An Assessment of the Interaction between High Tunnels and Crop Insurance for Specialty Crop Producers

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Abstract:

Protective covers, such as high tunnels, are being used by specialty crop producers to enhance production quality and yields, expand or growing seasons, and protect crops from some extreme elements. While growing in popularity, one barrier to larger utilization includes the uncertainty regarding their practices and benefits. This paper recognizes that high tunnels can be used as a form of risk management and examines the relationship with crop insurance in order to better define optimal risk management strategies.

Keywords: high tunnels, specialty crop insurance, risk management

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Introduction

Agricultural production is an inherently risky venture. In order to help mitigate this risk, the Federal Crop Insurance Corporation (FCIC) was established in 1938 in response to the Great Depression and Dust Bowl. Beginning in 1980, the federal government took steps to expand crop insurance programs to more crops and regions. The expansion of crop insurance was and is thought to be used in order to substitute for disaster aid relief. One very successful tool used to expand crop insurance participation was through the use of subsidized premium rates. While crop insurance had experienced high participation rates with major grains, specialty crops have historically been underrepresented in crop insurance programs. Specialty crop coverage has increased since the 2000 Agricultural Risk Protection Act as the number of specialty crops insured increased by 29% from 1998 to 2003. As with major grains, offerings for specialty crop growers include yield and revenue-based insurance tools. Additionally, Adjusted Gross Revenue (AGR) – Lite allows growers to insure across multiple crops and is based on IRS tax forms.

While crop insurance provides risk mitigation products, the use of high tunnels in production is becoming a more viable option for growing specialty crops as technology moves to lower the fixed costs associated with installing a high tunnel. High tunnels are unheated, plastic-covered structures that provide an intermediate level of environmental protection and control compared to open field conditions and heated greenhouses A recent pilot project

initiated by the USDA NRCS has led to the funding of more than 2,400 seasonal high tunnels in 43 states (USDA, 2011). Protective covers, such as high tunnels, can enhance the quality of fruits and vegetables, offer protection from climatic extremes, extend seasonality to generate significantly more revenue, ease the transition from conventional to organic food production, offer a solution to diminishing farmland availability, help provide a source of diverse locally grown food, and advance economic sustainability for many fruit and vegetable growers. Researchers and growers worldwide using high tunnels and plasticulture have reported improved yields and quality as well as extended early and late season production (Lamont, 2005). However, evidence of the overall economic potential of high tunnels is ambiguous as profitability hinges on labor efficiency, capital investments and financial credit availability (Waterer, 2003). Current studies aim to specify when high tunnels are profitable for small farmers (Conner, 2008).

There are two main ways that high tunnels work to effectively lower profitability risk associated with specialty crop production: (1) the tunnel can block heavy winds or dampen sun-exposure from drought thus mitigating downside yield risk; and (2) since the temperature inside the tunnel is higher than the outside temperature, the grower can plant earlier, leading to an earlier harvest and a premium in price that might offset any downside price risk. For these two reasons the investment in high tunnel production might crowd out crop insurance expenditures. With this in mind, this paper aims to examine the potential relationship between using federal crop insurance and utilizing a high tunnel. The results from this study are intended to aid high tunnel producers in drafting optimal risk management strategies.

Underpinning the question of optimal risk management strategies and the use of federal crop insurance, we also examine the commercial viability of high tunnel usage in a range of settings. In order to conduct this study, we utilize results from experiments on tomatoes, strawberries, and lettuce under high tunnel production in Mount Vernon, WA; Lubbock, TX; and Knoxville, TN. These experiments are funded by a transdisciplinary research and extension project on Biodegradable Mulches for Specialty Crops Produced under Protective Covers (NIFA's SCRI Program #2009-02484) and use split plot data to compare yields, quality, and timing differences between growing with and without a high tunnels. These results are then combined with enterprise crop budgets that are complied for each of the three locations. Then based on the different inputs and budgets, we use Monte Carlo simulation to assess the differences in expected profits using different crop insurance strategies. The distribution of expected profits is then compared to evaluate the substitutability or complementarities between high tunnel production and insurance preferences.

Given the ongoing commitment from the USDA to look into and fund high tunnel production, there are expected to be a plethora of producers who are novice high tunnel users. Given this demographic, this research is important and timely in that it provides strategies for managing risk when high tunnels are used. This research is also likely to incite a discussion regarding the potential influence of crop insurance on specialty crop production and the likely acreage effects caused by subsidized insurance. Further, we look to provide information on the economic viability of high tunnel production, as compared to open field production, as well as the distinct optimal composition of risk management strategies in specialty crop production.

Literature Review

High tunnels are regarded as one of the high efficient low-cost technologies to increase product yields, and improve the product quality and extend the growing season. There are many of advantages that come from using a high tunnel that include earlier time-to-market, reported increased yields, and lower yield variability. However, the cost of building a high tunnel cannot be neglected, especially for the small farmer.

The cost of high tunnel construction varies by the geography location, since local weather conditions can determine the necessary construction. Additionally, local labor markets also have an impact on the cost of constructing a high tunnel. Many studies have collected costs for the local markets to build the high tunnel. Coolong (2010) reported that the cost for a standard size tunnel, including plastic (two layers) and all the materials required for construction can range from $1.50-$2.50 per square foot without labor and freight charges. From the report of University of Kentucky cooperative extension service, the approximate cost of a floating cover is less than a penny per square foot, excluding labor cost. A low tunnel is about $ 0.25 per square foot, with high tunnels costing from $0.75 to $1.30 per square foot, also excluding labor. Plastic mulch and irrigation costs are approximately @0.20 per square foot. In New Mexico the size of 12-ft*40-ft. high tunnel will cost around $ 1 per square foot (Jimenez, Walser and Torres, 2005). For Blomgren and Frisch (2007), the conventional single bay high tunnel will cost about $2 to $3 per square foot and the three-seasonal high tunnel will cost around $0.75 to $1.25 per square foot in Pennsylvania. There are still lots of other different organizations reporting their own high tunnel costs. Such variable costs depend on the

locations and the special structures of the high tunnels. The majority range is around $1-$3 per square foot without labor.

After building the high tunnel, growers then look to find ways to maximize the return on investment by the extending growing seasons and taking advantages of increased quality and quantity of the crops. Several case studies cited in Blomgren and Frisch (2007) mentioned the earlier harvest and the premium in price. Ralph Cramer and Keith, a southern Pennsylvania cut and dried flower farmer, reported that four or more week harvest advantage and superior quality bring a price that is 30 to 40% higher ($4.15 per bunch versus the $2.95 bunch price). Weaver's Orchard in Pennsylvania adopted the high tunnel technology to resistant the frost causing the flowering drop. The structures can advance the ripening of early cherry varieties up to one week and the earliness can raise the price 30 to 40 cents a pound or more.

Many other case studies collected by Blomgren and Frisch (2007) also proved that high tunnels can improve the product quality by against the adverse weather. In Ralph Cramer and Keith's case, the attack of Hurricane Isabelle and other catastrophic wind and rain events did not affect the flower plantings in the high tunnels. For Weaver's Orchard, the lost controlled by the high tunnel is only 2 or 3% of the crop compared with the highest 90% in the uncovered orchard blocks for some years. At the same time, the high tunnel coverage provides insurance that the orchard will provide a consistent supply year after year, which will help to retaining the market. With the help of the high tunnel, the cherry can stay longer in the trees and add extra 20% potential weight. Cedar Meadow farm in Pennsylvania gained extra 70% yield (3,400 boxes) of tomato in the second year after using the high tunnel. In New York, Slack Hollow Farm found that the first cutting of the winter spinach is of the highest quality and the sugar levels

seem to be higher. Customers notice that it is sweeter than outdoor in season. All those cases demonstrate that higher yields, higher quality and a price premium help to pay for the costs of the tunnels.

The high yield and high quality leads to the high return of the high tunnel investment. However, risk factors still remain and include the extreme weather and the outbreak of the insects and diseases inside of the high tunnel that can cause significant loss. Buying a crop insurance policy is a risk management tool available to agricultural producers. It also can be applied and benefits for the high tunnel investors. USDA Risk Management Agency (RMA) provides policies for more than 100 crops. Crop insurance is widely available for the major commodities such as cotton, corn, and wheat. Coverage now is also available in the specialty crop. The definition of the specialty crops given by USDA is "fruits and vegetables, tree nuts, dried fruits, horticulture, and nursery crops (including floriculture)." Specialty crop insurance expanded from 48 crops in 1998 to 54 crops (RMA, 2011) in 2012.

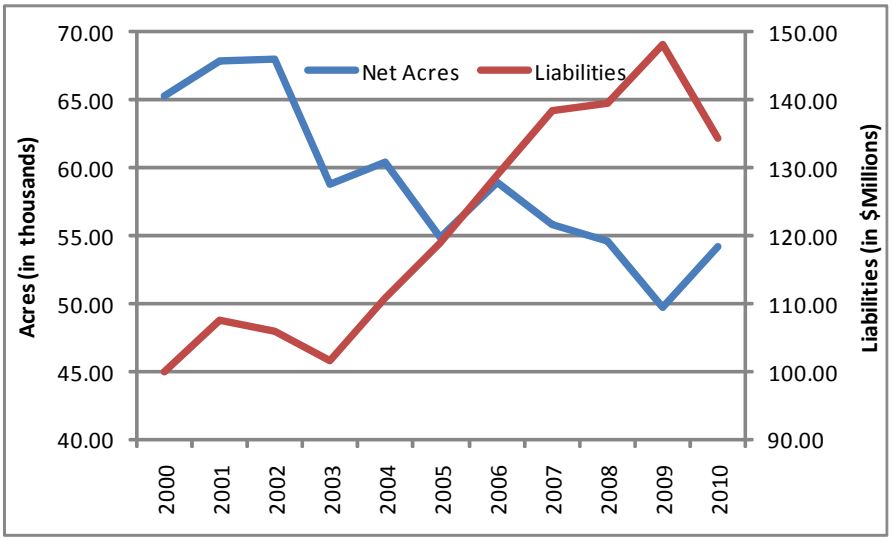
The main insurance policies are Actual Production History (APH), Fixed Dollar Plan (DOL), Catastrophic (CAT), Average Revenue History (ARH) and Adusted Gross Income-Lite (AGR-Lite). As of 2011, lettuce is not currently insurable through federal crop insurance programs, while strawberry is on the pilot list under APH and tomato is on the insurable list under APH and DOL. APH is the policies insure producers against weather-related yield losses such as drought, excessive moisture, hail, wind, frost, insects, disease, and certain other unavoidable perils. While high tunnel can block some weather elements, extreme elements such as hail and flooding can compromise plantings inside of the tunnel, leading to uninsured risk when crop insurance is not purchased. The selected coverage levels range from 50-75 percent (in some

areas to 85 percent). The producer selects the percent of the predicted price to insure; between 55 and 100 percent of the crop price established by RMA. Indemnity is paid by the difference of the yield insured and the harvested plus any appraised production. DOL policy provides protection against declining value due to damage that cause a yield shortfall. The amount of insurance is based on the cost of growing a crop in a specific area. A loss occurs when the annual crop value is less than the amount of insurance. The maximum dollar amount of insurance is stated in the actuarial document. The insured may select a percent of the maximum dollar amount equal to CAT, or purchase additional coverage levels.

According to USDA RMA (2011) report, total insured acres were over 256 million acres with a total liability of over $78 billion. Of the total liability, about 21.5% came from specialty crops, as defined by the USDA. Specialty crops can be insured using a multitude of products, while the main products include APH, DOL, AGR-Lite, and AGR. In this study, we evaluate a cropping system that includes fresh tomatoes, strawberries, and lettuce. While strawberries and lettuce do not have specific product offerings, they can be insured under the umbrella products (AGR-Lite and AGR). Fresh tomatoes, on the other hand, can be insured using APH and DOL plans under RBUP and CAT delivery methods. Figure 1 shows the gains in insured

liabilities for fresh tomatoes and relative decreases in net acres insured.

Figure 1. Fresh Tomatoes Insured Net Acres and Liabilities (includes APH and DOL)



The average loss ratio for fresh tomatoes including all products is 0.98. While the CAT has a substantially lower loss ratio, the average ratio between 2000-2010 was 0.90 for DOL and 1.3 for APH.

Talking about reducing the risk, proper crop insurances will be greatly appreciated. Some other considerable methods reduce the risk. Community Supported Agriculture (CSA) will be one of the alternatives. Typically CSA members will share the financial risks with farmer when they purchase a share in advance to cover the anticipated costs of the farm operation and farmer's salary. Correctly using the marketing should be another alternative in efficiently reducing the risks brought by the cost of high tunnel. Selling directly to the restaurants and specialty stores will open up a niche for small farmers who depend on direct marketing.

Methodology

This study evaluates the distributional properties of expected profits in order to evaluate the differences in profitability when considering use of high tunnels and/or crop insurance in specialty crop production. While past studies have indicated that the use of high tunnels can result in higher yields (Median et al. 2008), less variability, and earlier marketing periods that result in price premiums (Blomgren and Frisch 2007).This is the first study to identify the impacts from using these multiple means of risk management.

Both crop insurance and high tunnels are used as a means of risk management, however, one question of interest in this study is the degree to which their interaction leads to better risk coverage. The advantages of crop insurance in risk mitigation are clear; depending on the purchase of yield-based or revenue-based products, the lower tail of yield or revenue realizations is truncated based on the coverage level. What might be less clear is the extent to which high tunnels provide risk management with and without the use of crop insurance.

To simulate these scenarios, we assume that profits (π) are determined based on

$$\pi = P \times Q - TC \tag{1}$$

where P is the output price, Q is the quantity produced, and TC is the total cost associated with production, which includes both fixed and variable costs. In the case of high tunnel production, there is a significant one-time fixed cost which includes the construction of the high tunnel. In the case of specialty crops, it is often the case that growers will grow multiple crops under the high tunnel. This diversity of production leads to the following extended profit function for a system that produces three crops

$$\pi = P_1 \times Q_1 + P_2 \times Q_2 + P_3 \times Q_3 - TC. \tag{2}$$

There are essentially two steps in simulating this system. The first includes the characterization of the equation based on historical and current data, while the second step includes the simulation of the correlated random variables. For example, prices can be determined based on existing futures contracts where uncertainty can be characterized by a lognormal distribution (Goodwin and Kerr, 2002). Output (Q) for each of the three commodities can be expressed as the product of yields (Y) and acreage (ACRE). Since ACRE is set a priori when land decisions are made, the random component of Q comes only from Y. As such, Y can be characterized as a multivariate normal distribution, where

$$\begin{bmatrix} Y_1 \\ Y_2 \\ Y_3 \end{bmatrix} \sim MVN(\mu, \Sigma)$$

such that μ is a (3x1) vector containing the mean for each series, and Σ is a (3x3) covariance matrix that identifies both the variance associated with each commodity as well as the covariance between commodities. Given the close proximity for each crops, we anticipate each of these commodities to be highly correlated with one another such that random weather events that impact one crop and likely to have a similar impact on other crops. The use of high tunnels will present unique distributional parameters regarding yields as well as a price premium based on earlier marketing and any quality differences between standard specialty crop practices.

Based on Adhikari, Knight, and Belasco (2011), the inclusion of crop insurance for a single crop augments equation (1) to read as follows

$$\pi = P \times Q + I(\alpha) - \gamma - TC$$

where $I(\alpha)$ is the indemnity payout, which is based on coverage level (α), $I(\alpha) = P_G \times Max(\alpha Y_{APH} - Y, 0)$. P_G is the guaranteed price determined by the RMA, Y_{APH} is the APH yield based on historical outcomes, and Y is the observed yield. Additionally, γ is the premium paid or the cost of insurance which is equal to the actuarially fair premium rate (exactly equal to the expected loss) minus the federally mandated subsidy which is based on coverage level and is a percentage of the premium. In order to accommodate growers who diversify by growing multiple crops, the RMA also provides coverage across a range of products through its Whole Farm Revenue product.

Using simulated values based on the empirical parameters, we are able to construct a distribution of profits (π), which can then be used to compute certainty equivalents based on Adhikari, Knight, and Belasco (2000). This provides a method to compare scenarios that incorporates the multiple dimensions of mean and variance in a way that is more robust than stochastic dominance methods.

Empirical Application

In this empirical application, we first deal with the ability of high tunnel producers to make a return on the investment, which is constructing a high tunnel. There are two principle benefits which come into play when considering return on investment for high tunnel producers: (1) the ability to spread the marketing period in order to obtain a premium in months where seasonal prices are higher; and (2) increased yields. We first deal with the first situation, where we evaluate returns from an earlier marketing season. To put this into perspective, Figures 2a and 2b show the monthly prices for tomatoes and strawberries.

Figure 2a. Monthly Fresh Strawberry Prices over Time

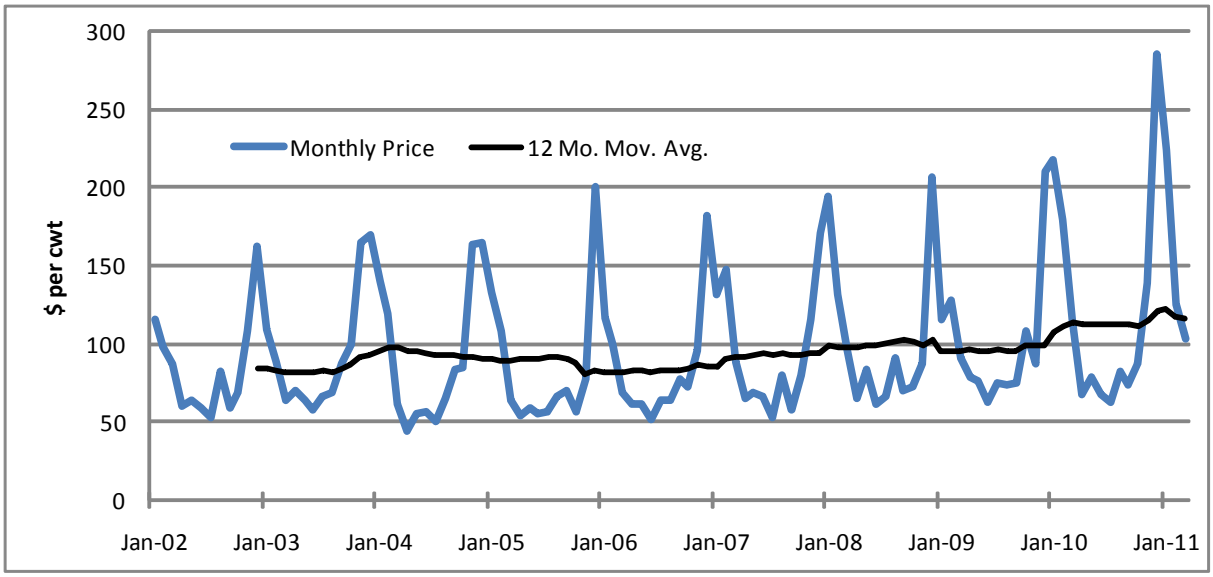
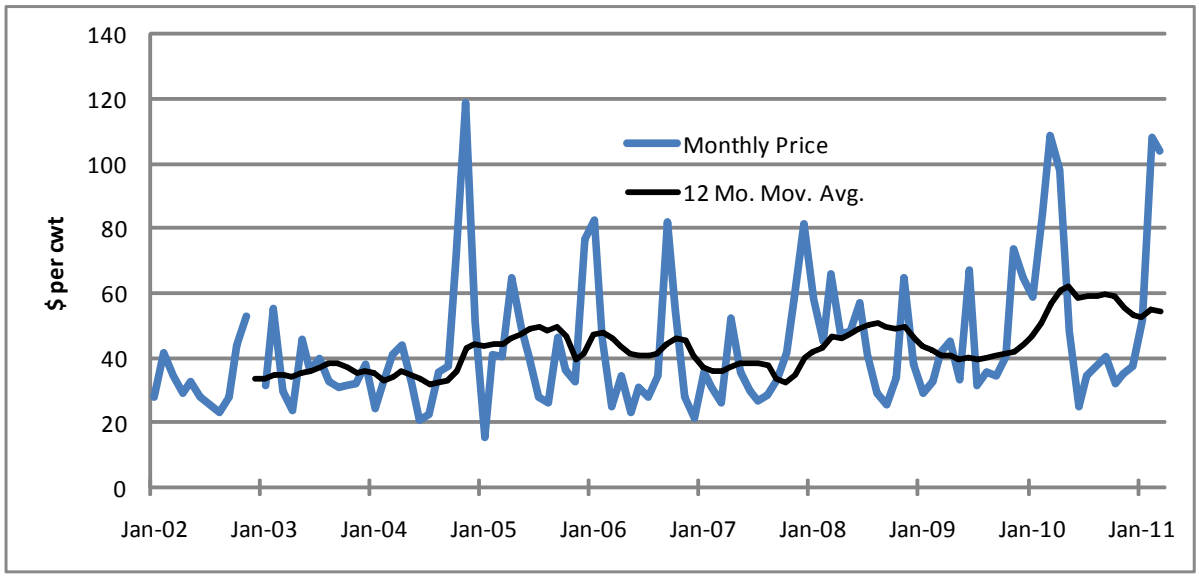


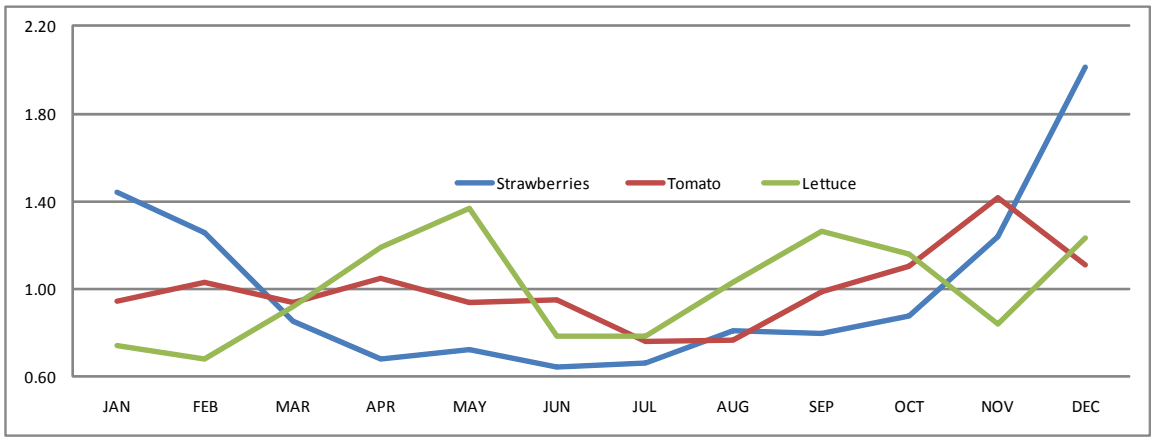
Figure 2b. Monthly Fresh Tomato Prices over Time



While there is a slight upward trend, especially over the last couple of years, it is clear that seasonal features to this price series. This systematic seasonal component allows for producers to methodically make plans to market earlier or later than the typical growing season through

the use of high tunnels in order to receive a premium. In Figure 3, we evaluate these seasonal features using normalized monthly NASS prices.

Figure 3. Monthly Indexed National NASS Prices Received for Fresh Markets (1.0 = Annual Mean) - (2002 - 2009)*



	Jan/Feb	Feb/Mar	Apr/Mar	May/Apr	Jun/May	Jul/Jun	Aug/Jul	Sep/Aug	Oct/Sep	Nov/Oct	Dec/Nov
Strawberries	**15.0%**	47.7%	24.6%	-6.0%	12.6%	-2.8%	-17.9%	1.4%	-9.3%	-29.1%	-38.5%
Tomatoes	-8.6%	10.3%	-10.6%	11.6%	-1.6%	25.2%	-0.7%	-22.4%	-10.4%	-22.1%	27.3%
Lettuce	9.2%	-26.0%	-22.5%	-13.1%	74.8%	-0.2%	-23.9%	-18.6%	9.2%	37.5%	-31.5%

*Note: This implies that the average indexed prices for strawberries are **15.0%** higher in January than in February, which serves to approximate the premium associated with moving the marketing period from February to January.*

** Lettuce prices include 2006 and 2008 only*

Strawberries are one product of interest where earlier marketing by one month, particularly in January, February, and March can retrieve a significant premium. For example, if growers are able to market in March instead of April, they can expect strawberry prices to be 24.6% higher. This obviously has a substantial impact on revenue and can quickly retrieve the cost of high tunnel production.

The second way in which high tunnel producers can collect on their investment is through higher yields. While varieties respond differently to high tunnels, relative to open field production, all commodities considered in this study have shown increased yields across varieties and commodities. This allows for an increase to revenue to occur even when produce is marketed in traditional months. A conservative 5% increase to yields, has a substantial

impact on revenue. In these two ways, preliminary evidence has shown promise in high tunnel producers retrieving their initial investment.

Discussion and conclusions

This study has focused on evaluating the impact of using high tunnels on marketing specialty crops such as lettuce, strawberries, and tomatoes. Through increased yields and earlier marketings, high tunnels can be used to increase revenue. While insurance options remain limited for producers, diverse growers may be able to make use of subsidized crop insurance in order to minimize risk while fresh tomato producers can benefit from the many options available, which include APH and DOL with delivery methods RBUP and CAT.

Some issues that were not discussed in this paper include the risk assessment of the high tunnel itself. For example, high tunnels have been shown to get blown out by the wind, do not stop severe hail storms from damaging crops, and can lead to increased pests when flooding conditions exist. These problems call for an additional assessment in order to accurately describe the profit risk faced by a specialty crop producer when using a high tunnel.

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