Education for Farmers, by Farmers

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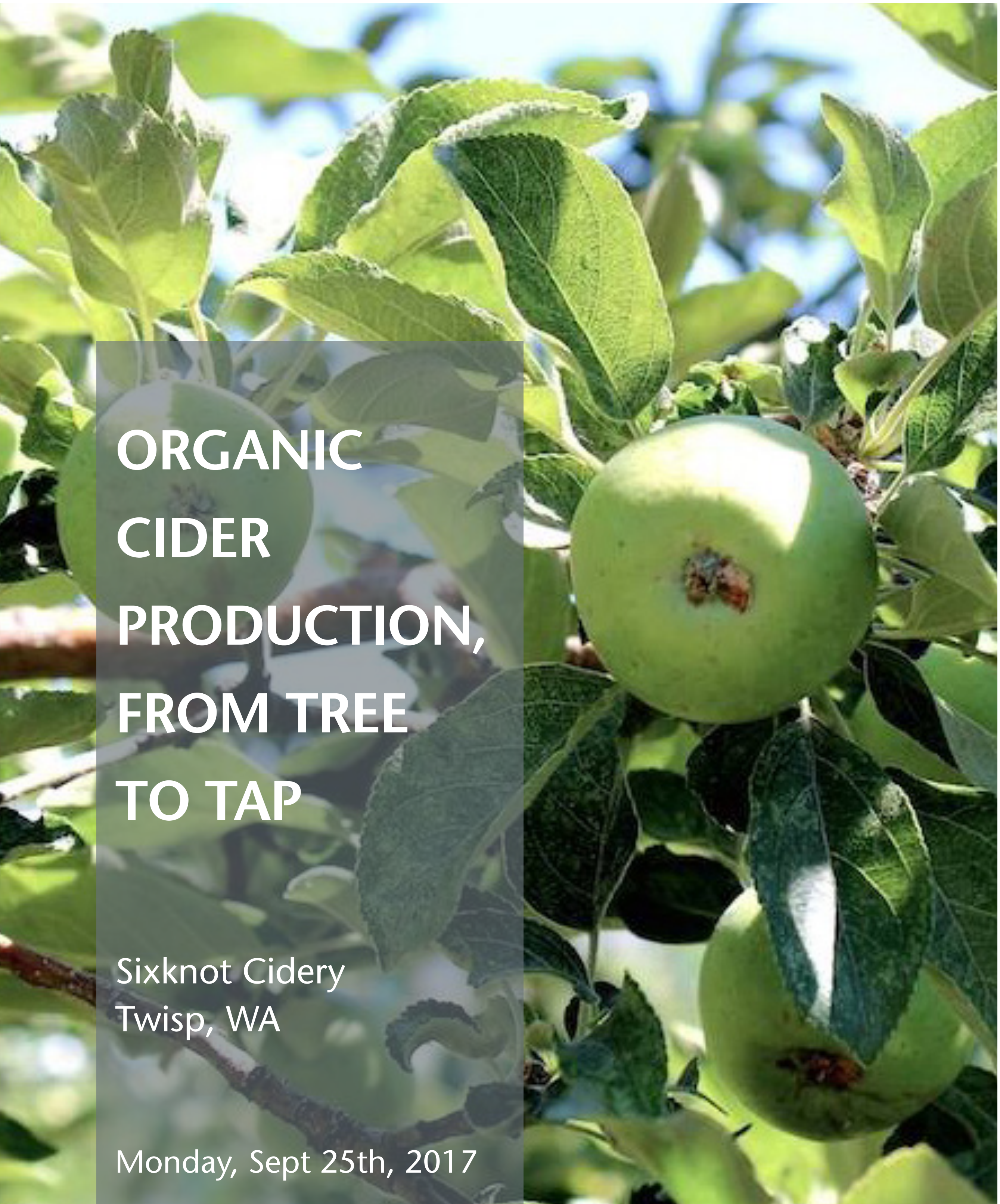


ORGANIC CIDER PRODUCTION, FROM TREE TO TAP

Sixknot Cidery
Twisp, WA

Monday, Sept 25th, 2017

presented collaboratively by:

tilth ALLIANCE

Food Systems
WASHINGTON STATE UNIVERSITY

This project was funded by the Washington State Department of Agriculture 2015 Specialty Crop Block Grant Program grant number WSDA-USDA-SCBGP-K1780-2015-2018

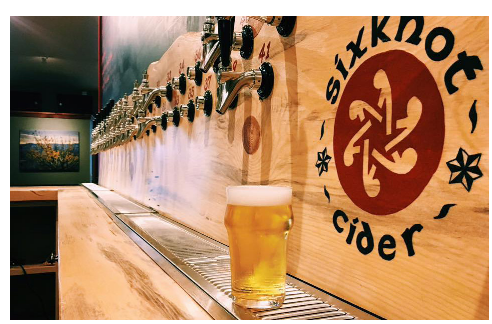
WSDA 100 YEARS Specialty Crop Block Grant Program

ABOUT SIXKNOT CIDERY...

Sixnot Cidery rests on the banks of the Methow River near Twisp, Washington. An area that has become a cider making hot spot of Central Washington. Head Cidermaker, John Sinclair, practices organic orchard management, and minimal intervention in the ciderhouse. “We only press certified organic Washington apples, selected from our trees and other local orchards. We do not add sulfites, preservatives or sugars. To retain the subtle flavors often lost in processed ciders, we do not filter. Our cidermaking is kith and kin to the natural wine movement.” John argues that cider is all about how the fruit is grown, and his artisnal process aims to highlight the *terroir* of the Methow Valley.

Beth and John Sinclair’s orchard and cidery are both powered by the sun.

Beyond organic practices in the orchard and cidery, Sixknot is also largely powered by a 7-kilowatt solar array. The way John looks at it, everything on the farm is produced by solar energy: the apples, the cider, and the electricity that powers the machines. The Sinclair’s have also expanded their venture to include a taphouse, which recently opened in Winthrop, WA. They feature their lovingly crafted ciders and offer up house-made hand pies!



2015 COST ESTIMATES OF ESTABLISHING AND PRODUCING SPECIALTY CIDER APPLES IN CENTRAL WASHINGTON

By
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2015 Cost Estimates of Establishing and Producing Specialty Cider Apples in Central Washington

Preface

Cider is fermented apple juice and is often called "hard cider" in the US. However, worldwide, the term "cider" is used most often to describe this fermented beverage and will also be the term used throughout this publication. The results presented in this publication serve as a general guide for evaluating the economic feasibility of producing cider apples in central 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 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 yield
- Cultural practices
- Input prices
- Orchard size
- Cider apple prices
- Management skills
- Type and size of machinery and irrigation system

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

Cider Apple Production in Washington State

Cider apples can be produced with fewer pesticide inputs than dessert apples since minor surface blemishes are tolerated if yield and internal fruit quality are not compromised (Peck and Merwin 2008). Cider apples are grown throughout Washington. There were an estimated 204 acres of cider apples produced in Washington State in 2010 and 256 acres in 2011 (Northwest Agriculture Business Center 2013). The top cider apple varieties grown in the state are Ashmead's Kernel, Brown Snout, Dabinett, Frequin Rouge, Harrison, Hewes Virginia Crab, Kingston Black, and Yarlington Mill (Miles et al. 2015). Examples of cider apple varieties that are grown in central Washington include some of the aforementioned varieties as well as Foxwhelp and Porter's Perfection (Table 1).

Study Objectives

According to the Alcohol and Tobacco Tax and Trade Bureau (various years), the production of cider in Washington State on which taxes were paid was approximately 56,600 gallons in 2008 and had risen to over 853,900 gallons by 2015—a 15-fold increase in 7 years and a 48% growth rate per year on average. As the production of cider continues to rapidly expand, the demand for specialty cider apples is expected to increase (Merwin et al. 2008). As such, growers will need reliable and objective information on the costs of establishing and producing apples for cider. This publication enables growers to estimate (1) the costs of equipment, materials, supplies, and labor required to establish and produce cider apples in central Washington, and (2) the ranges of price and yield at which cider apple production would be a profitable enterprise.

The primary use of this publication is in identifying inputs, costs, and yields considered to be typical of well-managed cider apple orchards in central Washington. This publication does not necessarily represent any particular orchard operation and is not intended to be a definitive guide to production practices. However, it does describe current industry trends and can be helpful in estimating the physical and financial requirements associated with establishing a profitable cider apple-producing operation.

Sources of Information

The data used in this study were gathered from two commercial apple growers, each with about 8 years of experience growing cider apples, and 10–35 acres of diverse cider apple cultivars in central Washington (Figure 1). Both growers are still experimenting and fine tuning their planting of cider apples; hence, there is no particular cultivar or mix of cultivars that can be definitely recommended for the region at the time of this study. The production practices and input requirements of the participating producers form the baseline assumptions that are used to develop this enterprise budget. In Table 1, examples of cider apple cultivars that can be produced in central Washington are listed. The production costs and returns presented in the enterprise budget is an average for the different cider apple cultivars planted.

Figure 1. A new cider orchard (left) and an established cider orchard (right) in central Washington.

The data provided represent the crop yield and application rates of inputs that these producers anticipate over a cider apple orchard's life based on the established assumptions and if no unforeseen failures occur. Given that many factors affect cider apple production costs and returns, individual producers 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 100 acres of mixed fruit trees. Bearing acres include: 75 acres of apples (75% of total area), 16 acres of sweet cherries (16%), and 9 acres of pears (9%).
2. The budget is based on an 11-acre cider apple block within the 100-acre farm operation. It is assumed that 1 acre of this block is dedicated to roads, a pond, loading area, buildings, etc., rather than to fruit production. Therefore, the total productive area for this block is 10 acres. Table 1 shows the assumed cider apple block specifications.
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 infrastructure is a dual system: drip system and sprinkler system (mainly for the ground cover). Water is provided through a public irrigation district.
5. Cultural practices and harvest activities are done by hand and using ladders (no mechanical aids).
6. Management is valued at $300 per acre by a foreman or head supervisor (applied to the entire 100-acre farm). This value represents a fair return to producer's management skills based on the interviewed producers.
7. Post-production costs, such as extended storage, juicing, and transportation to a cidery are not included in this budget.
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 Results

Table 2 shows the estimated annual cost and returns for growing cider apples in central Washington. 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, material and application costs, and maintenance and repairs. Fixed costs are incurred whether or not apples are produced. These costs will generally be calculated for the whole farm enterprise and allocated across each unit of production. The fixed costs include depreciation on capital, interest, taxes, insurance, 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.

This study assumes that cider apple trees achieve full production in their sixth year. Based on the given assumptions, the total production costs for cider apples during full production are estimated at $11,941 per acre. The estimated net returns (shown in Table 2) represent what a producer may earn from investment in land and management after all costs are subtracted, including labor the producer contributed to crop production. The breakeven price for cider apples during full production is about $239 per 900 lb bin (or $0.27/lb) given a yield of 50 bins (45,000 lb) per acre.

Crop yield and prices can vary from year to year. Therefore, to be of use to potential investors, the assumptions underlying the estimates in this enterprise budget should be carefully examined. This study assumed a production level of 50 bins per acre during the full production years (that is, years 6 to 30). This level of production is what experienced cider apple growers estimate to be an average over the remaining years that the orchard is in full production given the study's assumed production specifications and given annual crop yield variability (i.e., due to biennial bearing, extreme temperatures, and pest infestation, among others). To further help users evaluate potential production scenarios, Table 3 illustrates likely per-acre net returns for a fully established orchard given different price and yield levels.

Most of the budget values given in Table 2 are based on more comprehensive underlying cost data, which are shown in Tables 4 through 7. Table 4 presents the annual capital requirements for a 10-acre cider apple block. Table 5 specifies the machinery and building requirements for the 100-acre diverse cultivar orchard. Interest costs and depreciation are listed in Tables 6 and 7, 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. The amortized establishment costs assume a total productive life of 30 years, which includes 5 years of establishment and 25 years of full production. The amortized establishment costs must be recaptured during the full production years in order for an enterprise to be profitable. 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 cider apple 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., 30 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 opportunity cost of capital.

Assuming a price of $315 per 900 lb bin ($0.35/lb) and a discount rate of 5%, the NPV of the investment or expected profits (in present-day dollars) over the lifetime of the cider apple orchard is $0.49 million (Table 8). The estimated discounted payback period for the orchard investment can vary depending on the costs included in the calculation, and ranges from 6.7 to 11.9 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 6.7 years. Whereas, if one includes all production costs (which is the sum of total cash costs, management costs, and fixed capital investment), the discounted payback period is 11.9 years. Table 8 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 calculations can be found in Appendix 6 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 Workbook

An Excel spreadsheet version of this enterprise budget (Table 2), as well as associated data underlying the per-acre cost calculations (Tables 5 through 7 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 production costs and returns.

Additional Cider Research Information

WSU Mount Vernon Northwestern Washington Research and Extension Center (NWREC) is actively investigating cider apple production and mechanical harvest. The new cider research orchard at WSU NWREC includes 60 specialty cider apple varieties (Figure 2). More information about cider research at WSU and in the US can be found on the WSU Hard Cider website.

Figure 2. The new cider experimental orchard at WSU Mount Vernon NWREC.

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Table 1. Cider Apple Block Specifications

Architecture	Three dimensional central leader
In-row Spacing	3 feet
Between-row Spacing	10 feet
Rootstock	Dwarf - M9 series
Block Size	10 acres
Cider Apple Variety	Several varieties (e.g., Dabinett, Foxwhelp, Golden Russet, Harrison, Kingston Black, Porter's Perfection, Yarlington Mill, etc.)
Life of Planting	30 years
Tree Density	1,452 trees per acre
Trellis System	Tall spindle

Table 2. Cost and Returns per Acre of Producing Cider Apples on a 10-Acre Orchard Block in Central Washington

	Establishment Years					Full
	Year 1	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**Production**[A]
Estimated Production (bins/acre)[B]			10.00	30.00	40.00	50.00
Estimated FOB Price ($/bin)			315.00	315.00	315.00	315.00
TOTAL RETURNS ($/acre)			**3,150.00**	**9,450.00**	**12,600.00**	**15,750.00**
Variable Costs						
Establishment[C]	10,900.22	0.00	0.00	0.00	0.00	0.00
Orchard Activities[D]	1,721.00	2,088.00	2,529.60	2,864.60	3,412.60	3,713.60
Harvest Activities[E]			600.00	1,800.00	2,400.00	3,000.00
Maintenance and Repairs[F]	232.00	292.00	322.00	386.50	386.50	410.50
Other Variable Costs[G]	1,317.46	243.95	563.26	727.21	844.88	843.70
Total Variable Costs	**14,170.68**	**2,623.95**	**4,014.86**	**5,778.31**	**7,043.98**	**7,967.80**
Total Fixed Costs[H]	**2,040.67**	**2,851.23**	**3,365.85**	**3,577.38**	**3,572.67**	**3,973.00**
TOTAL COSTS ($/acre)	**16,211.34**	**5,475.18**	**7,380.71**	**9,355.70**	**10,616.65**	**11,940.80**
ESTIMATED NET RETURNS ($/acre)	**-16,211.34**	**-5,475.18**	**-4,230.71**	**94.30**	**1,983.35**	**3,809.20**

Notes:

A. The full production year is representative of all the remaining years the orchard is in full production (Year 6 to Year 30).

B. Bin size is 900 lb.

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

D. Includes pruning and training, green fruit thinning, irrigation labor, chemicals, fertilizer, frost protection (labor), beehives, general farm labor, and irrigation and electric charge.

E. Picking labor rate is $60 per 900 lb bin.

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

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

H. 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 3. Estimated Net Returns[A] ($) per Acre at Various Prices and Yields of Cider Apples during Full Production in Central Washington

Yield	FOB Price ($/bin)[C]					
(bins/acre)[B]	$195	$225	$255	$285	$315	$345
40	-$3,487	-$2,287	-$1,087	$113	$1,313	$2,513
45	-$2,839	-$1,489	-$139	$1,211	$2,561	$3,911
50	-$2,191	-$691	$809	$2,309	$3,809	$5,309
55	-$1,543	$107	$1,757	$3,407	$5,057	$6,707
60	-$894	$906	$2,706	$4,506	$6,306	$8,106
65	-$246	$1,704	$3,654	$5,604	$7,554	$9,504
70	$402	$2,502	$4,602	$6,702	$8,802	$10,902

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 production expenses have been accounted.

B. Assumes a 900 lb bin.

C. Price represents gross return before any expenses are subtracted.

Table 4. Summary of Annual Capital Requirements for a 10-Acre Cider Apple Block in Central Washington

	Establishment Years					Full
	Year 1	Year 2	Year 3	Year 4	Year 5	Production[A]
Land (11 acres)	132,000.00					
Trellis System	25,000.00					
Irrigation System	30,000.00					
Mainline & Pump	6,500.00					
Pond	3,000.00					
Wind Machine			41,289.60			
Operating Expenses[B]	148,356.75	32,889.50	46,798.64	64,433.13	77,089.83	86,327.98
Total Requirements ($)	**344,856.75**	**32,889.50**	**88,088.24**	**64,433.13**	**77,089.83**	**86,327.98**
Receipts ($)	**0.00**	**0.00**	**31,500.00**	**94,500.00**	**126,000.00**	**157,500.00**
Net Requirements ($)	**344,856.75**	**32,889.50**	**56,588.24**	**-30,066.87**	**-48,910.17**	**-71,172.02**

Notes:

A. The full production year is representative of all the remaining years the orchard is in full production (Year 6 to Year 30).

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

The yields of cider apples from Year 3, Year 4, Year 5, and Full Production are 10 bins/ac, 30 bins/ac, 40 bins/ac and 50 bins/ac, respectively.

Gross return is $315 per 900-lb bin.

Table 5. Machinery, Equipment, and Building Requirements for a 100-Acre Diverse Cultivar Orchard

	Purchase Price ($)[A]	Number of Units	Total Cost ($)
Housing for Manager	135,000	1	135,000
Machine Shop/Shed[B]	50,000	1	50,000
Tractor-70HP, 4WD	32,500	1	32,500
Tractor-40HP, 4WD	25,000	1	25,000
4-Wheeler	7,500	2	15,000
Speed Sprayer	20,000	1	20,000
Weed Spray Boom & Tank	7,000	1	7,000
Mower-Rotary (7 ft)	5,000	1	5,000
Flail Mower	8,000	1	8,000
Fork Lift	25,000	1	25,000
Bin Trailer	7,500	1	7,500
Pickup Truck	20,000	1	20,000
Ladder-8'	100	50	5,000
Miscellaneous Equipment[C]	20,000	1	20,000
Shop Equipment[D]	50,000	1	50,000
Total Cost			**425,000**

Notes:

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

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

B. Includes pesticide handling area and storage, dry storage, area for equipment cover, and shop bay for equipment work/repair.

C. Includes mobile portable toilet (2), quick connect loader, utility trailer, ladder trailer (2), etc.

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

Table 6. Annual Interest Costs per Acre for a 10-Acre Cider Apple Block in Central Washington

	Total Purchase Price ($)	Salvage Value ($)[A]	Number of Acres	Total Interest Cost ($)	Interest Cost Per Acre ($)[B]
Irrigation System[C]	30,000	0	10	750	75.00
Land	132,000	N/A	11	6,600	600.00
Machinery, Equipment, & Building[D,E]	425,000	24,000	100	11,225	112.25
Mainline & Pump[C]	6,500	0	10	163	16.25
Pond[C]	3,000	0	10	75	7.50
Trellis[C]	25,000	0	10	625	62.50
Wind Machine[C]	41,290	0	10	1,032	103.22

Notes:

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

B. Annual interest cost is calculated as: (Total Purchase Price + Salvage Value) ÷ 2 × Interest Rate. For land the calculation is: Total Purchase Price × Interest Rate because there is no salvage value for land.

C. The irrigation system, mainline 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 (10 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 7. Annual Depreciation Costs per Acre for a 10-Acre Cider Apple Block in Central Washington

	Total Purchase Price ($)	Number of Acres	Total Value Per Acre ($)	Years of Use	Depreciation Cost Per Acre ($/yr)[A]
Irrigation System	30,000	10	3,000.00	30	100.00
Mainline & Pump	6,500	10	650.00	30	21.67
Pond	3,000	10	300.00	50	6.00
Trellis	25,000	10	2,500.00	30	83.33
Wind Machine	41,290	10	4,128.96	30	137.63
Machinery, Equipment & Building[B]					291.17

Notes:

A. Annual 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 8. 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)
3%	$778,436	6.43	10.77
4%	$618,889	6.55	11.28
5%	$487,766	6.67	11.86
6%	$379,392	6.80	12.55
7%	$289,330	6.94	13.37
8%	$214,092	7.09	14.39
9%	$150,923	7.26	15.69

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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2017 Geneva Rootstock Tour

September 8, 2017

Summary written by Tianna DuPont, WSU Extension Specialist. Rootstock information from Tom Auvil.

Growers often ask which is the 'best' apple rootstock. The replant tolerant Geneva rootstocks (G.11, G.41, G.214, G.935, G.210, G.969, G.890) are much better than the available standards of Bud 9, Mark, M.9 clones, M.26 and the semi-dwarf rootstocks. But, which rootstock you use depends on your site, goals and scion. Years of experience will show us which scions will do better on which rootstocks in a given site. Try multiple rootstocks in your site to see which combination is better in your particular location. Here are some considerations from the Washington State Tree Fruit Research Commission trials and recent tour.

Background

England's East Malling Research station gathered selections and determined trueness to name. Finding many misnamed collections of plant materials Dr. R. Hatton properly divided the 24 selections found and assigned them a roman numeral. These numerals were not in order by tree size and thus M.9 is smaller than M.2. Of this group M.9, M.7, M.2, M.8 and M.13 have been commercially important in the US. In succeeding years M.26 and M.27 were developed from controlled crosses. In 1917 the John Innes Institute of Merton England joined with East Malling Research Station with an effort toward developing woolly apple aphid resistant rootstocks. Of these Malling-Merton rootstocks the MM.106 and M.111 are still widely used. In the 1960 East Malling and Long Ashton research stations in England worked to remove viruses and the resulting incompatibility problems from rootstocks. The resulting 'cleaned up' rootstocks are the EMLA group. Since this time most modern rootstocks have had viruses removed. New rootstocks are being developed the first of which was the Budagovsky series designated Bud or B. The newest rootstocks being developed and released are the Geneva series from Cornell University's breeding program.

Washington Tree Fruit Research Commission Trial

The Washington Tree Fruit Research Commission (WSTFRC) installed Geneva rootstocks trials in three locations with multiple scions in order to evaluate rootstocks in multiple soil types and growing conditions. Trees are managed by growers to approximate their normal growing practices. Trees are now in their third leaf. This fall, fruit evaluations will be conducted, allowing for observations on fruit yield and quality. This trial is meant to compliment the national NC140 rootstock trials.

Brief comments on rootstocks in TFRC trial listed from smallest to largest:

Smallest size

Bud.9 is a newer dwarfing rootstock bred in the Soviet Union from the cross of M.8 x Red Standard (Krasnij Standart). Trees in this series are 15-25% smaller than M.9 depending on the cultivar and site. B.9 appears to be resistant to collar rot and very cold hardy.

Small size

Malling 9 (M.9) is the industry standard for dwarfing rootstocks. Numerous clones of M.9 are available from nurseries including the M.9.337 clone used in this trial. **Size/vigor:** In trials M9.337 is considered to be 30% of seedling with the same scion and site. ***Pest/disease resistance:*** M.9 337 has low replant resistance, no fire blight resistance, no wooly apple aphid resistance and high crown/root rot resistance.

G.11 G.11 has the most history of the Geneva rootstocks. For example, McDougall and Son's Legacy Orchard has 8^{th} leaf trees on G.11 that are performing better than M9.337. ***Size/vigor***: Geneva 11 is considered an excellent M.9 replacement. It does well in loam and clay-loam soils. In sandy soils it must be planted closer together in order to fill space. ***Disease/pest resistance:*** G.11 is not woolly apple aphid resistant. Replant resistant. Crown and root rot resistant. Moderately resistant to fire blight[1]. ***Nursery performance:*** Stable. ***Disadvantages:*** Less tolerant to growing in sandy soil.

G.41 G.41 is the most widely available Geneva rootstock with woolly apple aphid, firelight and replant resistance. It is a cross of M.27 and Robusta 5. It has performed well across soil types including in sandy as well as loam soils. **Size/vigor:** G.41 is M9.337 size class. Some variability in vigor has been observed where Fuji on G.41 was more vigorous than Gala. In NC.140 trials in 12 locations with Golden Delicious scion it is a similar size tree to M.9 but with higher yield efficiency and fewer root suckers. ***Disease/pest resistance:*** It is highly resistant to fire blight, replant, and phytophthora crown and root rot and has woolly apple aphid resistance. ***Nursery performance:*** G.41 grows prostrate in the nursery and has union strength issues related to vigor in very large finished trees, making it challenging in the nursery. ***Disadvantages:*** G.41 has had some problems with breakage at the graft union. G.41 is sensitive to water stress. It is important to water immediately (the same day) as planting. However, it seems to recover from initial water stress.

G.214 is in the M.9 337 size class with fireblight and wooly apple resistance. ***Size/vigor:*** G.214 is similar in size to G.11 and G.41 in the M9.337 size class. In TFREC trials it had reasonable croploads in 2^{nd} and 3^{rd} leaf trees indicating potential for precocity. In all three blocks trees were above the top wire. It filled canopy and grew well. ***Disease/pest resistance:*** Replant and fire blight resistant. Wooly apple aphid resistant. ***Nursery performance:*** It is nearing commercial availability. ***Disadvantages:*** Availability is low due to prior problems with mislabeling of foundation material shipped to tissue culture companies.

Medium Full Dwarf rootstocks

M.9 Nic 29® is 20-25% larger than M.9 337 (25 to 40% of seedling). Nic 29® is a Malling 9 type rootstock. ***Size/vigor:*** It usually exhibits a better root system than M.9 337 or M.9 EMLA. Of the various types of Malling 9, Nic 29® exhibits stronger vigor, yet is still a full dwarf. The rootstock is both precocious and productive, usually fruiting in second or third leaf. ***Disease/pest resistance:*** Highly susceptible to fire blight. No wooly apple aphid or replant resistance documented. ***Disadvantages:*** Root death from fire blight infections before scion symptoms are present.

G.969 is in the large M.9 group of dwarfing rootstocks in Washington trials. ***Size/vigor:*** It is classified as having growth between M.7 and MM.106 in prior Cornell trials. More recent trials from Terrence Robinson at NYSAES Geneva, have transitioned the G.969 classification to significantly smaller. In TFRC trials it was in the size class of Nic 29. ***Disease/pest resistance:*** Fire blight, crown rot and woolly apple aphid resistance. ***Nursery performance:*** Excellent, best of the Geneva family. ***Disadvantages:*** Lack of experience with scions, sites and growers.

G.935 G.935 is the most precocious of the Geneva series in these trials. However, some new plantings have had problems that might be virus sensitivity and it should only be planted with fully virus screened scions until the issue is further understood. It is a 1935 cross of Ottawa 3 and Robusta 5. ***Size/vigor:*** Semi-dwarf reported to be slightly larger than M.26. Production efficiency rated equal to M.9. ***Disease/pest resistance:*** It is not resistant to woolly apple aphid. It has fire blight and crown rot resistance. ***Nursery performance:*** Very good. ***Disadvantages:*** Virus sensitivity was not demonstrated in known virus trials. Should be planted with virus-free scions or scions with several years of good results on G.935.

Largest

G.890 G.890 is a larger rootstock. It seems able to scavenge for water and nutrients making it a successful replacement tree rootstock. It is considerably more precocious than Malling stocks of similar vigor. ***Size/vigor:*** G.890 and 210 are the most vigorous of the Genevas. Size is similar to an M.7 but with higher and earlier production. In the TFRC trial G.890 with fruit was bigger than 210 without fruit. ***Resistance:*** Resistant to fire blight, crown rot, and wooly apple aphid. ***Nursery performance:*** Very good. ***Disadvantages:*** It is vigorous.

Tips and Comments

Tips for working with G.41. G.41 has had some problems with trees breaking at the union of the scion and the root. This brittleness is associated with high rigidity. Most of this injury happens in the nursery but at the field day Auvil explained some ways to prevent injury at planting. First, "Don't buy big trees." Bigger trees are more susceptible to breakage. "Buy ½ inch whips if you can." " ½" whips have very few problems and can be planted mechanically," Auvil explained. If you do buy larger caliper trees it is important to handle them gently. Build your trellis before you plant. Clip your trees to the trellis as you go and be gentle as you handle the bundle. "Instruct your crew to lift trees with two hands," Auvil reminded the group. Damage can occur as they untangle the trees. The NC-140 group has also found that BA applications directly to the graft union increase break strength (1). Apogee also increased strength but reduced scion growth.

Freestanding trees? Participants asked which rootstocks could be freestanding trees. Auvil reminded them that free standing is a cultural practice not a rootstock trait. Any rootstock in the trial would have to be headed back multiple times to create a free standing tree. Rootstocks that have good anchorage can be cultivated into free standing. Pruning, especially to develop free standing trees will significantly delay fruiting.

Availability. G.11, G.41 and G.935 are widely available in good supply. Other Genevas are available in smaller quantities and by per-arranged contractual agreements.

Favorite? Scott McDougall and Auvil explained that G.41 is the best all-around rootstock available right now. It has replant, fireblight and woolly resistance and has performed well across soil types. G.969 looks like it will have a good future as growers gain experience with the very new rootstock and will be a good Nic 29 replacement. G.969 is easier to plant and stands up nicely in the nursery.

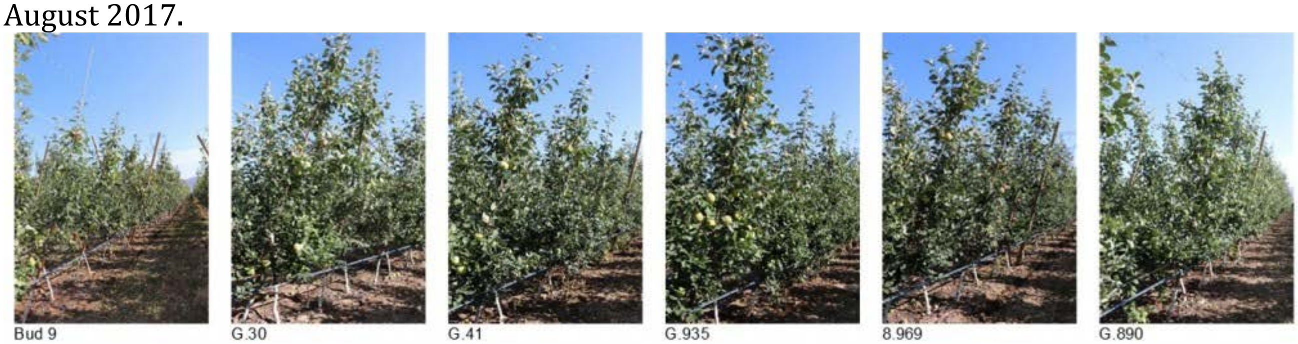
[1] In Cornell trials G.11 plants inoculated with fire blight developed 25% infection under high inoculation pressure with one of four strains of E. amylovora.

		Cold Hardy	Soil Type Compatibility		Resistance				Replace-ment trees	Nursery friendly	Challenges
			Loams/ clay	sandy	Fire Blight	Re-plant	Crown/ root rot	Woolly apple aphid			
smallest	Bud 9	Mod			High	None	High	None		Very Good	
small	M.9 337									Good	
	G.11	Mod			High	Good	High	None			Sandy soil
	G.41	High			High	High	High	High		Fair	Breakage
	G.214	High	TBD	TBD	High	High	High	High		Good	
med	Nic 29	Low			None	Low	High	None		Good	
	G.969	TBD	TBD	TBD	High	High	High	High		Excellent	
	G.935	High	TBD	TBD	High	High	High	None		Good	Virus sensitivity
largest	G.890	High	TBD	TBD	High	High	High	High		Very Good	

Attributes: Adapted from information provided to the Good Fruit Grower by Tom Auvil and Dr. Gennaro Fazio, Feb 2016.

Figure 1. Third leaf Pzazz trees in new ground in Brewster WA, August 2017.

Figure 2. Third leaf Honeycrisp trees in a non-fumigated old orchard site in Oroville WA, August 2017.



Third leaf Honeycrisp in new ground in East Wenatchee WA, August 2017.

Additional Information

http://treefruit.wsu.edu/varieties-breeding/rootstocks/

http://articles.extension.org/pages/60736/apple-rootstock-characteristics-and-descriptions

NC-140 Regional Research Project http://www.nc140.org

Geneva Rootstock Trial Update 2016 http://treefruit.wsu.edu/news/geneva-rootstock-performance-2016-rootstock-trial-update/

Virus Sensitivity in G 935 http://treefruit.wsu.edu/news/virus-sensitivity-in-g-935/

References

(1)Adams, S. Black, B.L., Fazio, G., Roberts, N.A. 2017. Journal of the American Pomological Society. 71(1): 8-18 2017

Penn State Tree Fruit Production Guide. 2016.

WASHINGTON TREE FRUIT RESEARCH COMMISSION

Compost Use for Tree Fruit

Tianna DuPont, WSU Extension Specialist

For crop success we want the soil to hold water and nutrients like a sponge where they are readily available for plant roots to take them up and suppress pests and diseases that may attack plant roots. Compost like many other organic matter sources can help increase the soil function. Here are a few considerations for orchardist using compost.

What is Compost?

According to the USDA "Composting is the controlled aerobic decomposition of organic matter by microorganisms into a stable, humus-like soil amendment." The final composted material should have the following physical and odor qualities: unrecognizable original materials; dark brown to black; foreign matter/materials less than 1%; relatively porous, not compacted or hard; and no objectionable odors, but an 'earthy' smell.[1]

- Moisture less than 60%;
- Organic Matter not less than 40% (oven dried mass);
- And C:N ratio of less than 25:1.

Certified organic producers should know that compost must be made according to the criteria set out in § 205.203(c)(2). This section of the regulations specifies that:

- The initial carbon:nitrogen ratio of the blended feedstocks must be between 25:1 and 40:1.
- The temperature must remain between 131 °F and 170 °F for 3 days when an in-vessel or a static-aerated-pile system is used.
- The temperature must remain between 131 and 170°F for 15 days when a windrow composting system is used, during which period the windrow must be turned at least five times.

Materials not decomposed in this manner also provide organic matter and nutrients. Manure based products must be applied a minimum of 90 days before harvest for crops like fruit which do not grow touching the ground. An additional product sometimes considered in this category are heat treated manures. To be considered processed, the manure must be heated to 150 °F for 1 hour and dried to 12 percent moisture or less. Please check with your food safety inspector.

[1] BC Agricultural Composting Handbook

Compost Testing

There are multiple testing labs that are certified to conduct compost tests (See appendix 1). Make sure to run a compost test, not a soil test. A soil test run on compost will give you inaccurate results.

A few things that you want to look for are:

- **Nutrient content.** Nutrient content can be highly variable between composts and even among batches from the same supplier.
- **Electrical conductivity (EC).** This is an indicator of the salt level in the compost. However, it also relates to the nutrient content. The units dS/m = mmhos/cm=mS/cm.
- **Sodium (Na) %.** Less than 0.5% is desirable.
- **pH.** – avoid high pH compost on high pH soil
- **NO3 vs NH4**. Compost with more ammonium (NH4) are less mature.
- **C:N.** 20 to 25:1, no net effect on N.
- **Organic matter %.** 50-60% indicates maturity.
- **Bioassay.** Occasionally compost can have herbicide residual or high enough salts or nutrients to reduce plant growth. An emergence test with a susceptible plant helps to indicate whether the risk of problems is higher.
- **Pathogens.** Salmonella and *E. Coli* levels can indicate levels of pathogens of potential human risk.
- **Arsenic.** Is less of a concern under current regulations, but heavy metals contamination from compost is to be avoided.

Potential to Improve Water Holding and Buffering Capacity

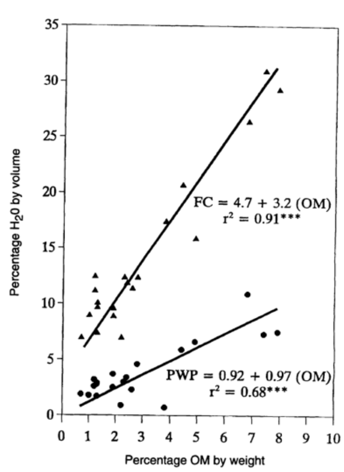


Figure 1. Soil available water capacity increases with soil OM. Hudson, B. 1994. Journal of Soil and Water Conservation.

Compost like many other types of biomass inputs can increase the soil organic matter and consequently the water holding capacity of soil. Organic matter is the living, dead and very dead components of the soil act like a sponge holding water and nutrients in the soil and releasing them slowly over time. In the well drained orchard soils of the east this is an important characteristic.

In the middle of summer an orchard may need 3 acre inches of water per week to keep up with their evapotranspiration needs. Water stress can lead to small size fruit and calcium disorders like cork spot and bitter pit. Remember calcium moves through the plant from the soil through the roots and the xylem the water moving tubes in the plant. Water stressed plants have less water with its suspension of calcium being pulled into fruit and calcium disorders are more common.

Soil scientists report that for every 1 percent of organic matter content, the soil can hold 16,500 gallons of plant-available water per acre of soil down to one foot deep. See figure below.

Surface application of organic matter like compost can also help with water retention. For example, Gerry Nielsen at AgriFood Canada in one study found that mulching saved more than 50% on irrigation. In another study, surface application of mulch decreased water depletion by 24% (Granatstein 2001 unpublished data). Note, mulch studies were generally done with low nutrient products like wood chips.

Figure 2. Effect of Mulching on Water Use in Apple Trees in Lysimeter Plots, 2001

Trunk diam	H2O used/tree (L)		Irrigation saved by mulching (%)
(mm)	non-mulched	mulched	
25	1009	466	54%
50	2427	2072	15%

Fertility Inputs from Compost

Organic nutrient sources such as compost and manure can be a good source of nutrients.

Figure 3.

Median values from analysis of 126 manure compost samples at PSU Ag Analytical Lab. All test values based on percent dry weight.

Parameter	Test Value	lbs applied per Ton
Organic Matter	45%	900
Total Nitrogen	1.45%	29
P_2O_5	0.96%	19
K_2O	1.08%	22
C/N (estimated)	17	

Keep in mind the feedstock will affect the nutrient content.

Nutrient Content of Washington Composts

	Unit	Chicken (3)	Cow (4)	Yard (3)
OM	%	74-78	30-50	30-50
pH		6.3-8.3	6.1-8.9	6.3-7.6
E.C.	mmho /cm	25-30	7-25	2-13
C:N		10-38	10-32	13-23
Tot N	%	1.1-4.2	0.9-1.9	0.8-2.0
NO3-N	ppm	162-2460	36-2081	8-1421
NH4-N	ppm	3600-9780	16-306	17-50
Tot P	%	0.9-1.8	0.2-0.8	0.2-0.3
Tot K	%	0.6-2.5	0.3-1.4	0.4-1.1
Ca	%	3.0-5.5	1.1-2.5	1.1-1.5
Mg	%	0.4-0.7	0.5-1.0	0.4-0.5
Zn	ppm	142-516	73-271	143-207
B	ppm	29-59	61-242	59-62
Cu	ppm	33-930	37-96	26-80

**Granatstein 1996

Keep in mind that the nutrient composition of compost can be highly variable depending on what feedstock is used. Make sure to test your compost or request the most recent analysis from your supplier.

For example, here are nutrient values from several local compost sources.

Nutrients (lbs) Applied per Ton of Compost (dry weight)

	Tot N	P2O5	K2O	Ca	Mg	Na	Sulfur	Boron	Zinc	Mn	Copper	Iron
Royal Organics (Compell)	48	20	50	54	11	3.8	5.6	0.04	0.21	0.51	0.06	32
Royal Organics (Royal Classic)	33	12	24	34	9	2.8	3.8	0.04	0.26	0.63	0.07	28
Royal Organics (Mint)	84	30	34	54	19	1.8	8.8	0.06	0.13	0.32	0.05	9
Rexius	34	12	22	40	9	0	0	0.00	0.00	0.00	0.00	0
Eko	28	38	13	32	10	1.1	0.4	0.04	0.03	0.56	0.28	13
Ava Gro	31	42	71	0	0	0	0	0.00	0.00	0.00	0.00	0
Natural Selections	42	36	34	79	14	8.2	6.6	0.07	0.33	0.81	0.10	33

On average compost contains 1-3% nitrogen (about 30-60 lb/Ton). However, nitrogen in compost is not all available in the year you apply it. The mineralization rate will vary depending on whether the compost is finished or not. Generally, between 5 and 20% will be mineralized per year. For finished compost an estimate is that 15% will be available the year after you apply it and 10% the next two years. After that point the compost will continue to contribute as part of the organic matter component of the soil. We generally assume a credit of 20 lb/A available N for every percent OM more than 2%.

Nutrients Available Year 1 (lbs) per Ton of Compost (dry weight)
Assuming an Availability factor of 0.15 for nitrogen

	Tot N	P2O5	K2O	Ca	Mg	Na	Sulfur	Boron	Zinc	Mn	Copper	Iron
Royal Organics (Compell)	7	3	7	8	1.7	0.6	0.8	0.0	0.0	0.1	0.0	4.8
Royal Organics (Royal Classic)	5	2	4	5	1.4	0.4	0.6	0.0	0.0	0.1	0.0	4.2
Royal Organics (Mint)	13	4	5	8	2.9	0.3	1.3	0.0	0.0	0.0	0.0	1.3
Rexius	5	2	3	6	1.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Eko	4	6	2	5	1.4	0.2	0.1	0.0	0.0	0.1	0.0	1.9
Ava Gro	5	6	11	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Natural Selections	6	5	5	12	2.2	1.2	1.0	0.0	0.0	0.1	0.0	4.9

Using the Oregon State Calculator, you can get a more accurate mineralization rate that takes into account the carbon to nitrogen ratio of the product and the dry matter content. For example see below, availability factors vary from 5-10% dry weight and 2-22% wet weight.

Nitrogen Available Year 1 (lbs) per Ton of Compost (as is basis)

	Compost Type	% Tot N (dry weight)	% Tot N (as is)	% solids	PAN (lb N/100 lb) dry weight basis (full season)	PAN (lb N/100 lb) (as is basis) (full season)	lb available N/Ton (as is basis)
Royal Organics (Compell)	manure	2.4	2.16	0.9	0.10	0.22	**11**
Royal Organics (Royal Classic)	greenwaste	1.7	1.3	0.9	0.10	0.17	**6**
Royal Organics (Mint)	mint	4.2	2.69	0.64	0.10	0.27	**23**
Rexius	greenwaste	1.7	0.72	0.43	0.05	0.04	**1**
Eko		1.4	0.7	0.53	0.05	0.03	**1**
Ava Gro	broiler	1.6	1.2	0.76	0.05	0.02	**1**
Natural Selections	greenwaste	2.1	1.7	0.55	0.10	0.17	**7**

Example Calculation A.

For example, assume a 75 bin/acre crop goal on dwarf trees where crop needs are: 66 N, 11 P, 121 K. If you are working with a compost with an analysis of 31.5 lb total N/T, 41.6 lbs P_2O_5/T and 70.7 K_2O/T. If you apply 3T/A of compost will you supply your crop with sufficient N? Use a generous 15% mineralization rate for this example.

Do you have sufficient nitrogen to meet your crop needs?

	Nitrogen (N) lbs/A	**Phosphate (P_20_5) lbs/A**	**Potash (K_2O) lbs/A**
1. Nutrient needs based on soil, tissue test and crop goals.	66	11	121
2. This years application (source 1)	14	124.8	212.1
3. Balance	52	- 113	- 91

$$\frac{31.5\ lbs\ N}{Ton\ compost} \times \frac{3\ Ton\ compost}{A} = \frac{94.5\ lbs\ N\ applied}{A}$$

$$\frac{94.5\ lb\ N\ applied}{A} x \frac{0.15\ lb\ N\ available\ year\ 1}{lb\ N\ applied} = \frac{14\ lb\ N\ available\ year\ 1}{A}$$

Example Calculation B.

If it is not your first year using compost you likely need to also consider contributions from previous applications. In this case we will consider a field with a history of compost applications. Assume soil organic matter of 3.0%. Assume that 3T/A was applied last year as well.

	Nitrogen (N) lbs/A	Phosphate (P_2O_5) lbs/A	Potash (K_2O) lbs/A
1. Nutrient needs based on soil, tissue test and crop goals.	66	11	21
2. Credits from previous season			
a. Soil organic matter	20		
b. Manure			
c. Compost	9		
d. Prior legume cover crop			
e. Prior leguminous crop			
3. Total credits (add a. +b. + c. +d +e.)	29		
4. Additional needed (1 minus 3)	27	11	21
5. This years application (source 1)	14	124.8	212.1
(source 2)			
6. Balance	13	-113	-91

2.a. Give yourself a credit of 20 lb/A of available N for every %OM over 2%.

$$3.0\%\ OM - 2\%\ OM = 1.0\ x\ \frac{20\ lb\ N}{A} = \frac{20\ lb\ available\ N}{A}$$

2.c. Give yourself a credit for nitrogen mineralizing from the previous year's compost applications.

$$\frac{31.5\ lbs\ N}{Ton\ compost} \times \frac{3\ Ton\ compost}{A} = \frac{94.5\ lb\ N\ applied}{A}\ x\ \frac{0.10\ lb\ N\ available\ year\ 2}{lb\ N\ applied} = \frac{9\ lb\ N\ available\ year\ 2}{A}$$

5.0 Calculate the input from this year's compost application.

$$\frac{31.5\ lbs\ N}{Ton\ compost} \times \frac{3\ Ton\ compost}{A} = \frac{94.5\ lbs\ N\ applied}{A}$$

$$\frac{94.5\ lb\ N\ applied}{A}\ x\ \frac{0.15\ lb\ N\ available\ year\ 1}{lb\ N\ applied} = \frac{14\ lb\ N\ available\ year\ 1}{A}$$

Compost Potential to Impact Replant Disease

In general soils with higher organic matter as a result of compost or other carbon inputs have larger more active soil biota. Beneficial soil biota populations can reduce the potential for infection from plant pathogens. However, the impacts of compost have been variable.

Compost Testing Services

A&L Great Lakes Labs 3505 Conestega Drive Fort Wayne, IN 46808
www.algreatlakes.com

A&L Western Laboratories, Inc. 1311 Woodland Ave. Suite 1
Modesto, CA 95351

Ag Analytical Services Lab Penn State University Tower Road University Park, PA 16802. 814-863-0841 http://agsci.psu.edu/aasl

Central Testing Laboratory Ltd. Unit 9-851 Lagimodiere Blvd.
Winnipeg, MB Canada R2J 3K4. www.ctl.mb.ca

Colorado Analytical Laboratories, Inc. 240 S. Main St. Brighton, CO 80601
www.coloradolab.com

Environmental Research and Innovation Center University of Wisconsin Oshkosh
800 Algoma Blvd. Oshkosh, WI 54901

Soiltest farm consultants - 2925 Driggs Dr Moses Lake WA 98837. www.soiltestlab.com. (509) 765-1622

Soil Control Lab - 42 Hangar Way, Watsonville, CA 95076. (831)724.542

Texas Plant & Soil Lab 5115 W. Monte Cristo Rd. Edinburg, Texas 78541 www.TexasPlantAndSoilLab.com

Compost Suppliers

Ava Gro - Granger WA Gary Dixon(509) 864-2601 garyldixon1937@gmail.com

Biowest Ag Solutions - 3301 W. Kingsgate Way, Richland, WA 99352 – (509) 572-0034

Columbia Valley Compost (509) 948-028 - dan@compostblend.com

Corfe's Premium Chicken Manure Compost - 3950 Wood Avenue
Armstrong, BC V0E 1B2 - (250) 546-9732
Nature's Nutrients - 4430 Hullcar Road, Armstrong, BC, Canada - (250) 550-4100 - len@nnorganics.com

Eko Compost available through Northwest Wholesale

Natural Selection Farms - PO Box 419, Sunnyside, WA 98944 – (509) 837-3501
Chelsea@naturalselectionfarms.com www.naturalselectionfarms.com

Pacifi Clean - 111 N Post St #200, Spokane, WA 99201 - (509) 455-5477

Rexius Forest By Products Inc - 1275 Bailey Hill Rd., Eugene, Oregon 97402- (541) 335-8008
jackh@rexius.com

Royal Organics - 17405 Road 13 SW, Royal City, WA 99357 - (509)554-3885
info@roporganic.com http://roporganics.com

Yield, labor, and fruit and juice quality characteristics of machine and hand harvested 'Brown Snout' specialty cider apple

Miles, Carol A. and Jaqueline King. 2014. Yield, labor, and fruit and juice quality characteristics of machine and hand-harvested 'Brown Snout' specialty cider apple. HortTechnology 24(5):519-526.

For the full article, contact the author: milesc@wsu.edu

Summary
In this 2-year study of 'Brown Snout' specialty cider apple (*Malus domestica*) grafted onto Malling 27 (M.27) and East Malling/Long Ashton 9 (EMLA9), we compared weight of total harvested fruit, labor hours for harvest, tree and fruit damage, and fruit and juice quality characteristics for machine and hand harvest. Machine harvest was with an over-the-row small fruit harvester. There were no significant differences due to rootstock however there were differences between years for most measurements. Weight of harvested fruit did not differ due to harvest method, however harvest efficiency was 68% to 72% for machine pick and 85% to 89% for machine pick + clean-up weight (fruit left on trees and fruit knocked to the ground during harvest) as compared to hand harvest. On average for the 2 years, hand harvest required 23 labor-hours per acre at a total cost of $417, while machine harvest required 5 labor-hours per acre at a cost of $93. There were no differences due to harvest method on damage to spurs (four to eight damaged per tree) or limbs (0.5 -0.8 damaged per tree). While there were also no differences due to harvest method on fruit bruising (100% for both harvest methods in this study), 10% of fruit were sliced and 4% of fruit were cut in half inadvertently with machine harvest, and none were sliced or cut with hand harvest. Harvest method had no effect on fruit quality characteristics, specifically, soluble solids concentration (SSC), pH, specific gravity, titratable acidity (malic acid equivalents), or percent total tannin, when fruit was pressed immediately after harvest or stored for 2, 3 or 4 weeks before pressing. Juice quality characteristics were affected by storage, and SSC increased 11% in 2011 (3 weeks storage), and 12% and 18% in 2012 (2 and 4 weeks storage, respectively). Similarly, specific gravity increased both years after storage, 1% in 2011, and 1% and 2% in 2012 (a 1% increase in juice specific gravity corresponds to a potential 1.3% increase in alcohol by volume after fermentation for cider). Both years, juice pH tended to decline when fruit was stored (0.01 pH units in 2011, 0.06-0.12 pH units in 2012). Overall, cider apple harvest with an over-the-row small fruit machine harvester used four times less labor than hand harvest, yield reached 87% that of hand harvest (when clean-up yield was included), and juice quality characteristics were not negatively affected. These results suggest that machine harvest may be suitable for cider apples if equipment is available and affordable.

Regional variation in juice quality characteristics of four cider apple (Malus × domestica Borkh.) cultivars in northwest and central Washington

Alexander, T.R., J. King, A. Zimmerman, and C.A. Miles. 2016. Regional variation in juice characteristics of four cider apple (Malus × domestica Borkh.) cultivars in central and northwest Washington. HortScience 51(12):1-5.

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Summary

In this study, four cider apple (Malus × domestica Borkh.) cvs., Brown Snout, Dabinett, Kingston Black, and Yarlington Mill, were collected from four orchards, two in northwest Washington and two in central Washington, to compare juice quality characteristics. Northwest Washington has a cool, humid summer climate (16.0 °C on average during this study) and is the origin of the state's cider apple industry, while central Washington has a hot, dry summer climate (22.1 °C on average during this study) and is the center of the state's dessert apple industry. Each year from 2012 to 2015, fruit of the four cultivars was harvested and stored at each orchard until it was collected. Fruit were pressed and the juice analyzed for five quality characteristics important to cider making: soluble solids concentration [SSC (percent)], specific gravity (SG), pH, titratable acidity [TA, malic acid equivalent (g.L-1)], and tannin [tannic acid equivalent (percent)]. Harvest dates and climate data were recorded annually for each orchard location. There were no significant differences in any of the juice quality characteristics due to region and no significant interaction of region, cultivar, and/or year. Results did show, as expected, a significant difference in all five juice characteristics due to cultivar. 'Brown Snout', 'Dabinett', and 'Kingston Black' were higher in SSC and SG than 'Yarlington Mill'; 'Dabinett' had the highest pH and lowest TA while 'Kingston Black' had the lowest pH and highest TA; and tannin was highest in 'Yarlington Mill' and lowest in 'Kingston Black'. There was also a difference in SG and tannin due to year; SG was lowest in 2013 while tannin was highest in 2012. The difference in SG from year to year may be a result of variable year-to-year storage time at each orchard prior to collection of fruit. The difference in tannin from year to year was likely due to climatic variation over the four years of the current study. On average, growing degree days increased 10% and chilling hours decreased 10% from 2012 to 2015 in both regions. Classification of the four cultivars included in this study differed from historical records at the Long Ashton Research Station (LARS) in England; in this study the four cultivars exhibited tannin levels below 0.20% and would not be classified as bitter, unlike their historical classification at LARS. Results from this study indicate that variations in juice quality characteristics occur between cultivars as expected and occur within a cultivar from year-to-year, but for the four cultivars included in this study variations did not occur due to production region in Washington.

Yield, fruit damage, yield loss and juice quality characteristics of machine and hand harvested 'Brown Snout' specialty cider apple stored at ambient conditions in northwest Washington.

Alexander, T.R., J. King, E. Scheenstra, and C.A. Miles. 2016. Yield, fruit damage, yield loss and juice quality characteristics of machine and hand harvested 'Brown Snout' specialty cider apple stored at ambient conditions in northwest Washington. HortTechnology 26(5):614-619.

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Summary

In this 2-year study, 'Brown Snout' specialty cider apple (*Malus* x *domestica*) that had been hand harvested or machine harvested with an over-the-row shake-and-catch small fruit harvester was ambient stored (56 °F mean temperature) for 0, 2 and 4 weeks to evaluate yield, fruit damage, yield loss and juice quality characteristics. The average yield (pounds per acre) of fruit picked and retained by the mechanical harvester was 74% that of the hand harvest yield and 81% that of the hand harvest yield when fruit that fell out of the harvester was included in the machine harvest yield. Percent fruit bruised and cut were greater for machine harvest (97.5% and 25.5%, respectively) than for hand harvest (47% and 0.5%, respectively), on average for 2014 and 2015. Yield loss to rot was greater for machine harvest than for hand harvest, and increased for both methods over time; percent rot doubled from 2 weeks to 4 weeks storage for machine harvest (22% to 41%), and while negligible, tripled from 2 weeks to 4 weeks storage for hand harvest (0.7% to 2.1%). Juice quality characteristics did not differ due to harvest method, but did differ due to year and storage time. Soluble solids concentration [SSC (percent)] and specific gravity (SG) did not change due to storage in 2014, but in 2015 SSC and SG were greater on average for 2 and 4 weeks storage duration (15.00% and 1.062, respectively) than at harvest (13.31% and 1.056, respectively). Titratable acidity [TA (malic acid $g{\cdot}L^{-1}$)] decreased in 2014 from 2.98 $g{\cdot}L^{-1}$ at harvest to 2.70 $g{\cdot}L^{-1}$ on average for 2 and 4 weeks storage duration, but did not differ due to storage in 2015. Tannin [tannic acid equivalent (percent)] was unchanged in 2014 from harvest to 4 weeks storage, but increased in 2015 from 0.16% at harvest to 0.19% by 4 weeks storage. These results indicate that harvest efficiency could be improved with some engineering modifications of the over-the-row mechanical harvester and training modifications for the trees. A comparison of the aromatic and phenolic contents of mechanically harvested and hand harvested 'Brown Snout' would be a valuable next step in evaluating shake-and-catch mechanical harvest technology for cider apple production.

ONLINE RESOURCES...

Orchard and Cider Production

Hard Cider Production and Orchard Management in the Pacific Northwest
https://pubs.wsu.edu/ItemDetail.aspx?ReturnTo=0&ProductID=15402

2013 Cost Estimation of Establishing a Cider Apple Orchard in Western Washington
http://cru.cahe.wsu.edu/CEPublications/FS141E/FS141E.pdf

Feasibility of Different Harvet Methods for Cider Apples: Case Study for Western Washington
http://cider.wsu.edu/wp-content/uploads/sites/54/2017/04/Feasibility-of-Different-Harvest-Methods-for-Cider-Apples-Case-Study-for-Western-Washington.pdf

A Northwest Cidermaker's Terroir, written by Cidermaker John Sinclair of Sixknot Cider
http://www.sixknotcider.com/terroir.html

WSU Extension Cider Website
http://cider.wsu.edu/cider-information

Codling Moth Management Program - WSU IPM Decision Aid System
http://decisionaid.systems/page/cm_management_program

Strategies for controlling Obliquebanded Leafroller - WSU IPM Decision Aid System
https://www.decisionaid.systems/news/story/2017/03/28/Most_Effective_Strategies_for_Control_of_Obliquebanded_Leafroller

Upcoming Educational Event from WSU Cider
http://cider.wsu.edu/events/

Article in Methow Valley New about Sinclair's and Sixknot Cidery
http://methowvalleynews.com/2015/10/08/a-solar-powered-organic-cidery-comes-into-its-own/

Washington State Organic Certification Processes

WSDA Organic Program: Interested in Organic Certification?
A webpage dedicated to resources for new applicants beginning the certification process. Available at:
https://agr.wa.gov/FoodAnimal/Organic/NewOrg.aspx

WSDA Organic Program's Organic Certification Fee Calculator. Estimate certification costs, determine the forms needed for certification, and evaluate other requirements and licenses needed for your business. Available at:
https://agr.wa.gov/foodanimal/organic/orgcertfeecalc.aspx.

National Organic Program Website:
https://www.ams.usda.gov/about-ams/programs-offices/national-organic-program

National Organic Program Guide to Organic Certification:
https://www.ams.usda.gov/publications/content/guide-organic-certification

Interactive video on the certification steps: "The Road to Organic Certification"
https://www.ams.usda.gov/reports/road-organic-certification

National Organic Program Factsheet: Making the Transition to Organic Production and Handling:
https://agr.wa.gov/FoodAnimal/Organic/NewOrg.aspx

NCAT-ATTRA: Hoja de Datos: Transición al Manejo Orgánico de Huertos Frutales:
https://www.ams.usda.gov/sites/default/files/media/FINAL%20Transicion%20al%20Manejo%20Organico%20de%20Huertos%20Frutales.pdf

Food Systems

WASHINGTON STATE UNIVERSITY

Supporting thriving Washington farms, ecosystems, and food economies to provide communities with equitable access to sustainably produced and healthy foods.

Our food systems work is guided by an interdisciplinary team of WSU Faculty, Staff, and critical non-WSU partners. Team members collaborate on initiatives that promote research, implement change, and provide unparalleled educational opportunities for communities, graduates and undergraduates. All of this work is supported through the Center for Sustaining Agriculture and Natural Resources (CSANR) which convenes extension, research, and academics. Find us at foodsystems.wsu.edu

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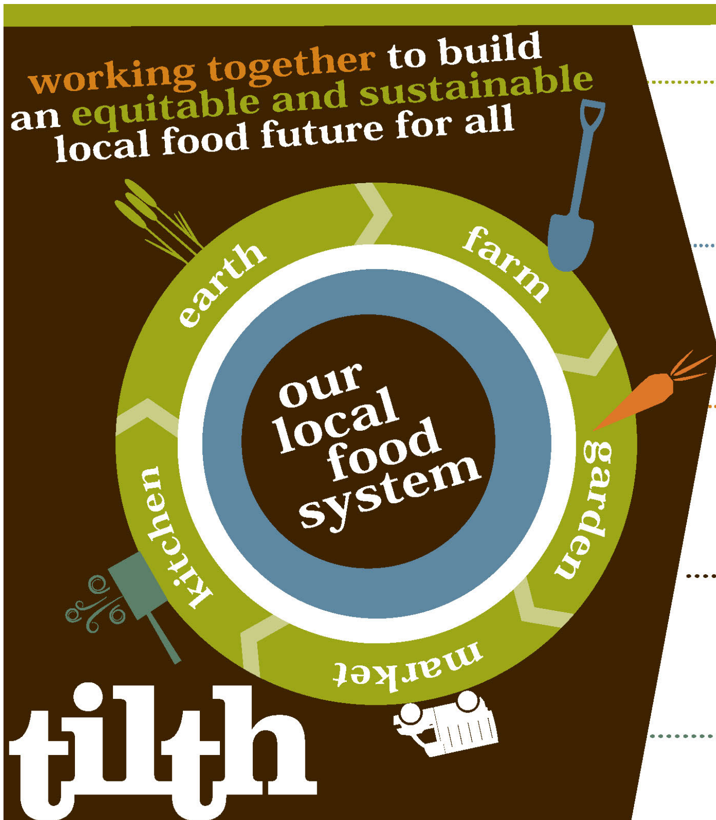

earth

A healthy environment is the foundation for growing healthy food. We enable community members to build healthy soil, restore the environment, manage pests naturally, protect water quality and teach others.

soil and water stewardship training | Garden Hotline Master Composter / Soil Builder training | restoration projects

farm

All farmers need support to thrive. We provide Washington's farming community with peer-to-peer education, connect them with the land they need and support their business enterprises.

farmer-to-farmer education | farm business incubator
FarmLink | Tilth Conference | Tilth Producers Quarterly

garden

People who know how to grow food have better health, a stronger connection to the land and more resilience. We teach people of all ages and incomes to grow food.

adult classes | school tours | mobile classroom
children's camps | community learning gardens
teacher workshops | Tilth Alliance Youth Garden Works

market

Farmers need secure markets, and everyone has a right to food that is good for them and for the environment. We help consumers find local products and get produce into their hands through farmers' markets, community supported agriculture (CSA) and subsidized access for low-income families.

Farm Guide | CSA | Good Food Bags

kitchen

People who know how to cook and understand nutrition are empowered to eat well every day. We share cooking skills, nurtition knowledge and food traditions through classes, events and youth programs.

community dinners | youth cooking clubs | senior meals

tilthalliance.org