2011 Cost of Producing Head Lettuce in High Tunnels in Western Washington

WASHINGTON STATE UNIVERSITY EXTENSION FACT SHEET • FS092E

Preface

The information in this publication serves as a general guide for producing head lettuce in high tunnels in western Washington as of 2011. This guide can be used by new and existing high-tunnel lettuce 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 farm 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 Head Lettuce 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. For a sturdy and durable high-tunnel structure, the hoops are made of steel and the plastic is greenhouse grade 6 mil (0.15 mm) with UV light protection. The plastic covering can be easily removed and replaced if it is damaged, or if the structure is "rested" for a season. The structure can be disassembled and moved to other locations; however, if placed in a windy environment, the required wind reinforcement makes it cumbersome to move. A grower can use a three-season structure or a four-season structure. Four-season tunnel structures can withstand wind and snow loads, and are left covered all year. Three-season tunnel structures are not made to withstand heavy wind or snow loads so the plastic covering is removed from these structures during the winter months. High tunnels are generally 9-feet to 12-feet high, which allows for a small- to medium-sized tractor to be used inside the tunnel. High tunnels provide protection from seasonal rainfall and direct sunlight. In cool climates, such as western Washington, they elevate the heat inside the tunnel, especially under sunny conditions.

Head lettuce is grown in the ground within high tunnels (Figure 1), and benefits most from high-tunnel production in fall, winter, and spring seasons. Lettuce is not grown in high tunnels during the peak of summer due to the elevated temperature within the structure. The high temperatures promote bolting (flowering), which reduces lettuce quality and marketability. Drip irrigation is essential in high tunnels year round (Figure 2). Fertilizer can be incorporated into the bed prior to planting or applied through the drip system during the growing season.

Figure 1. A bed with different head lettuce varieties in a high tunnel in western Washington.

Figure 2. Drip irrigation set up in beds of lettuce in a high tunnel.

The number of acres of high-tunnel lettuce production in Washington is limited, likely less than 20 acres in 2011. However, the potential for quality crop production is very good during the fall, winter, and spring seasons. Lettuce seeded during the late summer can be harvested throughout the fall. Lettuce seeded prior to mid-September can be overwintered in non-heated high tunnels, and harvested throughout the winter and spring. Lettuce can be seeded in high tunnels as early as February for spring and early summer crops. Lettuce can be harvested 3 to 4 months after seeding in fall and spring, or 4 to 5 months after seeding in the winter months.

Objectives

The objectives of this publication are to: (1) provide an estimate of capital requirements and production costs of growing head lettuce in high tunnels in western Washington, (2) provide growers with a procedure and a tool for analyzing the profitability of high-tunnel lettuce 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 head lettuce based on assumptions described below. This publication does not represent any particular farm and is not intended to be a definitive guide for 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 a group of experienced high-tunnel lettuce growers in western Washington. Their production practices and input requirements form the baseline assumptions that were used to develop the enterprise budget. Additionally, the data represent what these growers anticipate if no unforeseen production failures occur. 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 head lettuce production. The high tunnel is an add-on to an already existing farm enterprise. The basic overhead costs of a farm, such as buildings, farm equipment, vehicles, fees, and other dues, 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 20-feet by 96-feet with end walls, and is a three-season structure that is set up in mid-April and taken down in November. It is assumed that only head lettuce is being produced in the high tunnel.
3. Table 1 shows the assumed specifications for high-tunnel lettuce production. The production area for the high-tunnel (row area multiplied by the number of rows in the tunnel) is approximately 1,597 sq ft. 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 $110. An irrigation outlet installed outside the high tunnel costs $815.
5. The growing season of head lettuce is from February 1 to mid-October, and the harvest season is from late April to mid-October.
6. There are 2,300 heads of lettuce grown in the high tunnel with a marketable yield of 75%. Head lettuce is sold through direct marketing (e.g., CSA, farmers markets, local restaurants) at $2 per head.
7. Interest on investment is 5%.

Summary of Results

The estimated cost of producing head lettuce in a high-tunnel system is shown in Table 2. Variable costs comprise field operations, harvest, packing, marketing, labor, materials, maintenance, and repairs. Fixed costs (which are incurred whether the crop is grown or not) include interest, depreciation on capital, property tax, and management.

The total cost of producing head lettuce in a high tunnel is about $2,965/tunnel or $1.86 per square foot of growing area. This production cost is higher than the estimated total production cost of field-grown head lettuce, which is about $0.37/sq ft (Galinato and Miles, 2012). Assuming a price of $2 per head, the net return for high-tunnel lettuce is approximately $0.30/ft^2, which is less than the net return of $0.52/ ft^2 for field-grown lettuce. Consequently, high-tunnel head lettuce grown from February through October is 42% less profitable per square foot than field-grown head lettuce. Figures are expressed in square feet and are based on the estimated growing areas for lettuce, which are 1,597 ft^2 and 43,560 ft^2 (equivalent to 1 acre) for high tunnel and open field, respectively.

Throughout the growing season, high-tunnel head lettuce yields approximately 1.08 head/ft^2, compared to 0.45 head/ft^2 for field-grown lettuce. This implies a 140% yield advantage for tunnel-grown head lettuce. The yield of field-grown head lettuce is within the range of the yield compiled by Galinato and Young (2012), which is 0.29-0.67 head per sq ft of bed area. The yield of head lettuce grown in high tunnels is well beyond this range. 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. There are field studies that report higher marketable yields of lettuce in a high tunnel compared to open field (e.g., Kelly 2005; Rader and Karlsson 2006; Belasco et al. 2012).

Based on production assumptions in western Washington, the greater production costs for tunnel-grown lettuce offset the yield advantage for summer production, resulting in the profit disadvantage cited above. Profits may be greater if high-tunnel lettuce was produced only in the spring and fall, when produce prices tend to be higher.

Retail prices of lettuce vary and growers should be aware of the market prices as they examine their own budgets. In addition to prices, yields can also affect the net returns. Table 3 shows the sensitivity of net returns to different price and yield scenarios for lettuce produced in a high-tunnel system.

Fixed costs (Table 2) are based on the underlying cost data shown in Tables 4 through 6. Table 4 presents the physical capital requirements. Interest and depreciation costs applied to the high-tunnel lettuce enterprise are listed in Tables 5 and 6. Interest costs represent required return on investments. These costs can be actual interest payments on funds borrowed to finance high-tunnel lettuce production and physical capital investments, or an opportunity cost, or a combination of the two.

WSU enterprise budgets are economic budgets (not financial/cash budgets). Economic budgets require an understanding of the *opportunity cost* concept. 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 equipment, which is the amount a producer would pay to replace equipment per year, on average. The use of replacement prices may overstate costs currently being experienced by growers. However, 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 lettuce (Table 2), as well as associated data underlying the cost calculations (Tables 4–6), are available at the WSU School of Economic Science Extension website: http://extecon.wsu.edu/pages/Enterprise_Budgets. 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 of Head Lettuce in a High Tunnel

High tunnel size	20 ft by 96 ft
In-Row Spacing	10 inches
Between-Row Spacing	10 inches
Density	2,300 lettuce plants
Number of Rows	20 rows

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

Total Returns	Unit	Price ($)/unit	Quantity	Total ($)	Note	Your Return
Lettuce	head	2.00	1,725	3,450.00	Estimated yield is 2,300 heads of lettuce but only 75% is marketable.	
Variable Costs	**Unit**	**Cost ($)/unit**	**Quantity**	**Total ($)**	**Note**	**Your Cost**
Soil preparation						
Spread compost						
Material	yard	21.00	3.50	73.50		
Labor	hour	15.00	2.00	30.00	Hand labor	
Till cover crop and compost	hour	165.00	0.09	14.85		
Chisel plow	hour	165.00	0.09	14.85		
Till beds	hour	165.00	0.09	14.85		
Fertilizer						
Material				80.00		
Labor	hour	165.00	0.09	14.85		
Irrigation						
Labor	hour	15.00	0.60	9.00	Hand labor	
Seeding and Transplanting						
Seeds	per 1,000	0.01	2300.00	23.00		
Transplants	pot	0.07	2300.00	161.00		
Planting	hour	15.00	5.00	75.00	Involves 5 people working 1 hour each	
Production Costs						
Fungicide				0.00		
Herbicide				0.00		
Insecticide				0.00		
Irrigation water	month	10.00	2.00	20.00	Using city water for 2 months	
Irrigation power				0.00	Included in overhead cost	
Harvest and Post-harvest Costs						
Picking	hour	15.00	18.00	270.00	Picking to fill 72 cases, 24 heads of lettuce per case	
Washing, grading (per pound)	case	1.50	72.00	108.00	Labor cost	
Supplies	each	0.25	72.00	18.00	Twist ties, etc. used in cases	
Packaging	case	3.20	72.00	230.40	24 heads of lettuce per case	
Hydro Cooling	case	0.80	72.00	57.60	Cooler, electricity, etc.	
Marketing						
Delivery	box	0.50	72.00	36.00		
Maintenance and Repairs						
Irrigation system maintenance and repair				45.00	Cost of parts	
Tunnel and equipment maintenance and repairs				166.00	Maintaining the high tunnel including repairs due to wind damage, equipment, etc.	
Other Variable Costs						
Irrigation management	hour	15.00	15.00	225.00		
Tunnel temperature management	hour	15.00	15.00	225.00	15 minutes per day for 2 months	
High tunnel set up and removal*	hour	25.00	11.00	275.00	Construction labor cost at $25/hour	
Overhead (5% of variable costs)				109.35		
Interest on variable costs (5%)				114.81		
Total Variable Costs				**2,411.06**		
Fixed Costs						
Depreciation						
High tunnel				178.98		
Irrigation system				151.00		
Equipment annual replacement cost				100.00		
Interest						
Equipment				25.44		
High tunnel				32.62		
Irrigation system				23.13		
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				**554.11**		
Total Cost				**2,965.17**		
Estimated Net Returns				**484.83**		

*Takes 3 hours, 2 people to set it up; 3 hours to take it down; 2 hours additional for clean up.

Table 3. Estimated Net Returns ($/tunnel) at Various Prices and Yields of High-Tunnel Grown Head Lettuce

Marketable Yield (heads/tunnel)	Price ($ per head)				
	1.50	2.00	2.50	3.00	3.50
1,500	-616	134	884	1,634	2,384
1,600	-510	290	1,090	1,890	2,690
1,700	-404	446	1,296	2,146	2,996
1,800	-298	602	1,502	2,402	3,302
1,900	-192	758	1,708	2,658	3,608

Table 4. Physical Capital Requirements of Head Lettuce Production in a High Tunnel

	Purchase Price ($)[1]	Total Cost ($)
High tunnel structure (20' 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)[2]	*50.00*	
Fertilizer injector		475.00
Harvest tools[3]		450.00
Irrigation system—Drip (inside the high tunnel)		110.00
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		**3,036.00**

[1]Purchase price is approximate and corresponds to new high tunnel structure, equipment, or supplies.
[2]To keep the high tunnel in place during windy conditions.
[3]Includes plastic bins, etc.

Table 5. Interest Costs ($/tunnel) of Head Lettuce Production in a High Tunnel

	Total Purchase Price ($)	Salvage Value ($)	Total Interest Cost ($)
Equipment and supplies	925	93	25
High tunnel—poly	344	34	9
High tunnel—skeleton/metal parts	842	84	23
Irrigation system	925	0	23
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 6. Depreciation Costs ($/tunnel) of Head Lettuce Production in a High Tunnel

	Total Purchase Price ($)	Years of Use	Depreciation Cost ($)
High tunnel—poly	344	3	103
High tunnel—skeleton/metal parts	842	10	76
Irrigation system			
Drip	110	5	22
Irrigation pipe & risers	340	10	34
PVC unit and other PVC pieces	475	5	95
Equipment*			100

Notes:
The depreciation cost (except for 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 equipment. Replacement prices may overstate growers' perceptions; however, they indicate the earnings needed to replace depreciable assets.

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