



2014 COST ESTIMATES OF ESTABLISHING, PRODUCING, AND PACKING FUJI APPLES IN WASHINGTON STATE

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Preface

The results presented in this publication serve as a general guide for evaluating the feasibility of producing Fuji apples grown under two types of trellis systems—angled and spindle—in Washington State as of 2014. 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 budget assumptions were adopted for this study, but these assumptions may not fit every situation since production costs and returns vary across orchard operations, depending on the following factors:

- Capital, labor, and natural resources
- Crop yields
- Type and size of machinery, irrigation, and frost control systems
- Input prices
- Cultural practices
- Apple prices
- Orchard size
- Management skills

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

Fuji Production in Washington State

According to the latest tree fruit acreage report, Fuji has been in the top three dominant apple varieties produced in Washington State between 1993 and 2011, following Red Delicious and Gala in terms of production acreage (USDA-NASS 2011). In 2011, acres planted to Fuji represented 17% of the state's total apple acreage. Thirty-eight percent of all Fuji bearing acres are located in the Columbia Basin, 36% in the Yakima Valley, 19% in Wenatchee, and 7% in other areas. In the 2013–2014 marketing seasons, Fuji accounted for 13% of total fresh apple shipments from Washington State (WSTFA 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 a Fuji orchard under two trellis systems—spindle and angled—and (2) the ranges of price and yield at which Fuji apple production would be a profitable enterprise.

The primary use of this report is in identifying inputs, costs, and yields considered to be typical of well-managed Fuji orchards. This publication does not necessarily represent any particular orchard 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 a group of experienced Fuji apple growers in 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 area growers anticipate over an orchard's life, if no unforeseen failures occur. Given that many factors affect production costs, pack-out, and returns, individual growers are encouraged to use the Excel Workbook provided to estimate their own costs and returns.

Budget Assumptions

1. The area of the total farm operation is 300 acres. Bearing acres include: 225 acres of apples (75% of total area), 48 acres of sweet cherries (16%), and 27 acres of pears (9%).
2. This budget is based on a 21-acre block within a 300-acre diverse cultivar orchard. It is assumed that one acre of this block is not used for the direct production of tree fruit; rather, it is dedicated to roads, a pond, a loading area, and the like. Therefore, the total productive area for this block is 20 acres. Table 1FA and Table 1FS show the assumed Fuji block specifications with angled and spindle training systems, respectively. The only differences are in the architecture and spacing of planted trees and, thus, the tree density. Under the angled trellis system, the tree density is 1,452 trees per acre; while under the spindle trellis system, it is 1,089 trees per acre.

3. The total value of bare agricultural land (including water rights) is \$12,000 per acre with annual property taxes of \$120 per acre.
4. The irrigation system consists of overhead cooling and under-tree drip sprinklers, with two separate sub-main lines. Water is provided through a public irrigation district.
5. The pond is installed in Year 1.
6. Warehouse packing charges assume a 925-lb bin. There is no pre-sorting of apples in the field, thus the grower is charged for the 925-lb, packed bin that will include pack-outs and culls.
7. Cultural practices and harvest activities are done by hand and using ladders (no mechanical aids).
8. Management by a foreman or head supervisor is valued at \$300 per acre (applied to the entire 300-acre farm). This value represents a fair return for a producer's management skills based on the interviewed producers.
9. 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

A detailed budget is presented for the establishment and production costs of Fuji apple trees trained under an angled trellis system (FA Tables) and a spindle trellis system (FS Tables). The study assumed that a Fuji orchard in either trellis system could achieve full production in the sixth year of operation. Based on the assumptions used, the estimated full production costs for Fuji grown under an angled trellis system is \$29,848 per acre (Table 2FA) and \$27,532 per acre for Fuji under a spindle trellis system (Table 2FS). The components of the major costs shown in these tables are provided in more detail in the Excel Workbook discussed in the next section.

Production costs are classified into variable costs and fixed costs. Variable costs comprise orchard operations, harvest activities, materials, maintenance and repairs, and packing costs. Fixed costs are incurred whether or not apples are produced. These costs will generally be calculated for the whole farm enterprise and allocated for the unit of production. The fixed costs include depreciation on capital, interest, amortized establishment costs, taxes, insurance, and management.

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. 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. The amortized establishment costs assume a total productive life of 20 years, which includes five years of establishment and 15 years of full production. The amortized establishment costs must be recaptured during the full production years in order for an enterprise to be profitable.

Land cost is approximated by using the 5% interest rate multiplied by the land value of \$12,000 per acre to get a \$600 per acre expected return on land or proxy for land rent. 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. Most of the budget values given in Table 2FA and Table 2FS are based on more comprehensive underlying cost data, which are provided in the Excel Workbook described below.

Assuming an 80% pack-out for Fuji in both systems, the breakeven price is estimated at \$452 per 925-lb bin or \$19.56 per 40-lb box when grown under an angled system; and \$459 per 925-lb bin or \$19.84 per 40-lb box when grown under a spindle system. Table 3FA and Table 3FS show the sensitivity of net returns to different price and yield combinations given the different trellis systems.

The economic feasibility of investing in a Fuji orchard 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., 20 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 used 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 opportunity cost of capital. Assuming a price of \$516 per 925-lb bin and a discount rate of 5%, the NPV of the investment or expected profits (in present-day dollars) over the lifetime of the orchard is about \$0.83 million for a Fuji orchard under an angled system, and \$0.67 million for a Fuji orchard under a spindle system (Table 4). The difference between the two is mainly due to higher yields assumed for Fuji production under an angled trellis system.

The estimated discounted payback period for the orchard investment, which gives the number of years to recover an investment while accounting for the time value of money, can vary depending on the costs included in the calculation, and ranges from 6.0 to 10.1 years for Fuji under an angled trellis system, given a discount rate of 5%. If one includes total cash costs (which are the sum of total variable costs, miscellaneous supplies, land and property taxes, and farm insurance), the discounted payback period is 6.0 years. Whereas, if one includes all production costs (which are the sum of total cash cost, management, and fixed capital investment), the discounted payback period is 10.1 years. In the case of Fuji production under a spindle system, the payback period is 6.4 years for total cash costs and 10.8 years for total costs. Table 4 also shows the sensitivity of these 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 six years (2010 to 2015) is between 4% and 6%, according to the Federal Reserve Bank of Kansas City (2016). The other discount rates are added to further demonstrate the opportunity of better investments or risk of inflation. The NPV and payback period calculations are shown in detail in Appendix 10 of the Excel Workbook.

The key results of these enterprise budgets are based on 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 entire population of growers. An interactive Excel Workbook is provided to enable individual growers to estimate their returns based on the costs of their production.

Excel Workbooks

Supporting data for Fuji under the two trellis systems can be found in the following Excel Workbooks: Tables for Fuji under Angled Trellis System and Tables for Fuji under Spindle Trellis System. Excel spreadsheet versions of the enterprise budgets (Table 2FA and Table 2FS), as well as associated data underlying the per acre cost calculations (Appendixes 1 through 10 for capital requirements, calculation of interest cost, establishment costs, full production costs, calculation of salvage value and depreciation costs, amortization calculator, other production-related data, and NPV and payback period calculators) are available on the [WSU School of Economic Sciences Extension website](http://www.wsu.edu/extension).

Growers can modify select values and use the Excel Workbooks to evaluate their own production costs and returns.

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References

Federal Reserve Bank of Kansas City. 2015. [Agricultural Finance Databook: Tables](http://www.frbkc.org/publications/financial-databook/tables).

USDA-NASS (US Department of Agriculture National Agricultural Statistics Service). 2011. [Washington Tree Fruit Acreage Report 2011](http://www.nass.usda.gov/2011/washington-tree-fruit-acreage-report). U.S. Department of Agriculture National Agricultural Statistics Service, Washington Field Office.

WSTFA (Washington State Tree Fruit Association). 2015. Annual Crop Summary: 2013–14 Marketing Season. Yakima, WA.

Table 1FA. Fuji Block Specifications, Angled Trellis System

Architecture	Formally trained with 20-inch radius from tree center
In-row Spacing	2.5 feet
Between-row Spacing	12 feet
Rootstock	M9
Block Size	20 acres
Life of Planting	20 years (5 years establishment, 15 years full production)
Tree Density	1,452 trees per acre

Table 1FS. Fuji Block Specifications, Spindle Trellis System

Architecture	Randomly trained with 18-inch radius from tree center
In-row Spacing	4 feet
Between-row Spacing	10 feet
Rootstock	M9
Block Size	20 acres
Life of Planting	20 years (5 years establishment, 15 years full production)
Tree Density	1,089 trees per acre

Table 2FA. Cost and Returns of Establishing, Producing and Packing Fuji under an Angled Trellis System on a 20-Acre Orchard Block

	Establishment Years					Full Production ^A
	Year 1	Year 2	Year 3	Year 4	Year 5	
Estimated Net Production (bins/acre) ^B			24.00	38.00	52.00	66.00
Estimated FOB Price (\$/bin) ^C			516.00	516.00	516.00	516.00
TOTAL RETURNS (\$/acre)			12,384.00	19,608.00	26,832.00	34,056.00
Variable Costs						
Establishment ^D	11,168.60					
Orchard Activities ^E	1,743.00	1,974.00	2,553.20	2,979.20	3,614.20	3,608.70
Harvest Activities ^F			1,207.50	1,911.88	2,616.25	3,320.63
Warehouse Packing Charges			5,764.50	9,127.13	12,489.75	15,852.38
Maintenance and Repairs ^G	272.00	282.00	312.00	377.00	377.00	401.00
Other Variable Costs ^H	1,351.32	231.24	1,217.79	1,684.98	2,166.94	2,311.62
Total Variable Costs	14,534.92	2,487.24	11,054.99	16,080.18	21,264.14	25,494.32
Total Fixed Costs^I	2,061.46	2,891.28	3,351.71	3,452.85	3,449.10	4,353.60
TOTAL COSTS (\$/acre)	16,596.38	5,378.52	14,406.70	19,533.03	24,713.24	29,847.92
ESTIMATED NET RETURNS (\$/acre)	(16,596.38)	(5,378.52)	(2,022.70)	74.97	2,118.76	4,208.08

Notes:

A. The full production year is representative of all the remaining years the orchard is in full production (Year 6 to Year 15).

B. Estimated net production considers an average pack-out of 80%. Calculated as gross yield per acre multiplied by 0.8.

C. These prices reflect the return before any expenses are subtracted. Bin size is 925 lb.

D. Includes costs of soil preparation and planting (trees and labor).

E. Includes pruning and training, green fruit thinning, irrigation labor, chemicals, fertilizer, weed control, frost protection (labor), beehives, general farm labor, irrigation and electric charge, and organic certification fee (starting Year 4).

F. Includes picking labor, other labor (checkers, tractor drivers), and hauling apples.

G. Includes maintenance and repair, and fuel and lube.

H. Includes crop insurance (starting Year 3), overhead, and interest on operating capital.

I. Includes depreciation and interest on fixed capital, interest on establishment, and other fixed costs (miscellaneous supplies, land and property taxes, farm insurance, management cost, and amortized establishment cost).

Table 2FS. Cost and Returns of Establishing, Producing and Packing Fuji under a Spindle Trellis System on a 20-Acre Orchard Block

	Establishment Years					Full Production ^A
	Year 1	Year 2	Year 3	Year 4	Year 5	
Estimated Net Production (bins/acre) ^B			16.00	28.00	40.00	60.00
Estimated FOB Price (\$/bin) ^C			516.00	516.00	516.00	516.00
TOTAL RETURNS (\$/acre)			8,256.00	14,448.00	20,640.00	30,960.00
Variable Costs						
Establishment ^D	8,674.79					
Orchard Activities ^E	1,683.00					
Harvest Activities ^F	0.00					
Warehouse Packing Charges			3,843.00	6,725.25	9,607.50	14,411.25
Maintenance and Repairs ^G	272.00					
Other Variable Costs ^H						
Total Variable Costs	11,719.34	2,354.94	8,369.30	12,551.36	16,892.17	23,242.31
Total Fixed Costs^I	1,922.70	2,604.80	3,044.30	3,202.18	3,267.46	4,290.06
TOTAL COSTS (\$/acre)	13,642.05	4,959.74	11,413.60	15,753.54	20,159.63	27,532.36
ESTIMATED NET RETURNS (\$/acre)	-13,642.05	-4,959.74	-3,157.60	-1,305.54	480.37	3,427.64

Notes:

A. The full production year is representative of all the remaining years the orchard is in full production (Year 6 to Year 15).

B. Estimated net production considers an average pack-out of 80%. Calculated as gross yield per acre multiplied by 0.8.

C. These prices reflect the return before any expenses are subtracted. Bin size is 925 lb.

D. Includes costs of soil preparation and planting (trees and labor).

E. Includes pruning and training, green fruit thinning, irrigation labor, chemicals, fertilizer, weed control, frost protection (labor), beehives, general farm labor, irrigation and electric charge, and organic certification fee (starting Year 4).

F. Includes picking labor, other labor (checkers, tractor drivers), and hauling apples.

G. Includes maintenance and repair, and fuel and lube.

H. Includes crop insurance (starting Year 3), overhead, and interest on operating capital.

I. Includes depreciation and interest on fixed capital, interest on establishment, and other fixed costs (miscellaneous supplies, land and property taxes, farm insurance, management cost, and amortized establishment cost).

Table 3FA. Estimated Net Returns^A at Various Prices and Yields of Fuji during Full Production under an Angled Trellis System

Net Yield (bins/acre) ^B	FOB Price (\$/bin) ^C				
	\$440	\$480	\$520	\$560	\$600
48	-\$3,032	-\$1,112	\$808	\$2,728	\$4,648
56	-\$2,043	\$197	\$2,437	\$4,677	\$6,917
66	-\$808	\$1,832	\$4,472	\$7,112	\$9,752
72	-\$67	\$2,813	\$5,693	\$8,573	\$11,453
80	\$922	\$4,122	\$7,322	\$10,522	\$13,722

Notes:

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

A. Includes amortized establishment costs. Net return is what the grower receives after all costs (e.g., production expenses and packing costs) have been accounted.

B. Assumes a 925-lb bin. Takes into account an average packout equivalent to 80%.

C. Price represents the gross return, that is the return before any expenses (including packing charges) are subtracted. One box is equal to 40 lb. To convert price per bin to price per box, multiply by (925/40). The price range in this table is based on the free on board (FOB) price of Fuji apples between 2008-2009 and 2014-2015 marketing seasons. During this period, the minimum FOB price is \$440 per 925 lb bin, maximum FOB is \$631 per 925 lb bin, and 7-year average FOB is about \$516 per 925 lb bin (Source: WSTFA).

Table 3FS. Estimated Net Returns^A at Various Prices and Yields of Fuji during Full Production under a Spindle Trellis System

Net Yield (bins/acre) ^B	FOB Price (\$/bin) ^C				
	\$440	\$480	\$520	\$560	\$600
48	-\$2,619	-\$699	\$1,221	\$3,141	\$5,061
56	-\$1,628	\$612	\$2,852	\$5,092	\$7,332
60	-\$1,132	\$1,268	\$3,668	\$6,068	\$8,468
72	\$354	\$3,234	\$6,114	\$8,994	\$11,874
80	\$1,345	\$4,545	\$7,745	\$10,945	\$14,145

Notes:

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

A. Includes amortized establishment costs.

B. Assumes a 925-lb bin. Takes into account an average packout equivalent to 80%.

C. Price represents the gross return, that is the return before any expenses (including packing charges) are subtracted. One box is equal to 40 lb. To convert price per bin to price per box, multiply by (925/40). The price range in this table is based on the free on board (FOB) price of Fuji apples between 2008-2009 and 2014-2015 marketing seasons. During this period, the minimum FOB price is \$440 per 925 lb bin, maximum FOB is \$631 per 925 lb bin, and 7-year average FOB is about \$516 per 925 lb bin (Source: WSTFA).

Table 4. NPV and Payback Periods given Different Discount Rates

Discount Rate	NPV	Payback Period of Total Cash Cost ^A (years)	Payback Period of Total Cost ^B (years)
Fuji under Angled Trellis System			
3%	\$97,648.08	5.81	9.34
4%	\$1,002,518	5.89	9.70
5%	\$826,811	5.97	10.09
6%	\$674,305	6.07	10.54
7%	\$541,607	6.17	11.05
8%	\$425,867	6.27	11.67
9%	\$324,686	6.39	12.39
Fuji under Spindle Trellis System			
3%	\$1,009,561	6.20	9.94
4%	\$830,843	6.29	10.33
5%	\$676,378	6.39	10.78
6%	\$542,547	6.49	11.29
7%	\$426,316	6.60	11.89
8%	\$325,144	6.71	12.60
9%	\$236,890	6.83	13.47

Notes:

A. Cash cost is the sum of total variable cost and land rent. 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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