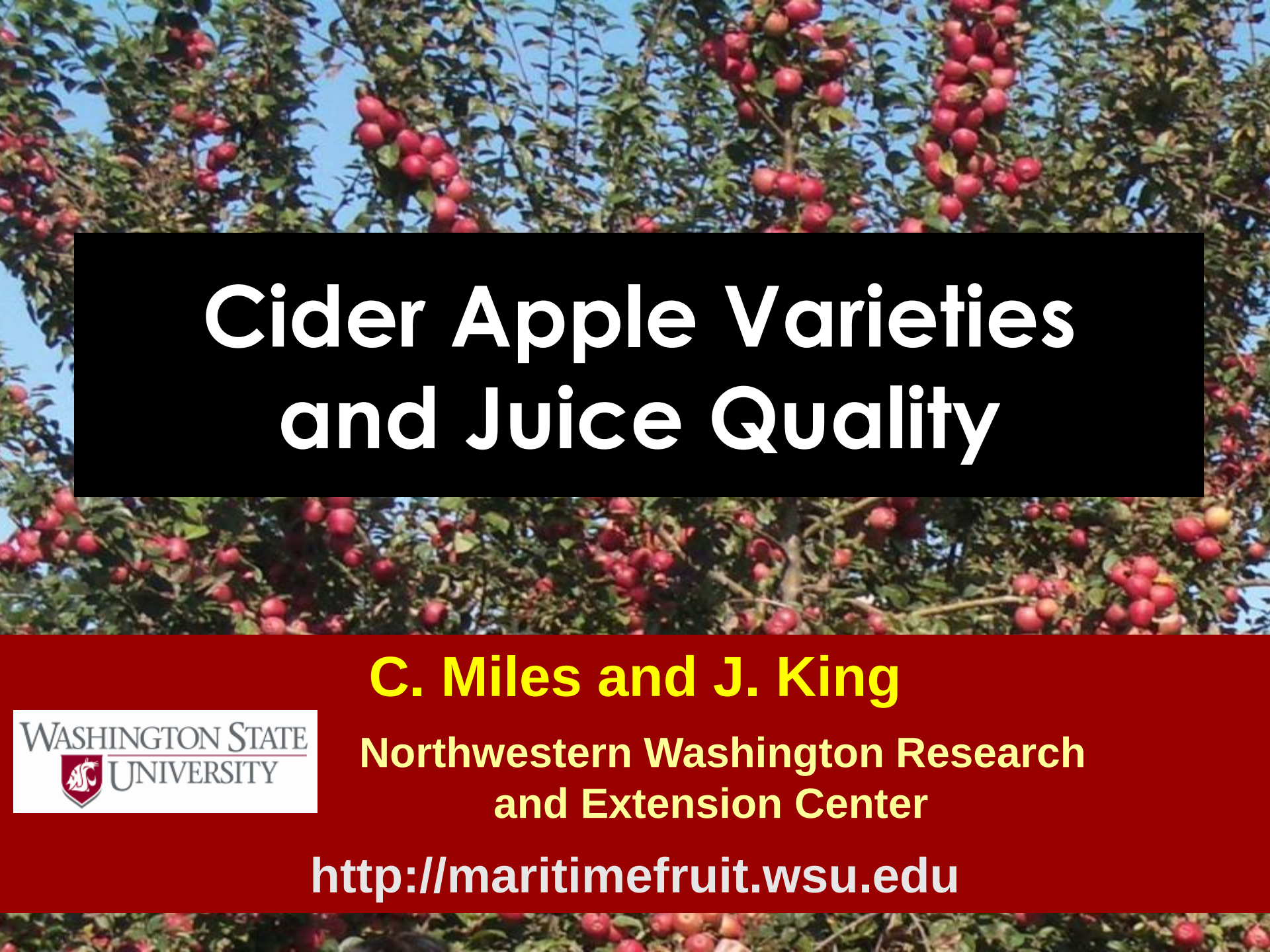


Cider Apple Varieties and Juice Quality

C. Miles and J. King

Washington State University

Northwestern Washington Research and Extension Center

http://maritimefruit.wsu.edu

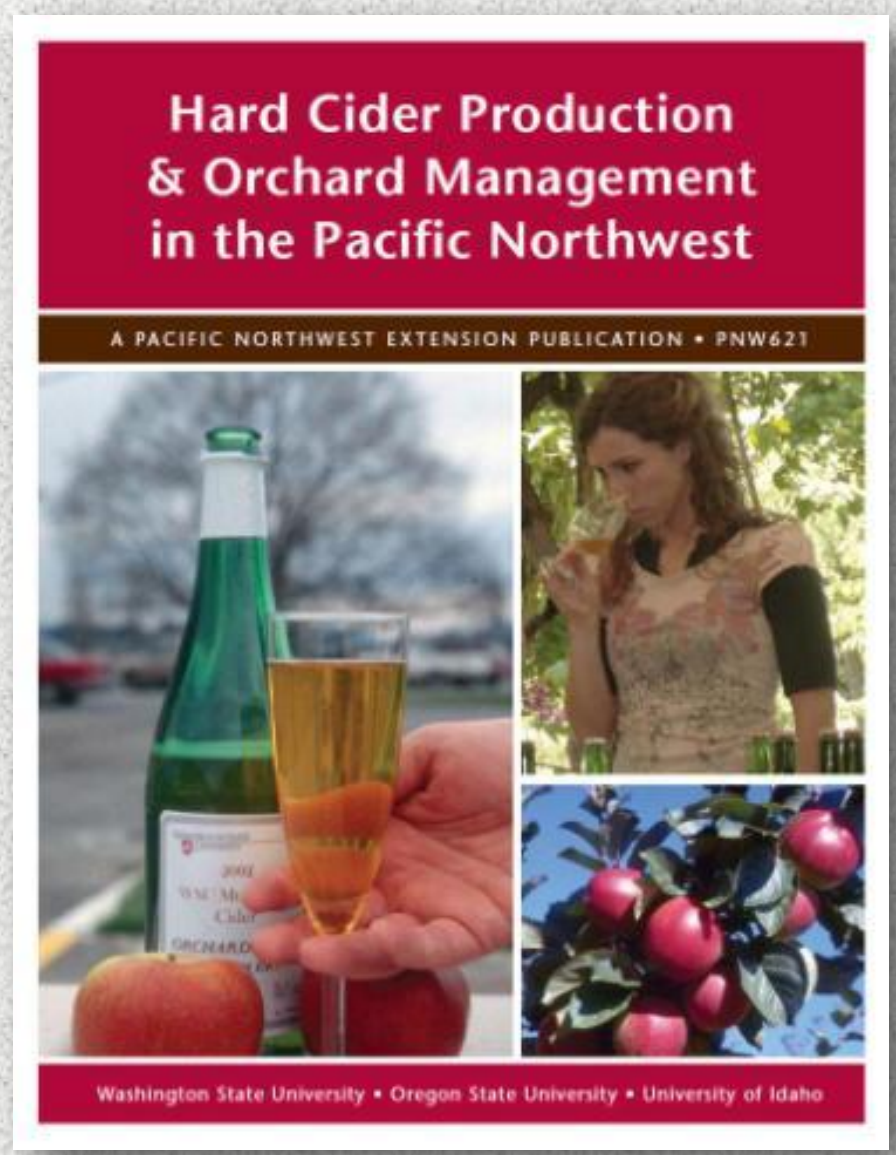
Introduction

- Hard cider is alcoholic, containing up to 7% alcohol
- Cider sales in U.S. increased 54% each year from 2007 through 2012
- Commercial cideries in Washington: 2 in 2003, 34 in 2014
- Cider apples used to make high quality artisanal cider

Extension Manual

WSU Extension Manual PNW0621 (2010)

http://maritimefruit.wsu.edu



Cider Apples: High Tannins

High tannin varieties produce complex flavors, body, and astringency when fermented

Dessert apples tend to be thin and bland when fermented

Blending produces cider with high viscosity and satisfying mouth feel

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Apple Types

Cider apples classified into 4 categories according to acid and tannin content (Long Ashton Research Station, Bristol, England; Barker, 1903).

Type	Tannin (%)	Acid (%)
Sharp	< 0.2 Low tannin	> 0.45 High acid
Bittersharp	> 0.2 High tannin	> 0.45 High acid
Bittersweet	> 0.2 High tannin	< 0.45 Low acid
Sweet	< 0.2 Low tannin	< 0.45 Low acid

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Examples of Apple Varieties

Some common cider varieties and dessert varieties within each type

Sharp	Bittersharp	Bittersweet	Sweet
Brown's Apple	Cap of Liberty	Bedan	Michelin
Tom Putt	Domaines	Chisel Jersey	Peau de Vache
Breakwell Sdlg.	Foxwhelp	Dabinett	Pomme Gris
Frederick	Hewes VA Crab	Frequin Rouge	LeBret (Sweet Alford)
Harrison	Kingston Black	Harry Masters' J.	Sweet Coppin
Smith's Cider	Lambrooke Pip.	Reine des Pommes	Taylor's
Bramley's Sdlg.	Stoke Red	Porter's Perfection	Baldwin
Golden Russet	Pearmain,	Vilberie	Ben Davis
Gravenstein	Worcester	Yarlington Mill	Gala
Jonagold	Dolgo Crab	Newtown Pippin	Fuji
Roxbury Russet	Hagloe Crab	Red Astrachan	

Most Common Cider Apples

- Common cider apple varieties grown: Ashmead's Kernel, Brown Snout, Chisel Jersey, Dabinett, Golden Russet, Gold Rush, Harrison, Harry Masters' Jersey, Kingston Black, Nehou, Newtown, Roxbury Russet, Hewes Virginia Crab, Wickson Crab, Winesap, Yarlington Mill
- Choose varieties based on your site and cider style
- Pest management: less intensive than dessert apples
- Environment-induced diseases (e.g., scab) do not limit yields

Obtaining Fruit for Cider

- Commercial dessert orchards with cull fruit
- Specialty cider orchards
- Purchase juice or concentrate
- Local orchards with heritage varieties, often not suitable for fresh market
- Start your own orchard

Fruit Sources & Costs

- Cost* of cider apples: $0.15 to $0.75/lb
- Cost* of cull dessert apples: $0.10 to $0.25/lb
- Future possibility: 5 year contract with grower
- “It’s easier for an orchardist to become a cider maker than for a cider maker to become an orchardist”

*Galinato et al. 2013

Yarlington Mill

Brown Snout

Dabinett

Kingston Black

Sources of Cider Apple Trees

- Plan ahead! 1-2 years for nursery to make cider trees
- Scionwood can be ordered through NABC
- Video on apple chip bud grafting online
- Nurseries listing cider apple varieties online

http://extension.wsu.edu/maritimefruit/Pages/CiderInfo.aspx

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Rootstock Factors to Consider

- Size of mature trees
- Precocity - how long till first fruiting
- Will trellis be needed, and what is the cost?
- Suitability to soil conditions
- Disease susceptibility - can be very important in fire blight prone areas

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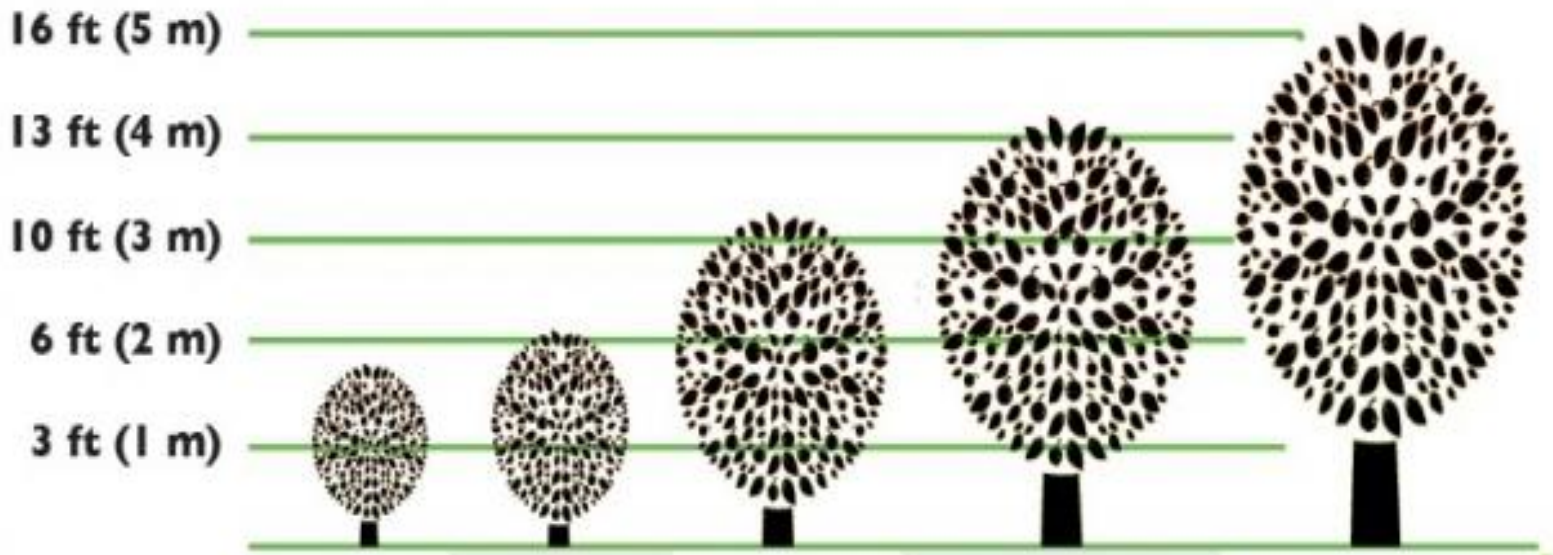
Rootstock Choices

Malling and Geneva comparative sizes



M.27	M.9	M.26	MM.106	M.25
G.65	G.11, G.41 G.214, G.935	G.202	G.30, G.890, G.969, G.210, G.222	

Source: Dr. Terence Robinson, Cornell University

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Rootstock Effects

‘Yarlington Mill’ on M106 (L) and M9 (R)

Freestanding Tree

Freestanding trees on semi vigorous rootstocks such as M106 the current method in most cider orchards

'Brown Snout'

Fruit and Juice Yields

1 dwarf cider apple tree will produce about 45 lbs. fruit.

(Proulx and Nichols, 2003)

At NWREC, 'Brown Snout' on M9 and M27, 6.5 ft. narrow trellis, produced 26 lbs. fruit

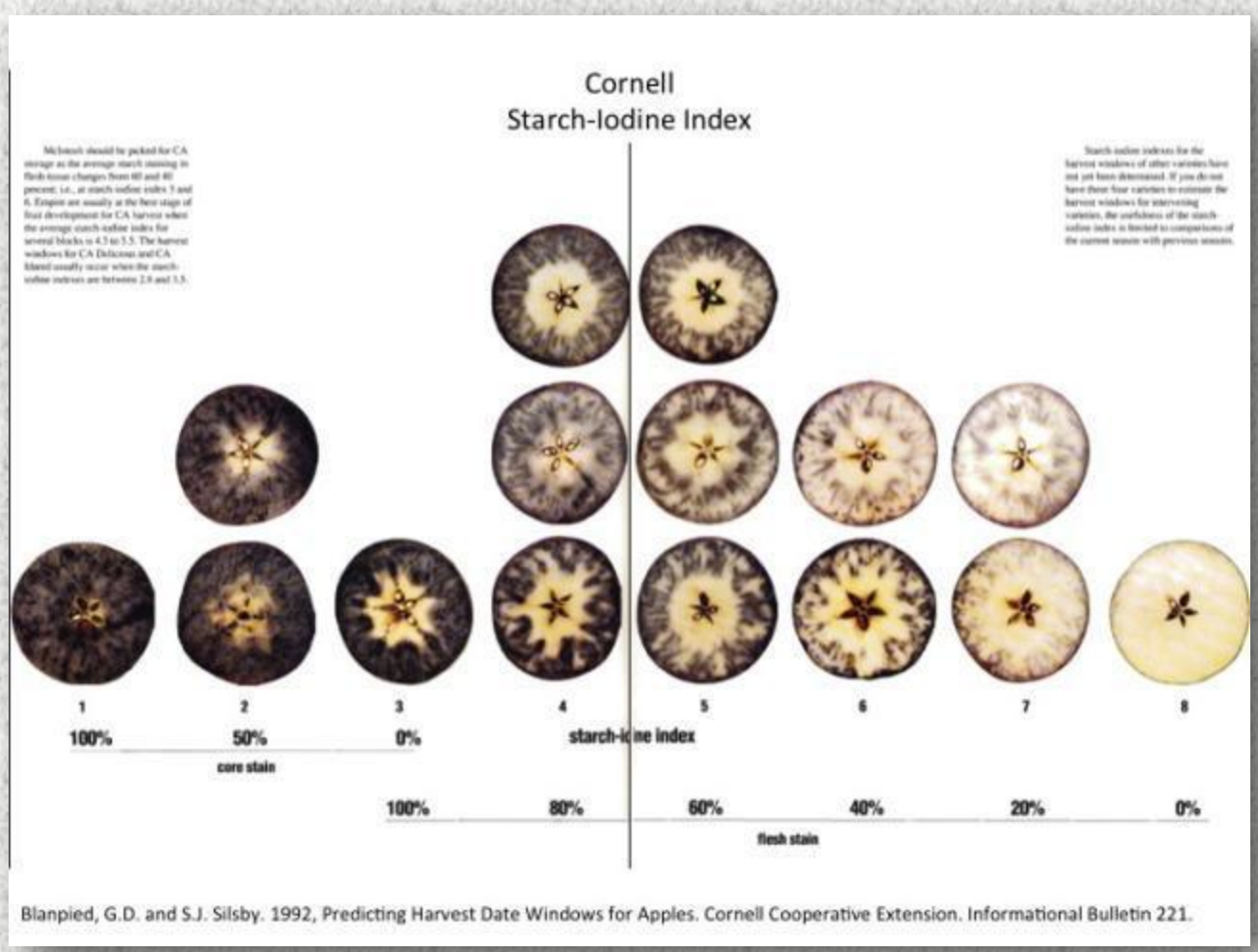
(Miles and King, 2014)

- **13-16 lbs. fruit produce 1 gal. cider, depending on variety and pressing method**

Yarlington Mill / M9 rootstock

Evaluating Fruit and Juice

- **Before harvest, evaluate ripeness using the starch conversion test - harvest at full ripeness to yield the highest sugar at pressing.**



Blanpied, G.D. and S.J. Silsby. 1992, Predicting Harvest Date Windows for Apples. Cornell Cooperative Extension. Informational Bulletin 221.

Milling and Pressing

- After picking, fruit left to sweeten or “sweat”
- Before grinding, wash fruit and remove rot

- Apple shredder to mill fruit (Zambelli Enotech MuliMax 60)
- Bladder press to extract juice (40-L Enotechnica Pillan)

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Sorting & Washing

Grinding/Milling

Commercial hammer mill

Kickapoo Orchard, Inc., Gay Mills, WI

Batch type grinder mill

Suntech Mfg. Co. , Spokane, WA

Batch & Continuous Presses

Hydraulic batch press

Continuous press

Kickapoo Orchard, Inc., Gay Mills, WI

Pressing

- **Add rice hulls and/or enzymes during pressing to increase juice extraction**

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Cider Juice Analysis

Summary of juice analysis for cider apple varieties grown at WSU Mount Vernon NWREC from 2003-2013 (data not collected in 2007).

		Tannin %		Malic Acid g/l		ºBrix		pH	
Cultivar	Yrs Eval.	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Amere de Berthcourt	3	0.48	0.20	1.90	0.53	12.9	1.55	4.31	0.14
Breakwell Seedling	5	0.27	0.22	7.82	3.27	10.9	0.97	3.23	0.13
Brown Snout	7	0.19	0.06	3.37	0.84	13.5	1.77	3.87	0.16
Dabinett	8	0.29	0.18	2.55	1.30	14.0	1.18	4.37	0.25
Golden Russet	5	0.13	0.05	6.64	0.91	16.9	1.33	3.67	0.25
Harrison	3	0.16	0.03	7.77	2.58	15.8	0.21	3.37	0.39
Kermerrien	6	0.37	0.09	2.44	0.21	13.2	1.22	3.76	0.25
Kingston Black	7	0.17	0.11	6.45	1.04	13.4	1.39	3.45	0.19
Medaille D'Or	4	1.05	0.49	3.43	0.48	15.8	1.73	4.19	0.18

°Brix and pH

- °Brix – place 2-3 drops juice sample onto refractometer
- pH – measure 100 ml juice sample with digital pH meter

< Digital refractometer

Digital pH meter >

% Tannins

- **Tannins measured using Lowenthal permanganate titration:**
  - **Standard procedure used at Long Ashton Research Station**
  - **Can compare WSU data with English data**
  - **WSU on-line training video: How to Test Tannin Levels in Apple Juice Using Lowenthal Permanganate Titration**

- **Cider juice solution blue at start of titration**
- **Cider juice solution yellow at final point**

Malic Acid (g/l)

- Titrate with 0.2 M solution of sodium hydroxide (NaOH) to 8.1 pH
- Record volume of solution used
- Calculate malic acid using the equation:

$$\text{Malic acid } (g \cdot l^{-1}) = \text{ml NaOH} \times 0.536$$

Yeast and Fermentation

- Wild yeast (naturally occurring) works, but results variable and unpredictable
- Commercial wine or champagne yeast most common
- At NWREC: Lallemand DV-10 (Champagne)
- Some yeast specifically for cider
- Choice depends on cider style
- Purchase or order from brewing supply sources, local or online

Commercial wine yeast common for cider making

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Varietal Cider

Adding yeast

Fermention

Bottling

Sensory analysis

Sample Cider & Perry Organoleptic Profile*

1. Appearance	Description								
Clarity									
Color									
Other									
2. Aroma & Flavor Attribute	**Intensity**								
	None	**Slight**			**Mod.**				**Hi**
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
3. Taste									
Sweet									
Sour									
Bitter									
Salty									
4. Mouth Feel									
Astringency									
5. Aftertaste									
Length & Characteristics									
6. Overall									
Balance and overall summary									

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Varietal Cider Descriptions

Variety	Description	Color	Aroma	Overall
Blanc Mollet	Mild to mod. bitter French bittersweet	Deep gold	Caramel, pear & Jolly Rancher with wood, biscuit & tropical fruits	Medium bodied , light flavors & aromatics. Medium length finish with bitter & mildly astringent aftertaste.
Chisel Jersey	Full English bittersweet	Golden amber	Bittersweet apple, phenolic, citrus, floral, spicy, earthy & woody	Barnyard character typical of English farmhouse cider; pronounced bitterness. Very long tannic, astringent finish.
Golden Russet	Medium sharp russet dessert apple	Straw	Estery, green apple, candy apple, honey, cidery & tropical fruits	Full-bodied, alcoholic, complex aromatics, good acid. Medium length. Excellent base for dessert apple cider blend.
Granniwinkle	Old American moderately sharp cider apple	Straw	Estery, floral, tropical fruit, confectionary, woody, green apple, cidery	Clean, crisp and fruity, light bodied, short finish . Refreshing aftertaste of melon, currant, honey and dried fruit; potential Champagne cider.

http://maritimefruit.wsu.edu

Tax by ABV

Finished ciders and fermenting ciders at WSU Mount Vernon NWREC

- Cider is defined by its alcohol content, “alcohol by volume” (ABV)
- Apples naturally have 10-20% sugar content, produce ciders with final ABV 4-9%
- In most states, cider below 7% ABV taxed at a lower rate
- Cider with greater than 7% ABV taxed as wine

Finishing

- Adding sugar to juice prior to fermentation (Chaptalizing) to standardize the alcohol content
- Adding carbon dioxide (CO_2) under pressure (carbonation) produces bubbles and a little acidity
- The “Champagne method” of yeast fermentation can also produce carbonation

Cider Apple Production Costs and Mechanization

C. Miles, S. Galinato and J. King

Washington State University

Northwestern Washington Research and Extension Center

http://maritimefruit.wsu.edu

Orchard Establishment Costs

- **Overview of cider apple production in Washington**
- **Enterprise budget for Western Washington**
  - Estimate main production costs
  - 'Cost Estimation of Establishing a Cider Apple Orchard in Western Washington' (FS141E)
  - http://cru.cahe.wsu.edu/CEPublications/FS141E/FS141E.pdf

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Budget Assumptions

Field specification	Assumed values
Total orchard operation	10 acres
Growing area	9 acres
Architecture	Central leader system
Rootstock	Dwarf – M9 series
Cider apple variety	Several varieties (e.g., Kingston Black, Yarlington Mill, Brown Snout, Dabinett, Porter's Perfection, Vilberie, Foxwelp)
In-row spacing	5 feet
Between-row spacing	12 feet
Density	726 trees/acre
Commercial life of planting	25 years (including 4 years of establishment)

Per Acre Cost and Returns of Establishing and Producing Cider Apples in Western WA

	Establishment Years				Full Production[1]	
	Year 1	Year 2	Year 3	Year 4		Your Costs
Estimated Gross Production (bins/acre)			5.00	12.00	46.00	
Estimated Price ($/bin)			315.00	315.00	315.00	
Total Returns ($/acre)			1,575.00	3,780.00	14,490.00	
Variable Costs ($/acre):						
Establishment						
Soil Preparation	500.00					
Trees (including labor)	5,263.50					
Orchard Activities						
Pruning & Training[2]	288.00	720.00	1,080.00	1,440.00	1,260.00	
Green Fruit Thinning[3]		144.00	288.00	576.00	576.00	
Irrigation Labor[4]	480.00	480.00	480.00	480.00	480.00	
Chemicals[4,5]	350.00	350.00	350.00	350.00	350.00	
Fertilizer[5]		60.00	60.00	60.00	248.00	
Manual Pest Control[6]	120.00	120.00	120.00	120.00	120.00	
Beehive			50.00	50.00	50.00	
General Farm Labor[7]	180.00	180.00	180.00	180.00	180.00	
Irrigation/Electric Charge	144.00	144.00	144.00	144.00	144.00	
Harvest Activities[8]						
Picking Labor			405.00	972.00	3,726.00	
Maintenance and Repairs						
Machinery Repair	50.00	75.00	100.00	120.00	140.00	
Fuel & Lube	70.00	70.00	110.00	130.00	140.00	
Irrigation System Maintenance	50.00	50.00	50.00	50.00	50.00	
Other Variable Costs						
Overhead (5% of VC)	374.78	119.65	170.85	233.60	373.20	
Interest (5% of VC)[9]	393.51	125.63	179.39	245.28	293.90	
Total Variable Costs	8,263.79	2,638.28	3,767.24	5,150.88	8,131.10	
Fixed Costs ($/acre):						
Depreciation						
Irrigation System	100.00	100.00	100.00	100.00	100.00	
Machinery, Equipment & Building	564.16	564.16	564.16	564.16	564.16	
Trellis	90.51	90.51	90.51	90.51	90.51	
Interest						
Irrigation System	62.50	62.50	62.50	62.50	62.50	
Land	675.00	675.00	675.00	675.00	675.00	
Machinery, Equipment & Building	452.60	452.60	452.60	452.60	452.60	
Trellis	56.57	56.57	56.57	56.57	56.57	
Establishment Costs (5%)		514.30	773.04	1,022.41		
Other Fixed Costs						
Miscellaneous Supplies	200.00	200.00	200.00	200.00	200.00	
Land & Property Taxes	135.00	135.00	135.00	135.00	135.00	
Insurance Cost (all farm)	50.00	50.00	50.00	50.00	50.00	
Management Cost	300.00	300.00	300.00	300.00	300.00	
Amortized Establishment Costs[10]					1,939.27	
Total Fixed Costs	2,022.19	2,536.49	2,795.22	3,044.60	3,961.46	
TOTAL COSTS	10,285.98	5,174.77	6,562.47	8,195.48	12,092.55	
ESTIMATED NET RETURNS	(10,285.98)	(5,174.77)	(4,987.47)	(4,415.48)	2,397.45	
Accumulated Establishment Costs	10,285.98	15,460.74	20,448.21	24,863.69		

[1] The full production year is representative of all the remaining years the orchard is in full production (Year 5 to Year 25).
[2] Hand labor rate is $12/hour in Year 1, and $15/hour in subsequent years.
[3] For pruning and training, hand labor rate is $12/hour in Year 1, and $15/hour in subsequent years. For green fruit thinning, hand labor rate is $12/hour. Labor rate includes all applicable taxes and benefits.
[4] Irrigation labor and chemical application is $12/hour and includes all applicable taxes and benefits.
[5] Includes materials and labor.
[6] Hand removal of pests, including tent caterpillars.
[7] General farm labor rate is a lump sum per acre and applied to miscellaneous/all other labor. Rate includes applicable taxes and benefits.
[8] Hand labor. Picking rate = $60/bin.
[9] Interest expense on full year during establishment years and for 3/4 of a year during full production.
[10] Represents the costs incurred during the establishment years (minus revenues during those years) that must be recaptured during the full production years.

$ 3,726 per acre
Hand harvest =
46% of variable costs

$ 12,092 per acre =
Total fixed and
variable costs

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Estimated Costs & Returns ($/Acre)

Estimates	Production Year				
	1	2	3	4	Full
Yield (bins/A)			5	12	46
Price ($/bin)			315	315	315
Total Returns			**$1,575**	**$3,780**	**$14,490**
Establishment	$5,764				
Operations	$1,562	$2,198	$2,752	$3,400	$3,408
Harvest			$405	$972	$3,726
Maintenance	$170	$195	$260	$300	$330
Total Variables	***$8,264***	***$2,638***	***$3,767***	***$5,151***	***$8,131***
Depreciation	*$730*	*$730*	*$730*	*$730*	*$730*
Interest	*$1,226*	*$1,771*	*$2,063*	*$2,346*	*$1,226*
Total Fixed Costs	***$2,642***	***$3,187***	***$3,478***	***$3,762***	***$4,789***
Total Costs	**$10,905**	**$5,828**	**$7,425**	**$8,913**	**$12,920**
NET RETURNS	-$10,905	-$5,828	-$5,850	-$5,133	$1,570
Accumulated Costs	$10,905	$16,731	$22,401	$27,534	

Estimated Net Returns per Acre

Price and yield scenarios during *full production*

Yield (bins/A)	Price (per bin)					
	300	320	340	360	380	400
20	-4,626	-4,226	-3,826	-3,426	-3,026	-2,626
25	-3,567	-3,067	-2,567	-2,067	-1,567	-1,067
30	-2,508	-1,908	-1,308	-708	-108	492
35	-1,450	-750	-50	650	1,350	2,050
40	-391	409	1,209	2,009	2,809	3,609
45	668	1,598	2,468	3,368	4,268	5,168
50	1,727	2,727	3,727	4,727	5,727	6,727

1 bin = 900 lbs

$300 = $0.33/lb ***$340 = $0.38/lb*** ***$380 = $0.42/lb***

Cider Apple Harvest

- Many cider apple varieties small-fruited, take up to 4 times longer to hand pick than dessert apples
- Mechanized harvest of cider apples common in Europe
- Mechanized harvest reduces harvest labor, primary cost consideration
- Shake-and-sweep harvest not suitable for trellised or semi-dwarf cider apple orchards

European Harvest Equipment

Tree Shaker

Harvesters/ Sweepers

Mechanical Harvest in U.S.

- Dwarf and semi-dwarf rootstocks can be damaged by trunk shakers
- Modern apple trellising systems are conducive to over-the-row harvesters
- Small-fruit harvesters used in Western WA, idle during time of cider apple harvest

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Small Fruit Harvester

Littau OR0012

VIDEO - https://www.youtube.com/watch?v=hCEjbuML5GA

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Mechanical Harvest

Before

After

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Summary of Harvest Study

- **Mechanical harvest efficiency:**
  70% hand v. mechanical pick
  87% hand v. mechanical pick + cleanup
- **Picking cost 7 times lower in 2011 (high yield year) and 2 times lower in 2012 (low yield year)**
- **Tree damage doubled with mechanical harvest, but still relatively low (4 v 8 spurs; 0.5 v 0.8 limbs)**
- **Fruit 100% bruising with hand and mechanical harvest**
- **Fruit 10% cut and 4% sliced with mechanical harvest**
- **No difference in fresh juice quality; higher sugar and specific gravity in fruit cold-stored up to 4 wk**

Mechanized Production Systems

Dwarfing rootstock requires trellis; research orchard at WSU Mount Vernon NWREC (Geneva 935)

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Small Fruit Harvesters

BEI harvester

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Tree Harvesters

- Grape
- Citrus
- Nuts
- Coffee

Fruiting Wall

Self-supporting trees, mechanical pruning and harvest

Photo: GoodFruit Grower

Video: Jon Clements, UMass
https://video.search.yahoo.com/video/play;_ylt=A86.JyfFx9tUrH0ApPsnnIlQ;_ylu=X3oDMTB0MzkwOG5yBHNlYwNzYwRjb2xvA2dxMQR

Mechanical Pruning

Hedging

LaGasse Works

Research Cider Orchards at WSU

1979 6 cider apple varieties first planted at WSU Mount Vernon NWREC

1983 to 1994 20 varieties added, observations made on productivity, growth habit, and disease susceptibility

1994 Cider apple trial orchard established with over 70 different varieties

2002 to current Varieties evaluated for juice characteristics

2014-15 Planted 64 varieties in a replicated research orchard

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Overview of WSU Cider Program

- **Evaluation of cider apple juice (2002-current)**
- **Make and evaluate single-varietal ciders (4-5 each year)**
- **Compare juice quality of 4 varieties grown at 5 WA locations**
- **Evaluate mechanical harvest using over-the-row harvesters**
- **Measure costs of cider apple orchard establishment**
- **Provide cider production education in cooperation with NABC**
- **Publish results – website, Extension, journal articles**
- **On-line training videos – grafting, tannin testing**

http://maritimefruit.wsu.edu

Thanks to the supporters of WSU cider apple research

Washington State Dept. of Agriculture
Northwest Agriculture Business Center
WSU Center for Sustaining Agriculture & Natural Resources (CSANR)
Northwest Cider Association
Northwest Agricultural Research Foundation

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