2015 COST ESTIMATES OF ESTABLISHING AND PRODUCING CONVENTIONAL HIGHBUSH BLUEBERRIES IN WESTERN WASHINGTON

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Preface

The results presented in this publication serve as a general guide for evaluating the feasibility of producing blueberries using conventional practices in western Washington as of 2015. This publication is not intended to be a definitive guide to production practices, but it is helpful in estimating the physical and financial requirements of comparable plantings. Specific assumptions were adopted for this study, but these assumptions may not fit every situation since production costs and returns vary across operations, depending on the following factors:

- Capital, labor, and natural resources
- Crop yields
- Cultivar ('Duke' was assumed for this study)
- Type and size of machinery, and irrigation system
- Input prices
- Cultural practices
- Conventional blueberry prices
- Size of the farm operation
- Management skills

Cost estimations in the enterprise budget also vary depending on its intended use. To avoid drawing unwarranted conclusions for any particular field or grower operation, readers must closely examine the assumptions made in this guide, and then adjust the costs, returns, or both as appropriate for their own operation.

Blueberry Production in Washington State

As of 2014, Washington State is the third largest producer of conventional highbush blueberries (*Vaccinium corymbosum*) in the US in terms of volume of production at 94.6 million lb, following Michigan (99 million lb) and Georgia (98 million lb) (USDA 2015). Conventional blueberry production in Washington State increased from 18 million lb to 94.6 million lb between 2004 and 2014—a 425% growth over 10 years. Of the total utilized production, production for the processing market was twice as large as the production for the fresh market: 63 million lb versus 31.6 million lb in 2014 (USDA 2015).

Blueberry yield per acre in Washington State increased from 7,500 lb/acre to 10,400 lb/acre between 2004 and 2014—a 36% increase over the 10 year period, which is higher than other major blueberry producing states (USDA 2015). For example, in the same period, the yield per acre in Michigan and Georgia increased from 4,600 lb/acre to 4,900 lb/acre (7% increase) and from 4,380 lb/acre to 5,540 lb/acre (25% increase), respectively (USDA 2015). The season-average grower price of blueberries in Washington as of 2014 was $1.19/lb, which was relatively lower than the prices in other major producing states except for Oregon: $1.25/lb in Michigan, $1.29/lb in Georgia, $1.17/lb in Oregon, and $2.16/lb in California (USDA 2015).

Study Objectives

This publication is designed to enable growers to estimate (1) the costs of equipment, materials, supplies, and labor required to establish and produce conventional highbush blueberries and, (2) the breakeven returns at which conventional blueberry production would be a profitable enterprise.

The primary use of this report is in identifying inputs, costs, and yields considered to be typical of a well-managed conventional blueberry operation. This publication does not necessarily represent any particular operation and is not intended to be a definitive guide to production practices. However, it describes current industry trends and, as such, can be helpful in estimating the physical and financial requirements of comparable plantings.

Information Sources

The data used in this study were gathered from experienced conventional blueberry growers in western Washington and validated by Extension educators and industry representatives. Western Washington blueberry growers typically sell their fruit in the processed market, which influences some of the information presented in this report. 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 over a blueberry's productive life, if no unforeseen 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. This budget is based on a 67-acre field of conventionally produced ‘Duke’ blueberries within a 100-acre farm operation of diverse crops (e.g., raspberries, apples, blackberries, strawberries, vegetables, and other horticultural crops). It is assumed that 1acre of this field is not used for the direct production of blueberries; rather it is dedicated to roads, a pond, loading area, etc. Therefore, the total productive area for the blueberry field is 66 acres. Table 1 shows the assumed specifications for conventional blueberry production.
2. The value of bare agricultural land (including water rights) is $13,000 per acre with annual property taxes of $130 per acre.
3. The irrigation infrastructure is dual system drip irrigation. Water is provided through a public irrigation district.
4. Cultural practices are done by hand (no mechanical aids). In most cases in Washington State, blueberries going to the fresh market are harvested by hand, and those going to the processing market are mechanically harvested.
5. The field does not produce until Year 3. Fruit production is suppressed through blossom/fruit removal in Years 1–2 in order to encourage planting establishment.
6. Thirty percent of the total yield goes to the fresh market and 70% goes to the processing market. The gross return is $1.90/lb for fresh blueberries and $0.95/lb for processing blueberries.
7. Management is valued at $300 per acre. This value is representative of what the producer group felt as a fair return for an operator’s management skills.
8. Interest on investment is 5%. Five percent is the median of the range of the average annual effective interest rates on non-real estate bank loans made to farmers from 2010 to 2015 (Federal Reserve Bank of Kansas City 2016).

Summary of Study Results

Table 2 shows the estimated annual cost and returns for a 66-acre field of conventional ‘Duke’ blueberries in western Washington. The components of the major costs shown in this table are provided in more detail in the Excel Workbook described below. Production costs are classified into variable costs and fixed costs. Variable costs comprise field, harvest, and packing activities, materials and application costs, maintenance and repairs, fuel and lube, and fees. Fixed costs are incurred whether or not the crop is produced. These costs will generally be calculated for the whole farm enterprise and be allocated for the unit of production. The fixed costs include land rent, depreciation and interest costs on fixed capital, management, and amortized establishment costs. Management is treated as a fixed rather than a variable cost because, like land, management has been committed to the production cycle of the crop. The amortized establishment costs assume a total productive life of 25 years, which includes 6 years of establishment and 19 years of full production. The amortized establishment costs must be recaptured during the full production years in order for an enterprise to be profitable. Most of the values given in Table 2 are based on more comprehensive underlying cost data, which are shown in Appendix Tables 1 through 4 of the Excel Workbook described below.

The study assumed that conventional ‘Duke’ blueberries could achieve full production in the seventh year after planting. Based on the above assumptions, the total production costs for ‘Duke’ blueberries during full production are estimated at $17,288 per acre. Given these costs and holding all else constant, the breakeven return required for fresh-market blueberries during full production is estimated at $1.34/lb assuming a yield of 4,860 lb/acre. On the other hand, the breakeven return for blueberries that go to processors is $0.71/lb, assuming a yield of 11,340 lb/acre. Table 3 shows the breakeven returns for different levels of cost recovery during full production.

Considering that 70% of the harvested fruit goes to the processing market and the remaining goes to the fresh market, in Table 3, the breakeven prices in the first row ($0.27/lb, fresh; $0.25/lb, processing) are the prices required to cover total variable costs (e.g., field, harvest and packing activities, materials and application costs, maintenance and repairs, fuel and lube, and fees). The breakeven price in the second row ($0.36/lb, fresh; $0.29/lb, processing) should cover total cash costs (e.g., variable costs, land and property taxes, insurance, and miscellaneous supplies), assuming no outstanding loans or land rent.

The breakeven price in the third row ($0.55/lb, fresh; $0.37/lb, processing) is the amount required to cover total cash costs and depreciation costs, and must be realized to stay in business over the long run. Note that if the intention of using this enterprise budget is to analyze the farm economic situation in the short run, then only cash costs should be considered. For example, in the short run it is often considered that reinvestment in capital costs (i.e., new machinery and equipment) is not needed and therefore not included; if not included in the long run, on the other hand, this implies the risk that capital might be eventually depleted (Missouri Extension 2011). However, note that for conventional blueberry production, variable costs might not be variable in the strict sense. Once the field is established, a farmer could consider the establishment costs as fixed costs and would continue to produce even if profits appear as negative in one or two years.

The final breakeven price in the fourth row ($1.34/lb, fresh; $0.71/lb, processing) covers the total cost of production (e.g., total cash costs, depreciation, and opportunity costs). It is only when this breakeven price is received that the grower can recover all cash costs, depreciation, and opportunity costs. Not obtaining the final breakeven price means the grower will not receive a return on capital contributions equal to what could have been earned through an alternative investment. On the other hand, receiving an actual price greater than the estimated total cost breakeven price means that in addition to covering all cash and opportunity costs, the grower will receive a return for management and the financial risk assumed in producing conventional blueberries.

Tables 4 and 5 show the sensitivity of net returns to different price and yield combinations of fresh market blueberries and processing blueberries, respectively, considering that 30% of the total yield goes to the fresh market and 70% goes to processing. Positive grower returns can be observed when both prices and yields are at high levels (for example, price at $2.15/lb and yield at 7,280 lb/acre, fresh; price at $1.10/lb and yield at 10,920 lb/acre, processing).

Table 6 presents the annual capital requirements for a 66-acre conventional ‘Duke’ blueberry field. Table 7 specifies the machinery, equipment, and building requirements for the 100-acre farm operation. Interest costs and depreciation are listed in Tables 8 and 9, respectively. Interest costs represent required return on investments. They can be actual interest payments on funds borrowed to finance farm operations and physical capital investments, an opportunity cost (a return that would have been received if the investment had been in an alternative activity), or a combination of the two. All interest and amortization costs assume a 5% interest rate. Depreciation costs are annual, non-cash expenses that are calculated over the asset’s useful life. These expenses represent the loss in an asset’s value due to use, age, and obsolescence.

The economic feasibility of investing in a conventional blueberry operation is further assessed by using the net present value (NPV) and discounted payback period. NPV is the sum of the discounted cash flows from the first year to the last year of the planting’s productive life (i.e., 25 years). NPV provides an indicator of an investment’s feasibility by estimating and converting its future profits into present-day dollars given the cost and length of the investment, time value of money, and how long it takes for an investment to return a profit. The discounted payback period gives the number of years it would take to recoup an investment from discounted cash flows. Discounting is a method to estimate the present value of future payments. A discount rate of 5% is used in the calculation of NPV and payback periods, and represents the time value of money or the opportunity cost of capital.

The NPV of the investment is $1.92 million given a discount rate of 5% (Table 10). The estimated discounted payback period for the blueberry operation can vary depending on the costs included in the calculation and ranges from 7.35 to 14.62 years. If one includes total cash costs (which is the sum of total variable costs, miscellaneous supplies, land and property taxes, and farm insurance), the discounted payback period is 7.35 years. Whereas, if one includes all production costs (which is the sum of total cash cost, management cost, and fixed capital investment), the discounted payback period is 14.62 years. Table 10 also shows the sensitivity of the NPV calculations to different discount rates—3% through 9%. The range of the average annual effective interest rates on non-real estate bank loans made to farmers in the past 6 years (2010 to 2015) is between 4% and 6% according to the Federal Reserve Bank of Kansas City (2016). Alternative discount rates are included to demonstrate the value of better (or worse) investments or possible impacts of inflation. The NPV and payback period calculators can be found in Appendix 6 of the Excel Workbook.

The key results of this enterprise budget are formed by production-related assumptions established for the study. Production costs and returns for individual growers may differ, thus the results cannot be generalized to represent the population of farmers. An interactive Excel Workbook is provided to enable individual growers to estimate their returns based on the costs of their production.

Excel Workbook

An Excel spreadsheet version of this enterprise budget (Table 2) as well as associated data underlying the per-acre cost calculations (Tables 6 through 9 and Appendices 1 through 6 for establishment costs, full production costs, calculation of salvage value and depreciation costs, amortization calculator, production-related data, and NPV and payback period calculators) are available at the WSU School of Economic Sciences Extension website.

Growers can modify select values and thus use the Excel Workbook to evaluate their own blueberry enterprise. For example, the planting material to be used will influence the establishment and productivity of the blueberry field. The cost of plants will vary depending on the type of material and attention should be paid to this on the establishment cost worksheet of the Excel Workbook.

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Table 1. Conventional Highbush Blueberry Production Specifications

In-row Spacing	3 feet
Between-row Spacing	10 feet
Cultivar	Duke
Block Size	66 acres
Life of Planting	25 years (6 years of establishment, 19 years of full production)
Plant Density	1,452 plants per acre
Trellis System	Basic tree post trellis system

Table 2. Cost and Returns per Acre of Establishing and Producing Conventional Highbush Blueberries on a 66-Acre Field in Western Washington

	Establishment Years							Full
	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Production[A]
Gross Production (lb/acre), Fresh[B]				1,080.00	2,160.00	3,240.00	4,320.00	4,860.00
Price ($/lb), Fresh[C]				1.90	1.90	1.90	1.90	1.90
Gross Production (lb/acre), Processed[B]				2,520.00	5,040.00	7,560.00	10,080.00	11,340.00
Price ($/lb), Processed[C]				0.95	0.95	0.95	0.95	0.95
TOTAL RETURNS ($/acre)				**4,446.00**	**8,892.00**	**13,338.00**	**17,784.00**	**20,007.00**
Variable Costs ($/acre):								
Establishment[D]	8,907.00	1,246.75	8.00	8.00	1,048.00	8.00	8.00	384.70
Field Activities[E]	866.00	1,449.50	1,547.50	2,403.50	2,619.50	2,323.50	2,323.50	2,779.50
Harvest Activities[F]				625.20	1,219.20	1,813.20	2,407.20	2,704.20
Packing and Handling Charges[G]				1,080.00	2,160.00	3,240.00	4,320.00	4,860.00
Maintenance and Repairs[H]	150.00	275.00	275.00	299.20	299.20	299.20	299.20	299.20
Other Variable Costs[I]	756.63	226.56	139.58	387.08	660.86	737.00	915.01	1,067.51
Total Variable Costs	**10,679.63**	**3,197.81**	**1,970.08**	**4,802.98**	**8,006.76**	**8,420.90**	**10,272.91**	**12,095.11**
Fixed Costs ($/acre):								
Depreciation[J]	650.73	650.73	895.53	895.53	895.53	895.53	895.53	895.53
Interest[J]	1,059.36	1,716.10	1,527.84	2,441.50	2,663.45	2,834.39	2,155.55	1,212.36
Other Fixed Costs[K]	745.00	745.00	745.00	745.00	745.00	745.00	745.00	3,085.31
Total Fixed Costs	**2,455.10**	**3,111.83**	**3,168.38**	**4,082.04**	**4,303.99**	**4,474.93**	**3,796.08**	**5,193.21**
TOTAL COSTS ($/acre)	**13,134.72**	**6,309.64**	**5,138.45**	**8,885.02**	**12,310.75**	**12,895.83**	**14,068.99**	**17,288.32**
ESTIMATED NET RETURNS ($/acre)	**-13,134.72**	**-6,309.64**	**-5,138.45**	**-4,439.02**	**-3,418.75**	**442.17**	**3,715.01**	**2,718.68**

Notes:

A. The full production year is representative of all the remaining years the blueberries are in full production (Year 7 to Year 25).

B. Thirty percent of the total yield goes to the fresh market, and 70% goes to procesing.

C. These prices reflect the return before any expenses (including packing charges) are subtracted.

D. Includes soil preparation, planting and cover crop. Soil analysis is done every year for $8/acre.

E. Includes the costs associated with pruning, chemicals (herbicide, insecticide, fungicide), fertilizers, beehives, bird control, hand weeding, irrigation labor, general farm labor, integrated pest management (IPM) scouting, and irrigation and electric charge.

F. Includes the costs associated with hand harvest, mechanical harvest labor, and loading and hauling.

G. Packing charge for fresh blueberries is $0.65/lb; Handling charge for processed blueberries is $0.15/lb.

H. Includes the costs of maintenance and repair, and fuel and lube.

I. Includes commission fees, overhead, and interest on operating capital.

J. Includes depreciation and interest costs of fixed capital.

K. Includes rental and miscellaneous supplies, land and property taxes, insurance cost, management cost, and amortized establishment costs.

Table 3. Breakeven Return ($/lb) for Different Levels of Enterprise Costs during Full Production of Conventional Highbush Blueberries in Western Washington[A]

		Cost ($/acre)	Breakeven Return ($/lb), fresh[B]	Breakeven Return ($/lb), processing[C]
1.	Total Variable Costs	12,095.11	0.27 [D]	0.25 [D]
2.	Total Cash Costs = Total Variable Costs + Land & Property Taxes + Insurance Cost + Miscellaneous Supplies	12,540.11	0.36 [E]	0.29 [E]
3.	Total Cash Costs + Depreciation Costs	13,435.65	0.55 [F]	0.37 [F]
4.	Total Cost = Total Cash Costs + Depreciation Costs + Interest Costs + Management Cost	17,288.32	1.34 [G]	0.71 [G]

Notes:

A. Of the total yield, 30% goes to the fresh market and 70% goes to processing.

B. Breakeven return is calculated as cost divided by yield of blueberries for the fresh market, holding the total return from processing blueberries constant.

C. Breakeven return is calculated as cost divided by yield of blueberries for the processing market, holding the total return from fresh blueberries constant.

D. If the return is below this level, blueberries are uneconomical to produce.

E. The second breakeven return allows the producer to stay in business in the short run.

F. The third breakeven return allows the producer to stay in business in the long run.

G. 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[A] ($) per Acre at Various Prices and Yields of Fresh-Market Highbush Blueberries during Full Production in Western Washington

	Price ($/lb)[C]					
Net Yield (lb/acre)[B]	**$1.40**	**$1.65**	**$1.90**	**$2.15**	**$2.40**	**$2.65**
4,880	-$3,341	-$1,808	-$275	$1,259	$2,792	$4,325
5,680	-$2,314	-$581	$1,152	$2,885	$4,618	$6,351
6,480	-$1,288	$645	$2,579	$4,512	$6,445	$8,378
7,280	-$261	$1,872	$4,005	$6,138	$8,272	$10,405
8,080	$766	$3,099	$5,432	$7,765	$10,098	$12,431

Notes:

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

A. Net returns consider only the changes in prices and yields of fresh market blueberries, holding all else constant.

B. The yield only considers blueberries going to the fresh market. Thirty percent of the total yield goes to the fresh market and 70% goes to processing.

C. Price represents the gross return or price before any expenses (including packing and handling charges) are subtracted.

Table 5. Estimated Net Returns[A] ($) per Acre at Various Prices and Yields of Highbush Blueberries for Processing during Full Production in Western Washington

Net Yield (lb/acre)[B]	FOB Price ($/lb)[C]					
	$0.65	$0.80	$0.95	$1.10	$1.25	$1.40
7,320	-$3,034	-$1,654	-$275	$1,105	$2,485	$3,865
8,520	-$1,968	-$408	$1,152	$2,712	$4,272	$5,832
9,720	-$901	$839	$2,579	$4,318	$6,058	$7,798
10,920	$166	$2,085	$4,005	$5,925	$7,845	$9,765
12,120	$1,232	$3,332	$5,432	$7,532	$9,632	$11,731

Notes:

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

A. Net returns consider only the changes in prices and yields of processing blueberries, holding all else constant.

B. The yield only considers blueberries going to the fresh market. Seventy percent of the total yield goes to processing and 30% goes to the fresh market.

C. Price represents the gross return or price before any expenses (including packing and handling charges) are subtracted.

Table 6. Summary of Annual Capital Requirements for a 66-Acre Conventional Highbush Blueberry Field in Western Washington

	Establishment Years							Full Production[A]
	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	
Land (21 acres)	871,000.00							
Mechanical Harvester				750,000.00				
Trellis System			159,720.00					
Irrigation System	196,680.00							
Well& Pump	33,000.00							
Pond	19,800.00							
Operating Expenses[B]	754,025.50	260,225.32	179,194.99	366,166.74	577,616.28	604,949.59	727,182.32	847,447.44
Total Requirements ($)	**1,874,505.50**	**260,225.32**	**338,914.99**	**1,116,166.74**	**577,616.28**	**604,949.59**	**727,182.32**	**847,447.44**
Receipts ($)	**0.00**	**0.00**	**0.00**	**293,436.00**	**586,872.00**	**880,308.00**	**1,173,744.00**	**1,320,462.00**
Net Requirements ($)	**1,874,505.50**	**260,225.32**	**338,914.99**	**822,730.74**	**(9,255.72)**	**(275,358.41)**	**(446,561.68)**	**(473,014.56)**

Notes:

A. The full production year is representative of all the remaining years the orchard is in full production (Year 7 to Year 25).

B. Operating expenses are the sum of the total variable costs, rental and miscellaneous supplies, land and property taxes, insurance cost, and management cost.

Table 7. Machinery, Equipment, and Building Requirements for a 100-Acre Diversified Farming Operation

	Purchase Price ($)[A]	Number of Units	Total Cost ($)
Machine Shop/Shed[B]	40,000	1	40,000
Tractor-75HP, 4WD	60,000	2	120,000
Fertilizer Spreader (broadcast bander)	20,000	1	20,000
Planter (6 ft)	5,000	1	5,000
Air-blast Sprayer (400 gal)	50,000	2	100,000
Weed Sprayer (400 gal)	20,000	1	20,000
Cultivator (6 ft disk/ripper)	3,500	1	3,500
Flail Mower (5 ft)	6,000	1	6,000
Fork Lift	30,000	1	30,000
4-Wheeler ATV	20,000	1	20,000
Pickup Truck (1/2 ton 4x4, gas)	25,000	1	25,000
Mechanical Harvester[C]	250,000	3	750,000
Miscellaneous Equipment[D]	15,000	1	15,000
Shop Equipment[E]	5,000	1	5,000
Total Cost			**1,159,500**

Notes:

Machinery, equipment, and building requirements are utilized in growing diverse crops in the 100-acre farm, which include conventional blueberries. The costs of fixed capital are allocated on the entire farm operation.

A. Purchase price corresponds to new machinery, equipment, or building.

B. A 40 ft × 80 ft pole barn with partial slab floor.

C. Over-the-row blueberry harvester. Need one mechanical harvester per 20 acres of blueberries.

D. Includes blades, straight blade, quick connect loader, mechanical weeder, soil aerator, utility trailer, etc.

E. Includes compressor, welder, pressure washer, and miscellaneous tools.

Table 8. Annual Interest Costs per Acre for a 66-Acre Conventional Highbush Blueberry Field in Western Washington

	Total Purchase Price ($)	Salvage Value ($)[A]	Number of Acres	Total Interest Cost ($)	Interest Cost Per Acre ($)[B]
Irrigation System[C]	196,680	0	66	4,917	74.50
Land	871,000	N/A	67	43,550	650.00
Machinery, Equipment & Building[D,E]	1,159,500	99,950	100	31,486	314.86
Well & Pump[C]	33,000	0	66	825	12.50
Pond[C]	19,800	0	66	495	7.50
Trellis[C]	403,920	0	66	10,098	153.00

Notes:

A. Not applied to land because land is not a depreciable asset.

B. Interest Cost is calculated as: (Total Purchase Price + Salvage Value) ÷ 2 × Interest Rate. For land, the calculation is: Total Purchase Price × Interest Rate because land has no salvage value.

C. The irrigation system, well and pump, pond, trellis system, and wind machine are used for the direct production of the fruit. Hence, their respective interest costs are divided by the production area (66 acres) to get the interest cost per acre.

D. Total area of the farm operation is 100 acres and machinery, equipment, and building are used in the entire, diverse cultivar farm. Thus, the corresponding interest costs are divided by the total area (100 acres) to derive the interest cost per acre.

E. See Excel Workbook (Appendix 3) for a detailed calculation of the salvage value of machinery, equipment, and building.

Table 9. Annual Depreciation Costs per Acre for a 66-Acre Conventional Highbush Blueberry Field in Western Washington

	Total Purchase Price ($)	Number of Acres	Total Value Per Acre ($)	Years of Use	Depreciation Cost Per Acre ($/yr)[A]
Irrigation System	196,680	66	2,980.00	25	119.20
Mainline & Pump	33,000	66	500.00	25	20.00
Pond	19,800	66	300.00	25	12.00
Trellis	403,920	66	6,120.00	25	244.80
Machinery, Equipment & Building[B]					499.53

Notes:

A. The depreciation cost is calculated as straight line depreciation: (Total Purchase Price − Salvage Value) ÷ Years of Use.

B. See Excel Workbook (Appendix 3) for calculation of the depreciation cost of the machinery, equipment, and building.

Table 10. NPV and Payback Periods given Different Discount Rates

Discount Rate	NPV	Payback Period of Total Cash Cost[A]	Payback Period of Total Cost[B]
3%	$3,394,297	7.02	12.83
4%	$2,593,895	7.18	13.64
5%	$1,919,835	7.35	14.62
6%	$1,349,926	7.53	15.84
7%	$866,224	7.73	17.44
8%	$454,170	7.94	19.69
9%	$101,900	8.19	23.28

Notes:

A. Cash cost is the sum of total variable cost, miscellaneous supplies, land and property taxes, and insurance cost. Excludes interest on operating capital.

B. Total cost is the sum of: total cash cost, management cost, and fixed capital investment. Excludes interest on operating capital and interest on fixed capital.

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