Budget Analysis of Organic High-Tunnel Strawberry Production on the Berea College Farm

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Introduction

Profitability is an essential element of agricultural sustainability, yet it is sometimes difficult to determine if an individual enterprise on a diversified farm is profitable because of the challenge of precisely parsing resource use, like labor or equipment, among different production systems on a farm. Enterprise budgets are useful tools because they outline the costs and provide approximate values that can be modified by a grower to customize to their own circumstances and conditions. In this report I present an enterprise budget for small-scale, USDA certified organic strawberries produced in an unheated high tunnel using production data and records from the Berea College Farm, Berea, Kentucky. The objective was to determine: 1) if this represents a potentially profitable production system; 2) which inputs or expenses are most important in determining profitability; and 3) whether changes might be made to improve the financial performance of the system.

Background

As one of the most popular fruits in the United States (US), strawberries (*Fragaria* x *ananassa*) rank behind only a few others, like apples and bananas, in annual per-capita consumption. Strawberry production has steadily increased to meet consumer demand and the US leads the world in production (Wu et al. 2018). Most commercial US production is concentrated in California, with Florida a distant second. These two states, along with North Carolina and Oregon, account for about 99% of all domestic production (Tabatabaie and Murthy 2016) and imports from Mexico supply most of the remaining consumer market demand. Despite this imbalanced situation, opportunities exist for small-scale producers throughout the United States to grow and sell strawberries as demand for local and organic products continues to rise (Samtani et al. 2019).

Increasing public interest in the environmental impacts of food, particularly related to climate change, means that producers are giving more attention to assessing, improving, and communicating their performance to consumers (Kateman, 2020). In their recent overview of the US strawberry industry, Samtani et al. (2019) discussed the various factors affecting production today, including the loss of methyl bromide as a soil fumigant, restrictions of pesticides, challenges of finding labor, and China's ban on importing plastics for recycling. They predict that "[o]rganic berry production is likely to increase in the future with increasing consumer demand and the consumer's willingness to pay a premium price for organically grown produce." This obviously presents opportunities for small producers willing to pursue organic certification and direct marketing strategies to sell their products.

The Berea College Farm, the oldest continuously operating student educational farm in the US, has produced strawberries on a small scale for decades. Over the past several years, the farm has been growing certified organic strawberries using annual hill production in unheated high tunnels, with woven plastic fabric for weed management. This system has generated higher fruit yields with fewer blemishes and longer shelf life (Kaiser and Ernst 2019). And the approach can be highly suitable for seasonal direct marketing to consumers interested in fresh, local, organic products. Most of the practices and inputs could also be compatible with and appealing to small-scale conventional production in the region because of the potential savings in herbicide and fungicide expenses from the polyethylene protection above and the weed barrier on the ground.

In previous research supported by the Kentucky Horticulture Council, I worked with a team including Berea College students and a researcher and life-cycle assessment (LCA) expert from the USDA to determine the carbon footprint of organic strawberries grown in high tunnels (Clark and Mousavi-Avval 2022). In that study, the global warming potential of organic strawberries grown under high tunnels in Berea, Kentucky, was assessed using LCA methodology and found to be 0.57 kg CO_2-eq per kg of strawberries, with the combined impact of the aluminum and plastic manufacturing accounting for 44% of the total and the direct production activities, including labor, accounting for another 28%. The average yields of 16,940 lbs/acre of fresh fruit over the two years (2020–2021) were comparable to those reported in the southeastern USA for conventional production but generated lower GHG emissions than typical commercial production in the US (Tabatabaie and Murthy 2016).

In fact, this carbon footprint per pound of fruit was lower than most other values reported globally in the literature, except for those from the Mediterranean region where conditions are ideal for high production even with low inputs. This research demonstrates the potential to improve this important aspect of environmental performance with organic production methods by maintaining yields even as carbon-intensive inputs are reduced.

Methods

The material-input (equipment and supplies) and yield data used to generate this budget were collected from annual organic strawberry production in high tunnels on the Berea College Farm in Berea, Kentucky, USA, using management and harvest records from the 2020 to 2023 production years. Detailed determinations of the labor requirements for all activities were collected only in 2023. Costs were amortized, as appropriate, based on the expected years of productive use.

The site had been managed using organic practices according to USDA National Organic Program for two decades and has been used to produce a wide range of vegetables and fruits annually within high tunnels. Each high tunnel measured 95 by 20 ft (RT 20’ Cold Frame, Atlas Manufacturing Inc., Alapaha, Georgia) and consisted of an aluminum frame covered with a single 6-mil layer of clear polyethylene sheeting (**Figure 1**). Plants were grown directly in the soil, which was routinely amended with composts and commercial organic fertilizers. All high tunnels were equipped with drip irrigation and were opened and closed manually for ventilation as needed.

Strawberries occupied one or two of the eight high tunnels at the farm in any given year and required nine months to complete a cycle, from ground preparation and transplanting to clean-up after the harvest (**Figure 2**). Woven, plastic landscaping fabric was used to cover the entire ground surface within a high tunnel before transplanting. Prior to putting the fabric down in the high tunnel for the first time, holes were burned into it with a propane torch with spacings of 12 in between each row on a bed and 14 in between plants within a row. Certified organic strawberry plugs were purchased and planted in late September or early October of each year and planted into three rows on each of three beds in each high tunnel (or two rows in 2023, see below). Two lines of irrigation drip tape were positioned on each bed between the rows.

In 2023 the center row was left empty or planted to onions to provide more space for the strawberry plants to expand. During the winter, the beds were covered with floating row cover for additional protection. Harvests typically began in late April and continued through early June (nearly eight weeks). In all years except one, the strawberry cultivar ‘Chandler’ was grown in both high tunnels; in 2021, ‘Ruby June’ was grown in one and ‘Chandler’ in the other.

While records on purchased materials inputs and yields were collected in all years, detailed data on worker labor hours were recorded only in 2023. All student workers were asked to record activities and their time spent associated with all tasks related to strawberry production. This allowed the labor efficiency of fruit harvesting to be determined throughout the harvest window and a more precise cost of harvest to be determined based on yield.

Some costs were not included in this budget and could vary considerably for other growers depending upon their unique circumstances. The cost to sell the packaged fruit was not included because all fruit was either sold directly to customers at weekend, on-farm plant sales during the Spring or sold through the campus farm store, located 0.5 mile from the production site. Thus, the costs for this budget stop accruing after the harvested fruit has been packaged. In addition, no costs for land or taxes were included. The omission of these costs could skew in favor of a more profitable outcome. On the other hand, the labor force for this production system was composed of largely inexperienced Berea College students working part-time, which could bias the outcome in the other direction.

Figure 1. *Unheated high tunnels (20 ft by 95 ft) being used for organic strawberry production in 2023 on the Berea College Farm, Berea, Kentucky.*

Figure 2. *The production cycle for certified organic strawberries grown in unheated high tunnels requires about nine months to complete. A) Transplanting takes place in late September or early October into raised bends covered in woven plastic weed barrier. B) Relatively little labor is required in the winter beyond covering the plants with floating row cover during cold periods and removing early blossoms. C) Harvesting typically begins in April and continues through early June. D) The fruit is packaged in biodegradable kraft paper clamshells for retail sale at the Berea College Farm Store.*

Results and Discussion

Strawberry yields over the four years averaged 644 lbs per high tunnel (1,900 ft^2), which is equivalent to 14,758 lbs per acre (**Table 1**), an average comparable to conventional yields reported for the southeastern United States. According to an industry overview published by Samtani et al. (2019), average conventional strawberry yields for Alabama, North Carolina and Virginia were 11,787 lbs/acre, 13,452 lbs/acre, and 16,142 lbs/acre, respectively. Organic strawberry yields would be expected to be lower than conventional yields, but in this system with protection from the high tunnel, yields were maintained.

The retail price of the strawberries sold by the Berea College Farm ranged from $6 to $8 per quart over the four yields (2020-23). The price in 2023 was $8.00/quart, with a quart averaging 1.25 lbs of fruit, so that is the value used for the default budget analysis. At this price, the average gross income generated by a single high tunnel (1,900 ft^2) would be $4,120 (**Table 2**). Because this relatively high retail price may not be viable in some areas of Kentucky or for farms without organic certification, **Table 2** includes expected gross income at $6.00 and $7.00/quart as well.

Table 1. *Strawberry yields (lbs) from USDA certified organic high-tunnel production systems on the Berea College Farm, 2020 to 2023. Equivalent yields on a per-acre basis are provided for comparison with other reported yields.*

Cultivar	Year	Yield per high tunnel (lbs)	Equivalent yield per acre (lbs)
Chandler	2020	721	16,530
Ruby June	2021	755	17,309
Chandler	2021	465	10,661
Chandler	2022	562	12,885
Chandler	2022	711	16,301
Chandler	2023	672	15,406
Chandler	2023	620	14,214
Average	**2020-23**	**644**	**14,758**

Table 2. *Gross retail value of USDA certified organic strawberries produced in an unheated high tunnel (1900 ft^2) on the Berea College Farm, 2020 to 2023. They were sold for $6.00-8.00/quart over the period with $8.00/quart the price in 2023. Each quart contained an average of 1.25 lbs.*

Cultivar	Year	Yield (lbs per high tunnel)	Value at $6.00/qt	Value at $7.00/qt	Value at $8.00/qt
Chandler	2020	721	3,461	4,038	4,614
Ruby June	2021	755	3,624	4,228	4,832
Chandler	2021	465	2,232	2,604	2,976
Chandler	2022	562	2,698	3,147	3,597
Chandler	2022	711	3,413	3,982	4,550
Chandler	2023	672	3,226	3,763	4,301
Chandler	2023	620	2,976	3,472	3,968
Averages	**2020-23**	**644**	**3,090**	**3,605**	**4,120**

Although some of the high tunnels used for organic strawberry production at the Berea College Farm between 2020 and 2023 were 20 years old or more, the costs of all material inputs, including equipment and supplies, are based on current (2023) local and regional market prices for consistency in comparison. These costs were amortized based on expected useful lifespan (**Table 3**).

The cost of hourly labor is also a factor that will vary by location and can have an important influence on profitability. Although the minimum wage in Kentucky remains at $7.25 per hour, the recent pay rate for seasonal part time workers at the Berea College Farm, at $12.00 per hour, suggested that an hourly cost of $15.00 was appropriate and realistic. It should be pointed out that this is still lower than the minimum indicated by the Living Wage Calculator for Kentucky from the Massachusetts Institute of

Technology. To explore the effects of labor costs on potential profitability, this analysis also examines outcomes if the cost of labor were set at $12.00 per hour, which would translate to an hourly wage of about $10.00 per hour.

The labor activity most affected by crop yield is harvesting. The higher the yield, the higher the costs to harvest and package the fruit. To determine the labor efficiency of harvest, the student workers on the farm engaged in strawberry production recorded their time spent in labor activities and the yields of fruit when they harvested each time. This allowed the labor cost per pound of fruit to be calculated and used in the default budget. While some students had some limited experience in farming and gardening, most did not, and this should be considered in using this budget as a guide. Seasonal yield patterns will also affect harvesting efficiency. In 2023 the yield harvested per hour ranged from 4.5 lbs/hour spent harvesting on the first day of the harvest window, April 17, to a high of 15.8 lbs/hour on May 6. The average harvest efficiency for the season (May 6 to June 9) was 8.1 lbs/hour, and is the value used in the budget (**Table 3**).

Using the sell price of $8.00/quart and the average yield (2020-23) of 644 lbs, the value of the output is $4,120 (**Table 2**) while the total amortized cost of inputs is $3,673 (**Table 3**) for a net profit of $447 per high tunnel (**Table 4**) or the equivalent of $10,248/acre of production. The total cost of labor in the production budget is $2081 with harvesting, the largest fraction, accounting for 57% of the total labor costs. And the labor costs comprise 57% of the total annual production budget of $3,673. The enterprise generates a loss at the average yield if the lower retail prices of $6.00 and $7.00/quart are used.

If the cost of labor is reduced from $15.00/hour to $12.00/hour, the cost of labor operations is reduced to $1,675 and the total annual production budget to $3,257. At a retail value of $8.00/quart, this would result in a net profit of $863 per high tunnel, which is equivalent to $19,785/acre. However, if we assume the retail value of $6.00/quart, which is more realistic in areas where labor costs are $12/hour, the net return is a loss of $167 per high tunnel because the gross income is reduced to just $3,090 while the total annual costs are $3,257. At $7.00/quart, the system nets $348 per high tunnel if labor costs $12.00/hour, which is equivalent to $7,978/per acre.

In both hourly-labor cost scenarios and at the average yield sold at $8.00/quart, the system is profitable with net returns equivalent to $10,248 to $19,785/acre. At $7.00/quart the system is unprofitable at the average yield (**Table 4**). This wide range of possible outcomes demonstrates the sensitivity to wages and market prices. At the premium price of $8.00/quart, the net returns compare favorably to those expected for small-scale vegetable and melon options according the 2022 enterprise budgets offered by the University of Kentucky's Center for Crop Diversification. Among the various crops listed, only fresh-market, staked tomatoes projected similar net returns to organic strawberries in this study (University of Kentucky, 2022). It is worth noting that the assumed hourly wage for these budgets was $16.50, higher than that used for this 2023 organic, high-tunnel strawberry budget.

Similarly, the budget developed by Rysin et al. (2015) at North Carolina State University for organic strawberry production presents a marketable yield of 14,100 lbs of fruit and a net revenue of $19,394/acre. This is a comprehensive budget accounting for all costs to the producer and reported that labor was only about 30% of total costs. However, it was assumed that 40% of the fruit was U-pick (Rysin et al. 2015), which would cut labor costs substantially.

Table 3. *Costs for producing USDA certified organic strawberries in unheated high tunnels (1,900 ft^2) on the Berea College Farm using average yields from 2020-23 and 2023 market prices for inputs and the retail value of direct-marketed fruit. Labor cost is $15 per hour and strawberries are valued at $8.00/quart. The costs of land and taxes are not included.*

Category	Materials/Activities	Quant./ high tunnel	Unit	Lifespan (years)	Initial cost ($)	Amortized cost per year ($)
High Tunnel	Total cost of constructed high tunnel	1	each	30	18,600	620
	Plastic (6 mil polyethylene film)	1	each	5	1,000	200
Strawberry Plants	Strawberry plants total (certified organic)	1	total	1	225	225
Production Equipment	Woven plastic landscape fabric	19	lb	5	97	19
	Water supply line to high tunnel	30	lb	20	1,500	75
	Irrigation header line (plastic)	15	lb	5	8	2
	Irrigation drip tape (plastic)	4	lb	1	96	96
	Irrigation valves	1	lb	2	23.1	12
	Spun polyester row-cover fabric	21	lb	4	60	15
	Sod staples (to pin landscape fabric)	1	lb	5	55	11
	Two-wheel tractor with rotary plow	2	hour	1	20	20
	Propane burner	3	hour	1	5	5
Supplies	Water	16,000	gallon	1	104	104
	Organic fertilizer – Nature Safe 13-0-0	30	lb	1	30	30
	Gasoline (two-wheel tractor, rotary plow)	1	gallon	1	4	4
	Propane (burner)	1	gallon	1	3	3
Labor Operations	Bed preparation (two-wheel, walk-behind tractor)	2	hour	1	30	30
	Compost application	3	hour	1	45	45
	Burning holes in landscape fabric	1	hour	5	3	3
	Laying and pinning landscape fabric	2	hour	1	30	30
	Planting	32	hour	1	480	480
	Irrigating	4	hour	1	60	60
	Harvesting	80	hour	1	1193	1,193
	Clean-up	16	hour	1	240	240
Harvest Equipment	Aluminum trays	6	lb	10	102	10
	Plastic buckets	5	lb	2	20	10
Packaging	Retail container	515	each	1	118	118
Compost	Compost	200	lb	1	3	3
Organic Certification	Annual fee with inspection through Kentucky Department of Agriculture	1	fee	1	10	10
Total annual cost						3,673

Table 4. *Calculated scenarios for net returns from USDA certified organic strawberries produced in an unheated high tunnel (1900 ft^2) on the Berea College Farm at the average, highest and lowest yields obtained from 2020 to 2023, at three assumed retail prices ($6.00-8.00/quart; each quart contained an average of 1.25 lbs), and assuming $15 per hour for labor.*

Yield scenario	Yield (lbs per high tunnel)	Retail price at $6.00/qt	Retail price at $7.00/qt	Retail price at $8.00/qt
Lowest	465	($1,077)	($705)	($333)
Average	644	($583)	($68)	$447
Highest	755	($270)	$334	$938

Kaiser and Ernst (2019) do not provide a detailed budget in their publication on high-tunnel strawberry production in Kentucky, but they do report an expected net return of $365 to land, capital and management from a single high tunnel (measuring 100 ft by 25 ft) and assuming an hourly wage of $12.50. In this case, experienced pickers were assumed who could harvest 12-15 lbs per hour.

Clearly, the cost of labor and the market value of the strawberries have a substantial influence on potential profit outcomes. These are also factors that are strongly affected by location and largely outside the control of the producer. Where market demand exists, organic certification offers a means of obtaining price premiums for a modest annual fee. But organic certification requires a 3-year transition period before products can legally be sold as certified organic. In this analysis, the $250 annual fee was divided over gross income of all organic crops sold from the farm, resulting in a very low cost for the high-tunnel strawberry enterprise.

Where organic certification does not seem feasible but strong demand for local, conventional strawberries exists, the use of synthetic fertilizers in a high-tunnel system may result in higher yields than reported here. That could increase gross income and spread the costs of the equipment over more units (quarts), resulting in greater profitability has long as the retail price is not markedly lower than that used here.

Another consideration in accounting for the amortized costs of equipment, such as the high-tunnel structure, plastic, and irrigation system, is whether or not to allocate an entire year for a crop that requires 9 months. In a rotation in which three crops are rotated through a two-year cycle and the high tunnel is always in use, allocating such costs based on the months of active use might be more justifiable. If this is done, the total cost for producing a strawberry crop over a 9-month period (September through June) decreases by about $200. Finally, it's worth noting that extreme factors, such as storm damage or exotic pest outbreaks, could have a dramatic effect on the financial outcomes of this enterprise and were not encountered or considered in this analysis.

Conclusions

At current costs and retail prices in Berea, Kentucky, producing USDA-certified organic strawberries in one or several high tunnels can generate a small profit of a few hundred to a few thousand dollars per year. When viewed on a per-acre equivalency, in comparison to other fruit and vegetable crops, producing organic strawberries in this manner appears favorable as few crops typically have consistently high consumer demand, relatively few production problems, and comparable net returns.

Scaling up to an acre or more might seem to make sense on a small farm given the small profit margin at this very small scale, but such a pursuit would present new risks if market demand were uncertain and competition enters the market, pushing retail prices down. Also, labor demand is very uneven over the course of the 9-month production period. Harvesting in the spring requires the most labor, followed by planting in the fall. Other tasks, like irrigation and weeding, can be accomplished with ease by a manager or owner-operator without additional hired help. On small, diversified farms where workers are shifting tasks with the seasons, this might fit nicely within a whole-farm system. Such diversified farms are complex to manage but the tasks associated with high-tunnel strawberry production are relatively predictable and can be planned. Keeping the high tunnels full with marketable crops year-round is also desirable, as this spreads of capital costs of the high tunnel over more revenue streams.

High tunnels are versatile and growing organic strawberries in them offers a potentially viable option based on the data collected for this study. Of course, the Berea College Farm is unique, and the conditions may not be representative of other apparently similar farms in Kentucky or the surrounding region. The close proximity of the point of sale (Berea College Farm Store), the strong market demand for local organic products, no land costs or taxes, and a largely inexperienced student workforce suggest some caution in extrapolating these results. But the comparison to other budget data from the University of Kentucky and North Carolina State University indicate this budget is a reasonable starting point for producers interested in organic, high-tunnel strawberry production.

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Budget & Expenditures

Category	***Description***	***Budgeted Amount ($US)***	***Amount Spent ($US)***
Personnel	Faculty researcher stipend for project coordination and completion	$4,500	$4,500
Travel	Conference registration, transportation, lodging, and meals	$500	$500
Total		$5,000	$5,000