
Local Food Prospectus for the Tri-State Region

An analysis of the wholesale fruit and
vegetable industry in
Illinois, Iowa, and Wisconsin

This report is a project of Southwestern Wisconsin Regional Planning Commission in Wisconsin, East Central Intergovernmental Association in Iowa, and the Tri-County Economic Development Alliance in Illinois. It is funded by the USDA Rural Development.

The project is administered by Southwestern Wisconsin Regional Planning Commission. Both Atten Babler Risk Management in Illinois and East Central Intergovernmental Association in Iowa are providing additional staffing.

Many regional experts contributed to this report. Project staff are very appreciative for the time and energy these experts took to contribute their knowledge and perspectives.



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A regional response to local needs



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- Southwestern Wisconsin: Crawford, Grant, Green Iowa, Lafayette, and Richland Counties

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Executive Summary

Exploring the feasibility of scaling up wholesale fruit and vegetable production in the Tri-State region to compete with other produce regions such as California, Canada, and Mexico.

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This report explores the feasibility of scaling up wholesale fruit and vegetable production in the Tri-State area.

This report explores how feasible it is for Illinois, Iowa, and Wisconsin to scale up produce production for wholesale markets and compete with other produce regions such as California and Mexico. The purpose of analyzing these issues is to explore the feasibility of capitalizing on the local and regional food trend to build up the produce industry. Wholesale production is the focus of this report because that is where the greatest amount of economic opportunity is found.

Assumptions

This research project initially operated under the assumption that a lack of produce processing infrastructure is the major barrier to a strong local produce industry. However, this assumption has been shown to be incorrect. Instead, increased local production of fruits and vegetables is needed. The Tri-State area has more demand for local produce than produce supply.

Challenges & Opportunities

This report explores the viability of produce production in the study area by looking at supply, demand, pricing, cost, and comparative economics of the produce industry. The report identifies several key challenges and opportunities that will likely affect this viability:

International competition is increasing and US produce production is declining, becoming more specialized and geographically concentrated. Increased dependence on foreign imports leads to tradeoffs often involving short term benefits (lower prices) and long term costs (food insecurity, higher prices and volatility). This is especially true for products like fresh fruits and vegetables where it is difficult to quickly and cost effectively increase domestic production once it is lost.

US fruit and vegetable consumption is increasing and “Buy Local” movements are spreading. The Tri-State area has a surplus or balanced trade of low-demand vegetables such as carrots, cabbage, peas, potatoes, and snap beans with a major deficit of high-demand produce such as peppers, lettuce, and tomatoes. The Buy Local trend has produced key components needed to build a larger and more efficient wholesale production model by tapping into existing distribution systems and developing a more advanced processing infrastructure within the region.

Transportation costs are increasing. Increasing transportation costs are an opportunity for growers in the Tri-State area, provided the same aggregation and distribution efficiencies can be achieved as growers in California and other competing regions. These efficiencies require a scale of farm production and packaging to fill semi-trucks in order to fully take advantage of lower transportation costs.

Fruit and vegetable production is risky in the Tri-State area. The level of production risk that growers in the Tri-State region assume is significantly higher than other produce growing regions or with row crops grown within the region. This is partly due to policies supporting fruit and vegetable production in other areas and encouraging corn and soybean production in the Tri-State area.

Produce-based agriculture may be an opportunity to attract new farmers to the region. As land prices increase, small-scale farmers could strategically decide to farm on fewer acres but grow higher value crops such as fruit and vegetables.

The Tri-State region faces a shortage of skilled labor. Fresh fruit and vegetable production is very labor intensive and requires a labor force skilled in production and harvesting. The Tri-State area currently faces a shortage in this labor force. An increase of migrant workers in the rural Midwest is a positive trend. However, California retains a clear competitive advantage with regards to current labor supply for produce production.

Recommendations

Based on the report findings, the following recommendations are developed:

Policy Challenge: Current federal policies incentivize producing crops such as corn and soybeans. Midwestern fruit and vegetable producers do not receive the same benefits that fruit and vegetable producers in other parts of the US receive.

Policy Recommendation: Coordinate a unified regional voice to advocate for federal policy changes.

Risk Challenge: Fruit and vegetable production is risky.

Risk Recommendation: Customize weather insurance to the risks of growing produce in the Tri-State region.

Markets and Aggregation Challenge: The majority of existing production is small-scale with a focus on direct marketing. Existing local food distribution systems are inefficient.

Markets and Aggregation Recommendation: Aggregate small producers and encourage production at a large enough scale so a single producer can fill a truckload of produce.

Production Knowledge Challenge: There are producers in the Tri-State area that are highly skilled at growing produce. However, overall there is a lack of production and harvesting knowledge appropriate for the region's unique characteristics.

Production Knowledge Recommendation: Develop and exchange knowledge on fruit and vegetable production and harvesting as applicable to the Tri-State area.

Labor Challenge: Fruits and vegetables are generally labor-intensive crops. The region has a lack of skilled labor for growing and harvesting produce.

Labor Recommendation: Increase mechanization to reduce the demand for labor and coordinate between producers and universities to develop innovative systems and equipment engineering.

Physical Infrastructure Challenge: Fruit and vegetable production in the Tri-State area is currently small-scale. The biggest constraint to reaching economies of production scale is a lack of farm equipment and mechanization.

Physical Infrastructure Recommendation: Find ways to share physical infrastructure to reduce duplicative investments and eliminate barriers to new growers.

The demand for local fruits and vegetables in the Tri-State area is higher than the supply. Currently, the major barrier to a strong local produce industry is a lack of production.

Project Background & Context

Background information on the project including the purpose of the report, the project process, and an overview of the project study area.

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Section Summary

This section provides background information on the project, including the purpose of the report and the project process. It also provides a general overview of relevant information about the project study area.

Section Highlights

- Many of the fruits and vegetables being produced in the region are being marketed directly to individuals through small-scale arrangements. In order for the local food system to be sustainable, production needs to scale up to meet the needs of wholesale markets. This is where there is a lot of economic opportunity, as processing, aggregation, and distribution jobs are available.
- The regional food system has a number of opportunities, including larger markets, than the local level. Stakeholders need to consciously and strategically act on these opportunities in order to take advantage of them.
- This research project began with the assumption that a lack of processing infrastructure is the main challenge to strengthening and growing the local fruit and vegetable industry. However, it appears that overall there is sufficient processing and storage infrastructure. The focus for scaling up should be on production.
- The majority of producers interviewed for this report do not anticipate scaling up production in the near future. This is due in part because of the production and marketing challenges they currently face. There are also producers who have made a lifestyle choice to stay small.
- The aggregators in the region are the most confident of expansion opportunities and are growing quickly.
- Institutional buyers who see their customers valuing local foods indicated that there is not enough local product to meet their demand.
- Where local and regional fruit and vegetables are successfully entering wholesale value chains are where someone – aggregators or cooperatives – is working in the middle to get product from producers to buyers.

Project Background

This report explores how feasible it is for Illinois, Iowa, and Wisconsin to scale up produce production for wholesale markets and compete with other fruit and vegetable production regions such as California and Mexico. This report examines stakeholder interest in expansion of local and regional produce and the challenges they face. It also provides basic information on growing selected crops, including factors such as financial investment.

This research focuses on produce because the fruit and vegetable industry in the Tri-State area has not been explored nearly as much as the meat or dairy industries. Additionally, strengthening the fruit and vegetable industry would diversify the Tri-State agricultural economy. The purpose of analyzing these issues now is to explore the feasibility of capitalizing on the local and regional food trend to build up the produce industry. Wholesale production is the focus of this report because that is where the greatest amount of economic opportunity, such as jobs in processing, aggregation, and distribution, is.

Project Team

This report is a project of Southwestern Wisconsin Regional Planning Commission (SWWRPC) in Wisconsin, East Central Intergovernmental Association (ECIA) in Iowa, and the Tri-County Economic Development Alliance in Illinois. It was funded by the USDA Rural Development and administered by SWWRPC. Both Atten Babler Risk Management in Illinois and ECIA provided staffing and technical expertise.

The project is guided by a 26-member steering committee with representatives from Iowa, Illinois, and Wisconsin. This committee has representation from producers, processors, buyers, economic development organizations, policy-makers, higher education and university extension, USDA, researchers, and food advocates.

At several key points in the project, focus groups of experts reviewed project materials and provided guidance and feedback. A 5-member crop selection panel consisting of both conventional and organic producers and university extension specialists made recommendations as to which crops to focus on. Some of the factors that were taken into consideration were yield potentials, growing capabilities, regional import/export trends, and labor and mechanization needed.

Data Collection

Data was collected from numerous sources, including USDA and university extension offices. State databases on permits and licenses, managed by the state agricultural and health departments, were used to learn more about regional infrastructure capacity.

Additionally, project staff conducted over 22 surveys of stakeholders from Iowa, Illinois, and Wisconsin. Several of these stakeholders are operating regionally and work in Minnesota and Michigan as well; others are national, with operations across the US. Discussions with producers included some very new producers who just started last year and some who have been operating for over a decade. Growers surveyed are both very small, farming on just a couple of acres, as well as very large operations that source

product nationally. The agribusinesses surveyed are working regionally and expanding their geographies rapidly; the distributor who helped inform this report operates nationally. The buyers surveyed include representation from medical centers, large and small grocery stores, cafes, and a restaurant.

Study Area Overview

While the Tri-State region loosely refers to the area where Iowa, Illinois, and Wisconsin meet, the specific Project Produce study area is 18 partner counties (Map 1). These counties are as follows:

Northwest Illinois: Carroll, Jo Daviess, Lee, Ogle, Stephenson, and Whiteside Counties

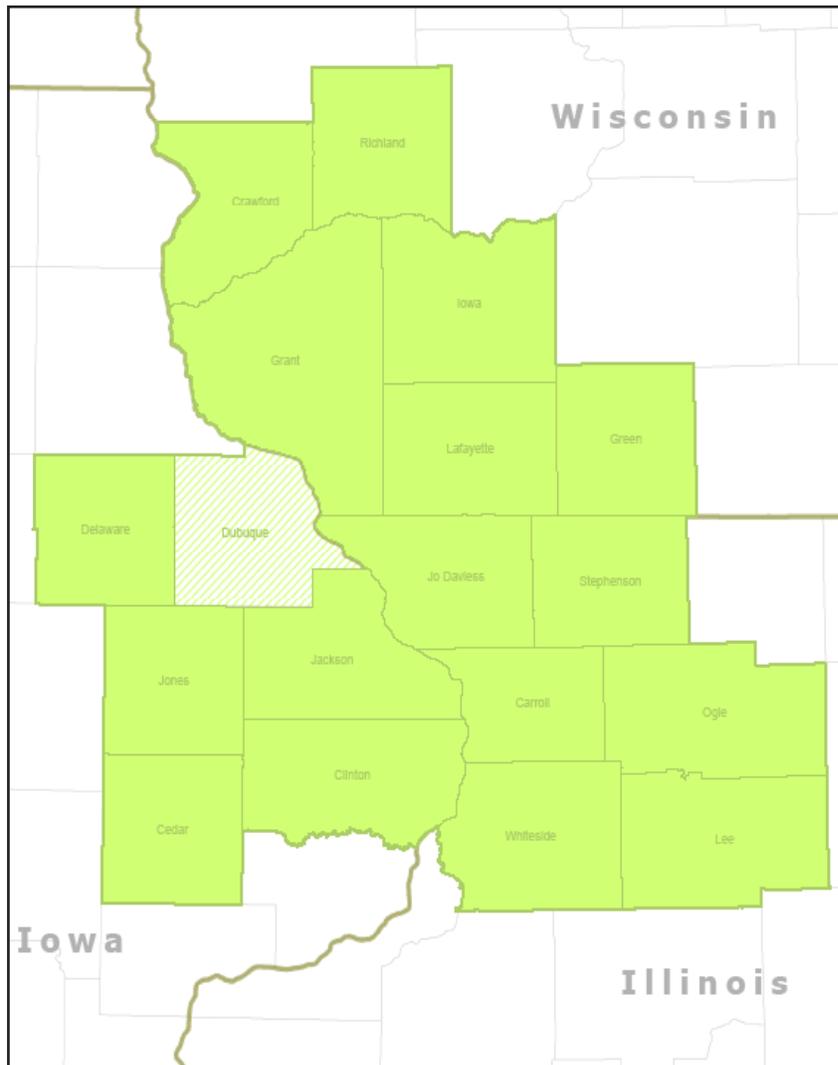
Northeast Iowa¹: Cedar, Clinton, Delaware, Jackson, and Jones Counties

Southwestern Wisconsin: Crawford, Grant, Green Iowa, Lafayette, and Richland Counties

¹ Dubuque County was unable to be a project partner because it is considered an urban county. All other counties are rural by USDA definition, allowing this study to be funded by USDA Rural Development.

Map 1: Project Study Area

(Source: U.S. Census, 2010)



Defining Local & Regional

Local foods² are a small but rapidly growing part of the food market. Nationally, direct to consumer marketing almost doubled between 1997 and 2007, from \$551 million to \$1.2 billion in sales.³ The purpose of analyzing the potentials of scaling up the regional fruit and vegetable industry now is to explore strategies to capitalize on the local and regional food trend to build up the produce industry.

One way to understand the different layers of the food system is through the tiers model developed by the Center for Integrated Agricultural Systems at the University of Wis-

² There are a number of definitions for local food, but for the purposes of this study “local” is defined by a 250 mile ring around the partner counties.

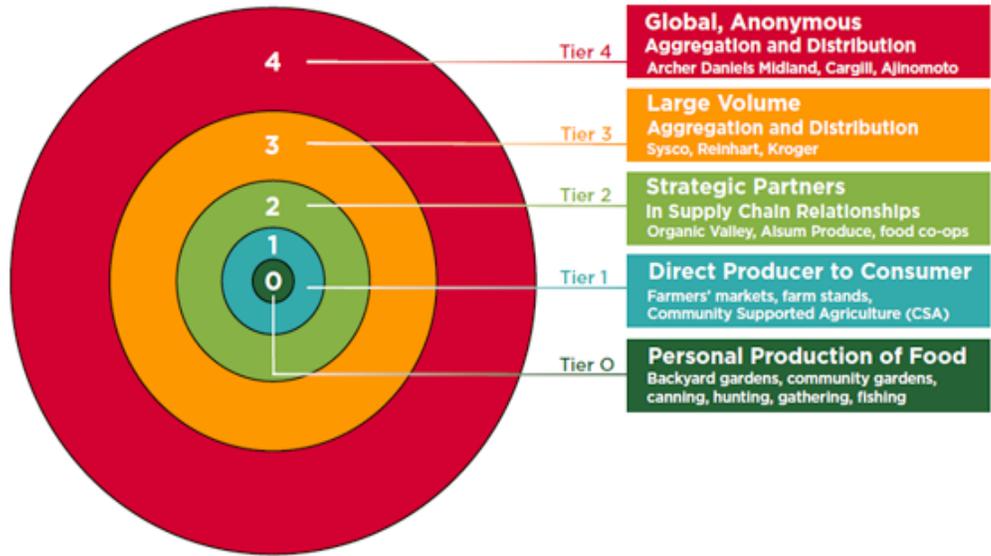
³ Martinez, Steve, Michael Hand, Michelle Da Pra, Susan Pollack, Katherine Ralston, Travis Smith, Stephen Vogel, Shelley Clark, Luanne Lohr, Sarah Low, and Constance Newman. Local Food Systems Concepts, Impacts, and Issues. Rep. no. 97. United States Department of Agriculture Economic Research Service, 2010.

Much of the fruit and vegetable production in the study area is small-scale. It is sold directly to individuals through farmers' markets and CSA arrangements. Scaling up production for wholesale markets is where a lot of the economic opportunity is.

consin-Madison. Currently, much of the local foods activity in the Tri-State area takes place on Tier 1, "Direct Producer to Consumer" (Figure 1). Much of the fruit and vegetable production occurring in the project area is directed to individuals, farmers' markets, and community supported agriculture (CSA) arrangements.

Figure 1: Tiers of the Food System

(Source: Center for Integrated Agricultural Systems, University of Wisconsin Madison)



However, in order for local food systems to be sustainable they need to scale up to better access a broader market beyond Tier 1 customers. This means increasing the level of activity in Tier 2 "Strategic Partners in Supply chain Relationships" and Tier 3 "Large Volume Aggregation and Distribution." These tiers are where a lot of economic opportunity, such as processing, aggregation, and distribution jobs are available. This report focuses on exploring increased activity in Tiers 2 and 3.

Tiers 2 and 3 of the food system are uniquely positioned with a variety of opportunities and advantages that communities and regions can capitalize on in order to reach their goals. For example, a regional scale has a larger amount of available resources, such as a larger land base and larger markets, than the local level, but can still keep financial resources in local communities. The regional level is also large enough to accommodate and strengthen mid-size producers who may be too large to rely on farmers' markets and too small to compete with large-scale producers.

There are a number of benefits to local and regional food systems. These benefits include:

Economic

- Keeping money in local communities is important. For every \$1 spent locally there is a \$2.60 multiplier in economic activity⁴ and 2.2 jobs are created for every \$100,000 in food sales.⁵
- Strong regional food systems support small and midsize producers providing better opportunities to access markets and resources that they may not have otherwise had access to.

Environmental

- A well-developed local food system can result in less transportation pollution, although this depends on a variety of factors, including production methods and vehicular fuel efficiency.
- Improving biodiversity by encouraging the planting of diverse crops.

Social

- Local and regional food systems may help to improve diets by increasing access to and encouraging fruit and vegetable consumption.
- Shorter supply chains minimize chances of food contamination while increasing food safety and quality
- Increased interaction between community members builds a sense of community.

The regional level of the food system has a variety of opportunities, but communities and stakeholders need to consciously and strategically act on these opportunities in order to take advantage of them. Later in this report possible strategic actions are identified.

Proximity to Markets

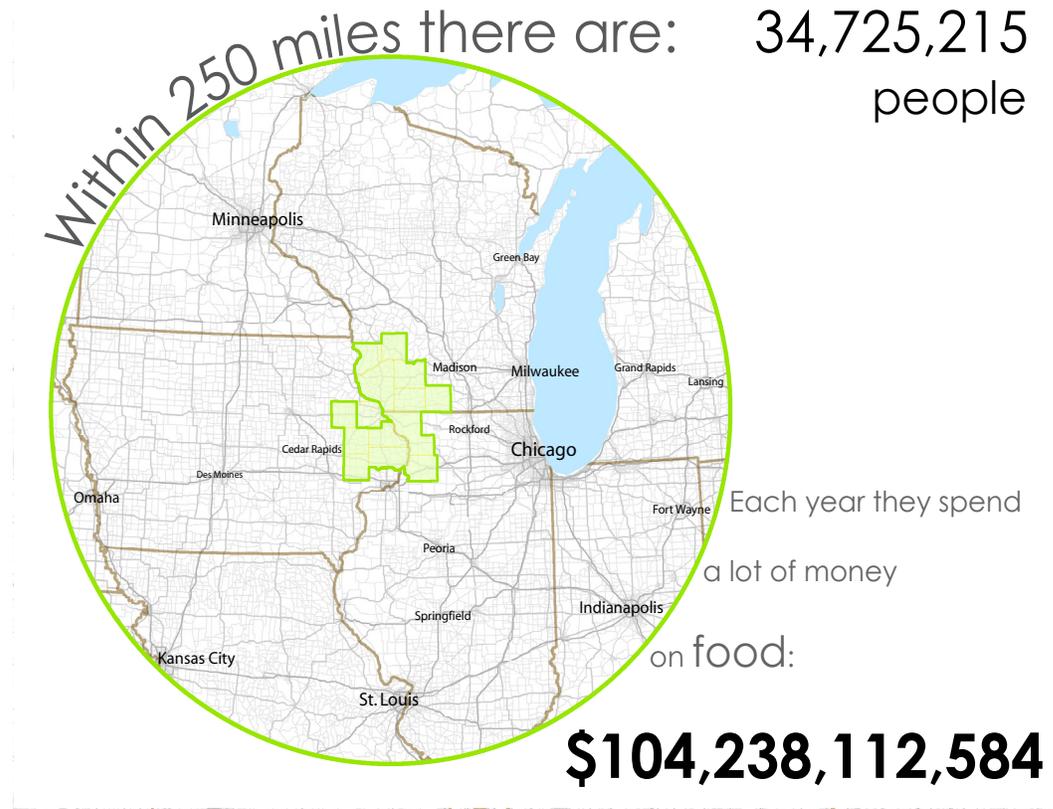
As shown in Map 2, the study area is located within 250 miles of several major markets; it is approximately 1.5 hours from Dubuque, IA to Madison, WI, 2.5 hours from Dubuque, IA to Milwaukee, WI, 3.5 hours from Dubuque, IA to Chicago, IL, and 4.5 hours from Dubuque, IA to St. Paul, MN.

The regional scale has a large amount of available resources and opportunities, such as a larger land base and larger markets and it can keep financial resources in local communities. Communities and stakeholders need to consciously and strategically act on these opportunities in order to take advantage of them.

4 Meter, Ken. Local Food as Economic Development. Crossroads Resource Center, Oct. 2008. Web. 4 Jan. 2013. <<http://www.crcworks.org/lfced.pdf>>.

5 Parry, Olivia, Laura Witzling, and Rosa Kozub. 2010 Program Report. Rep. Dane County Institutional Food Market Coalition, 2010. Web. 4 Jan. 2013. <<http://lgc.uwex.edu/Downtowns/DOC/Apr11/IFM%202010%20Prog%20Rep%20FINAL%20FOUND-READINGS.pdf>>.

Map 2: Proximity to Markets
 (Source: ESRI Business Analyst 2011)



As Table 1 shows, agriculture is the fifth largest industry in terms of employment in the study area. Jobs in the agricultural sector are also the lowest paid among the top five industries.

Table 1: Top 5 Industries by Employment
 (Source: EMSI Complete Employment -- 2012.3)

Description	2012 Jobs	% Change 2011-2012	2012 Avg. Annual Wage
Retail Trade	43,094	-1%	\$25,903
Manufacturing	42,864	2%	\$61,191
Government	39,696	-1%	\$46,338
Health Care and Social Assistance	35,608	0%	\$38,833
Agriculture, Forestry, Fishing, and Hunting	24,929	1%	\$24,550

There are 609,417 people living within the study area, 11,965 (1.9%) of which have farming as their primary occupation, as shown in Table 2. With 4,775 people farming as their primary occupation, Wisconsin has the most number of farmers, followed by Iowa (4,032), and Illinois (3,158).

Table 2: Population & Principal Farm Operators by Primary Occupation

(Source: USDA Agricultural Census 2007 and US 2010 Census)

	Farming	Total Population	Farming Percentage
Illinois	3,158	235,689	1.34%
Iowa	4,032	216,400	1.86%
Wisconsin	4,775	157,328	3.04%
Region Total	11,965	609,417	1.96%

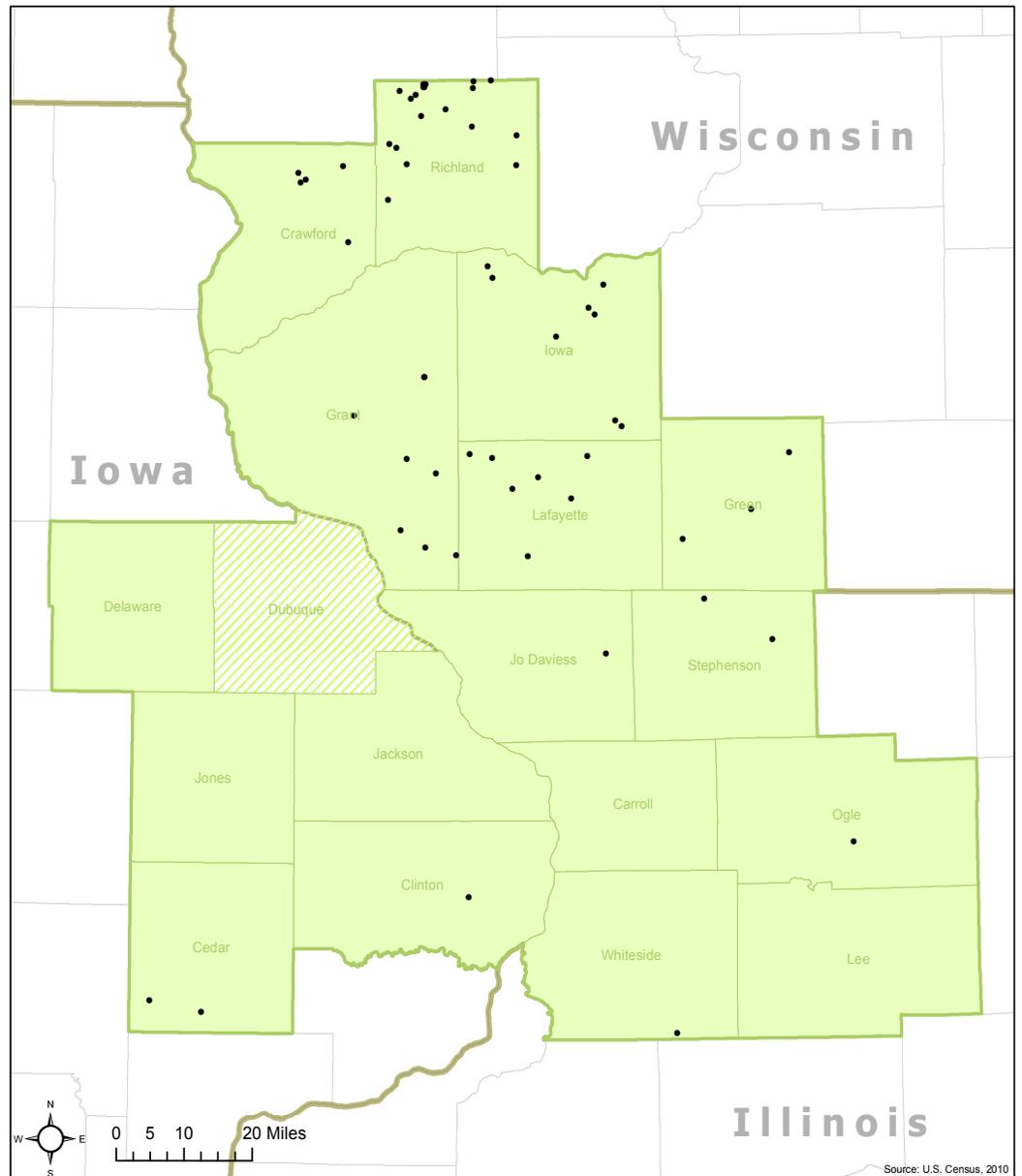
It is extremely difficult to obtain data on the number of produce growers in the Tri-State area. In some cases data is most readily available for certified organic produce growers. This data does not include all produce growers, as many follow conventional production practices and many follow organic practices but have chosen not to become certified. Map 3 shows the location of certified organic produce growers.⁶ This map shows more producers in Wisconsin than in Iowa and Illinois. This map also shows an increased concentration of certified organic producers in the northern parts of the study area, which may be reflective of the influence of Organic Valley, the largest cooperative of organic farmers in the US. Organic Valley's headquarters are in La Farge, Wisconsin, just north of the project study area.

⁶ This report looks at fruit and vegetable production without advocating for or against any specific production method.

This research began with the assumption that a lack of processing infrastructure is the main challenge to strengthening the local fruit and vegetable industry. However, it appears that overall there is sufficient processing and infrastructure. The focus for scaling up should be on production.

Map 3: Certified Organic Producers in the Tri-State Region

(Source: U.S. Census, 2010)



Location quotients (LQ) are a way of quantifying how concentrated a particular industry is in a region as compared to the nation by measuring jobs. The LQ reveals what makes a particular region unique. High LQ industries with significant numbers of jobs indicate that these industries are critical to the regional economy because they tend to generate income from non-regional sources – industries producing more than what is needed locally and are creating surplus that is exported to other regions.

If LQ is greater than 1, this indicates a relative concentration of activity in the area compared to the nation as a whole. If LQ equals 1, the region has a share of activity equal to the national base for that industry. When LQ is less than 1, the region has less of a share of activity than is found nationally. As shown in Table 3, the LQ for agriculture is 3.71, indicating that this is a major export industry for the region.

Table 3: Top 5 Industries by Location Quotient*(Source: EMSI Complete Employment -- 2012.3)*

Description	2012 Location Quotient	2012 Avg. Annual Wage
Agriculture, Forestry, Fishing, and Hunting	3.71	\$24,550
Manufacturing	1.76	\$61,191
Utilities	1.53	\$133,787
Retail Trade	1.25	\$25,903
Educational Services (Private)	1.19	\$27,837

The gross regional product (GRP) is defined as the final market value of all goods and services produced in the region. This figure is the sum of earnings, property income, and taxes on production. Table 4 shows that agriculture and related industries amounts to 6% of the total GRP.

Table 4: Gross Regional Product*(Source: EMSI Complete Employment -- 2012.3)*

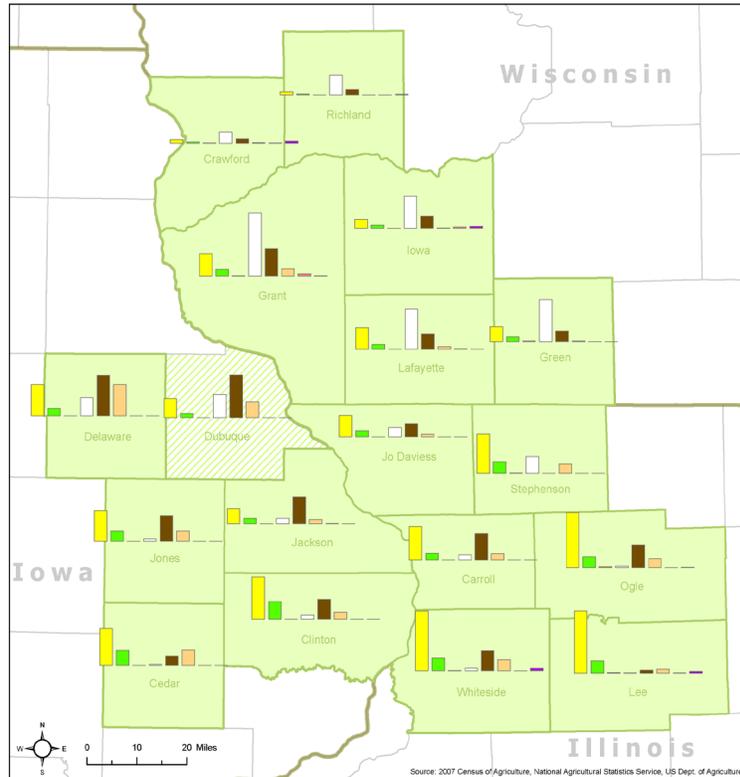
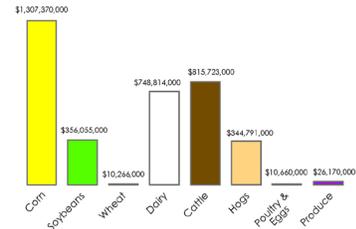
Industry	GRP (2011)	% of Total
Manufacturing	\$4,248,724,660	21%
Government	\$2,083,258,235	10%
Retail Trade	\$1,904,052,766	10%
Finance and Insurance	\$1,733,286,762	9%
Health Care and Social Assistance	\$1,567,258,537	8%
Agriculture, Forestry, Fishing, and Hunting	\$1,221,313,411	6%
Wholesale Trade	\$1,153,696,681	6%

Map 4 shows the predominant agricultural industries by geography. This shows the relative strength of the corn industry in Illinois, the cattle and hog industry in Iowa, and the dairy industry in Wisconsin. This map also shows that the non-wheat produce sales in the region are greater than the produce sales for wheat or poultry.

Map 4: Total Agricultural Sales in the Tri-State Region

(Source: 2007 USDA Agricultural Census)

Total Agricultural Sales
Tri-State Region
2007 Census of Agriculture
Illinois, Iowa, Wisconsin



Production Infrastructure

One way to explore the current state of the produce industry is to understand existing industry infrastructure such as warehouses and processing facilities, aggregators, and distributors. This research project began with the assumption that a lack of processing infrastructure is the main challenge to strengthening and growing the local fruit and vegetable industry. However, it appears that overall there is sufficient processing and storage infrastructure. The focus for scaling up should be on production.

Infrastructure Trends

The data presented in the previous *Study Area Overview* section confirm that agriculture is a strong industry in the Tri-State area. The available information shows that we have sufficient infrastructure for well-developed industries such as meat and dairy.

Infrastructure data for the fruit and vegetable industry is extremely difficult to obtain, particularly from Iowa and Illinois. Available data, however, indicates a much smaller amount of infrastructure for produce than for established industries such as meat,

dairy, and grain. This is understandable considering the produce industry is significantly smaller than these industries. This comparative amount of infrastructure indicates that produce is not yet a developed market in the Tri-State area. As mentioned previously, a lot of production is happening on a scale too small for wholesale markets. Therefore the region is not yet in need of this infrastructure.

Though it is difficult to track infrastructure trends, discussions with various stakeholders indicated that much of the challenge to developing processing and storage infrastructure lies in increasing fruit and vegetable production. This is contrary to what was previously assumed at the start of this research project. One facility feasibility study indicated that there are not enough producers to supply the facility, further supporting this theory.⁷

Data obtained from Wisconsin Department of Agriculture, Trade, and Consumer Protection (DATCP) indicates that infrastructure in Southwestern Wisconsin has returned to levels from 10 years ago after a short decline. There are also a number of infrastructure projects being organized and explored.⁸ Slow Money Wisconsin generated a report indicating that Wisconsin is “one of the few places in the U.S. on the cusp of filling and rebuilding wholesale value chains.”⁹

As discussed later in the report, coordinating mechanisms working to make local produce available at the wholesale level helps to address a lot of stakeholder challenges. In both Iowa and Illinois there are currently projects underway to develop coops. One official at the Illinois Department of Public Health noted that in Illinois there is a trend away from smaller facilities and towards larger facilities.¹⁰

Infrastructure Data

Understanding the available infrastructure for the produce industry, such as processing facilities and food warehousing, is difficult due to data that is both limited and poor in quality. Comparison of the available infrastructure in the three different states is also very difficult. Illinois, Iowa, and Wisconsin maintain data in different formats and varying levels of detail. Also, each state handles regulation and inspection of produce in very different ways. Available data indicates the following state trends:

Illinois

The Illinois Department of Agriculture focuses solely on meat and grain production and regulation while the Department of Public Health handles licensing of facilities for produce. This institutional separation of food production may result in missed op-

7 The *Southern Wisconsin Food Hub Feasibility Study*, conducted by the Dane County Planning and Development Department in September 2011.

8 Some examples include co-ops in Dubuque, IA, Jo Daviess County in Illinois, a greenhouse project being explored by Southwest Opportunities Center, and the Highland Quick Freeze Feasibility Study.

9 Slow Money Wisconsin. California Environmental Associates, 2009. Web. 4 Jan. 2013. <http://www.veda-wi.org/PDF/_notes/Slow+Money+Wis%20Amy%20Dickie%20111809.pdf>.

10 Phone conversation between SWWRPC staff and Illinois Department of Public Health staff, October 2012.

opportunities for produce growers. The Department of Public Health is looking at it from a sanitation and health perspective instead of a production and marketing perspective. A Department of Public Health official said that produce is not regulated and that when the Department has made efforts to introduce state regulatory legislation, they have not been able to find a sponsor.¹¹ Additionally, the official noted that the data collected is very difficult to access. Though the Department recently switched to a new database system, so far the database has not been fully populated. This means that to respond to a comprehensive data request such as specific locations of produce warehouses and processing facilities, the official would need to sort through books of hard copy files -- a very time-intensive task. The Department was not able to provide historical data or differentiate between processing and warehouse facilities.

Iowa

The Department of Inspections and Appeals within the Food and Consumer Safety Bureau handles licensing of produce infrastructure. Their current database tracks historical data up until 2005, showing when facilities opened, went out of business, and for new businesses that have not yet been inspected and are not yet operating. Their database also differentiates between a processing facility and a warehouse. The Department anticipates having a new database in 2013. This is an opportunity to improve the quality of data they maintain.

Wisconsin

DATCP regulates all agriculture and food safety in Wisconsin. The Department is charged with licensing food processing, warehousing, and distribution facilities and can provide a cd with all active licensing data. Licenses are differentiated, between processing facilities and warehouses and the facility location is included. DATCP provides historical data dating to 2003.

Federal Data Sources

Though the U.S. Department of Agriculture conducts a census every 5 years, there is not enough produce production in the Tri-State area at a large enough scale to provide much data. The U.S. Census Bureau's North American Industry Classification System (NAICS) classifies businesses by industry to provide statistical economic data. The NAICS does not get down to the level of detail needed to differentiate between businesses dealing predominantly in produce versus other foods such as meat or dairy, although they do specify certain types of produce production.

Recommendations

Scaling up local produce wholesale value chains will require the region to add additional facilities to support a greater level of produce production. The immediate need is for the region to scale up produce production; processing and storage infrastructure will follow. This issue is addressed in more detail in the market feasibility analysis.

The Tri-State area would benefit from improving data gathering for produce production. Increased information on produce infrastructure could be very useful to the private sec-

¹¹ Phone conversation between SWWRPC staff and Illinois Department of Public Health staff, October 2012.

tor as businesses determine where to re-locate or start a new business and to stakeholders working to strengthen the local and regional food economy. Without this data it is very difficult to identify growth trends and infrastructure needs.

Both Illinois and Iowa are currently in the process of making changes to their databases. This is an opportunity to improve the level of detail of data collected, such as tracking the type of processing and storage facilities. This would increase transparency and access to people working to strengthen the local and regional food system.

Additionally, Illinois and Wisconsin should follow Iowa's lead by institutionalizing the promotion of local and regional food systems at the state and local levels. This is seen in the Iowa Local Food and Farm Plan (2011) and the development of regional planning programs directed specifically at local and regional foods. A unique aspect of the Iowa Local Food and Farm Plan is that it was a document guided by the Leopold Center for Sustainable Agriculture and requested by Iowa legislators who sought a plan specific enough to allow them to take action. It was specifically designed with legislative action in mind, which is reflected in the Plan's recommendations.

Stakeholder Perspectives

To help better understand stakeholder perspectives, over 22 stakeholders in Iowa, Illinois, and Wisconsin were interviewed. These stakeholders include fruit and vegetable producers, aggregators, distributors, and buyers. Below is a summary of findings from each stakeholder group.

Producers

Producers are people currently growing fruit and vegetables. Many producers are also directly involved in processing, storing, and distributing their own product. Some producers have their own cleaning and packing, storage, and/or distribution facility. Others are processing by renting time at a shared facility. Several of the producers are using season-extension infrastructure such as greenhouses. The producers that are distributing on their own are distributing very locally, within approximately 50 miles of their business. One larger producer is distributing nationally.

Scale & Aggregation

Much of the challenge to scaling up remains in aggregating, distributing, and marketing. The majority of the producers are selling product through small-scale arrangements -- directly to individuals through CSAs, farmers' markets, and farm stands. Small-scale producers, which are predominant in the region, are selling a pound at a time by hand, which is very time and energy intensive. One producer noted that he preferred to sell at farmers' markets because he received a higher price that way instead of for wholesale. A few producers are selling to large processing businesses or wholesale grocers. While some producers enjoy the lifestyle of small-scale production, high production and market risks are challenges that prevent producers from scaling up.

Risks & Mitigating Risks

Fruit and vegetable production is risky. Weather and irrigation can be challenging production factors. Vegetables can be more difficult to produce than meat or dairy and their

Currently the majority of producers are selling product through small-scale arrangements such as farmers' markets and CSAs. Growing fruits and vegetables is very risky, and the majority of producers interviewed are not interested in expanding.

Fruit and vegetable production is very labor-intensive. One of the major challenges producers face is finding a skilled labor force.

seasonality and quick deterioration can make their availability less predictable and more difficult to guarantee to customers. One potential solution is to increase production of processed fruit and vegetable products such as frozen foods. However, there are not many opportunities for small to mid-size growers individually to process foods. Many institutions prefer frozen foods, so an institutional quick freeze facility¹² would be beneficial. This type of upstream facility would allow small to mid-size growers breathing room to over-produce.

Expansion

Many producers are at a scale that is too small for wholesale markets. Making a leap to scale up can be risky. Aggregation, marketing, and distributing are also challenges. As one producer said, they are each a full-time job. Operating at a small scale makes sense, as producing, marketing, and distributing is very time and resource intensive.

The majority of the producers interviewed are not interested in expanding, commenting that it is too much work and they are already producing as much as they can handle. Some producers, including newer producers, note that they were not left with much surplus product at the end of the season but are interested in expanding. One producer expressed interest in expansion but was uncertain as to whether or not the market exists. Another producer is interested in expanding specifically to meet the needs of his expanding catering business. For that, he is increasing production of crops such as potatoes, onions, carrots, turnips, rutabagas, and winter squash – product that store well. These are stable crops, the production of which has already been scaled up to some extent in the region. These crops are more reliable, making them easier to guarantee to a client.

In multiple conversations throughout the region, it is noted that without an increased amount of produce and without aggregation of produce, scaling up local and regional foods in the Tri-State area will be very difficult.

Labor

Another challenge facing producers is finding a skilled labor force. Many producers in Wisconsin are Amish where larger families and a cooperative culture help mitigate labor issues, but non-Amish producers have reported difficulties in finding labor. As one said, for the last decade or so it has been difficult to find people willing to work in the field and harvest produce. People think agricultural work is beneath them; it is difficult work and people do not want it. Some producers hire seasonal workers, but the worker generally requires training. Some workers are high-school age and require careful supervision. As the workforce changes each year, employers must spend time and energy training new employees. Additionally, producers noted difficulty in paying a living wage and keeping crop prices low.

Aggregators & Distributors

Aggregators and distributors are businesses who process, store, distribute, and/or transport product for multiple producers. Aggregators focus predominantly on aggregating product and have close relationships with producers, though they may also distribute to

¹² A feasibility study for a quick freeze facility in Highland, Wisconsin, was recently conducted by Southwestern Wisconsin Community Action Program.

multiple buyers and markets and may process product. Distributors may also aggregate product, work with producers, and process product, but their focus is predominantly on distributing product to buyers and market.

The distributor interviewed for this report grows and distributes product nationally. Their production is based in different areas based on the timing of growing seasons. All the product is aggregated and it is not differentiated based on where production occurs. The only way that product could be differentiated is based on what time of the year it is produced. This distributor has not seen a demand from their customers to know the product's specific origin.

Interest in Expansion

Of all the stakeholder groups, aggregators and distributors are expanding the most rapidly. They are increasing the amount and variety of product they offer and building new facilities. The aggregators interviewed for this report are smaller and relatively new, having started aggregating in the last 4 years, but they are expanding quickly. They are currently distributing to Dubuque, Minneapolis, Madison, Milwaukee, and Chicago, although their geographies are increasing as well. There is enough demand and interest in locally sourced foods that these aggregators have producers and buyers calling them looking to work with them.

Additionally, one of the aggregators is expanding the amount of processed product he provides. He currently processes fresh cut items and dried goods and plans on processing dried herbs and soup mixes, experimenting to determine market demand.

Infrastructure

One of the aggregators is currently renting space from the Food Enterprise Center in Viroqua, Wisconsin, a 100,000 square foot multi-tenant aggregation, storage, processing, and distribution facility. Another aggregator is currently renting storage space at multiple locations and is planning to build a warehouse next year.

Labor

The aggregators do not have the labor challenges that the producers have; it appears more people are interested and willing to handle marketing, processing, and trucking jobs than production jobs.

Converting Producers from Row Crops to Produce

A distributor that was interviewed for this report approaches growers currently producing row crops such as field corn and soybeans and works with them to produce vegetables. The distributor approaches the producer with a contract using prices based on field corn or soybean price averages and provides seed for producers to plant. Farmers receive guidance from the company throughout the growing process and the distributor harvests the crop. Though vegetables are a higher-value crop than row crops, they are higher risk and more labor intensive, so initially some producers are skeptical when first approached. However, the distributor guarantees a minimum return per acre to help mitigate risk.

Some farmers are not able to raise vegetables because of policies in the Farm Bill. Some-

The most confident expansion is taking place by aggregators and distributors in terms of offering more product and building facilities.

Multiple buyers noted that there is not enough local supply to fill demand. They must source from further away even though they prefer to source locally whenever possible.

times farmers are able to get exceptions from the government to allow them to produce vegetables, but that may require an exception to a policy. Generally, once the farmer switches from field corn or soybeans to vegetables, they are pleased with the change. However, it depends a lot on the growing season.

Challenge: Lack of Distributor Commitment

A lack of commitment from large distributors can be a challenge. These distributors are still learning to handle local food and it is such a small part of their overall business that they do not dedicate much energy or personnel to it. An aggregator noted that larger distributors will be enthusiastic about local food in winter but will not carry through with orders or make much of a commitment. This can be difficult for producers, because without a commitment it is difficult for them to determine what or how much to grow as there is no guarantee they can get their product to market.

The larger distributors such as Sysco and Reinhart are, however, starting to incorporate programs differentiating local and regional product. Reinhart, for example, is part of the Fifth Season Cooperative,¹³ and is discussed in more detail in the Buyers section.

Challenge: Scale

A big challenge to building the regional produce industry is reaching the economy of scale to improve profitability. Having a continuous and robust supply of local product can be a challenge, as can having a product list that appeals to buyers. Aggregators are looking for upper-small to medium producers so they can be certain of enough product to be profitable to work with that producer.

Additionally, it is important to improve distribution efficiencies. For example, trucks are not always filled to capacity. One potential solution would be to develop mechanisms to share trucks. However, this could be complicated, as this is in part dependent on where the trucks are delivering.

Challenge: Coordination & Collaboration

The aggregators interviewed for this report were enthusiastic and confident enough about market opportunities that they were not concerned about competing with other local aggregators. They observed that the market is growing so fast and the local aggregators are so small that there is no way they can cover the whole market. One of the aggregators currently ships for several farms that do not have a contract with him. This helps him to get his product to its destination more cheaply, and this agreement builds a relationship between the aggregator and the producer.

¹³ Fifth Season Cooperative is a multi-stakeholder cooperative made up of producers, producer groups, food processors, distributors, and buyers from the 7 Rivers Region. The 7 Rivers Region is located north of this project's study area and includes the following counties in Iowa, Minnesota, and Wisconsin:

Iowa: Allamakee and Winneshiek.

Minnesota: Houston and Winona.

Wisconsin: Jackson, Juneau, La Crosse, Monroe, Trempealeau, and Vernon.

Challenge: Facility Profitability

Scaling facilities to match growth can be a challenge. The financial aspect of maintaining a specialized facility can also be difficult, an issue that is discussed in more detail in the *Processing & Facility Needs* section of the *Grower Guide*. Some plants process a different type of product during the offseason. For example, a plant might continue to process a product that isn't as perishable as vegetables, such as meat.

Buyers

For the purposes of this report, buyers are large volume buyers, not individual households. These include grocery stores and institutions such as hospitals, medical centers, schools, and restaurants. Though it is still not very frequent, sourcing local and regional food is a growing trend¹⁴. As one chef noted, this has the potential to be an economic development opportunity, not only by supporting local and regional farms and agribusinesses, but also by developing the region as a culinary destination.

A commonly identified challenge is the need for producers and aggregators to understand the buyers needs. A number of stakeholders noted that it is particularly important to find middle ground between producers and buyers. This section will explore challenges buyers experience and some solutions to these challenges.

Challenge: Lack of Consistency & Quantity

Multiple buyers noted that there isn't enough local supply to fill the demand, so they must source from further away, even though they prefer to source locally whenever possible. This concern was particularly strong amongst those buyers who have found that their customers are willing to pay more for local produce. One Iowa buyer noted that the distance from growers and the lack of availability in eastern Iowa is a challenge. Additionally, some buyers have had experiences where producers are growing as a hobby and are not committed to consistently providing a product. This is a huge challenge for buyers, who require high quality products of sufficient quantity to meet demand. As one buyer for a medical institution noted, reliability is critical for large institutions so they can depend on the availability of the product. From a buyer's perspective, knowing that the product is consistent is important when using recipes. Additionally, the same challenges that producers experience with variable weather and crop availability directly impacts buyers. Many buyers prefer the predictability and simplicity of sourcing from broadliners¹⁵ who can provide products at any time, regardless of weather challenge.

14 Within the National Restaurant Association's top 20 trends for 2013, five are related to local products: (1) locally sourced meats and seafood, (2) locally grown produce, (4) environmental sustainability, (7) hyper-local sourcing, and (11) farm/estate branded items.

"What's Hot: 2013 Chef Survey." (n.d.): n. pag. National Restaurant Association, 4 Dec. 2012. Web. 8 Jan. 2013. <<http://www.restaurant.org/pdfs/research/WhatsHotFood2013.pdf>>.

15 A "broadliner" is a "foodservice distributor who carries a 'full-line' of products including dry grocery, frozen, tabletop, equipment, and supplies. Many broadliners also carry perishable items such as meat, dairy, and produce." "Broadline Distributor." Technomic. Web. 8 Jan. 2013. <http://www.technomic.com/Resources/Industry_Facts/dyn_glossary.php>.

Challenge: Logistics

Working out the logistics of sourcing local food can be a challenge, particularly when sourcing is based on arrangements directly between the buyer and multiple producers and it is necessary for both parties to have a mutually agreeable arrangement. As one buyer noted, sometimes there are really great producers, but they are not able to come to an arrangement because the buyer needs a particular delivery schedule. Additionally, buyers may have a challenge coordinating with many local producers instead of conveniently of sourcing from a broadliner.

Additionally, for restaurants and institutions such as hospitals and schools, it can be extremely difficult and resource-intensive to manage a kitchen while handling the multiple product inquiries and deliveries from local producers. Working with many producers is less resource-intensive than working with a few aggregators or distributors. Local food availability is also largely dependent on seasons, except when season-extenders such as greenhouses are used. This seasonal availability can pose challenges, such as requiring a change in menus.

Challenge: Competitive Pricing

Several buyers noted that growers sometimes ask for a higher price than the market allows. Buyers emphasized that producers need to know market prices and understand what constitutes a reasonable price. Additionally, for buyers who are selling their products to a final customer, such as in a restaurant, the price of the end product, for example, a salad, matters a lot and is determined by produce costs. Affordability is crucial. A buyer is only able to pass increased food prices along to the customer when that customer is willing to pay a premium price for local food. In some cases, the customer is willing to pay more but in most he/she is not. In these cases competitive pricing is crucial.

Challenge: Existing Contracts & Relationships

One medical institution reported that they are required to go through their existing vendors and that they could only purchase local products if they are included in their contracts with these vendors. These contracts result in the institution using the same products year round, which is much more convenient for the institution. As the institution noted, in order for an increase in sourcing local or regionally sourced food, it must be easy to do so. For example, when aggregators or distributors are sourcing the local food so there are fewer deliveries.

This same challenge of buyers having existing contracts and strong relationships within existing, non-regional streams was observed elsewhere. One aggregator noted that even when he could quote lower prices than what the buyer was getting from their existing contract, the buyer would not accept because they had the existing relationship with another supplier.

Challenge: Buyer Preference

Though some grocers, restaurants, and institutions noted that they have certainly seen customers willing to pay a premium for local or regional foods, others said that the food source was not a priority for their customers. Therefore, the institution is not interested in sourcing local or regional products unless it is just as convenient and competitively

priced as non-local products.

In another case, an Illinois chef held events designed to connect restaurants and growers, but they were the only restaurant to show up. If local food is not a priority for buyers, then it will be difficult to develop channels and systems supporting integrating local and regional food into institutions. Also, even when chefs and cooks of an institution are interested in sourcing more local and regional food, oftentimes they are dependent on whether or not they have the freedom to do so from the owners.

Challenge: Cooking & Food Preparation Styles

The majority of institutions and restaurants are not putting a priority on sourcing locally or regionally and are not willing to struggle with the logistics to make that work. Restaurant culture in the Tri-State area has not necessarily promoted local and regional food and it is not necessarily something a lot of food preparers have experience with. Chefs and cooks don't necessarily have the knowledge to work with whole ingredients. On some level that is shifting because there are an increasing number of interested customers.

Solutions & Lessons

Currently, the buyers that are sourcing local and regional food are going out of their way to do so and are making it a priority. Some buyers are going to farmer's markets and pushing through the difficulties because they see their customers valuing local and regional foods enough to make the logistics work. However, if the Tri-State region is going to scale up production, solutions other than the dedication of passionate individuals will be required. Below are some solutions and lessons from leaders in the Tri-State area.

Coordinating Actors

Local produce is successfully entering wholesale and mainstream value chains is where someone – aggregators or cooperatives -- is working in the middle to get product from producers to buyers. For this reason, co-ops have been used by medical institutions and other buyers.

One such co-op is the 5th Season Cooperative based in Viroqua, Wisconsin. This co-op has organized to get product to larger institutions such as hospitals and schools. 5th Season Cooperative is a multi-stakeholder cooperative that includes buyers, producers, distributors, and those who are creating value-added product. The co-operative has helped in getting product to large institutions and handling food safety issues. For a buyer to purchase local food from the participating distributor, the buyer selects specific item codes for local products.

Additionally, the co-op helps facilitate price structure both on the producer end and the buyer end. The producers know what they'll get from the co-op and stakeholders hope that soon the co-op will be able to contract with producers. This also helps the buyer to know that they can get tomatoes locked in at a certain price during the season. The co-op also helps minimize the number of deliveries, as multiple deliveries are time-consuming and costly. Partnering with organizations such as 5th Season Co-operative and Reinhart can make incorporating local and regional foods easier and more manageable.

Local produce is successfully entering wholesale and mainstream value chains where someone -- aggregators or cooperatives -- is working in the middle to get product from producers to buyers.

The need for the sourcing process to be simplified, particularly for institutions who are ambivalent to food source requires getting local and regional foods into mainstream distributor warehouses.

Another solution is for restaurant and other owners to give buyers the freedom to source produce from alternative sources as they deem appropriate. A lot of the ability to source local and regional food comes down to owners giving buyers the freedom to determine where they purchase products. Some owner concerns about sourcing local food can be mitigated by requiring producers to show proof of insurance and compliance with food safety practices.

Value-Added Products

For restaurants and institutions where cooks and food preparers are more familiar with cooking from a can instead of using whole ingredients, it is necessary to have value-added products available. This would increase the accessibility of local and regional products to cooks who don't have the background to use products from scratch. As mentioned in the *Aggregation and Distribution* section, value-added processed products are also a way to generate income from lesser-quality product that is still safe for consumption, minimizing food waste.

Buyer Pricing Strategies

One Illinois restaurant altered their meal structure so that soup and salads are now extra so that people only receive them if ordered. This has helped both with the cost of the meal and with reducing food waste.

Additionally, for institutions or cooks working to convince an owner to try local products, it can be beneficial to look at the budget as a whole. This is because seasonal costs can change significantly and can be a bit unfamiliar for restaurants and institutions used to traditional accounting. For instance, one institution substitutes a cheaper product in a recipe when incorporating local/regional products so that the overall product price remains close to the same. This institutional buyer noted that, depending on the season, you may pay more for a conventional product anyways.

Seasonal Menus

Institutions who have successfully integrated local products are solving seasonal availability issues in part by having a variety of menus and by being vague on the menu items. The chef at an Illinois restaurant has a vague base menu that does not elaborate on what a seasonal vegetable is, providing flexibility. Additionally, every night there are three meat specials, which allows for flexibility in showcasing local and regional meats. From March to November, he runs a chef's menu series. The theme of the menu is laid out ahead of time so it can be marketed, but the actual menu isn't posted until approximately two weeks before it is served. This provides flexibility in use of ingredients.

Another institution has started taking steps towards creating more seasonal menus by substituting seasonal sides such as vegetables based on seasonal availability.

Marketing & Product Differentiation

Time and again, producers, marketers, and buyers emphasize the importance of “telling the story” of the food. An Illinois restaurant does this through daily staff training to ensure that staff can answer questions about ingredients and the food. They also work to incorporate products from other shops and businesses in the area to make specialty products and meals. This demands a higher level of professionalism and detail than would be required from staff if they worked at restaurants that do not focus on telling that story. This restaurant also uses social media in their marketing. Additionally, at the entrance of the restaurant they place chalkboards listing the specials and the local produce that is available so that customers can see them as they walk in.

An Iowa grocery store and a medical institution put labels and signs to differentiate local and regional products to the end customers. When the product is regional the store uses a “product of the Midwest” label. It also incorporates large signs with pictures and information about the producers and their farm. A Wisconsin medical institution intends to make this information electronic soon. They also put up nutritional information, which meant that even though they had to raise prices slightly when they switched to a healthier product, there were no complaints from customers.

Market Feasibility Analysis

Exploring the supply, demand, pricing, cost, and comparative advantage of fruit and vegetable production in the study area.

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Federal policies encourage geographic concentration of fruit and vegetable production. This makes the fresh produce supply increasingly vulnerable to environmental shocks.

Section Summary

The *Market Feasibility Analysis* explores the viability of increased produce production in the study area by looking at supply, demand, pricing, cost, and comparative economics of the produce industry.

Section Highlights

There are several key trends that will likely affect this viability:

- **Fruit and vegetable production is risky in the study area.** The amount of production risk that growers face in the Tri-State region is significantly higher than other produce growing regions or with row crops within the region. This is due to limited production experience and knowledge, and lack of shared infrastructure such as greenhouses and equipment. Current government policies that only subsidize corn and soybean production in the area only exasperates the lack of insurance for produce growers. A combination of policy changes and private solutions are needed to overcome this challenge.
- **The Tri-State area is lacking in skilled labor.** Fresh fruit and vegetable production is very labor intensive. An increase of migrant workers in the rural Midwest is a positive trend, but it is not sufficient to meet the demand required for the growth of the produce industry in the region. California has a clear competitive advantage with regards to current labor supply for fruit and vegetable production. The increasing supply of skilled migrant labor into the Tri-State region provides opportunity to foster fruit and vegetable production, thereby supporting higher value crop production compared to the lower value commodity production that currently exists. It is also an opportunity to diversify the regional agriculture economy away from commodities such as corn and soybeans and therefore reduce consumer dependence on any single geographic location for produce.
- **US fruit and vegetable production is declining, becoming more specialized, geographically concentrated and posing new risks for consumers.** As fruit and vegetable production declines in many parts of the country, increased geographic concentration of the United States fresh produce supply poses new risks for consumers. Produce supply is increasingly vulnerable to drought or other environmental shocks that lead to crop failure. Increased dependence on foreign imports may lead to food security risk and a greater chance of supply disruptions. Impacts from these trends are difficult to quantify and can lead to both short-term benefits (lower prices) and long-term costs (food insecurity, higher prices and volatility). Produce is particularly vulnerable since it is difficult to quickly and cost effectively scale up domestic production once it is lost.
- **Transportation costs are increasing.** Increasing transportation costs may benefit growers in the Tri-State region if marketing efficiencies such as those found in California can be achieved. These efficiencies require a scale of farm production and packaging capable of filling semi-trucks and therefore take advantage of lower transportation costs. Large scale production and sufficient quality control is also important to supply wholesale buyers with the same standards as California

produce and minimize brokerage fees or marketing costs per pound. In general, existing producers in the study area have not achieved this scale of production and consequently the transportation advantages have not been fully realized. Marketers, through collection and aggregation, have worked to improve farm-to-wholesale transportation but the model is still inadequate relative to California producers. It will be imperative to develop a marketing and distribution system that takes full advantage of potential transportation savings in order to increase production in the region.

- **The US diet is becoming more diversified.** In recent years, US consumption of fruits and vegetables has increased considerably. This shift is significant for the Tri-State area because the region has a surplus or balanced trade of low demand vegetables like carrots, cabbage, peas, potatoes, and snap beans and a major deficit of produce that is experiencing a growing demand, such as peppers, lettuce, and tomatoes. There is little evidence to indicate these trends will change. The increasing cultural and ethnic diversification within the US is broadening fruit and vegetable consumption. Additionally, there is a greater focus on health and obesity issues. These cultural trends generally favor less consumption overall but higher consumption of fresh fruits and vegetables. Producers should focus efforts on crops with expanding demand such as spinach, peppers, eggplant, and tomatoes.
- **“Buy Local” demand has been high.** Support for the “Buy Local” movement has been a boon for the advancement of grassroots, small scale farms (2 to 5 acres) in the region. This has supported the development of physical infrastructure such as farmers markets, restaurants, distribution trucks, storage facilities, etc. “Buy Local” demand has also increased production knowledge. This correlates with a nationwide consumer interest in the origin of food and how it was produced. This trend has produced key components needed to build a larger scale more efficient wholesale production model by tapping into existing distribution systems and developing a more advanced processing infrastructure within the region.

Increasing transportation costs may benefit growers in the Tri-State region if marketing efficiencies such as those found in California can be achieved. These efficiencies require a larger scale of production and aggregation is currently exists.

Produce consumed in the study area, especially fresh produce, is increasingly likely to come from California, Florida, or as far away as South America, even during harvest season in the Midwest.

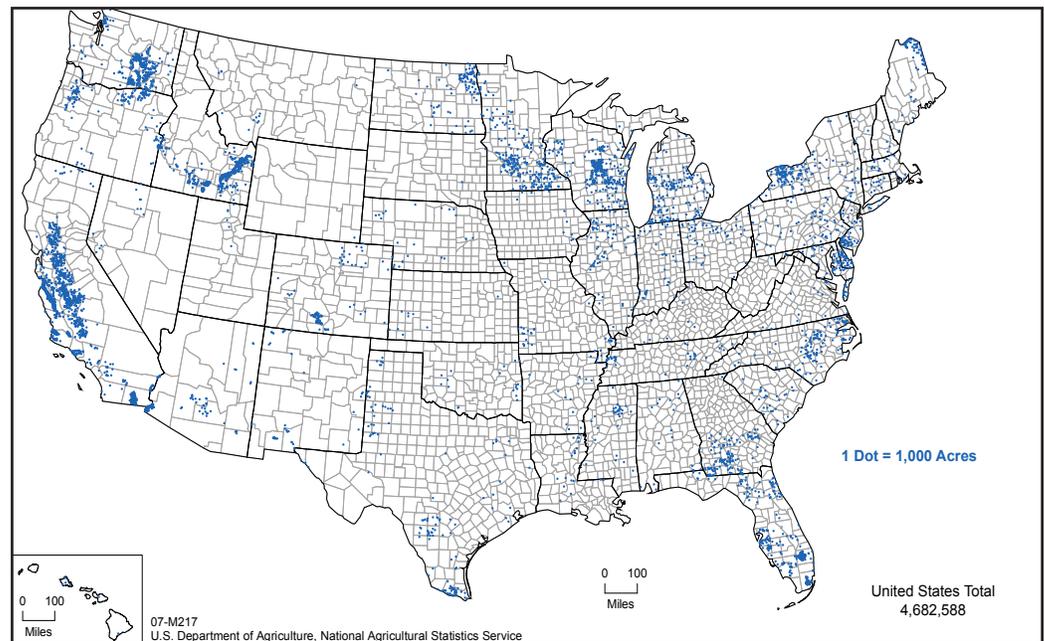
Supply

The produce consumed in the Tri-State Region is generally grown more than 100 miles from region, and even outside of the Midwest. Produce consumed in the study area, especially fresh produce, is increasingly likely to come from California, Florida, or from as far away as South America. This is true even during harvest seasons in the Midwest.

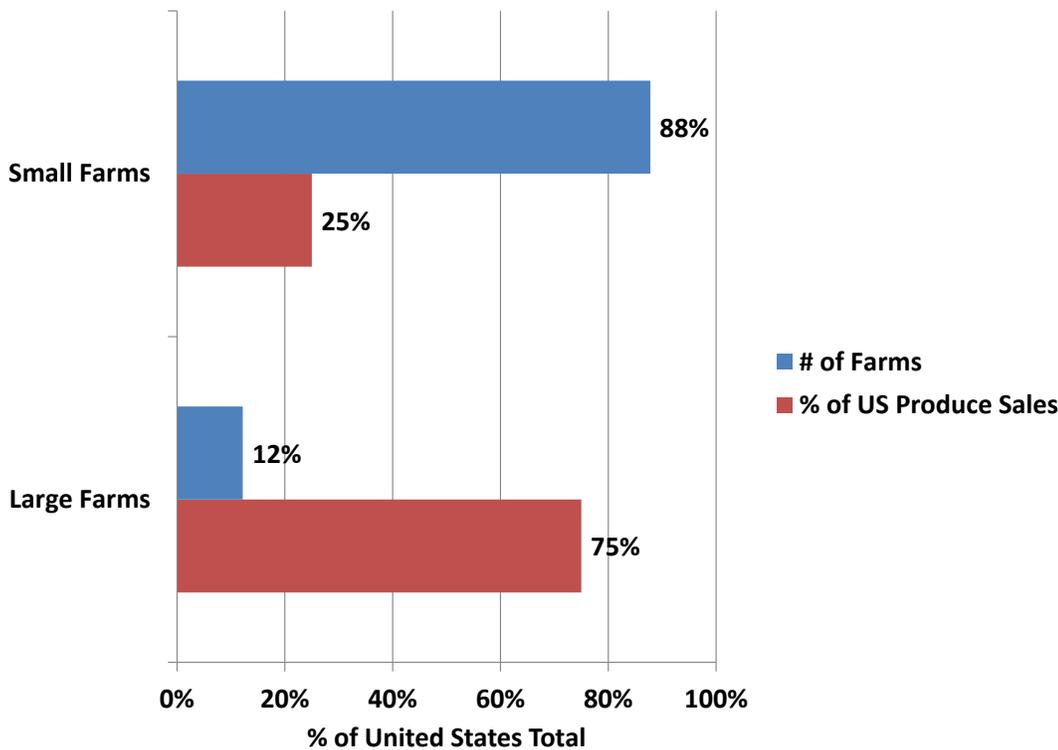
The United States produces about 90% of the produce that it consumes. Of this, the largest vegetable production acreage is in California, North Dakota, Idaho, Michigan, Minnesota, Washington, and Wisconsin (Map 5). Over half of all vegetable production occurs on irrigated land. California and Florida produce the most diverse selection and largest amount of fresh produce by value in the country.

Map 5: Land Used for Vegetables, 2007

(Source: Prepared by USDA, Economic Research Service using data from USDA, National Agricultural Statistics Service, 2002 Census of Agriculture)



According to the 2007 US Census of Agriculture, the majority of US vegetable farms are small (defined as less than 25 acres) and individually owned. Roughly 88% of the over 69,000 farms producing vegetables harvest less than 25 acres each. At the same time, large operations (25 acres or more) make up the majority of sales. In fact, about 12% of large operations account for 75% of the dollar value sold by US growers (Figure 2).

Figure 2: Comparison of Fruit and Vegetable Production v. Farm Size*(Source: 2007 Agricultural Census, USDA)*

Due to the climate in the US, most domestic fruit and vegetable production is seasonal, with the largest harvests occurring in the summer and fall. In the winter, much of the fresh produce is imported from other countries. The majority of domestic produce originates from California during the summer and fall, and from Florida during the spring.

US fruit and vegetable yields per acre have slowly risen in recent years due to the introduction of hybrid plant varieties, many of which exhibit improved disease resistance, better storage attributes, and greater production per plant. The adoption of precision farming techniques such as drip irrigation, plastic mulches, row covers and high tunnels, more effective pesticides, high-density planting, and the use of global positioning systems have also boosted yields and advanced the ability to grow crops in diverse regions.

Despite these per-acre yield increases, domestic production overall has been on the decline in recent years, resulting in produce being imported from Canada and Mexico even during the US production seasons. This decline is correlated with a number of Federal policy changes. Biofuels policy shifted dramatically in 2005, increasing the demand for corn-based ethanol. Agreements from the North American Free Trade Agreement (NAFTA) ended trade duties between Mexico and the United States for produce and meat earlier in the decade. Additionally, the evolution of federal crop insurance over the last two farm bills (2002, 2007) may have played a significant part in the sharp decline in domestic produce production. These ideas are substantiated by the empirical data found in the *Supply* section and will be explored with greater depth later in this report.

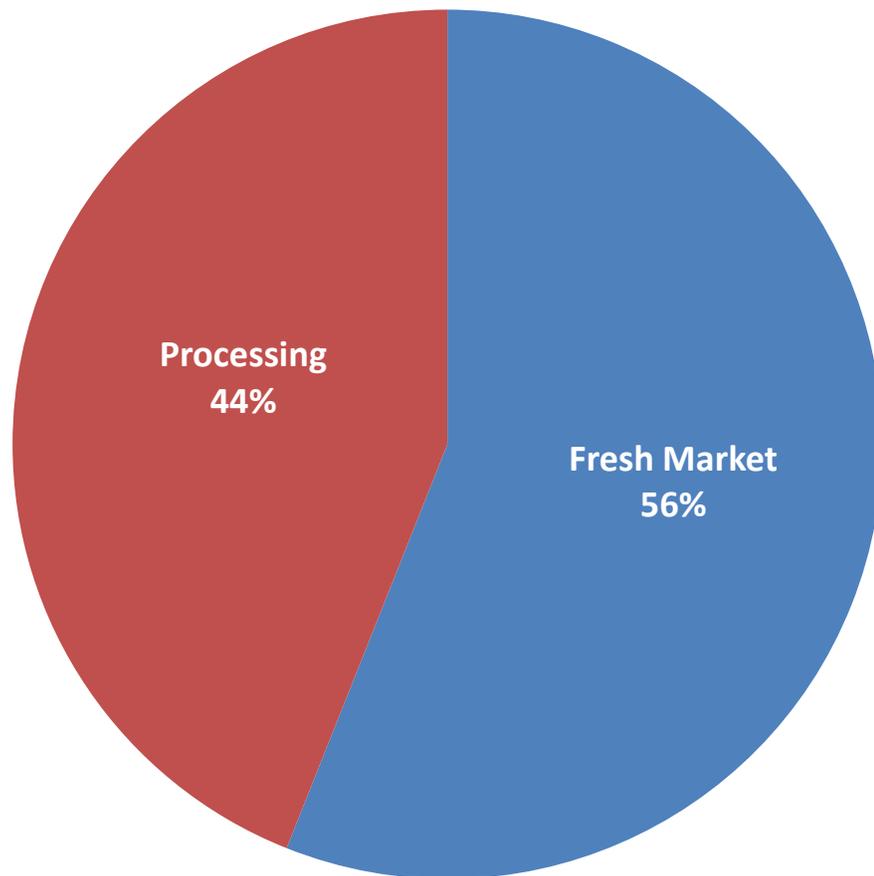
Domestic production of fresh produce has been on a steady decline over the last decade, leading to an increase in US net imports. This increase in imports is also due to a slight increase in fresh vegetable consumption.

Fresh Fruits & Vegetables

The produce industry is generally classified by two major end uses: fresh market and processing. Fresh market produce accounts for approximately 56% of land in fruit and vegetable production in the US (Figure 3). Produce grown for fresh market is often produced using different seed varieties and production methods than produce for processing since the physical appearance of the end product is often a major consideration for the fresh market.

Figure 3: Produce Area Harvested by End Market Type

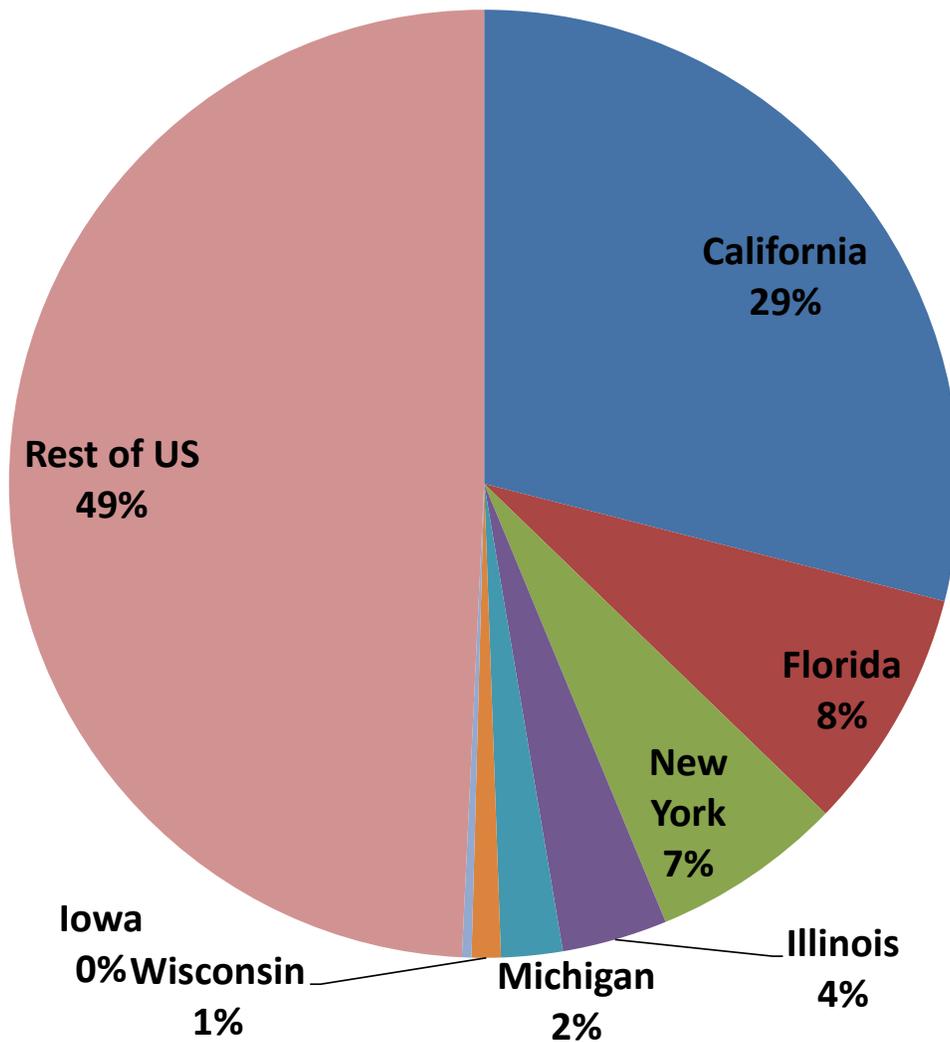
(Source: USDA NASS)



California, Florida, Arizona, Georgia, and New York produce most of their fruit and vegetable crops for fresh markets. California's share of fresh produce production is nearly four times larger than its closest domestic competitor, Florida, (Figure 4) and accounts for approximately 29% of all US fresh produce sales.

Figure 4: US Fresh Produce Sales by State

(Source: US Census Wholesale Sales Data)

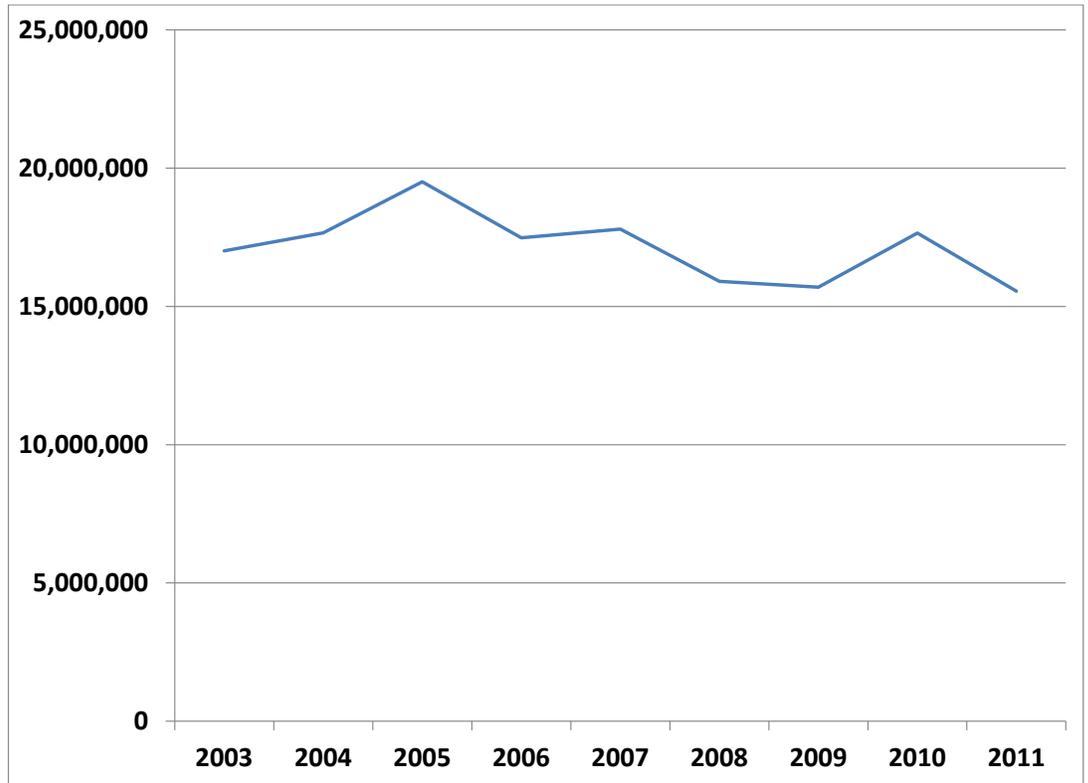


Domestic production of fresh produce has been on a steady decline over the last decade, leading to an increase in United States net imports. In 2011, domestic production levels fell below 1994 levels and appear to be following a downtrend that started in 2005 (Figure 5). Acreage dedicated to fresh produce declined from about 2 million in 2003 to about 1.8 million today. Approximately one-third of that decline occurred in California, a 10% decrease. From 2003 to 2007, the Tri-State region lost 40,000 of 265,000 fresh produce acres,¹ a 15% decline in 5 years.

¹ High quality county level data is difficult to obtain for production of both fresh and processed produce involved in the study area. The data available is either outdated (2007 Agriculture Census) and/or generally less reliable than state or nationwide figures.

Almost \$1 out of every \$10 spent on produce in the US is going to foreign producers and associated transportation costs.

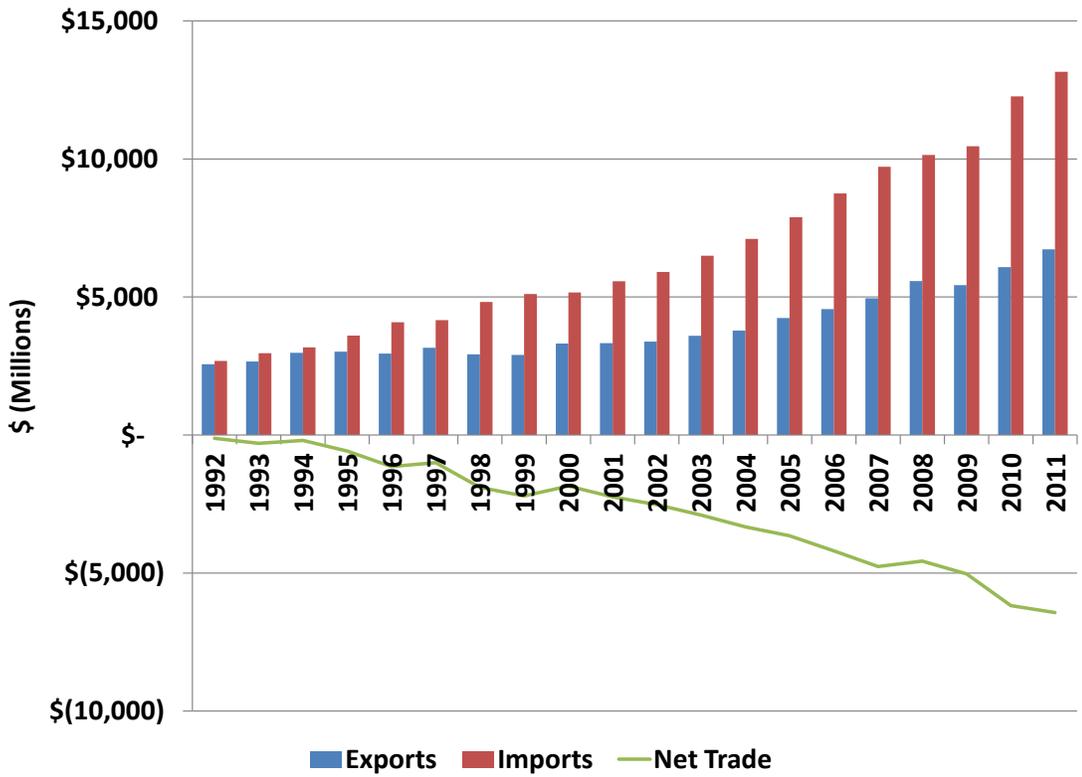
Figure 5: US Production of Major Fresh Market Vegetables
 (Source: USDA NASS)



While California remains the single largest source of fresh produce in the United States, imports have been the fastest growing area of new supply. After being a net exporter in the 1980s, the United States now has an annual fresh produce trade deficit of over \$6 billion (Figure 6). This means almost \$1 out of every \$10 spent on produce in the United States is going to foreign producers and associated transportation costs. This trend has noticeably accelerated in recent years due to an increase in conventional row crop production and foreign subsidies that undercut domestic suppliers. It is probable that rising net imports will continue. These imports are sensitive to fuel and transportation costs, however, especially considering the majority of imports are coming from Mexico and Latin America via truck.

Figure 6: US Fresh Produce Trade -- Annual

(Source: USDA FAS)

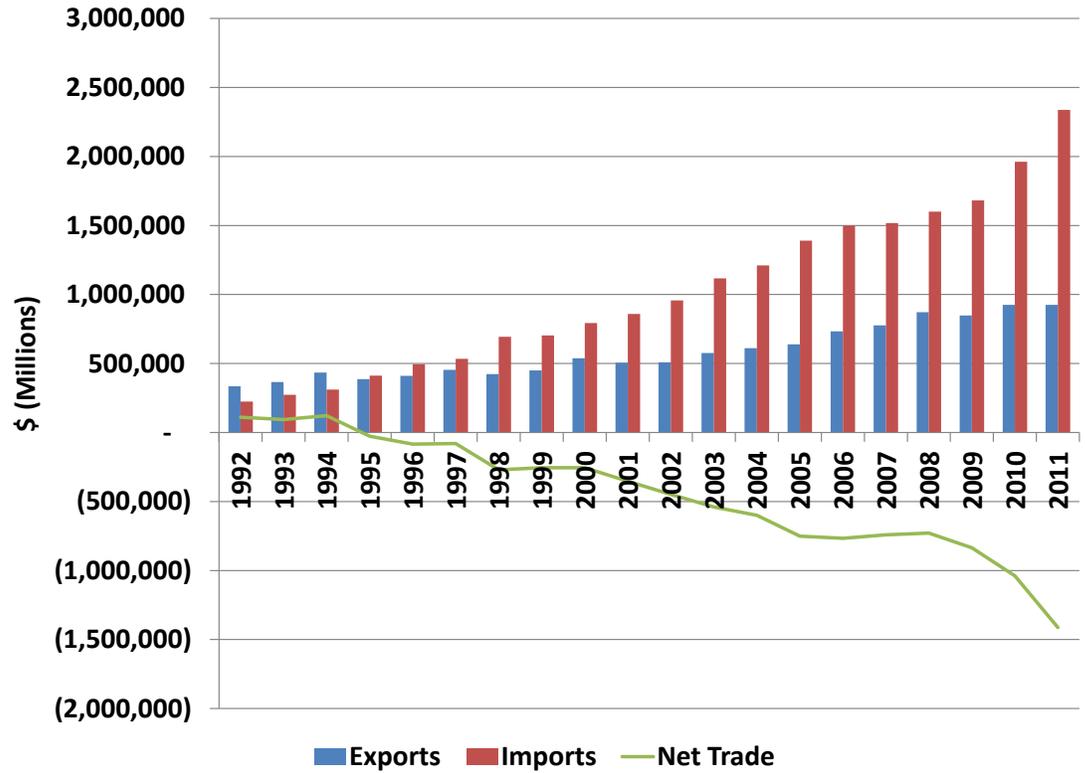


Current policies have created a strong trend of exporting grain and meat, not produce. A change in US agricultural policy may provide more incentive for produce growers in the Tri-State area.

Data on seasonal fresh vegetable imports reflect a 25% surge between June to November annually over the last two years versus a less severe 6% annual growth the prior previous 5 years (Figure 7). This is driven primarily by declining production in the United States, but also reflects a slight increase in fresh vegetable consumption, which will be reviewed in detail in the *Demand* section.

Figure 7: US Fresh Vegetable Trade -- Seasonal

(Source: USDA FAS)

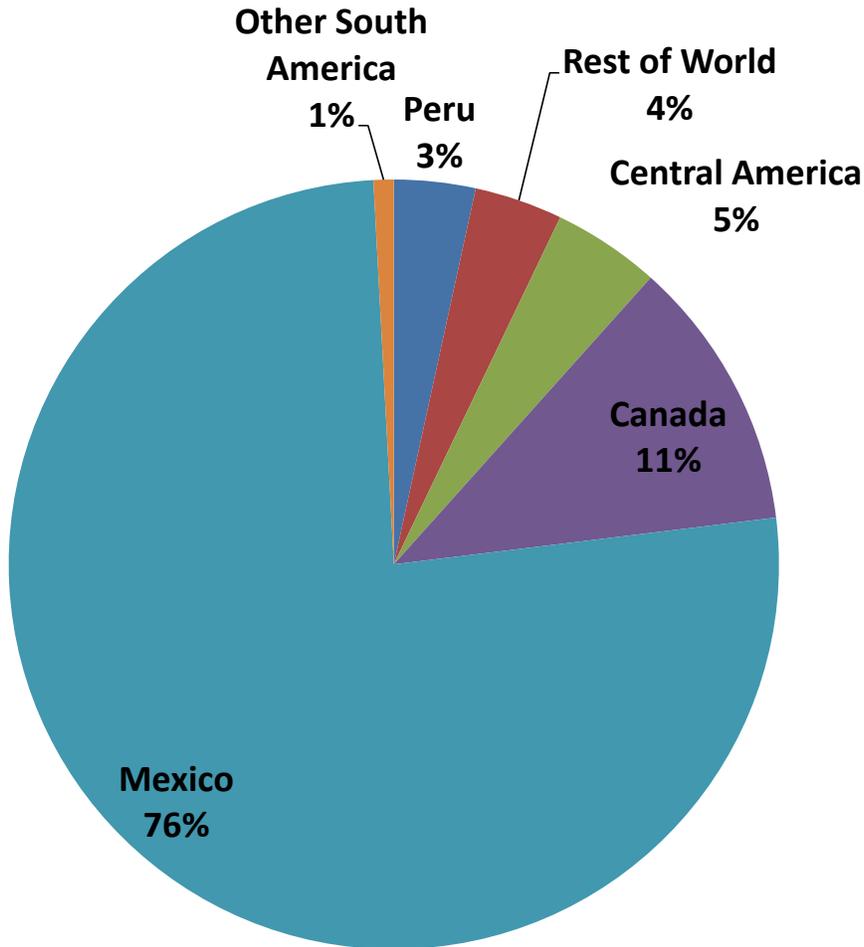


Mexico made up over 75% of all the fresh vegetable imports followed distantly by Canada at 11% (Figure 8). Climate and labor differences are major reasons why Mexico has such a significant share of fresh fruit and vegetable exports to the US.

Also contributing to the trend is liberalization of trade due to NAFTA that allows for duty free imports of Mexican produce and large subsidies for row crops such as corn, wheat, and soybeans in the United States. These trends induce crop production in Mexico towards produce and away from row crops. A change in US agricultural policy could reverse this trend and make row crop production less profitable while creating an opportunity to increase domestic produce production. More analysis on federal farm policy and its impact on produce production in the Midwest is found in the *Conclusion and Recommendations* section.

Figure 8: US Annual Fresh Vegetable Import Sources

(Source: USDA FAS)



Tomatoes are the primary fresh vegetable imported from Mexico followed by peppers, cucumbers, onions, lettuce, and squash (Figure 9). Mexico exporting nearly \$750 million worth of tomatoes to the US in 2011 to meet the significant demand. However, the production is extremely seasonal. The number of tomato and bell pepper shipments from Canada and Mexico rise during the offseason between December and May and subsides when California production increases in June (Figures 10 and 11).

**Figure 9: Seasonal Imports of Fruits and Vegetables from Mexico
June to November**

(Source: USDA EAS)

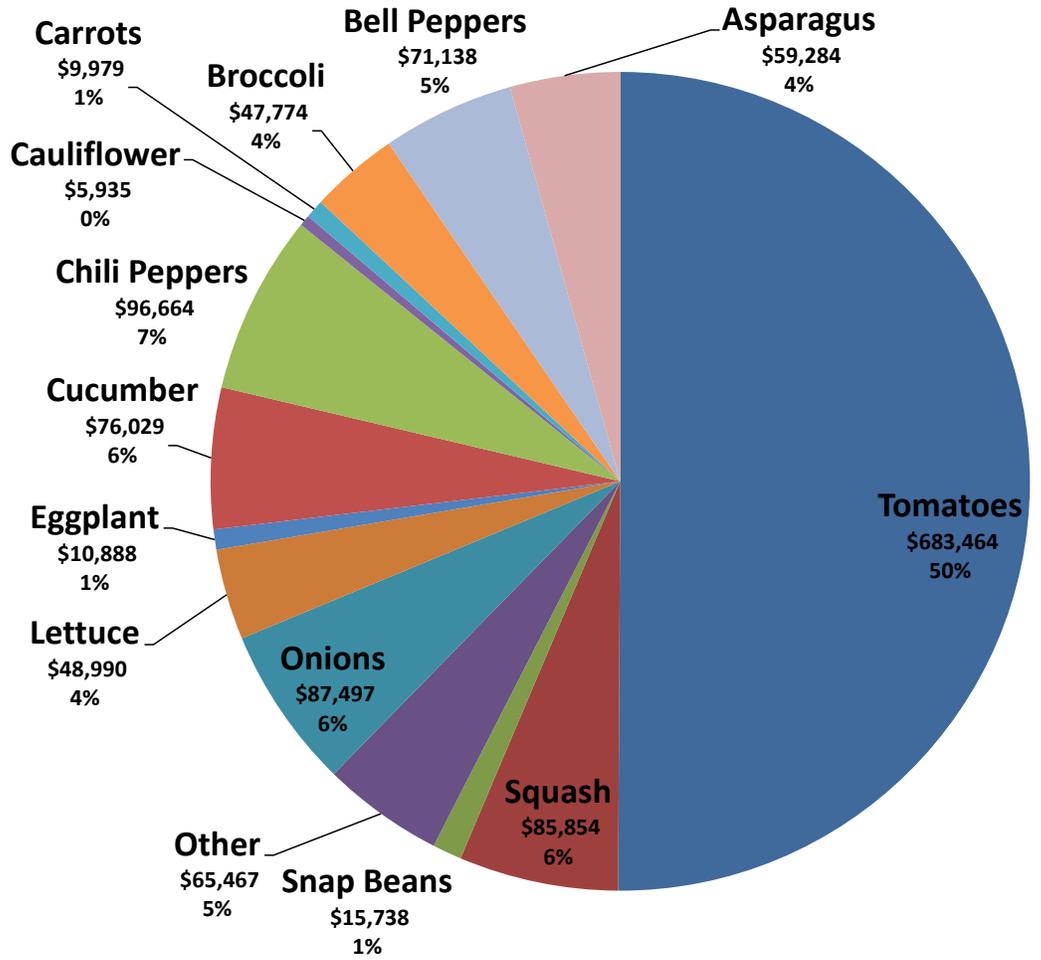
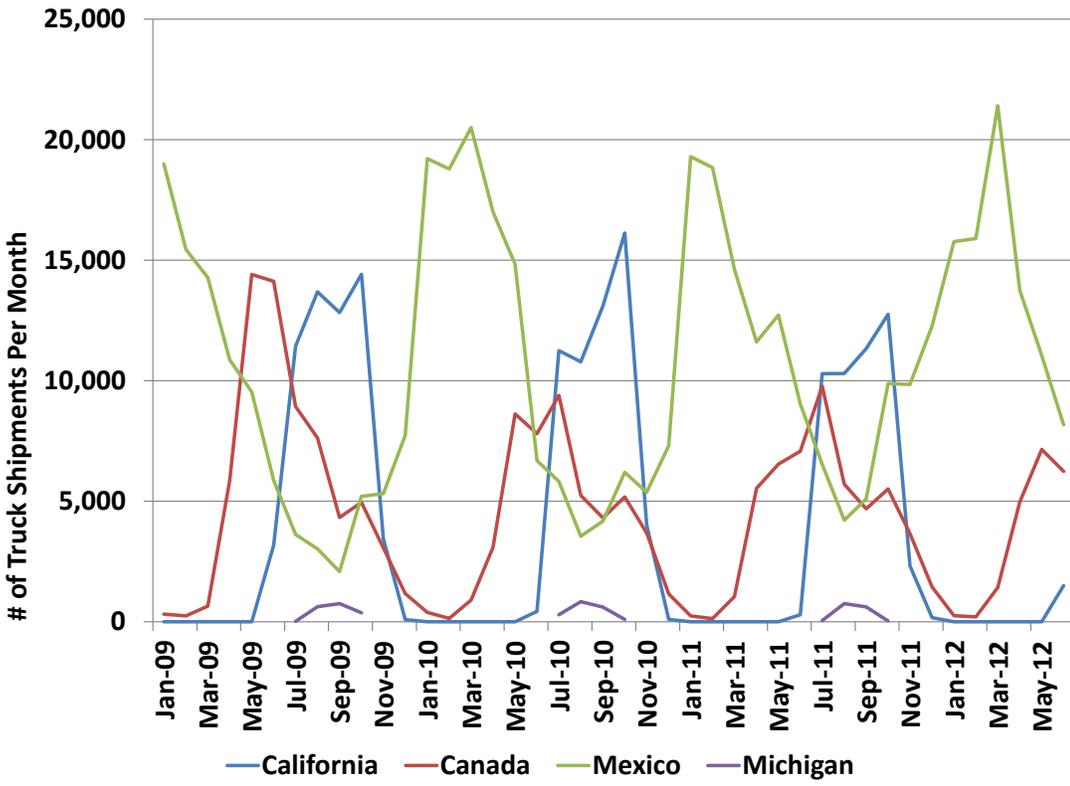


Figure 10: Tomato Shipments by Source in the United States
(Source: USDA AMS)



The US is increasingly dependent on foreign countries for our food sources.

Figure 11: Bell Pepper Shipments by Source in the United States

(Source: USDA AMS)

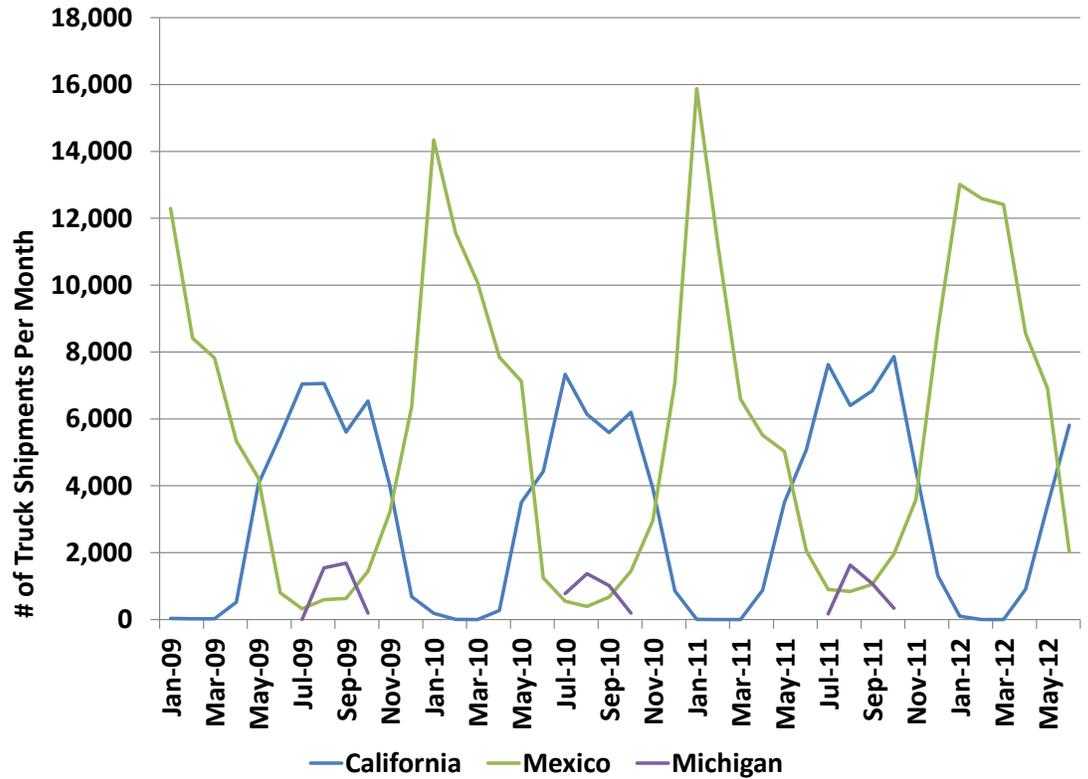
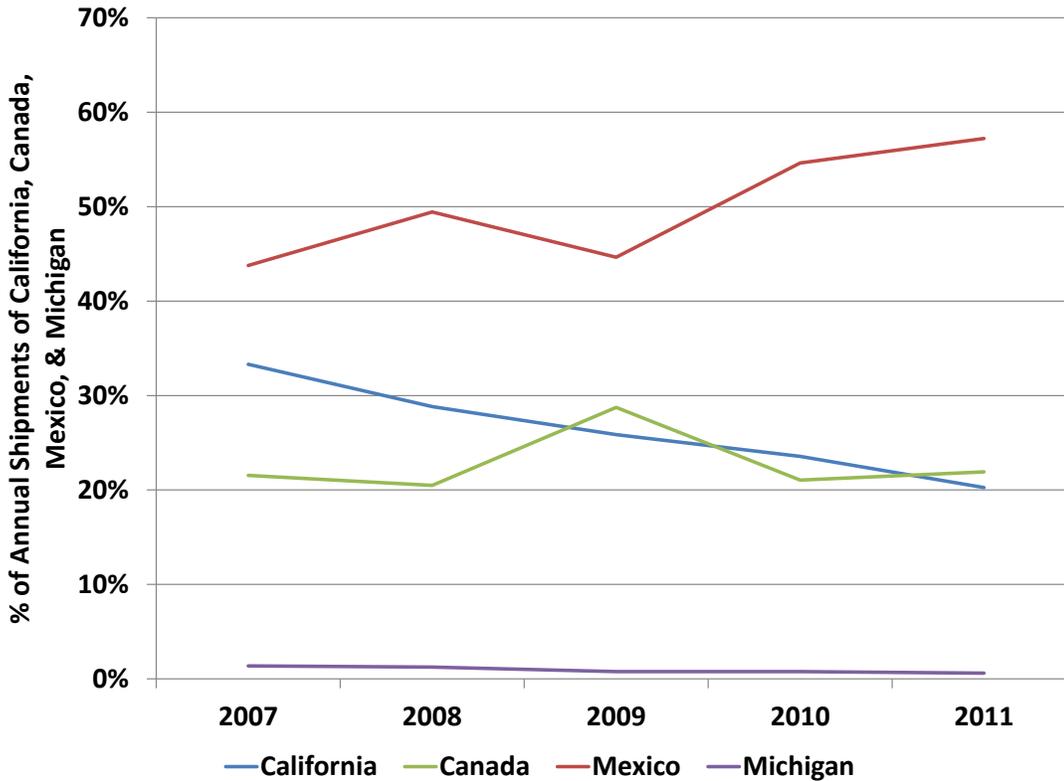


Figure 12 shows the trend towards increasing shares of fresh tomato shipments from Mexico and Canada versus California. Mexico has steadily gained market share of fresh tomatoes over California in the last 5 years in part by increasing sales during peak US production period from June to November. Similar trends are found in many other major fresh fruits and vegetables consumed in the United States, including bell peppers, squash, cucumbers, and leafy greens.

Figure 12: Tomato Market Share by Source

(Source: USDA AMS)



Most of the produce grown in the Upper Midwest and the Pacific States is for processing. The Upper Midwest produces a large share of the US' canned green peas, snap beans, and sweet corn.

Processed Fruits & Vegetables²

Processed fruits and vegetables account for about 44% of land dedicated to fruit and vegetable production in the US. Produce farmed for processing is often grown differently than that grown for the fresh market. Many varieties grown for processing are better suited to mechanization and often are not as desirable for the fresh market. For example, processing tomatoes tend to be smaller with unique internal characteristics compared to fresh varieties. Processed fruits and vegetables are often categorized by type: canned, frozen, juice, and dehydrated products.

Most of the produce grown in the Upper Midwest (Wisconsin, Minnesota, and Michigan) and the Pacific States (California, Washington, and Oregon) is grown for processing. The Upper Midwest produces a large share of domestic canned green peas, snap beans, and sweet corn. The Northwest (Washington, Oregon, and Idaho) and New York are among the largest producers of frozen produce in the country, with potatoes comprising

² This report does not focus on processed produce with as much depth as fresh produce because much research has already been completed on the subject within the study area. Additionally, this report recommends that the region focus on increasing production of fruit and vegetables for fresh markets. The reasoning for this recommendation is explained in greater detail in the next several pages. Nonetheless, once sufficient production levels have been reached it will be important to develop processing infrastructure that adds value for both growers and the regional economy.

a significant share of the produce grown for freezing in these states.

Processed fruit and vegetable production has several economic advantages to fresh fruit and vegetable production. Processed production tends to be more resilient during periods of economic weakness than fresh production. During economically difficult times, consumers prefer the less expensive processed products over more expensive fresh produce.

Processing also allows for extension of consumption into non-seasonal periods and creates a steadier stream of year round economic activity. However, fruits and vegetables for processing require significantly more start-up costs, which can be a deterrent for small or beginning producers.

New processing capacity for the region may benefit more from being a value add to 'seconds' or non-market grade fresh produce than by relying on produce grown specifically for processing. This diversifies market opportunities for producers since processing can effectively take and market fresh produce that would otherwise be left in the fields as waste product and bring value to them as processed product. This would likely be a more optimal fit than a facility designed to take a specific product with hard terms and quality specifications. This would require a more flexible structure that allows for handling and processing of multiple types of produce, with diverse varieties and varying levels of quality and size. Contrast this with produce grown specifically for processing, which may be viable if area and expertise expands but initially seems to be less of a direct need to support wholesale fresh market production.

Typically, processing companies contract with growers in advance of the production season to lock in supplies and secure an expected flow of raw product. Processors typically select the appropriate varieties of a given fruit or vegetable for a grower to produce. In addition to variety reaction to weather, insect and disease resistance there are also differences in size, shape, time of maturity, and resistance to physical damage that impact the varietal choice of processors. These differences translate into storage stability and suitability for processing methods like canning, freezing, pickling or drying. For example, one variety of peas suitable for canning may be unsatisfactory for freezing while a variety of potatoes that is preferred for freezing may be undesirable for drying or potato chip manufacturing. The differences occur due to characteristics of vegetables that change with varieties, such as chemical composition, cellular structure, and biological activity of enzyme systems.³

Contract growing makes up approximately one-third of vegetable production in the United States and the majority of the contracts are for processed vegetables.⁴ Agreements are generally referred to as marketing or production contracts. Under a mar-

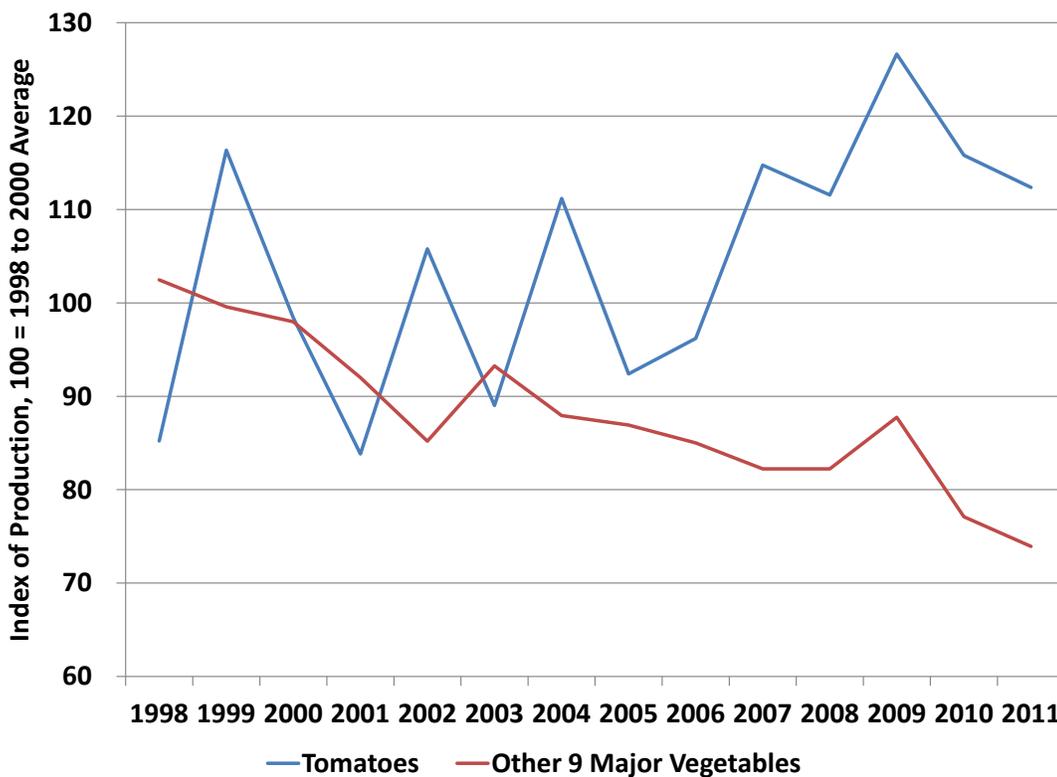
3 Enachescu Dauthy, Mircea. Fruit and Vegetable Processing. Rep. no. 119. Food and Agriculture Organization of the United Nations, 1995. Web. 22 Dec. 2012. <<http://www.fao.org/docrep/V5030E/V5030E0q.htm>>.

4 Ligon, Ethan. "Contractual Arrangements for Fresh Produce in California." Agricultural and Resource Economics 5 (2001). University of California Giannini Foundation. Web. 22 Dec. 2012. <http://giannini.ucop.edu/media/are-update/files/articles/v5n2_1.pdf>.

keting contract the producer assumes the market or price risk until delivery. Under a production contract the handler or buyer assumes all of the price risk while the grower is responsible for production risk. These contracts often specify the variety to be grown and require a fairly rigid quality spectrum to be met. They also ensure market access for producers so that they know the crop being produced has a buyer.

The production of processed fruits and vegetables has shown diverging trends since 1998 (Figure 13). Overall, the volume of product grown in the US destined for processing has increased about 7% since 1998, a rate of approximately 1% annually. However, when excluding tomato processing the trend has been very different. The volume for the other top nine vegetables for processing (asparagus, snap ‘green’ beans, broccoli, carrots, cauliflower, cucumbers, peas, spinach, and sweet corn) is down 28% since 1998, a rate of decline of approximately 2.3% annually.

Figure 13: Trends in Processed US Vegetable Production
(Source: USDA NASS)



Demand

Understanding demand is important to understanding the produce industry. US produce consumption rates are tied to a number of factors, including the cost of food, household income-levels, dietary trends, and physical access to the foods. These factors shape both regional and national demand.

Within 100 miles of the study area, there are approximately 6 million households with

New processing capacity for the region may benefit from being a value add to “seconds” (non-market grade fresh produce) by relying on produce grown specifically for processing. Processing can take and market fresh produce that would otherwise be left in the fields as waste produce and bring value to them as a processed product.

over 16 million individuals.⁵ This includes the major population centers of Chicago, Milwaukee, Madison, Cedar Rapids, and Dubuque. There is nearly \$500 million of produce imported into this area each year. This amount only includes 13 types of fruits and vegetables grown during the seasonal production periods (Table 5). If these crops were grown locally, they would require over 50,000 acres land to produce.

Table 5: Estimated Regional Supply and Demand Balance for Select Produce

(Source: USDA ERS Fruit and Vegetable Data and USDA AMS Terminal Market Pricing)

Estimated Project Produce Supply & Demand Balance for Select Produce	Demand, Tons (000s)		Deficit (Surplus), Tons (000s)		Deficit (Surplus), \$s (000s)		Estimated Farthest Distance of Major Supplier
	250 Mile Radius	100 Mile Radius	250 Mile Radius	100 Mile Radius	250 Mile Radius	100 Mile Radius	
Eggplant	7	4	4	3	\$4,166	\$2,621	Outside Midwest
Asparagus	13	6	0	6	\$618	\$20,296	Michigan
Cauliflower	20	10	19	9	\$30,386	\$13,168	Outside Midwest
Broccoli	26	12	24	11	\$40,813	\$18,922	Michigan
Spinach	28	13	14	7	\$21,696	\$11,172	Outside Midwest
All Squash	37	18	-16	-6	-\$15,640	-\$6,000	Wisconsin
Garlic	44	21	49	20	\$149,989	\$70,636	Outside Midwest
Celery	54	26	22	26	\$11,582	\$13,374	Outside Midwest
Lettuce	73	33	72	34	\$102,472	\$48,581	Outside Midwest
Fresh Bell Peppers	84	40	70	33	\$78,239	\$39,393	Outside Midwest
Strawberries	97	41	96	41	\$333,337	\$158,308	Outside Midwest
Watermelon	132	63	64	30	\$23,300	\$19,944	Indiana
Fresh Tomatoes	172	82	110	37	\$122,672	\$69,512	Outside Midwest
Total	777	369	513	293	\$906,329	\$473,927	N/A

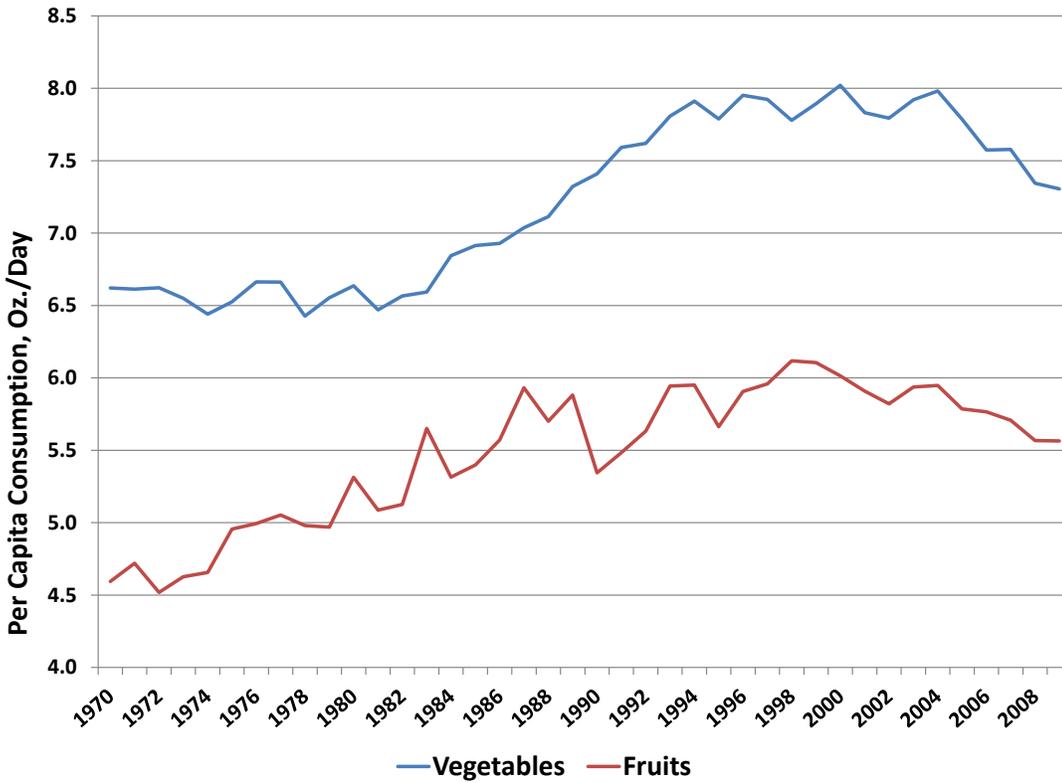
In 2009, the US produced approximately 312 pounds of fresh and 335 pounds of processed fruits and vegetables per capita.⁶ The average person eats about 12.9 ounces per day of fruits and vegetables.⁷ This is down about 7% from a peak of 14 ounces a day in 2000 (Figure 14). However, population growth has offset declines in per capita consumption keeping total US demand steady since 2004. The weak demand has been a negative trend for growers and correlates with the increasing costs of fruits and vegetables relative to total incomes.

5 ESRI Business Analyst referencing U.S. Bureau of the Census Data

6 Adjusted to farm weights, which includes culling loss from the farm to the plate.

7 This is after water loss from evaporation (shrink), pruning in processing or at grocery stores, and other factors that reduce farm weight by about 55% to the consumed weight.

Figure 14: US Per Capita Consumption of Fruits and Vegetables
 (Source: USDA ERS)

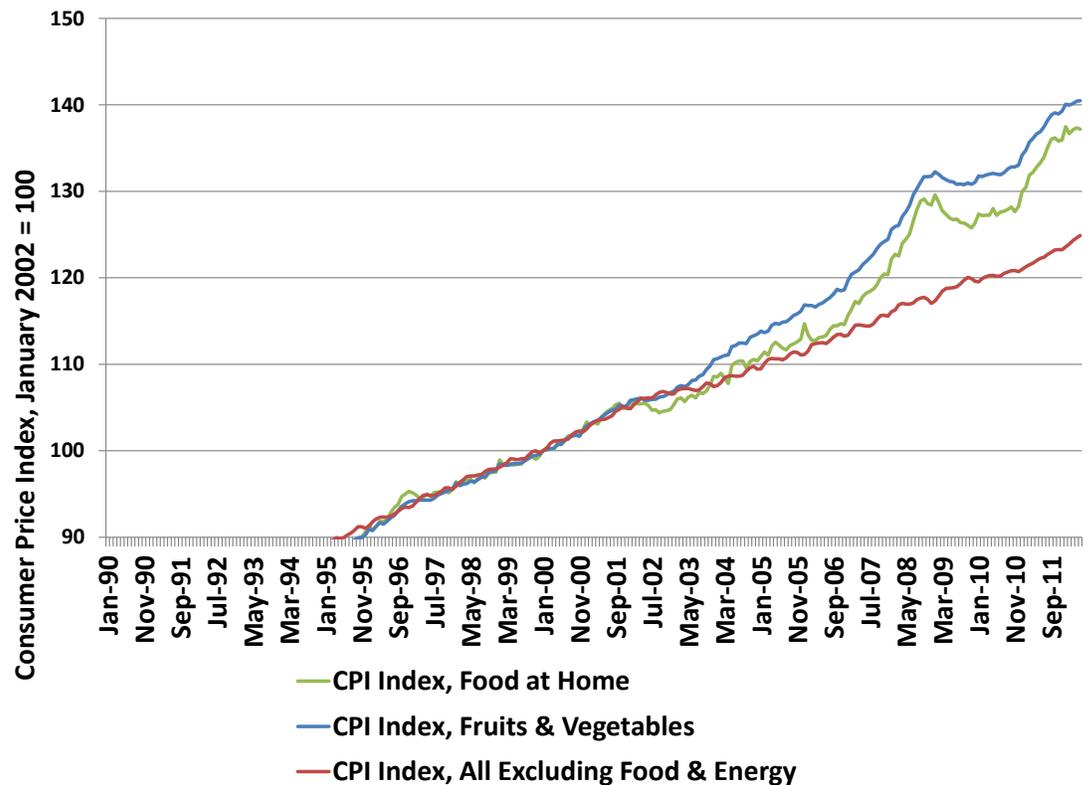


Rising food prices and a weak economy have kept consumption in check in recent years. Since 2007, food prices are up over 60% more than non-food and energy goods and services, with fruits and vegetables rising even faster (Figure 15). This is contrary to the price trends for the past 20 years when food prices rose in tandem with prices in the rest of the economy.

Since 2007, food prices are up over 60% more than non-food and energy goods and services. Consumers have responded by reducing rates of consumption for most foods, keeping food expenditures per capita steady.

Figure 15: Food Prices from 2007 to 2012

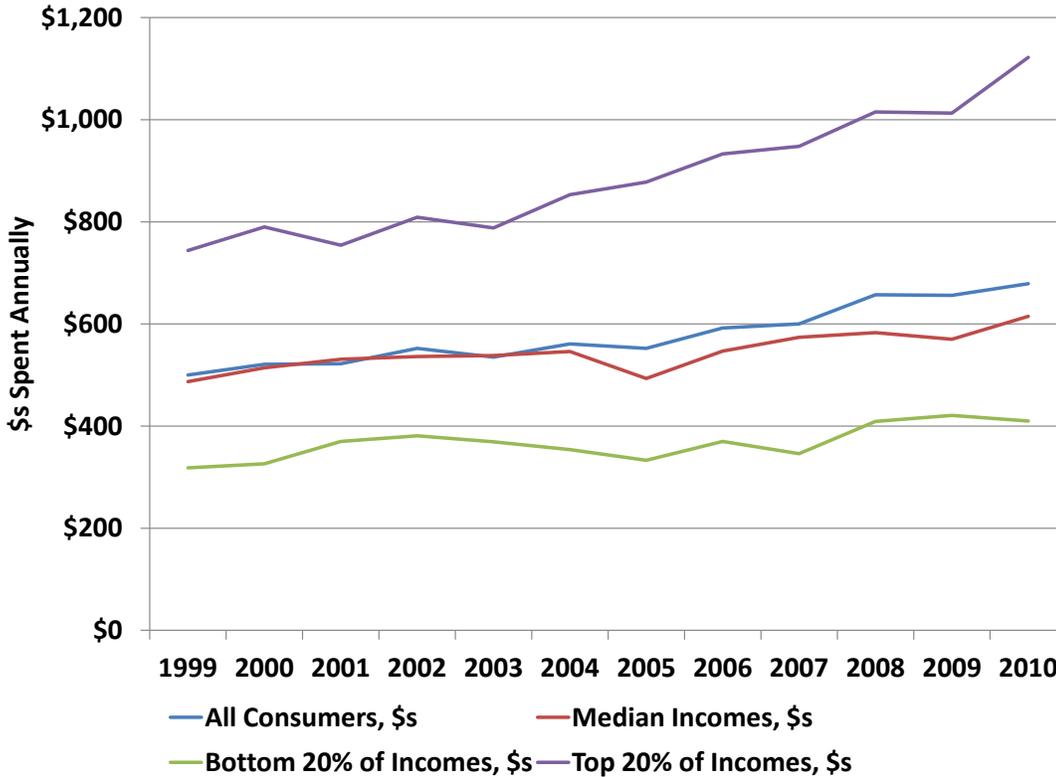
(Source: US Census)



Consumers have responded by reducing rates of consumption for most foods, keeping per capita food expenditures steady. In other words, families below the median national income where wages are falling are eating less amounts or lower quality food but spending about the same amount to buy that food (Figure 16). Declining wages for those with lower incomes are significant because these families tend to be on fixed budgets and experience a greater sensitivity to changes in produce prices. These families adjust demand downward more rapidly to offset higher food prices if income is stagnant. Conversely, higher income families are not as sensitive to rising prices. Figure 16 shows that expenditures on produce by the bottom 20% of incomes have hardly changed since 2007, despite rising prices. Expenditures by the top 20% of incomes increases with prices. The net result is that higher income consumers continue to include fruits and vegetables in their diets at similar rates while lower income consumers are reducing total food consumption and/or substituting towards lower cost calories.

Figure 16: Expenditures on Fruits and Vegetables by Income Levels

(Source: US Census)



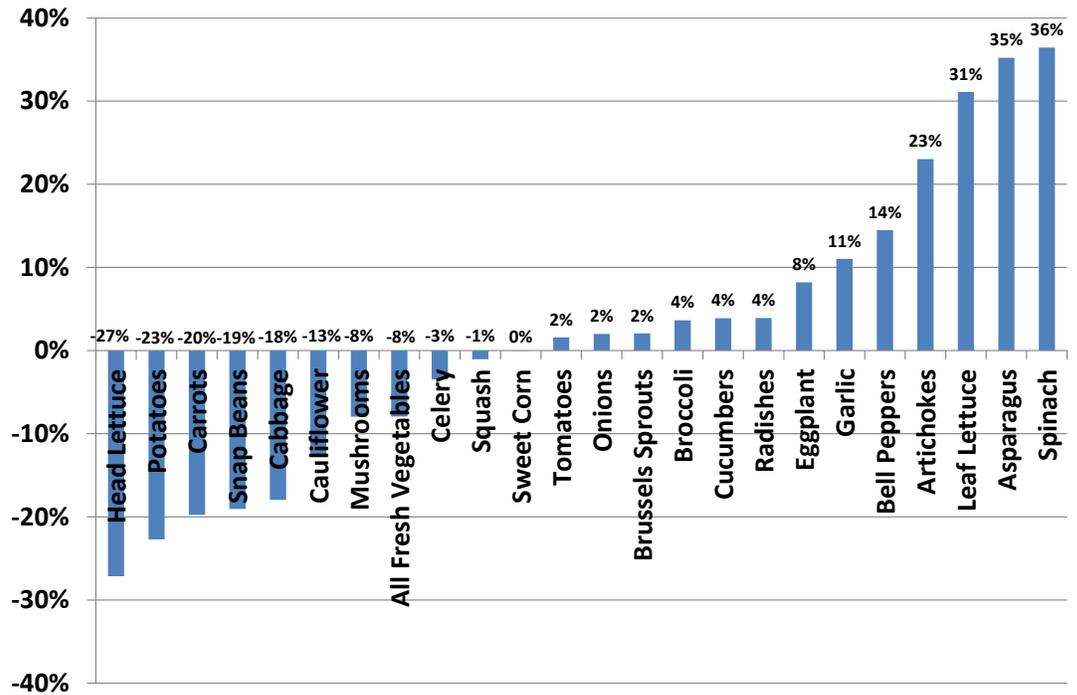
Families below the median national income where wages are falling are eating less amounts or lower quality food but spending about the same amount to buy that food.

The overall trend for per capita produce consumption is decreasing. Crops experiencing a decrease in per capita consumption are cheap commodity crops, found on the left side of Figure 17. Historically, the Tri-State region has currently produced these products. However, as US dietary trends change, certain crops are experiencing a large increase in per capita consumption. These high-value crops are fresh produce, found on the right hand side of Figure 17. These consumption trends are another reason this report focuses on production for fresh markets.⁸

⁸ These trends were also taken into consideration when determining which crops to focus on for the *Grower Guide* section of this report.

The focus is on fresh fruit and vegetable production in order to identify the factors impacting the wholesale and on-farm produce prices that may provide a competitive advantage for producers.

Figure 17: Change in Per Capita Vegetable Consumption since 2000
 (Source: USDA ERS)



Prices & Costs

While processed fruits and vegetables are an important component of a robust produce industry, the following section focuses on fresh fruit and vegetable production in order to identify the factors impacting the wholesale and on-farm produce prices that may provide a competitive advantage for producers now or in the future.

Prices

Produce prices fit into three primary categories:

Shipping Point Price (or farm price) is the price received for harvested, cleaned, and packaged produce at the initial point of shipment. An average of all California shipping prices is used in this study because California is the study area’s primary competition for growing produce in the US in-season.

Terminal Price (or wholesale price) is the price received at terminal markets around the United States that take in produce and redistribute it regionally. There are fifteen terminal markets in the United States that the USDA Agriculture Marketing Service (AMS) tracks including Chicago, St. Louis, Detroit, and Los Angeles. Chicago is the focus of this study because it is the primary terminal market that serves the Tri-State area.

Retail Price is the price paid by consumers in supermarkets across the US. These prices are typically aggregated and a regional average is given by the AMS. Retail

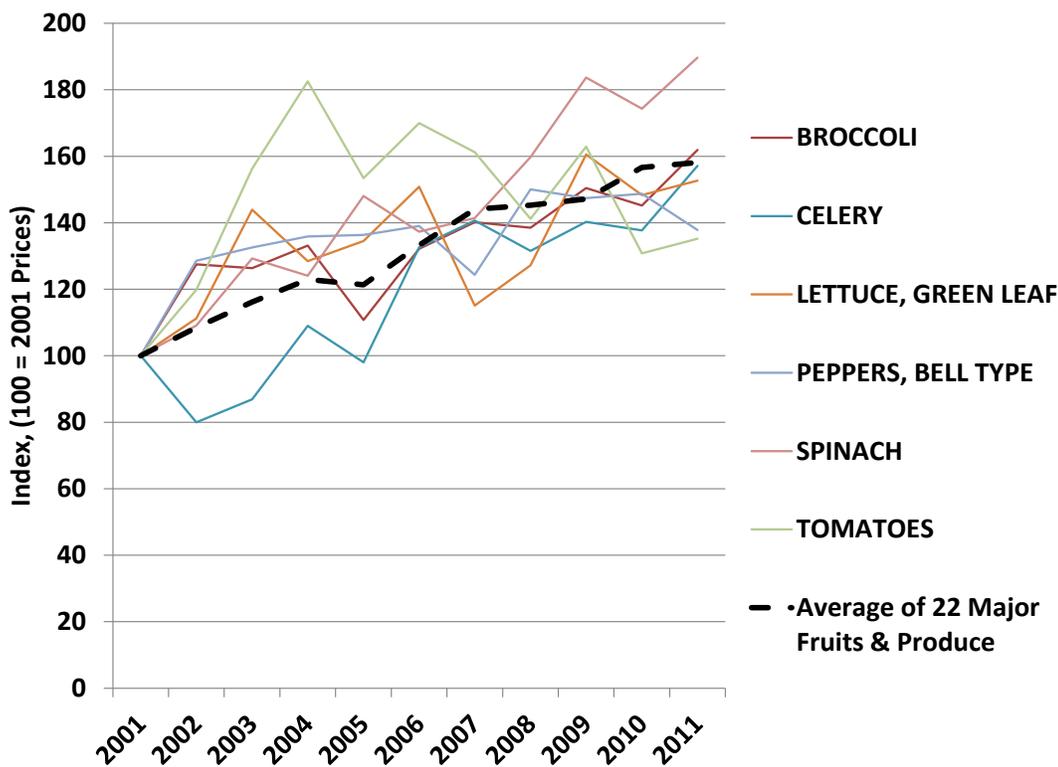
prices are not discussed in detail in this report since the primary focus of this study is to analyze fruit and vegetable production for wholesale markets .

Shipping Point Prices

Shipping point prices are largely driven by supply and demand variables in the short run. In the long run shipping point pricing gravitates towards the farming cost of production. The trend has been higher pricing since 2001 with shipping prices for the most in-demand produce up 60% (Figure 18). Different types of produce have varying degrees of change in shipping prices but in general, shipping prices have trended higher to sharply higher. In fact, out of the fruits and vegetables evaluated,⁹ only blueberries declined in shipping price from the early part of the decade to 2012. These rising prices likely stem from a combination of tightening supplies as well as higher production costs in major production regions.

Figure 18: US Produce Shipping Point Prices

(Source: AMS Shipping Market Price Report)



Terminal Prices

Fruit and vegetables move from shipping points into distribution hubs called terminal markets. Fresh produce is shipped primarily from California, Florida, and Mexico. Not all fruits and vegetables move through these markets and some cities have multiple market locations for receiving, storage, and distribution. However, even if produce does

⁹ The following fruits and vegetables were evaluated: asparagus, beans, blackberries, blueberries, broccoli, cabbage (including Chinese), carrots, cauliflower, celery, cucumbers, eggplant, green leaf lettuce, green peas, honeydew melon, onions (dry), peppers (bell type), romaine lettuce, spinach, squash (summer and winter), strawberries, tomatoes, and watermelons.

Under existing policies, a beginning grower in the study area would likely not qualify for any of the subsidized federal crop insurance programs.

not physically move through the terminal markets, regional wholesale pricing is typically geared around them. Also, as there is limited pricing data outside of these terminal markets, they are useful for analyzing price levels, trends, and production economics.

Picture 1: Chicago International Produce Market



The primary location in Chicago is the Chicago International Produce Market, a state of the art wholesale distribution center spanning a massive 26 acres (Picture 1). This center can take in almost any type of produce for storage and provides readily accessible supplies for buyers to inspect and purchase. It has the capacity to do ripening for products such as bananas or tomatoes or climate controlled environments to deter unwanted maturing of products. Their facilities offer labeling, repackaging, and logistics services for both vendors and buyers.

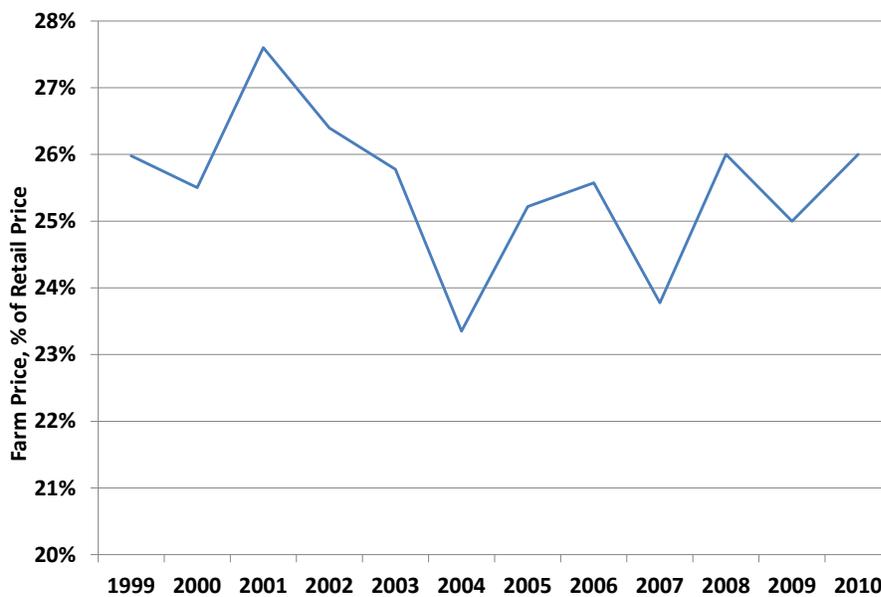
Chicago terminal market prices are used in this report (minus the shipping cost to reach the Chicago market) as a pricing point for growers in the Tri-State area. In general, terminal prices have followed the same trend as shipping point prices, although changes in transportation costs also impact terminal prices. Details on terminal pricing relative to shipping point pricing can be found in the *Handling and Transportation Costs* section of the report.

Retail Prices

Fruit and vegetable retail prices are driven by a number of variables including the on-farm cost of production, storage, handling, transportation, marketing, and grocery store mark-ups. The on-farm price for fresh vegetables has averaged 25% of the final retail price over the last 10 years (Figure 19). This is despite volatility and a general trend towards higher farm and retail prices that indicate increasing costs associated with each stage of production.

Figure 19: Farm Vegetable Prices as a Percentage of Retail Price

(Source: USDA ERS)



The Midwest is dominated by lower cost, mechanized crops while the West has high input and high cost crops.

Production & Marketing Costs

Farm production costs vary from region to region depending on the types of fruits and vegetables grown. For instance, the Midwest is dominated by lower cost, mechanized crops while the West has high input and high cost crops. Fresh market produce typically requires higher inputs and is sourced from California. Therefore, in order to decipher the impact on price, it is important to understand the costs and trends in California production.

Production costs are broken down into three categories including labor, non-labor variable costs, and non-labor fixed costs. These categories help compare trends and also provide an understanding of comparative advantages between production in California and the Midwest. Additionally, it will help quantify the risks of labor, energy, policy, or other changes that impact costs for both prospective farmers and consumers in the area.

Labor Costs

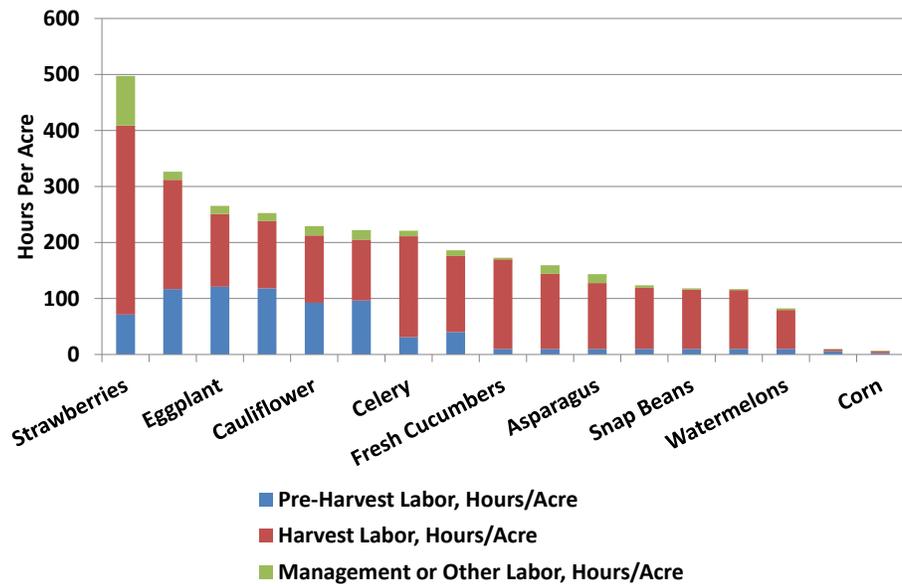
Productivity, efficiency, and prevailing labor rates all impact labor costs. There are labor costs for planting, management, harvesting, and handling. Harvesting and handling are typically the majority of labor inputs (Figure 20). For example, fresh-market vegetables are often produced from transplants grown in a greenhouse and planted by hand. Vegetables often need to be thinned and cultivated by hand. Many fresh vegetables are grown with irrigation that may also be labor-intensive. Lastly, harvest of fresh produce is labor intensive. Tender, fresh vegetables are picked, sorted, and packed mostly by hand and must be done in a timely manner to preserve quality and shelf life. Although some mechanization is beginning to appear in fresh-market crops such as green beans, sweet corn, and some leafy crops, manual labor remains the highest single farm cost at approxi-

California has a significant advantage over most Midwestern growers due to a better trained workforce.

mately one-third of total costs, with some variations by produce type.

Figure 20: Rough Estimates of Labor Needs by Produce Type

(Sources: University of Wisconsin Madison-Extension, Iowa State University, North Carolina State University, University of California-Davis, University of California-Berkeley, USDA ERS)



Because labor is such a large input, any changes economically or politically that impact labor rates can have a significant, direct impact on fresh fruit and vegetable prices. Changes in labor laws or more stringent enforcement of immigration laws that reduce labor productivity or availability in primary production regions such as California or Mexico may push up produce prices and/or move production to other countries. This also increases the sensitivity to transportation costs. Greater use of mechanization in the production of fresh produce could reduce labor costs. Still, many fresh fruits and vegetables will require significant technology advancements in harvesting equipment for this to occur.

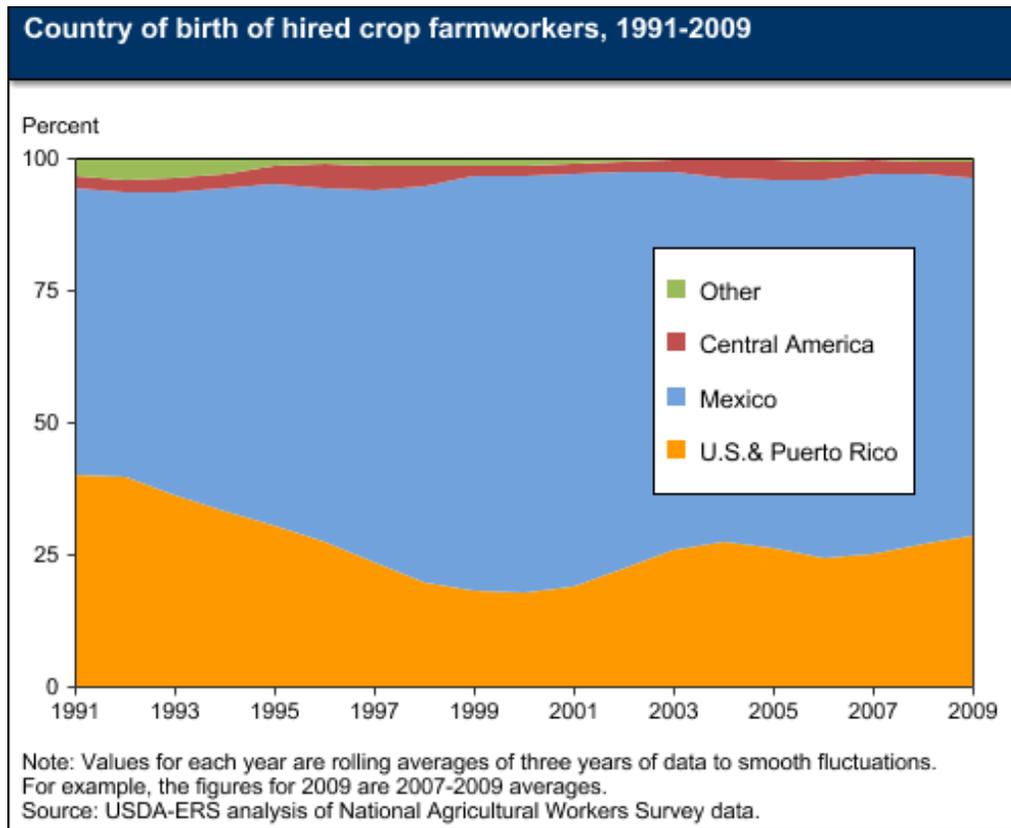
Labor costs can be impacted by more than just fluctuations in hourly rates or wages. Productivity is very critical and a trained, experienced workforce provides a competitive advantage. Any policy shifts that support or are detrimental to this productivity may have a greater impact on labor costs than prevailing wages. For example, fresh tomatoes are a labor intensive crop with labor costs being an estimated 30% to 35% of total costs. This equates to about \$0.15/lb, meaning a 20% decline in harvest productivity could change tomato prices by \$0.03/lb. This can have a significant impact on farm profitability which is generally only a few cents per pound.

In terms of comparative advantage, California has a significant labor advantage over most Midwestern growers due to a better trained workforce. Immigrant labor is a major variable accounting for an estimated 95% of farmhands in California. Over 75% of the new hires in California vegetable production are unauthorized Mexican immigrants

(Figure 21).¹⁰ As shown in Figure 22, average pay is estimated at \$9.50 per hour (2008 dollars). Research has concluded that immigrant labor is largely performing tasks that domestic workers have been unwilling to do at prevailing wages. Only about 1.23 domestic workers are displaced for every 100 illegal immigrants. Without immigrant labor most labor intensive crop production would likely occur outside of the US.

Figure 21: Country of Birth of Hired Crop Farmworkers, 1991-2009

(Source: USDA ERS)



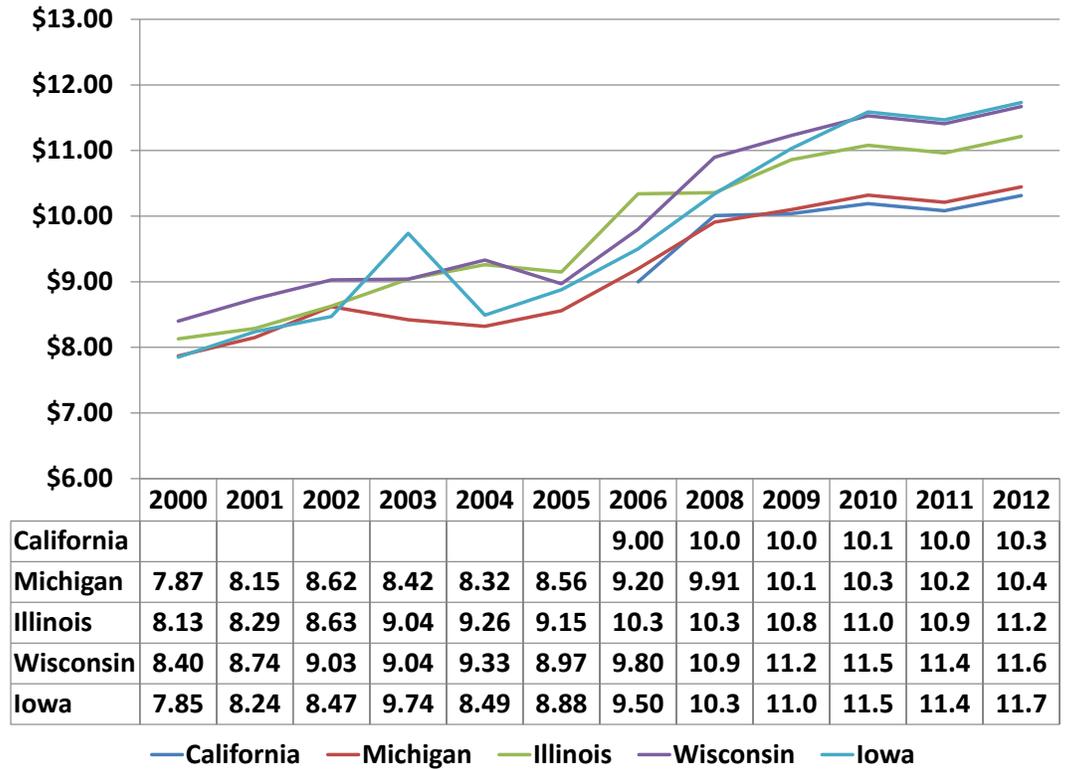
Wages for crop labor have trended steadily higher with the rate of inflation rising on average 2% to 3% annually over the last decade.¹¹ California’s farm crop hourly wages are estimated to be 10% to 15% below comparable wages in Illinois, Wisconsin, and Iowa. This may stem from the large supply of migrant laborers willing to do the strenuous fieldwork that domestic workers have historically been unwilling to do.

10 Devadoss, Stephen, and Jeff Luckstead. “Contributions of Immigrant Farmworkers to California Vegetable Production.” *Journal of Agricultural and Applied Economics* 40.3 (2008): 879-94. Southern Agricultural Economics Association. Web. 22 Dec. 2012. <<http://ageconsearch.umn.edu/bitstream/47265/2/jaac-40-03-879.pdf>>.

11 USDA and the National Agriculture Workers Survey

Figure 22: Farm Crop Labor Rates

(Source: USDA NASS)



California has a significant labor advantage in regards to supply and skill, however data indicates a rising population of migrant workers to the Midwestern states and the study area in particular. For instance, the number of farming operations using migrant labor more than doubled from 2002-2007 (Table 6). This is in tandem with a 33% decline in California operations with migrant workers. Wisconsin has the greatest number of operations with migrant worker labor in the study area but Iowa and Illinois have the greatest growth of workers.

Table 6: Number of Farms with Migrant Workers

(Source: 2002 and 2007 US Agriculture Census)

State Totals	2002	2007	% Change
California	8787	5866	-33%
Illinois	339	529	56%
Iowa	101	123	22%
Wisconsin	424	636	50%
Study Area Counties Only	2002	2007	% Change
Illinois Counties*	13	60	362%
Iowa Counties**	4	20	400%
Wisconsin Counties***	49	71	45%
Total	66	151	129%

*Carroll, Jo Daviess, Lee, Ogle, Stephenson, and Whiteside

**Cedar, Clinton, Delaware, Dubuque, Jackson, Jones

***Crawford, Grant, Green, Iowa, Lafayette, Richland

Non-Labor Farm Costs

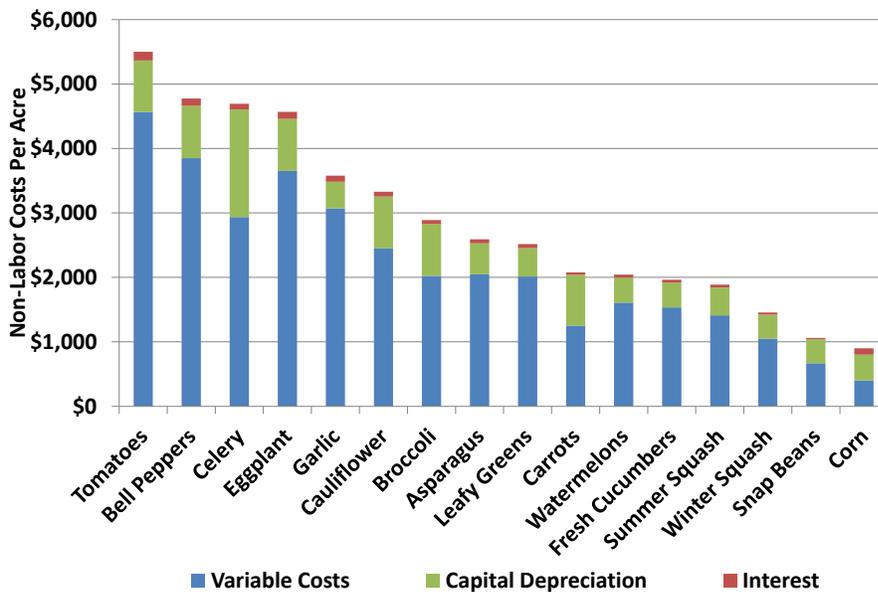
Compared to corn or soybeans, capital investment throughout each stage of fruit and vegetable production is high. For example, heated greenhouses with maximized automation are critical to start and grow healthy transplants for timely planting. Planting requires an array of equipment from standard tractors to mechanized mulch layers to specialized transplant planters. Crops often require irrigation with timely fertilizer applications, all of which require capital investments in pipes, tubes, valves, controls, and applicators. Harvest requires timely removal of crops to quickly cool, sort, and package for quality control. All of this generally requires significant upfront investment and financing.

The more capital investment required to grow an acre of a crop, the more risk the farmer takes.

The rough estimates in Figure 23 contextualize the range of per-acre investments needed to grow various produce crops relative to feed corn.¹² The more mechanized, non-irrigated crops that can be planted from seed such as carrots, squash, or snap beans (green beans) require significantly less capital than tomatoes, peppers, or even spring broccoli. Crops like tomatoes, peppers, and spring broccoli all require more costly heated greenhouses, irrigation, and efficient harvesting systems.

Figure 23: Non-Labor Input Costs

(Sources: University of Wisconsin Madison-Extension, Iowa State University, North Carolina State University, University of California-Davis, University of California-Berkeley, USDA ERS)



Generally, the more capital investment required to grow an acre of a crop, the more risk the farmer takes. The more capital and labor investment it takes to grow a crop, the more crucial it is to get good yields and quality production. If equipment breaks, disease spreads, or weather disrupts any stage of production the resulting drop in yield can severely impact profitability. Regions with established production and multiple crop grow-

12 #2 yellow commodity grade corn.

Under existing rules and policies, a beginning grower in the study area would likely not qualify for any of the subsidized federal crop insurance programs.

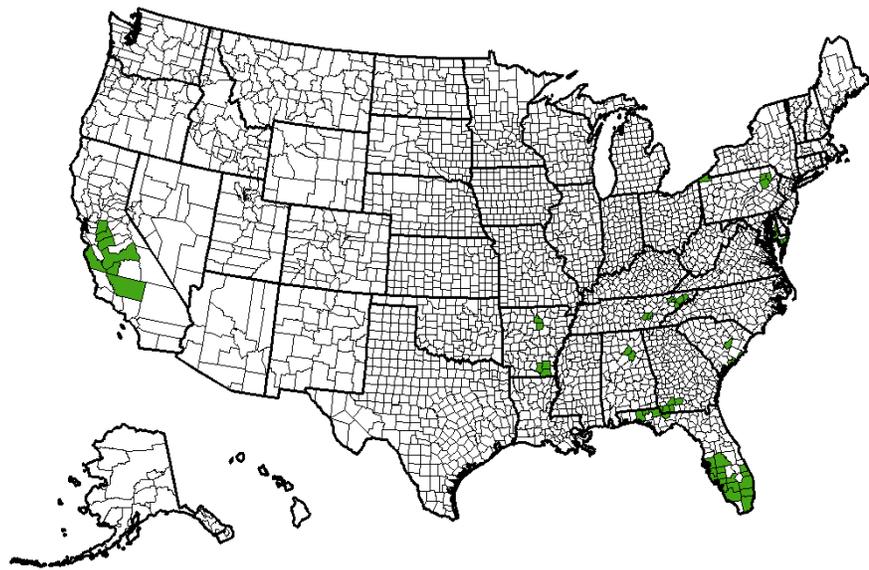
ers have infrastructure in place to reduce and mitigate production risks. Neighboring greenhouses may share backup heating systems or planting equipment. Expertise and knowledge is exchanged between growers with access to specialized agronomists who can advise on everything from seed selection to disease identification and treatment.

Crop insurance for commodity crops like corn and soybeans is easily accessible and highly subsidized within the Tri-State region. The revenue insurance and subsidies almost guarantee a profit for crop farmers with currently near record high corn and soybean prices. The high prices have been indirectly supported by federal policies subsidizing corn consumption through ethanol production.

Federal insurance is available for produce growers in select states and counties who meet a select list of criteria. For example, Map 6 highlights the limited areas that qualify for fresh market tomatoe federal crop insurance. A beginning grower in the study area would likely not qualify for any of the subsidized federal crop insurance programs under existing policies.¹³ Hail insurance, which is privately offered, may be the only insurance available for many growers, and even that may not be easily accessible.

Map 6: Fresh Market Tomatoes -- Counties with a 2012 Program

(Source: USDA Risk Management Agency)



Handling & Transportation Costs

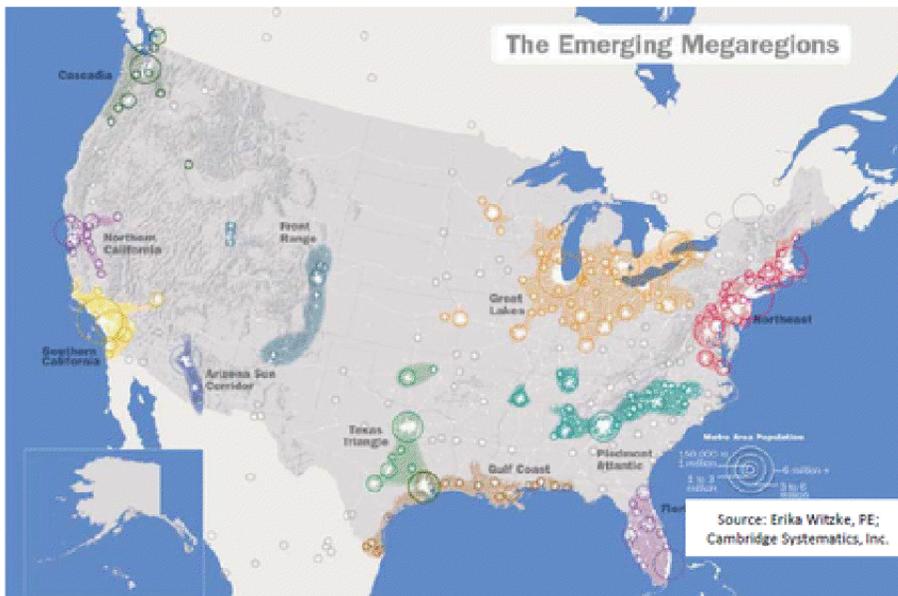
Though labor and production risks are significant hurdles to increasing regional production, transportation is a tremendous advantage for the Tri-State region. Fresh produce is bulky, high in water content, and requires a climate-controlled environment to maintain

¹³ For more information, please see the Insurance Programs and Subsidies portion of the *Conclusion and Recommendations* section.

quality. In 2010, 95% of California produce was shipped in a refrigerated truck.¹⁴ All of these factors make it very expensive to ship and the cost to consumers is the highest of any other agriculture industry.

Shipping produce and moving it through distribution hubs across thousands of miles takes time thus reducing produce quality and shelf life. Map 7 highlights the major distribution points¹⁵ across the United States. Product that moves into the upper Midwest from California typically moves through the Chicago hub resulting in as many as ten days of transportation spanning multiple exchange points before produce arrives at a nearby grocery store or restaurant.

Map 7: The Emerging Megaregions
(Source: Erika Witzke, Cambridge Systematics, Inc)



The data available on loss of shelf life from transport is limited. It is known that losses vary by produce type and are also dependent on pre-transport harvest and handling practices. Tomatoes are an extreme example because they ripen and spoil so quickly. Green picked tomatoes have a post-harvest life of three weeks. Tomatoes picked when pink have a lifespan of 10 to 14 days. Therefore, a seven day transport time can take away a third to half of potential shelf life at the grocery store, restaurant, or other buyer. This results in higher cull rates and ultimately lower value for the buyer and consumer. It is a quality opportunity cost of shipping a product over 2,000 miles through hours of traffic congestion and the multiple loading and unloading exchanges to get to a final destination. It is also an opportunity for a regional producer looking to ship less than

14 Paggi, Mechel S., Jay E. Noel, Fumiko Yamazaki, Sean Hurley, and Michael McCullough. An Analysis of California Agricultural Transportation Origins, Destinations, Modal Competition, and Industry Perspectives Selected Fruits and Vegetables. Rep. Agricultural Marketing Service, US Department of Agriculture, July 2012. Web. 23 Dec. 2012. <http://cab.cati.csufresno.edu/docs/pdf/2012_transportation_project_final_report.pdf>.

15 Distribution points are the same as megaregions.

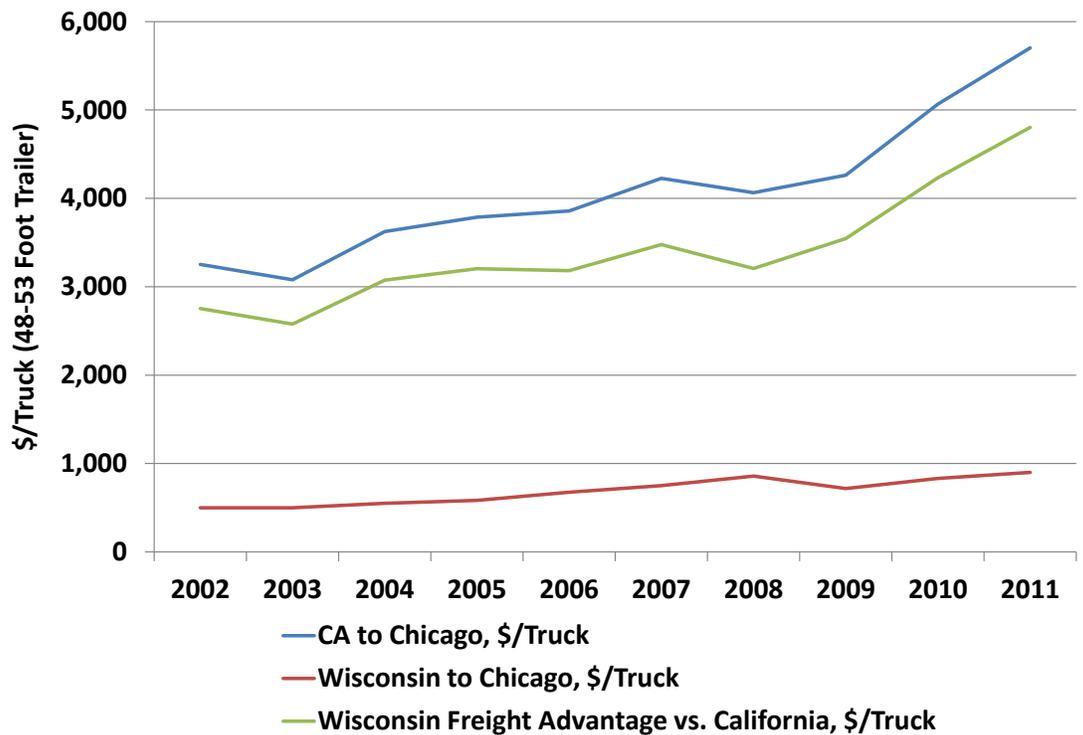
It currently costs nearly \$6,000 per shipment to move refrigerated produce from California to Chicago compared to nearly \$1,000 from the Tri-State area to Chicago. This transportation advantage is an opportunity for local producers.

200 miles in a day or two to Dubuque, Rockford, Madison, or even Minneapolis, Milwaukee, and Chicago.

The monetary cost of transportation is also a significant advantage to local production. It currently costs nearly \$6,000 per shipment to move refrigerated produce from California to Chicago (long-haul) compared to nearly \$1,000 from Wisconsin¹⁶ to Chicago (short-haul) (Figure 24). This is a significant cost gap and the difference has been increasing since 2003, benefiting local growers but hurting local consumers.

Figure 24: Rising Transportation Advantage

(Source: USDA AMS Weekly Trucking Rate Report)



The main reason long-haul freight rates have been increasing is rising fuel prices. Shipping costs are correlated with diesel fuel prices over the last ten years (Figure 25). With \$4 per gallon diesel fuel prices, roughly half of the cost of a shipment from California to Chicago is the cost of fuel. Each \$1 per gallon change can impact freight costs by 10% to 15% in both directions, adding volatility and risk to cost which ultimately impacts wholesale prices.

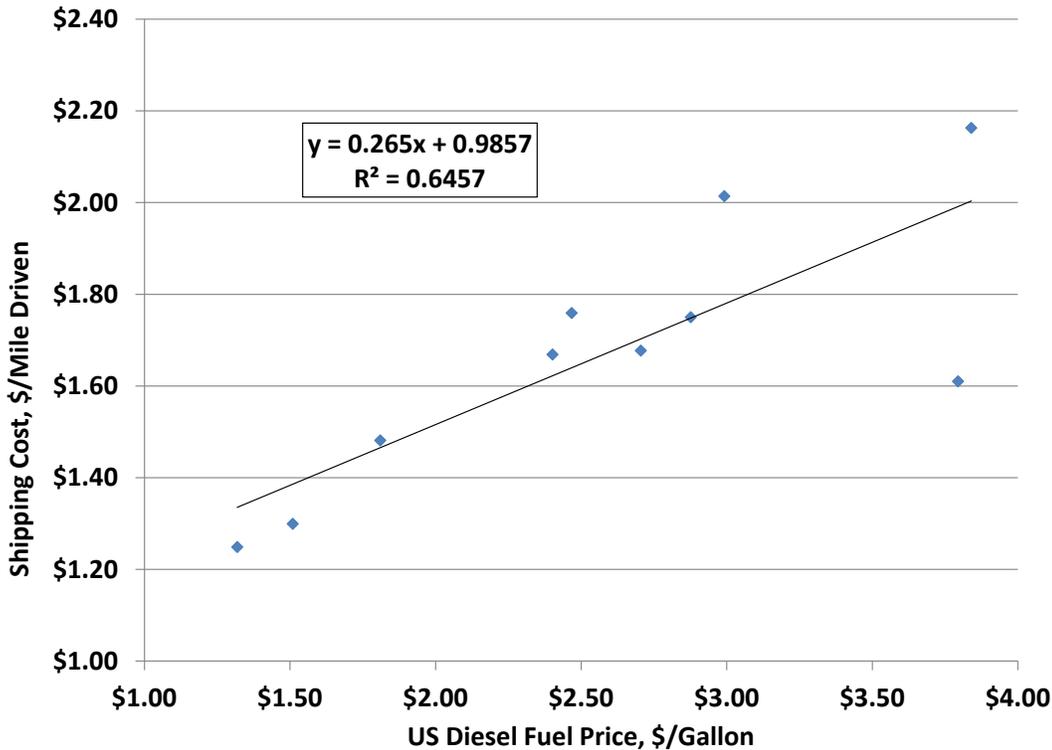
Other factors that are driving shipping rates higher include new regulations and a shortage of qualified drivers. New regulations in California on air quality continue to reduce the available supply of trucks while increasing the cost of the trucks in use. There is also a shortage of young new drivers in long-haul freight according to the American Truck-

¹⁶ The data available for this estimate used northern Wisconsin as a basis. However, this estimate has been verified by an aggregator operating in the study area who distributes to Chicago.

ing Association. Data from the Bureau of Labor Statistics supports this assessment. Job openings of heavy truck drivers are expected to grow significantly faster than other jobs because of increased retirement and high turnover among new drivers.

Figure 25: Shipping Costs from California v. Diesel Fuel Prices

(Source: USDA AMS Trucking Rate Report and US Energy Information Administration)

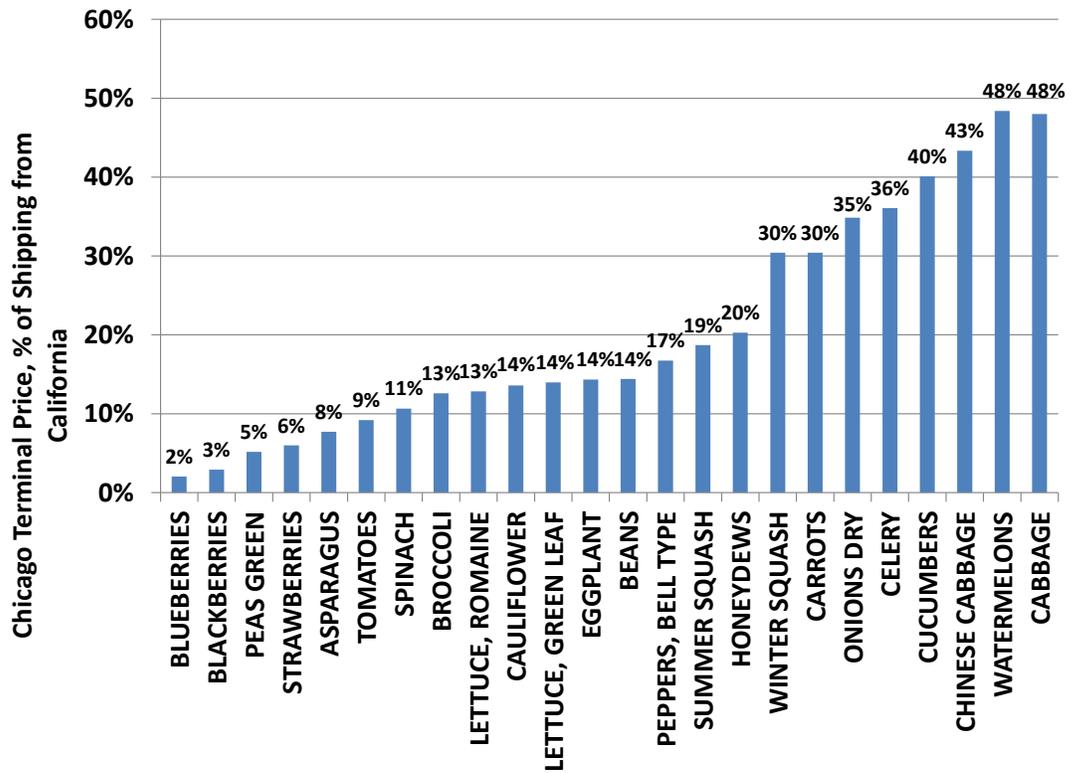


The sensitivity to transportation cost varies by the type of produce. Fruits and vegetables that have a high value or price per pound are less impacted than produce that is a lower price per pound (Figure 26). This is because transportation cost per pound is nearly the same across all types of produce. For example, a refrigerated shipment in July 2012 cost approximately \$6,000 or \$0.15 per pound of freight. A shipment of strawberries with a delivered Chicago price of \$1.90 per pound equates to about 8% of that price whereas a shipment of celery with a Chicago price of \$0.34 per pound shipping equates to 44% of that price. Therefore, there is a greater transportation advantage for produce that is less valuable per pound, but still being sourced from California like celery, squash, peppers, lettuce, eggplant, or tomatoes.

The sensitivity to transportation cost varies by the type of produce. High value fruits and vegetables are impacted less by high transportation costs than low value produce.

Figure 26: Transportation Cost from California as a Percentage of Wholesale Prices

(Source: AMS Trucking Rate Report, AMS Terminal Market Price Report)

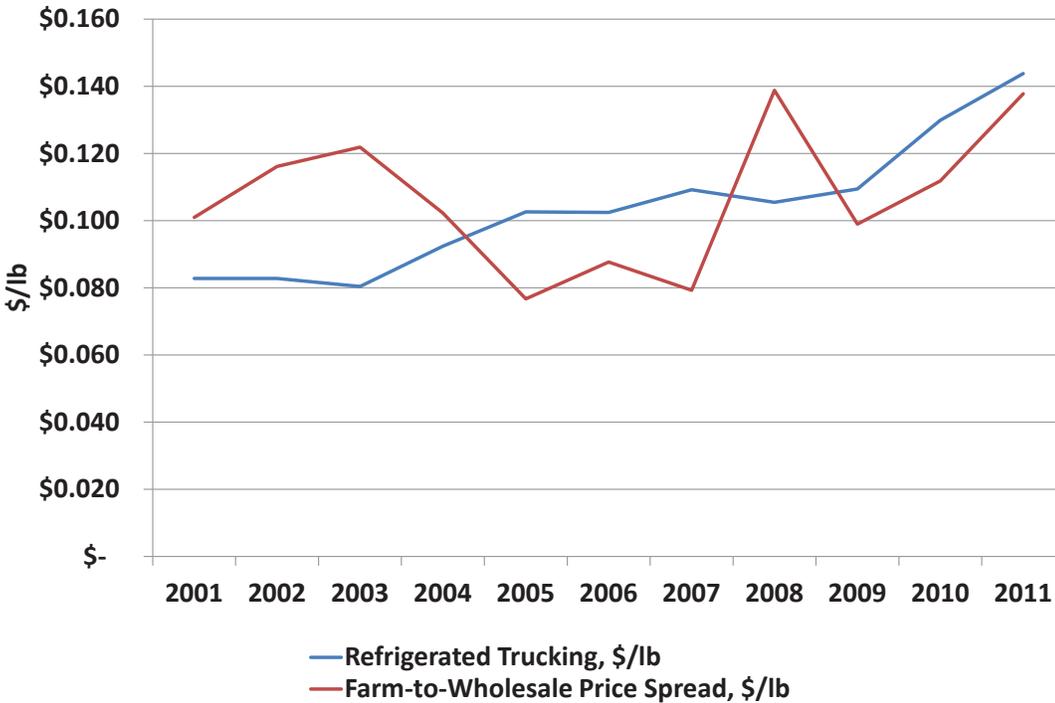


Midwest farm prices should be tied fairly closely to farm prices in California plus the shipping costs to reach the Midwest. Figure 27 shows bell pepper prices as an example. This shows that the spread between California farm prices and Chicago wholesale prices have correlated closely to transportation costs over the last ten years. There are other ancillary costs to transportation including storage, handling, and marketing, but generally these costs tend to be small relative to transportation costs. For bell peppers, over 90% of the farm-to-wholesale cost (price spread) is transportation. This means that local growers have the opportunity to be paid close to Chicago wholesale markets instead of the lower California farm prices. It also means there is a competitive advantage for local growers over California producers.

Not all produce comes from California. This is especially true for the seasonal production periods. Potatoes are produced in large surplus in Wisconsin and the Midwest as a whole. The same is true for crops like onion, green beans, cucumbers, and cabbage. These crops would not be expected to be as sensitive to transportation costs as produce that needs to be shipped into the region. Therefore, when looking at potentials to scale up strategically, focusing on crops that have a transportation advantage may be beneficial if freight costs remain high.

Figure 27: Bell Pepper Price Spreads v. Trucking Rates

Compares In-Season Prices to Shipping Rates for June to October of Each Year
 (Source: USDA AMS Trucking Rates and USDA AMS Fruit and Vegetable Prices)



Crops in shortage have had an average price increase of 46% from 2003 to 2012 compared to 17% for crops produced regionally.

Table 7 shows the fresh market crops that are in shortage in the Midwest during the seasonal production periods. There is a stark correlation between produce that is in shortage and wholesale price changes since 2003. Crops in shortage have had an average price increase of 46% from 2003 to 2012 compared to 17% for crops produced regionally.¹⁷ The vast majority of this difference is attributable to rising transportation costs for refrigerated long-haul freight.

¹⁷ This was another factor taken into consideration when determining which crops to focus on for the grower guide.

Table 7: In Season Midwest Balance of Trade of Selected Crops*(Source: USDA AMS and USDA ERS)*

Produce	Chicago Price Change since 2003	In Season Midwest Balance of Trade
BLACKBERRIES	-11.13%	Net Export
BEANS	2.31%	Net Export
HONEYDEWS	9.53%	Net Import
LETTUCE, ROMAINE	11.04%	Net Import
BLUEBERRIES	14.02%	Net Export
PEPPERS, BELL TYPE	19.68%	Net Import
CUCUMBERS	21.15%	Net Export
EGGPLANT	25.00%	Net Import
STRAWBERRIES	25.68%	Net Import
LETTUCE, GREEN LEAF	26.02%	Net Import
LETTUCE, ICEBERG	26.77%	Net Import
POTATOES	27.95%	Net Export
CABBAGE	49.20%	Net Export
CAULIFLOWER	64.37%	Net Import
GARLIC	64.49%	Net Import
SPINACH	69.14%	Net Import
BROCCOLI	84.60%	Net Import
TOMATOES	127.01%	Net Import

Comparative & Substitution Economics

A major consideration in evaluating the viability of growing any crop in a given area is how productive it is relative to other regions. This analysis focuses on season lengths compared to growth periods and impact on yields.¹⁸

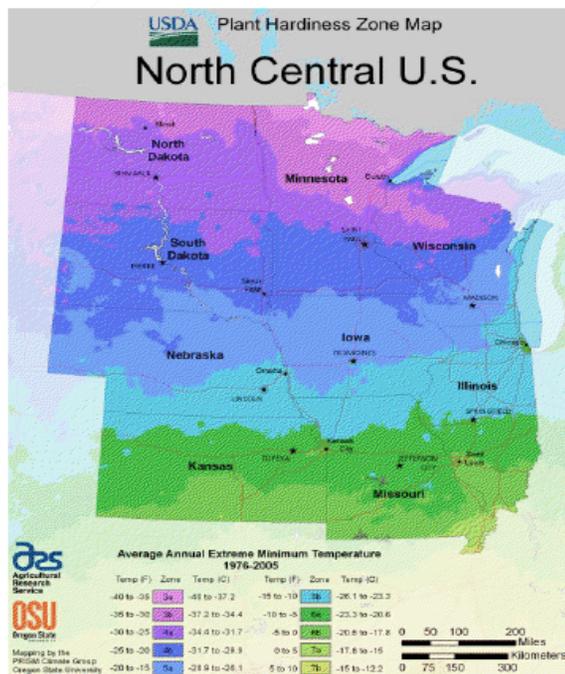
Growing Zone & Climate Considerations

Hardiness zones are areas with climate conditions suitable for certain plant growth including the average extreme minimum temperature range. One weakness to the hardiness zones is the focus on winter conditions, which tend to be only corollary to growing season lengths and summer climate conditions. While the Tri-State area's climate is clearly very different than California's, this does not mean that the region cannot grow fruits and vegetables. The Tri-State area should develop knowledge on growing fruits and vegetables specific to the region's climate.

The study area is predominately in the USDA Plant Hardiness zone 5a (Map 8), which has fairly harsh winters and shorter growing seasons than major competitor regions such as California or Mexico. However, most fruit and vegetable crops are capable of being grown within the typical window between the last spring frost and first fall frost.

¹⁸ Though a number of fruit and vegetable producers and university extension specialists provided knowledge and feedback on appropriate crops for the study area, the authors of this report are not experts in agronomic considerations. These sections will be left to a surface level assessment that relies on university estimates of potential crop yields.

Map 8: Plant Hardiness Zone Map -- North Central US
(Sources: USDA Agricultural Research Service and Oregon State University)



Yield Comparisons

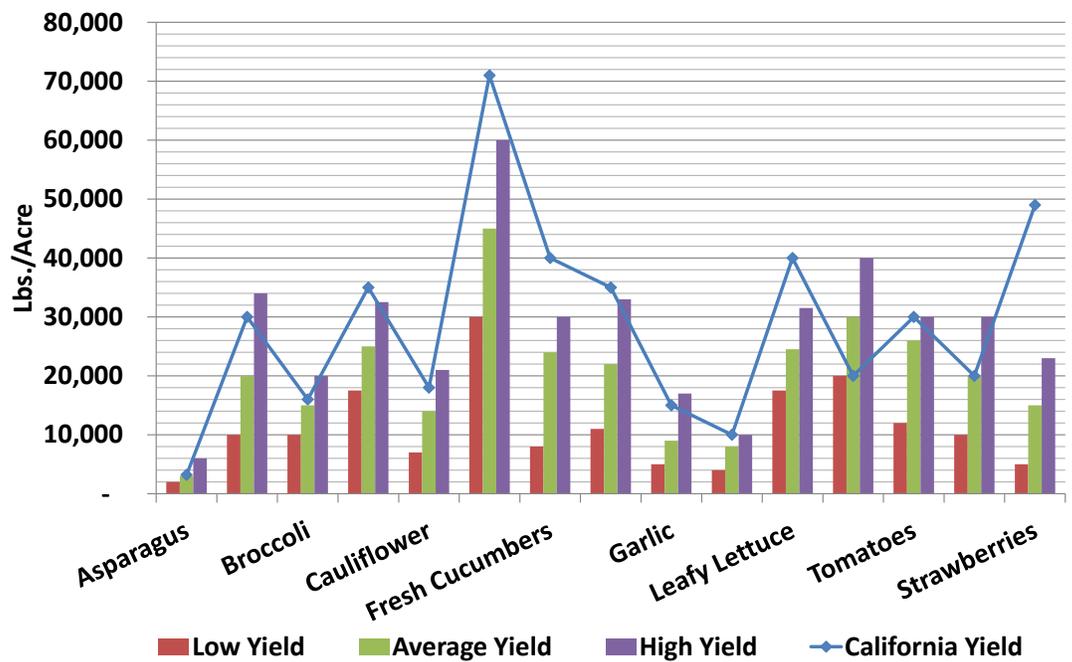
Accurate yield estimates for produce grown in the Midwest are very difficult to find because not many commercial fruit and vegetable crops are produced in the region. Yield estimates in this report rely heavily on research done by Wisconsin, Illinois, Iowa, Minnesota, and California university systems. Instead of focusing on outright comparisons of yield per acre, this section focuses on production risks and what they mean for Midwest producers.

Produce yields in California are higher across nearly all produce types when compared against average Midwest yield estimates (Figure 28). However, because of the longer growing season and access to irrigation in California compared with the study area, the same is also true for conventional crops like corn and alfalfa. As shown in Figure 28, estimated average yields for asparagus, broccoli, snap beans, summer squash, and winter squash are close to or greater than average California yields. Application of new season extension technology such as row covers and more efficient wood burning stoves to heat greenhouses has the potential help equalize these factors within the study area.

Produce yields in California are higher across nearly all produce types when compared against average Midwest yield estimates. Because of California’s longer growing season and access to irrigation compared to the study area, the same is also true for conventional crops like corn and alfalfa.

Figure 28: Midwest Yield Estimates v. California Yields

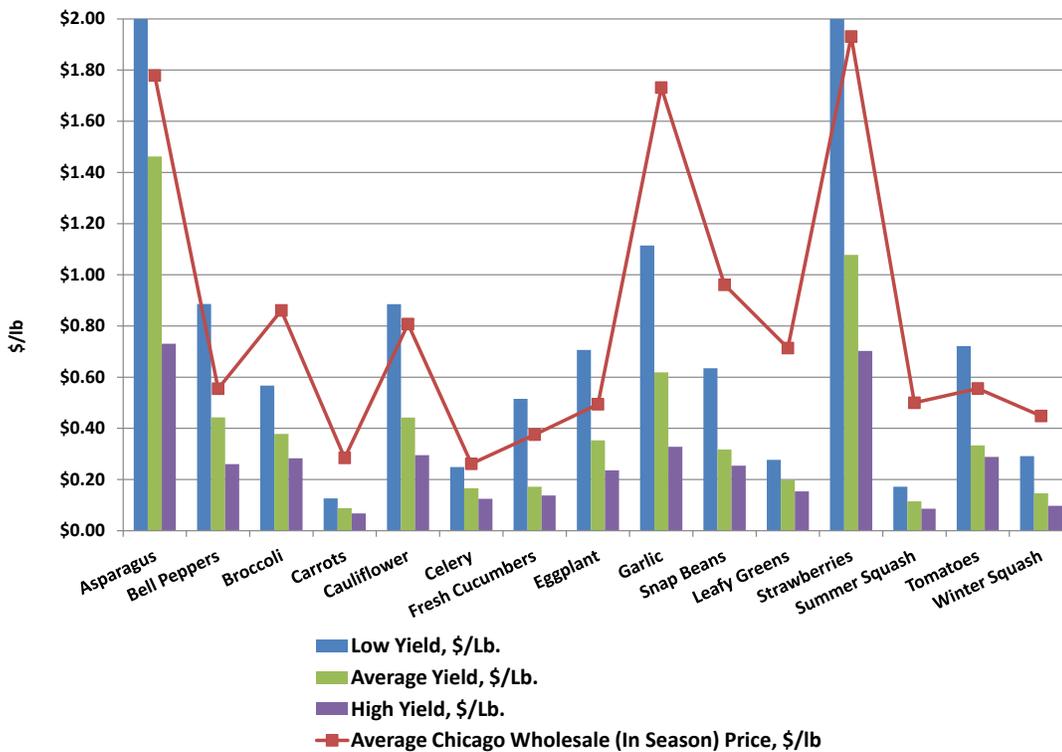
(Sources: University of Wisconsin Madison-Extension, Iowa State University, North Carolina State University, University of California-Davis, University of California-Berkeley, USDA ERS)



The gap between high and low yield estimates of produce is so large for Midwest production that profitability will ultimately be driven by a combination of on-farm yield optimization and resolving external optimization challenges such as labor and transportation efficiencies. Maximizing these yield potentials will be a particularly challenging task for growers who in many instances have never grown anything but feed crops like corn, soybeans, and alfalfa or who have never farmed. Production risk for these new growers is even greater for fresh market produce crops because quality is so crucial for success of these products. Given these challenges, if even just average produce yield estimates were achieved, fruit and vegetable production for many produce crops would likely prove profitable in the study area (Figure 29).

Figure 29: Breakeven Cost of Production with Average Labor Costs and Varying Yields

(Sources: University of Wisconsin Madison-Ext., Iowa State University, North Carolina State University, University of California-Davis, University of California-Berkeley, USDA ERS)



If even just average produce yield estimates were achieved, fruit and vegetable production for many produce crops would likely prove profitable in the study area.

Row Crop Competition

The current profitability of row crops such as corn and soybeans creates a challenging environment for recruiting producers into fruit and vegetables. Farm income is at its second highest level since the 1960s. Land area in production for corn, soybeans, and wheat is at a 30 year high. Profitability in feed crop production has been increasing with rising feed prices driven in part by new demand from ethanol refineries. Rising corn and land prices also mean that it is difficult for new farmers to gain access to land to farm. However, growing high-value fruits and vegetables can be a strategy for new farmers who struggle with access to land. This is discussed in more detail in the *Conclusion & Recommendations* section. Commodity prices, however, have a history of being cyclical with high peaks and low valleys. A diversified regional agricultural economy would help dampen this cycle.

Farm profitability has been very good since 2006 when the ethanol boom first started. This has continued into 2012 for grain farmers despite a historic drought, largely because of crop insurance that nearly guaranteed a profit for corn production. The outlook for profitability in corn production and near breakeven profit levels for soybeans remains very strong in 2013 (Table 8). This profitability will likely assure corn, soybeans, and wheat plantings at the highest levels since the early 1980s (Figure 30).

There may be opportunities for partnerships between existing landowners who have resources such as equipment and land with existing small-scale produce growers or new young producers.

Table 8: Outlook for Corn and Soybean Profitability

(Source: University of Illinois)

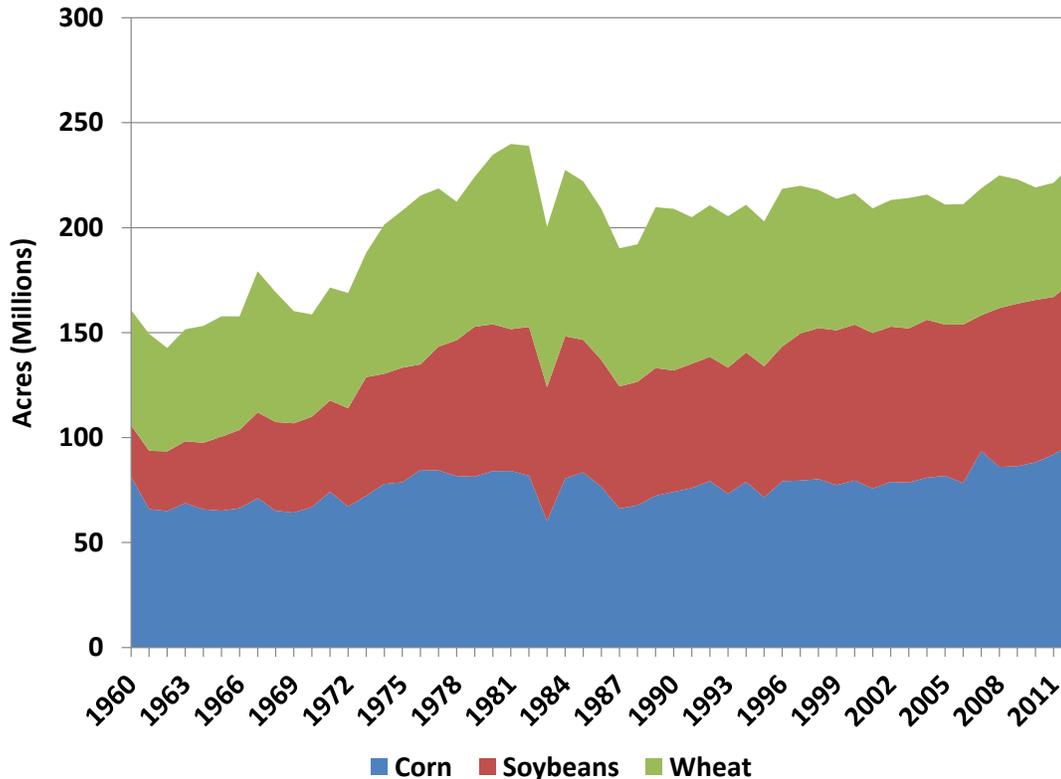
	Corn			Soybeans		
	Year			Year		
	2011	2012P	2013P	2011	2012P	2013P
Yield per acre	174	135	195	56	46	57
Price per bu	\$5.95	\$8.00	\$6.00	\$12.27	\$16.00	\$12.50
Crop revenue	\$1,035	\$1,080	\$1,170	\$687	\$736	\$713
ACRE revenue	0	0	0	0	0	0
Direct payments	24	24	0	24	24	0
Crop insurance proceeds	23	115	0	11	30	0
Gross revenue	\$1,082	\$1,219	\$1,170	\$722	\$790	\$713
Fertilizers	\$159	\$165	\$155	\$55	\$58	\$53
Pesticides	50	50	52	31	31	33
Seed	96	98	100	62	63	65
Drying	19	19	19	1	1	1
Storage	8	8	8	4	5	5
Crop insurance	30	28	28	20	20	20
Total direct costs	\$362	\$368	\$362	\$173	\$178	\$177
Machine hire/lease	\$8	\$8	\$8	\$8	\$8	\$8
Utilities	4	4	4	3	4	4
Machine repair	17	18	18	16	17	17
Fuel and oil	18	17	17	17	11	11
Light vehicle	1	2	2	1	1	1
Mach. depreciation	39	41	43	35	39	42
Total power costs	\$87	\$90	\$92	\$80	\$80	\$83
Hired labor	\$13	\$12	\$12	\$14	\$12	\$12
Building repair and rent	7	7	7	4	4	4
Building depreciation	9	9	9	5	3	3
Insurance	8	10	10	8	10	10
Misc	7	7	7	8	7	7
Interest (non-land)	16	17	17	11	12	12
Total overhead costs	\$60	\$62	\$62	\$50	\$48	\$48
Total non-land costs	\$509	\$520	\$516	\$303	\$306	\$308
Operator and land return	\$573	\$699	\$654	\$419	\$484	\$405
Land costs	248	288	302	248	288	302
Operator return	90	90	90	85	85	85
Net return	\$235	\$321	\$262	\$86	\$111	\$18

¹Results for 2011 are summarized from grain farms enrolled in Illinois Farm Business Farm Management. Budgets for 2012 and 2013 are projections.

Prepared by: Gary Schnitkey, University of Illinois, schnitke@uiuc.edu, 217 244-9595.
Available in the management section of *farmdoc* (www.farmdoc.illinois.edu).

Figure 30: Land in Row Crops -- 1960 to 2012

(Source: USDA ERS)



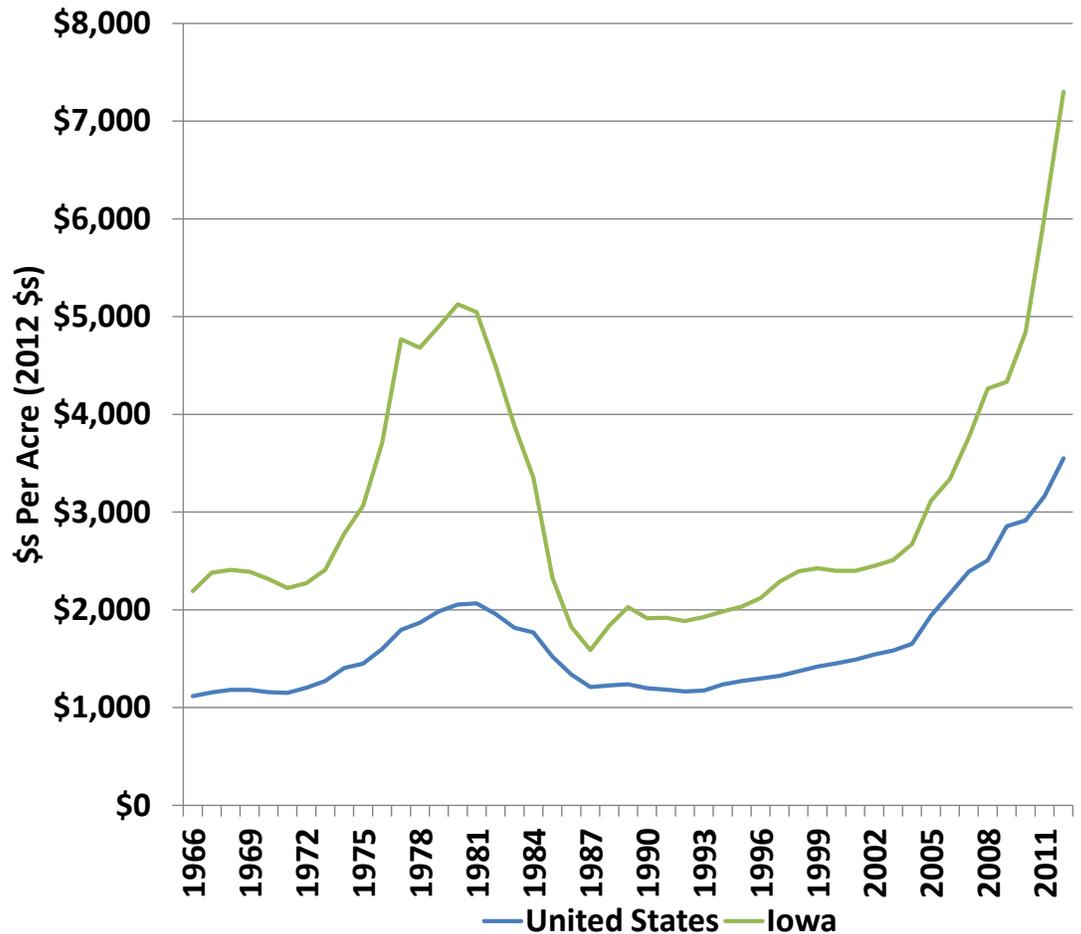
After adjusting for inflation, the surge in profitability and demand for corn production has pushed land prices to the highest levels on record (Figure 31). In contrast to the 1980s, debt levels have not increased as rapidly relative to land values, which may lessen the concern for another farm crisis similar to the 1980s.¹⁹ This leaves most landowners in an adequate financial position to deal with a sharp decline in land prices. This is an opportunity for fruit and vegetable production in the study area because there is plenty of equity and capital that current landowners and farmers could use to invest in a new fruit and vegetable production business. However, given the average age of the study area farm community, it is also likely that current landowners and feed crop farmers are reluctant to take on a new produce business and its associated risk.

Increasing fruit and vegetable production may be a strategy not only to diversify the region's agricultural system, but also an opportunity for new growers. There may be opportunity to partner existing landowners who have resources such as tractors, equipment, land, and equity with existing smaller scale produce growers or new young producers.

¹⁹ See the following source, Chapter 23: Technology and Other Innovations 1975-2000 Agricultural for background on the 1980s farm crisis: Campbell, Rex R., Mary Campbell, and Coleen Hughes. *A Revolution in the Heartland: Changes in Rural Culture, Families, and Communities*. Columbia, Missouri: Department of Rural Sociology, University of Missouri, 2004. Web. 23 Dec. 2012. <<http://web.missouri.edu/~campbellr/Book/>>.

Figure 31: Historical Land Prices Adjusted for Inflation

(Source: USDA ERS)



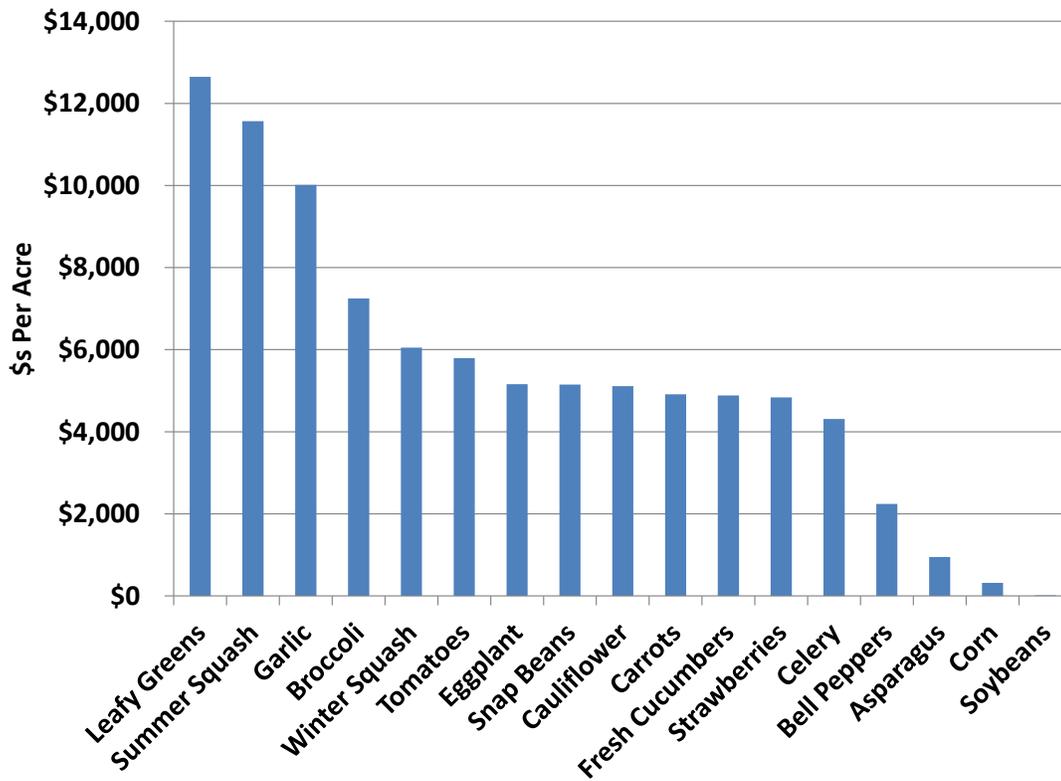
Land prices are the highest on record even after adjusting for inflation, which adds to the risk for a beginning farmer. Young producers are challenged to find the 40% down payments needed in most cases to secure new land. Thus, to buy 500 acres of prime crop ground that costs \$8,000 per acre or \$4 million dollars and requires an approximately \$1 million dollar down payment is typically not feasible of new or younger growers. Younger producers able to make such purchases are generally doing it with the help of their families. Renting land is less risky but challenging and investment in equipment and buildings is very expensive. Without family relationships or an existing land base from which to start, renting for row crop production has been challenging because most of the profitability gets passed onto the land owners, equipment manufacturers, or crop input producers.

One option for new or existing small-scale farmers is growing fewer acres than for conventional row crops but producing higher value crops such as fruit or vegetables. Successful production of higher value crops has the potential to be significantly more profitable per acre (Figure 32). For example, a farmer growing 1,000 acres of corn on her own land making \$300 per acre profit would earn \$300,000 in profit. It would take an estimated 50 acres of winter squash to yield the same \$300,000 in profit. However, a

new farmer who can only afford to farm 300 acres of corn and is only making \$150 per acre because of high rent could grow 8 acres of winter squash and make the same profit of \$45,000. In this way, fruit and vegetable production is an opportunity to help bring new farmers to the land and region.

Figure 32: Estimates of Profit with Average Yields

(Source: University of Wisconsin Madison-Extension, Iowa State University, North Carolina State University, University of California-Davis, University of California-Berkeley, and USDA ERS)



Fruit and vegetable production is an opportunity to help bring new farmers to the land and region.

Conclusions & Recommendations

This section discusses both challenges and opportunities discussed in previous sections and develops recommendations that focus on areas stakeholders could work on to minimize challenges and leverage existing resources.

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Section Summary

This section discusses both challenges and opportunities discussed in previous sections and develops recommendations that area stakeholders could work on to minimize challenges and leverage existing resources. The section briefly summarizes information from previous sections and explores recommendations to minimize challenges and maximize opportunities.

Section Highlights

Challenges and solutions discussed in this section include the following:

- Policy Challenge: Current federal policies incentivize producing crops such as corn and soybeans. Midwestern fruit and vegetable producers do not receive the same benefits that fruit and vegetable producers in other parts of the US receive.
 - *Policy Recommendation*: Coordinate a unified regional voice to advocate for federal policy changes.
- Risk Challenge: Fruit and vegetable production is risky.
 - *Risk Recommendation*: Customize weather insurance to the risks of growing produce in the Tri-State region.
- Markets and Aggregation Challenge: The majority of existing production is small-scale with a focus on direct marketing. Existing local food distribution systems are inefficient.
 - *Markets and Aggregation Recommendation*: Aggregate small producers and encourage production at a large enough scale so a single producer can fill a truckload of produce.
- Production Knowledge Challenge: There are producers in the Tri-State area that are highly skilled at growing produce. However, overall there is a lack of production and harvesting knowledge appropriate for the region's unique characteristics.
 - *Production Knowledge Recommendation*: Develop and exchange knowledge on fruit and vegetable production and harvesting as applicable to the Tri-State area.
- Labor Challenge: Fruits and vegetables are generally labor-intensive crops. The region has a lack of skilled labor for growing and harvesting produce.
 - *Labor Recommendation*: Increase mechanization to reduce the demand for labor and coordinate between producers and universities to develop innovative systems and equipment engineering.
- Physical Infrastructure Challenge: Fruit and vegetable production in the Tri-State area is currently small-scale. The biggest constraint to reaching economies of production scale is a lack of farm equipment and mechanization.
 - *Physical Infrastructure Recommendation*: Find ways to share physical infrastructure to reduce duplicative investments and eliminate barriers to new growers.

Several of these recommendations involve issues that regional stakeholders cannot directly affect, such as federal policy. However, the recommendations regarding weather insurance, capital infrastructure, and production knowledge are able to be implemented entirely by regional stakeholders and can be done independently of state or federal policy.

Policy

Challenge: Federal Policy

Current federal policies incentivize producing crops such as corn and soybeans. Midwestern fruit and vegetable producers do not receive the same benefits that fruit and vegetable producers in other parts of the US receive.

Current federal policies are a major barrier to increasing the agricultural diversity in the region and expanding fruit and vegetable production in the Tri-State area. The increasing trend of growing highly subsidized crops such as corn and soybeans leaves the region dependent on the federal policies that provide these subsidies.

Direct Subsidies & Biofuel Policy

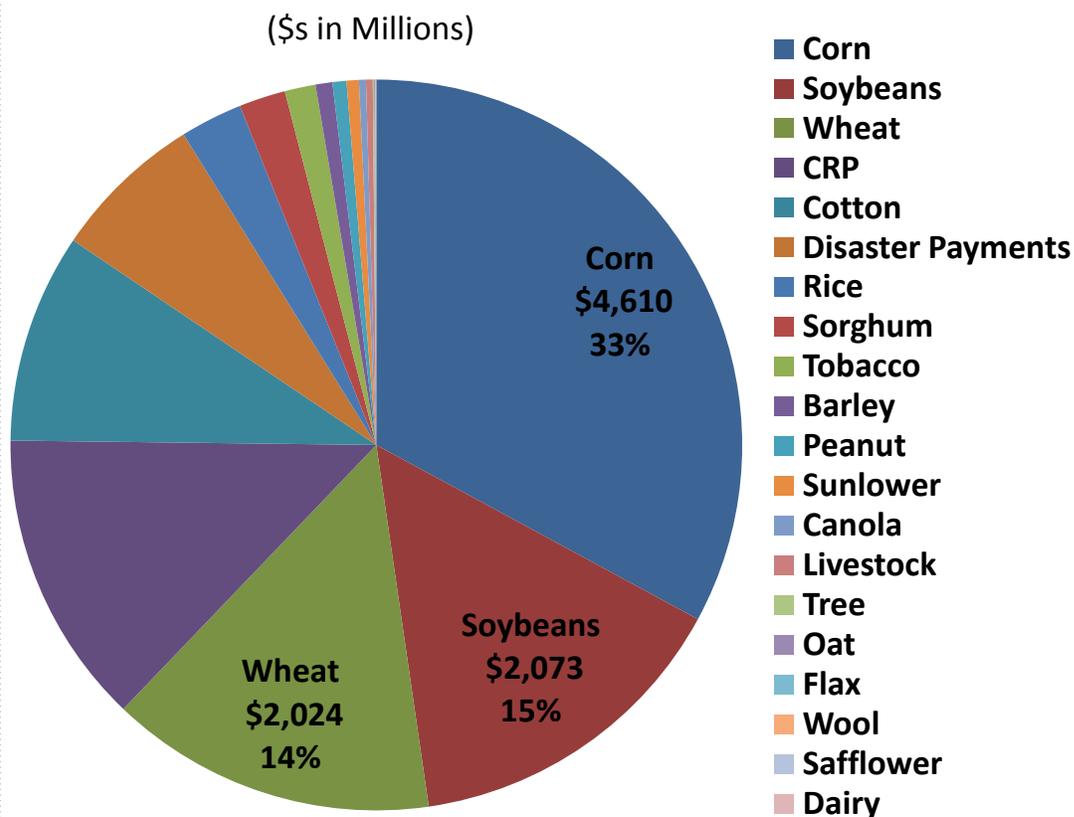
Direct subsidies are paid to farmers who choose to grow a specific crop such as corn, grain sorghum, barley, oats, wheat, or soybeans. These subsidies are based on a farmer's average yield multiplied by a per bushel payment. Direct payments are paid for growing an eligible crop regardless of price or profit levels.

In 2011, approximately 62% of all direct US farm subsidies went towards the production of corn, wheat, and soybean row crops (Figure 33). This is more than 600 times the amount of US subsidies paid to fruit and vegetable growers. These direct subsidies do not include the sizable indirect benefits that corn and soybean producers received from biofuel subsidies and other mandates. In 2011 alone, biofuel subsidies and mandates cost taxpayers over \$7 billion.

The difference in crop insurance opportunities for a new fruit and vegetable producer in the Midwest versus produce growers in California or corn producers in the Midwest is a huge barrier to new production in the study area.

Figure 33: 2011 Farm Subsidies by Crop

(Source: USDA ERS Farm & Commodity Policy)



In 2011, direct payments equaled approximately 5% of total US corn revenue. Applying the same policy to produce production at the same 5% of total revenue would yield an estimated \$750 payment per acre of tomatoes (Table 9). This would add a significant incentive to grow vegetable crops.

Table 9: Hypothetical Direct Payments for Select Produce

(Source: USDA ERS)

Hypothetical Direct Payments	Revenue Per Acre*	\$/Acre**
Tomatoes	\$15,000	\$750
Bell Peppers	\$11,000	\$550
Winter Squash	\$9,000	\$450

*Assumes Estimated Average Yields for Midwest x Chicago Terminal Prices

**Assumes 5% of Revenue Per Acre

In addition to direct payments, corn and soybean farmers have indirectly benefited from policies that subsidize the use of biofuels and mandate their usage. Corn and soybeans are partially consumed in ethanol and biodiesel production. Policies incentivizing the use and production of biofuels support the consumption of corn and soybeans. Even favorably accounting for byproducts left over from the remainder of the corn during the ethanol process, approximately 25% of all corn produced in the United States went to

ethanol production. In 2011, ethanol production required 20 million acres. In contrast, nearly all of the US fruit and vegetable production in 2011 was on 6 million acres.¹

These policies have either already been phased out or are on the verge of being less meaningful. Ethanol subsidies disappeared at the end of 2011 and the mandated usage of ethanol is leveling out. Direct payments were the first item discussed for elimination in the recent farm bill. The legislation is still tied up in Congress but expectations are that when the new farm bill arrives in 2013 it will not contain direct payments. However, it may add additional subsidies to an already highly subsidized federal crop insurance program.

Insurance Programs & Subsidies

The difference in crop insurance opportunities for a new fruit and vegetable producer in the Midwest versus produce growers in California or corn producers in the Midwest is a huge barrier to new production in the study area. The federal crop insurance program began in 1938 near the end of the Great Depression. The current program is administered under the USDA Risk Management Agency covering various crops including a few vegetables. However, access to the federal insurance program for produce growers varies by state. The agency works with private insurance companies who sell and service the contracts. The USDA provides a significant premium subsidy to most policies and also frequently shares the risk of crop failure or low market prices with the private insurers. According to a recent paper by the Congressional Research Service, approximately 60% of insurance premiums are covered by federal taxpayers.

It is estimated that in the last 10 years \$65 billion will have been spent on federal crop insurance by federal taxpayers (Figure 34).² Corn, cotton, soybeans, and wheat accounted for 84% of premium subsidies in 2009 with fruit and vegetable growers making up less than 10% of the subsidies. In fact, over the last five years these subsidies have been more generous for corn and soybean farmers than direct payments. Combined with direct payments, a federal subsidy equivalent to 10% of all 2011 revenues³ has been paid to corn and soybean farmers. The 10% of subsidies would equate to over half of the average net profits for these crops. If this benefit was available to fruit and vegetable growers, it would be between \$1,000 and \$6,000 per acre depending on the crop.

1 Thornsby, Suzanne. "Vegetables and Pulses." Economic Research Service, US Department of Agriculture, n.d. Web. 23 Dec. 2012. <<http://www.ers.usda.gov/topics/crops/vegetables-pulses.aspx>>.

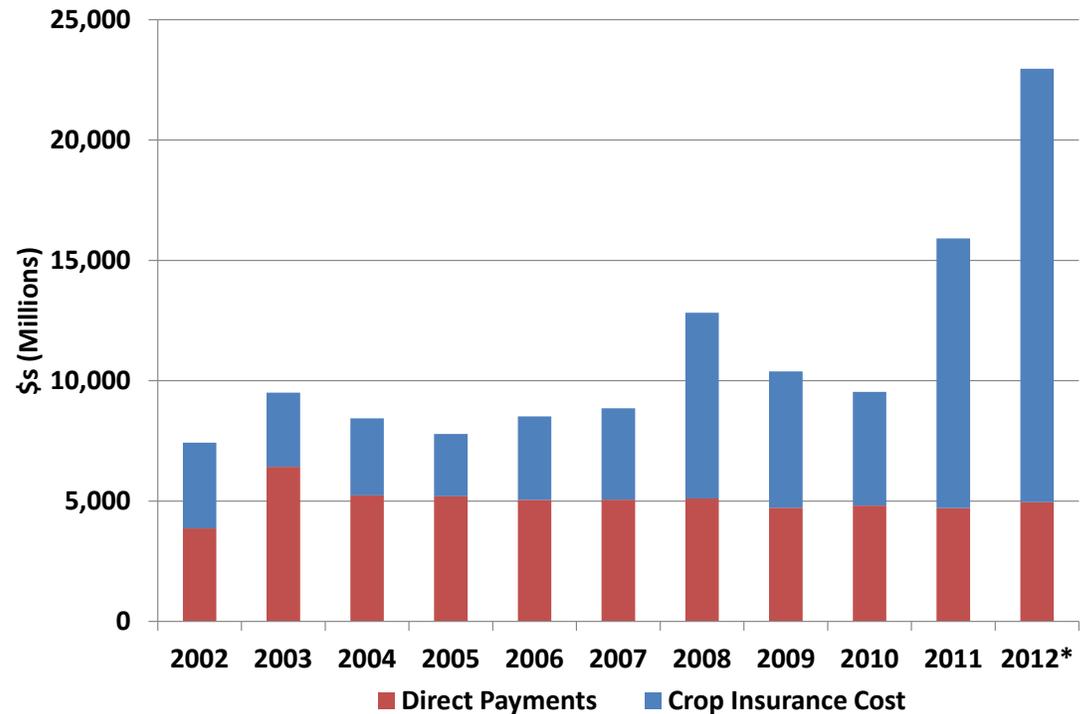
2 RMA USDA. Crop Year Government Cost of Federal Crop Insurance. [Http://www.rma.usda.gov/aboutrma/budget/cycost2002-11.pdf](http://www.rma.usda.gov/aboutrma/budget/cycost2002-11.pdf)

3 For more information, please see previous section for a comparison on direct payments.

The inability to acquire federal crop insurance limits bank lending because new produce farming businesses are perceived to be too risky.

Figure 34: Federal Crop Insurance Cost to Taxpayers

(Source: USDA Risk Management Agency, Vincent Smith, Economist at Montana State University and other private economists)⁴



Another barrier is access to insurance. Typically, only counties with significant areas in production for a given crop are eligible for federal crop insurance programs. This limits fruit and vegetable production to the Southwest and Southeast, mostly in California and Florida. Competing producers in California have access to crop insurance programs that are typically not “means” tested. This allows growers to fully participate in the heavily subsidized programs, regardless of size. This also likely explains the high-density levels of 2012 indemnity payments from the USDA for California and Florida counties (Map 9). These growers receive subsidies giving them an advantage to a producer in the Midwest. Midwestern producers do not receive comparable support.

In fact, the only major federal insurance available to Midwest vegetable growers is under the Noninsured Crop Disaster Assistance Program (NAP).⁵ The program only provides payments to qualified growers who lose 50% or more of their crop or are unable to plant 35% of their crop or more. Payments are based on yield history and production records meaning a new producer in the study area would not qualify for NAP.

These insurance policies are a major deterrent to growing fruit and vegetables in the

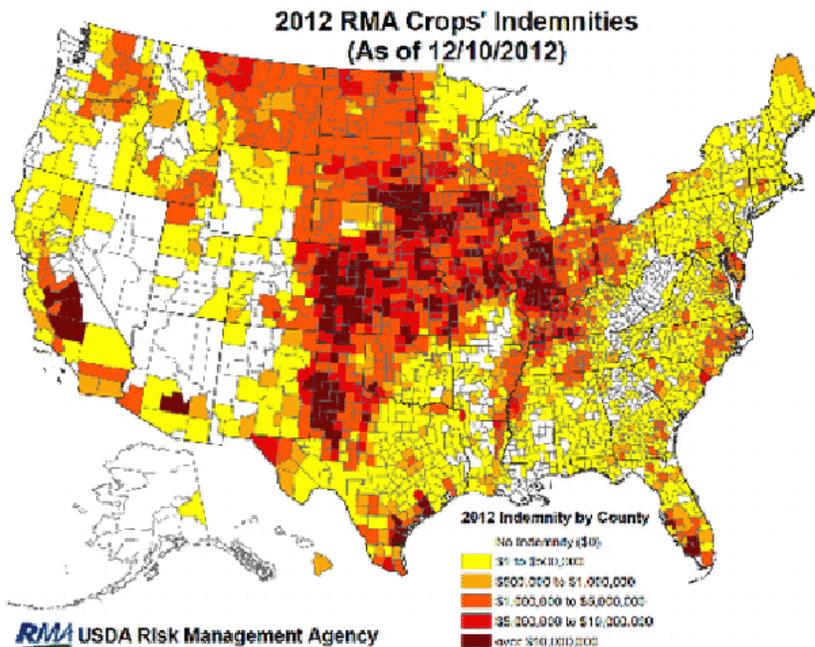
⁴ Please note that the 2012 figure is an estimate calculated by Vincent Smith, Economist at Montana State University.

⁵ Specialty Crop and Organic Agriculture Programs, Subcommittee on Horticulture and Organic Agriculture, Committee on Agriculture, US House of Representatives Cong. (2010) (testimony of Margaret A. Smith). <http://sustainableagriculture.net/wp-content/uploads/2008/08/Margaret-Smith-written-testimony-7-21-10.pdf>

Midwest. The subsidies put potential new growers at revenue (direct payments) and cost (insurance premiums) disadvantages to both competing growers in California and corn farmers in the Midwest. Additionally, farming is a capital intensive business which requires significant lending for buildings and buying land as well as operating loans to manage annual crop inputs until revenues arrive in the fall. The inability to acquire federal crop insurance limits bank lending because new produce farming businesses are perceived to be too risky.

Map 9: 2012 USDA Risk Management Crops' Indemnities

(Source: USDA Risk Management Agency)



Policy Recommendation

Coordinate a unified regional voice to advocate for federal policy changes.

As discussed above, current policies provide strong support for corn and soybean production and very little support for Midwestern fruit and vegetable production. Without policy changes such as the complete removal of subsidies or the inclusion of produce growers into comparably subsidized programs, new investments in produce farming will be significantly hindered.

The current national discussion on federal deficit reduction and reduced spending may provide a window of opportunity for reform. The farm bill will be a major piece of legislation in 2013, potentially impacting the policies discussed above. Coordinating a unified voice to advocate for policy changes may be part of the solution to removing these barriers for produce farmers in the Midwest.

The policy area that stands to benefit fruit and vegetable producers the most is changes

Policy changes on the federal level are difficult and take a longer amount of time than other recommendations, however the benefits are significant if successful.

in federal crop insurance programs. Increased access to federal crop insurance for new or beginning growers would be a significant step towards getting more producers to invest in new produce farms along with greater financing from traditional lenders. Policy changes on the federal level are difficult and take a longer amount of time than other recommended actions but the benefits are significant if successful.

Strategy 1: Develop a working group of local producers, elected officials, and other interested stakeholders. This working group should push for action to level the policy playing field for local produce growers. Below are some policy ideas to push for:

The creation of a new insurance product submitted through the Federal Crop Insurance Corporation (FCIC) section 508 (h). The 2008 farm bill dedicated a section within the crop insurance program for the outside development of insurance tools. The FCIC Board of Directors is able to advance funding for concept proposals for new insurance programs to aid in actuarial and research based on these criteria:⁶

- Will likely result in a viable and marketable policy consistent with section 508(h) of the Act;
- In the sole opinion of the Board, the concept will, if developed into a policy or plan of insurance and approved by the Board, provide crop insurance coverage:
 - In a significantly improved form;
 - To a crop or region not traditionally served by the Federal crop insurance program; or
 - In a form that addresses a recognized flaw or problem in the program; and
- The proposed budget and timetable are reasonable. Reasonableness may be determined by comparing the proposed concept to other similar proposed concepts or policies or plans of insurance (based on originality, complexity, and scope) that have been approved under section 508(h) of the Act and received research and development costs under section 522(b) of the Act or any other manner determined, at the sole discretion of the Board, to be appropriate.

This document identifies the need for crop insurance in the region and provides a significant amount of supporting material for the submission process. Furthermore, the crops analyzed fit the criteria of not being traditionally served by federal crop insurance in the region. Currently, the biggest gap is actuarial insurance expertise. This could be sought out from participating stakeholders or a private insurance party interested in developing new customers. This idea has the added benefit of working through existing policy procedures for changes versus advocating for a legislative change which may be more challenging.

Strategy 2: Develop a regional trade association to advocate legislative changes on the farm bill set to be discussed in the spring of 2013. Potential advocacy areas include:

⁶ US Department of Agriculture. Federal Crop Insurance Corporation Approved Procedures for Submission of Concept Proposals Seeking Advance Payment of Research and Development Expenses. Page 4. Jan. 2009. [Http://www.rma.usda.gov/fcic/2009/107procedures.pdf](http://www.rma.usda.gov/fcic/2009/107procedures.pdf).

Reform farm subsidies by eliminating direct payments for any crop or developing direct payments for produce growers. It would likely be easier in today's fiscal environment to strive for eliminating subsidies instead of trying to get equivalent subsidies for fruit and vegetable growers. Adding direct payments for fruit and vegetable growers would likely not be a significant budget cost. However, the current direct payment program is already unpopular and is anticipated to be eliminated. An advocacy group could add an additional voice to push for the elimination of these subsidies.

The current federal crop insurance program allows private insurers to sell insurance and can provide a maximum liability guarantee for these private insurers. However, the USDA highly regulates the types of insurance that can be sold, limiting access to only certain crops in certain areas. This creates an inherent disadvantage for crops not able to participate in the guarantee program. A change to consider for federal crop insurance would be to alter how the subsidies are transmitted to producers and make the benefits of the insurance subsidies available to all crops. The federal crop insurance program could provide rebates directly to farmers for purchasing either yield or revenue insurance without requirements where they must buy the insurance. This would provide growers with the flexibility to customize insurance policies to their needs and risks. It would help produce growers in the study area by providing a subsidy for purchasing insurance that is currently received by corn, soybean, and wheat growers.

Another recommendation is to expand liability guarantees to any private policies, but only allow the federal government to equivalently share in liabilities for unregulated policies. For example, a private insurer could write a customized policy for a grower guaranteeing minimum revenue of \$5,000 per acre at a premium cost of \$100 per acre. The private insurer could submit this policy to a federal insurance program for reinsurance on 50% of the policy at a cost to the private insurer of 50% of the annual premium. In this example, private insurer would pay the federal insurance program \$50 per acre to share half of the liability on the insurance. Therefore, if there were a \$1,000 claim, the private insurer would be responsible for \$500 and the federal insurance program would be responsible for \$500. This is a simplified example but it is the type of addition to federal farm insurance that would create greater equality in insurance opportunities for specialty produce growers.

Expand on the Beginning Farmer Loan Program. The current loan guarantee program focuses primarily on supporting existing agriculture practices because loans are typically originated through traditional lending channels, such as a bank. Existing agriculture businesses tend to get priority over a beginning, non-traditional produce farmer in this structure. The regional trade association could advocate for beginning farmer loans for non-traditional crops.

Explore opportunities at the state level to seek legislative support for increased fruit and vegetable production. It is difficult to fully evaluate all of the potential avenues that may be available for each state because this report is a three state initiative. Nonetheless, there may be existing programs that could be expanded or improved that would support either new or the expansion of existing growers. Collaborating and communicating with state representatives in the region may lead to new ideas and opportuni-

Resources should be focused on reducing risks associated with start-up investment needs and crop productions.

ties. In any case, advocating for policy changes at both the local, state, and federal levels may be a low cost but potentially high reward approach to stimulating additional growth in specialty crop production for the region.

Challenge: Risk

Fruit and vegetable production is very risky.

Reducing risk for new and existing growers and private businesses would help stimulate new investment and provide production experience that could translate into a self-sustaining industry. The primary focus of funding to support production for wholesale markets should be to reduce the primary risk for a grower looking to reach the 25 acre scale of production needed to be cost competitive in the wholesale market. Therefore, resources should be focused on reducing risks associated with start-up investment needs and crop production. The reductions in upfront risk to individual growers increase the probability of a producer taking the initial step into produce farming or expanding an existing small scale produce farm.

Risk Recommendation

Customize weather insurance to the risks of growing produce in the Tri-State region.

Strategy 1: Customize weather insurance to the risks of growing produce in the region. This can be implemented through partnerships between growers, weather insurance providers, universities or university extension offices, and the USDA.

Weather insurance is privately offered and is independent of federal crop insurance. Weather insurance uses historical statistics on rainfall and temperatures to write insurance policies for producers. These policies have certain weather triggers that if occur result in an indemnity payment to the producer. A few examples of policies include coverage for a late spring freeze, excessive moisture, heat or cold stress, and an early fall freeze. The main caveat is that weather is not monitored at individual farms but at weather stations which may be a few miles away. It also only insures weather 'events' and not yield results so if yields are poor due to disease, insects, or other non-weather reasons there is no coverage.

The important variables would determine which weather events are most damaging to the types of crops being grown and the cost of damage to a grower. This is challenging because the yield loss from excessive moisture for tomatoes may not be clear for this specific region. There have been field trials of various crops across the United States that could be used as a gauge for these types of questions.

Seek grant funding to develop and administer private weather insurance as well as potentially subsidize the policies during the initial years of testing. This type of project could incentivize innovation for reducing weather risks for growers. Grant funding in this area is appealing for a couple reasons. First, it combines university educational research in agronomics, agribusinesses, and actuarial science with produce growers and

private weather insurers to solve a challenging problem. This serves the dual purpose of funding education and supporting local produce production. Second, it has the potential to be a solution to the unequal access of federal crop insurance that currently exists. Weather insurance likely could not be subsidized similar to federal crop insurance because of cost. Still, it would provide an available alternative to federal crop insurance for mitigating one of the significant risks faced by new producers and investors.

Human Capital, Physical Infrastructure, & Scale of Production⁷

Challenge: Markets & Aggregation

The majority of existing production is small-scale with a focus on direct marketing. Existing local food distribution systems are inefficient.

Although there has been significant improvement in production knowledge, the majority of existing production is done on small farms with a focus on direct marketing. This has had a positive impact on developing production knowledge such as cultivar selection and unique practices appropriate for the region's unique characteristics. Increased communication between growers and buyers is resulting in the expansion of market opportunities. Additionally, the 'Buy Local' movement has supported farmers by expanding market size and potential and providing a premium for regional products. However, existing local food distribution systems are inefficient.

This inefficiency reduces the advantage over producers in California in transportation costs. Growers who wish to remain small have access to direct and other value added markets. However, marketing in small volumes has inefficiencies that usually increase costs for consumers. For example, driving 200 pounds of local fresh produce 20 miles to market is equivalent in shipping costs to move 30,000 pounds of produce 3,000 miles from California. Additionally, the current local food system is missing the largest market for fresh produce: the wholesale conventional grocery and restaurant distribution systems.

Markets & Aggregation Recommendation

Aggregate small producers and encourage production at a large enough scale so a single producer can fill a truckload of produce.

Tapping into wholesale markets requires full truckloads of high quality fresh produce delivered on a more reliable schedule than currently exists. Low production cost is also important to reach these markets, but not as important as product quality and reliable delivery schedules. This can be achieved through aggregation of small producers, but this is costly and can result in a lower quality product. Additionally, existing growers are spread out across the region and effectively matching production and harvest schedules is chal-

One solution to tapping into wholesale markets is to achieve a scale of production where a single grower can fill a full truckload of produce in a given harvest day or cycle. This scale is around 25 acres for many crops.

⁷ Both human capital such as knowledge and skills and physical infrastructure such as buildings, equipment, and land are very important to determining the viability of fruit and vegetable production in the region.

lenging. One solution is to achieve a scale of production where a single grower can fill a full truckload of produce in a given harvest day or cycle. This scale is around 25 acres for many crops and is the level of production that should be targeted by growers looking to market wholesale produce.

Strategy 1: Increase and improve coordination between aggregator and potential processing operations. There are aggregators who have developed working relationships with growers and are already successfully aggregating product. Processors looking to either build or diversify into local fruit and vegetable products provide a secondary market for aggregators which could add value to both themselves and growers. Additionally, developing a relationship between aggregators and processors would help transmit important information such as how much processing grade supplies could be available and when it would be delivered. Lastly, aggregators may be better able to recruit new production if they could effectively coordinate with a new processing facility that would provide an added value to second grade crops. Better coordination between aggregators and processors would allow for more effective local marketing. Additionally, some existing large-scale aggregators who are sourcing fruits and vegetables from the Tri-State area do not label their end product as being produced in a particular area. By doing so they could tap into some of the “Buy Local” market.

Challenge: Production Knowledge

There are producers in the Tri-State area that are highly skilled at growing produce. However, overall there is a lack of production and harvesting knowledge appropriate for the region's unique characteristics.

Experienced producers are a critical component for the region to increase fruit and vegetable production. There are producers in the Tri-State area that are highly skilled at growing produce. However, overall there is a lack of production and harvesting knowledge suitable to the region's unique characteristics and growing conditions. This overall knowledge needs to be developed in order for the Tri-State area to be competitive.

Production Knowledge Recommendation

Develop and exchange knowledge on fruit and vegetable production and harvesting that is applicable to the Tri-State area.

Strategy 1: Find ways to coordinate available resources in order to improve knowledge for new growers. The region is made up of farming communities who have knowledge and skills required to understand soil types, scout crops for weeds or disease, and operate large machinery like tractors. Also, there are an increasing number of small scale produce farmers starting in the area that support CSAs, farmers markets, and direct sales to restaurants. Additionally, there are extension agents and other knowledgeable public officials that may be able to support new production. Though the region's skills are not necessarily specialized to fruit and vegetable farming, they could be easily adaptable.

Strategy 2: Support agronomic decision making for beginning farmers and educate them

on skills needed to run a successful fruit or vegetable farm. The last recommendation is to imitate an existing grant funded project being administrated by the Crop Science department at the University of Illinois Extension in Urbana, Illinois.⁸ It was grant funded by the USDA Beginning Farmers and Ranchers Development Program. Project goals include increasing the viability of new fruit and vegetable production to meet rising local demand, and to support local economies.

Challenge: Labor

*Fruits and vegetables are generally labor-intensive crops.
The region has a lack of skilled labor for growing and harvesting produce.*

Labor supply and skill is a major barrier but recent trends have been favorable (see the *Market Feasibility Analysis* section for details). This section explores the amount of labor, including seasonal labor, needed to support expanded fruit and vegetable production.

As before, an assumption of 25 acres in production is assumed for analysis reasons of greenhouse sizes, specialized planting and harvesting equipment costs, and the size of a semi-truck. Crops vary in labor demand primarily due to two variables. Crops that require early greenhouse starts and hand transplanting are more labor intensive than seed planting with a mechanized planter. Secondly, some crops require multiple harvests which are very labor intensive. The work is seasonal, so even though there may be only a few full-time equivalent jobs it often requires 2 to 3 times that job estimate in part-time workers. This is challenging because it means having to train and rely on 2 to 3 times that number of workers. Table 10 gives a very rough estimate of hours, full-time, and part-time work generated from a 25 acre farm of those crops.

8 Weinzierl, R., E. Gonzalez, J.D. Kindhart, W.H. Shoemaker, J.R. Pike, and D. Cavanaugh-Grant. Preparing a New Generation of Illinois Fruit and Vegetable Farmers. Current Research Information System. USDA National Institute of Food and Agriculture, n.d. Web. 26 Dec. 2012. <<http://cris.nifa.usda.gov/cgi-bin/starfinder/0?path=fastlink1.txt&id=anon&pass=&search=R=53243&format=WEBFMT6NT>>.

In order for the Tri-State area to be competitive, production and harvesting knowledge that is appropriate for the region's unique characteristics and growing conditions must be developed.

Table 10: Labor Needs for Select Crops (25 acre production)

(Source: University of Wisconsin Madison-Extension, Iowa State University, North Carolina State University, University of California-Davis, University of California-Berkeley, USDA ERS)

Labor Needs	Hours Labor (25 Acres)	Full Time Equivalent (2,000 Hours Per Unit)	Part Time Equivalent (600 Hours Per Unit)
Winter Squash	2,921	2	5
Fresh Cucumbers	4,319	3	8
Leafy Greens	4,650	3	8
Broccoli	5,553	3	10
Cauliflower	5,731	3	10
Tomatoes	6,313	4	11
Eggplant	6,635	4	12
Bell Peppers	8,162	5	14

The second consideration is the volume of labor for the region. There is a deficit in quantity of production for a 100 mile radius from the study area. Assuming the study area could fill 10% of that need, it would equate to roughly 2,000 acres of primarily vegetable production. Table 11 calculates a generic example of the number of workers needed to support that level of production. The 1,089 estimate of part-time workers would be a fairly small amount relative to the 600,000 population in the 18 county study areas.

Table 11: Labor Needs for Select Crops (2000 acres of production)

(Source: University of Wisconsin Madison-Extension, Iowa State University, North Carolina State University, University of California-Davis, University of California-Berkeley, USDA ERS)

Labor Needs	Hours Labor (2,000 Acres)*	Full Time Equivalent (2,000 Hours Per Unit)	Part Time Equivalent (600 Hours Per Unit)
Winter Squash	233,660	117	390
Fresh Cucumbers	345,540	173	576
Leafy Greens	372,000	186	620
Broccoli	444,240	223	741
Cauliflower	458,500	230	765
Tomatoes	505,020	253	842
Eggplant	530,820	266	885
Bell Peppers	652,950	327	1,089

*Estimated number of hours to capture 10% of the 100 mile fruit and vegetable production deficit, discussed in the *Market Feasibility Analysis* section

While supply of labor and labor productivity is important, labor rates were not found to be a limiting factor. Analysis shows that if productivity and overall efficiencies are optimized, there is plenty of room to increase hourly wages as Table 12 shows. For an example that assumes the estimated average yields could be achieved, breakeven labor rates would range from \$19 to \$80 per hour. This example assumes that the farm dedicates all income to labor, leaving zero net-income once labor is paid. While hypothetical, this example indicates that based on revenue from average yields, labor prices could be offered that would be competitive with other industries, and which would be well above the prevailing wage rates for the area for farm field labor (based on USDA estimates of \$11.67/hour currently).

Table 12: Comparison of Wage Rates v. Yield for Select Crops

(Source: University of Wisconsin Madison-Extension, Iowa State University, North Carolina State University, University of California-Davis, University of California-Berkeley, USDA ERS)

Wage Rates v. Yield	Breakeven Labor Rates with Average Yields	Breakeven Labor Rate with Low Yields
Bell Peppers	\$19.37	\$0.89
Fresh Cucumbers	\$31.94	\$0.60
Cauliflower	\$34.80	\$0.88
Tomatoes	\$35.45	\$0.72
Eggplant	\$40.78	\$0.52
Broccoli	\$45.12	\$0.57
Winter Squash	\$64.30	\$0.29
Leafy Greens	\$80.48	\$0.28

Labor Recommendation

Increase mechanization to reduce the demand for labor and coordinate between producers and universities to develop innovative systems and equipment engineering.

The bigger issue for labor focuses on productivity. Unlike competitor regions such as California and states in the Southeast, labor is not trained with the necessary skills needed for intensive produce farming. It is crucial to have as much mechanization as possible implemented on the farm to increase productivity and reduce the physical stress on workers. Potential for entrepreneurial innovation exists in systems and equipment engineering. This is especially true for the very physically intensive field harvest process. This is an area where coordination between private farmers, public universities, and trade schools can provide unique opportunities for the region.

Challenge: Physical Infrastructure

Fruit and vegetable production in the Tri-State area is currently small-scale. The biggest constraint to reaching economies of production scale is a lack of farm equipment and mechanization.

Physical infrastructure is a broad category of resources that includes greenhouses, irriga-

tion equipment, planters, tractors, and mulch layers as well as harvesters, packing equipment, cold storage, and distribution warehouses. A significant challenge to developing or redeveloping a market is getting the initial capital investments needed to make it competitive. Initial investments are risky because typically there is not existing infrastructure in place to help support the new investment. Wholesale fruit and vegetable production lacks infrastructure that would provide access to equipment, production knowledge, labor skills, and marketing.

The biggest constraint to reaching economies of scale appears to be the lack of equipment and mechanization on the farm. The infrastructure after the farm is either available like a semi-truck or could be constructed if there was produce supply to support it like a produce quick freeze and packaging facility.

In wholesale, fresh market vegetable production it is critical to reach a scale of production that takes advantages of farming and marketing efficiencies. It varies by crop but generally it is a scale of farming where enough transplants can be started in a greenhouse that fully takes advantage of the heating and human resources needed to support that greenhouse. It is also a scale where a truck can be fully loaded with each harvest to make sure quality is high and shipping efficiencies are maximized. This is critical to take advantage of the transportation cost advantage that exists for the study area over California growers. The assumption used for this analysis is a minimum of 20 to 25 acres based on typical greenhouse sizes, specialized planting and harvesting equipment costs, and the size of a semi-truck. This is a general estimate but will serve the purposes of this discussion.

The estimates in Table 13 reflect a 25-acre assumption of production with initial investment reflecting amounts needed for startup buildings and equipment. Annual operating costs include seed, plastic mulch, electricity, greenhouse heating, and labor. Initial investment costs are generally funded partially through equity investment. The remainder in debt or loans from a bank while the operating line is generally secured against the crop to be produced. The amount of equity to debt will vary by business but a general assumption in today's lending environment is 40% of initial investment is equity. For a beginning tomato farmer this means it would take about \$95,000 in equity to get a loan for the remaining initial investment of \$140,000 and \$195,000 annual operating line of credit. A \$95,000 initial investment to start a 25-acre tomato farm is very reasonable and access to an opportunity like that would be achievable for many interested new farmers.

Table 13: Capital Needs for Select Crops

(Source: University of Wisconsin Madison-Extension, Iowa State University, North Carolina State University, University of California-Davis, University of California-Berkeley, USDA ERS)

Capital Needs	Initial Investment (25 Acres)	Annual Operating Costs (25 Acres)	40% of Initial Investment (Equity)	Total Debt* (Loan Amounts)	Total Equity & Debt
Winter Squash	\$101,630	\$62,709	\$40,652	\$123,687	\$164,339
Fresh Cucumbers	\$107,616	\$92,335	\$43,046	\$156,905	\$199,951
Leafy Greens	\$125,876	\$108,444	\$50,350	\$183,969	\$234,319
Garlic	\$127,122	\$126,557	\$50,849	\$202,830	\$253,678
Broccoli	\$216,646	\$120,015	\$86,658	\$250,003	\$336,661
Cauliflower	\$219,837	\$132,879	\$87,935	\$264,781	\$352,716
Eggplant	\$229,120	\$174,248	\$91,648	\$311,720	\$403,368
Bell Peppers	\$231,703	\$198,270	\$92,681	\$337,292	\$429,973
Tomatoes	\$234,114	\$193,038	\$93,645	\$333,506	\$427,152

*Initial Investment - Equity + Operating Costs

This is where the lack of federal crop insurance is a challenge for banks and lenders. If there is no way to competitively insure the crop, it adds risk to both the initial investment loan and especially the operating loan compared to a conventional corn farmer. Lenders, if they even lend, may require higher initial investment in equity and may not provide an operating loan. What originally would have taken \$95,000 in cash equity now requires \$425,000 because of no borrowing capacity stemming from lack of comparable federal insurance programs as other produce or corn farmers.

Physical Infrastructure Recommendation

Find ways to share physical infrastructure to reduce duplicative investments and eliminate barriers to new growers.

Strategy 1: Coordinate shared resources and specialization in the different segments of production such as greenhouses, crop husbandry, harvesting, and marketing. Finding ways to share skills and knowledge, increase access and lending capacity, and reduce duplicative investments is imperative to eliminating barriers for new growers.

The initial capital costs to start a 25 acre produce farm range from \$100,000 to \$235,000 depending on the crop (Table 13). Initial capital investment in a greenhouse can range from \$60,000 to \$80,000 while equipment for planting and post-harvest handling can

The biggest constraint to reaching economies of scale appears to be the lack of equipment and mechanization on the farm.

cost an additional \$40,000. This does not include tractor and tillage equipment costs which would be more economical to rent along with the land. Mechanized harvest equipment varies and in most cases is not economical unless it is used on hundreds of acres. These capital investments for 25 acre farms or larger may pay for themselves. However, it can be risky for producers to scale up and many are currently reluctant to do so. Below are some ideas to address this issue:

Improve labor and capital efficiencies by renting services through new businesses, private partnerships, or cooperatives. Specializing is a strategy to avoid making the full capital investment needed to reach efficient economies of scale. Finding ways to divide the largest initial investment segments of greenhouse and equipment costs across as many acres as possible is important to making the investments worthwhile. An individual or private business could choose to build a large greenhouse for growing transplants that could provide many growers with transplants at an affordable cost.

Specialize mechanization equipment and planting and harvesting services. An entrepreneur can create a rental business or a custom planting and harvesting service. A grower could contract for planting services in the spring with costs dependent on criteria specified by the grower. For example, if the grower wants to contract 5 acres of peppers planted in plastic mulch beds at a rate of 1 plant per foot it may cost \$600 per acre plus materials. The \$3,000 total contract cost per year would be economical whereas the \$15,000 in equipment and 100 hours of labor needed to plant 5 acres would not be justified financially. Additionally, labor efficiencies could be realized. A crew of four could plant the 5 acres in a couple days and then move on to the next job. This efficiency could be reached from mechanization and because the crew would be trained and experienced service. This system could reduce weather preventing or delaying plantings in the spring. Contracting services could include planting, crop scouting, harvest, and post-harvest services. The challenge with this level of specialization is that it typically requires a more mature industry where demand for specialized services is greater. This is not currently the case for fruit and vegetable production in the region which curtails interest in providing a service business around produce production.

A cooperative of growers that commit resources to this type of business and contribute a known demand for the services. The cooperative structure could include an upfront equity contribution. The equity contribution could be used to secure a loan on the remaining equipment purchases. A labor force could be contracted out with a set schedule to operate across the production season given a correct diversification of crops. There are examples of this type of labor contracting with regional seed corn producers in the region. Seed corn growers' contract for detasseling and other field labor tasks in June and July when the work is needed. A produce cooperative could have the potential of contracting for full time jobs from April to October.

The cooperative members could rent the equipment or labor services for various production tasks throughout the season. The rental and service price for the growers would need to be sufficient to cover the expenses of the cooperative such as interest, principal, repairs, administrative, and other miscellaneous costs. Demand for the equipment and services would oscillate from high to low throughout the season depending on the types

of crops grown. Finding a group of growers with a diversified crop rotation throughout a season would be challenging but important. A diversified crop between the cooperative members would allow for the equipment and services to be used across the full production season, driving down both equipment and labor costs per acre of crops grown.

Grower Guide

Exploring the amount of crops needed to support a processing facility, the amount of investment needed to achieve that supply, and production practices for select crops.

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There needs to be an expansion in production and more efficient aggregation of local fruit and vegetable growers in order to economically support new processing facilities.

Section Summary

This section explores the amount of crops needed to support a processing facility and the amount of investment needed by growers to achieve that supply. Production machinery and practices for select crops are also explored. The section closes with a list of useful crop production resources.

The purpose of the section is to present sources of information uncovered during the research of this project in a format that allows readers to gather a very introductory understanding of produce growing. It is not comprehensive and does not exhaust all available sources of information. This guide is only a general resource and does not advocate for purchasing or investing in any specific equipment or crops. Nor does it advocate for the practice of any particular method or approach to produce growing.

Any examples found within the document or links to additional resources were based on the most readily available information from public institutions (Universities or State & Federal Agencies) or from internet searches. The accuracy of information represented in this research is based on the best efforts of its authors but errors and inconsistencies undoubtedly still exist. It is strongly advised that information contained within is only utilized as a starting point or guide for additional research and not as a fully encompassing tool for future research projects, investments, or any other application.

Processing & Financial Needs

The market feasibility research identified that the primary challenges to advancing wholesale fruit and vegetable production is on the supply side and not the processing infrastructure. There needs to be an expansion in production and more efficient aggregation of local fruit and vegetable growers in order to economically support new processing facilities. Therefore, the existing need for additional processing infrastructure for fruit and vegetable production in the region is limited. However, it will be important to establish value added processing in the future if regional production increases. This section analyzes the amount of supply needed to support a processing facility and how much investment will be needed by growers to achieve that supply.

Supply

This section makes an assumption of a facility able to take in 30,000 lbs or 15 tons per day of unprocessed vegetables. Optimizing this facility would require a diverse crop mix starting with early crops such as spinach, asparagus, or strawberries followed by mid-season crops such as broccoli, peppers, and tomatoes then ending with late crops such as squash or fall broccoli. The assumption is a facility would begin operating in May and complete operations in November.

Table 14 is very generic but helps to illustrate the amount of supply needed from these various specialty crops to support a processing facility seven months out of the year. There is a total need of approximately 800 acres of production given the mix of crops selected above. If assuming the average farm produced 25 acres of wholesale crops, it would take roughly 30 to 35 farms to support the facility.

To support a processing facility requires approximately 800 acres of production based on crop selection. It would take roughly 30 to 35 farms to support the facility assuming the average farm produced 25 acres of wholesale crops.

The *Grower Guide* focuses on the production logistics of crops the *Market Feasibility Analysis* found to have the greatest potential for wholesale production in the Tri-State area.

Table 14: Hypothetical Processor Seasonal Flow Table for Select Crops

(Source: University of Wisconsin Madison-Extension, Iowa State University, North Carolina State University, University of California-Davis, University of California-Berkeley, USDA ERS)¹

Hypothetical Processor Seasonal Flow Table		May	June	July	August	September	October	November	Total
Spinach*	Yield, Tons	4.0							
	% Processing Market	100%							
	Acres	100							100
	Tons for Processing	400							400
Asparagus	Yield	1.5							
	% Processing Market	40%							
	Acres	50							50
	Tons for Processing	30							30
Broccoli	Yield		6.0			6.0	6.0		
	% Processing Market		25%			25%	25%		
	Acres		150			60	60		270
	Tons for Processing		225						225
Strawberries	Yield		10.0						
	% Processing Market		40%						
	Acres		50						50
	Tons for Processing		200						200
Peppers	Yield			15.0	15.0	15.0			
	% Processing Market			30%	30%	30%			
	Acres			40	40	30			110
	Tons for Processing			180	180	135			495
Tomatoes	Yield			20.0	20.0	20.0			
	% Processing Market			40%	40%	40%			
	Acres			40	40	30			110
	Tons for Processing			320	320	240			880
Winter Squash*	Yield						10.0	10.0	
	% Processing Market						75%	60%	
	Acres						50	75	125
	Tons for Processing						375	450	825
Total Tons for Processing		430	425	500	500	465	465	450	3,235
Total Acres		150	200	80	80	120	110	75	815

*Assumes crops are grown primarily for processing

Investment

As discussed in the *Market Feasibility Analysis* section, it takes about \$125,000 to \$250,000 in initial investment for a producer to start a 25 acre produce farm.² It takes a similar amount to operate a farm with variable expenses such as crop inputs and labor costs. In the hypothetical example above, it is assumed it would take about 32 growers on 815 acres to support a facility (Table 15). The example would require approximately \$10 million in initial investments and operating capital or about \$312,500 per grower. This is a significant level of investment in new production. Getting this investment into new production is the primary barrier to growing the industry within the region.

1 Monthly totals are total tons per day for each day that month.

2 For many crops, 25 acres of production is the scale a producer should target if the aim is to produce for wholesale markets. At this scale a single grower can fill a truckload of produce in a given harvest day or cycle.

Table 15: Capital Needs for Select Crops to Support Processing Facility

(Source: University of Wisconsin Madison-Extension, Iowa State University, North Carolina State University, University of California-Davis, University of California-Berkeley, USDA ERS)

Capital Needs	Initial Investment (Per Acre)	Annual Operating Costs (Per Acre)	# of Acres	Total Initial Investment	Annual Operating Costs
Asparagus	\$5,426	\$3,843	50	\$271,312	\$192,154
Winter Squash	\$4,065	\$2,508	125	\$508,150	\$313,547
Spinach	\$5,035	\$4,338	100	\$503,503	\$433,775
Broccoli**	\$4,333	\$2,400	270	\$2,339,771	\$648,081
Bell Peppers	\$9,268	\$7,931	110	\$1,019,495	\$872,288
Tomatoes	\$9,365	\$7,722	110	\$1,030,100	\$849,368
Strawberries	\$9,518	\$15,211	50	\$475,894	\$760,537
Total to Support Processing Facility			815	\$6,148,228	\$4,069,850

*Initial Investment - Equity + Operating Costs

**Assumes producers double crop spring and fall crops

Limited processing infrastructure is not a significant barrier today, but if produce supplies expand there will be opportunities for investment in new infrastructure. The hurdle to being a beginning wholesale producer is a significant \$300,000 or more under the current industry structure with risk from weather threatening to wipe that out investment out at any moment. Reducing this upfront investment hurdle and weather risk are important to getting new supply and, ultimately, processing.

Production Manual

The *Grower Guide* is a basic introduction to produce production and marketing. The guide is not meant to be a fully comprehensive manual. Instead, it is a sampling of many of the tools and equipment that can be used to grow vegetables and fruits. The Guide focuses on the production logistics of crops the *Market Feasibility Analysis* found to have the greatest potential for wholesale production in the study area. There is less focus on soil and disease agronomic variables because an excellent breadth of this knowledge is already widely available across many state extension offices.³

Production & Equipment

This section outlines information on equipment that can increase farm productivity and allow for greater production with less labor. Fruit and vegetable production requires a range of unique and specialized infrastructure, tools, and equipment compared to farming feed crops like corn or alfalfa hay. The information and descriptions are listed in order of pre-planting, planting, harvest, and packing systems, tools, and equipment.

³ Sources to the extension sites along with the sources for the guide on specific pieces of equipment, crops, or handling and packaging standards are found on pages 39 and 40 of this document. Interested and potential growers are strongly encouraged to study and use these sources.

Greenhouse & Pre-planting

The greenhouse is an important tool for crops that are to be started indoors and transplanted in the spring. Greenhouse considerations are dependent on many factors unique to a location or individual business. For example, locations that are windy may desire a different design structure than others. Access to timber may impact heating considerations. It is beyond the scope of this guide to evaluate all of the various considerations that go into greenhouse production. Instead, the guide will make a general introduction to just a few of the aspects that go into building a greenhouse.

Location

Greenhouse location can impact future decisions such as size, design, materials, and heating. It is important to locate a greenhouse with access to full sun and, if possible, with a wind barrier. There are numerous research resources available on this consideration; some resources are listed in the Resource Section on pages x and x.

Materials

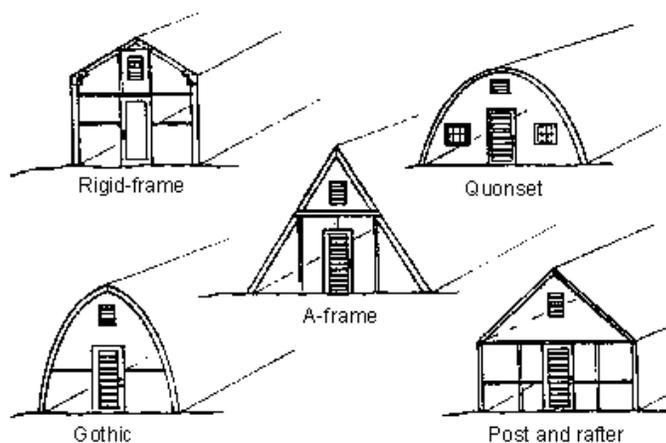
Greenhouses can be built out of various types of materials. In order of cost from high to low, materials generally used are glass, fiberglass, and plastic. Material selection is dependent on cost, durability, and periods of use. For example, a greenhouse being used in the deeper winter period from December to May has different needs and economics than a greenhouse used only from the late winter period of February to May.

Design

There are a variety of greenhouse designs which all have strengths and weaknesses. Deciding location and application of the greenhouse helps determine the optimal design. For example, a greenhouse attached to an existing building structure may use a different design than free standing structures that need more protection or durability against severe weather.

Picture 2: Greenhouse Designs

(Source: West Virginia University Extension Service)



Heating

The heating requirements depend on the required temperature for the plants grown, location, and design of the greenhouse. Much of the daily heat needs come from the sun, but most greenhouse structures require additional heat for cold winter nights. The heating system must be adequate to maintain desired temperatures during extreme winter weather. Selecting an adequate heating system is complicated but there are online tools that are helpful for estimates based on various materials and sizes selected.⁴

Picture 3: Greenhouse Controller

(Source: www.GrowHubHydroponics.com)



Greenhouse Controller (\$500 to \$2,000) – Introductory greenhouse controllers that work with heating, air quality, and watering systems are a relatively low cost component of a greenhouse costing between \$500 to \$800 depending on the number of sensors, while more sophisticated systems can be more expensive.⁵

Planting Materials

There is an extensive list of materials that go into greenhouse production. They include tables and watering equipment to seed trays and germination chambers. Often these materials lend themselves to highly customizable design aspects, including the types of fittings on watering systems to the soil mixtures used for plant starts.

A few important tools in a greenhouse for labor efficiency and quality when growing transplants for 20 acres of production or 300,000 to 400,000 plants would be soil mixers and sterilizers along with seed flat fillers and seeders. The following examples of equipment are samples found in doing the research for this guide. It is not an extensive list and the guide does not endorse any source listed below.

4 Here is one of many online calculators available <http://www.greenhouses.com/buyersguidebtcalculator.html>.

5 See here for examples of controllers <http://www.hydrofarm.com/catalog.php?category=4>.

Sterile soil mixtures are important to reducing challenges such as disease and foreign weed seeds. Mixing and sterilizing soil mixtures may be more economical than purchasing the mix pre-made and sterilized. Equipment is available for both mixing and sterilizing soil but it may not be economical for smaller scale greenhouse operations compared to other equipment investments.

Picture 4: 1/2 Yard Fast Batch Mixer

(Source: http://cdn.greenhousemegastore.com/images/uploads/7871_2016_popup.jpg)



1/2 Yard Fast Batch Mixer (\$4,500 to \$5,500) – Sales information for this intro system and other more advanced systems can be found here: http://www.usgr.com/soil-handling_soil-mixers/soil_mixing_handling.php.

Picture 5: Steam Soil Sterilizer

(Source: www.gothicarchgreenhouses.com)



Steam Soil Sterilizer (\$6,500 to \$9,000) - Sales information for this intro system and other more advanced systems can be found here: <http://www.gothicarchgreenhouses.com>.

com/commercial_steam_soil_sterilizer.htm. Seed flat soil fillers could be engineered by individuals but there are commercial models available at reasonable costs for a smaller scale producer.

Picture 6: Mini-Flat Filler

(Source: www.bouldinlawson.com)



Mini-Flat Filler (\$2,000 to \$3,000) – Sales information can be found here: http://www.usgr.com/soil-handling_soil-mixers/flat_fillers_mini.php or here with a video http://www.bouldinlawson.com/nursery/equipment_detail.php?product=4&subsection=greenhouse.

Automated seeders significantly reduce labor productivity with the ability to accurately fill a seed tray with potting mixture and a seed in under a minute per tray or faster depending on the system. There are multiple models with varying levels of cost. Below are several examples:

Picture 7: Evergreen Vacuum Seeder

(Source: www.stuewe.com)



Evergreen Vacuum Seeder (\$900 to \$1,200) – A setup manual can be found here <http://lib.store.yahoo.net/lib/yhst-63803600799585/EvergreenVacuumSeeder-HowToUse.pdf> and a video demonstration is here <http://www.youtube.com/watch?v=w14foYnDsAw>.

Picture 8: E-Z Seeder

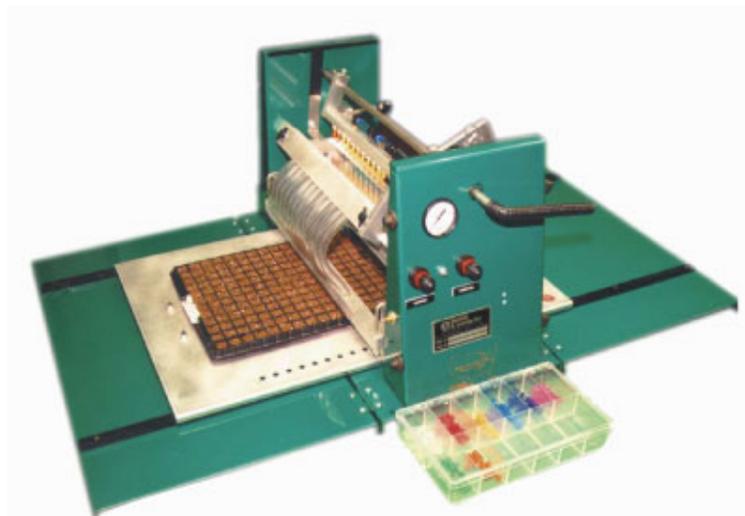
(Source: Sezsd.com)



E-Z Seeder (\$750 to \$1,000) – Sales information and tray filling rates can be found here http://www.usgr.com/seeder-equipment/seeder_E-Z-seeder.php.

Picture 9: Needle Seeder

(Source: www.bouldinlawson.com)



Needle Seeder (\$3,000 to \$3,500) – Sales information and tray filling rates can be found here <http://www.usgr.com/seeder-equipment/compact-needle-seeder.php>.

Planting Equipment

A variety of equipment is available to increase labor productivity and crop quality. Most pieces of equipment can be used across many types of produce but some equipment is highly specialized to one or a few crops. The more basic equipment needs include a standard tractor and tillage equipment. These are readily available in most areas for rent from either nearby farmers or equipment dealerships. Tractors and tillage equipment are necessities for efficient produce production but because they are readily available this section will not focus on them. Instead, the section will give a brief summary of the numerous pieces of specialized produce equipment for field preparation, planting, and crop growth.

Picture 10: Vegetable Seed Planters

(Source: www.suttonag.com)



Vegetable Seed Planters (\$1,500 to \$3,000) – There is a large range in cost of seed planters but sizes that fit the needs of a 20 acre farm would likely fit in the price range above. Here is an example of a belt (shown above) or vacuum planter <http://www.suttonag.com/Stanhay.html>. There are many other makes and models available.

Picture 11: Transplant Bed Former plus Mulch and Drip Tape Layer*(Source: www.rainfloirrigation.com)*

Transplant Bed Former plus Mulch & Drip Tape Layer (\$3,000 to \$7,000) – Farms looking to use plastic mulch and drip irrigation systems should investigate this type of equipment. There are a range of sizes and features. Here is a demonstration video <http://www.youtube.com/watch?feature=endscreen&v=E7VQfmyveNo&NR=1> of a plastic mulch layer that is forming a bed using drip tape. There are a number of manufacturers and sellers. A few are listed here:

- *Rain-Flo Irrigation* - <http://www.rainfloirrigation.com/equipment/345-flatbed-plastic-layer.php>
- *Mechanical Transplanter* - <http://www.mechanicaltransplanter.com/shaper.html>

Picture 12: Mechanical Transplanting Machine*(Source: www.mechanicaltransplanter.com)*

Mechanical Transplanting Machine (\$3,000 to \$10,000) – This equipment helps reduce manual labor for transplanting. It still requires some manual labor but productivity is greatly enhanced and the labor is much less intensive. There are several makes and models with some designed specifically for planting in plastic mulch. The lower cost is for single row planters while multiple row planters are more efficient but higher cost.

Here is a video demonstration <http://www.youtube.com/watch?v=GmayzsVdZvc>. The planter above is a plastic mulch transplanting machine. More details can be found at <http://www.mechanicaltransplanter.com/plastic.html>.

Picture 13: Row Cover Laying Machine

(Source: www.robertmarvel.com)



Row Cover Laying Machine (\$2,500 to \$5,000) – Row covers can be used for extending seasons by providing a mini greenhouse after transplant to protect against cool weather and encourage strong early growth. Row covers can be made of either fabric or plastic with each having advantages and disadvantages that may serve certain crops better than others. Row covers are not necessary for most crops but could allow Midwest growers to reach markets sooner and extend season length. Here is a video demonstration http://www.youtube.com/watch?v=Sjbe-_KkB2I of the model above also found with this web link <http://www.mechanicaltransplanter.com/tunnel.html>. Another model can be found here <http://www.buctraco.com/3%20Online%20Catalog/RowCoverLayersPL.htm>.

Picture 14: Plastic Lifter or Remover

(Source: www.buctraco.com)



Plastic Lifter or Remover (\$2,000 to \$4,000) – The lifter is used to remove plastic mulch and drip tape after the growing season is over. This is necessary because leaving plastic in the field is a hazard for future seasons. Here is a video demonstration of a lifter

in action <http://www.youtube.com/watch?v=z14QPqhrI8>.

Irrigation Equipment

Irrigation is not necessary for all crops but because high yields are extremely important for successful wholesale vegetable production, farm irrigation is typically economical. There are different types of systems, including large center-pivot or smaller drip irrigation. The center-pivot systems can span the width of entire fields and move up and down field length to water plants from overhead. These systems require large and mostly open fields for the systems to function and be cost effective. Drip irrigation can be used on smaller farms and requires much lower initial investment. Therefore, this guide will focus on drip irrigation equipment.

Drip irrigation is the use of drip lines (thin hoses) with small holes every foot or two that drip water. The lines are typically laid in or near the plant row and can be laid underneath plastic mulch to efficiently water root zones. The drip line can be laid using a standalone machine costing \$1,000 to \$1,500 or with an attachment to a mulch layer that is minimal cost.

There are a number of components that make up a drip irrigation system. A source for costs and directions on setting up a drip irrigation system can be found on the University of Florida Extension website (<http://edis.ifas.ufl.edu/hs388>). The cost estimates in the Florida analysis of \$500 to \$1,200 per acre are high relative to firsthand experience setting up a drip irrigation system. Costs vary greatly depending on access to water due to differing filtration needs. A 20-acre farm with well access with strong water pressure could likely set up a high quality irrigation system for \$250 to \$500 per acre. Here are a few of important components needed to setup a drip irrigation system:

Picture 15: Drip Line

(Source: www.rainbird.com)



Drip Line (\$100 to \$300 Per Acre) – Drip irrigation costs depend on the number of rows and plants per acre. The higher the plant density the more drip line/tape needed. A foot of drip tape costs roughly two cents per foot.

Picture 16: Drip Tape Fittings and Filters

(Source: http://i01.i.aliimg.com/img/pb/529/143/493/493143529_670.jpg)



Drip Tape Fittings & Filters (\$25 to \$50 Per Acre) – Drip tape fittings and filters attach drip tape to a main water line and filter impurities so they do not plug the tiny holes in the drip tape. Initial costs are typically minimal and most fittings and filters will last multiple years if properly cared for.

Picture 17: Water Flow and Pressure Control Systems

(Source: http://edis.ifas.ufl.edu/LyraEDISServlet?command=getImageDetail&image_soid=FIGURE%2011&document_soid=HS388&document_version=96844)



Water Flow & Pressure Control Systems (\$75 to \$150 Per Acre) – Water controllers (solenoids) and pressure regulators are needed to set up watering zones in fields. These zones can then be controlled through a centralized control panel where watering lengths and times can be customized. A water source with a high water flow rate to the field (20 to 30 GPM) could water 20 acres of vegetable crops. Wells with older pumps may strug-

gle to reach these flow rates but most new pumps would likely be fine.⁶

Picture 18: Water Pump

(Source: http://img.directindustry.com/images_di/photo-g/centrifugal-water-pump-40807-2801931.jpg)



Water Access & Pumps (\$0 to \$3,000) – Access to water is a major factor in a successful drip irrigation system. Newer wells with high water pressure and a large pump may not require any additional investment. However, inadequate water pressure or the need to replace a well pump can quickly increase costs. Using surface water such as ponds or lakes for irrigation is also a possibility but requires approval and permits. The resource page has information on surface water irrigation regulations for Wisconsin, Iowa, and Illinois. Understanding water access is an important factor in deciding whether to use drip irrigation and estimating the maximum number of acres a single water source can service.

Harvesting & Packing Equipment

Harvest mechanization is a challenge for smaller producers for a number of reasons. Fresh produce generally requires very careful handling and it is important to correctly grade and package the produce. This limits the ability to fully mechanize harvest. Additionally, the harvesting equipment that is available is prohibitively expensive, costing between \$200,000 and \$400,000 per unit.

An example of a harvesting system is a mechanical water jet lettuce harvester.⁷ The harvester has the capacity to pick more than 12,000 lbs per hour which is exponentially higher than picking by hand. This is very efficient but unless it can be used over hundreds of acres it is not economical for the small produce farm. Therefore, focusing on crops

⁶ A quick way to test how long it takes a pump to fill a five gallon bucket, is to divide 60 seconds by the number of seconds and then multiply x 5 gallons. For example, if it takes 10 seconds to fill a 5 gallon bucket it would take $60 \text{ seconds} / 10 \text{ seconds} = 6 \times 5 \text{ gallons} = 30$ gallons per minute of water flow.

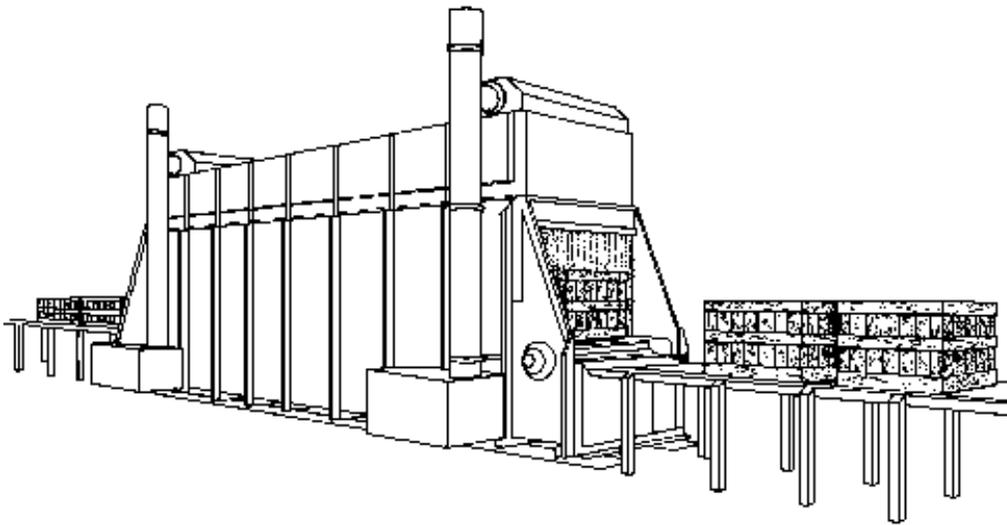
⁷ Demonstrated in this video <http://www.ramsayhighlander.com/products/romaine/Romaine-Mechanical-Harvester-Water-Jet-Stainless-Steel.htm>.

that do not require mechanized harvest can be more appealing. Fresh peppers, tomatoes, eggplant, or summer squash are a few examples of crops that are still manually picked.

Post-harvest handling and packing is also critical for a successful produce farmer. Quality and shelf life begins to decline when a product is picked from the plant. It is important to quickly cool the produce and move into a climate controlled environment if possible.

Picture 19: Hydro-Cooling System

(Source: North Carolina State University)



Fortunately there are low cost methods to effectively cool produce for smaller growers. The use of water in hydro cooling systems is the most common approach to cooling. Examples of systems built for less than \$2,000 are available.⁸ However, these systems may lack the full needs of a 20-acre farm processing more than a quarter million pounds of produce per year. Commercial systems can cost well over \$100,000 and are not be economically viable on a 20 acre farm. Finding a system that cost-effectively cools produce is important for success.

Harvest and post-harvest equipment is less readily available and more costly than the mechanization detailed in previous sections. It will take a combination of increasing the scale of production to 20 acres or more and innovative engineering to find better solutions for produce farms in the 20 to 100 acre range.

Marketing

The marketing section focuses on the importance of produce handling, the rules overseeing handling, and a detailing of liability insurance. A great deal of this information has already been established in an excellent guide by the Leopold Center for Sustainable Agriculture of Iowa State University. A great deal of that guide was established by a

⁸ A Low Cost Hydro-cooling Unit for Horticultural Commodities, Marcel Tsang and Sheldon Furutani, University of Hawaii at Hilo, College of Agriculture

cooperative in Decorah, Iowa called GROWN Locally.⁹ Instead of duplicating these efforts, this section adds detail to areas less focused on in the Leopold guide, including how to be successfully audited for Good Agriculture Practices (GAP) and Good Handling Practices (GHP), along with cost information on liability insurance.

GAP & GHP Certification

The USDA offers voluntary audits of produce suppliers throughout the supply chain. Audits can also be completed by independent private auditors.¹⁰ The objective of GAP is to verify that fruits and vegetables are produced, packed, handled, and stored according with the Food and Drug Administration's (FDA) Guide to Minimize Microbial Food Safety Hazards for Fresh Fruits and Vegetables and general industry practices. There is an industry effort to harmonize the audit process and expectations starting in 2013 around a specific set of requirements and questions for all auditors.

For growers looking to produce for the wholesale market, it is a necessity for most to get GAP certification. For producers doing extensive post-harvest handling, GHP certification will also be necessary. It is standard for wholesale buyers and institutional buyers to require certifications from any producer they source from. The primary goal is to minimize risks of pathogens that cause food borne illnesses. For more information please see <http://www.ams.usda.gov/AMSV1.0/HarmonizedGAP>.

GAP Certification Costs

The cost of certification varies depending on variables such as the size of the operation and the existing farm conditions. A beginning farmer has the advantage of planning for GAP certification which can greatly reduce capital costs by replacing old or faulty equipment that may not meet certification standards. An existing grower may not have the luxury of starting from scratch and planning around the GAP approval process. These variables make it difficult to fully quantify certification costs. However, a case study by a farmer in Vermont producing \$1 million in annual revenue revealed the cost to be between 1 to 3 percent of total revenue. This would be \$10,000 to \$30,000 per year for that particular grower, with the lower estimate assuming fewer changes in physical infrastructure like water systems and manure management at that specific farm. The higher end assumed significant upgrades to these systems.¹¹

A rough certification cost estimate for a 20-acre produce farm growing \$250,000 per year in produce would be \$5,000 per year. This would be 2% of income and assumes the producer is able to plan his/her farm around the GAP certification requirements from day one instead of modifying an existing operation.

⁹ The guide can be found here <http://www.leopold.iastate.edu/sites/default/files/pubs-and-papers/2011-10-growers-manual-template-grower-cooperatives.pdf> and is a must read for a step by step procedure for sanitation and quality control.

¹⁰ A few auditors listed in the Leopold Guide are AIB International, NFS Davis Fresh Technologies, GlobalGAP, ISO International Standards Organization, Primus Labs, Scientific Certification Systems, and Silliker.

¹¹ This case study can be found here <http://www.uvm.edu/vtvegandberry/GAPS/HarlowFarmGAPSCaseStudy.pdf> and is a useful resource to understanding the types of challenges to getting certified.

Insurance Coverage Availability & Cost

Fresh fruit and vegetable production has multiple risks from foodborne illness. Vegetable and fruit producers have a liability risk from consumers sickened by an outbreak who take legal action against the grower. Additionally, recalls or food warnings stemming from an outbreak can lead to loss in sales. This section details insurance coverage available to protect against these risks.

General Farm Liability Insurance

General farm liability insurance generally covers injury or damage to property that takes place on the farm due to farm operations. Farm liability insurance may also protect farmers' direct marketing of raw, unprocessed produce from an on-farm roadside stand or at a farmers' market. It does not cover produce grown by another producer but only produce sold by the policy holder. Policy costs can vary by policy holder claims history and other factors but it typically costs about \$1,000 to \$2,000 per \$1 million in protection. It is typical to carry \$1 million policy or less for most small scale produce growers.¹²

Product Liability Insurance

Product liability insurance protects policy holders against claims of harm caused by a defective or hazardous product such as food borne illnesses. The standard policy level varies by buyer but typically it is \$1 to \$2 million for smaller wholesale growers.

Premium costs vary considerably and depend on annual revenue, previous claims, types of produce sold, and handling practices. For example, GAP certification helps reduce liability insurance premiums. The average annual premium is estimated at \$1,000 per \$1 million in coverage based on analysis in 2007 by Rob Holland, an extension specialist in Tennessee. A smaller farm may be less than Holland's example, due primarily to lower annual revenue than larger growers.¹³

Product Recall & Other Insurance Policies

There are a number of other insurance policies that are available to produce growers. These policies include product recall insurance which protect against the cost of recalling a farm's contaminated produce. It does not cover costs related to loss of sales or if a recall occurs because of another grower by no fault of the policy holder. Accidental or Product Contamination Policies cover both recall costs and loss of sales due to recall. However, this policy also does not provide coverage if the contamination or recall was caused by another grower even if the policy holder was indirectly impacted.¹⁴

12 Insurance Coverage Options for Fresh Produce Growers. North Carolina State University. Web. 28 Dec. 2012. <http://www4.ncsu.edu/~rmrejesu/Food_Safety_Risk/ag-710%20final%20printed.pdf>.

13 A more detailed explanation with resources to find an insurer can be found in his report here <http://homebasedbaking.com/wp-content/uploads/2009/06/Product-Liability-Insurance-in-TN.pdf>.

14 These policies are detailed in this report http://www4.ncsu.edu/~rmrejesu/Food_Safety_Risk/ag-710%20final%20printed.pdf by the North Carolina State Extension.

Crop Selection

The crops were selected based on profit potential, growing climate suitability, production difficulty, and startup capital needed to reach a minimum scale for wholesale production. This crop list was vetted by regional experts as described in the *Project Background and Context* section. For background on profit potential and startup capital estimates please see the *Market Feasibility Analysis* section.

Table 16: Definitions

Categories	Definition
Plant Type	Annual or perennial; annual crops can be replanted at least once per year. Perennial crops are grown without replanting for at least two years.
Germination and Soil Temperature	The estimated days and the ideal soil temperature range for germination.
Planting (Indoor or Outdoor), Rates per Acre	Indoor or outdoor; indoor crops are recommended to be started in doors and transplanted. Outdoor crops may be directly seeded. Planting rates are also included.
Planting Depth	The soil depth to plant the seed or transplant.
Soil pH	Soil pH is the acidity or alkalinity or the number of hydrogen ions in the soil. Soil pH ranges from acidic (0) to alkaline (14). In general, a soil pH of 6 - 7 is ideal for most crops.
Soil Type	An optimal soil texture for growing the specified crop. Soil types are based on the USDA soil texture pyramid.*
Plant Spacing	The space or distance recommended between seeds or transplants in a row.
Row Spacing	The distance between rows.
Days to First Harvest	The number of days from seed germination to first crop harvesting.
Irrigation and Water Needs	Description of general water needs and if irrigation equipment is recommended.
Specialized Equipment	Equipment use that is unique to a crop or the crop and a few others.
Mechanization Potential	Planting or harvesting; listed if there is equipment available that either automates or results in at least a 10x increase in manual labor productivity.
Range (Yield/Acre)	The low to high estimate of potential yields of the crop in Illinois, Iowa, and Wisconsin.
Macro Nutrients Pre-Planting	The estimated amount of nitrogen (N), phosphorus (P), and potassium (K) needed by the plant for healthy growth in pounds per acre.

* "Soil Texture Calculator." USDA Natural Resource Conservation Service, 27 Dec. 2012. <<http://soils.usda.gov/technical/aids/investigations/texture/>>.

Asparagus

	J	F	M	A	M	J	J	A	S	O	N	D
Seed				█	█	█						
Grow				█	█	█						
Harvest				█	█	█						

Plant Type: Perennial

Germination and Soil Temperature: 10 to 20 days at 60° to 80°F

Outdoor Planting, Rates per Acre: Seed, seedling, or crown

Planting Depth: 5” – 6” for heavy soils, 8” for light soils

Soil pH: 6.5 – 7.5

Soil Type: Sandy loams

Plant Spacing: 12” – 18”

Row Spacing: 4” – 5”

Days to First Harvest: 1 to 2 years

Irrigation and Water Needs: Important

Specialized Equipment: Bare root planters currently available, prototype mechanical harvester being developed but not yet commercially available¹⁵

Mechanization Potential: Planting and harvesting

Range (Yield/Acre): 2 to 5 tons/acre

Macro Nutrients Pre-Plant:¹⁶

- N 70 lbs/acre
- P 25 – 200 lbs/acre
- K 0 – 250 lbs/acre

Suggested Cultivars: All male hybrids: Jersey Giant, Jersey Knight, Jersey Supreme, Jersey King. Open pollinated varieties: Viking KB3, Mary Washington.

Production: Asparagus is more easily started from one year old roots, but starting from seed or a seedling is possible. Asparagus should not be planted in any field in which asparagus had been planted in the past. If it is necessary to do so, the soil should be fumigated to reduce the incidence of Fusarium wilt and several root rots. Proper soil preparation and fertilizer application is important for quality development.

Harvest: Crops are generally not harvested in the first year of growth to allow for healthy root development. The plant usually reaches peak yields in years 5 -12 with

¹⁵ Mechanical Asparagus Harvester Patent Published March 2012, <http://www.freepatentsonline.com/8136336.pdf>, Haws, Kim Spencer

¹⁶ Adjust for soil type, previous management, and soil test results.

steady decline after that. Plants are usually replaced between 15 and 20 years.

Cleaning: Wash, sanitize, and rinse.

Cooling and Storing: Typically cools during harvest cleaning, then hydro-cool. Store near 32°F at 90% - 95% relative humidity.

Sorting and Grading: Stalks should have closed bracts and be 6” – 10” long. They should be fairly straight and fresh as well as free from decay and damage. There should be no broken tips, dirt, disease, or insect damage. They should be free of excess woody fiber in the stems. Do not harvest asparagus when the stem is thinner than a pencil. Bunch with a rubber band in 1 pound bunches with similar diameters and trim for uniform height. Asparagus should be packed upright.

Packing: 10# case - 1 1/9 bushel box with bag liner and damp paper towels on bottom.

Broccoli

	J	F	M	A	M	J	J	A	S	O	N	D
Seed*				■	■	■	■					
Grow				■	■	■	■	■	■	■		
Harvest						■	■			■	■	

* All of April (indoors 6 to 8 weeks before the last frost)

Plant Type: Annual

Germination: 6 – 8 days

Outdoor Planting, Rates per Acre: 1/2 to 3/4 oz seed/acre

Planting Depth: 1/4”

Soil pH: 6.0 to 6.5

Soil Type: Well-drained loam well supplied with organic matter

Plant Spacing: Start 3” apart, thin to 14” to 18”

Row Spacing: Alternate rows 12” to 14” with wider rows (28” to 38”) for manual harvest. Uneven row spacing can be employed to get different “heading” outcomes. Plant in wide rows for larger heads and narrow rows for more compact heads.

Days to Harvest: 60 to 70 days

Irrigation and Water Needs: Average and evenly moist

Specialized Equipment: Mechanical transplanter

Mechanization Potential: Transplanting

Range (Yield/Acre): 5 to 10 tons/acre

Macro Nutrients Pre-Plant:¹⁷

- N 80 – 120 lbs/acre
- P 25 – 200 lbs/acre
- K 0 – 250 lbs/acre

Suggested Cultivars: Arcadia, Diplomat, Early Dividend, Emperor, Green Belt, Green Comet, Green Valiant, Goliath, Guy Lon, Gypsy, Leprechaun, Marathon, Packman, Pre-

¹⁷ Adjust for soil type, previous management, and soil test results.

mium Crop, Triathlon, Veronica, and Windsor

Production: Use only the highest quality sized and density graded seed. Seed coating is not recommended. Preparation for direct seeding needs considerable attention. A moderately fine-textured soil, free of rocks, clods, and trash, firm and very level, is required for precision seeding. Tilling the soil excessively increases the risk of crusting. Attempt to keep soil aggregates about 1/4 to 1/2-inch in size. To ensure uniform and successful stand establishment, use vermiculite anti-crustant or have solid set irrigation available to keep soil moist and free from crusting until the stand has been established. Do not plant broccoli in an area where brassicas (spinach, cabbage, cauliflower, etc.) have been planted within the past few years, as it can introduce pest and disease problems. Set out transplants in early to mid-April. Broccoli is sensitive to hot weather so it needs to be encouraged to head as early as possible.

Harvest: Harvest firm head with buds not open. Head should be 4"-6" in diameter, with 6" - 8" of stem. There should be no discoloration of bud clusters and the head should be free from decay, dirt, and insects. Bud clusters should be generally compact. Pack so that stem ends do not damage crowns.

Cleaning: Sanitize with approved solution and rinse thoroughly.

Cooling and Storing: Hydro-cool promptly and store at 32° F.

Packing: 18# case – 1 1/9th bushel box with bag liner

Cucumbers

Slicers

	J	F	M	A	M	J	J	A	S	O	N	D
Seed												
Grow												
Harvest												

Picklers

	J	F	M	A	M	J	J	A	S	O	N	D
Seed												
Grow												
Harvest												

Plant Type: Annual

Germination: 7 – 10 days at 70° to 85°F

Outdoor Planting, Rates per Acre: 2-3 lb seed/acre using a precision seeder

Planting Depth: 1/2" – 1"

Soil pH: 5.5 – 7.0

Soil Type: Well drained with about 2 – 3% organic matter and a high level of fertility.

Plant Spacing:

- Slicers: Rows: 6” – 8”
- Picklers: Rows: 5” – 7”

Row Spacing:

- Slicers: 4’ – 5’
- Picklers: 18” – 20”

Days to Harvest: 38 – 55

Irrigation and Water Needs: Heavy during fruiting; all other times average and evenly moist; deep.

Specialized Equipment:

- Slicers: Vegetable seeder
- Picklers: Vegetable seeder and mechanical harvester

Mechanization Potential:

- Slicers: Planting, harvesting typically for processing grade cucumbers only
- Picklers: Planting and harvesting

Range (Yield/Acre):

- Slicers: 5 to 15 tons/acre
- Picklers: 7 to 12 tons/acre

Macro Nutrients Pre – Plant:¹⁸

- N 40 – 60 lbs/acre
- P 0 – 150 lbs/acre
- K 0 – 200 lbs/acre

Suggested Cultivars:

- Slicer Suggested Cultivars: Aremenia, Burpee Hybrid II, Cobra, Dasher II, Diva, Eureka, Fanfare, General Lee, Kyoto Three Feet, Lightning, Marketmore 76, Marketmore 86, Orient Express, Poona Kheera, Rocky, Salad Bush, Spacemaster, Speedway, Straight Ace, Sweet Slice, Sweet Success, Tasty Jade and Thunder.
- Pickler Suggested Cultivars: Alibi, Bush Pickle, Calypso, Carolina, Diamonte, Eureka, Fancipak, Green Spear 14, Homemade Pickles, Northern Pickling, and Score.

Production: The temperature range for optimum cucumber growth is 86° - 90° F. Night temperatures above 70° F, especially when combined with moisture stress, result in rapid seed development and the softening of internal tissues. Use treated seed. Proper seed treatments can dramatically improve stands. To avoid diseases that survive over winter on debris of cucumbers and other cucurbits, it is best not to plant this crop behind cucumbers, muskmelons, squash, pumpkins, or watermelons. A good rotation is to follow with small grain or corn. Sequential plantings are necessary for orderly harvest. Fields intended for hand harvest are planted as soon as weather permits with subsequent planting dates left largely up to the grower. Fields for machine harvest are planted on a tight schedule to fit product grade requirements, processing plant capabilities, and harvesting machinery availability.

¹⁸ Adjust for soil type, previous management, and soil test results.

Harvest: Harvest when dry, regardless of temperature. Fruit should be firm, glossy, crisp, and free from injury from sunscald, scarring, mosaic, and other diseases. Fruit is over-ripe when the skin starts to yellow and the seeds start to harden.

Cleaning: Cucumbers can be brush washed; if washing, sanitize and rinse.

Cooling and Storing: Store at 50°-54°F

- Slicer Sorting and Grading: Slicing cucumbers should be at least 6” long. Cucumbers within a case should be uniform in size.
- Pickler Sorting and Grading: Pickling cucumbers are sorted to US number 1, 2, or 3 based on color, form, firmness, and size. All must be free from decay or damage caused by dirt, freeze, sunburn, or disease to avoid culling.

Packing:

- Slicer Packing: 20# case - 3/4 bushel box. Cucumbers within a case should be uniform in size.
- Pickler Packing: Typically sorted and transported in bulk containers pallet size or larger.

Eggplant

	J	F	M	A	M	J	J	A	S	O	N	D
Seed: Indoor												
Seed: Outdoor (Plants)												
Grow												
Harvest												

Plant Type: Annual

Germination and Soil Temperature: 10 – 12 days at 75° - 85°F

Outdoor Planting, Rates per Acre: 1 oz seed = 3,500 plants for transplant

Planting Depth: Barely cover

Soil pH: 6.0 – 6.8

Soil Type: Well drained, moderately fertile sandy loam

Plant Spacing: 1 1/2” – 2’

Row Spacing: 2 1/2 – 5’

Days to Harvest: 70 – 80

Irrigation and Water Needs: Lighter soils need more frequent irrigation, but less water applied per irrigation.

Specialized Equipment: Mechanical transplanter

Mechanization Potential: Planting

Range (Yield/Acre): 5 to 15 tons/acre

Macro Nutrients Pre-Plant:¹⁹

- N 30 lbs/acre
- P 0 – 240 lbs/acre

¹⁹ Adjust for soil type, previous management, and soil test results.

- K 0 – 300 lbs/acre

Suggested Cultivars: Black Beauty, Black Bell, Caspar, Classic, Diamond, Dusky, Epic, Fairytale, Ghostbuster, Ichiban, Kiko, Little Fingers, Machiaw, Millionaire, Nadia, Orient Express, Rosita, and Zebra.

Production: Eggplant requires a long growing season, so transplants are most commonly used. They are usually started in a greenhouse or hotbeds. Use treated seed. Sow seeds in shallow flats of soil mix 9 to 10 weeks before transplanting to the field.

Constant temperatures must be maintained as young plants are easily checked by cool temperatures or droughts. Transplants grown in the greenhouse should be kept at the following temperatures for best results:

- Days: 70° to 81° F
- Nights: 64° to 70° F

Use transplants grown in jiffy pots or similar containers so as to minimize the shock of field transplanting. To reduce risk from verticillium wilt and other diseases, avoid using fields in which tomatoes, peppers, potatoes, strawberries, raspberries, and blackberries have been planted.

Harvest: Pick when dry. Harvest with clippers and keep the stem short. Wear cotton gloves to wipe field dirt off the eggplant.

Cleaning: Trim before washing. Wash only if necessary. Wash and rinse thoroughly to remove all the dirt from outside the eggplant.

Cooling and Storing: Rapid cooling to 50°F is necessary. Store at 50° - 54°F.

Sorting and Grading: The flesh must be firm, the calyx must be a fresh green, and the color must be bright. Be careful not to scratch the fruit.

Packing: 20# case - 1 1/9 bushel box

Garlic

	J	F	M	A	M	J	J	A	S	O	N	D
Seed												
Grow												
Harvest												

Plant Type: Annual

Germination and Soil Temperature: Plant in the fall, usually within 1 to 2 weeks after the first killing frost (32°F)

Outdoor Planting, Rates per Acre: 750 – 1,000 cloves/acre

Planting Depth: 3” – 4”

Soil pH: Mineral soils: 6.0 – 6.8 Organic soils: lime if pH is less than 5.2

Soil Type: Well drained, friable soil with good organic matter content

Plant Spacing: 1 1/2”

Row Spacing: 12” – 36”

Days to Harvest: 90 to 100 days from spring emergence

Irrigation and Water Needs: Heavy during fruiting; all other times average and evenly moist; deep.

Specialized Equipment: Bulb planter and garlic harvester

Mechanization Potential: Planting and harvesting

Range (Yield/Acre): Yield depends on the type of garlic and can range from 2 to 8 tons/acre.

Macro Nutrients Pre-Plant: Garlic has a moderate to high demand for nitrogen (N). Recommendations for nitrogen are based on previous crop and organic matter content. Reduce recommended rates of nitrogen by: 70 lb. nitrogen per acre (N/A) if the previous crop is alfalfa, 40 lb. N/A if the previous crop is clover, and 20 lb. N/A if the previous crop is soybean or peas. Soil tests should be taken before planting to determine phosphorus (P) and potassium (K) needs. Use the Bray P1 test if soil pH is 7.4 or less and use the Olsen test if soil pH is greater than 7.4. All P and K fertilizers should be incorporated before planting.

Suggested Cultivars:

- *Hardneck, Porcelain group:* Georgian Crystal, German Extra Hardy, Music, Polish Hardneck.
- *Hardneck, Rocambole group:* Capathian, German Red, Killarney Red, Spanish Roja.
- *Hardneck, Purple Stripe group:* Chesnok Red, Metechi, Persian Star.
- *Softneck, Artichoke group:* Inchelium Red, Korean Red.
- *Softneck, Silverskin group:* Idaho Silverskin.
- *Other:* Giant Siberian

Production: Garlic for seed purposes should not be stored under refrigeration. When necessary, store garlic for seed at 50° F, and maintain a humidity of 65-70%. Garlic cloves sprout most rapidly at 40° to 50° F hence prolonged storage at this temperature range should be avoided. Storage of planting stock at temperatures below 40° F may result in rough bulbs, side-shoot sprouting and early maturity, while storage above 65° F may result in delayed sprouting and late maturity.

Extreme care must be exercised in using pest-free planting stock. Bulbs and cloves used for planting can carry and transmit diseases such as *Sclerotinia cepivorum* (white rot), *Fusarium cumorium*, (basal rot), and possibly *Botrytis allii* and *B. porri*. The seed may also be infected by *Penicillium*, a fungus that can cause a decay of the seed pieces and reduce stand. Other important pests that can be carried on the seed stock are several species of nematode (stem and bulb). Some of these pests may render the soil unusable for further production of garlic, onions, and related crops. Whenever possible observe the field from which the planting stock is to be obtained for these and other pests.

Harvest: Harvest when the tops have fallen over and partially dried. Lift from soil and dry protected from sun and rain.

Cleaning: Remove the outer 1 - 2 layers of skin after curing. The stem end should be at least 1” and the roots removed.

Cooling and Storing: To cure, bunch in 10 - 12 stems and hang, or lay on a screen in a warm, ventilated environment for 8-10 days. Cooling is not necessary. For long-term storage, store at 32°F at 65% - 70% humidity for 6 to 7 months. After drying, trim roots and remove tops or leave tops on for braiding.

Sorting and Grading: Should be clean and consistent in color and size. Bulbs can be graded into the following diameter sizes: <2 inches, 2 to 2.5 inches, 2.5 to 3 inches, and >3 inches. Premium bulbs are those 2.5 inches and larger. Minimum diameter is 1 ½”.

Packing: 15 or 30 lb cases

Green Beans

	J	F	M	A	M	J	J	A	S	O	N	D
Seed: 1					■	■	■					
Seed: 2						■	■	■				
Grow: 1					■	■	■	■				
Grow: 2						■	■	■	■			
Harvest						■	■	■	■	■		

Plant Type: Annual

Germination and Soil Temperature: 7 – 10 days at 75° to 85°F

Outdoor Planting, Rates per Acre: 85 lbs/acre

Planting Depth: ¾” in cold, wet soils and 1 ½” in warm, dry soils

Soil pH: 6.0 – 6.8

Soil Type: Silt loam

Plant Spacing: Bush: 4” – 6” Pole: 12”

Row Spacing: 18” – 36”

Days to Harvest: 50 – 65

Irrigation and Water Needs: Low until plant flowers, then average

Specialized Equipment: Harvester

Mechanization Potential: Planting and harvesting

Range (Yield/Acres): 2 to 5 tons/acre

Macro Nutrients Pre-Plant:

- N 0 lbs/acre
- P 0 – 100 lbs/acre
- K 0 – 190 lbs/acre

Suggested Cultivars:

- Bush: Benchmark, Blue Lake 274, Bronco, Bush Romano, Contender, Daytona, Derby, Envy, Evergreen, Flo, Gold Mine (yellow), Hileah, Improved Tender Green, Labrador, Opus, Provider, Rushmore, Sequoia, Strike, Tema, Tender Crop, Tender Pod, Top Crop, Royal Burgundy, Venture.
- Pole: Blue Lake, Kentucky Blue, Kentucky Wonder, Kentucky Wonder Wax, Scarlet Runner. Lima: Big Mama, Bridgeton, Cherokee, Fordhook, Fordhook 242, Henderson Bush, King of the Garden.
- Wax/Yellow: Blue Lake, Cherokee, Eureka, Green Lake, Gold Crop, Gold Rush, Kinghorn Wax, Klondyke, Nugget.

- Yardlong: Red Noodle.

Production: Plant beans in fields that had been in wheat or other cereal crops to reduce damage from soil-borne diseases. Avoid fields containing residues of lettuce, carrots, cabbage, parsnips, potatoes, tomatoes, and cucurbits such as pumpkins, squash, and zucchini, since these may harbor white mold disease sclerotia. Also avoid fields which were in strawberries, because these may harbor gray mold disease sclerotia. Use fungicide and insecticide-treated seed.

Good germination is obtained at soil temperatures of 60° F to 84° F. Seed rot is a serious problem at lower temperatures and seedling injury from soil incorporated herbicides may be increased due to longer exposure times from slow germination. Beans are sensitive to cold water imbibition which may result from early spring rains and cold soils coupled with excessively dry seed (below 10% moisture). This problem may be reduced by conditioning such seed for several days by exposing it to ambient humidity, allowing the seed to absorb moisture from the air. This may be done by opening seed bags and holding them for several days in an unheated barn or storage area.

Make every effort to establish the stand without post-plant irrigation. Plant into moisture or, if soil moisture is too deep, pre-irrigate the field before planting or culti-pack the field lightly after planting to bring soil moisture to the seed level. Irrigation after planting increases the risk of soil crusting, chilling of the seed and un-emerged seedlings, and increases risk of anaerobic conditions, and should be done only as a last resort. Seedlings should emerge in about 10-14 days. Any delay in emergence exposes seedlings to increasing rates of incorporated herbicides, as well as seed and seedling pathogens. Uniform emergence is important, especially at high plant populations, in which a delay of emergence of only 2-3 days behind the rest of the stand will result in such plants being barren. Always handle bean seed with care. Rough handling lowers the percentage of germination and increases the number of crippled seedlings.

Harvest: Do not harvest when wet. Do not pick when they are too young – the pods should be well formed and straight.

Cleaning: Washing is not needed if the beans are clean. If beans are hydro-cooled they should be drained and as dry as possible.

Cooling and Storing: Put directly into the cooler or hydro-cool. Store fresh at 41° - 46°F, 95% relative humidity for 7 - 10 days

Sorting and Grading: Bulging seeds and fibrous pods are too old and unacceptable. Beans should be free from soft rot and damage and not broken.

Packing: 25# - 1 1/9 bushel box with bag liner

Lettuce

Head

	J	F	M	A	M	J	J	A	S	O	N	D
Seed												
Grow												
Harvest												

Leaf

	J	F	M	A	M	J	J	A	S	O	N	D
Seed: 1												
Seed: 2												
Grow: 1												
Grow: 2												
Harvest: 1												
Harvest 2:												

Plant Type: Annual

Germination and Soil Temperature: 7 – 10 days at 65° - 70°F

Outdoor Planting, Rates per Acre: Head, precision seeding: 5 ½ oz/acre

Planting Depth: ¼” – ½”

Soil pH: 6.5 – 6.8

Soil Type: Sandy peats and mucks, deep black sandy loams

Plant Spacing: 2” – 3”/12”, thin to 11” – 13”/plant

Row Spacing: 14” – 18”

Days to Harvest: Head: 60 – 70, Leaf: 40 – 50

Irrigation and Water Needs: Low to medium

Specialized Equipment: Precision planter and harvester

Mechanization Potential: Planting and harvesting

Range (Yield/Acre): 6 to 12 tons/acre

Macro Nutrients Pre-Plant:²⁰

- N 60 lbs/acre
- P 0 – 150 lbs/acre
- K 0 – 200 lbs/acre

Suggested Cultivars:

- Butterheads: Bibb Blend, Buttercrunch, Deer Tongue, Ermosa, Esmeralda, Four Seasons, Loma, Nevada, Sylvesta, Yugoslavian Red Butterhead.
- Head: Black Jack, Cerbiata, Firecracker, Great Lakes, Iceberg, Igloo, Ithaca, Nati-dad, Prizehead, Red Giant, Red Grand Rapids, Ruby Red, Salad Bowl, Summer-time.
- Leaf: Aruba, Baby Oakleaf, Black-Seeded Simpson, Dark Lolla Rossa, Green Oakleaf Tango, Green Wave, Glossy Green, Lolla Rossa, Oakleaf, New Red Fire, Prizeleaf, Red Sail, Red Salad Bowl, Sierra, Simpson Elite, Sunfire, Tango, Tiara,

²⁰ Adjust for soil type, previous management, and soil test results.

Vulcan.

Production: Germination occurs at as low as 40° F and may not occur at temperatures of 90° F and over unless irrigation is used to cool the soil. Crop growth is usually good between 61° and 65° F. Lettuce is planted from April through mid-August. Lettuce seed numbers approximately 400,000 per pound. Use only mosaic-indexed and fungicide-treated seed from a reliable seed source. For direct field seeding, 1/4 to 1/2 lb/acre is required when a precision seeder is used with unpelleted seed. Pelleting greatly improves precision planting and reduces thinning costs. Advances in priming and coatings can improve stand establishment under adverse conditions. Head lettuce is most commonly direct seeded in the field. Leaf types are currently mostly transplanted from greenhouse-grown plugs. Raised beds are ideal for lettuce production. They help prevent damage from soil compaction and flooding. This is especially important for the variety Summertime. Transplants put out early will benefit from a starter solution high in phosphate.

Sow seeds in early spring. Lettuce flowers and turns bitter with the onset of hot weather. Fall plantings can be in August.

Harvest: Lettuce should be fresh, green, and not soft or split, with no leaf decay, spotting, or discoloration. Harvest with a field knife and remove damaged or yellow leaves. Cut above ground and be sure to keep your knife clean. Cut open a couple of heads to ensure there is no tip burn on internal leaves. For loose lettuce, pick small leaves, nothing over 3" long. Remove all damaged and imperfect leaves as well as foreign materials, including insect damage, wilted or holey leaves, grasses, and sticks. For all loose greens it is best to harvest them in the morning when it is cool and the sugar content is highest. A field knife should be used to harvest to prevent crushing the stem. Mechanical harvesting is being used in some regions.

Cleaning: Handle greens carefully: do not run water directly on greens at high pressure, as this will damage the leaves. Wash and rinse thoroughly. Sanitize with approved solution. Rinse thoroughly. Spin dry.

Cooling and Storing: Greens should be cooled to 32°F as soon as possible after harvest. Loose lettuce can be stored at 32° - 40°F at 80% - 90% relative humidity for up to 1 month. Head lettuce can be stored for up to 2 months if kept properly cooled. Hydro-cool head lettuce and set heads upside down to drip dry or cool as soon as possible after harvest in a cooler at 32°F.

Sorting and Grading: Leaves that are loose, discolored, damaged, soiled and diseased should be removed. The butt ends are cut cleanly for packing. Leaf, butterhead, and cos types should be cut, trimmed and tied into compact bundles before being placed in cartons. Lettuce is graded according to head size. Good quality lettuce is free from wilting, seeding or bitter taste and is firm, fresh, clean, and crispy.

Packing: Do not over-pack by smashing greens. Pack loosely in boxes and bags to prevent leaf breakage. 12 heads - 1 1/9 bushel box with bag liner

- **Iceberg lettuce:** commonly packaged in 43 to 48-lb, 24-count cartons.

- Boston lettuce: commonly packaged in 20-lb cartons.
- Romaine lettuce: commonly packaged in 24-count cartons.
- Leaf lettuce: commonly packaged in 20 to 25-lb or 24-count cartons.
- Bibb lettuce: commonly packaged in 10-lb cartons.
- Greenhouse lettuce: commonly packaged in 10-lb cartons

Peppers (Sweet, Hot)

	J	F	M	A	M	J	J	A	S	O	N	D
Seed: Indoor												
Seed: Outdoor (Plants)												
Grow												
Harvest												

Plant Type: Annual

Germination and Soil Temperature: 7 to 10 days; Days: 65°-85° F & Nights: 60°-65°F

Outdoor Planting, Rates per Acre: 1 oz seed = 3,000 plants for transplant

Planting Depth: 1/4"

Soil pH: 5.5 – 7.0 (7.0 for maximum yields)

Soil Type: Well drained, moderately fertile

Plant Spacing: 12" – 24"

Row Spacing: 18" – 36"

Days to Harvest: 60 – 70

Irrigation and Water Needs: Irrigation is necessary for dry spells and especially during fruit production periods in July

Range (Yield/Acre): 15 – 25 tons/acre

Macro Nutrients Pre-Plant:²¹

- N 30 lbs/acre
- P 0 – 240 lbs/acre
- K 0 – 300 lbs/acre

Suggested Cultivars:

- Hot: Ancho 101, Ancho San Martin, Beaver Dam, Tiburon, Ventura.
- Anaheim: Big Chile, Anaheim TMR23.
- Cayenne: Big Red, Charleston Hot, Long Red Slim.
- Jalapeno: Biker Billy, Conchos, Early Jalapeno, Mucho Nacho.
- Serrano: Serrano Chile. Thai; Kung Pao, Thai Dragon Hybrid.
- Other: Cherry Bomb, Maraichi.
- Sweet – Red: Antohi Romanian, Biscayne, Blushing Beauty, California Wonder, Carmen, Cherry Pick, Crusader, Early Crisp, Fat 'N' Sassy, Fooled You, Giant Marconi, King Arthur, Lantern, Lipstick, Orion, Red Knight, Red Knight X3R, Red Ruffled Pimento, Revolution, Round of Hungary, Sheepnose Pimento, Snapper, Sweet Banana, Yankee Bell.
- Sweet – Brown: Chocolate Beauty, Sweet Chocolate, Tawny Port.
- Sweet – Green: Alliance, Aristotle X3R, Brigadier, Lafayette, Paladin, Sentry, Soc-

²¹ Adjust for soil type, previous management, and soil test results.

rates.

- Sweet – Ivory: Alba, Bianca.
- Sweet – Orange: Aruba, Gourmet, Gypsy, Sunrise Orange, Tangerine Pimento.
- Sweet – Purple: Purple Marconi, Islander, Lilac Bell.
- Sweet – Yellow: Golden Baby Belle, Sunray, Super Heavyweight, Yellow Corno di Toro.

Production: To reduce risk from Verticillium wilt and other diseases avoid using fields in rotation plans in which eggplant, tomato, pepper, potato, strawberry or caneberries²² have been planted. Pepper seeds number approximately 72,000 per pound. Bell peppers are not normally direct seeded. Use high quality fungicide treated seed in the production of transplants. Some seed companies now offer “vigorized” or “conditioned” seed which has better germination under cool soil conditions. Peppers are sensitive to damping-off. In direct-seeded plantings a pop-up fertilizer solution may be helpful. Spray directly on the seed a solution of pop up fertilizer of 2-6-0 at 1 pint per 100 lineal feet of row (use 1/2 this rate on sandy soils). A 2-6-0 solution is equivalent to 1 part of 10-34-0 liquid fertilizer diluted with 4 parts of water.

Peppers are a warm-temperature vegetable and require a long growing season. Transplants which are grown should be kept close to the following temperatures: Days: 65°-85° F. Nights: 60°-65° F. Temperatures above 95° F may result in flower bud drop. Highest yields are obtained when soil temperatures remain in the 70°-75° F range. Soil temperatures below 68° F may result in substantial yield reductions. Seeds should be planted in a heated greenhouse 6-8 weeks before the field transplanting date. When growing transplants in unheated greenhouses, cold frames, or field transplant beds, 8-14 weeks may be necessary. Seedlings are transplanted to other flats when the first true leaves are 1.5” long and spaced 2” to 2.5” apart in the greenhouse or plant bed. At all times handle pepper seedlings with care because they are easily broken or damaged. Harden transplants for about a week before transplanting to the field, reducing moisture and maintaining a temperature of 55° to 65° F.

Plant seedlings in mid-May. The last practical date for planting eggplants is June 20.

Harvest: Peppers should be free from injury caused by sunscald, decay, or insects. Colored peppers should be at least 95% colored. Pick when dry.

Cleaning: Spray wash, sanitize, and rinse.

Cooling and Storing: Hydro-cool or cool immediately to no lower than 45°F, as peppers are subject to chilling injuries. Store at 45° - 55°F at 90% - 95% relative humidity for 2-3 weeks.

Sorting and Grading: They should be of similar size and variety when packed. Size A will be 2 -3 peppers per pound and Size B will be 3 - 4 peppers per pound. Seconds are peppers that are somewhat misshapen and may have some scarring. Seconds will not have decay or injury from insects.

22 Such as black berries and raspberries.

Packing: 20# case - 1/1/9 bushel box; 10# case - 3/4 bushel box; 5# case - 1/2 bushel box

Spinach

	J	F	M	A	M	J	J	A	S	O	N	D
Seed: 1				█								
Seed: 2								█				
Grow: 1				█	█							
Grow: 2								█	█			
Harvest: 1						█	█					
Harvest 2:									█	█	█	

Plant Type: Annual

Germination and Soil Temperature: 7 to 10 days at 75° to 85°F

Outdoor Planting, Rates per Acre: 8 ¼ lbs/acre

Planting Depth: ¾” for cold, wet soils or 1 ½” for warm, dry soils.

Soil pH: 6.5 – 7.0 (6.2 – 6.9 is optimum)

Soil Type: Muck soils

Plant Spacing: 6” – 8”

Row Spacing: Sets: 10 – 12”, Singly: 18 – 36”

Days to Harvest: 40 – 50

Irrigation and Water Needs: Low until plants flowers, then average

Specialized Equipment: Precision seeder and mechanical harvesters.

Mechanization Potential: Planting and harvest

Range (Yield/Acre):

- **Processing:** 8 – 10 tons/acre
- **Fresh:** 4 – 6 tons/acres

Macro Nutrients Pre-Plant:²³

- N 30 lbs/acre
- P 0 – 240 lbs/acre
- K 0 – 300 lbs/acre

Suggested Cultivars: Avon Hybrid, Baby Leaf Hybrid, Bloomsdale Long Standing (spring), Decatur, Early Hybrid No. 7 (fall), Early Hybrid No. 10 (fall), Harmony Hybrid, Melody, New Zealand, Old Dominion (fall), Reddy Hybrid, Salad Fresh, Tye Hybrid, Tye Melody, Unipak 151 (semi-savoy), Virginia Savoy (fall).

Production: The use of proper varieties is very important. Slow-growing, slow-bolting (slow seed-stalk development as day length increases) varieties are used for late spring and summer harvest, while fast-growing vigorous varieties should be used for fall, winter, and early spring harvest. Bolting is increased by exposure of young plants to low (40° to 60° F) temperatures. Treated seed is generally recommended. Spinach is susceptible to damping off. A temperature of 50°-63°F is ideal for optimal growth. Generally a lower seeding rate is used when spinach is planted for processing and a higher rate when spinach is to be bunched or bagged. Seeding rates should be reduced when spinach is to be

²³ Adjust for soil type, previous management, and soil test results.

grown during high temperatures.

Harvest: Remove all damaged and imperfect leaves as well as foreign material. These include insect damage, wilted or holey leaves, grasses, and sticks. For processing - harvest before plants are too large or begin to bolt (usually when 16” to 17” tall). Sometimes a second cut is made for a chopped pack after suitable regrowth has developed. At harvest, the first cut is made 6”-7” above the ground in order to eliminate as much stem and petiole as possible for the whole leaf pack. This is also done to avoid as many of the yellow or old leaves as possible. At the second cutting, small disks are used to cut away these yellow or old leaves and to remove some soil away from the crown to facilitate harvest. Depending on temperature and plant density 3-4 weeks are needed between the first and second cutting to obtain adequate regrowth. For fresh market, plants should be dry and slightly wilted to prevent petiole breakage. When harvesting by hand, cut above the crown or soil line and bunch. Care should be taken to exclude leaves that are dirty with soil or are yellow. Bunched spinach must be handled extra carefully to reduce breakage of plants or bunches during bunching, washing, and packaging.

Cleaning: Wash and rinse thoroughly. Sanitize with approved solution. Rinse thoroughly. Spin dry.

Cooling and Storing: Field heat should be removed as soon as possible with hydro-cooling. Hold spinach at 32° F and 95 to 100% relative humidity. Spinach is very perishable, so it can be stored for only 10 to 14 days. The temperature should be as close to 32° F as possible because spinach deteriorates rapidly at higher temperatures. Crushed ice should be placed in each package for rapid cooling and for removing the heat of respiration. Top ice is also beneficial.

Sorting and Grading: Stems should be no longer than 1”. There should be no coarse stems.

Packing: 3# case – ¾ bushel box, with bag liner. Most spinach for fresh market is pre-packaged in perforated plastic bags to reduce moisture loss and physical injury. Controlled atmospheres with 10 to 40% carbon dioxide and 10% oxygen have been found to be beneficial to slow yellowing and maintaining quality.

Squash (Summer)

	J	F	M	A	M	J	J	A	S	O	N	D
Seed												
Grow												
Harvest												

Plant Type: Annual

Germination and Soil Temperature: 7 to 14 days at 75° to 85°F

Outdoor Planting, Rates per Acre:

- **Zucchini:** 7 ¼ lbs/acre

- Yellow Summer: 5 lbs/acre
- Patty Pan/Scallop: 4 ½ lbs/acre

Planting Depth: 1" – 1 ½"

Soil pH: 6.0 – 6.8

Soil Type: Light, well drained

Plant Spacing:

- Bush types: 18" – 24" apart.
- Vining types: 2' – 5' apart

Row Spacing:

- Bush types: 4' – 6' apart
- Vining types: 6' – 8'

Days to Harvest: 50 to 60

Irrigation and Water Needs: High

Specialized Equipment: Mechanical transplanter or seed planter

Mechanization Potential: Planting

Range (Yield/Acre): 30 tons/acre

Macro Nutrients Pre-Plant:²⁴

- N 50 lbs/acre
- P 0 – 150 lbs/acre
- K 0 – 200 lbs/acre

Suggested Cultivars:

- Straightneck: Butterstick, General Patton, Goldfinger, Gold Rush, Golden Dawn, Golden Delight, Lemondrop L, Liberator III, Monet, Multipick, Saffron, Sunray, Sweet Gourmet, Zephyr. Crookneck; Dixie, Pic-n-Pic, Prelude, Sundance.
- Patty Pan/Scallop: Green Tint, Peter Pan, Scallopini, Sunburst, Sunny Delight.
- Other: Lita, Bonita.
- Zucchini: Dividend, Independence III, Jaguar, Puma, Revenue, Spineless Beauty.

Production: Summer squash seedlings are susceptible to damping off and decay when soils are cool and wet. Zucchini and summer squash plants bear separate male and female flowers on the same plant (monoecious). Only the female flowers set fruit. Bees transfer pollen from male flowers to female flowers, making fruit set possible. It is recommended that one honey bee hive should be introduced for every 1 to 2 acres during the blooming period since the native bee population may not be adequate or may not coincide properly with the blooming period.

Black plastic ground mulch is sometimes used in the production of summer squash to enhance yield and earliness. It controls weeds, may increase soil temperature, conserves moisture, and protects fruit from ground rots. For black plastic mulch to increase soil temperature, it is imperative that the soil surface be smooth and that the plastic be in close contact with the soil. This can only be achieved by laying the plastic with a machine designed and properly adjusted for this task. Clear plastic mulch is very effective at transferring heat to the soil but does not control weeds. A new generation of plastic mulch films allows for good weed control together with soil warming that is intermediate between black plastic and clear film. These films are called IRT (infrared-transmitting) or

²⁴ Adjust for soil type, previous management, and soil test results.

wavelength-selective films. They are more expensive than black or clear film, but appear to be cost-effective where soil warming is important. Plastic and non-woven materials have been developed as crop covers for use as windbreaks, for frost protection, and to enhance yield and earliness. They compliment the use of plastic mulch and drip irrigation in many crops. Covers should be removed when plants begin to flower to allow proper pollination. Row covers increase heat unit accumulation by 2 to 3 times over ambient temperature. Two to four degrees of frost protection may also be obtained at night. Soil temperatures and root growth are also increased under row covers as are early yields and in many cases total yields.

Harvest: Cut the stems instead of breaking them off; wear clean cotton gloves and handle with care because of the delicate skins. The surface should be shiny, clean, and free of physical injury.

Cleaning: If necessary, wipe off squash with a clean product towel.

Cooling and Storing: Store at 50 - 60°F at 60% - 70% relative humidity for 4 – 6 months

Sorting and Grading: Zucchini, yellow straightneck squash, and crookneck squash should be 5” - 9” long and not over-ripe. Patty pan squash should be 3-5” in diameter. Baby squash are any summer squash that are 2”-4” long.

Packing: 20# case - 3/4 bushel box; 12# case - 1/2 bushel box (baby). Be sure to avoid stem damage when packing boxes. Squash should be uniform in size within each case.

Squash (Winter)

	J	F	M	A	M	J	J	A	S	O	N	D
Seed												
Grow												
Harvest												

Plant Type: Annual

Germination and Soil Temperature: 7 – 14 days at 75° - 80°F

Outdoor Planting, Rates per Acre: 2 – 8 ½ lbs/acre

Planting Depth: 1 – 1 ½”

Soil pH: 6.0 – 7.5

Soil Type: Light, well drained

Plant Spacing: 24” – 36”

Row Spacing: 72” – 84”

Days to Harvest: 90 – 120

Irrigation and Water Needs: High

Specialized Equipment: Mechanical transplanter or seed planter

Mechanization Potential: Planting

Range (Yield/Acre):²⁵

²⁵ Yield numbers are for pumpkin type winter squashes.

- Small: 5 – 7 tons/acre
- Large: 10 – 20 tons/acre

Macro Nutrients Pre-Plant:²⁶

- N 50 lbs/acre
- P 0 – 150 lbs/acre
- K 0 – 200 lbs/acre

Suggested Cultivars:

- Acorn: Autumn Cup, Cream of the Crop, Early Acorn, Jet, Mesa Queen, Seneca Autumn Queen, Sweet Mama, Table Ace, Table Gold, Table King, Table Queen, Table Star, Table Treat, Tay Belle.
- Buttercup: Amber Cup, Autumn Cup, Bonbon, Burgess, Buttercup, Emerald Bush Buttercup, Mooregold, Orange Cutie, Queensland Blue, Sun Spot, Super Delight.
- Butternut: Autumn Glow, Bugle, Butter Boy, Butternut Supreme, Early Butternut, Metro, Sweet Mama, Waltham, Zenith.
- Delicata: Bush Delicata, Carnival, Cornell's Bush Delicata, Sweet Dumpling.
- Hubbard: Blue Hubbard, Golden Hubbard, Red Kuri, Sugar Hubbard.
- Kabocha: Confection, Sunshine.
- Spaghetti: Hasta La Pasta, Pasta Hybrid, Tivoli, Vegetable Spaghetti.
- Other: Long Island Cheese, Marina Di Chioggia, Sugar Loaf.

Production: Pumpkin and squash seedlings are susceptible to damping-off and decay when soils are cool and wet. Pumpkins and squash are usually direct-seeded when all danger of frost has passed. Transplants may also be used. Winter squash and pumpkin root to a depth of 48" or more. Maintain soil moisture above 60% of the soil water holding capacity. It is important to regulate irrigation properly to avoid excessive moisture or water stress. Use windbreaks as necessary. Grain windbreaks have been found effective when grain rows are used for each crop row. Crop rows and windbreaks should be cultivated after they are well established. Windbreaks may be cut off or rotary tilled around June 25 before vines develop long runners that may be damaged by tractor tires.

Good management practices are essential if optimum fertilizer responses are to be realized. These practices include use of recommended varieties, selection of adapted soils, weed control, disease and insect control, good seed bed preparation, proper seeding methods, and timely harvest. Because of the influence of soil type, climatic conditions, and other cultural practices, crop response from fertilizer may not always be accurately predicted. Soil test results, field experience, and knowledge of specific crop requirements help determine the nutrients needed and the rate of application.

Harvest: Cut squash with pruners and leave a short stem.

Cleaning: Wash or wipe off with clean product towel at time of shipment.

Cooling and Storing: Cooling is not necessary. To cure, place in warm, ventilated dry

²⁶ Adjust for soil type, previous management, and soil test results.

area, in temperatures from 85° to 95°F for 8 to 10 days. Store at 50° - 55°F. Squash can be sold immediately without curing but should be cured for long storage.

Sorting and Grading: Flesh should be bright yellow or orange, with a fine, moist texture.

Packing: 35# case - 1 1/9 bushel box; crates may be used for bulk orders. Package to ensure stems do not bruise other squash.

Tomatoes

	J	F	M	A	M	J	J	A	S	O	N	D
Seed: Indoor												
Seed: Outdoor (Plants)												
Grow												
Harvest												

Plant Type: Annual

Germination and Soil Temperature: 7 – 14 days at 65° - 75°F daytime, 60° - 65°F night-time

Outdoor Planting, Rates per Acre: 1 oz seed = 7,400 plants/acre

Planting Depth: 1/2" – 3/4"

Soil pH: 6.0 – 6.8

Soil Type: Sandy loam

Plant Spacing: 18" – 36"

Row Spacing: 36" – 42"

Days to Harvest: 65 – 80

Irrigation and Water Needs: Medium and deep until harvest

Specialized Equipment: Mechanical transplanter

Mechanization Potential: Planting

Range (Yield/Acre): 230 – 270 cwt/acre or 1,200 20lb boxes²⁷/acre

Macro Nutrients Pre-Plant:²⁸

- N 30 lbs/acre
- P 0 – 240 lbs/acre
- K 0 – 300 lbs/acre

Suggested Cultivars:

- Paste (determinate): Amish Paste, Red Agate, Roma VF, Viva Italia.
- Slicing (determinate): Amelia, BHN 589, Biltmore, Bush Beefsteak, Bush Celebrity, Bush Early Girl, Celebrity, Crista, Ensalada, Fabulous, Florida 91, Mountain Pride, Mountain Spring, Orange Blossom, Oregon Spring, Patio Princess, Red Sun, Sun Brite, Sunsation, Sunshine, Sweet Tangerine, Ultrasweet.

²⁷ Cherry tomatoes are commonly packaged in 8-lb baskets. Mature green tomatoes are commonly packaged in 30-lb cartons and wirebound crates, volume-fill pack. Pink and ripe tomatoes are commonly packaged in 20-lb two-layer flats and cartons, tray pack; or 28-lb three-layer lugs and cartons, tray pack; or 30-lb cartons, loose pack.

²⁸ Adjust for soil type, previous management, and soil test results.

- Slicing (indeterminate): Better Boy, Big Beef, Big Boy, Black Krim, Black Prince, Brandywine, Champion, Cherokee Purple, Dafel, Early Girl, First Lady, Florida 47, Fourth of July, Jet Star, Long Keeper, Mountain Fresh, Mortgage Lifter, Pink Beauty, Quimbaya, Steak Sandwich, Striped German, Sun Leaper, Tolstoi.
- Cherry (indeterminate): Brown Berry, Golden Sweet, Sweet Juliet, Red Grape, Small Fry, Sugary, Sugar Snack, Sun Cherry, Super Sweet 100, Sweet Cluster, Sweet Million, Tiny Tim, Yellow Pear.

Production: To reduce risk from Verticillium wilt and other diseases avoid using fields in which eggplant, tomato, pepper, potato, strawberry, or caneberries have been planted.

Tomato is a warm-temperature vegetable and requires a long growing season. Transplants should be kept close to the following temperatures: 64° to 70° F during the day, 55° to 61° F at night until the seedlings are thinned out. Water plants before signs of wilting appear. When the first true leaf has formed, early flowering can be increased by a one-week cold treatment at 54° F. Caution: Do not subject transplants with 4-5 true leaves to cold temperatures (around 50° F nights and 60°-65° F days) for more than a week since this will increase catfaced fruit. Condition transplants for 1-2 days before transplanting to the field by slightly reducing the moisture and maintaining approximate outdoor temperatures. Do not over-harden (see note on catfacing above). Thoroughly water plants 12 to 14 hours before transplanting to the field. Plants should be dug or cut loose from the soil when being transplanted; ensure the roots are not exposed to sun or drying wind.

Harvest: Ripeness required varies by buyer. Wholesalers generally want tomatoes that are less ripe. They should be picked when the pink on the blossom end is the size of a dime and shoulders are pale or green; these will ripen in 3 days at room temperature. Retail customers will want the tomatoes that are ripe and fully red but still firm. Tomatoes should be picked without the stem, unless they are heirlooms, and put in boxes stem end down. Tomatoes should not have splits. Do not pick over-ripe cherry or grape tomatoes as they will split in shipping.

Cleaning: If necessary, wipe off tomatoes with a clean product towel.

Cooling and Storing: Ripe 45° -50° F green: 55° - 70°F at a relative humidity of 90% - 95%. Store ripe 4 -7 days; green 1 - 3 weeks.

Sorting and Grading: Number 1 tomatoes will be of the same variety type, mature (not over-ripe or soft), clean, well developed, and fairly smooth and well formed. They should be free from decay, freezing injury, sunscald, or damage from any other cause. Seconds, or Number 2s, are similar to Number 1s but may be misshapen or slightly damaged. They may be slightly damaged by sunscald, but not seriously damaged by other causes other than decay and freezing.

Packing: 18# case - Tomato box; 10# Flat - Cherries/Grapes; 12 Pints - Flat - Cherries/Grapes

Resources

Other Grower Guides

Midwest Vegetable Production Guide for Commercial Growers, 2012

This is an excellent, detailed guide for commercial growers on production. It contains a huge array of knowledge on crop production but not a lot of detail on mechanization and resource management. <http://www.btny.purdue.edu/pubs/id/id-56/ID-56.pdf>

Greenhouse Information

Planning & Building a Greenhouse, West Virginia University Extension

A good introduction to the different aspects of greenhouses ranging from structural design, location, heating and ventilation. <http://www.wvu.edu/~agexten/hortcult/greenhou/building.htm>

Greenhouse Structures Presentation, Colorado State Extension

A good presentation on how to select materials and structures for greenhouses. http://ghex.colostate.edu/presentations/Greenhouse_Structures.pdf

Commercial Greenhouse Vegetable Production in Alberta, Canada

Economic assessment of greenhouse vegetable production in Canada. It is not applicable to using greenhouses for transplant production but explains the general economics and challenges of a greenhouse business. [http://www1.agric.gov.ab.ca/\\$department/deptdocs.nsf/all/agdex1443](http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/agdex1443)

Production Information

University of Massachusetts Agriculture Extension, Vegetable Program

A broad array of information on soil management, pests, insects, disease, and weeds. <http://extension.umass.edu/vegetable/soil-crop-pest-management/soil-nutrients>

Use of Plastic Mulch and Row Covers in Vegetable Production, University of Oklahoma State Extension

A good overview on how to use plastic mulch and row covers along with pros and cons of this method. <http://pods.dasnr.okstate.edu/docushare/dsweb/Get/Document-1099/F-6034%20web.pdf>

Surface Water Irrigation Regulations & Permitting

Wisconsin Waterway and Wetland Permits: Withdrawals and Irrigation

http://dnr.wi.gov/topic/Waterways/water_levels_crossings/irrigation.html

Iowa Water Use & Allocation Program

<http://www.iowadnr.gov/InsideDNR/RegulatoryWater/WaterSupplyEngineering/WaterAllocationUse.aspx>

Illinois Water Rules & Regulations

There are currently no water withdrawal regulations for surface water aside from Lake Michigan according to the National Conference of State Legislatures website.²⁹ There are regulations on well water withdrawals. <http://www.epa.state.il.us/water/rules-regulation.html#groundwater>

Harvest & Post Harvest Information

Small-Scale Postharvest Handling Practices:

A Manual for Horticultural Crops

4th Edition, Lisa Kitinoja and Adel A. Kader, 2003

A detailed guide that reviews how to harvest, handle, and market various types of fruit and produce. This is a highly recommended resource for produce growers of all sizes. <http://ucce.ucdavis.edu/files/datastore/234-1450.pdf>

Horticulture Information Leaflets: Postharvest Handling of Horticulture Crops, North Carolina University Extension

Includes four short pamphlets with introductory information on quality, cooling, handling, and mixed loads. <http://www.ces.ncsu.edu/hil/post-index.html>

A Low Cost Hydro-cooling Unit for Horticultural Commodities

A guide to building a low cost hydro-cooling system for small growers. A useful starting point for growers looking to engineer their own system. <http://hilo.hawaii.edu/panr/writing.php?id=161>

Marketing Guide Information

Grower's Manual: A Template for Grower Cooperatives,

Leopold Center, Iowa State University

An excellent guide to post-harvest handling and storage practices. <http://www.leopold.iastate.edu/sites/default/files/pubs-and-papers/2011-10-growers-manual-template-grower-cooperatives.pdf>

Insurance Coverage Options for Fresh Produce Growers

USDA Agriculture Marketing Services (AMS) and

North Carolina State University Extension

Description of the types of insurance for produce farming. http://www4.ncsu.edu/~rmrejesu/Food_Safety_Risk/ag-710%20final%20printed.pdf

Here Comes GAP Certification! The inside story of a Vermont farm going for USDA GAP certification.

A case study by Vermont University on a farm striving for GAP certification. <http://www.uvm.edu/vtvegandberry/GAPS/HarlowFarmGAPSCaseStudy.pdf>

Food Product Liability Insurance

Rob Holland 2007. Analysis on Produce Liability Insurance cover standards and pre-

²⁹ "State Water Withdrawal Regulations." National Conference of State Legislatures. N.p., n.d. Web. 28 Dec. 2012. <<http://www.ncsl.org/issues-research/env-res/state-water-withdrawal-regulations.aspx>>.

mium cost ranges. <http://homebasedbaking.com/wp-content/uploads/2009/06/Product-Liability-Insurance-in-TN.pdf>

Crop-Specific Resources

Asparagus

“Asparagus.” Commercial Vegetable Production Guides. Oregon State University, 6 Aug. 2004. Web. 10 Sept. 2012. <<http://nwrec.hort.oregonstate.edu/asparagu.html>>.

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