INSTITUTE FOR AGRICULTURE AND TRADE POLICY

# Extending the Growing Season

## High Tunnels Use and Farm to School in the Upper Midwest

**By Pete Huff**

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## Introduction

The Upper Midwestern states of Minnesota, Iowa and Wisconsin are simultaneously known for their cold winters and their high agriculture production. Like many states in the country, these states are experiencing increased interest in local and regional food procurement, particularly from institutions such as schools, childcare centers, universities and hospitals. While many farms in the Upper Midwest only produce during the typical growing season of mid-May through early October,[1] the use of technology and practices to extend the growing season is rising, in part as a response to the increased demand for local and regional fruit and vegetables. This report focuses on the current use of season extension technology and practices in the Upper Midwest and particularly the use of high tunnels and hoop houses identifies potential strategic pathways for ramping up season-extending production of fruits and vegetables in the region to meet growing demand, particularly in the K-12 market.

## Overview of Season Extension Technologies and Practices

Season extension technologies and practices span a wide range of options that can be adapted to the needs of individual farms. The purpose of season extension is to modify agriculture micro-climates to provide enhanced growing conditions beyond the typical growing season of the region. According to the National Sustainable Agriculture Information Service, such technologies and practices are divided into two categories—cultural practices and "plasticulture" practices (i.e. use of plastic technology). Cultural practices can modify growing conditions with or without additional infrastructure and may include: irrigation, "smudge pot" heaters and/or wind machines; wind breaks, cultivar selection, shade, transplanting, multiple cropping and other practices such as mulching. Plasticulture practices, in their use of manufactured products, usually require infrastructure and may include: plastic film mulches, drip irrigation tape, row covers low tunnels and high tunnels.[2] Traditional greenhouses, as well as hydroponic and aquaculture operations, are also a form of season extension, as they create highly managed growing environments for year-round production. Regardless of the form, multiple season extension technologies and practices are often implemented simultaneously or in coordination on a farm to maximize productivity.

A low tunnel. Image used under creative commons license from Flickr user osumg.

A high tunnel. Image used under creative commons license from Flickr user usdagov.

Within the range of options, this report specifically addresses the use of high tunnels—also known as hoop houses or passive solar greenhouses—amongst small- to medium-scale specialty crop farmers in the Upper Midwest of the United States. This particular season extension technology and set of practices is a common, inexpensive option for Upper Midwestern farmers interested in extending their growing season.

## High Tunnel Technology and Practices

Though the designs of different tunnels vary, high tunnels typically consist of steel hoops fixed in place above productive land and covered by greenhouse-grade plastic. These structures are usually freestanding, with optional heating or electricity, and ventilation (passive or automated) to regulate temperature. High tunnels are typically tall enough for tractor cultivation, and crops are typically planted in the ground at

grade. High tunnels can be mobile, though this often requires specialized planning for a track or sledge system to move the structure over adjacent plots. An average high tunnel for crop production is usually in the range of 2,000 to 6,000 square feet, but some are much larger.[3]

Aside from structure type and scale of tunnel, farmers also employ methods to maximize the production period, quality and quantity of their products. The correct choice of cultivar and crop rotation are key factors of high tunnel success, with certain plant varieties growing best in the shoulder months (early or late season). Organic growing can also be enhanced by high tunnel use, as the structure limits access to pests and reduces the need for chemical control. However, poor management can lead to the reverse—pest infestations can be common and intense due to the more hospitable environment provided by the high tunnel. To promote an early harvest, many growers are shifting to transplants rather than direct seeding, and grow starters under cover that are later planted in the field to give them a jump-start on the season. Farmers are taking full advantage of potential square footage under protection by using space vertically (e.g. hanging pots and trellising).

Many farmers are integrating supplementary crop protection technologies to maximize their high tunnel outputs, such as the integration of row covers or low tunnels—plastic or agricultural fabric supported by short hoops over a row crop. Many farmers have started using alternative energy sources in response to the high cost of gas to heat their crop-covering structures, should their high tunnel be equipped in this capacity. These unconventional sources may include wood and corn boilers, or different technologies such as screens, heat storage tanks or cogeneration to improve energy efficiency.

## Producer Profile: ZJ Farm

ZJ Farm is an 80-acre organic vegetable farm in Solon, Iowa that was founded in 1994. The farm is operated by Susan Jutz, whose primary market is a community supported agriculture (CSA) program that offers approximately 130 vegetable shares to customers between April and December.

The farm erected its first high tunnel in 2000 to provide a seedling germination space and added a second, larger (30-by-72 foot) tunnel in 2010 to provide wind and flood protection for crops. The second, larger tunnel provides the farm's primary protected production space. This mobile tunnel cost $14,225 or $6.50 per square foot due to the addition of solar vents and partial automation. Jutz received $3,000 from a United States Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) Environmental Quality Incentives Programs (EQIP) grant and paid the remaining $11,225 out of pocket.

Mobile high tunnel at ZJ Farm

The high tunnels add an additional six weeks to the growing season, a critical factor for the success of the farm's CSA and the source of $18,000 to $25,000 in added annual revenue. Jutz reports increased crop yield and quality from the high tunnel as compared to crops grown in the field—particularly for salad greens, which make up most of what Jutz grows in her high tunnel. For lettuce, she produced $18,648 in gross revenue in the high tunnel in 2011. Factoring in expenses such as labor, fertilizers, seeds and water, the 2011 net revenue for her high tunnel lettuce production was $16,305. This equates to an operating cost of $2,343 and a net profit of $12.70 per square foot of high tunnel lettuce for the year. Lettuce used just under 30 percent of her total high tunnel square footage.

High tunnel at ZJ Farm

This case demonstrates that with proper planning and care, growing in a high tunnel can be immensely profitable for farmers and quickly cover tunnel costs. Jutz made the money for her initial tunnel back within the first year of its operation. The mobility of the tunnel allowed her to double her production area, a factor that was maximized by her meticulous planning, monitoring of growing conditions and recordkeeping.

Source: Interview with Susan Jutz, Owner and Operator (August 2014)

As with the general agriculture sector, lean labor is another way farmers have cut down on resource inputs, replacing labor with technology.

## High Tunnel Costs and Income

High tunnel infrastructure costs can vary depending on the overall size, material components (basic and upgraded) and construction costs. One high tunnel manufacturer prices a basic high tunnel at $2.95 per square foot, and an upgraded high tunnel with features such as enhanced ventilation, double layer plastic and metal or polycarbonate end walls, at $6.13 per square foot.[4] Another publication from Iowa State averaged information from five growers to conclude that a 2,160-square-foot tunnel costs $7,000, which equates to approximately $3.25 per square foot.[5] Typically, the plastic covering of a high tunnel has a four- to five-year lifespan depending on condition. At the end of its lifespan, the plastic must be replaced, creating ongoing material and labor cost. The agricultural zone also determines the technology selection. In the western and southern U.S., high tunnels tend to feature lighter weight steel, hoops and plastic due to warmer average temperatures and reduced snow-loading. In northern and eastern regions, high tunnels often need additional reinforcement (higher gauge hoops and plastic) and additional technologies (such as heat) to maintain optimum growing temperatures throughout the cold seasons to handle harsher winters.

Further, the cost of high tunnels can fluctuate depending on geographic access to required materials. In the East, the amount of land under cover is reported to be about one-third in California, which benefits from inexpensive tunnel materials procured from China. This access can lower the cost of the steel needed to construct high tunnels to $0.45 per square foot for California farmers. This is a significant difference from the East Coast, where the cost of steel components is nearly double at $0.85 per square foot.[6] Naturally, the scale of high tunnel construction—be it the size of an individual tunnel or the number of tunnels constructed—can reduce the overall cost.

Cost of high tunnel implementation and operation is also heavily influenced by the potential income such a technology and practice would yield. The productive capacity and subsequent gross income of a single high tunnel is heavily dependent on numerous factors, such as the size of the tunnel, the utilization of the available space and the type of markets available. Research from Iowa State University estimates that a standard 30-by-70-foot high tunnel utilized for the production of eight to 10 crop varieties from March-September will produce $9,600 gross income—or $5.30 per square foot—when operating at 84 percent capacity (approximately 100 labor hours). Comparatively, focusing production in the same high tunnel on a single crop during the same growing period could gross between $3,000 (cucumber) to $10,000 (tomato), depending on the crop. Tomato production numbers from Wild Onion Farm in Lawrence, Kansas offer another picture of potential profits. While located in Zone 5, the farm reported that one 20-by-68-foot high tunnel grossed $3,162 for 3,162 pounds of tomatoes. With operating and fixed costs, the net return for the high tunnel in one season was $1,506.77. With a $0.50 increase in price per pound, the same tunnel would net $3,087.77 per year.[7] For single crop production, the Iowa State Extension research indicates that a minimum of six high tunnels would be needed for tomatoes to gross $30,000 per year, and substantially more tunnels would be needed for crops such as cucumbers or sweet peppers; for mixed crop production, approximately six to eight high tunnels would be necessary to gross $30,000 per year.[8]

The range of productivity in high tunnel production is further demonstrated by a 2010 high tunnel trial with 12 novice farmers that was conducted by University of Michigan Extension. During the trial, in which the participating farmers were provided a 30-by-96-foot high tunnel in exchange for recording production and sales data for 30 months, the experience of individual farmers varied. Gross annual high tunnel income averaged $11,451.78, with the minimum income reported as $2,400 and the maximum income reported at $22,256.25. With operating costs ranging from $1,482.70 to $7,056.20, farmer profits ranged from $350.05 to $16,899.29. Farmers averaged 1,096.4 labor hours for high tunnel operation per year, with the minimum hours reported as 264.4 per year and the maximum reported as 3,074.5.[9] However, the input of labor hours is not the sole determinant of gross income, as greater labor input can compound a technical learning curve to produce low effective wages. The average farmer wage during the trial was $9.29 per hour, with a minimum reported at $0.28 per hour and a maximum reported at $23.87 per hour.[10] As UM-Extension trials demonstrate, the productivity and income produced by high tunnels can vary considerably based on the experience of the producer.

### High Tunnel Application

On the whole, high tunnels are generally accepted as beneficial, low-risk tools that are applicable on a variety of farm scales. Adam Montri, Hoophouse Outreach Specialist at Michigan State University's Department of Horticulture, notes that most small- to medium-scale, diversified, direct market farms established within the past 10 years in the Upper Midwest have high tunnels or are in the process of adding high tunnels, based on his experience. Montri, who works extensively with farmers in the Upper Midwest, also noted that high tunnels are increasingly considered a normal component of new farm startups.[11] More are applying high tunnel structures to their

farm operations, oftentimes combining these with open field production. While they often operate independently, high tunnels can also operate as a multi-unit system to streamline operations, justify specialized equipment and increase profits—ranging from a handful of tunnels on small farms up to hundreds of tunnels in tandem operation, such as those on large-scale berry-production farms in California and the United Kingdom. Many of the large, commercial-scale bramble operations use high tunnels—California's bramble farmers, for instance, comprise the largest markets in North America for high tunnels.[12]

There are mixed perspectives on what size farm most commonly integrates high tunnels into their operations. High tunnels are widely used by small growers who have the capacity to market their products directly to high-end markets (such as restaurants or retail). Since high tunnels require relatively little capital for construction and operation, even small family farms with more limited financial and human resources utilize them, or inexpensive variations of them (e.g. caterpillar tunnels).

In urban centers, farmers are maximizing limited space by constructing high tunnels in a variety of sizes and forms. While zoning presents an obstacle to working in urban environments, many urban farm projects have found success in working with city governments to create the processes necessary to legally establish high tunnels on previously under-utilized land. Similar to their rural farmer counterparts, urban farmers are also benefiting from high tunnel use by intensifying

## Producer Profile: Uproot Farm

Uproot Farm is a small, diversified vegetable farm about an hour north of the Twin Cities, between Princeton and Cambridge, Minnesota operated by Sarah Woutat. The farm started in 2011 and currently operates six acres of vegetable production, which is sold via CSA and one farmers market. The farm also sells to a local market, a co-operative market and a food truck. The farm is transitioning to become Certified Organic.

The farm constructed a 30-by-96-foot high tunnel in 2011, during its first full growing season. A high tunnel was not part of the original farm planning, but information from the local NRCS office during the early phase of implementation motivated the farm to apply for funding under the Season High Tunnel Initiative. The farm covered its share of the tunnel's cost through growing spinach for the wholesale market during the winter of 2011 and spring of 2012.

The implementation of the high tunnel through the EQIP program has encouraged the farm to expand high tunnel and greenhouse production, adding two additional structures in 2014 for early season greens, tomatoes and cucumbers.

High tunnel frame at Uproot Farm

The farm has faced some high tunnel challenges, specifically pest and weed management. The post-harvest handling of cut greens—particularly washing—has also been a challenge for the farm in the winter due to limited infrastructure. Expanded operation would be dependent on building a wash-and-spin system that could operate effectively and comfortably during the colder fall and winter months when the high tunnel is in production.

High tunnel at Uproot Farm

Overall, the farm has had positive experiences working with their local NRCS office through the EQIP program–noting that the limited number of farmers utilizing the Seasonal High Tunnel Initiative in the district has resulted in the farm receiving a high level of attention. The farm did experience some challenges going through the required process to receive funding, but felt that the cost-share incentive was strong enough and that the resulting high tunnel would provide welcome profits for the farm. This benefit has been realized by the farm since implementing the initial tunnel.

The farm noted that a greater level of technical support for farmers using high tunnels would be beneficial. Such technical support would be particularly useful if it focused on how existing farmers can integrate a tunnel into an existing operation.

Source: Phone Interview with Sarah Woutat, Owner and Operator (November 2014)

their growing and harvesting efforts in the shoulder months (November/December and March/April). The productivity of high tunnels can help small, decentralized urban farm operations be more profitable than they would be otherwise.

## Benefits of High Tunnel Implementation

Once in place over a growing area, high tunnels can work as an effective option for extending and/or modifying the agricultural micro-climate of that area. High tunnel systems can increase yields and reduce yield variability.[13] In regard to extending the growing season, high tunnels help to increase soil temperature in the early spring and maintain warmer soil temperature longer into the early winter—thus adding weeks or even months to the growing season. Crops selected to grow in tunnels are usually those most susceptible to weather and pest impacts (salad greens, berries, etc.) and high-value fruit and vegetable crops with strong early- or late-season profit margins (tomatoes, peppers, etc.). During the standard growing season, high tunnels allow farmers to modify the growing conditions (air temperature, moisture, pest control, etc.) within the structure. When managed properly, high tunnels can result in the quality of many crops being greatly improved over adjacent field production.[14] For tomatoes grown in USDA climate zone 6, growers can often plant four to five weeks earlier in the spring and can expect to harvest fall-planted tomatoes well into November or December.[15] For strawberries, Illinois Extension reports that using a high tunnel results in a harvest approximately five weeks before field-grown strawberries.[16]

These additional weeks and months translate directly to income, as they serve thin direct-sale markets (farmers markets, CSAs, etc.) that respond to higher prices.[17] Consumer research at Michigan farmers markets has shown that market shoppers are willing to pay a premium for fruits and vegetables that enter the market early, particularly when they know that this food is locally produced via high tunnels.[18] Similarly, consumer research in Alabama on tomato purchasing demonstrated that market shoppers were willing to pay between 30.5 to 58 percent higher prices for early-season, locally grown tomatoes.[19] Beyond commanding a higher price and extending income into traditionally slow months, farmers who consistently access markets early or later can build customer loyalty for the standard growing season.

A study done at the University of Wisconsin–River Falls compared the performance of lettuce and tomato varieties grown in a high tunnel as compared to the open field. The study found that crop yields were significantly higher when grown in a high tunnel. Lettuce yields were 48 percent higher in a high tunnel the first year of the study and 59 percent higher in a high tunnel the second year of the study. Tomatoes performed similarly, with a 35 percent higher yield in a high tunnel the first year of the study and a 47 percent higher yield in a high tunnel the second year of the study.[20] Various studies have also concluded that other crops including strawberries, raspberries, blackberries, muskmelon and peppers have higher yields when grown in high tunnels compared to the open field.[21,22,23]

During early spring and late fall, which can have dramatically variable weather patterns, high tunnels also provide crops additional protection from extreme weather events—such as hail, heavy rain, and killing frosts. Due to the semi-permanent nature of the structures, crop protection is provided throughout the growing season. Thus, high tunnels can provide a buffer for variable growing conditions, reducing crop loss risk for farmers. Published research indicates that, when there is yield and price premium confidence, high tunnels can be expected to produce positive profits that are comparable to crop insurance payout for damage to non-high tunnel production. This research shows that, "while crop insurance provides a safety net for farmer revenue, high tunnels shift and shrink distributions of yields while positively affecting price premiums…this outcome effectively aids in managing risk by upshifting potential profit."[24] Once they are fully owned by a farmer, high tunnel use can ensure profitability while minimizing dependency on external financial sources.

## Challenges of High Tunnel Implementation

Despite their increasing popularity and multiple benefits, small- and medium-scale farmers face challenges when incorporating high tunnels into their operations. The primary obstacles that these farmers face are financial and technical. With the average high tunnel costing approximately $7,000, the startup cost can be prohibitive for certain farmers—particularly beginning and/or small-scale farmers. High tunnels often require additional materials for their successful operation in areas with high snowfall—such as additional and/or thicker steel hoops, as well as a double layer of plastic and/or supplemental heating. Thus, depending on the locational needs, high tunnels can increase costs of production by $10,000 per acre.[25]

Further, the technical capacity to successfully and profitably operate a high tunnel can also be a barrier for farmers of any scale or level of experience. Farmers must maintain a carefully controlled growing environment over varying seasons,

## Producer Profile: High Meadow Farm

High Meadow Farm, located in Johnson Creek, Wisconsin, is run by Meg, Mike and Matt Kelly. The Kellys purchased the farm in 1980. They have 40 acres, 6.5 of which are in vegetable production and 3 of which are orchard. At first, the Kellys raised and farmed with draft horses and had a large garden for selling at the farmers market. This was not fruitful, so the Kellys went to work full-time outside the farm. In 2007, they started their CSA as a way to get back to farming, and they have been doing it ever since.

The Kellys sell their produce almost exclusively through their CSA. Their first year, they had 25 families signed up for CSA shares, but in 2014 they had approximately 220 families signed up for summer shares, and about 30 for winter shares and 30 for spring shares. Season extension techniques are what enabled their CSA to expand as much as it has. They erected their first low tunnel in 2008 using the top rail from steel fencing and plastic sheeting as a way to grow the greens that they love for more months of the year. They found it to be productive and rewarding, so in 2012, they built a 96-foot by 100-foot high tunnel. This tunnel has allowed the Kellys to grow cold-tolerant vegetables nearly year-round, and is what enabled them to offer winter and spring CSA shares.

High tunnel frame at High Meadow Farm

The high tunnel requires daily work; although the Kellys have not run into any insect or weed problems, they pay close attention to the temperature. They cover the plants with row covers on cold days, and make sure to uncover them if the heat builds up on sunny days. Their reported biggest challenge, which most farmers would agree with, is an unpredictable climate. Especially in very cold winters, their winter CSA shares are volatile. They have sidestepped this challenge by making sure to keep an assortment of winter storage produce available so that winter CSA members are not completely dependent on the high tunnel.

High tunnel frame at High Meadow Farm

When asked what technical or operational support they thought would encourage broader season extension uptake, the Kellys reported that their ability to succeed has been greatly enhanced by attending workshops and visiting other farmers that use high tunnels to learn from them. The Kellys have also attended a High Tunnel Organic University program and other workshops at the Midwest Organic and Sustainable Education Service (MOSES) conference. If they were to build another high tunnel, they would be interested in detailed information on implementing crop rotations in the tunnel.

Source: Phone Interview with Meg Kelly, Owner and Operator (August 2014).

which requires consistently monitoring temperature, light, and nutrients. Preserving soil quality and fertility alone can be a challenge because protected crops produce more than crops in the field, thus requiring additional soil nutrients to support the intensified growth.[26,27] Pest and disease management for crops grown under protection is also different than for crops grown in the field. This intensified management requires highly technical knowledge to implement, and one grower described it as a "day-to-day babysitting operation."

Even when armed with season extension manuals and technical instructions, farmers encounter a steep learning curve when choosing appropriate cultivars, developing the planting and harvesting schedules, and managing protection. In addition, integrating high tunnel production with in-field production can be a challenge, since different equipment may be needed and the crops may have different requirements than they do when grown in the field. A study by the University of Minnesota compared tomatoes grown in a high tunnel versus in the field, and found that the same crop could be planted 37 days earlier in a high tunnel, at a date that planting the same crop in the field would not be feasible. The same study found that productivity per square foot was two to five times greater in a high tunnel than in the field, meaning that soil in the high tunnel needed to provide extra nutrients to support the extra growth.[28] All of these factors make high tunnel growing distinct from growing the same crops in the field, adding a level of complexity to farm planning and operation.

Higher farm input costs can compel farmers to price crops grown under protection higher than those grown in the open field, which can limit the range of viable markets. Buyers such as K-12 schools may not be able or willing to pay higher prices even for premium products grown out of season.

# Governement and Non-government support for high tunnels

## Government support

The Seasonal High Tunnel Initiative operated by the United States Department of Agriculture (USDA) via the Natural Resource Conservation Service's (NRCS) Environmental Quality Incentives Program (EQIP) is the largest program providing financial assistance to farmers to construct high tunnels. Established in 2009 as a three-year pilot program, the Season High Tunnel Initiative provides cost-share funding and technical assistance to farmers for high tunnel construction and has helped to expand the use of high tunnel construction nationally and in the Upper Midwest. The Initiative was initially designed to help NRCS assess the environmental benefits of high tunnel use. The pilot program was well-received and utilized by farmers, resulting in the Season High Tunnel Initiative transitioning to an established conservation practice in 2014. According to the National Sustainable Agriculture Coalition (NSAC), "the EQIP Seasonal High Tunnel Initiative has provided assistance for over 13,000 high tunnels on farms in all 50 states as well as Puerto Rico and the Pacific Basin," accounting for approximately $61 million of cost-share assistance.[29]

The NRCS will cover up to 75 percent of the high tunnel cost for the standard applicant through the Seasonal High Tunnel Initiative. This funding is limited to high tunnels to a total 2,178 square feet—regardless of whether an applicant intends to build a single structure or multiple structures. The high tunnel must be put on existing cropland that has an active crop production history, and crops must be planted into at-grade soil or raised beds (i.e. not containers, growing racks or hydroponic systems). The NRCS does accept applications from urban farmers, but those farmers are responsible for navigating the relevant zoning law for their areas. The Initiative assumes that high tunnels will not "over-winter," be used year round and that any structural considerations for winter stability (stronger hoops, thicker plastic, etc.) are not covered through EQIP. High tunnel applications are managed through local NRCS offices.

The EQIP Seasonal High Tunnel Initiative provides additional support (i.e. up to 90 percent of the total high tunnel cost) for historically underserved farmers and ranchers, which the USDA defines to include: beginning farmers and ranchers who have materially and substantially participated in a farm or ranch operation for less than 10 consecutive years; limited-resource farmers and ranchers who fall below the national poverty line with static direct or indirect gross farm sales over a two year period; and socially disadvantaged farmers and ranchers (e.g. African Americans, American Indians, Alaskan natives, Hispanics, Asians and Pacific Islanders).[30]

Farmers and ranchers qualifying as historically underserved are eligible for an increased EQIP payment rate in purchasing a high tunnel through the Seasonal High Tunnel Initiative. All three categories of underserved individuals have responded to the Seasonal High Tunnel Initiative, with over 70 percent of total high tunnel contracts going to these farmers and ranchers.[31] The Initiative has been most strongly utilized by beginning farmers—according to NSAC's analysis of USDA data, "between 2010 and 2013, beginning farmers' high tunnel contracts increased from 39 to 51 percent of total program contracts."[32]

The rise of urban agriculture in major metropolitan areas has resulted in the creation of special initiatives within the EQIP Seasonal High Tunnel Initiative. These programs —such as the Wayne County (Detroit) Seasonal High Tunnel Educational Initiative in Michigan and the Cleveland High Tunnel Initiative in Ohio—support small urban growers to increase their productivity and participation within local food markets, such as Farm to School programs. These pilot programs were launched under the Know Your Food, Know Your Farmer program started by President and First Lady Obama.

The Wayne County initiative was allocated $150,000 in 2014 to assist eligible applicants with installation of seasonal high tunnels in Detroit and Wayne County. Eligible farmers may receive up to $9,474.30 in cost-share assistance. Select practices (e.g. nutrient management, mulching, etc.) can also be included where eligible. The Initiative is funded by USDA NRCS and supported by the City of Detroit. The Southeast Michigan Resource Conservation & Development Council and other community groups, such as the Detroit Black Community Food Security Network and Keep Growing Detroit, help run the program and provide outreach. According to their website, the Southeast Michigan RC&D and community partners "bring together the area's agricultural farmers, local food advocates, and community organizations to build partnerships around this issue and will produce a series of educational materials [including workshops] to provide valuable information to local farmers."[33]

The Cleveland High Tunnel Initiative is a pilot program that began in 2011. It covers 90 percent of the cost of a high tunnel —up to $6,709 for high tunnels up to 30-by-72 foot (2,178 square feet)—for qualified applicants. According to the Initiative website, "NRCS accepts the dollar value of in-kind services towards the 10 percent." With 23 high tunnels funded in 2012, the program shifted priority in 2013 to "applicants located in city-targeted agricultural use areas, areas designated as food deserts by USDA, and applicants from one of the 20 HUD Neighborhood Stabilization Program target areas,"[34] resulting in 26 funded tunnels. In 2014, 43 applications for high tunnel funding under the initiative have been received.

While it does not provide funding for high tunnel construction directly, the USDA Agricultural Marketing Service does fund considerable high tunnel research through the Specialty Crop Block Grant Program (SCBGP). These grants, which have been issued since 2006, focus on projects that enhance the competitiveness of specialty crop growers (e.g. fruits, vegetables, tree nuts, dried fruits, horticulture and nursery crops—including floriculture) that do not benefit from commodity support programs of the Farm Bill. This can include a broad range of activities, such as: value-added processing businesses, food hub development, farmer safety training, and Farm to School. Grants are only available to State Departments of Agriculture, which typically work with nonprofit groups, producer groups and/or colleges and universities to develop ideas and appropriate work. According to NSAC, the SCBGP has provided more than $285 million since 2008. In that time, the SCBGP has funded approximately 125 high tunnel, hoop house or plasticulture research projects in 33 states, including Minnesota, Wisconsin and Iowa.[35]

## Non-goverment support

Beyond federal-level programs, funding for high tunnel construction is increasingly coming from non-government sources. Ranging from co-op grocery grants to private companies, such as Patagonia's Environmental Grant Program, these non-traditional sources of seed funding or loans can provide farms the support they need to implement or expand high tunnel operations. The New York Farm Viability Institute is a "farmer-led nonprofit group that awards grant funds for applied research, outreach education, and agricultural economic development projects that help farms increase profits and provide models for other farms."[36] The organization has been funded by state and federal legislatures and agencies, as well as farmers, Cornell University and the Cooperative Extension service, the State University of New York agriculture colleges, NYS Department of Agriculture and Markets, agribusiness, government, nonprofit agencies, and others. It operates a multi-million-dollar grant program that has funded nearly $500,000 in high tunnel research since 2006.

However, the Institute does not pay for high tunnels outright, instead focusing their funding to demonstration trials, workshops, expertise, consulting and coordination. One funded project in 2008-2009, entitled "Fostering Use of High Tunnels for Season Extension in NY," worked with 14 farmers (with an additional 11 advising) who were currently using high tunnel systems to identify and address tunnel production constraints. From this process, the project resulted in those farmers increasing their total tunnel areas by 17 percent, their number of workers in tunnels by 18 percent and their farm income by 164 percent. Further, the project provided engagement and education opportunities for 850 New York Farmers on high tunnels construction and profitable operation.[37] Overall, the New York Farm Viability's funded projects demonstrate that, with proper management, high tunnels can quickly become profitable and cover their implementation costs.

A program of the Natural Capital Investment Fund—established by the Conservation Fund and the U.S. Endowment for Forestry & Communities—the ShadeFund provides microloans up to $50,000 of funding that, according to their website, "targets and supports forestry-related businesses and small-scale agricultural farmers."[38] Interest rates are four percent to nine percent, and vary according to loan amount, available collateral and credit worthiness. While the program focuses on a specific core geography (West Virginia, North Carolina, Virginia, Kentucky, Ohio, Tennessee, Georgia and South Carolina), funding is available nationwide and has provided support for high tunnel development in the Upper Midwest. Once approved, borrowers are featured on the ShadeFund website where they can raise a portion of their loan from individuals. The ShadeFund loan program provided Ten Hens Farm in Bath, Michigan with $15,000 to expand their 12-month high tunnel production, particularly winter greens. The loan also allowed the farm to invest in a walk-in cooler, allowing the farmers to store field-grown products longer as well as harvest them on multiple days during the week, rather than the night before or morning of deliveries.

There are numerous examples of co-operative grocery retailers supporting loans and grants for their associated farmers to build infrastructure that improves their production, including high tunnels. Many of these programs involve the co-operative grocery serving as a connecting point between multiple other stakeholders—including farmers, community groups, government agencies, private companies and co-operative grocery members.

The Willy Street Co-op is located in Madison, Wisconsin. In 2014, the co-op launched its Local Vendor Loan Fund in collaboration with Forward Community Investments, University of Wisconsin-Extension and Slow Money Wisconsin. According to their website, the pilot program aims to provide mid-scale loans (up to $50,000) for the co-op's vendors and helps these businesses "get financial and technical support that isn't available in the conventional financing lending system."[39] The program also pairs loan recipients with a technical advisory to assist with scaling up business practices sustainably. The program has provided loans for three of the co-op's vendors. This includes Keewaydin Farms, which utilized the capital to expand high tunnel production.

The Marquette Food Co-op (MFC) is located in Marquette, Michigan, which is in the state's Upper Peninsula. For the past five years, the co-op has engaged with two initiatives to

increase the number of high tunnels in their region. A 2009 partnership with Northern Initiatives, an economic development nonprofit, and Northern Michigan University's School of Hospitality Management, the co-op helped to construct a 22-by-48-foot high tunnel. The tunnel has been the focal point of research and education programs, as well as a source of food for local food pantries and the NMU's culinary arts program, which provides ongoing funding. The MFC has also supported the construction of three smaller high tunnels at three public schools, in partnership with the Marquette County Health Department—the fiscal sponsor. This includes one elementary, one middle and one high school. MFC staff work with faculty and students to grow food in each high tunnel.

In response to the flooding of the Mississippi River in August 2007, the Sow the Seeds Fund was originated by The Wedge and the Institute for Agriculture and Trade Policy (IATP). The fund distributed two rounds' worth of grants totaling $119,000 each to 20 farmers in southeast Minnesota, southwest Wisconsin and northeast Iowa that suffered significant losses from the flooding. The Fund prioritized small organic and sustainable farmers, who may not have had the level of insurance needed for adequate compensation—farm businesses vital for the region's direct-market and co-operative grocery economy. $98,000 was contributed by co-operative groceries throughout the Midwest and Texas. The National Co-operative Grocers Association contributed an additional $50,000. The remainder of the funds generated came from private foundations, individual donors and private businesses. In 2008-2009, the Sow the Seeds Fund continued to support

## Producer Profile: Growing Lots Farm

Growing Lots Urban Farm began in 2010 on a small site in south Minneapolis and has since grown to cover 1.75 acres split between two urban lots and a small acreage in Afton, MN. Since its inception, Growing Lots has used the CSA farm model and currently has 60 members, as well as limited sales at farmers markets.

The farm is managed intensively, pulling from the philosophies of permaculture, ecological agriculture, biodynamics and biointensive growing methods to maximize and diversify a unique growing environment. Very minimal machinery is used. Growing Lots cultivates over 30 different vegetables, fruits and herbs, along with a new experimental focus on cut flowers in the 2014 growing season.

Tomatoes being grown in the Growing Lots high tunnel

The farm features a 20-by-64-foot high tunnel that was funded through grants from the Seward Co-operative Market, located in Minneapolis, and Patagonia, an outdoor clothing and gear company based in California. The implementation of the high tunnel was part of the original farm design and was partially inspired by Growing Power's operation in Milwaukee, Wisc. However, due to funding constraints, it was not installed until the 3rd growing season.

The tunnel cost was approximately $6,500, of which $1,000 was funded by the farm. Construction costs were minimal, as the farmers did all the labor themselves. The high tunnel was purchased as a kit from Poly-Tek Industries in Minnesota. The company was specifically chosen because it was a local company.

Growing Lots' experience in this area is limited as it didn't finish final construction of the high tunnel until June of 2013, and so only has one partial and one full growing season under its belt to maximize the growing potential of a high tunnel system. However, during that time, the farm has used the tunnel to grow tomatoes, spring greens, ginger and fall greens. The most successful crop to date has been the high tunnel-grown ginger, due to its rarity as a locally grown item in Minnesota. Growing Lots successfully sold all 150 lbs of grown ginger at $12 per lb. In terms of gross sales per square foot of cultivated ground in the high tunnel, it ranged from $4 to $8 per square foot.

The farm notes that the high tunnel provides a more stable growing environment that has less plant disease, cleaner product (particularly salad greens that are not exposed to soil splash from rain) and greater overall plant productivity. Early season salad greens have been valuable for the farm's market sales, as well as their fall CSA share—both factors that have driven customer loyalty.

The farm has faced challenges with the high tunnel, particularly snow-loading during the winter and hail damage in the summer. The farm has also had difficulty with the management of the tunnel's internal temperature, primarily due to the lack of automated venting and the considerable temperature fluctuations of Minnesota spring. The farm is aware that some other farmers have reported declining soil fertility in stationary high tunnels, but they have not experienced any such issues to date. This would be the main motivation for transitioning to a mobile tunnel.

Source: Email interview with Stefan Meyer, Production Manager (November 2014)

farmers in flood-affected areas by providing trainings and informational resources on the use of season extension techniques, specifically high tunnels, as a response to climate change and extreme weather events.

Beyond funding, the growth in high tunnel construction is partially propelled by university and nonprofit technical research and support. Agricultural research and cooperative Extension programs are testing and validating how tunnels extend growing seasons, protect crops against weather extremes, improve labor efficiency, increase quality and yields, and provide many other positive outcomes for growers. This data can be found in manuals produced by Extension programs, including manuals particular to the upper Midwestern states of Iowa[40,41] and Minnesota.[42] These manuals also detail construction, water requirements, crop production schedules, temperature control, budget examples and supplementary technology. Such resources disseminate the technical expertise needed to get started with season-extended production in specific parts of the country.

University- or Extension-sponsored education is not the only means through which farmers have been learning season extension techniques. Farmer-to-farmer peer learning is becoming more common, through an increasing number of workshops, conferences and online education materials. In the Midwest, various organizations including Practical Farmers of Iowa, the Sustainable Farming Association of Minnesota, the Midwest Organic and Sustainable Education Service (MOSES) and others host regular field days on high tunnels in the upper Midwest. These field days showcase season extension options, crop performance and return on investment.

## Current Levels of High Tunnel Use

High tunnel use outside of the United States is well-established, with an estimated 1,448,805 acres in production under plastic structures and/or high tunnels worldwide in 2009.[43] Within this figure, Asia (1,087,284 acres) is a clear global leader and is followed by the Mediterranean (239,696 acres) and Africa/Middle East (42,008 acres)[44] Global high tunnel production focuses on the production of vegetables, small fruit, cut flowers and tree fruit. The primary vegetables grown include tomato, sweet pepper, cucumber, muskmelon, lettuce, summer squash and eggplant. Secondary vegetables include spinach, swiss chard, broccoli, cabbage, chinese cabbage, cauliflower, kale, kohlrabi, okra, onion, leek, garlic and herbs. Small fruit, such as strawberries and other berries (e.g. red raspberry, blackberry, etc.) are also popular high tunnel crops; tree fruit high tunnel operations typically focus on sweet cherry production.

The use of high tunnels in the United States is steadily growing, with approximately 5,000 acres in production using over 2,500 high tunnels estimated in 2007; for the Upper Midwest (Iowa, Minnesota, Wisconsin), it is estimated that there were approximately 270 high tunnels in operation in 2007.[45] The precise number of acres in high tunnel production within the United States is not available, with the previous estimations based on interviews conducted with state Extension vegetable specialists. The USDA Census of Agriculture does not specifically count high tunnel production, instead including the practice under the category of "Greenhouse, Nursery and Floriculture Production." Within this category, the USDA does count "Food crops grown under cover," noting that there were 2,044 farms within this category, harvesting a total of 18,712 acres of protected cropland in 2007.[46] As of the 2014 USDA Census of Agriculture, 3,138 farms were classified within this category and a total of 135,425 acres of associated cropland harvested.[47] While the data does not specify, the increase in food production under cover or protection between the 2007 and 2014 data indicates that existing farms have dramatically increased their scale of "under cover" production and/or that new, farms with "under cover" production have emerged.

A clearer picture of the increase in high tunnel use amongst small- and medium-scale farms is presented in the examination of the USDA's Season High Tunnel Initiative (SHTI). Not surprisingly the Seasonal High Tunnel Initiative has been most popular in states with short growing seasons, with Wisconsin and Minnesota in the top five states for EQIP high tunnel contracts (preceded by Missouri, Alaska and Michigan). According to Terry Nennich, an Extension Educator at the University of Minnesota, high tunnel use in the Upper Midwest "is increasing by leaps and bounds,"[48] and this observation is supported by the 2010-2013 SHTI pilot program data for the region. As seen in Table 1, from the years of 2010 to 2013 there were 458 new EQIP high tunnel contracts in Minnesota, 468 in Wisconsin, and 315 in Iowa. Among three states, the number of Seasonal High Tunnel Initiative contracts from 2010 to 2013 averaged 221, slightly higher than the national average of 202 high tunnels per state—demonstrating accelerated high tunnel use in the Upper Midwest.

Table 1: Number of EQIP High Tunnel Contracts in Minnesota, Wisconsin, and Iowa from 2010-2013

| | 2010 | 2011 | 2012 | 2013 | Total |
|---|---|---|---|---|---|
| Wisconsin | 184 | 77 | 107 | 100 | **468** |
| Minnesota | 197 | 111 | 87 | 63 | **458** |
| Iowa | 113 | 63 | 86 | 53 | **315** |
| Nationally | 2,111 | 1,905 | 3,283 | 2,974 | **10,273** |

Wisconsin, Minnesota and Iowa are slightly higher than the national average in their participation rates for historically underserved farmers and ranchers in the Seasonal High Tunnel Initiative, with 73 percent of all high tunnel contracts going to these farmers and ranchers in 2013—up from 45.7 percent in 2010. Similarly, beginning farmers in the three states accounted for just over 57 percent of the states' high tunnel contracts in 2014, up from 32.7 percent in 2010. These numbers only provide a small snapshot of high tunnel construction because they only include tunnels built through the EQIP initiative—the major financial driving force for high tunnel implementation and documentation in the country. Many farmers build tunnels with their own dollars, and those structures, if they are reported via the USDA Census of Agriculture, are difficult to determine.

## Farm to School market overview

On the whole, Farm to School is a relatively new practice in the Unites States. Farm to School practices have steadily grown in popularity since they first emerged in the 1990s, when the nationwide movement to reconnect schools to local agriculture started to gain traction.[49] Widespread and national Farm to School efforts emerged in 1996, with the formation of the National Farm to School Network and national attention on programs such as The Edible Schoolyard in Berkeley, California. The National Farm to School Program (NFSP) was established via the Child Nutrition and WIC Reauthorization Act of 2004 and is currently administered by the Food and Nutrition Service of the USDA. Upon its establishment, the NFSP included 400 programs in 22 states—it has since expanded to more than 40,000 schools in all 50 states.[50]

Farm to School practices are widely considered to be a "win-win-win" for farmers, students and local economies. According to the National Farm to School Network, "students gain access to healthy, local foods as well as education opportunities such as school gardens, cooking lessons and farm field trips. Farm to school empowers children and their families to make informed food choices while strengthening the local economy and contributing to vibrant communities."[51] When the Healthy, Hunger-Free Kids Act of 2010 (HHFKA) formally established a Farm to School Program within USDA, the agency conducted a Farm to School Census for 2011-2012. This Census revealed that 4,322 school districts—composed of 40,328 schools serving over 23 million children—were participating in some form of Farm to School practice. Of the $3 billion that these schools spent on school food in 2011-2012, over $385 million of those expenditures were directed to local purchases—primarily fruit and vegetables.[52] Within Minnesota, Wisconsin and Iowa, 408 school districts—composed of 2,942 schools serving 1,300,556 students—reported Farm to School activities in 2011-2012. This equates to approximately $23,503,179 in local purchases.[53]

Research conducted by the University of Minnesota Extension in 2014 on the market potential for farm to institution markets (including education and healthcare facilities) in Central and Northeastern Minnesota revealed that the K-12 schools in the region have the potential to purchase $724,765 of food during a standard growing season. Of this, approximately 28 percent is fruit and vegetable sales. For an extended growing season, the same research estimated that the market potential for schools within the 12-county region would be approximately $1,357,332. Of this, approximately 61 percent is fruit and vegetable sales. Despite the doubling of potentially available fruits and vegetables to schools due to extended seasonality, schools within the region only purchased $15,750 of local produce in 2011-2013.[54]

## School procurement

To understand the gap between the market potential and market reality of K-12 schools for purchasing locally produced foods, particularly season-extended produce from farmers using high tunnels, it is important to understand how public schools procure food. A majority of public schools purchase food through private vendors, with the average school relying on several broadline distributors for a majority of their food procurement and, in certain cases, smaller distributors to fulfill additional needs. These vendors, along with any vendor seeking to sell to a public school, must be selected through a competitive bid process—established by federal and state law—that assesses vendor quotes via a number of criteria, including food quality, food safety and sanitation, and price.[55] This bidding and contracting process—as well as overall meal planning and budgeting—is the responsibility of school food-service directors and/or staff.

The typical drivers behind the school lunch budget for a school district are: federal/state reimbursements; student participation rates in lunch programs; school lunch prices; a la carte sales; concessions and vending; and catering and related enterprises.[59] The initial three are primary drivers and the latter two are typically secondary. Federal funding is predominantly provided through the National School Lunch Program (NSLP). Established in 1946 under the National School Lunch Act, the NSLP is administered by the USDA's Food and Nutrition Service and provides subsidies to schools who serve free or reduced-price school meals to income-eligible students. The NSLP also provides minimal reimbursement for qualifying, full-price meals. A majority of federal reimbursements to individual school districts are for free and reduced-price meals and the level of reimbursement

## Producer Profile: Pahl's Market

Pahl's Market is located in Apple Valley, Minnesota—a fifth-generation, family-run farm that spans 1,100 acres of vegetable production and nursery operation. The farm produces 13 varieties of sweet corn, as well as pumpkins, squash, tomatoes, cabbage, green beans, peppers, cucumbers and dill. According to their website, all produce is sustainably grown with minimal pesticide use.

Within their operation, Pahl's has approximately three acres in high tunnel production, with the first high tunnel built in 1996. Today, the farm's three acres of automated high tunnel production boasts 11 high tunnels. Plans exist to build four additional high tunnels in 2015. The primary products grown inside the high tunnels are tomatoes, peppers and flowers.

The high tunnels at Pahl's average about 6,000 square feet, and the average cost per high tunnel is $40,000. This breaks down to about $6.67 per square foot. The largest costs are reportedly the cement footings and the automated heating and ventilation systems. However, these upgrades allow the farmers to pay less direct attention to each high tunnel. Pahl's pays for all their own high tunnels and has not used government or other assistance programs.

Tomatoes being grown in Pahl's Market high tunnel

Employees at Pahl's report that high tunnels provide a one-month extension to the beginning of the growing season, but limited light at the end of the season means that high tunnels don't extend the season to a significant degree for the farm. However, tunnels provide a benefit in that they enable space to be used incredibly efficiently. Vegetable and seedling production is paired with bedding plant production by using a racking system to hang flower pots above the vegetables during the early growth period. This maximizes the productivity of each tunnel with bedding plants sold via the farm's nursery business.

Pahl's sells to a diverse range of customers, primarily through wholesale relationships with processors and distributors such as Russ Davis—a fresh produce wholesale distributor that also works with Farm to School programs in the Twin Cities. The farm also sells a significant amount of their high tunnel produce to the restaurant industry. Finally, the farm sells produce via a popular CSA and an on-farm market. The farm's high tunnel production does not go to the farm to school portion of their business, but rather the higher-margin restaurant market.

When asked about the largest barriers to farmers interested in implementing season extension, employees at Pahl's reported a steep learning curve on hoop house management, primarily on maintaining fertility, light, temperature, and ventilation. Furthermore, they would like to see more resources to navigate the issues associated with food safety, OSHA employee safety requirements and other regulations.

A high tunnel at Pahl's Market

The employees at Pahl's emphasized the importance of post-harvest curing and handling facilities. They have tried curing and storing their own produce in the past, but found no notable price benefit. They also noted that working with aggregators and distributors helps farms successfully engage with farm to school, as these businesses are better equipped than individual farms to deal with institutional markets such as schools or hospitals that have limited ability to pick up produce or need large quantities at once.

Source: Interview with Gary Pahl, Co-Owner, and Cole Moldenhauer, Production Manager (August 2014)

is based on the financial eligibility of students enrolled, as well as the overall need of the school. According to the USDA, approximately 21.5 million children qualified for and received free or reduced-price lunches during the 2012-13 school year.[56]

Federal funds are administered by state agencies, with some states providing additional reimbursement to supplement federal funds. Participating schools receive cash reimbursements per meal serve: $2.98 for free lunches; $2.58 for reduced price lunches; and $0.28 for paid lunches in 2013-2014.

School districts participating in the NSLP are also eligible to receive commodity food donations such as meat, cheese and processed foods—valued at $0.2325 per lunch served in 2014.[57] Federal and state funding is contingent upon schools meeting nutritional standards established by the NSLP and updated by the Healthy, Hunger-Free Kids Act of 2010. School meals that do not meet these nutritional standards are not eligible for the associated reimbursement. Schools are not required to participate in federal and state meal reimbursement

programs—they may choose to run their food service independent of such support and, as a result, are not required to meet nutrition requirements.

According to the School Nutrition Association, the average K-12 breakfast cost $1.32 and the average K-12 lunch cost $2.32 in 2013-2014.[60] Approximately 35 to 45 percent of this cost is for the food itself, with the labor to prepare and serve it representing an additional 40 to 50 percent and operation costs representing the remaining five to 25 percent. Thus, the average school district has approximately $0.81-$1.04 to purchase food for its lunch meals. Depending on the needs of the school district and the students served by it, the breakdown of budget drivers varies considerably.

### School Challenges

Despite the multiple benefits and increasing popularity of Farm to School practices demonstrated over the past two decades, schools face many systemic obstacles that must be overcome when developing initiatives to integrate fresh, local foods into their school meal programs. These obstacles are related to budgetary, logistical and infrastructure/labor constraints. The budgets available for public schools to procure food are increasingly tight and are a major limiting factor for Farm to School practices. While they have historically been included in the local school district budget, school foodservice budgets are now typically required to be self-sufficient and cover their own costs (e.g. food, labor, equipment, utilities, trash removal, rent and building maintenance.)[58] Regardless, the budgets available for purchasing food for public school meals are typically insufficient and rely heavily on government reimbursements, commodity donations and broadline distributors who have the scale to offer the lowest prices, with the greatest level of consistency and flexibility, in the competitive bidding process.

It should be noted that, according to the State Farm to School Legislative Survey 2002-2013 produced by the National Farm to School Network and the Center for Agriculture and Food Systems, 18 states provided additional reimbursement to schools for sourcing locally produced foods for meals. These states include: Alaska, California, District of Columbia, Massachusetts, Maine, Montana, North Carolina, New York, Oregon and Pennsylvania.[61] While reimbursement rates vary from state to state, such supplemental funds reduce the financial barrier for schools to procure locally or regionally sourced fruits and vegetables. Perhaps the most active in this regard, the State of Oregon passed legislation in 2013 that allocated $1.2 million to support schools purchasing Oregon-grown produce during the 2013-2015 biennium. Most of the allocated funds will directly reimburse schools through a competitive grant process that will fund up to $0.15 per meal using Oregon foods, with the remainder being used to fund food, garden and agricultural education for students.[62] Similarly, the District of Columbia passed the Healthy Schools Act of 2010 that provides an additional $0.05 per meal that contains at least one locally-grown, unprocessed meal component.[63] Financial incentives for schools to procure locally grown produce are key to encouraging increased Farm to School activities within a region—driving additional dollars directly to local farmers and indirectly to other local businesses that support their operation, such as processors or distributors. Such investment in the local economy has been proven to have an economic multiplier effect. A study of Oregon's Farm to School programs found that each $1 of investment by schools in local foods stimulated an additional $1.86 of economic activity within the state's economy.[64] Thus, while increases to school food budgets may result in increases to the affordability of season-extended produce for school meals, any Farm to School activity within a region is likely to result in a more robust agricultural and overall economy—factors that would certainly influence extended local food production.

Logistically, Farm to School practices present a challenge to interested school districts and can require additional labor and equipment. This is typically due to the fact that a majority of public schools are accustomed to working with distributors who have the capacity to offer a large and varied supply of whole and processed produce—as well as "heat-and-serve" products—via standardized delivery, streamlined ordering/billing and quality control/liability systems.[65] Similarly, the shift toward a reliance on "heat-and-serve" meals—driven by reduced budgets and the availability from broad line distributors—has also resulted in a large number of schools lacking the cooking equipment and skilled labor necessary for scratch cooking, particularly whole, unprocessed produce available from local farmers who may not be equipped for sophisticated processing and/or packing.

## Farm Challenges

Despite the market potential of Farm to School that has been demonstrated by various research and modelling, small- and medium-scale farmers still struggle to overcome systemic budgetary and logistical challenges in order to access Farm to School market channels. As a result, the revenue from Farm to School market channels does not yet reflect the market potential, with results varying from farmer to farmer and school to school. While participation varies, Farm to School sales are typically one of many market channels pursued by diversified farms—representing a small but increasing percentage of their overall sales. A 2012 survey of over 100 farmers, ranchers, orchardists and other farmers in the Upper Midwest indicated that 35 percent of respondents had experience selling their products to schools, and a majority of this group "reported that

prices received from their K-12 buyers are 'about the same' as prices received from other wholesale accounts for comparable product. Ninety-five percent indicated that they felt they received a fair price from their school buyers."[66] Comparing Farm to School to other markets, the same 2011-2012 survey does indicate that 66 percent of growers surveyed felt that the prices received from K-12 schools were "about the same" as the prices they received from other wholesale or institutional accounts for comparable products. Only 18 percent of growers surveyed reported that the prices they received from K-12 schools were "somewhat lower" than other wholesale or institutional accounts; a further eight percent said that prices from schools were "significantly lower." [74] It should be noted that these responses were for all Farm to School sales, not specifically season-extended produce.

As the primary benefit of high tunnel production is increasing income for farmers by extending their access to markets, the price of season-extended produce is often beyond the limited budgets of many schools. Research from a farmers market survey that spanned Utah, Nevada and Idaho demonstrated that, while the price of season-extended fruits and vegetables varies from crop to crop and season to season, the overall price of fruits and vegetables produced in high tunnels is notably higher than field crops. Notably, tomatoes and cucumbers—two of the most popular Farm to School purchased in the Upper Midwest[71]—are characterized by a significant early season advantage, with prices nearly double in early months ($6.50 per pound for tomatoes and $2.00 each for cucumbers) compared to the height of the growing season ($3.00 per pound for tomatoes and $1.00 each for cucumbers).[72] The higher price of high tunnel fruits and vegetables at farmers markets is driven by the willingness of customers to pay a premium for the product, as is demonstrated by a farmers market survey conducted in Michigan. This survey showed that, of the market shoppers that were surveyed, 49 percent would be willing to pay up to a $3.00 premium for locally produced foods—including early- and late-season crops. An additional 19 percent were willing to pay up to a $3.50 premium. For local crops produced specifically in high tunnels, the same survey respondents indicated that they were most likely to buy tomatoes (85 percent), lettuce and spinach (70 percent each).[73] This consumer preference and willingness to pay a premium for season-extended produce was confirmed in interviews with multiple farmers in the Upper Midwest, resulting in many prioritizing this market for their high tunnel produce.

The total amount of product sold to schools can vary from farm to farm. A study of seven farmers engaged in Farm to School practices in the Upper Midwest and the Northeast—ranging in size from 50 to 1200 acres—found that sales to schools ranged from less than one percent to approximately four percent of their total profits. However, the same farmers indicated that they remain committed to Farm to School, despite current low percentage of their sales, for other motivations—namely, extending market diversification and generating social benefits.[67] Market diversification—either through low-level income provided by school sales in shoulder (i.e. early- or late-season) months or accessing a market for fruit and vegetable "seconds" (i.e. out-size or second-class products)—is of critical importance for small- to medium-scale farms to spread their risk through multiple income streams. Further, Farm to School sales can also provide farmers with reliable and predictable sales when such relationships are effectively arranged. This predetermination of quantity and price for products is particularly important for beginning farmers.

Perhaps more importantly, farmers participating in Farm to School often cite the social benefit that they believe the practice provides. The 2012 Institute for Agriculture and Trade Policy survey of 101 farmers in the Upper Midwest on to topic of Farm to School indicated that the top three reasons for their participation were: "educate children about the food system and where food comes from;" "increase access to healthy, locally grown food;" and "build relationships within my community."[70] Thus, the financial benefits of Farm to School can be and often are outweighed by other benefits of the practice.

While the price of fruits and vegetables from high tunnel production could be anticipated to drop considerably during the primary growing season—when market advantage has been lost due to supply increases—the demand from the K-12 market also drops dramatically due to the summer holiday. A 2011-2012 survey of 101 Minnesota, Wisconsin, Iowa, North Dakota and South Dakota growers on Farm to School sales indicated that that most challenging aspect of selling produce to schools was that the seasonality of farm produce doesn't fit schools' ordering schedules. This challenge was followed in priority by the challenge of farms guaranteeing specific quantities of product on specific dates. These challenges would appear to be partially addressed by high tunnel production.

## Producer Profile: Snug Haven Farm

Snug Haven Farm is a family-owned and operated farm located in south-central Wisconsin. The farm operates a total of two acres, primarily producing cut flowers and annual vegetables. The farm markets its produce via farmers market, restaurant and CSA sales. The farm utilizes 13 high tunnels, 30-by-95 foot each, primarily producing "frost sweetened spinach" for winter markets between November to May. The tunnels produce between 10,000 to 12,000 pounds of spinach each year, sold at premium quality prices ($10 to $11 per pound).

For the past 10 years, the farm has operated a Customer Assistance Fund (CAF). The fund provides reduced rate spinach to the Dane County Research, Education, Action and Policy on Food Group (REAP" "Farm to School Snack Program" and other families in need. The REAP "Farm to School Snack Program" purchases Wisconsin-grown produce and prepares in-classroom snacks for students in 13 Madison elementary schools participating in the USDA Fresh Fruit and Vegetable Program. Snug Haven Farm provides spinach to REAP at $7.50 per pound, with the cost subsidize by their winter spinach CSA. CSA subscribers are given the option to pay an additional $3.00 per pound. for the total cost of the very popular one-, two- or three-pound spinach shares to fund the REAP program. The farm also gives subscribers the option to make additional donations to the program. The Fund and its funding via CSA prices are promoted on the farm's website.

The REAP program often provides volunteer labor to the farm to harvest the spinach purchased for the program, reducing the overall cost to the farm. This is usually timed during the spring transition (April/May) in the high tunnels, when the winter spinach must be cleared for tomato planting. The farm has been committed to supporting farm to school and social initiatives since its inception, including supplying cherry tomato seedlings for schools over the years. Through the success of their CSA model, the farm is able to participate in the less lucrative, yet socially rewarding, Farm to School market.

Source: Phone interview with Bill Warner, Co-0perator and http://www.snughavenfarm.com/about/

When K-12 schools do have the resources to purchase season-extended produce, their required volume and consistency may not attract producer interest in comparison to that of other institutions or retailers. Thus, there can be a fundamental mismatch between maximizing the profitability of high tunnel production and selling to schools, particularly when other high-margin markets (e.g. season-extended farmers markets, CSAs, restaurants, etc.) are available. While high tunnel farmers do participate in Farm to School markets, they tend to do so to a limited or subsidized degree. Schools are more likely to expand their purchasing of field-grown produce during the primary production months before allocating funds for higher cost, season-extended produce.

While Farm to School sales may be initially low-income, many farmers also see them as low-effort and worth building over time.[68] Further, it should be noted that the Farm to School market is an emerging market channel that has been exponentially growing in both breadth and depth over the past two decades, consistently reducing systemic limitations. As the market channel evolves, it is likely to drive investments and efficiencies that will overcome budgetary, logistic and infrastructure/labor constraints. This is evident not only in the number of schools participating in Farm to School, but also in the $385.7 million that these schools spent on local food in the 2011-2012 school year[69]—sales that encouraged school district investment equipment and staff, as well as dollars that stimulated local farms and the associated businesses that support them. It is likely that, over time, Farm to School will become an increasingly viable market channel for farmers to include in their overall farm enterprise planning.

## Integrating High Tunnel Production and Farm to School

While the relationship between high tunnel production and Farm to School markets may face challenges, there are examples of how the two practices can be integrated successfully and demonstrate the beneficial relationship. The Farm to School Grant Program, administered by the USDA's Food and Nutrition Service (FNS), has funded two projects that integrated high tunnels and school gardens in order to simultaneously produce season-extended fruits and vegetables while also providing student education. The projects—the first awarded to the Bayfield Regional Food Farmers Cooperative in northern Wisconsin and the second to Detroit Public Schools—both feature school districts engaging with area farmers to improve the capacity to provide season-extended produce. The Detroit project, to begin in FY 2015, focuses on high tunnel trainings that are, according to the FNS website, "designed to grow and distribute more local products to all 90 schools and create a model for other urban areas."[77] As the project unfolds, it will certainly expand the understanding of how high tunnels can support Farm to School.

In an effort to grow the Farm to School programs in the Chequamegon Bay region, located in northern Wisconsin, the Bayfield Regional Food Farmers Co-operative (FPC) applied for and was awarded a USDA Farm to School grant program in December 2013. The region has a significantly limited growing season, with the first frost typically happening in early September and the last frost typically happening in mid-May. The grant program, entitled "Meeting the Challenge of Winter: Using High Tunnels to Expand Farm-to-School in Northern Wisconsin," focuses on three components: increasing the supply of locally produced fruits and vegetables for the region's school districts; educating students about Farm to School and high tunnel production; and improving overall community access to locally produced fruits and vegetables.

The Chequamegon project's fiscal sponsor is FPC and the project is coordinated by University of Wisconsin Extension. Americorps also provides project support through their staff placed within individual school districts, as well as their regional coordinator. The project does currently rely on the

voluntary interest and participation of teachers and students within the school districts. To reduce this burden on teaching staff, the project focuses on deeper community engagement and participation. The $76,000 grant has been primarily used to install 25-by-48-foot high tunnels at the five school districts in the region—South Shore, Drummond, Washburn, Bayfield and Ashland—integrating the tunnels with existing STEM (science, technology, engineering and mathematics) curriculum and school gardening programs.

Chequamegon Bay School high tunnel frame

High tunnel at Chequamegon Bay School

A local producer, Todd Rothe of River Road Farm, was hired to construct the tunnels, which were all completed by October 2014. The tunnels have been laid out to optimize student education, rather than production. Another producer, Kelsey Rothe of River Road Farm, was hired to provide technical consulting services for the operation (i.e. management and maintenance) of the high tunnels, including working with University of Wisconsin Extension educator Jason Fischbach and Americorps staff to develop integrated curriculum. The five high tunnels collectively focus on growing the same crops in a given growing season, as this allows for a more focused curriculum and ensures higher quantities of food for the Farm to School programs. Though it varies from school to school due to existing food distributor contracts and facilities, the foodservice staff for each school district have committed to purchasing and using as much high tunnel produce as is possible.

The Chequamegon program is also working with 4H and Youth Development Agents, Ian Meeker and Doug Liphart, to also develop an "agripreneur" training program who will provide specialized training for older students in the districts that are interested in pursuing horticulture and/or agriculture careers using high tunnels. With the opportunity to sell extra produce at farmers markets, these training programs are intended to show students the financial benefits of high tunnel production and encourage them to be advocates for such practices in the wider community. Further, according to the project's website: "another component of the grant will have the current Farm-to-School Community Outreach Coordinator, Magdalen Dale, and the UW-extension Nutrition Education Program Coordinator, Kathy Beeksma, working with a group of community members to create and promote a menu of meals and snacks that are healthy, tasty, easy-to-prepare, culturally significant, and made with locally sourced ingredients."[78] This menu will be rolled out throughout the community, with the participation of restaurants and grocery stores to ensure that featured recipes and ingredients are widely available to community members.

Chequamegon Bay students working in a high tunnel

Operated by the Michigan Farmers Market Association (MIFMA), the Hoophouses for Health program is a national leader in providing innovative support for high tunnel implementation within the context of food access, food security and farm to institution. The program is funded by the W.K. Kellogg Foundation, is administered by MIFMA and the Michigan State University (MSU) Center for Regional Food Systems, and technical support provided by the MSU Student Organic Farm. The privately funded program offers

zero-interest loans up to $15,000 for high tunnel construction to farmers who are vendors at select farmers markets. Participating farmers can repay these five-year loans by distributing eligible foods to low-income individuals via a farmers market voucher system or via farm to institution. The program works with low-income communities that have well-established farmers markets accepting funds from food benefits programs (e.g. SNAP, WIC, FMNP, etc.). These are located in close proximity to an existing Head Start program and established community engagement organizations. Currently, the program has engaged 15 farmers markets, providing high tunnel loans for 31 farmers.[75]

Once engaged in the program, farmers have the option to repay their high tunnel loan via farmers market "sales," farm to institution "sales," or a hybrid between the two (with up to 50 percent of the loan eligible to be repaid via farm to institution). For farmers markets repayment, the program issues serialized vouchers to low-income families via Head Start agencies. Families can use the vouchers to purchase from participating farmers at approved farmers markets. According to the program website, "Farmers can exchange vouchers for any food product or food-producing plant produced on their farm and presented for sale at the farmers market. Products do not have to come from the high tunnel supported by the Hoophouses for Health."[76] Value-added products can only be purchased with a voucher if the majority of the ingredients (50 percent by weight) were produced on their farm. Vouchers cannot be used to purchase non-food items such as cut flowers, or items to be re-sold by the loan recipient that were not grown or produced on the recipient's farm. Once used, farmers submit vouchers to MIFMA, and the total value is deducted from their high tunnel loan. This program not only creates an opportunity for farmers to install high tunnels and provide fresh food to those who need it most; it also encourages low-income communities to patronize farmers markets.

For farm to institution repayment, participating farmers work with MIFMA and the Michigan Farm to School Network to identify a "match" with an institution (e.g. K-12, preschool or early childcare—home and center) where at least 50 percent of the children attending qualify for free or reduced meals under USDA programs. Once matched, the farmer and the institution arrange logistics and deliveries of food are provided to the institution for free. The farmer provides the institution an itemized invoice for the value of the food, but no payment is required. A copy of the invoice is submitted to MIFMA by the farmer and—similar to the farmers market vouchers—the value of the food provided is deducted from the farmer's high tunnel loan (up to 50 percent of the total). This repayment option is designed to be complementary to the farmers market voucher program and is intended to maximize access to fresh food for children of low-income families.

Further, farm to institution repayments are also intended to build relationships between farmers and institutional buyers by creating low-risk arrangements that financially benefit both parties. Once a high tunnel loan is repaid, the program anticipates that a farm to institution relationship established through the program will continue in a modified form, as an existing business relationship exists. Success in this process could also lead individual farmers to expand their farm to institution sales to other schools, preschools and childcare providers; equally, a successful process encourages institutions to work with other farmers to increase their farm to institution offerings. MIFMA chooses the loan beneficiaries and monitors voucher redemption on a monthly basis to ensure the program goals are being met. Farmers are also required to keep records of crop production inside of their hoop houses, including crop selection, schedule, yields, revenue, and resource inputs including labor and applicable expenses. These records are submitted to MIFMA monthly for the life of the loan.

The Hoophouses for Health Program was designed to work alongside the NRCS EQIP Seasonal High Tunnel Initiative, with farmers eligible to finance high tunnels through both programs concurrently. However, the financing structures are not compatible, and repayments for the two programs must remain distinct. The Hoophouses for Health Program was designed to minimize the number of steps and loan approval wait-time required for a producer to participate. According to program staff, farmers approved for a high tunnel loan are provided their full loan amount within 30 days of approval—allowing for quick turnaround for construction and operation. The program also provides comprehensive technical support through MSU, which helps farmers that are new to using high tunnels to maximize their productivity.

High tunnels are also producing food at schools through integration with agriculture education programs. The Holdingford Public School district is located in central Minnesota, 1.5 hours northwest of Minneapolis. The high school features a well-developed garden, including a 26-by-32-foot high tunnel that has been in place since 2012. The high tunnel was constructed via a $3,600 Minnesota Agricultural Education Leadership Council grant, as well as financial and material support from local businesses. The funding process and the construction of the high tunnel was overseen by the high school's agriculture teacher, John Roberts. Construction was completed by the school's agriculture building class.

Now in its second growing season, the Holdingford high tunnel is used by students in Robert's horticulture classes beginning in January/February and continue production until September, when the school's irrigation is closed for the winter. Students grow a variety of crops, including romaine lettuce, tomato, pepper, onion, spinach, bok choi, zucchini, cucumber and more. All produce is used by the high school food service throughout the growing season, even in the summer when school is not in session. Interested high school students tend the high tunnel during the summer months, coordinating their harvests with Melissa Anderson, the school's Food Service Director. Anderson and her staff process and preserve the summer harvest for use in the autumn (e.g. grating and freezing zucchini for zucchini muffins). Holdingford Public School District has been highly active in pursuing Farm to School funding over the past years, including upgrades to their kitchen facilities through funding by the Minnesota Department of Agriculture and private foundations. Summer produce that cannot be utilized by the kitchen is available for sale at the farmers market by the students managing the high tunnel during the summer, creating an incentive for their participation and ongoing interest in horticulture and agriculture. Students can also earn FFA credits for helping with high tunnel operation over the summer.

## Conclusions & Recommendations

The use of high tunnels is an important and increasingly popular season extension tool for small- and medium-scale farmers in the Upper Midwest. High tunnels allow for a greater level of control in growing conditions, which—with the proper planning and management—can extend their growing season by weeks or months. With the proper access to and analysis of markets for season-extended produce, high tunnels can provide extended income for farms outside of the traditional growing season. As small- and medium-farm incomes increase through the use of high tunnels, there is a potential for the productivity and success of individual farms. As a result, the economic activity of the associated local and regional food markets are likely to become more robust and diverse. While financing and technical integration pose challenges to the increased uptake of high tunnels in the region, existing programs are making inroads into greater on-farm support and establishing innovative approaches for linking high tunnel production to markets that service vulnerable communities. In encouraging further uptake of the use of high tunnels overall, there are opportunities to further support, integrate and expand models for technical and financial assistance:

- **Continuation of an Improved EQIP Seasonal High Tunnel Initiative**
  The current level of funding for high tunnel implementation through EQIP is a critical support for farmers, particularly beginning, low-income and historically underserved farmers, and should be maintained or increased. With mandatory funding for EQIP increasing from $1.35 million in FY2014 to $1.75 million in FY2018 under the 2014 Farm Bill,[79] financial resources are available for increased, broad-scale promotion and support for high tunnels. This process should ensure sufficient support for the individual State Technical Boards that are responsible for overseeing EQIP program criteria and fund allocation in each state. Through conversations with farmers who have gone through the process, opportunities for improving the accessibility and impact of the program have been identified:

- **Establish Special Seasonal High Tunnel Initiatives in Upper Midwest States**
  Federal EQIP dollars are allocated to states' general funds and, once in place, can be further allocated by the states to initiatives based on state conservation priorities. EQIP funds coming out of a state's general fund do not roll over from one year to another unless allocated to special initiatives. Thus, while funding under the Seasonal High Tunnel Initiative is available to all farmers in all states, the level of promotion as a priority initiative and the subsequent funding available varies on state-by-state basis.

  The general consensus among EQIP experts is that high tunnel demand currently exceeds allocated resources. Thus, the participation trends for the Seasonal High Tunnel Initiative are predominantly influenced by available funds in each state rather than producer interest. Given this demand and the benefit that season extension offers farmers and local food markets in the Upper Midwest, special initiatives for high tunnel promotion, funding and ongoing technical support should be established in each Upper Midwestern state. This should be based on engagement with and promotion to farmers to establish a firm understanding of potential demand. The result of such consistency would be an increase in total high tunnel applications that more accurately reflects the high tunnel potential for each state.

- **Provide Higher Level of Pre-Application Technical Advice and Planning**
  Criteria for applying for and receiving funding for a high tunnel under the Season High Tunnel Initiative are designed to be achievable for

many farmers, particularly with the formal and informal support of local NRCS offices and staff. However, there is limited capacity to consistently work with farmers during the pre-application period to determine if their business is ready for the integration of high tunnel and, if so, how they should plan to maximize the benefit of this technology and practice. Specifically, this should include a farm operation assessment that reflects the most appropriate high tunnel to meet the needs of a particular farm. Such pre-application technical and business planning advice would likely result in slightly fewer yet higher-quality high tunnel applications. This would minimize the risk of poorly planned applications being approved and technically inappropriate high tunnels failing to operate successfully or efficiently, particularly for beginning, low income or historically underserved farms.

- **Increase Individual Tunnel Funding for Upper Midwest Applications**
  While the current Seasonal High Tunnel Initiative covers up to 75 percent of high tunnel costs (up to 90 percent for beginning, low-income and historically underserved farmers), there is general consensus that the cost of a high tunnel that is well-suited for the Upper Midwest exceeds the state-by-state EQIP funding thresholds. Given the typical weather conditions for the region (e.g. high winds, heavy rain, hail, heavy snowfall/snow load, etc.), high tunnels in the Upper Midwest must be constructed with a high level of structural integrity to endure the conditions of extended production (i.e. thicker hoop gauge, closer hoop spacing, double plastic covering with inflation, tunnel end bracing, etc.)

  However, at this point, the Initiative clearly notes that high tunnels are intended to be "seasonal" structures—with farmers responsible to the decision to remove the plastic covering. Under the expectation that the plastic will be removed and reinstalled each season—an activity that is not likely to occur—the Initiative justifies a lower cost-share threshold and externalizes the remaining cost of a well-suited high tunnel to the producer. Seeking to minimize their out-of-pocket costs, farmers may construct tunnels that are of lower quality and/or poorly suited for their growing conditions. While an increasing number of high tunnel manufacturers are developing basic high tunnel kits that are suited to the EQIP program, there is still financial incentive to build a high tunnel based on financial considerations, rather than operational considerations. Thus, the NRCS should support the state technical committees in Upper Midwestern states to conduct a longitudinal high tunnel study on the viability of high tunnels in order the determine the sufficient level of construction and, subsequently, funding for the region. In doing so, local NRCS offices would be given the opportunity to continue engagement with farmers with funded high tunnels and develop a clear understanding of the high tunnel practices that should be sufficiently funded in order to ensure maximum impact.

- **Ongoing Technical Support for High Tunnel Farmers**
  The nature of high tunnel operation requires specialized training and support to maximize benefit during the early stages of implementation. While there are numerous avenues for technical support through extension educators and nonprofit organizations, the responsibility for achieving a level of technical high tunnel expertise is primarily the responsibility of the producer. This is due in part to the NRCS being a conservation-oriented agency and playing a predominantly funder role through the Seasonal High Tunnel Initiative. While high tunnels do provide numerous farm-based conservation benefits and work well in tandem with other conservation programs supported by the NRCS, they are predominantly sought by farmers as a means of increasing overall farm productivity. Thus, there is often limited expertise with high tunnel operation within the NRCS, with the ability to provide technical expertise varying from one local office to another.

  Given the level of investment through the EQIP program and the established frameworks for offering technical assistance through the NRCS for other on-farm practices, it is a natural fit for the Seasonal High Tunnel Initiative to not only provide technical assistance during the pre-application phase, but also during the construction and operation of a high tunnel. The general consensus among high tunnel experts is that technical assistance is as important—if not more important than—financial assistance. Additional technical assistance integrated into the Seasonal High Tunnel Initiative would be particularly

beneficial for beginning farmers and farmers with limited exposure to high tunnel operation. The result would be a more comprehensive program that works in congruence with other venues for technical support to provide farmers with consistent information and hands-on support.

- **Support High Tunnel Programs Outside of EQIP**
  Recognizing that a diversity of funding and technical assistance programs will support a broader range of farmers suited for and interested in high tunnel production, states in the Upper Midwest should explore options for supporting high tunnel programs outside of, yet working in harmony with, the Seasonal High Tunnel Initiative. Established models from other states—namely, Michigan's Hoophouses for Health program—should be studied for implementation as pilot projects within the Upper Midwest.

Due to the higher margins that season extension demands in certain market sales (e.g. farmers markets, restaurants, co-operative groceries, etc.), a viable financial relationship between high tunnel production and Farm to School practices without subsidy is difficult to establish and maintain. This is particularly true for small- to medium-scale specialty crop farmers. However, there is potential for this to change as both practices become increasingly common. Increased numbers of high tunnels in the Upper Midwest will certainly stimulate local and regional food markets, directly or indirectly benefiting Farm to School programs. Further, as Farm to School programs become more established and validated by longitudinal research, financial support for the procurement of local and regional food is also likely to increase. There are specific steps that could be taken to encourage this alignment more quickly and sufficiently:

- **Increasing School Meal Reimbursement Rates for Purchasing Local Foods:**
  Perhaps the most straightforward method for stimulating the relationship between high tunnel farmers and Farm to School initiatives is for states in the Upper Midwest to increase their per-meal reimbursement rate to schools purchasing and utilizing local or regional foods. Such reimbursements make schools a more competitive market for season-extended produce while simultaneously injecting dollars into local food economies, resulting in an economic multiplier effect. As previously addressed, there are multiple states that have increased their per-meal reimbursement rates to schools purchasing local and regional foods, establishing viable models for Upper Midwest states to emulate.

- **Promoting the Use of High Tunnels in School Gardens for Education and Production**
  The presence of high tunnels in school gardens creates an opportunity to increase student education on season extension and, if operated successfully, to increase the garden productivity for the benefit of associated Farm to School programs. This also presents an opportunity for schools and local farmers to work together for mutual benefit. While limited in their financial capacities, schools are often able to provide in-kind access to productive land on school grounds and funding sources that are unique to schools (e.g. Farm to School grants, etc.). Through these capacities, schools can create incentives for nearby farmers to operate school garden high tunnels—selling produce directly to schools while providing the garden expertise that is often difficult for schools to maintain.

- **Encouraging Freezing and Preserving of Local Foods by Schools During Summer**
  Beyond financial limitations, the alignment of the school year (i.e. the period of food procurement) and the agricultural production season of the Upper Midwest present a barrier for Farm to School programs. This results in schools missing opportunities to purchase local and regional foods during a time where their production is high and their market price is low. By encouraging financial and technical assistance for schools and/or school districts to implement or increase the infrastructure and staffing for freezing and preserving local and regional foods over the summer, states can help Farm to School programs capture high-quality foods at affordable prices. The success of this practice varies from crop to crop and school to school. However, in a 2012 report entitled "Frozen Local: Strategies for Freezing Locally Grown Produce for the K-12 Marketplace," IATP staff found that "a majority of the school food staff interviewed reported that the finished cost of various local foods they had frozen on-site was within their budget for occasional use."[80] As examples such as Holdingford Public Schools demonstrate, such freezing and preserving are great opportunities to provide students with local and regional foods while also providing additional summer employment for food-service staff.

- **Providing Increased Support for the Use of Local Foods in the USDA's Summer Food Service Program**
  Established in 1968 as an amendment to the National School Lunch Act, the USDA's Summer Food Service Program (SFSP), also known as "Summer Food Rocks," provides low-income children (e.g. 18 years and under) nutritious meals during the summer months when

school is not in session. Given the lower cost of local and regional foods during the summer months, SFSP programs could benefit from increased support for this type of procurement. This support would include financial and logistical resources.

## Endnotes


1. Minnesota Department of Natural Resources, "Final Spring/First Fall Freeze & Frost Date Probabilities," http://www.dnr.state.mn.us/climate/summaries_and_publications/freeze_date.html (accessed September 3, 2014).

2. National Sustainable Agriculture Information Service, "Season Extension Techniques for Market Gardeners," https://attra.ncat.org/attra-pub/summaries/summary.php?pub=366 (accessed September 3, 2014).

3. Jett, Lewis, High Tunnel Crop Production Tips, (Morgantown: West Virginia University), 3.

4. Four Season Tools, "Season Extension," http://www.smallfarmtools.com/pages/season-extension (accessed July 17, 2014).

5. Iowa State University Extension, Vegetable Production Budgets for a Hugh Tunnel (Ames: University of Iowa Extension, 2012), 8.

6. Keith Prince, Interview by Jessie Goff, Phone Interview, April 20, 2013.

7. Lynn Byczynski, The Hoophouse Handbook (Lawrence: Fairplains Publications Inc, 2006), 20.

8. Craig Chase, "Selected Alternative Agricultural Financial Benchmarks," Ag Decision Maker, November 2012. http://www.extension.iastate.edu/agdm/wholefarm/pdf/c3-65.pdf (accessed September 3, 2014).

9. Kurt Waldman, et al., "Hoophouse Farming Startup: Economics, Efforts and Experiences from 12 Novice Hoophouse Farmers," Michigan State University Extension Bulletin, no 3138 (December 2010): 6.

10. University of Michigan Hoophouse Farming Startup (2010).

11. Adam Montri, Interviewed by Pete Huff, Phone Interview, November 17, 2014.

12. Keith Prince, Interview by Jessie Goff, Phone Interview, April 20, 2013.

13. Y. Medina, et al., "Effects of Plastic Mulches on Microclimate Conditions, Growth and Yields of Strawberry Plants Grown Under High Tunnels in Northern Canadian Climate" Acta Horticulturae, no.842 (2009): 139-142.

14. Terrance T. Nennich, "Introduction to High Tunnel Production in Minnesota," Minnesota High Tunnel Production Manual for Commercial Growers, 2012, http://hightunnels.cfans.umn.edu/files/2012/11/2-Intro-to-HT.pdf (accessed September 3, 2014).

15. UK Co-operative Extension Service, High Tunnel Tomatoes (Lexington: University of Kentucky College of Agriculture, 2012), 4.

16. University of Illinois Extension, Production and Economics of High Tunnel Vegetables and Strawberries (Urbana-Champaign: University of Illinois Extension, 2014), 2.

17. Ted Blomgren and Tracey Frisch, "High Tunnels: Using Low-Cost Technology to Increase Yields, Improve Quality and Extend the Season," University of Vermont Center for Sustainable Agriculture, May 2007, http://www.uvm.edu/~susagctr/resources/HighTunnels.pdf (Accessed September 3, 2014).

18. David S. Conner, Adam D. Montri, Dru N. Montri and Michael W. Hamm, "Consumer demand for local produce at extended season farmers' markets: guiding farmer marketing strategies," Renewable Agriculture and Food Systems 24, no. 4, (September 18, 2009): 251-259.

19. Phillip Roy Sanders, "Evaluation of High Tunnel Production Systems as a Means of Enhancing Market Opportunities for Alabama Growers" (Masters of Science thesis, Auburn University, 2006), 57.

20. Karen Gjelhaug and Veronica Justen, "Season Extension of Vegetable Production Using High Tunnels" (poster presented at 2014 MOSES Conference, La Crosse, WI, February 26, 2014).

21. Doug Waterer, "Yields and Economics of High Tunnels for Production of Warm-season Vegetable Crops," HortTechnology 13 (April-June 2003): 339-343.

22. Kathleen Demchak, "Small Fruit Production in High Tunnels," HortTechnology 19 (March 2009): 44-49.

23. Sorkel Kadir, Edward Carey, and Said Ennahli, "Influence of High Tunnel and Field Conditions on Strawberry Growth and Development," HortTechnology 41 (2006): 329-335.

24. Eric Belasco, Suzette Galinato, Tom Marsh, Carol Miles, and Russell Wallace, "High Tunnels Are My Crop Insurance: An Assessment of Risk Management Tools for Small-scale Specialty Crop Producers," Agricultural and Resource Economics Review 42, no. 2 (August 2013): 14.

25. Craig Chase and Linda Naeve, "Vegetable Production Budgets for a High Tunnel," Ag Decision Maker, January 2013. http://www.extension.iastate.edu/agdm/crops/pdf/a1-23.pdf (accessed September 3).

26. Biernbaum, John, Water, Soil and Fertility Management in Organic High Tunnels (East Lansing: Michigan State University, 2013), 10.

27. University of Minnesota, "Soil Fertility: Fertility Management," http://hightunnels.cfans.umn.edu/management/soil-fertility/ (accessed September 4, 2014).

28. David Wildung and Pat Johnson, Managing Risk: Production Comparisons Between High Tunnels and the Field, (University of Minnesota, 2012), 12.

29. National Sustainable Agriculture Coalition, "Seasonal High Tunnels Support Conservation and New Farmers," National Sustainable Agriculture Coalition Blog, http://sustainableagriculture.net/blog/high-tunnel-update/ (accessed September 3, 2014).

30. Oregon Natural Resources Conservation Service, "Opportunities for Historically Underserved Clients," United States Department of Agriculture, http://www.nrcs.usda.gov/wps/portal/nrcs/detail/or/home/?cid=nrcs142p2_044199 (accessed September 3, 2014).

31.

32. National Sustainable Agriculture Coalition, "Seasonal High Tunnels Support Conservation and New Farmers," National Sustainable Agriculture Coalition Blog, http://sustainableagriculture.net/blog/high-tunnel-update/ (accessed September 3, 2014).

33. Southeast Michigan Resource Conservation and Development Council, "City of Detroit - Wayne Co. Seasonal High Tunnel Educational Initiative," Southeast Michigan Resource Conservation and Development Council, http://semircd.org/index.php/projects/hightunnels (accessed September 3, 2014).

34. Ohio Natural Resources Conservation Service, "Cleveland High Tunnel Initiative," United States Department of Agriculture website, http://www.nrcs.usda.gov/wps/portal/nrcs/detail/oh/programs/?cid=nrcs144p2_029508, (accessed September 3, 2014).

35. Agricultural Marketing Service , "Specialty Crop Block Grant Program Awards," United States Department of Agriculture website, http://www.ams.usda.gov/AMSv1.0/ams.fetchTemplateData.do?template=TemplateN&navID=GrantAwards&rightNav1=GrantAwards&topNav=&leftNav=&page=SCBGPNewsReleases&resultType=&acct=fvgrntprg (accessed September 3, 2014).

36. NY Farm Viability Institute, "About NYFVI," NY Farm Viability Institute website, http://www.nyfvi.org/default.aspx?PageID=2250 (accessed September 3, 2014).

37. H. Chris Wien, "Fostering Use of High Tunnels for Season Extension in NY," NY Farm Viability Institute website, http://www.nyfvi.org/default.aspx?PageID=2413&ProjectID=64&Contact=&Organization=&Keyword=high%20tunnel&Status=&Sort=Start+Date (accessed September 3, 2014).

38. Shade Fund, "Frequently Asked Questions," ShadeFund website, http://www.shadefund.org/about-shadefund/faq.htm (accessed September 3, 2014.).

39. Willy Street Co-Op, "Willy Street Co-op Loan Fund Borrowers Honored at FEED Kitchens," Willy Street Co-Op Website, http://www.willystreet.coop/willy-street-co-op-loan-fund-borrowers-honored-feed-kitchens (accessed September 3, 2014).

40. Iowa State University Extension, Vegetable Production Budgets for a Hugh Tunnel (Ames: University of Iowa Extension, 2012), 8.

41. Iowa State University Extension, Iowa High Tunnel Fruit and Vegetable Production Manual (Ames: Leopold Center for Sustainable Agriculture, 2010), 94.

42. University Of Minnesota Extension, Minnesota High Tunnel Production Manual for Commercial Growers (Minneapolis: University of Minnesota Extension, 2012), 164.

43. William J. Lamont, Jr., "Overview of the Use of High Tunnels Worldwide,"HortTechnology 19, no. 1 (January-March 2009): 26.

44. Ibid.

45. Edward E. Carey, et al., "Horticultural Crop Production in High Tunnels in the United States: A Snapshot," HortTechnology 19, no. 1 (January-March 2009): 2-3.

46. United States Department of Agriculture, 2007 Census of Agriculture: United States Summary and State Data, Volume 1, Part 51 (Washington, DC, 2009): 60.

47. United States Department of Agriculture, 2014 Census of Agriculture: United States Summary and State Data, Volume 1, Part 51 (Washington, DC, 2014): 61.

48. Terry Nennich, Interviewed by Tara Ritter, Phone Interview, April 14, 2014.

49. Betty T. Izumi, D. Wynne Wright and Michael W. Hamm, "Market diversification and social benefits: motivations of farmers participating in Farm to School programs," Journal of Rural Studies 26, no. 4 (October 2010): 375.

50. National Farm to School Network, "About The National Farm to School Network," National Farm to School Network website. http://www.farmtoschool.org/about (accessed September 6, 2014).

51. National Farm to School Network, "About Farm to School," National Farm to School website, http://www.farmtoschool.org/about/what-is-farm-to-school (accessed September 3, 2014).

52. Food and Nutrition Service, "The Farm to School Census: State & District," United States Department of Agriculture website, http://www.fns.usda.gov/farmtoschool/census#/map (accessed September 3, 2014).

53. Ibid.

54. Ryan Pesch, "Assessing the Potential Farm-to-Institution Market in Central and Northeast Minnesota," University of Minnesota Extension, July 2014, http://www.extension.umn.edu/community/research/docs/2014-Asessing-the-Potential-Farm-to-Institution-Market.pdf (accessed September 3, 2014).

55. Betty T. Izumi, D. Wynne Wright and Michael W. Hamm, "Market diversification and social benefits: motivations of farmers participating in Farm to School programs," Journal of Rural Studies 26, no. 4 (October 2010): 376.

56. Food Research and Action Center, "National School Lunch Program: 2012-2013 Participation Rates and 2014-15 School Year Federal Reimbursement Rates." Food Research and Action Center. http://frac.org/federal-foodnutrition-programs/national-school-lunch-program/ (accessed September 6, 2014).

57. Food and Nutrition Service, "Food Distribution: Value of Donated Food Notices," United States Department of Agriculture website, July 2014, http://www.fns.usda.gov/fdd/value-donated-foods-notices (accessed September 3, 2014).

58. Betty T. Izumi, D. Wynne Wright and Michael W. Hamm, "Market diversification and social benefits: motivations of farmers participating in Farm to School programs," Journal of Rural Studies 26, no. 4 (October 2010): 376.

59. JoAnne Berkenkamp, "Making the Farm/School Connection: Opportunities and Barriers to Greater Use of Locally-Grown Produce in Public Schools," University of Minnesota Department of Applied Economic, January 2006, http://www.iatp.org/files/258_2_96621.pdf (accessed September 6, 2014): 6-7.

60. School Nutrition Association, "School Meal Trends & Stats," School Nutrtion Association website, http://www.schoolnutrition.org/AboutSchoolMeals/School-MealTrendsStats/ (accessed September 6, 2014).

61. National Farm to School Network and Vermont Law School Center for Agriculture and Food Systems, "State Farm to School Legislative Survey 2002-2013," National Farm to School Network website, April 16, 2014, http://www.farmtoschool.org/Resources/State_Farm_to_School_Legislative_Survey_4_2014.pdf (accessed September 6, 2014): 2.

62. Ecotrust, "Oregon Designates $1.2 Million for Local Food in Schools," Ecotrust blog, July 12, 2013, http://www.ecotrust.org/oregon-designates-million-for-local-food-in-schools/ (accessed September 6, 2014).

63. DC Greens, "The D.C. Healthy Schools Act – Overview of Requirements and Funding for School Meals," http://dcgreens.org/wp-content/uploads/2013/05/School-Meals-Healthy-Schools-Act.pdf (accessed September 6, 2014).

64. Deborah Kane, et al., "The Impact of Seven Cents," Ecotrust, http://www.ecotrust.org/media/7-Cents-Report_FINAL_110630.pdf (accessed September 6, 2014): 27.

65. JoAnne Berkenkamp, "Making the Farm/School Connection: Opportunities and Barriers to Greater Use of Locally-Grown Produce in Public Schools," University of Minnesota Department of Applied Economic, January 2006, http://www.iatp.org/files/258_2_96621.pdf (accessed September 6, 2014): 6-7.

66. JoAnne Berkenkamp, "Grower Perspectives on Farm to School: A Survey of Interested Farmers, Ranchers and Other Producers," Institute for Agriculture and Trade Policy, March 2012, http://www.iatp.org/files/2012_03_16_F2S_Producer-Survey.pdf (accessed September 6, 2014): 3.

67. Betty T. Izumi, D. Wynne Wright and Michael W. Hamm, "Market diversification and social benefits: motivations of farmers participating in Farm to School programs," Journal of Rural Studies 26, no. 4 (October 2010): 378.

68. Jeri L. Ohmart, "Direct marketing to schools – a new opportunity for the family farmer," UC Sustainable Agriculture Research and Education Program, July 2002, http://www.sarep.ucdavis.edu/sfs/dm/cs/dm (accessed September 6, 2014.

69. Food and Nutrition Service, "The Farm to School Census: State & District," United States Department of Agriculture website, http://www.fns.usda.gov/farmtoschool/census#/map (accessed September 3, 2014).

70. JoAnne Berkenkamp, "Grower Perspectives on Farm to School: A Survey of Interested Farmers, Ranchers and Other Producers," Institute for Agriculture and Trade Policy, March 2012, http://www.iatp.org/files/2012_03_16_F2S_Producer-Survey.pdf (accessed September 6, 2014): 6.

71. Ibid., pg 5.

72. Kynda R. Curtis, et al., "Market and Pricing Potential for Extended Season Fresh Produce Sales: An Intermountain West Example," Journal of Food Distribution Research 45, no. 2 (July 2014).

73. David S. Conner, Adam D. Montri, Dru N. Montri and Michael W. Hamm, "Consumer demand for local produce at extended season farmers' markets: guiding farmer marketing strategies," Renewable Agriculture and Food Systems 24, no. 4, (September 18, 2009): 255.

74. JoAnne Berkenkamp, "Grower Perspectives on Farm to School: A Survey of Interested Farmers, Ranchers and Other Producers," Institute for Agriculture and Trade Policy, March 2012, http://www.iatp.org/files/2012_03_16_F2S_Producer-Survey.pdf (accessed September 6, 2014): 5-6.

75. Dru Montri, Interviewed by Pete Huff, Phone Interview, December 2, 2012.

76. Hoophouses for Health, "General Information," Hoophouses for Health website, http://mifma.org/hoophouses-for-health/ (accessed September 6, 2014).

77. Food and Nutrition Services, "USDA Farm to School FY 2015 Grant Awards," United States Department of Agriculture website, 2014, http://www.fns.usda.gov/sites/default/files/f2s/FY_2015_Grant_Award_Summaries.pdf (accessed September 6, 2014).

78. Chequamegon Bay Farm to School, "History of Farm to School in the Chequamegon Bay," Chequamegon Bay Farm to School website, http://chequamegonbay-farmtoschool.weebly.com/ (accessed September 6, 2014).

79. National Sustainable Agriculture Coalition, "Environmental Quality Incentives Program - Helping farmers and ranchers share the costs of addressing natural resource concerns," National Sustainable Agriculture Coalition website, October 2014, http://sustainableagriculture.net/publications/grassrootsguide/conservation-environment/environmental-quality-incentives-program/ (accessed September 6, 2014).

80. JoAnne Berkenkamp, Lynn Mader and Madeline Kastler, "Frozen Local: Strategies for Freezing Locally Grown Produce for the K-12 Marketplace," Institute for Agriculture and Trade Policy, December 2012, http://www.iatp.org/files/2012_12_11_FreezingReport_JB_web.pdf (accessed September 6, 2014).