. Hoop houses are constructed using galvanized steel tubing and covered in a single or double-layer of polyethylene plastic (Biernbaum 2006). Researchers have studied the profitability of hoop house production which is dependent on the types of horticultural crops produced: peppers, cucumbers, greens, and tomatoes (Chase and Naeve 2012; Conner 2010; Waldman et al. 2010, 2012). Salad mix revenues in these studies ranged from $1.44 per square foot (Conner 2010) to $3.22 per square foot (Chase and Naeve 2012), but their real value was in early and late season revenue generation for the farms.

Hydroponics production is better researched than either the field or hoop house production systems. Though controlled environment agriculture in the U.S. dates back to around 1925, modern day interest spiked in 1980 with increased consumer interest in local food and lower energy costs in the U.S. (Jensen 1997). Hydroponics were favored for their low

[8] https://www.johnnyseeds.com/growers-library/vegetables/salad-mix-production.html

environmental impacts including water efficiency and reduced pollution from transportation costs due to its proximity to urban consumers. Hydroponics is quite varied in its production methods which run the gamut from nutrient film technique (NFT), deep-water float systems, aquaponics, vertical farming techniques, and horizontal hydroponic systems (Parkell, Hochmuth, and Laughlin 2015). Production also varies between completely enclosed environments using artificial lighting or under greenhouses which provide natural solar light. The type of research performed on hydroponic production spans from life cycle analysis and the impact of climate change (Sanyé-Mengual et al. 2015), horticultural research comparing growing techniques (Johnson et al. 2017; Touliatos, Dodd, and Mcainsh 2016), and economic feasibility studies analyzing profitability (Asciuto et al. 2019; Grafiadellis et al. 2000; Lobillo-Eguíbar et al. 2020; Majid et al. 2020).

Hydroponic research with a focus on economic feasibility has studied a wide range of crop types and production styles. Examples include aquaponic production of baby leaf lettuce (i.e. salad mix) and tilapia (Asciuto et al. 2019), lettuce production in NFT hydroponic and conventional systems (Barbosa et al. 2015), and a comparison of deep-water float, NFT, and conventional lettuce production (Majid et al. 2020). Of these, Asciuto et al. (2019) is the only study that uses actual market data to access feasibility. Using pricing data from local restaurants, researchers found a net positive return using a break-even calculation. In general, profitability is sensitive to local retail prices and larger systems seem to be more viable than smaller ones (Greenfeld et al. 2019). Major factors that affect feasibility include energy costs (Barbosa et al. 2015) and labor costs (Lobillo-Eguíbar et al. 2020). In general, the heterogeneity of production methods and crop types make any generalizations about feasibility challenging. More research on distinct production styles and market types are necessary to provide informed recommendations for market feasibility.

CHAPTER 3
METHODS

Cost of Production Data

Four types of production methods were analyzed for this feasibility study: field no-till, field mechanical, hoop house, and hydroponic. These were selected because they are the production methods most frequently used by small farmers in Southeast Michigan. Similar to the research performed by Galinato and Miles (2015), farmers worked in focus groups to develop a single enterprise budget for each production method. While the goal was to enlist four small farmers for each focus group, the COVID-19 pandemic added significant strain to farmers' availability. Four producers for field no-till production met in March 2020 before the state went into a "stay at home" order. The research was put on hold and by December of 2020, just three producers for field mechanical production and one producer for hydroponic production were able to participate. The hoop house production budget was extrapolated using the cost-of-production figures from the no-till enterprise budget with additional variables such as the fixed cost of the hoop house and extended seasonality factored.

Hydroponic production is quite varied in production styles, presenting a significant challenge to assembling a focus group to develop a single enterprise budget around common costs. Most hydroponic research is case study based, with a single production type analyzed (see Chapter 2). The single producer selected to participate in this research uses NFT to grow salad mix, herbs, and micro-greens in an enclosed warehouse in Detroit, the major urban center in Southeast Michigan.

Focus group participants met for one four-hour session to develop the enterprise budget. A description of each participant's production experience is shown in Table 1. Their first objective was to determine a reasonable scale of production for which to develop the enterprise budget, which involved determining both the yield and the annual number of successions. Because this research is focused on small farm feasibility, the farmers were asked to develop the scale based on a cash gross farm income (CGFI) of $350,000 or less (the USDA definition of a small farm). The participants chose a scale of production that also took into account the necessity for a diverse crop and marketing plan as these are important risk-management strategies for small farmers. Next, each focus group discussed the basic order of operations for their given type of salad mix production and in doing so, developed a common production method for the budget. Bed preparation, cultivation techniques, pest management, irrigation, and harvest techniques were all discussed. Then the group inserted labor costs and material costs for the inputs discussed in each stage and estimated the lifespan of those products that are used over multiple years. The final enterprise budget was then reorganized by variable, labor, and fixed costs, which were depreciated using straight-line depreciation, to determine cost of production for both a single succession as well as annually.

Additional components of the enterprise budget were calculated following the focus group meetings. The cost of seed, sprays, irrigation materials, energy (for hydroponic), and hoop house materials were all calculated using product pricing information from suppliers recommended by the focus group participants. Once the base enterprise budget was developed, adjustments were performed to test the “scaling up” strategies under investigation: vertical collaboration using DSD delivery, technological innovation in the form of more efficient harvesting equipment, and centralized processing in a food hub type setting. A scenario of doubled production per succession was also assessed for its impact on the output price.

Table 1: Focus group participants

	No-Till				Mechanical			Hydro-ponic
Participant Characteristics	Grower A	Grower B	Grower C	Grower D	Grower E	Grower F	Grower G	Grower H
Time farming (yrs.)	8	8	14	8	11	21	17	5
Time owning/managing (yrs.)	5	6	9	8	9	9	12	2
Time growing salad mix (yrs.)	7	6	5	8	7	18	12	2
Land in production (acres)	3	1	3	1	6	13	4	1400 sq. ft.
Primary crops grown	Tomatoes Peppers Squash Greens	Greens Radish Turnips Carrots	Produce (diverse) Flowers Beef Seeds	Produce (diverse)	Produce (diverse) Meat Flowers	Salad mix Carrots Potatoes Onions Squash	Produce (diverse)	Salad mix Herbs Micro-greens
Volume salad mix produced in 2020 (lbs.)	2000	3560	1898	1200	700	2500	N/A	1088

Market Data

The pertinent market data to evaluate market feasibility include information on weekly volume, wholesale prices, internal store organization, willingness to pay, and previous experience working with local vendors. Using Google search engine results for grocery stores within the seven counties of Southeast Michigan (Jackson, Lenawee, Livingston, Monroe, Oakland, Washtenaw, Wayne) and the expertise of Michigan State University Product Center Innovation Counselors, a list of 24 independent or cooperative grocery stores was assembled. Independent stores, rather than large grocery chain stores, were chosen for this study because these types of retailers are more agreeable to local food procurement, as they see themselves embedded in the community (Guptill and Wilkins 2002).

Each store was contacted at least three times by phone or by email, and of the 24 identified stores, 12 agreed to the interview. The produce buyer, produce manager, or store manager (as a last resort) were principal for conducting the interview as these individuals have the most contact with pricing and ordering details for the store. The interview items included basic store specifications, current salad mix purchasing (brand, type, price), a willingness to pay scenario, and qualitative questions on local salad mix procurement. Two additional questions on purchasing changes due to the COVID-19 pandemic were also asked. The interviews were conducted in September of 2020 and each lasted between 15-30 minutes, depending on the level of detail the interviewee was willing to provide. The interview questions are listed in Appendix A.

Willingness to Pay

Research on Willingness to Pay (WTP) typically recommends the use of a detailed description of the good being offered (Portney 1994). The "local salad mix" product (see Appendix A) described for this research comprised of a 5 oz. clamshell of pre-washed salad mix, similar to the few local or regional salad mix brands (Revolution Farms and Bright Farms) currently sold in the local grocery stores. The salad mix was described as conventional (not certified organic) so that a base price could be determined. Interviewees were later asked how much more they would be willing to pay if the product was certified organic and what characteristics stood out to them as necessary for the product to perform competitively in their store.

The WTP scenario used an open-ended response format rather than providing dichotomous options. Since there are relatively small differences in estimates when comparing open-ended and dichotomous responses (Loomis 1990), open-ended responses were used to reflect the interviewees specific knowledge of wholesale salad mix pricing. One limitation of this WTP scenario was its failure to address hypothetical bias. Hypothetical bias is common in WTP research, especially when providing answers orally to the researcher, and oral responses tend to overstate their true valuation (Harrison and Rutström 2008). Follow-up questions with certainty responses have demonstrated effectiveness in removing hypothetical bias (Blumenschein et al. 2008), though certainty responses were not used in this study. So while it can be assumed these WTP responses could include some bias, it can also be argued that consumer perceptions differ from wholesale buyer perceptions and that wholesale buyers, due to the nature of their job, have a more straightforward understanding of the typical price-range for the items they procure regularly. Indeed, the wholesale prices and the WTP prices provided by the produce buyers were similar, potentially indicating minimal bias.

Organizing the Data

Raw data were arranged on an Excel spreadsheet by grocer (y-axis) and question (x-axis). Cross-tabulations were then conducted to analyze potential patterns or associations between data types, such as between the number of stores and previous experience working with local producers. Qualitative answers, such as those describing the challenges and benefits of working with local producers or the essential qualities in the WTP scenario, were assigned a theme, such as pricing, communication, quality, etc. Comments by theme were tabulated, and some key comments were extracted and shared in the findings (see Chapter 4).

Two pricing figures required further calculation: the wholesale prices paid for current salad mix brands and the price per pound figures for the WTP scenario. Both pricing figures were calculated by dividing the given case price by the number of units and then by package size (ounce). This price per ounce was then multiplied by 16 to produce a price per pound unit of measurement. Both the price per pound figure for current salad mix and the WTP price are important in the analysis in the next chapter.

CHAPTER 4
RESULTS AND DISCUSSION

The results are presented below and organized into three parts: production analysis, break-even analysis, and market analysis. The production analysis describes the production details for field mechanical, field no-till, hoop house, and hydroponic methods including their respective enterprise budgets. The break-even analysis establishes the output price for each production method, including key variations based on the recommended “scaling up” practices. The market analysis reviews the factors that could influence local supplier feasibility including distribution systems, wholesale prices, order volumes, certifications, willingness to pay prices, and the effects of COVID-19.

Production Analysis

Field Production: Mechanical and No-Till

In Southeast Michigan, salad mix can be seeded outside starting in April and harvested from May through November. However, the type of plants must change throughout the season to accommodate variations in temperature and humidity. For example, in the early spring and late fall, cold hardy brassica varieties such as kale (*Brassica napus*), mizuna (*Brassica rapa var. japonica*), mustard (*Brassica juncea*), and choi (*Brassica rapa var. chinensis*) can withstand light freezes and thus perform well during the cooler and wetter seasons. In the height of the summer, heat-tolerant varieties of lettuce (*Lactuca sativa*) are preferred. So long as buyers are lenient towards changes in seasonal variety, “salad mix” generally can be produced for as many as 24 weeks out of the year. The focus group chose to perform the enterprise budget on 22 weeks of annual production to account for a few weeks of accidental poor germination or weather-induced crop loss.

Both the mechanical and no-till focus groups chose to create an enterprise budget for 200-ft. beds planted one weekly for 22 weeks. This was the largest area they were willing to plant in conjunction with their diversified farm plan and still operate within the small farm scale. According to the farmers, diversification both in crops and markets is an important risk-management strategy for small farms who are often ineligible USDA crop insurance programs.

In a 200-ft. bed of salad mix, the no-till group estimated a typical harvest of 80-100 lbs. and the mechanical group estimated 50-200 lbs. Harvest volumes depend on the density of the planting which in turn depends on tractor implements and tractor wheel width. The no-till group chose to budget nine rows per bed, while the mechanical group chose to budget six. An average harvest of 100 lbs. per 200 bed feet was used for both enterprise budgets.

Bed Preparation and Seeding. In the no-till system, beds are tarped at least 3 weeks before planting. Tarping with black plastic increases soil nitrate composition, reduces weed seed viability, and increases soil moisture and temperature (Rylander et al. 2020). After three weeks, the tarp is pulled back, and the bed is broad-forked (to promote deep aeration), clawed (to promote surface-level aeration) and raked (to create a uniform seedbed to support uniform germination). In the mechanical system, an initial tillage is performed with either a tiller, disc, or plow followed by a final tillage and/or bed shaping.

Compost application varies based on soil type, previous land use, and crop types. For this budget, the no-till group chose to apply compost at a rate of 2 cubic yards per 200-ft. bed while the mechanical group chose 1 cubic yard per 200-ft. bed. Compost prices in Southeast Michigan vary between $20-$30 per cu yd. with delivery. For some farmers with fertile soil, a lesser application of compost may be sufficient. However, the clay soils of Southeast Michigan's urban-adjacent and urban farms require a larger compost application for guaranteed seed germination and plant health.

Farmers from both focus groups utilize three different salad mix seeding and planting techniques on their farms: transplanted Salanova lettuce heads (*Lactuca sativa*), direct-seeding, and broadcast-seeding. Both groups decided to perform the enterprise budget on the direct-seeded technique, as this is the most scalable, most utilized, and least dependent upon infrastructure (e.g. greenhouse for growing transplants) of the three.

In the no-till system, the preferred tool for seeding is the single-row Jang seeder – a precision seeder that is pushed by hand through the bed. The device works by cutting a furrow in the ground and using discs to deposit seeds from a hopper at a controlled rate. A roller then passes over the furrow covering the seed and ensuring good seed-soil contact. In the mechanical system, a similar device is attached to a tractor which can seed up to 12 rows at one time. In the no-till system, nine rows can fit comfortably in a 30-in. bed, while the tractor mounted varieties range from three to twelve rows per bed.

For lettuce-type seeds, seeding rates of 60 seeds per row foot is recommended while brassica-type varieties perform best at 15 seeds per row foot[9]. Average seed prices per planting vary greatly between lettuce and brassica plantings (e.g. $26.85 and $5.42 per planting respectively). In addition, seed prices are more than double when purchased by the ounce rather than by the pound or five-pound quantities. An average planting of nine rows per bed at one-

[9] Seeding rates calculated using Johnny's Seed Quantity Calculator: https://www.johnnyseeds.com/seed-quantity-calculator/?source=google_johnny_seeds&gclid=CjwKCAiAtej9BRAvEiwA0UAWXgbRzNSdHVklByWgAGMA1iYtuwB0hau4lvMg6JqJYA_xryrOb3v4VBoC26MQAvD_BwE and cross referenced using a seeding guide published by University of Maine Extension https://ucanr.edu/sites/cetrinityucdavisedu/files/258734.pdf.

pound price rate averages $13.99 per planting, while plantings at six rows per bed average $9.33 per planting (see Appendix B).

Growth Stage: Cultivation, Pest Control, Irrigation. For the no-till method, tarping and heavy compost application reduces weed seed germination, though if required, a tine weeder can be used when weeds are in the "white thread" stage. Without the use of tarps or heavy compost, the mechanical group required more labor on weed removal per planting. A combination of hand weeding (6 person hours per 200 ft. bed) and the use of a tractor-mounted implement (20 minutes per 200 ft. bed) are required per planting.

Flea beetles and cabbage loopers are the two most common pests for salad mix varieties. A thin woven fabric (row cover) is used to create a physical barrier between the plants and these pests. The initial application of the row cover takes approximately 30 minutes and requires securing the edges using shallowly dug dirt clods. The row cover is removed a few times during each planting to inspect germination rates and weed growth. Each removal requires only a few minutes to re-apply. A single sheet can be used multiple times over a season. If there is a heavy infestation, pesticides pyrethrin (*Chrysanthemum cinerarifolium)* and Bt (*Bacillus thuringiensis)* can be applied. Price per application was calculated using spray rates and costs,[10] and takes approximately 30 minutes including mixing and loading the materials into the backpack sprayer[11].

---

[10] Source for spray costs: https://www.arbico-organics.com/product/pyganic-gardening-home-use-pyrethrins/pyrethrin-insecticide and https://www.arbico-organics.com/product/dipel-df-dry-flowable-insecticide/biorational-controls-garden-and-garden

[11] Source for backpack sprayer cost: https://www.uline.com/Product/Detail/H-7986/Grounds-Maintenance/Backpack-Pressure-Sprayer-4-Gallon?pricode=WB2335&gadtype=pla&id=H-7986&gclid=CjwKCAiA57D_BRAZEiwAZcfCxZvgz4FwRAC38bUe_slip2FG8mxLAXRcIKY9iM0ypRqDIZ77OsokChoCrXsQAvD_BwE&gclsrc=aw.ds

The irrigation methods used on small farms are either drip irrigation or overhead sprinklers. In a planting with tight row-spacing, overhead sprinklers are favored, while wider spaced rows are better suited for drip irrigation. Both systems require a header which pulls water from a source (well or pond) to the beds. The cost of the header[12] can vary greatly between farm layouts, but for the 22 successions in this budget, 88 ft. is required and is durable enough to withstand around 5 seasons. The sprinkler system takes approximately 45 minutes to install but the range of the spray can cover four to six beds at a time. The sprinkler line can be moved easily to new plantings and lasts about five years. When using drip irrigation, one tape per row is applied at time of seeding. As beds are harvested, drip tapes can be moved to new plantings. The tapes last approximately one year. Pricing data was collected for 8 mil tapes with 4-in. emitters[13]. The tapes take approximately 30 minutes to apply to a 200-ft. bed.

Harvest, Washing, and Packing. In very small farm systems, harvest is often conducted by hand using knives and is estimated to take four person-hours per 200 ft. bed. In a large-scale system, a machine with reciprocating blades cuts and pulls greens up a conveyor belt into bins. In a smaller-scaled system, a machine called the “Quick-Cut Greens Harvester,” a handheld device powered by an electric drill, is popular. According to the company’s website, the harvester can cut 175 lbs. per hour. With an expected yield of 100 lbs. from a 200-ft planting, the Quick-Cut Greens Harvester can harvest the succession in 34 minutes. Because advances in harvest technology are a known indicator for increased profitability, the break-even analysis is assessed with both hand harvest and mechanical harvest figures.

Washing includes a double or triple rinse, often with a bubbler to help remove excess dirt, and then spun dry in either a converted washing machine or an industrial salad mix spinner.

[12] Source for header prices: http://trickl-eez.com/wp-content/uploads/2020/11/Catalog-2021.pdf (page 21)
[13] Source for irrigation prices: http://trickl-eez.com/wp-content/uploads/2020/11/Catalog-2021.pdf (page 17)

It is estimated to take two person hours to process 100 lbs. Packing the same volume into clamshells is estimated to require three person hours. If labeling the packages, this could add an additional two hours. The product is then stored in a cooler before transport to market. All focus groups farmers utilize a CoolBot[14] attached to an air conditioning unit for efficient cooling of the walk-in cooler structure.

Post-Harvest, Maintenance, and Labor Costs. After harvest in the no-till system, crop debris is cleared by hand, and either a tarp is applied or the bed is raked out for the next planting. In the mechanical system, no crop clean-up is needed because the bed is "cleaned out" with the tillage required for the next succession.

Maintenance to equipment is variable per succession. The no-till focus group chose to calculate 20 minutes per succession for general repairs and the mechanical focus group chose around 45 minutes per succession. Maintenance includes repairs to tractors, implements, the wash-pack station, or the cooler. Labor costs are calculated at a $14/hr. wage (+ 10% for FICA taxes) = $15.4/hr. Managerial overhead is calculated at 20% of total work hours and accounts for time spent on employee related costs such as processing payroll, supervising, training, or scheduling.

Hoop House Production

A hoop house (sometimes referred to as a high tunnel) is a greenhouse-type structure, often made of galvanized steel pipes, a polyethylene covering, two end-walls and roll-up sides to manage temperature and moisture (Biernbaum 2006). The structure uses passive solar heat to extend the growing season both in the spring and the fall in northern climates. In Southeast Michigan, cold-hardy plants like the brassica varieties described above can be seeded starting in

[14] https://smallfarms.cornell.edu/2012/06/coolbot-enables-small-farmers-to-build-do-it-yourself-coolers/

late February and harvested until early December. The structure also protects against wind and rain.

Due to complications from COVID-19 restrictions in 2020, a focus group to create an enterprise budget for hoop house production could not be assembled. However, cooperative extension bulletins (Chase and Naeve 2012; Kaiser and Ernst 2012; Waldman et al. 2010) and grower guides (Biernbaum 2006; Nennich and Wold-Burkness 2012; Grubinger 2016) on hoop house production provide enough information to construct a projected budget. The production techniques in hoop houses are similar to the ones used in the no-till system, though sometimes a walk-behind rototiller is used rather than hand tools for bed preparation.

A Michigan-based study conducted by Waldman et al. (2010), collected start-up and production data on 12 novice Michigan hoop house farmers. Each farmer was provided a 30-ft. by 96-ft greenhouse and was asked to keep production records on construction costs, labor, cash flow, and inputs over a three-and-a-half-year period. The findings in this study, combined with the cost of production figures determined by the no-till focus group, formed the hoop house enterprise budget.

Harvest dates for mixed greens production in a hoop house in a northern climate is estimated at 32 weeks from May through early December (Waldman et al. 2010). Similar to the field production budgets, two weeks are omitted to account for poor germination or weather-related events. A 30-ft. by 96-ft. structure can hold eight 30-in. by 90-ft. beds which can be seeded two at a time (180 bed ft. per succession) and harvested in 4-week intervals. Consistent with harvest rates from the no-till budget, a harvest volume of 90 lbs. per succession is estimated. Irrigation can be performed using a sprinkler system[15] which requires one-time

[15] Hoop house sprinkler pricing data: https://www.farmersfriend.com/products/irrigation/overhead-irrigation/config/standard

installation. Costs for bed preparation, seeding, weed cultivation, pest management, and harvest were assumed from the no-till production estimates. *See Appendix C for the field mechanical, field no-till and hoop house enterprise budget.*

Hydroponics Production

The scale of production determined by the farmer for the hydroponic enterprise budget is 19-pound successions harvested every week of the year. The farm operates a weekly planting and harvest schedule at this rate and so it was the most feasible to estimate expenses based on this scale. Much of the farm's revenue is attained through value-added processing: assembling salad kits from the harvested products. The farm's current annual revenue is estimated at $150,000-200,000, though their greens production accounts for a small portion. Like the no-till and mechanical farmers, diversification (in this case through value-added processing) helps increase overall revenue and manage market risk.

The production room is built inside a vacant warehouse. The room is 1400 sq. ft. and includes the germination cabinet, nursery, and a nutrient film technique (NFT) gutter system. The farm practices strict bio-security measures and employees work in full protective gear: a change of footwear, hair and beard nets, and protective jumpsuits over clothing. The room is made of washable floors, ceilings, and walls, and is cooled with a large fan.

Successions of 2,304 plants are started weekly and reach maturity at around 27 days. There are three production stages: germination (two days), nursery (five days), and the final stage in gutters (around 20 days). The varieties include kale (*Brassica napus*), romaine lettuce (*Lactuca sativa*), mizuna (*Brassica rapa var. japonica*), mustard (*Brassica juncea*), and choi (*Brassica rapa var. chinensis*).

Germination and Nursery. Seeds are planted into 32 72-cell trays in a peatmoss/polymer mixture and put into a “germ cabinet” for two days. The germ cabinet has no lights but is warm (78°F) and moist to support optimal seed germination. Many small hydroponic operations build their own germ cabs, but this farm opted to purchase a $2,000 kit. The germ cabinet is heated by an electrical heating element. Seed cost calculations can be found in Appendix B.

After two days, the trays are moved from the germ cabinet to the nursery where the sprouted seeds mature under lights. The lights are kept on 16 hours per day and the plants are watered daily. The nursery is built using wire shelving.

Final Stage: NFT. After five days, the seedlings are transplanted from the trays to the gutters or channels where they stay until maturity. The plants are transplanted by hand into each gutter at 48 plants per gutter and 48 gutters per succession. Water and fertilizer are cycled continuously through the channels to provide necessary nutrients to the plant roots. Each gutter is equipped with a light, and a fan runs continuously to cool the room from the heat produced by the lights.

The water used for the final stage is held in a 35-gallon reservoir and is pumped through a manifold that distributes 0.5 liters continuously to each gutter. Fertilizer is added to the water and pH is maintained at between 6 - 5.5pH using pH adjusting chemicals. Twelve additional gallons of water are added to the reservoir daily to compensate for evaporation.

The lights used in this stage are rented at an annual cost of $2880 per year. Utility costs for the lights can be calculated using the kilowatt per hour provided by the light manufacturer, multiplied by the kilowatt hour cost for utilities in Detroit[16] and hours used per day.[17]

Harvest. At this scale of production, hand-harvest using knives is the most scale-appropriate harvest method. The applicable mid-scale equipment referenced by the grower is a Hamill Harvester, which can cut three gutters of greens at a time. The soilless growing environment combined with the strict bio-security ensures product cleanliness without washing, so a washing step is avoided. *See Appendix D for the hydroponics enterprise budget.*

Break-Even Analysis

A common tool to test production feasibility is the break-even calculation (Dillon 1993). Rather than simply compare cost of production figures, the break-even calculation uses data on variable costs, fixed costs, profitability margins, and yield to calculate the output price for a given crop in order to "break even." The output price for a break-even budget is calculated via the following equation:

$$P = (VC + FC + p)/Y$$

Price = (variable costs + fixed costs + profits) / yield

Break-even analyses are conducted for no-till, mechanical, and field harvested crops when hand harvested, harvested mechanically, produced without washing and packing, and produced with both the mechanical harvester and without washing and packing (see Table 2). These modifications were chosen based on previous research for small farm profitability and

[16] https://www.bls.gov/regions/midwest/news-release/averageenergyprices_detroit.htm#:~:text=Detroit%20area%20households%20paid%20an,cents%20paid%20in%20September%202019.
[17] https://www.canr.msu.edu/news/how_much_does_it_cost_to_run_my_plant_lights

scaling up (see Chapter 1). The output price declines most dramatically when the wash-pack step is removed from the production budget.

Table 2: Break even analysis for field no-till, field mechanical, and hoop house production

	Variable Costs	Fixed Costs	Profit (30% of costs)	Yield (#)	Output Price ($/#)
No-Till					
Hand Harvest	12,764.04	683.01	4,034.11	2200	7.95
With Harvest Tech	11,606.57	848.01	3,736.37	2200	7.36
Without Wash-Pack	4,963.06	609.43	1,671.75	2200	3.29
Without Wash-Pack + Harvest Tech	3,800.97	774.43	1,373.62	2200	2.70
Mechanical					
Hand Harvest	14,655.17	2,226.31	5,064.44	2200	9.98
With Harvest Tech	13,260.67	2,391.31	4,695.59	2200	9.25
Without Wash-Pack	6,934.27	2,152.73	2,726.10	2200	5.37
Without Wash-Pack + Harvest Tech	5,501.15	2,317.73	2,345.67	2200	4.62
Hoop House					
Hand Harvest	15,403.94	1,567.28	5,091.37	2700	8.17
With Harvest Tech	13,819.28	1,732.28	4,665.47	2700	7.49
Without Wash-Pack	6,023.74	1,493.71	2,255.23	2700	3.62
Without Wash-Pack + Harvest Tech	4,439.08	1,658.71	1,829.34	2700	2.94

A separate break-even analysis was conducted for hydroponic production (see Table 3). At this scale, the hydroponic production is much less feasible than the field or hoop house production methods. The major costs in this budget include the growing medium, the lights, the cost to run the cooling fans, and the clamshells. In terms of labor, cleaning out the NFT gutters is the largest expense (see Appendix D).

To test improvements to the feasibility of this enterprise budget, a break-even analysis for a budget without the packing step, as well as a budget with doubled production, are analyzed. Without the packing step, the output price decreases 13.8%. If the production doubles using the same number of lights and no additional cooling fans, the break-even output price decreases 19.2%. If both the packing step is removed and production is doubled, the output price decreases 26.8%.

Table 3: Break-even analysis for hydroponic production

	Variable Costs	Fixed Costs	Profit (30% of costs)	Yield (#)	Output Price ($/#)
Base	20,351.85	695.85	6314.31	988	27.69
Without Packing	17,442.22	695.85	5441.42	988	23.87
Double Production	32,712.46	1,309.70	10,206.65	1,976	22.38
Without Packing and Double Production	29,485.71	1,309.70	9,238.62	1,976	20.26

Market Analysis

Distribution

Five of the twelve grocers had a single store location, while seven grocers had multiple locations in Southeast Michigan. Of those with multiple locations, the number of stores ranged from two to sixteen (see Table 4). In theory, multiple stores add additional logistics (either for the distributor or the grocer) or the volume needed to sufficiently supply the various store locations increases. Both factors could influence local producer feasibility for selling to a particular buyer. However, both single store companies and multi-store companies had purchased from local vendors in the past, therefore the number of store locations did not have an effect on the willingness to purchase from local vendors.

The seven grocers with multiple locations have a central purchasing department that determines the types of products the company will carry. Each individual store manager determines inventory and makes weekly orders. In all cases, the company requires distributors to deliver to each store individually. In addition, one grocer also manages an internal distribution system, and another manages internal distribution for local vendors only. Though the grocer with the local internal distribution option has the highest number of store locations, the company has a marketing focus on local food, and stated that their typical customers value local more so than organic. Systems for local vendors to supply the grocer more easily, such as an internal distribution system, indicate a commitment to these types of suppliers.

Table 4: Grocery store specifications

Store Number	Ownership Model	No. of Locations	Distribution Method (if multiple stores)	Produce Buyer
1	Cooperative	1	N/A	No
2	Independent	1	N/A	No
3	Independent	16	By distributor, internal for local vendors only	No
4	Independent	5	By distributor	No
5	Independent	5	By distributor	No
6	Independent	1	N/A	No
7	Independent	2	By distributor + internal	Yes
8	Independent	3	By distributor	Yes
9	Independent	1	N/A	No
10	Independent	4	By distributor	Yes
11	Independent	2	By distributor	Yes
12	Cooperative	1	N/A	No

Order Volumes and Wholesale Prices

Weekly salad mix orders ranged from 2 to 500 cases (typical case sizes are six units) with a median weekly order of 45 cases per week (see Table 5). One grocer mentioned that he prefers case sizes of six rather than eight or twelve for perishable or premium products. With larger case sizes, he is forced to purchase more inventory at a time, which increases his costs if they do not sell.

The wholesale price for the various salad mix brands and package sizes was calculated by dividing the case price by the units per case. Package sizes are heterogenous for salad mix brands and a standard unit of measurement was necessary to compare brands and package sizes to each other. Therefore, the packaged price was reduced to price per ounce unit and then multiplied by

16 for a comparable price per pound figure. These prices are estimates provided by the grocers and do not necessarily reflect true wholesale prices (see Table 6).

Almost all the grocers noted increased consumer demand for salad greens in the month or two following New Year's Eve (see Table 5). Additionally, two grocers mentioned that salad mix sales decreased in summer. One reasoned that because most of its stores are in a college town, the loss of students affects overall sales. The other stated that their customers often shop at the farmers market over the summer and so produce sales decrease. The increasing demand in January and February could be most easily captured by the hydroponics producers, who can reliably grow salad mix in the winter months.

Of the salad mix varieties carried by the grocers, Organic Girl and Revolution Farms are sold at the highest wholesale price per pound, which indicates the upper thresholds for salad mix on the wholesale market. It is important to note that the wholesale price per package never exceeded $4, no matter the package size. One grocer mentioned that customers are willing to spend up to $5.99 for a salad mix clamshell, but $6.99 is too much. Two grocers mentioned that their customers would be willing to spend $4.99 for a 5-oz. package, but not more. This indicates that one way a local vendor can increase the income per pound is to reduce the package size.

Table 5: Salad mix purchasing specifications at grocery stores

	Salad Mix Brands	Avg. Order Per Week (by case)	Volume Fluctuation	Price Fluctuation	Vendor Food Safety Certification	Vendor Product Liability Insurance
1	Bright Farms Earthbound Revolution Farms	26	Dec-Mar high	Rise during COVID-19	If local vendor: GAP audit or agriculture license	None
2	Earthbound Organic Girl	35-55	Summertime low	Very stable	None	None
3	Earthbound Farms Fresh Express Revolution Farms	90**	Jan-Feb high June-Aug low	Very stable	None	None
4	Dole Fresh Express	40-50	First half of month high	Increase in winter	None	None
5	Dole Organic Girl Revolution Farms	500	Jan high	Very stable*	None	None
6	Dole Earthbound Farms Fresh Express Taylor Farms	30-40	Jan-Feb high	Very stable	None	None
7	Dole Earthbound Farms Fresh Express Organic Girl Taylor Farms	210	Jan-Feb high	Very stable*	None	None
8	Earthbound Farms Fresh Express Organic Girl	130-200	Jan-Feb high Apr-May high	Very stable*	None	None
9	Organic Girl		May-Aug high	Very stable	None	None
10	Earthbound Fresh Express	20-40	Jan-Feb high		Unsure	Unsure
11	Fresh Express	60-120	When on sale	Very stable	Yes – posted at terminal offices	None
12	Revolution Farms	2-3	Unsure	Unsure	None	None

(*) = under contract
(**) = order volume for just one of the 16 stores in the company

Table 6: Salad mix wholesale pricing (estimates)

	Package Size (oz.)	**Wholesale Price/Pkg**	**Price Per Oz.**	**Price Per Lb.**
Bright Farms	6	2.67	0.45	7.12
Dole (clamshell)	10*	2.25	0.23	3.6
Earthbound Organic	5	2.38	0.48	7.62
	6*	2.18	0.36	5.81
	10	3.33	0.33	5.33
	16	4.00	0.25	4.00
Fresh Express	5.5*	2.24	0.41	6.50
	6	2.11	0.35	5.63
	9*	2.44	0.27	4.34
Organic Girl	5*	2.73	0.55	**8.74**
	6*	3.50	0.58	**9.33**
Revolution Farms	4*	2.82	0.70	**11.26**
Taylor Farms	6	2.44	0.27	5.63

(*) – indicates an average

Certifications and Insurance

Most of the interviewees stated that their store does not require any type of food safety certification from local vendors (See Table 5). A few mentioned that their distributors handle those types of things, and one mentioned that there were food safety signs posted at the wholesale terminal offices. One store stated that they require a USDA Good Agriculture Practice audit or an agriculture license from local vendors. Based on these responses, a food safety certification does not seem to be a common requirement for a local vendor to sell direct to retail grocery stores. However, if using a distributor, the distributor may require a food safety certification.

Similarly, product liability insurance is not required by any of the grocers (see Table 5). One grocer did mention that "it would be a nice thing for them to have," but none stated that this was a requirement. However, distributors may require product liability insurance, so if working with a distributor, this requirement might change.

Ten of the twelve grocers acknowledged that organic certification is an important quality for their customer base. Nine grocers said they would pay a premium of $0.50-$2 per package for organic salad mix. Cost for organic certification varies widely for producers, but a USDA Organic Cost-Share Program can cover up to 75% of inspection fees. Compliance requires a three-year transition period, education, an organic system plan and extensive record-keeping (Coleman 2012), all of which can be barriers to small farms interested in certification. For further discussion on recommendations for organic certification, see Chapter 5.

Willingness to Pay

Interviewees were willing to pay between $1.80 to $3.90 per package ($5.76 to $12.48 per pound) for a local salad mix product. Nine retailers were willing to pay an organic premium of $0.50-$2.00 per package (mean $1.25 per package), which if applied to the conventional figures, increases the WTP for an organic 5 oz. package to between $3.05 and $5.15 per package and between $9.76 and $16.48 per pound. The average per pound WTP figure for conventional and organic salad mix were $8.84 and $11.50 respectively. These estimates reflect the previously calculated upper limits of salad mix products currently carried in the grocery retail market (see Table 7).

Only one grocer was willing to pay more for hydroponic-produced salad mix, but of the brands carried in the twelve stores, the hydroponic brand had the highest price per pound. Organic was by far a more distinguishing factor in premium prices, and a few grocers stated that the customer knows and expects organic to carry a premium.

Table 7: WTP and organic

	WTP per oz. ($)	WTP per 5 oz. package ($)	WTP per lbs. ($)	Is Organic Important for customers?	Willing to Pay Premium for:	WTP with Avg. Organic Premium per pkg. ($)	WTP with Organic Premium per lb. ($)
1	0.60	3.00	9.60	Yes	OG, RG	4.25	13.60
2	0.56	2.80	8.96	Yes	OG	4.05	12.96
3	--	--	--	No	OG	--	--
4	0.40	2.00	6.40	No	none	2.00*	6.40*
5	0.36	1.80	5.76	Yes	OG	3.05	9.76
6	0.62	3.10	9.92	Yes	OG	4.35	13.92
7				Yes	OG		
8	0.50	2.50	8.00	Yes	OG	3.75	12.00
9	0.78	3.90	12.48	Yes	OG, NT	5.15	16.48
10	--	--	--	Yes	OG, HP, HH, NT, OT	--	--
11	0.45	2.25	7.20	Yes	none	2.25*	7.20*
12	0.70	3.50	11.20	Yes	none	3.50*	11.20*
AVG	**0.55**	**2.76**	**8.84**			**3.59**	**11.50**

OG = organic certified; HP = hydroponic grown; HH = hoop house grown; NT = no-till grown; OT = grown outside; RG = regenerative grown
* = organic premium not applied
-- = declined to answer

Desired Qualities and COVID-19

When asked what qualities of the WTP description are necessary for the buyer to consider carrying a local salad mix product, seven buyers mentioned attractive labeling that includes the words “local,” and five mentioned cleanliness and quality of the product. When asked to provide other comments about attributes they look for as a buyer of salad mix, clean or pre-washed, competitive price, and supplier reliability were frequently mentioned.

Eleven of interviewees had experience purchasing from local produce vendors, though not necessarily salad mix vendors. The challenges cited in working with local vendors include communication (n=4), availability, both in volume and seasonality (n=4), high price (n=2), and poor quality (n=1). Four buyers mentioned that they spent too much time on the phone with local vendors compared to their distributors. They would like a more consistent flow of product, and more information on delivery times and product availability. Solutions for addressing challenges in communication and availability are discussed in more detail in Chapter 5.

The benefits of working with local farms were stated to include superior quality (n=5) and a sense of community (n=3). Two grocers mentioned direct-store-delivery as a plus to working with a local vendor, and one mentioned that at times the local product is cheaper than the distributor price. Two grocers mentioned that the customer ultimately decides if the store will continue to carry the product, based on consistent sales.

The 2020, the COVID-19 pandemic affected the grocers' procurement systems in the following ways: sales increased (n=8), and suppliers (especially in the organic sector and the produce department) were unable to fully meet the increased demand (n=5). Three grocers stated that they did reach out to local vendors in order to better meet the demand. However, when asked specifically about local vendors as a risk aversion strategy for supply chain disruptions, only one grocer stated that they work with a variety of distributors and local vendors for this reason. The rest do not view local vendors as a strategy for avoiding supply chain disruptions. This indicates that grocers view local vendors as a stop-gap measure in times of crisis, rather than as a risk-management strategy.

CHAPTER 5
RECOMMENDATIONS AND CONCLUSIONS

This chapter provides four recommendations based on the research findings and informed by previous research on "scaling up" small farms. The recommendations include technology innovation, central packing and distribution, organic certification, and increased buyer-seller collaboration. These are followed by the conclusions, which include suggestions for future research.

Recommendations

Technology Innovation

Field Production. When asked about the usability of mid-level harvest equipment, most farmer participants were hesitant to adapt to mid-level technology. The main critiques included loss of quality control, ergonomics, and additional labor required for equipment cleaning and maintenance. Hand harvest allows the harvester to avoid weeds or diseased plants while harvesting, thereby performing a quality control step. For mid-level harvest equipment to be effective, the bed planting must be weed free with quality crop foliage. The handheld mechanical harvester critiqued by the farmers requires bending over and walking slowly down the bed, which is uncomfortable. Lastly, the fabric brushes and fabric basket on this tool cannot be sanitized, and thus do not meet the USDA's Good Agricultural Practices (GAP) food safety requirements. While only one of the grocers mentioned needing GAP certification from local farms, a distributor may require the certification. Indeed, the farmers reported frustration with this drawback of the machine.

Assuming the mid-level harvest equipment is used, the break-even output price reduces slightly. In the no-till system, the output price reduces from $7.95 to $7.36 (7.42% change). In the mechanical system, the output price falls from $9.98 to $9.25 (7.31% change), and in the hoop house budget from $8.17 to $7.49 (8.32% change). The hoop house production method is most responsive to improved technology which is likely due to having more successions per year. If the planting volume per succession were doubled (two 200 ft. beds per succession), the output price drops further to $6.89 (13.3% change), $8.34 (16.4% change), and $7.08 (13.3% change) for no-till, mechanical and hoop house production respectively. At double the volume, the mechanical production method is most responsive. This is likely due to greater labor savings from the mechanical technology (tractors and implements), as well as the fact that an additional hoop house is included in the doubled hoop house budget (see Table 8).

Table 8: Output price with increased tech and doubled production

	Variable Costs	Fixed Costs	Profit (30% of costs)	Yield (#)	Output Price ($/#)
No-Till					
Hand Harvest	12,764.04	683.01	4,034.11	2200	7.95
With Harvest Tech	11,606.57	848.01	3,736.37	2200	7.36
Double Production w/ Tech	22,472.08	848.01	6,996.03	4400	**6.89**
Mechanical					
Hand Harvest	14,655.17	2,226.31	5,064.44	2200	9.98
With Harvest Tech	13,260.67	2,391.31	4,695.59	2200	9.25
Double Production w/ Tech	25,846.69	2,391.31	8,471.40	4400	**8.34**
Hoop House					
Hand Harvest	15,403.94	1,567.28	5,091.37	2700	8.17
With Harvest Tech	13,819.28	1,732.28	4,665.47	2700	7.49
Double Production w/ Tech	26,915.60	2,508.27	8,827.16	5400	**7.08**

Hydroponic. When asked about mid-level harvest equipment, the hydroponic farmer confirmed that such equipment is not feasible at this scale, and thus the break-even analysis does not include figures of improved harvest technology. At a larger scale of production, machines similar to the ones mentioned in the field production analysis can be augmented and used in a hydroponic system. Hydroponic NFT production by nature is relatively tech-heavy, and advancements in other components could improve overall feasibility. Lighting, for example is a major expense in the indoor NFT model used in this research. Some NFT hydroponic systems are constructed in greenhouses and this eliminates the need for light structures altogether, though a greenhouse would present additional costs to the enterprise budget. Research on changes to output price in different hydroponic models is recommended for further research. In this NFT system, if the production doubled using the same number of lights (i.e. increasing the plants per gutter or positioning two gutters per light), the output price would decrease 19.2% (see Table 3). Myriad options for technological advances exist, and while multiple analyses are outside the scope of this study, further research on technological advancements and their potential impact on cost of production could help hydroponic growers reduce costs and improve market feasibility.

Central Packing and Distribution

The material and labor costs involved in washing and packing salad mix are significant in all four production enterprises. The output price decreases 58.6%, 46.2%, 55.7%, and 13.8% for no-till, mechanical, hoop house, and hydroponic production respectively when washing and packing is removed from the farm-gate budget (see Table 2 and Table 3). However, if a food hub or other centralized processing facility were to perform this function, the final output price to the grocery retailer would need to reflect the additional expenses incurred by the processor.

While a separate enterprise budget for centralized processing and packing is outside the scope of this study, the food hub financial report by Wallace Center at Winrock International (2019) provides a benchmark for typical food hub expenses which can be applied to this situation. Of the 50 food hubs surveyed, the cost of goods sold (COGS) was between 73.5% and 76.3%. This likely does not account for the cost of washing, as most food hubs do not wash product. Some food hubs do, though, engage in packing activities. Since the focus group farmers stated they spent two hours washing and three hours of packing, an estimate of 50% COGS rather than the aforementioned range of 73.5% to 76.3%, could conservatively account for the additional washing step. When the output price after centralized washing and packing is calculated using this COGS estimate, both no-till and hoop house methods fall within the $8.84 per pound threshold that grocery retailers claim they are willing to pay (see Table 9). While mechanical production does not meet this threshold, it does fall within the most premium wholesale figures for current salad mix procurement ($11.26 per pound).

One of the benefits of a food hub for central processing is the availability of grant and other external funding for these types of enterprises. Half the hubs surveyed in Bielaczyc et al. (2020) reported non-sales revenue, with the majority of that funding coming from grants. Grants and other fundraising opportunities, especially in the start-up phase of the hub, can offset equipment and marketing expenses and allow the hub to purchase greens at a price more favorable for small farmers.

Table 9: Output price after centralized processing

	Farmgate price without packing ($/lbs.)	**Doubled for processing costs ($/lbs.)**
No-Till	3.29	6.58
Mechanical	5.37	10.74
Hoop House	3.62	7.24
Hydroponic	23.87	47.74

Organic Certification

Both the wholesale buyers' and the consumer's acceptance for the premium price of organic makes the additional cost of certification for producers a necessary component to explore. Certification costs for producers vary because producers are often billed hourly. While the USDA maintains the National Organic Program, third-party inspectors verify the farms and costs differ between certification companies. CCOF Certification Services[18] estimates the cost of

[18] https://www.ccof.org/certification/how/organic-certification-fees

certification for a small farm to be around $750 the first year and between $375 and $575 in the years following. Oregon Tilth[19] charges $625 in the first year, with a billable rate of $65 per hour for the inspection. The Ohio Ecological Food and Farming Association[20] charges producers $1,150 annually. However, in all cases, the National Organic Cost Share Program refunds up to 75% or a maximum of $500 per producer for the cost of certification (United States Department of Agriculture 2021).

In addition to the cost of certification, the cost of record-keeping, education, and any production changes to the operation also factor into the producer's expenses for certification. A three-year transition period is required for any land previous managed conventionally, and this can result in three years of additional expenses, as well as loss of volume, which are not recouped by an organic premium on sales. Because these additional costs for certification vary greatly between operations, they cannot be reasonably factored into a modified break-even analysis. However, the base enterprise budgets developed by the farmers would meet organic certification (use of compost as fertilizer and absence of synthetic sprays for pest and weed control) and so no other production components would need to be adjusted to comply with the organic standards.

If the cost of certification were estimated at $500 annually (which factors in the refundable cost share program), the break-even output price increases 3.65%, 2.90%, and 2.94% for no-till, mechanical, and hoop house production respectively (see Table 10). The average organic premium ($1.25 per 5 oz. package) increases the average price per pound from $8.84 to $11.50 (30.1% change). All three production methods with organic certification fall within the

[19] https://tilth.org/certification/apply/understanding-fees/
[20] https://certification.oeffa.org/fees-and-deadlines/

acceptable WTP range for organic. For the mechanical method, the organic premium brings that product from an infeasible to a feasible price point.

Table 10: Change in break-even analysis with organic certification

	Variable Costs	**Fixed Costs**	**Profit (30% of costs)**	**Yield (#)**	**Output Price ($/#)**	**% Change**
No-Till	12,764.04	683.01	4,034.11	2200	7.95	3.65%
No-Till with Organic Certification	13,268.66	683.01	4,185.50	2200	8.24	
Mechanical	14,655.17	2,226.31	5,064.44	2200	9.98	2.90%
Mechanical with Organic Certification	15,155.17	2,226.31	5,214.44	2200	10.27	
Hoop House	15,403.94	1,567.28	5,091.37	2700	8.17	2.94%
Hoop House with Organic Certification	15,903.94	1,567.28	5,241.37	2700	8.41	

Until 2017, organic certification was not permissible for hydroponic production. Organic production standards were developed with the purpose of building soil organic matter as opposed to using synthetic chemicals and fertilizers (Alexander 2000). As such, a soil-less production style did not fit into the standard certification criteria. The USDA National Organic Program's decision to include hydroponic production in organic certification standards will pave the way for organic-approved hydroponic inputs on the market. However, research shows that organic fertilizers yield a slower growth rate in crops like lettuce than inorganic fertilizers (Nelson 2013). In addition, on-going court-cases challenging this USDA decision makes investment risky (Flynn 2021). The conventional hydroponic salad mix product currently sold in the local grocery stores already captures a premium price without the organic label, and therefore, a break-even modification for organic hydroponic is not performed.

Increased Collaboration Between Farmers and Grocers

Dunning (2016) and Guptill and Wilkins (2002) show that direct store delivery (DSD) is effective in improving grocer willingness to work with local vendors and for building relationships between grocers and local producers. The grocers in this study remarked on the added time local vendors require as compared to larger distributors, and so by transferring the cost of stocking shelves and managing inventory from the grocer to the producer, the local vendor becomes a more appealing partner to the grocer. The producer costs associated with a DSD model include fuel, labor, trucks, and insurance for managing deliveries as well as the labor to stock each store. Because average mileage will vary greatly between the producers and the stores, the specific costs for the producer to take on these functions cannot be calculated. However, the Michigan State University Product Center advises their clients to factor in a 22-30% mark-up for delivery costs (whether this is task is performed internally or outsourced) and this provides a rough estimate of the delivery costs. Therefore, we can test the feasibility of DSD for the producers by adding a distributor mark-up of 30% to each output price (see Table 11).

The estimate for no-till production with centralized packing and distribution ($8.55 per pound) falls within the WTP threshold ($8.84 per pound) and the figure for doubled no-till production with harvest technology is very close at $8.96 per pound. When organic premiums are factored, no-till and hoop house production meet the organic WTP price ($11.50 per pound).

Table 11: Distribution mark-up

	Output Price ($/#)	+ Distribution Mark-up (30%)
No-Till		
Hand Harvest	7.95	10.33
With Harvest Tech	7.36	9.57
Double Production w/ Tech	6.89	**8.96**
Central Packing Output Price	6.58	**8.55**
With Organic Certification	8.24	**10.27**
Mechanical		
Hand Harvest	9.98	12.97
With Harvest Tech	9.25	12.02
Double Production w/ Tech	8.34	10.85
Central Packing Output Price	10.74	13.96
With Organic Certification	10.27	13.35
Hoop House		
Hand Harvest	8.17	10.62
With Harvest Tech	7.49	9.73
Double Production w/ Tech	7.08	9.21
Central Packing Output Price	7.24	9.41
With Organic Certification	8.41	**10.94**
Hydroponic		
Hand Harvest	27.69	36.00
Double Production	22.38	29.10
Central Packing Output Price	47.74	62.06

Conclusions

Local food is a growing trend in the U.S. and while retail grocers are increasingly interested in sourcing local foods for their stores, small farmers face significant challenges in serving this market type. Increased supply chain specialization and consolidation has made it difficult for small farmers to compete on price or efficiencies accomplished by mainstream supply chains. As a result, small farmers rely on direct-to-consumer markets such as farmers markets, farm stands, or CSA programs, but these require significant marketing costs and are potentially becoming saturated. In response, researchers and practitioners have explored the idea of “scaling up” small farmers into intermediated markets such as restaurants, retail grocers, and institutions. Such strategies have included “piggy-backing” on traditional supply chain infrastructure, building new value-chains, and horizontal collaboration among producers. Data show that farmers with a hybrid marketing platform that includes intermediary sales are more likely to be profitable than those selling in direct-markets only. However, farmers' current lack of willingness to participate in intermediary markets presents a significant challenge to scaling them up into markets like retail grocery. Little research has demonstrated the feasibility of intermediary sales for small farmers using cost of production figures.

Using salad mix as a test crop and Southeast Michigan as a sample region, this research used small farm production figures to perform a feasibility study on salad mix sales to local independent and cooperative retail grocers. Four types of production enterprise budgets – field mechanical, field no-till, hoop house, and hydroponic – were developed to incorporate strategies previously identified in the literature for scaling up small farm enterprises. Those strategies included technology innovation, central packing and distribution, organic certification, and vertical collaboration between buyers and sellers.

Data show that of the four production methods studied at the base level (hand-harvested), no-till had the lowest cost of production, due in part to the low labor costs for hand weeding. Small-scale hydroponic production, on the other hand, had the highest cost of production and was found to be largely infeasible at a small scale of production. When the enterprise budgets were adjusted by scaling up strategies, centralized packing had by far the biggest impact on lowering the break-even output price for the producer. Even when estimated costs for central processing were factored, the output price to the retailer for both no-till and hoop house production remained within the price range retailers are willing to pay, and mechanical production stayed within the current range of wholesale prices. This study stops short of developing an enterprise budget for central processing to test the true feasibility of this option, but this is recommended for future research.

The findings suggest that advancements in harvest technology reduce the output price most when the technology is used more often, either with a greater number of successions (as in the hoop house production method) or doubled production. In addition, the impact of organic certification on output price is slight enough compared to the price premium that this differentiation strategy is recommended for mechanical, no-till, and hoop house production. The cost barriers for organic hydroponic production and the high price point for conventional hydroponic salad mix in the current market make organic hydroponic a less recommended option at smaller scales.

The adjustment that resulted in the lowest break-even prices are those that factor in the cost of distribution on each of the aforementioned "scaling up" strategies. No-till and hoop house produce that is centrally processed and delivered to the store using direct store delivery exhibits output prices that meet both the willingness to pay price and the current wholesale prices paid by grocery retailers. A combination of all three "scaling up" strategies (more efficient harvest technology, central packing, and doubled production) would have the greatest impact on reducing the break-even output price, but the dramatic impact that central processing has on output price makes it the most feasible strategy for scaling up small farmers.

Since this research focuses mostly on price feasibility, the findings do not address other qualities which may be essential for success in this market sector. Further research is recommended to examine the characteristics of mainstream salad mix players and how their scale, marketing, and production systems dictate success in the retail grocery market. A deeper understanding of produce buyer or purveyor needs could also help bolster a more well-rounded feasibility study on this market sector. Another consideration to analyze is the ongoing consolidation of the retail grocery sector. As more independent grocers are bought or squeezed out of the market by larger supermarkets, research that considers the feasibility of local product into larger supermarket retail chains is also recommended.

APPENDICES

APPENDIX A:
INTERVIEW QUESTIONS: GROCERS

1. Store Specs:
    a. How many store locations are in the company?
    b. What is the square footage of the store(s)?
    c. Which produce distributors do you work with?
    d. How is salad mix purveyed?
    e. What is your ownership model (independent retailer, cooperative, franchise)?

2. Current Salad Mix Supply
    a. What brands of salad mix do you carry and in what package sizes?
    b. What is the case size for each brand and package size?
    c. What price do you pay for a case of each type of salad mix?
        i. Does this price fluctuate throughout the year? If so, please describe.
    d. How many cases per week is an average order?
        i. Does your order volume fluctuate throughout the year? If so, please describe.
    e. Is organic-certified an important quality for you and/or your customers?
    f. Do you require any food safety certification from the vendor?
    g. Do you require product liability insurance from the vendor?
    h. What is the difference in both conventional v. organic in sale and price?

3. Contingent Valuation (Willingness to Pay) Exercise

    Description of Salad Mix:

    The good being offered is a pre-packaged salad mix in a 5 oz. plastic clamshell. The product is not certified organic. Upon inspection, you can see that the salad mix is clean, ready-to-eat, with attractive labeling. The phrase: "grown by local farmers" is displayed prominently on the front. The product holds food safety certifications from the USDA and is processed in an inspected facility.

    The packaged salad mix would be distributed by a regional distributor. The distributor is responsible for managing the cold-chain, providing invoices, and general customer service. The clamshells would arrive in a 6-unit case. An order could be filled in 1-7 days. Standing orders preferred.

4. Contingent Valuation Questions
    a. Based on the description above, how much would you be willing to pay for a case of this salad mix?
    b. Based on the description above, what details stand out to you that you deem necessary or are required for you to consider purchasing this item?
    c. Any other thoughts on the product description provided?
    d. Would you pay more for this local food salad mix if it was labeled as:

i. Certified Organic
ii. "Hydroponically grown"
iii. "Hoop-house grown"
iv. Produced using "organic no-till practices"
v. Grown outside

5. Qualitative Questions
    a. Have you ever purchased produce from a local vendor for your store?
    b. Please describe that process. What were the challenges, what were the benefits?
    c. What is your perception on local markets as a risk-aversion strategy in times of market disruption?
    d. How has your purchasing changed since the pandemic?

APPENDIX B:
SEED PRICES

Table 12: Seed costs

			Price per planting at 1 oz. seed price				Price per planting at 1 lbs. seed price		
	Seeds per Oz.	**Price per Oz.**	**6 rows per bed (mechanical)**	**9 rows per bed (no-till)**	**2,304 seeds (hydro-ponic)**	**Price per 1 lbs. package**	**6 rows per bed (mechanical)**	**9 rows per bed (no-till)**	**2,304 seeds (hydro-ponic)**
Red Russian Kale	8900	6.35	12.84	19.26	1.70	22.80	2.88	4.32	0.38
Lacinato Kale	9325	7.00	13.51	20.27	1.88	35.50	4.26	6.39	0.59
Pac Choi	13200	6.76	9.22	13.83	1.56	39.41	3.36	5.04	0.57
Mizuna	15350	7.25	8.50	12.75	1.67	39.50	2.89	4.34	0.57
Mustard #1	16400	6.35	6.97	10.45	1.24	56.00	3.84	5.76	0.47
Mustard #2	14700	7.80	9.55	14.33	1.24	58.15	4.45	6.68	0.58
SUB-AVERAGE			**10.10**	**15.15**			**3.61**	**5.42**	
Lettuce (pre-mix)	31450	18.68	42.77	64.15		159.89	22.88	34.32	
Lettuce (oakleaf)	37800	9.10	17.33	26.00		62.61	7.45	11.18	
Lettuce (romaine)	27600	18.85	49.17	73.76	1.57	174.6	28.47	42.70	0.91
Lettuce (lolla rosa)	31200	11.00	25.38	38.08		88.72	12.80	19.19	
SUB-AVERAGE			**33.66**	**50.50**			**17.90**	**26.85**	
TOTAL AVERAGE			**19.53**	**29.29**	**1.55**		**9.33**	**13.99**	**0.58**

APPENDIX C:

FIELD MECHANICAL, FIELD NO-TILL AND HOOP HOUSE ENTERPRISE BUDGET

Table 13: Field mechanical, field no-till, and hoop house enterprise budget, variable costs

VARIABLE COSTS

		No-Till		Mechanical		Hoop House (projected)	
Production Supplies	**Unit**	**Succession**	**Annual**	**Succession**	**Annual**	**Succession**	**Annual**
Bed Preparation							
Compost Application	$25/yd	50	1100	25	550.00	50	1,500.00
Gasoline	1 gal/hr			0.75	16.50		
Seeding							
Seeds (9 rows per bed)	$13.5/succession	13.5	297			13.5	405
Seeds (6 rows per bed)	$8.87/succession			8.87	195.14		
Gasoline	1 gal/hr			0.25	5.5		
Cultivation							
Gasoline	1.5 gal/hr			0.495	10.89		
Irrigation							
Drip Tape (6 lines per planting)	0.02/ft			24.00	96		
Pest/Disease Control							
Row Cover (AG-19)	0.12/ft	26.4	105.6	26.4	105.6	26.4	105.6
Pyrethrin (1 oz. per application)	2.03/oz			2.03	6.09		
Bt (0.32 oz. per application)	1.55/oz			0.50	1.488		
Harvest							
Electricity for Cooler	$1/day	7	168	7	168	7	224
Post-Harvest							
Clamshells (5oz pkg)	$0.82	262.4	5,772.80	$262.40	5,772.80	236.16	7,084.80
Total Production Supplies cost		**359.3**	**7443.4**	**357.69**	**6928.008**	**333.06**	**9319.4**

		No-Till		Mechanical		Hoop House	
Production Labor ($15.40/hr)	**Time (hr)**	**Succession**	**Annual**	**Succession**	**Annual**	**Succession**	**Annual**
Bed Preparation							
Broadforking	0.66	10.16	223.61			10.16	304.92
Hoe/Tiller/Racking	0.25	3.85	84.70			3.85	115.50
Tillage/Disc/Plow - Initial	0.25			3.85	84.70		
Final Tillage	0.25			3.85	84.70		
Compost Application	0.50	7.70	169.40			7.70	231.00
Compost Application	0.25			3.85	84.70		
Seeding							
Direct Seeding	0.33	5.08	111.80			5.08	152.46
Direct Seeding	0.25			3.85	84.70		
Cultivation							
Tine Weeding	0.17	2.62	57.60			2.62	78.54
Hand Weeding	6.00			92.40	2032.80		
Mechanical Weeding	0.33			5.08	111.80		
Irrigation							
Header set-up	1.00	0.70	15.40	0.70	15.40		
Sprinkler Install (6 needed annually)	0.75	11.55	69.30				
Drip Lines Install	0.50			7.70	169.40		
Checking and Turning On	0.01	0.15	3.39	0.15	3.39	0.15	4.62
Pest/Disease Control							
Row Cover - Initial	0.50	7.70	169.40	7.70	169.40	7.70	231.00
Row Cover - Removal/Reapplication	0.17	2.62	57.60	2.62	57.60	2.62	78.54
Spray Application	0.50			7.70	169.40		
Animal Management	0.25	3.85	84.70	3.85	84.70	3.85	115.50
Harvest							
Harvest w/ Quick-Cut Harvester	0.57						
Harvest w/ Knives	4.00	61.60	1355.20	61.60	1355.20	61.60	1848.00
Wash	2.00	30.80	677.60	30.80	677.60	30.80	924.00
Pack	3.00	46.20	1016.40	46.20	1016.40	46.20	1386.00
Post-Harvest							
Crop/Debris Removal	1.00	15.40	338.80			15.40	462.00
Overall							
Maintanence	0.33	5.08	111.80			5.08	152.46
Maintanence	0.75			11.55	254.10		
Management (20% of total hrs)							
No-Till	2.30	35.39	778.56				
Mechanical	3.75			57.78	1271.18		
Hoop House	1.95					30.00	899.98
Total Production Labor		**250.46**	**5,325.26**	**351.23**	**7,727.17**	**202.82**	**6,084.54**
TOTAL VARIABLE COSTS		**609.76**	**12,768.66**	**708.93**	**14,655.17**	**535.88**	**15,403.94**

Table 14: Field mechanical, field no-till, and hoop house enterprise budget, fixed costs

DEPRICIATED COSTS

			Annual Expense		
Depriciated Costs	**Base Cost**	**Lifespan**	**No-Till**	**Mechanical**	**Hoop House**
Tractors					
Main	40,000.00	50		800.00	
Cultivating (often purchased used)	2,000.00	20		100.00	
Hoop House					
Materials	15,000.00	25			600.00
Construction	3,649.80	25			145.99
Bed Preparation					
Broadfork	300.00	10	30.00		30.00
Scuffle Hoe	60.00	10	6.00		6.00
Wheel Hoe	300.00	10	30.00		30.00
Rake	50.00	10	5.00		5.00
Tarp	80.00	4	20.00		
Tilther	850.00	10	85.00		85.00
Tractor-Mounted Tiller	2,000.00	25		80.00	
Disc/Plow/Bed Shaper	1,000.00	25		40.00	
Tractor Compost Spreader	2,500.00	25		100.00	
Seeding					
Jang Seeder - push	600.00	10	60.00		60.00
Jang Seeder - tractor mounted	6,000.00	10		600.00	
Jang Rollers	100.00	10	10.00	10.00	10.00
Double Disc Opener	100.00	10	10.00		10.00
Cultivation					
Hand Tools (Various)	100.00	10	10.00	10.00	10.00
Tine Weeder	60.00	10	6.00		6.00
Basket Weaver or Shoes	2,000.00	25		80.00	
Irrigation					
Header	72.60	5	14.52	14.52	
Sprinkler	66.00	5	13.20		
Sprinkler system, hoop house	300.00	10			30.00
Animal Management					
Backpack Sprayer	125.00	10		12.50	
Live Trap	40.00	10	4.00		160.00
Harvest					
Quick Cut Greens Harvester	750.00	10			
Replacement Parts	90.00	1			
Harvest Bins	100.00	5	20.00	20.00	20.00
Tank (250gal) x2	300.00	10	30.00	30.00	30.00
Bubbler	150.00	10	15.00	15.00	15.00
Spinner	200.00	7	28.57	28.57	28.57
Cooler	2,000.00	7	285.71	285.71	285.71
Post-Harvest					
TOTAL DEPRICIATED COSTS			**683.01**	**2,226.31**	**1,567.28**
TOTAL COSTS			**13,451.66**	**16,881.48**	**16,971.22**

APPENDIX D:
HYDROPONIC ENTERPRISE BUDGET

Table 15: Hydroponic enterprise budget, variable costs

VARIABLE COSTS

Production Supplies	Unit	Hydroponic Per Succession	Hydroponic Annual
Germ Cabinet			
Seeds	$0.52/succession	0.52	27.04
Growing Medium	3.25/tray	104.00	5,408.00
Trays (used for 1 yr.)	2.88/tray	1.77	92.16
Heating Element	500W/hr	4.23	219.96
Nursery			
Fertilizer	0.21/watering	1.04	54.08
Lights - Utility	1.408 kwH/day	1.27	65.89
Final Stage/Gutters			
Water	$0.24/day	5.04	262.08
Fertilizer	$0.21/day	4.41	229.32
pH Adjustors (500mL per succession)	$27/gal	3.57	185.64
Lights - Rental	$2880/yr	55.38	2,880.00
Lights - Utility	$3.42/succession	3.42	177.63
Cooling Fans (cools 4 successions at a ti	$3.60/day	25.20	1,310.40
Harvest			
Packing			
Clamshells	$0.82	49.86	2,592.51
Electricity for Cooler	$1/day	7.00	364.00
General			
Biosecurity (gowns/caps/boots)	$250/employee/	9.62	500.00
Total Production Supplies cost		**276.32**	**14,368.72**

Production Labor ($15.40/hr)	Time (hr)	Hydroponic Per Succession	Hydroponic Annual
Germ Cabinet			
Seeding	0.53	8.16	424.42
Watering	0.07	1.03	53.33
Nursery			
Moving Trays	0.33	5.13	266.67
Daily Watering	0.17	2.57	133.41
Final Stage/Gutters			
Transplanting into Gutters	1.00	15.40	800.80
Harvest			
Harvest	0.75	11.55	600.60
Packing	0.33	5.08	264.26
Post-Production Clean Up			
Cleaning Gutters	2.00	30.80	1,601.60
Overall Expenses			
Equipment Maintenance	1.05	16.17	840.84
General Management (20% of total hou	1.25	19.18	997.19
Total Production Labor		**115.06**	**5,983.13**

TOTAL VARIABLE COSTS		**391.38**	**20,351.85**

Table 16: Hydroponic enterprise budget, fixed costs

DEPRICIATED COSTS

Depriciation Costs	Base Cost ($)	Lifespan	Annual Expense Hydroponic
Germ Cabinet			
Germ Cabinet	2,000.00	10.00	200.00
Nursery			
Shelving	390.00	10.00	39.00
Final Stage/Gutters			
Gutters ($20.58/gutter)	2,963.52	10.00	296.35
Frame	500.00	10.00	50.00
Waterin			
Basin	65.00	10.00	6.50
Pump	90.00	10.00	9.00
Tubing - flexible	30.00	10.00	3.00
Tubing - PVC	50.00	10.00	5.00
Fittings and valves	50.00	10.00	5.00
Climate Control			
Fan	600.00	10.00	60.00
Harvest			
Cambro (2)	60.00	5.00	12.00
Refrigerator	100.00	10.00	10.00
TOTAL DEPRICIATED COSTS			695.85
TOTAL ANNUAL COSTS			**21,047.70**

BIBLIOGRAPHY

BIBLIOGRAPHY

Abatekassa, Getachew and H. Christopher Peterson. 2011. "Market Access for Local Food through the Conventional Food Supply Chain." *International Food and Agribusiness Management Review* 14(1):63–82.

Agbo, Maxime, Damien Rousselière, Julien Salanié, Maxime Agbo, Damien Rousselière, and Julien Salanié. 2014. "Agricultural Marketing Cooperatives with Direct Selling : A Cooperative – Non-Cooperative Game."

Ahearn, Mary Clare, Kathleen Liang, and Stephan Goetz. 2018. "Farm Business Financial Performance in Local Foods Value Chains." *Agricultural Finance Review* 78(4):470–88.

Alexander, Tom. 2000. "Chapter 8: Organics and Hydroponics." in *Best of Growing Edge: Popular Hydroponics and Gardening for Small Commercial Growers*. New Moon Publishing, Inc.

Asciuto, Antonio, Emanuele Schimmenti, Carlo Cottone, and Valeria Borsellino. 2019. "A Financial Feasibility Study of an Aquaponic System in a Mediterranean Urban Context." *Urban Forestry and Urban Greening* 38(February):397–402.

Barbosa, Guilherme Lages, Francisca Daiane Almeida Gadelha, Natalya Kublik, Alan Proctor, Lucas Reichelm, Emily Weissinger, Gregory M. Wohlleb, and Rolf U. Halden. 2015. "Comparison of Land, Water, and Energy Requirements of Lettuce Grown Using Hydroponic vs. Conventional Agricultural Methods." *International Journal of Environmental Research and Public Health* 12(6):6879–91.

Barham, Debra, James Tropp, Kathleen Enterline, Jeff Farbman, John Fisk, and Stacia Kiraly. 2012. "Regional Food Hub Resource Guide — National Good Food Network." *USDA Agricultural Marketing Service*. Retrieved October 20, 2018 (https://ideas.repec.org/p/ags/uamsrr/145227.html).

Barrett, Christopher B., Maren E. Bachke, Marc F. Bellemare, Hope C. Michelson, Sudha Narayanan, and Thomas F. Walker. 2012. "Smallholder Participation in Contract Farming: Comparative Evidence from Five Countries." *World Development* 40(4):715–30.

Bauman, Allison, Dawn Thilmany McFadden, and Becca B. R. Jablonski. 2018. "The Financial Performance Implications of Differential Marketing Strategies: Exploring Farms That Pursue Local Markets as a Core Competitive Advantage." *Agricultural and Resource Economics Review* 47(3):477–504.

Berti, Giaime and Catherine Mulligan. 2016. "Competitiveness of Small Farms and Innovative Food Supply Chains: The Role of Food Hubs in Creating Sustainable Regional and Local Food Systems." *Sustainability (Switzerland)* 8(7).

Bielaczyc, Noel, Rich Pirog, John Fisk, Justin Fast, and Pam Sanders. 2020. *Findings of the 2019 National Food Hub Survey*.

Biernbaum, John A. 2006. "Hoophouses and High Tunnels for Local Food and Farming." *Michigan State University Department of Horticulture* 1–21.

Biggeri, Mario, Francesco Burchi, Federico Ciani, and Raoul Herrmann. 2018. "Linking Small-Scale Farmers to the Durum Wheat Value Chain in Ethiopia: Assessing the Effects on Production and Wellbeing." *Food Policy* 79(October 2017):77–91.

Blay-Palmer, Alison, Karen Landman, Irena Knezevic, and Ryan Hayhurst. 2013. "Constructing Resilient, Transformative Communities through Sustainable 'Food Hubs.'" *Local Environment*, May, 521–28.

Bloom, Dara J. and Clare Hinrichs. 2011. "Moving Local Food through Conventional Food System Infrastructure: Value Chain Framework Comparisons and Insights." *Renewable Agriculture and Food Systems* 26(1):13–23.

Bloom, J. Dara and C. Clare Hinrichs. 2017. "The Long Reach of Lean Retailing: Firm Embeddedness and Wal-Mart's Implementation of Local Produce Sourcing in the US." *Environment and Planning A* 49(1):168–85.

Blumenschein, Karen, Glenn C. Blomquist, Magnus Johannesson, Nancy Horn, and Patricia Freeman. 2008. "Eliciting Willingness to Pay without Bias: Evidence from a Field Experiment." *Economic Journal* 118(525):114–37.

Bowman, Maria S. and David Zilberman. 2013. "Economic Factors Affecting Diversified Farming Systems." *Ecology and Society* 18(1).

Buckley, Jenifer, David S. Conner, Colleen Matts, and Michael W. Hamm. 2013. "Social Relationships and Farm-to-Institution Initiatives: Complexity and Scale in Local Food Systems." *Journal of Hunger and Environmental Nutrition* 8(4):397–412.

Chase, Craig and Linda Naeve. 2012. "Vegetable Production Budgets for a High Tunnel." *Iowa State University Extension and Outreach* (January):8.

Chibanda, M., G. F. Ortmann, and M. C. Lyne. 2009. "Institutional and Governance Factors Influencing the Performance of Selected Smallholder Agricultural Cooperatives in KwaZulu-Natal." *Agrekon* 48(3):293–315.

Clark, Jill K. and Shoshanah M. Inwood. 2016. "Scaling-up Regional Fruit and Vegetable Distribution: Potential for Adaptive Change in the Food System." *Agriculture and Human Values* 33(3):503–19.

Coleman, P. 2012. *Guide for Organic Crop Producers*.

Colloredo-Mansfeld, Rudi, Meenu Tewari, Justine Williams, Dorothy C. Holland, Alena Steen, and Alice Brooke Wilson. 2014. "Communities, Supermarkets, and Local Food: Mapping Connections and Obstacles in Food System Work in North Carolina." *Human Organization* 73(3):247–57.

Community Involved in Sustaining Agriculture. 2009. *HACCP Feasibility 2009 - Salad Greens Market Study*.

Conner, David S. 2010. *Model Business Plan for Season Extension with Hoophouses*.

Cook, Roberta L. 2011. "Fundamental Forces Affecting U.S. Fresh Produce Growers and Marketers." *Choices* 26(4).

Detre, Joshua D., Hiroki Uematsu, and Ashok K. Mishra. 2011. “The Influence of DM Crop Adoption on the Profitability of Farms Operated by Young and Beginning Farmers.” *Agricultural Finance Review* 71(1):41–61.

Dillon, Carl R. 1993. “Advanced Breakeven Analysis of Agricultural Enterprise Budgets.” *Agricultural Economics* 9(2):127–43.

Dries, Liesbeth and Johan F. M. Swinnen. 2004. “Foreign Direct Investment, Vertical Integration and Local Suppliers: Evidence from the Polish Dairy Sector.” *World Development* 32(9):1525–1544.

Dunning, Rebecca. 2016. “Collaboration and Commitment in a Regional Supermarket Supply Chain.” *Journal of Agriculture, Food Systems, and Community Development* 1–19.

Estes, Edmund a, Tony Kleese, Laura Lauffer, and Raleigh North Carolina. 2003. *North Carolina Organic Vegetable Production Cost Study*. Raleigh, North Carolina.

Fan, Xiaoli, Miguel I. Gómez, and Phillip S. Coles. 2019. “Willingness to Pay, Quality Perception, and Local Foods: The Case of Broccoli.” *Agricultural and Resource Economics Review* 1–19.

Farnsworth, Lindsey Day, Brent McCown, Michelle Miller, and Anne Pfeiffer. 2009. *Scaling up: Meeting the Demand for Local Food*.

Feenstra, Gail and Shermain Hardesty. 2016. “Values-Based Supply Chains as a Strategy for Supporting Small and Mid-Scale Producers in the United States.” *Agriculture* 6(3):39.

Feldmann, Corinna and Ulrich Hamm. 2015. “Consumers’ Perceptions and Preferences for Local Food: A Review.” *Food Quality and Preference* 40(PA):152–64.

Fischer, Elisabeth and Matin Qaim. 2014. “Smallholder Farmers and Collective Action: What Determines the Intensity of Participation?” *Journal of Agricultural Economics* 65(3):683–702.

Fischer, Micaela, Rich Pirog, and Michael W. Hamm. 2015. “Food Hubs: Definitions, Expectations, and Realities.” *Journal of Hunger and Environmental Nutrition* 10(1):92–99.

Flynn, Dan. 2021. “Court Ruling Clears Way for Hydroponics to Join National Organic Program.” *Food Safety News*.

Fonsah, Esendugue Greg, Gerard Krewer, John Ed Smith, Danny Stannaland, and Julien Massonnat. 2011. “Economic Analysis of Rabbiteye Blueberry Production in Georgia Using Enterprise Budgets.” *Journal of Food Distribution Research* 42(1):54–58.

Friedmann, Harriet. 2007. “Scaling up: Bringing Public Institutions and Food Service Corporations into the Project for a Local, Sustainable Food System in Ontario.” *Agriculture and Human Values* 24(3):389–98.

Galinato, Suzette P. and Carol A. Miles. 2013. “Economic Profitability of Producing Tomato and Lettuce in Western Washington under Open-Field and High-Tunnel Production Systems.” *HortTechnology* 23(August):353.

Gerhart, Jae and Marissa Schuh. 2018. *Southeast Michigan Small Farm Needs Assessment*.

Givens, Graham and Rebecca Dunning. 2018. “Distributor Intermediation in the Farm to Food Service Value Chain.” *Renewable Agriculture and Food Systems* 1–3.

Goodman, David, E. Melanie DuPuis, and Michael K. Goodman. 2010. *Alternative Food Networks: Knowledge, Practice, and Politics*. New York, NY: Routledge.

Grafiadellis, I., K. Mattas, E. Maloupa, I. Tzouramani, and K. Galanopoulos. 2000. “An Economic Analysis of Soilless Culture in Gerbera Production.” *HortScience* 35(2):300–303.

Grashuis, Jasper and S. U. Ye. 2019. “A Review of the Empirical Literature on Farmer Cooperatives: Performance, Ownership and Governance, Finance, and Member Attitude.” *Annals of Public and Cooperative Economics* 90(1):77–102.

Greenfeld, Asael, Nir Becker, Jennifer McIlwain, Ravi Fotedar, and Janet F. Bornman. 2019. “Economically Viable Aquaponics? Identifying the Gap between Potential and Current Uncertainties.” *Reviews in Aquaculture* 11(3):848–62.

Grubinger, Vern. 2016. *High Tunnels and Other Season Extension Techniques*.

Gupta, Clare and Becca Jablonski. 2016. “Farm Impacts of Farm-to-Grocer Sales: The Case of Hawai’i.” *Journal of Food Distribution Research* 47(3).

Guptill, Amy and Jennifer L. Wilkins. 2002. “Buying into the Food System: Trends in Food Retailing in the US and Implications for Local Foods.” *Agriculture and Human Values* 19(1):39–51.

Guthman, Julie. 2003. “Fast Food/Organic Food: Reflexive Tastes and the Making of ‘Yuppie Chow.’” *Social and Cultural Geography* 4(1).

Hardesty, Shermain D. and Penny Leff. 2010. “Determining Marketing Costs and Returns in Alternative Marketing Channels.” *Renewable Agriculture and Food Systems* 25(1):24–34.

Harrison, Glenn W. and E. Elisabet Rutström. 2008. “Chapter 81 Experimental Evidence on the Existence of Hypothetical Bias in Value Elicitation Methods.” *Handbook of Experimental Economics Results* 1(C):752–67.

Hoken, Hisatoshi and Qun Su. 2018. “Measuring the Effect of Agricultural Cooperatives on Household Income: Case Study of a Rice-Producing Cooperative in China.” *Agribusiness* 34(4):831–46.

Holm, Desirée Blankenburg, Kent Eriksson, and Jan Johanson. 1999. “Creating Value through Mutual Commitment to Business Network Relationships.” *Strategic Management Journal* 20(5):467–86.

Howard, Phillip H. 2016. *Concentration and Power in the Food System: Who Controls What We Eat*. London: Bloomsbury Academic.

Ito, Junichi, Zongshun Bao, and Qun Su. 2012. “Distributional Effects of Agricultural Cooperatives in China: Exclusion of Smallholders and Potential Gains on Participation.” *Food Policy* 37(6):700–709.

Janssen, Brandi. 2018. “Small Farms, Big Plans: Mechanization and Specialization as Measures of ‘The Middle.’” *Culture, Agriculture, Food and Environment* 40(2):96–104.

Jensen, Merle H. 1997. “Hydroponics.” *HortScience* 32(6).

Johnson, Gaylynn E., Karen M. Buzby, Kenneth J. Semmens, Ida Holaskova, and Nicole L. Waterland. 2017. “Evaluation of Lettuce Between Spring Water, Hydroponic, and Flow-through Aquaponic Systems.” *International Journal of Vegetable Science* 23(5):456–70.

Kaiser, Cheryl and Matt Ernst. 2012. *High Tunnel Leafy Greens and Herbs*.

King, Robert P., Michael S. Hand, Gigi Digiacomo, Kate Clancy, Miguel I. Gómez, Shermain D. Hardesty, Larry Lev, and Edward W. Mclaughlin. 2010. “Comparing the Structure , Size, and Performance of Local and Mainstream Food Supply Chains.”

Kitinoja, Lisa. 2013. “Innovative Small-Scale Postharvest Technologies for Reducing Losses in Horticultural Crops.” *J. Appl. Sci. Technol. (Special Issue* 15(1):9–15.

Konefal, Jason, Carmen Bain, Michael Mascarenhas, and Lawrence Busch. 2007. “Supermarkets and Supply Chains in North America.” Pp. 268–88 in *Supermarkets and Agri-food Supply Chains*. Northampton, MA: Edward Elgar Publishing, Inc.

Kwon, Ik Whan G. and Taewon Suh. 2004. “Factors Affecting the Level of Trust and Commitment in Supply Chain Relationships.” *Journal of Supply Chain Management* 40(1):4–14.

LeRoux, M. N., T. M. Schmit, M. Roth, and D. H. Streeter. 2010. “Evaluating Marketing Channel Options for Small-Scale Fruit and Vegetable Producers.” *Renewable Agriculture and Food Systems* 25(1):16–23.

Lev, Larry and G. W. Stevenson. 2011. “Acting Collectively to Develop Midscale Food Value Chains.” *Journal of Agriculture, Food Systems, and Community Development* 1(14):119–28.

Lobillo-Eguíbar, José, Víctor M. Fernández-Cabanás, Luis Alberto Bermejo, and Luis Pérez-Urrestarazu. 2020. “Economic Sustainability of Small-Scale Aquaponic Systems for Food Self-Production.” *Agronomy* 10(10):1–19.

Loomis, John B. 1990. “Comparative Reliability of the Dichotomous Choice and Open-Ended Contingent Valuation Techniques.” *Journal of Environmental Economics and Management* 18(1):78–85.

Low, Sarah A., Aaron Adalja, Elizabeth Beaulieu, Nigel Key, Steve Martinez, Alex Melton, Agnes Perez, Katherine Ralston, Hayden Stewart, Shellye Suttles, Stephen Vogel, and Becca B. R. Jablonski. 2015. “United States Department of Agriculture Trends in U.S. Local and Regional Food Systems: A Report to Congress What Did the Study Find?”

Low, Sarah A. and Stephen Vogel. 2011. *Direct and Intermediated Marketing of Local Foods in the United States*.

Lugg, James, Myung Eun Shim, and David Zilberman. 2017. “Establishing Supply Chain for an Innovation : The Case of Prepackaged Salad.” *ARE Update* 20(6):5–8.

MacDonald, James M., Penni Korb, and Robert A. Hoppe. 2013. *United States Department of Agriculture Farm Size and the Organization of U.S. Crop Farming*.

Majid, Maliqa, Junaid N. Khan, Qazi Muneeb Ahmad Shah, Khalid Z. Masoodi, Baseerat Afroza, and Saqib Parvaze. 2020. “Evaluation of Hydroponic Systems for the Cultivation of Lettuce (Lactuca Sativa L., Var. Longifolia) and Comparison with Protected Soil-Based Cultivation.” *Agricultural Water Management* (August):106572.

Malaiyandi, Sangeetha, Stephen Bayite-kasule, and Samuel Mugarura. 2010. *Enterprise Budget Survey : An Analysis of Crop and Livestock Enterprises*.

Martinez, Steve. 2010. *Local Food Systems: Concepts, Impacts, and Issues*. Diane Publishing.

Martinez, Steve and David E. Davis. 2002. “Farm Business Practices Coordinate Production with Consumer Preferences.” *FoodReview* 25(1):33–38.

Michigan Municipal League. 2014. *Michigan Farmers Markets*.

Nelson, Jason Scott. 2013. “Organic and Inorganic Fertilization With and Without Microbial Inoculants in Peat-Based Substrate and Hydroponic Crop Production.” Kansas State University.

Nennich, Terrance and Suzanne Wold-Burkness. 2012. *Minnesota High Tunnel Production Manual for Commercial Growers*.

Organisation for Economic Co-operation and Development. 2020. *Agricultural Policy Monitoring and Evaluation 2020*. OECD Publishing Press.

Park, Timothy. 2015. “Direct Marketing and the Structure of Farm Sales: An Unconditional Quantile Regression Approach.” *Journal of Agricultural and Resource Economics* 40(2):266–84.

Parkell, Natalie B., Robert C. Hochmuth, and Wanda L. Laughlin. 2015. “An Overview of Lettuce Production Systems and Cultivars Used in Hydroponics and Protected Culture In.” 1–6.

Portney, Paul R. 1994. “The Contingent Valuation Debate: Why Economists Should Care.” *Journal of Economic Perspectives* 8(4):481–95.

Rakocy, James E., Donald S. Bailey, Kurt a Shultz, and William M. Cole. 1997. “Economic Analysis Of A Commercial-Scale Aquaponic System For The Production Of Tilapia and Lettuce.” *4th International Symposium on Tilapia in Aquaculture* 603–12.

Reardon, Thomas, Christopher B. Barrett, Julio A. Berdegué, and Johan F. M. Swinnen. 2009. “Agrifood Industry Transformation and Small Farmers in Developing Countries.” *World Development* 37(11):1717–27.

Reardon, Thomas, C. Peter Timmer, and Bart Minten. 2012. “Supermarket Revolution in Asia and Emerging Development Strategies to Include Small Farmers.” *Proceedings of the National Academy of Sciences of the United States of America* 109(31):12332–37.

Rhoads, Dale. 2002. “Lettuce Season Extension Trials: Final Report for FNC99-286.” *SARE North Central Region*.

Richards, Timothy J. and Paul M. Patterson. 2003. *Competition in Fresh Produce Markets: An Empirical Analysis of Marketing Channel Performance*.

Robinson, Miles D., John Brown, Alice Paris, Walter A. Hill, Tasha M. Hargrove, Barrett Vaughan, Raymon Shange, Al Hooks, Demetrius Hooks, Thomas Turner, Bobby England, and Audrey Zeigler. 2017. "The Small Farmers Agricultural Cooperative Today." *Professional Agricultural Workers Journal (PAWJ)* 4(174-2017–1477):6–14.

Ruml, Anette and Matin Qaim. 2020. "Effects of Marketing Contracts and Resource-Providing Contracts in the African Small Farm Sector: Insights from Oil Palm Production in Ghana." *World Development* 136:105110.

Rylander, Haley, Anusuya Rangarajan, Ryan M. Maher, Mark G. Hutton, Nicholas W. Rowley, Margaret T. McGrath, and Zachary F. Sexton. 2020. "Black Plastic Tarps Advance Organic Reduced Tillage I: Impact on Soils, Weed Seed Survival, and Crop Residue." *HortScience* 55(6):819–25.

Sanyé-Mengual, Esther, Francesco Orsini, Jordi Oliver-Solà, Joan Rieradevall, Juan Ignacio Montero, and Giorgio Gianquinto. 2015. "Techniques and Crops for Efficient Rooftop Gardens in Bologna, Italy." *Agronomy for Sustainable Development* 35(4):1477–88.

Silva, Erin, Fengxia Dong, Paul Mitchell, and John Hendrickson. 2015. "Impact of Marketing Channels on Perceptions of Quality of Life and Profitability for Wisconsin's Organic Vegetable Farmers." *Renewable Agriculture and Food Systems* 30(5):428–38.

Starr, Laura, Joshua Greenberg, and Janice Rowell. 2017. "Farming Muskoxen for Qiviut in Alaska: A Feasibility Study." *Arctic* 70(1):77–85.

Stevenson, G. W. and Rich Pirog. 2008. "Values-Based Supply Chains: Strategies for Agrifood Enterprises of the Middle." Pp. 119–43 in *Food and the mid-level farm: Renewing an agriculture of the middle*.

Thompson, Jennifer Jo and Julia Gaskin. 2018. "An Extension Specialist's Reflections from the Field: Discovering Ag of the Middle in the Shift from Direct Sale to Wholesale Vegetable Production." *Culture, Agriculture, Food and Environment* 40(2):124–29.

Touliatos, Dionysios, Ian C. Dodd, and Martin Mcainsh. 2016. "Vertical Farming Increases Lettuce Yield per Unit Area Compared to Conventional Horizontal Hydroponics." *Food and Energy Security* 5(3):184–91.

United States Department of Agriculture. 2021. "USDA Organic: Becoming a Certified Operation." Retrieved January 6, 2021 (https://www.ams.usda.gov/services/organic-certification/becoming-certified).

Verhofstadt, Ellen and Miet Maertens. 2013. "Processes of Modernization in Horticulture Food Value Chains in Rwanda." *Outlook on Agriculture* 42(4):273–83.

Waldman, Kurt B., David S. Conner, John A. Biernbaum, Michael W. Hamm, and Adam D. Montri. 2012. "Determinants of Hoophouse Profitability: A Case Study of 12 Novice Michigan Farmers." *HortTechnology* 22(2):215–23.

Waldman, Kurt B., David S. Conner, Adam D. Montri, Michael W. Hamm, and John A. Biernbaum. 2010. "Hoophouse Farming Startup : Economics, Efforts and Experiences from 12 Novice Hoophouse Farmers." *Education* (2006):1–12.

Wallace Center at Winrock International. 2019. "Financial Management for Food Hub Success: One KPI at a Time."