2011 Cost Estimates of Producing Strawberries in a High Tunnel in Western Washington

WASHINGTON STATE UNIVERSITY EXTENSION FACT SHEET • FS093E

Preface

The information in this publication serves as a general guide for producing annual June-bearing strawberries in high tunnels in western Washington as of 2011. This guide can be used by new and existing high-tunnel strawberry producers to help evaluate production decisions, determine potential returns, and prepare budgets. Specific assumptions are included in this publication, but these assumptions may not fit every situation since production costs and returns are highly variable for any particular high-tunnel operation due to case-specific:

- High-tunnel system
- Capital, labor, and natural resources
- Crop yields
- Type and size of machinery
- Input prices
- Cultural practices
- Commodity prices
- Management skills

Cost estimation also varies with the intended use of the enterprise budget. To avoid drawing unwarranted conclusions for any particular farm, readers must closely examine the assumptions made in this guide, and then adjust the costs and/or returns as appropriate for their situation.

High-Tunnel Strawberry Production in Washington

A high tunnel is a temporary agricultural field structure with arched or hoop-shaped frames. It is covered with one or more layers of clear plastic, is solar heated and has no electricity. The plastic covering can be easily removed and replaced as needed; and some high tunnel structures are tall enough to accommodate a tractor (Figure 1). The structure is portable and can be disassembled and moved to another location. However, if the structure has been reinforced to withstand wind damage, it can be cumbersome to move. Four-season tunnel structures can withstand wind and snow loads, and are left covered all year (Figure 2). Three-season tunnel structures are not made to withstand high wind or snow, therefore, the plastic covering is removed during the winter months (Figure 3). High tunnels provide protection from seasonal rainfall and direct sunlight. In cool climates, such as western Washington, they elevate the temperature inside the tunnel, especially under sunny conditions.

Figure 1. Tractor tilling beds in a high tunnel.

Figure 2. A four-season high-tunnel.

Figure 3. A three-season high-tunnel structure.

Strawberries are grown in the ground (Figure 4) or in containers within high tunnels. Production of high-tunnel grown strawberries typically begins and ends a week earlier than field-grown strawberries; which provides an opportunity to extend the season. In western Washington, June-bearing strawberries planted in a three-season tunnel during September will produce a crop the following spring. The use of a four-season high tunnel could substantially extend the growing season in Washington, as it does in other climates. Western Washington growers could consider day-neutral strawberries since they can be planted in three- or four-season tunnels in September for production the following spring, summer and autumn. However day-neutral cultivars do not produce well in tunnels during summer months in warm climates. Drip irrigation is essential for strawberry production in high tunnels. Fertilizer is incorporated into the bed prior to planting to ensure plant establishment, and is also applied through the drip system to sustain the plants through the growing season.

The number of acres of high-tunnel strawberry production in Washington is limited, likely less than 40 acres.

Figure 4. High-tunnel strawberry plants grown on a raised bed with plastic mulch.

However, high tunnels can substantially improve marketable yields, shelf life, and extend the marketing season for strawberries (Kadir and Carey, 2004; Santos et al., 2010; Belasco et al., 2012). By reducing leaf wetness, high tunnels can greatly reduce losses to Botrytis fruit-rot of strawberry fruit. The reduction in latent fruit-rot also contributes to a longer, and more predictable, shelf life for the fruit. High-tunnel production provides growers an opportunity to produce crops early, and beyond the normal season, when there is less competition and prices are higher. This publication offers growers baseline data that will assist them in evaluating the feasibility of strawberry production using a high-tunnel structure.

Objectives

The objectives of this study are to: (1) provide an estimate of capital requirements and production costs of growing annual June-bearing strawberries in high tunnels in Washington, (2) provide growers with a procedure and a tool for analyzing the profitability of high-tunnel strawberry production, and (3) develop an Excel workbook that allows the user to estimate production costs and examine different scenarios by changing input assumptions, price, and yield.

The primary uses for this publication are to identify inputs, costs, and yields of producing strawberries based on assumptions described below. This publication does not represent any particular farm and is not intended to be a definitive guide to production practices. However, it can be helpful in estimating the physical and financial requirements of comparable plantings.

Sources of Information

The data used in this study were gathered from an experimental trial of growing June-bearing strawberries in a high tunnel at the WSU Mount Vernon Northwestern Washington Research and Extension Center.

The profitability of high-tunnel strawberry production can also be assessed by comparing it to the profitability of an open-field strawberry enterprise. Growers in western Washington typically grow strawberries in a perennial system in the open field. For this study, a group of strawberry growers provided assistance in developing an enterprise budget for June-bearing strawberries using an annual open field system. Baseline assumptions and production cost data for field-grown strawberries can be downloaded from the WSU School of Economic Sciences Extension website: http://extecon.wsu.edu/pages/Enterprise_Budgets.

The cultural practices and input requirements in the high-tunnel operation form the baseline assumptions that were used to develop this enterprise budget. Given that many factors affect production costs and returns, individual growers can use the Excel workbook provided to estimate their own costs and returns.

Budget Assumptions

1. The enterprise budget is for high-tunnel strawberry production. The high tunnel is an add-on to an

already existing farm enterprise. The basic overhead costs of a farm, such as land, taxes, buildings, farm equipment, and vehicles, are assumed to be covered by the farm business. Only new expenses associated with the high tunnel are included in the production scenario.

2. The high tunnel is 28-feet by 96-feet with end walls. It is a three-season structure that is set up in mid-April and taken down in September. It is assumed that only strawberries are being produced in the high tunnel.
3. The growing area for strawberries is 1,440 sq ft (bed area multiplied by the number of beds in the tunnel) based on the specifications in Table 1. The remaining space in the tunnel is devoted to utility areas, paths, handling stations, and the like.
4. The high tunnel uses a drip irrigation system and has an installation cost of $186 ($141 for materials and $45 for labor). An irrigation outlet installed outside the high tunnel costs $815.
5. The growing season of strawberries is from September of the current year through September of the following year, and the harvest season is from June to September.
6. There are 960 June-bearing strawberry plants in the high tunnel. The total strawberry yield is about 727.5 pounds with a marketable yield of 80%. Strawberries are sold through direct marketing (e.g., CSA, farmers markets, local restaurants) at $3 per pound.
7. Agricultural plastic mulch (black, 1 mil) is used in the strawberry beds (Figure 4). The cost of the material to cover five 3-foot by 96-foot beds is approximately $16. A bed-shaping mulch layer combination machine is used to prepare and shape the beds and to lay the mulch in the tunnel. Shaping and laying the mulch require about 1.40 hours of labor. Removal of the plastic mulch and drip tape is done by hand, and takes approximately 4 hours of labor.
8. Interest on investment is 5%.

Summary of Results

The estimated cost of high-tunnel strawberry production is presented in Table 2. Production costs are classified as variable and fixed costs for the high tunnel. Variable costs comprise field operations, harvest, packing, labor, materials, maintenance, and repairs. Fixed costs (which are incurred whether the crop is grown or not) include depreciation on capital, interest, property tax and management.

Given the above assumptions, the cost of producing high-tunnel strawberries is estimated at $2.81/ ft^2, compared to about $0.64/ft^2 for field-grown strawberries (see Appendix Table 2 for field-grown strawberries at WSU School of Economic Sciences Extension website: http://extecon.wsu.edu/pages/Enterprise_Budgets). Figures are expressed in square feet and are based on the estimated growing areas for strawberries, which are 1,440 ft^2 and 43,560 ft^2 (equivalent to 1 acre) in a high tunnel and open field, respectively.

If the gross production area of strawberries is considered (gross production area for a high tunnel is 2,688 ft^2; and open field is 62,290.8 ft^2, which is equivalent to 1.43 acres), total production costs under the high tunnel and open field systems are $1.51/ft^2 and $0.45/ft^2, respectively.

Throughout the growing season the total yield of high-tunnel strawberries is approximately 0.26 lb/ft^2 of gross production area, compared to about 0.23 lbs/ft^2 for field-grown strawberries. This implies a 13% yield advantage for tunnel-grown fruit. The yields of high-tunnel and field-grown strawberries are not far from the 2007-2011 Washington State 5-year average strawberry yield of about 0.20 lbs/ft^2 (USDA NASS 2012). Larger crop yields in a high tunnel (relative to open fields) are generally attributed to the benefits of the production system which include temperature management and protection from rain, wind, and hail.

The net return for producing strawberries in a high tunnel is calculated in Table 2. It represents what the grower can anticipate after accounting for all costs. Based on the gross production area and bed growing area, the net returns are estimated at -$0.86/ft^2 and -$1.60/ft^2, respectively for high-tunnel strawberries; and $0.01/ft^2 and $0.02/ft^2 for field-grown (see Appendix Table 2 for field-grown strawberries at WSU School of Economic Sciences Extension website: http://extecon.wsu.edu/pages/Enterprise_Budgets).

Breakeven returns for different levels of cost recovery are presented in Table 3. The first breakeven return is the amount required to cover total variable costs. If this breakeven return is greater than the actual returns received, it is uneconomical to produce high-tunnel strawberries even in the short run, since the added production costs are greater than the added returns. The second breakeven return is to cover total cash costs, assuming no outstanding loans or land rent. This breakeven return represents what is needed to remain financially viable in the short run. Based on the assumptions, the return for high-tunnel strawberries needs to be at least $6.05/lb to be profitable in the short run.

The third breakeven return is the amount required to cover total cash costs and depreciation costs. This value must be realized to stay in business over the long run. The final breakeven return is the total cost breakeven return. It is only when this breakeven return is received that the grower can recover all out-of-pocket expenses, plus opportunity costs. Opportunity costs are defined as the returns a grower could receive from fixed resources in their next best alternative use. Not obtaining the final breakeven return means that the grower will not receive a return on capital contributions equal to what could be earned in alternative uses.

A return exceeding the total cost breakeven level means that in addition to covering all cash and opportunity costs, the grower will receive a return on the financial risk of producing strawberries in a high tunnel. Given the assumed production scenario, and costs of high-tunnel strawberry production, the return must be $6.96/lb in order to offset the estimated total cost of production.

Potential investors should carefully examine the assumptions underlying the estimates provided. Two key factors affecting net returns are the annual yield and received prices. Yields vary based on the high-tunnel location and cultural practices, among others. Also, retail prices vary, and growers should be aware of market prices at the venues where they sell their fruit. Table 4 shows the sensitivity of net returns to different price and yield scenarios for high-tunnel strawberries. Producers will desire to be "in the black" (gray zone in Table 4), which shows combinations of yield and price earning a positive profit. For example, a yield of 1,500 lbs/tunnel that sold for $3/lb, earns a profit of $95/tunnel.

Tables 5 to 7 show the cost data that underlie the fixed costs in Table 2. Table 5 presents the physical capital requirements. Interest costs and depreciation costs applied to the high-tunnel strawberry enterprise are listed in Tables 6 and 7. Interest costs represent the required return on investments. They can be actual interest payments on funds borrowed to finance high-tunnel operations and physical capital investments, or an opportunity cost, or a combination of the two.

WSU enterprise budgets are economic budgets (not financial/cash budgets), which require an understanding of the concept of *opportunity cost*. Opportunity cost is defined as the revenue foregone by not investing in the next best alternative carrying similar financial risk. For example, if a producer invests $30,000 of equity capital in equipment, the producer gives up the alternative of investing this money in the stock market, or paying off an outstanding loan. Thus, if the producer is to realize an "economic" profit, the equipment investment must earn a return greater than that associated with the next best alternative. If the next best alternative happens to be paying off an outstanding loan that carries an annual interest of 6%, economic profits are not realized until a net return greater than $1,800 is realized by the equipment investment. Thus, the high-tunnel enterprise budget reflects an interest cost on owned or borrowed capital.

The same is true for calculating the opportunity costs of operator labor and owned land. In calculating labor costs, operator labor is valued at the amount that could be earned by working on a neighboring farm, or the cost to hire someone else to do the labor which is being furnished by the producer. Likewise, the opportunity cost of owned land would be the amount that a producer could earn if the land was rented out rather than being used by the producer.

Depreciation costs include the annual replacement cost of machinery and equipment, which is the amount a producer would pay to replace machinery and equipment per year, on average. The use of replacement prices may overstate costs currently being encountered by growers. However, the replacement cost provides an indication of the earnings needed to replace depreciable assets. When looking at the long-term viability of the enterprise, it is important to consider the ability of the enterprise to replace its depreciable assets on a replacement cost basis.

Excel Workbook

An Excel spreadsheet version of the enterprise budgets of high-tunnel grown strawberries (Table 2), as well as associated data underlying the cost calculations (Tables 5–9), are available at the WSU School of Economic Sciences Extension website: http://extecon.wsu.edu/pages/Enterprise_Budgets. The workbook also includes the requirements for plastic mulch and weight calculators. The appendix tables for the estimated costs and returns of field-grown strawberry production are also available at the above website. Growers can modify select values and use the Excel Workbook to evaluate their own production costs and returns.

References

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Table 1. Production Specifications for High-Tunnel Grown Strawberries

Type of strawberry	June-bearing
Growing method	Annual system
High tunnel size	28 ft by 96 ft
In-row spacing	1 ft
Between-row spacing	1 ft
Row width	3 ft
Row length	96 ft
Density	960 strawberry plants or 192 plants per bed
Number of Beds and Rows	5 beds, 2 rows per bed

Table 2. Estimated Cost and Returns of Producing Strawberries in a High Tunnel ($/tunnel)

Total Returns	Unit	Price ($)/ unit	Quantity	Total ($)	Note	Your Return
Strawberry	pound	3.00	582.00	1,746.00	Total yield of June-bearing strawberries in the high tunnel is about 727.5 lbs but only 80% of the yield is marketable.	
Variable Costs	**Unit**	**Cost ($)/ unit**	**Quantity**	**Total ($)**	**Note**	**Your Cost**
Land preparation and planting						
Soil test				12.50		
Subsoil	hour	12.00	0.25	3.00	Labor cost	
Disc	hour	12.00	0.50	6.00	Labor cost	
Cultimulch	hour	12.00	0.25	3.00	Labor cost	
Dolomite (application & material)						
Labor	hour	12.00	0.25	3.00		
Lime	acre	139.20	0.06	8.59	Based on 2 tons/ac lime cost at $69.60/ton of ag lime	
Fumigation (custom application)	acre	800.00	0.06	49.37		
Pre-plant						
Shape and cover beds	hour	8.75	1.40	12.25		
Plastic mulch	roll	180.00	0.09	16.20	1 roll of mulch 4 ft x 4,000 ft	
Plant						
Strawberry plants	each	0.25	960.00	240.00		
Custom planting (labor)	hour	12.00	20.00	240.00		
Irrigate (labor)	hour	12.00	1.00	12.00		
Post-plant						
Weed control				48.00	Contact herbicide in alleyways, hand weed in planting holes	
Pre-harvest						
Irrigate (labor)	hour	12.00	24.00	288.00		
Weed control				73.00	Includes labor and material	
Spray miticide				49.00	Includes labor and material	
Spray insecticide				75.00	Includes labor and material	
Spray fungicide				98.00	Includes labor and material	
Harvest						
Picking and hauling	lb	0.25	582.00	145.50		
Flats	7-lb flat	1.00	83.00	83.00		
Packing and marketing						
Packing and delivery to market	5-lb tray	1.00	116.00	116.00	Labor cost	
Retailing at market	5-lb tray	2.50	116.00	290.00	Includes marketing and retail labor	
Year-end crop removal						
Plastic and drip tape removal	hour	12.00	4.00	48.00		
Disc	hour	15.00	0.50	7.50		
Subsoil	hour	15.00	0.50	7.50		
Maintenance and Repairs						
High tunnel equipment maintenance and repair					Includes maintenance of the high tunnel and repairs due to wind damage	
Labor	hour	12.00	15.00	180.00		
Parts				200.00		
Other Variable Costs						
Tunnel temperature management	hour	12.00	18.00	216.00	1 hour/week from May to August	
Irrigation management	hour	12.00	44.00	528.00	2 hours/week from May to September	
High tunnel set up and removal*	hour	12.00	11.00	132.00		
Plastic mulch disposal	lb	0.03	30.24	0.98	Disposal facility receiving charge is $65/ton or $0.0325/lb	
Overhead (5% of variable costs)				159.57		
Interest on Variable Costs (5%)				167.55		
Total Variable Costs				3,518.51		
Fixed Costs						
Depreciation						
High Tunnel				103.20		
Irrigation System				166.20		
Equipment Annual Replacement Cost				100.00		
Interest						
Equipment				102.85		
High Tunnel				9.46		
Irrigation System				4.65		
Land	acre	466.50	0.04	20.56	Estimated value of agricultural land is $9,330 per acre. Interest rate is 5%.	
Other Fixed Costs						
Land and Property Tax	acre	108.00	0.04	4.76		
Management	acre	400.00	0.04	17.63		
Permit				0.00	No building permit necessary for hoophouse built in Washington.	
Total Fixed Costs				**529.31**		
Total Cost				**4,047.82**		
Estimated Net Returns				**-2,301.82**		

Notes:
*Takes 6 hours to set it up (3 people at 2 hours each); 3 hours to take it down (3 people at 1 hour each); and 2 hours additional for clean up.
Hand labor rate is $12/hour and machinery/tractor labor rate is $15/hour. Labor rates include applicable taxes and benefits.

Table 3. Breakeven Return ($/pound) to Cover Production Cost

		Cost ($/tunnel)	Breakeven Return ($/pound)	Your Cost ($/tunnel)	Your Breakeven Return ($/pound)
1.	Total Variable Costs	3,518.51	6.05[1]		
2.	Total Cash Costs = Total Variable Costs + Land and Property Taxes + Permit	3,523.27	6.05[2]		
3.	Total Cash Costs + Depreciation Costs of High Tunnel, Irrigation System and Equipment	3,892.67	6.69[3]		
4.	Total Cost = Total Cash Costs + Depreciation Costs + Interest Costs + Management Cost	4,047.82	6.96[4]		

Notes:
Assumed marketable yield (lb/tunnel) = 582
Assumed price per lb = $3.00
Breakeven return is calculated as: Cost divided by 582.
[1]If the return is below this level, June-bearing strawberries are uneconomical to produce.
[2]The second breakeven return allows the producer to stay in business in the short run.
[3]The third breakeven return allows the producer to stay in business in the long run.
[4]The fourth breakeven return is the total cost breakeven return. Only when this breakeven return is received can the grower recover all out-of-pocket expenses plus opportunity costs.

Table 4. Estimated Net Returns ($/tunnel) at Various Prices and Marketable Yields of High-Tunnel Grown Strawberries

Marketable Yield (pounds/tunnel)	Price ($ per pound)				
	2.50	3.00	3.50	4.00	4.50
500	-2,700	-2,450	-2,200	-1,950	-1,700
750	-2,377	-2,002	-1,627	-1,252	-877
1,000	-2,053	-1,553	-1,053	-553	-53
1,250	-1,730	-1,105	-480	145	770
1,500	-1,405	-655	95	845	1,595

Note: Shaded area denotes a positive profit based on the combination of yield and price.

Table 5. Physical Capital Requirements of Strawberry Production in a High Tunnel

	Purchase Price ($)*	Total Cost ($)
High tunnel structure (28' x 96')		1,186.00
Hoops (Steel ribs or tubes)	*429.00*	
Stakes	*234.00*	
Anchors (6)	*24.00*	
Poly	*344.00*	
Rope	*50.00*	
End walls	*55.00*	
*Reinforcements (additional pipes)***	*50.00*	
Fertilizer injector		100.00
Supplies (strings, hanger, tomato clips)		140.00
Bed shaper and mulch layer (Rain-flo 2600)		3,500.00
Irrigation system—Drip (inside the high tunnel)		186.00
Irrigation system—Outlet (outside the high tunnel)		815.00
Irrigation pipe and risers	*340.00*	
PVC unit and various PVC pieces, ball valves, pressure gauge	*475.00*	
Total Cost		**5,927.00**

*Purchase price corresponds to new machinery, equipment, or buildings.
**To keep the high tunnel in place during windy conditions.

Table 6. Interest Costs ($/tunnel) of Strawberry Production in a High Tunnel

	Total Purchase Price ($)	Salvage Value ($)	Total Interest Cost ($)
Equipment	3,740	374	103
High tunnel—Poly	344	34	9
High tunnel—Skeleton/Metal part	842	84	23
Irrigation system	186	0	5
Interest Rate	*5.0%*		
Salvage Value	*10.0%*		

Notes:
Interest Cost is calculated as: (Total Purchase Price + Salvage Value)/2 x 5%.
Salvage Value refers to the estimated value of an asset at the end of its useful life. It is calculated as: Total Purchase Price x 10%.

Table 7. Depreciation Costs ($/tunnel) of Strawberry Production in a High Tunnel

	Total Purchase Price ($)	Years of Use	Depreciation Cost ($)
High tunnel—Poly	344	3	103
High tunnel—Skeleton/Metal part	842	10	76
Irrigation system			
Drip	186	5	37
Irrigation pipe & risers	340	10	34
PVC unit and other PVC pieces	475	5	95
Machinery & Equipment*			100

Notes:
The depreciation cost (except for Machinery & Equipment) is calculated as *straight line depreciation*: (Total Purchase Price – Salvage Value)/Years of Use.
*An estimate of average annual replacement costs, rather than depreciation costs, is used for machinery and equipment. Replacement prices may overstate growers' perceptions; however, they indicate the earnings needed to replace depreciable assets.

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