

# Cider Apple Evaluations in Vermont

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# Vermont Working Lands Enterprise Initiative

## *Apple Market Optimization and Expansion through Value-Added Hard Cider Production*

- Quantify production costs for apples managed specifically for hard cider production
- Identify fruit quality and yield characteristics of apple cultivars suited for hard cider production
- Coordinate fermentation trials and evaluate finished ciders made from Vermont apple cultivars



*Dan Rowell, CEO VT Hard Cider Company (left) and Dr. David Conner, UVM CDAE Dept. Photo: VT Working Lands Enterprise Initiative*



# USDA Federal State Marketing Improvement Program

## *Orchard Economic Assessment to Support Vermont Hard Cider Production*

- Assist in the development of more efficient marketing methods, practices and facilities to bring about more efficient and orderly marketing of cider apples, and reduce the price spread between growers and cideries
- Quantify the economic impact of hard cider and cider apple production on rural Vermont economies.



*Terence Bradshaw collects orchard yield data at Sunrise Orchards, Cornwall, VT. Photo: T. Bradshaw*

# Cider Makers Survey

Favored apple cultivars to source locally

Dessert	Dual-Purpose	Specialty cider
Cortland (1)	Ashmeads Kernel (4)	Ashton Bitter (1)
McIntosh (1)	Calville Blanc (1)	Bittersweet (1)
Organic Empire (1)	Cox's Orange Pippin (1)	Chisel Jersey (1)
Pinova (1)	Esopus Spitzenberg (4)	Dabinett (4)
	Golden Russet (4)	Ellis Bitter (2)
	Liberty (1)	Foxwhelp (1)
	Lodi (1)	Kingston Black (5)
	Northern Spy (3)	Major (1)
	Roxbury Russet (1)	Orleans Reinette (1)
		Reine des Reinette (1)
		Somerset Redstreak (1)
		Stoke Red (1)
		Wickson (4)
		Yarlington Mill (2)



# Cider Makers Survey: Prices paid per bushel

	n	Mean	Median
Specialty cider/bittersweet variety	3	\$19.00	\$20.00
Dessert variety (orchard-run)	2	\$4.30	\$4.30
Dessert variety (packing house culls)	1	\$5.00	\$5.00



# *What Makes a ‘Cider Apple’?*

## CIDERIES

Low purchase price?

High yield?

Consistent yield

Juice characteristics

- pG, TA, Brix
- Tannin
- Aromatics

Marketing story?

## APPLE GROWERS

High purchase price

Low production cost

High yield?

Consistent yield

Dual purpose?

Marketability



# Current Status of Cider Apple Sourcing in U.S.

## Dessert culls

- Volatile market (locally)
  - Reliance on 'oops' factor
- Generally large supply
  - Growth in cider industry may challenge
  - Cultivars may be 'right' for the product
- Infrastructure exists
- *What are the qualities of dessert fruit from a cidermaking perspective?*
- *What strategies can be adopted to reduce costs of production/increase supply/improve cider quality?*



# Current Status of Cider Apple Sourcing in U.S.

## Dual-purpose fruit

- Infrastructure generally exists
  - Older, 'back forty' orchards
  - Less profitable (fresh) varieties?
- |                |                 |
|----------------|-----------------|
| ◦ Idared       | ◦ Winesap       |
| ◦ Liberty      | ◦ Golden Russet |
| ◦ Jonagold     |                 |
| ◦ Northern Spy |                 |





# Current Status of Cider Apple Sourcing in U.S.

## ‘Specialty’ Cider Fruit

- Low production nationwide
- Increasing supply
- Often cidery-grown or managed
- High cost/low yield?
- *How do these cultivars perform in Northeast orchards?*
- *What management strategies can increase supply/profitability/cider quality?*



# 2014 WLEF: Production by cultivar & orchard system



Cultivar	Bushels / acre	Firmness (psi)	Starch index	Soluble solids (°brix)
Cortland	672	15.9	3.7	10.3
Empire	932	18.8	5.0	12.8
Idared	1221	17.4	4.0	10.6
Jonagold	338	16.0	7.4	12.6
Liberty	282	17.5	6.0	11.0
Macoun	705	15.4	5.0	10.9
McIntosh	1134	15.2	4.6	11.6
Paula Red	435	17.1	3.4	11.3

# 2014 WLEF: Cultivar juice characteristics



Cultivar	Soluble solids (°brix)	pH	Malic acid (mg/l)	Total polyphenols (%)	YAN (mg/l)
Ashmead's Kernel	17.6	3.25	10.40	0.075	262.4
Commercial blend	12.2	3.40	5.91	0.037	58.5
Cortland	11.2	3.43	4.74	0.047	45.1
Dabinet	13.1	4.13	1.88	0.109	60.6
Esopus Spitzenburg	15.3	3.48	7.10	0.035	113.4
Honeycrisp	12.6	3.52	4.97	0.027	85.0
Idared	10.8	3.29	5.98	0.017	15.5
Jonagold	12.3	3.40	5.12	0.021	38.6
Liberty	11.5	3.45	5.72	0.018	56.7
Macoun	11.7	3.47	4.17	0.021	65.1
McIntosh	11.7	3.25	5.48	0.036	30.1
PaulaRed	11.0	3.40	4.45	0.050	30.4
Topaz	12.4	3.35	9.86	0.056	16.1
Wickson	13.9	3.40	11.94	0.018	53.3

# 2014 Cider Evaluation

- 33 Participants
  - Growers & Cider makers
- 17 Ciders, Four cidermakers
  - Some replicated across multiple cidermakers
  - Single cultivar
- Evaluated as components of finished cider blend
- Hedonic evaluation
  - 1-5 scale of 'likeness'
  - 1 = Strongly Dislike
  - 3 = Neutral
  - 5 = Strongly Like



<b>Class</b>	<b>Cultivar</b>	<b>Appearance</b>	<b>Aroma</b>	<b>Sweetness</b>	<b>Acidity</b>	<b>Mouthfeel</b>	<b>Flavor</b>
Sharp	Ashmead's Kern.	3.67 *	3.47 *	2.63	2.97	3.03	3.17
Sharp	Es. Spitzenburg	2.61	3.00	2.57	2.84	2.84	2.69
Sharp	Idared	2.59	2.98	2.85	2.88	2.78	2.82
Sharp	Jonagold	3.21	2.82	2.73	2.97	2.92	2.86
Sharp	Liberty	3.34	2.97	2.75	2.87	2.79	2.72
Sharp	McIntosh	2.96	2.84	2.71	2.95	2.74	2.82
Sharp	Topaz	3.13	2.90	2.35	2.69	2.54	2.41
Sharp	Wickson	3.10	2.65	2.36	2.78	2.72	2.78
Bittersweet	BS Blend	3.90	2.84	2.76	2.94 *	3.19	3.13 *
Bittersweet	Dabinett	3.81	3.19	2.59	2.55	3.00	2.39
Sweet	Cortland	3.27 *	2.65 *	2.63	2.93 *	2.68 *	2.46
Sweet	Honeycrisp	3.25	3.02	2.73	2.98	3.00	2.79
Sweet	Macoun	3.24	2.30	2.47	2.57	2.61	2.43
Sweet	Paulared	3.79	3.07	2.40	2.79	2.77	2.67
Blend	Ch Heirloom	3.28 *	3.14	3.45 *	3.21	3.34	3.34 *
Blend	Cit Blend	2.53	2.77	2.72	2.79	2.93	2.77
Blend	VHC Local Nectar	3.20	3.03	3.10	3.14	3.23	3.03



# 2014 Cider Evaluation by Class

<b>Class</b>	<b>Appearance</b>	<b>Aroma</b>	<b>Sweetness</b>	<b>Acidity</b>	<b>Mouthfeel</b>	<b>Flavor</b>
<b>Sharp</b>	<b>3.08 *</b>	<b>2.92</b>	<b>2.68 *</b>	<b>2.89</b>	<b>2.81 *</b>	<b>2.79 *</b>
<b>Bittersweet</b>	<b>3.85</b>	<b>3.02</b>	<b>2.67</b>	<b>2.74</b>	<b>3.10</b>	<b>2.76</b>
<b>Sweet</b>	<b>3.37</b>	<b>2.79</b>	<b>2.58</b>	<b>2.83</b>	<b>2.79</b>	<b>2.61</b>
<b>Blend</b>	<b>3.00</b>	<b>2.98</b>	<b>3.09</b>	<b>3.05</b>	<b>3.17</b>	<b>3.04</b>

# 2015 Cider Apple Research

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# Barker's Classification of Cider Apples (LARS 1903)

<u>Classification</u>	<u>Acid (%)</u>	<u>Tannin (%)</u>
Sharp	> 0.45	< 0.2
Bittersharp	> 0.45	> 0.2
Bittersweet	< 0.45	> 0.2
Sweet	< 0.45	< 0.2





# 2015 Field Data

- Replicated evaluation of:
  - Scab-resistant cultivars suitable (?) for cidermaking
  - Early-production bittersweets & dual-purpose cultivars
- Early screening of non-replicated local cultivars
- M9/111, 9 x 14 spacing



# 2015 Cider Cultivar Yield Data

Cultivar	Total kg	Fruit wt (g)	TCSA (cm <sup>2</sup> )	Yield Eff.	% Rot
Ashmead's Kernel	7.2 ab	111.4 a	13.2 ab	0.55 bc	5.0
Calville Blanc	2.8 bc	135.1 a	20.1 a	0.17 cd	3.3
Es. Spitzenburg	2.2 bc	104.9 ab	12.3 b	0.20 cd	0.6
Brown Snout	3.3 bc	50.4 c	11.6 b	0.28 cd	4.7
Chisel Jersey	7.4 ab	61.0 c	10.8 b	0.69 b	4.5
Dabinett	4.0 bc	51.4 c	8.2 b	0.50 bc	7.2
Harry Master's Jers.	7.1 ab	72.9 bc	13.9 ab	0.51 bc	12.7
Redfield	11.1 a	99.1 ab	8.3 b	1.30 a	6.1
Tremlett's Bitter (Gen.)	0.0 c	100.0 ab	8.7 b	0.00 d	0.0
Yarlington Mill	10.4 a	50.8 c	8.9 b	1.14 a	0.1

# 2015 Cider Cultivar Yield Data



# 2015 Juice Lab Results: Cider Cultivars

<b>cultivar</b>	<b>Brix</b>	<b>pH</b>	<b>g/L malic acid</b>	<b>% Total Phenols (tannin)</b>	<b>mg/L YAN</b>
Ashmead's Kernel	18.0	3.03	10.78	0.07	166.30
Brown Snout	18.2	3.78	4.05	0.21	97.37
Calville Blanc	15.3	3.13	9.97	0.07	86.31
Chisel Jersey	13.1	4.07	1.47	0.24	55.41
Dabinett	13.1	4.15	1.10	0.37	31.79
Harry Master's Jersey -Drop	11.6	4.35	0.99	0.23	40.63
Harry Master's Jersey -Tree	12.4	4.17	1.36	0.19	32.67
Redfield	13.6	3.16	6.50	0.33	58.55
Spitz	15.8	3.13	9.34	0.06	112.68
Tremlett Bitter -Tree	13.2	2.88	12.26	0.29	67.47
Yarlington Mill	12.2	3.78	1.67	0.35	8.88



# Cider quality of SRCs

- Phenolic biosynthesis plays a critical role in Vf scab resistance (Mayr 1997)
- Some SRCs (Goldrush, Topaz) have shown significantly greater phenolics in pulp and skin than susceptible cultivars (Petkovsek, 2007)
- Vf SRCs generally developed as culinary apples, so don't expect tannins/flavenols of European cider cultivars
- Apple scab infection may increase phenolic content of fruit *at the expense of yield* (Petkovsek, 2008)



# 2015 Juice Analysis: Scab Resistant Cultivars

cultivar	Brix	pH	g/l malic acid	% tannin (total polyphenols)	YAN mg/l
Crimson Crisp	14.4	3.37	8.85	0.106	170.19
Crimson Gold	14.4	3.37	8.50	0.080	103.00
Crimson Topaz	14.3	3.13	12.35	0.067	151.89
Florina Querina	14.0	3.53	6.71	0.060	145.02
Galarina	14.9	3.46	8.47	0.059	193.31
Liberty	13.1	3.22	8.82	0.094	124.64
Williams Pride	10.0	3.42	5.43	0.039	55.78
Winecrisp	16.4	3.60	6.30	0.061	88.46
Ashmead's Kernel	18	3.03	10.78	0.07	166
Chisel Jersey	13.1	4.07	1.47	0.24	55



# Cultivar Discovery: Screening 'Natives'

- Initial evaluation of cultivars with promise
  - Franklin cider apple
  - Calais cider fruit
- Juice analysis & small-lot fermentation



# 2015 Juice Lab Results

<b>cultivar</b>	<b>Brix</b>	<b>pH</b>	<b>g/L malic acid</b>	<b>% Total Phenols (tannin)</b>	<b>mg/L YAN</b>
MC 1	9.3	2.94	9.03	0.22	26.71
MC 2	11.2	3.34	4.23	0.12	17.98
MC 3	8.9	3.32	4.70	0.10	9.87
MC 4	9.1	3.31	3.83	0.10	17.29
MC 5	8.8	4.01	1.10	0.10	9.29
MC 7	15.1	4.43	1.57	0.19	41.06
MC 8	11.3	3.12	8.70	0.23	27.05
MC 9	13.3	3.15	10.52	0.18	39.68
Franklin Cider Apple	16.9	2.83	7.77	0.36	28.36
Franklin Unknown Russet	16.0	3.27	12.10	0.09	93.93





# Unique production challenges with bittersweet cultivars



# Current & future research projects

## 2014 USDA FSMIP:

- Economic modeling of cider apple production
- Continued cultivar evaluation



# 2016 Northeast IPM Center

## “Addressing Unique IPM Needs in Northeast Cider Orchards”

- Reduced-input IPM programs for dessert cultivars sold to cideries
- Return bloom hormone sprays to reduce biennialism in European bittersweet cultivars



# 2016 Northeast SARE Partnership

## “Orchard Pruning for Cider Apple Production”

- Reduced labor inputs for production of dessert cultivars for cider making



# Cider Orchard Establishment @ UVM Horticulture Research & Education Ctr

## Phase 1 cider orchard:

- Kingston Black, Yarlington Mill, Dabinett, Ashmead's Kernel, Esopus Spitzenburg, Puget Spice, Porter's Perfection, Brown Snout
- Multiple rootstocks & training systems
- Phase 2: 2017



# 2016 UVM Apple Program

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Northeast IPM Center

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Vermont Agricultural Experiment Station

Vermont Tree Fruit Growers Association

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