

Apple Production for Cider Making

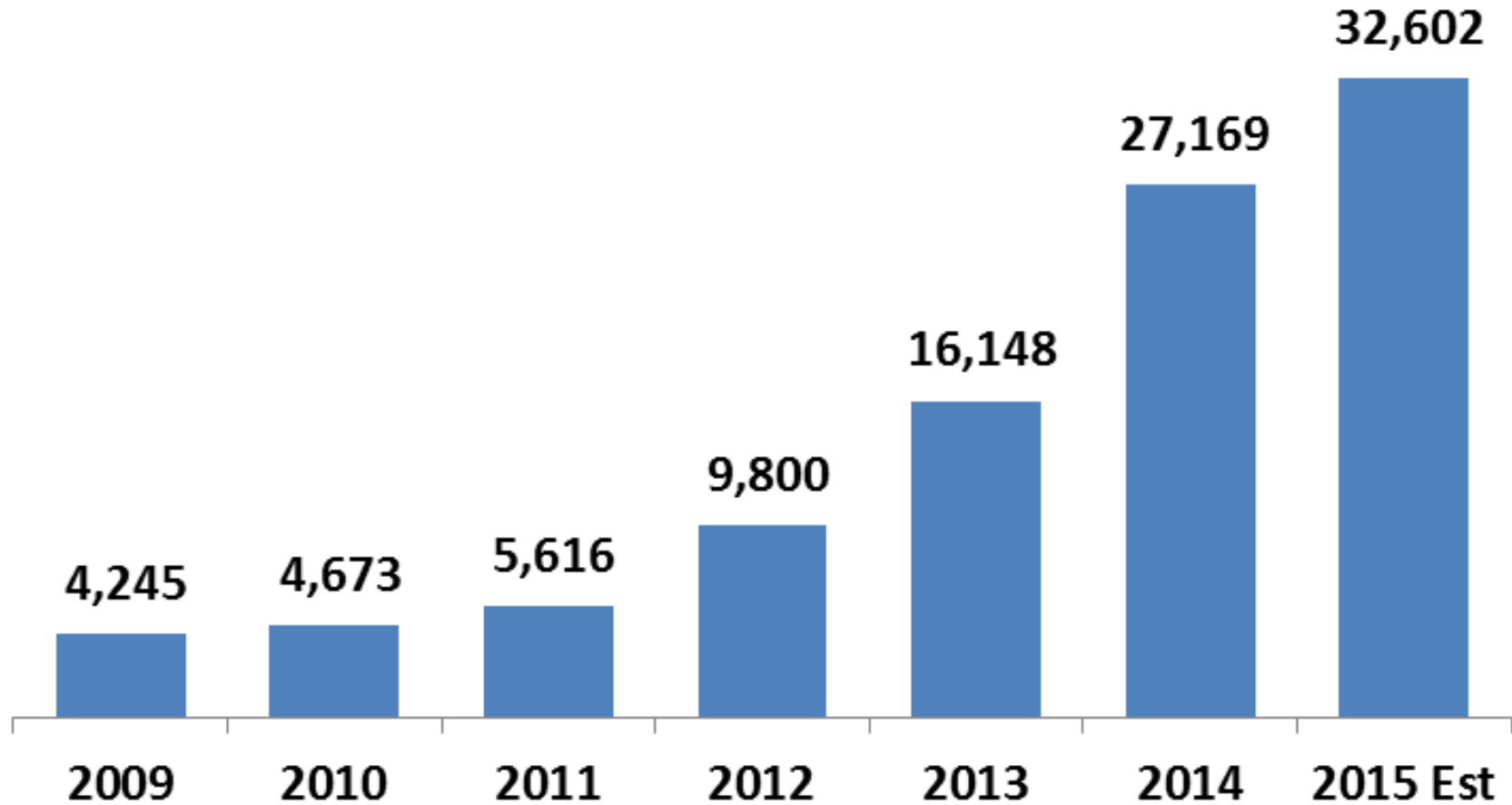
TERENCE BRADSHAW
UVM TREE FRUIT & VITICULTURE SPECIALIST

GREAT PLAINS GROWERS CONFERENCE
JANUARY 8, 2016



Annual Cider Category CE Vol

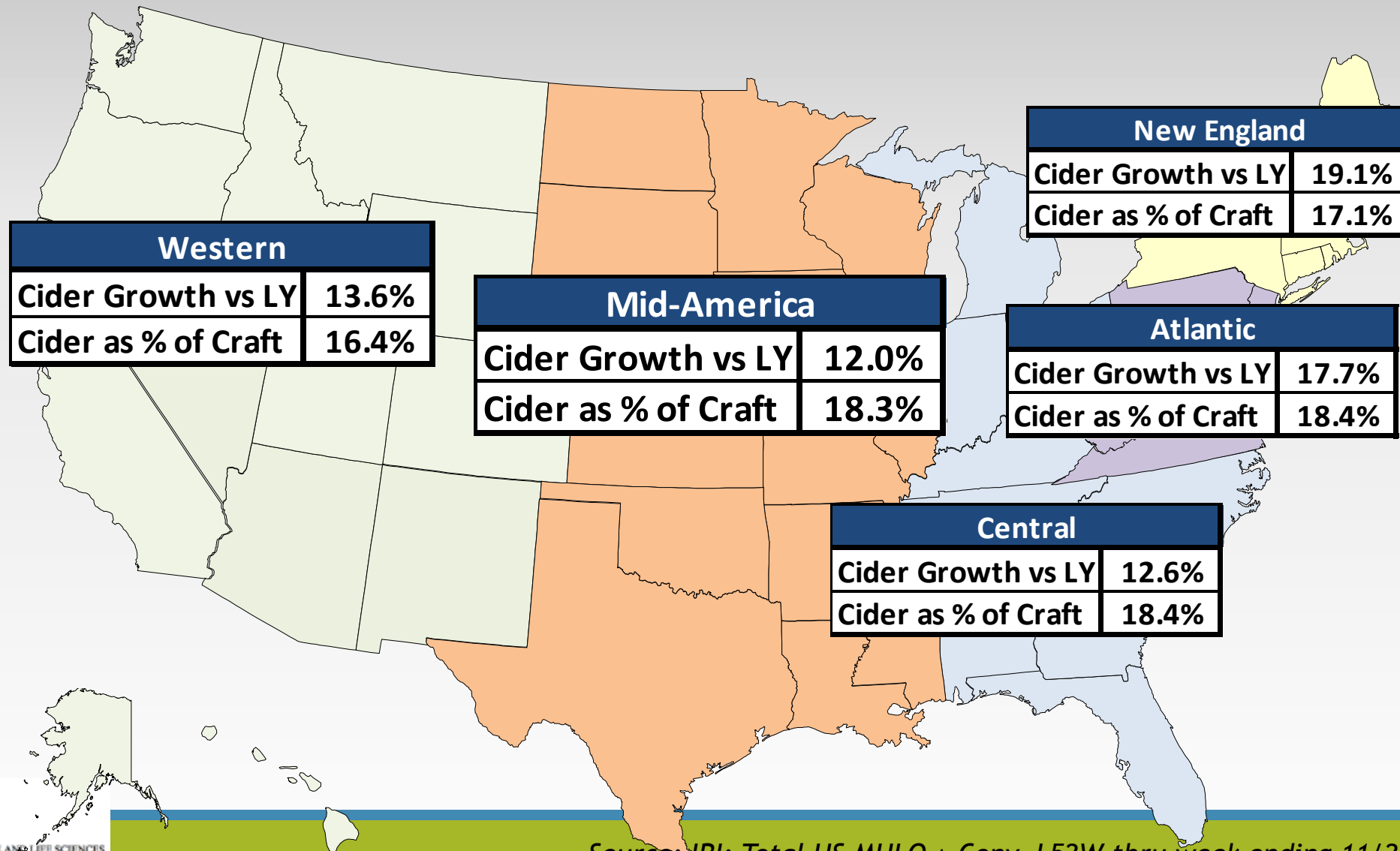
In Thousands



Source: Beer Institute, TTB and Commerce Department 2014. 2015 - BBC Projections



Cider Growth Across the Country



Source: IRI; Total US MULO + Conv L52W thru week ending 11/29/2015





NOVEMBER 14 – NOVEMBER 23, 2014

EVENTS

CIDER INFO

PRESS

ABOUT

JOIN THE HARD CIDER REVIVAL!



COLLEGE OF AGRICULTURE AND LIFE SCIENCES
UNIVERSITY OF VERMONT

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



Apple Growers Survey: Cider sales (n=24)

- 6 of the growers have sold to cideries
- 3 growers interested in starting to sell to cideries in next 5 years
- Handshake/verbal agreement with ciders for 4 of the growers and one grower used its own apples for cider production
- Proportion of apples sold to cideries: ranging from 2 % to 100% of production. Average 28% of production.
- 13 different cultivars sold, most popular: 'McIntosh', 'Macoun', 'Cortland' and 'Empire'



Apple Growers Survey: Prices received

		Price received			Target price			Average price difference in \$
Apple variety class	n	Mean	Min	Max	Mean	Min	Max	
Specialty cider/bittersweet	2	8.25	4	12.5	13.7	10	17.5	-5.45
Dessert variety tree pick	2	5.75	4	7.5	8.0	6.0	10.0	-2.25
Dessert variety cull	1	7.5	7.5	7.5	7.5	7.5	7.5	0
Dessert variety drop	1	-	-	-	7.5	7.5	7.5	-



Cider Makers Survey:

Cidery size and production levels

	Mean	Median
Cideries size		
Number of years in operation	7.9	4.5
Number of full time employees	25.1	2.0
Number of part time employees	3.8	2.0
Cider production in gallons		
2013 cider production	1,129,575	1,350
2014 anticipated cider production	1,130,150	1,350



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

Notes. When answer to quantity purchased was given in gallons, price was converted to \$U.S. per bushels where 1 bushel yields to 2.5 gallon of juice.



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)



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



Class	Cultivar	Appearance	Aroma	Sweetness	Acidity	Mouthfeel	Flavor
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

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

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



2015-16 Orchard Census Survey

- Cider apple cultivars
- Rootstocks
- Training systems
- Acreage
- Yield 2013-2015

2015 Cider Production

<https://go.uvm.edu/cidersurvey>

	Cultivar	Bloss	Acreage	Number of trees	Rootstock: actual stock or size class (1=Standard, 2=semi-dwarf, 3=dwarf)	Management Intensity: 1=Standard, 2=Reduced, 3=Certified	Pest management: 1=Conventional, 2=Cider IPM, 3=Organic	Yield 2013	Yield 2014	Yield 2015	Yield Unit (1=8 bushels, 2=bin)	\$ Price per bushel (Fresh Market)	\$ Price per bushel (Cider)	Target price: the ideal price you would have received.
1														
2														
3														
4														
5														



Two worlds of cider apple production

- Dessert fruit from existing/future plantings

- *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?*



Two worlds of cider apple production



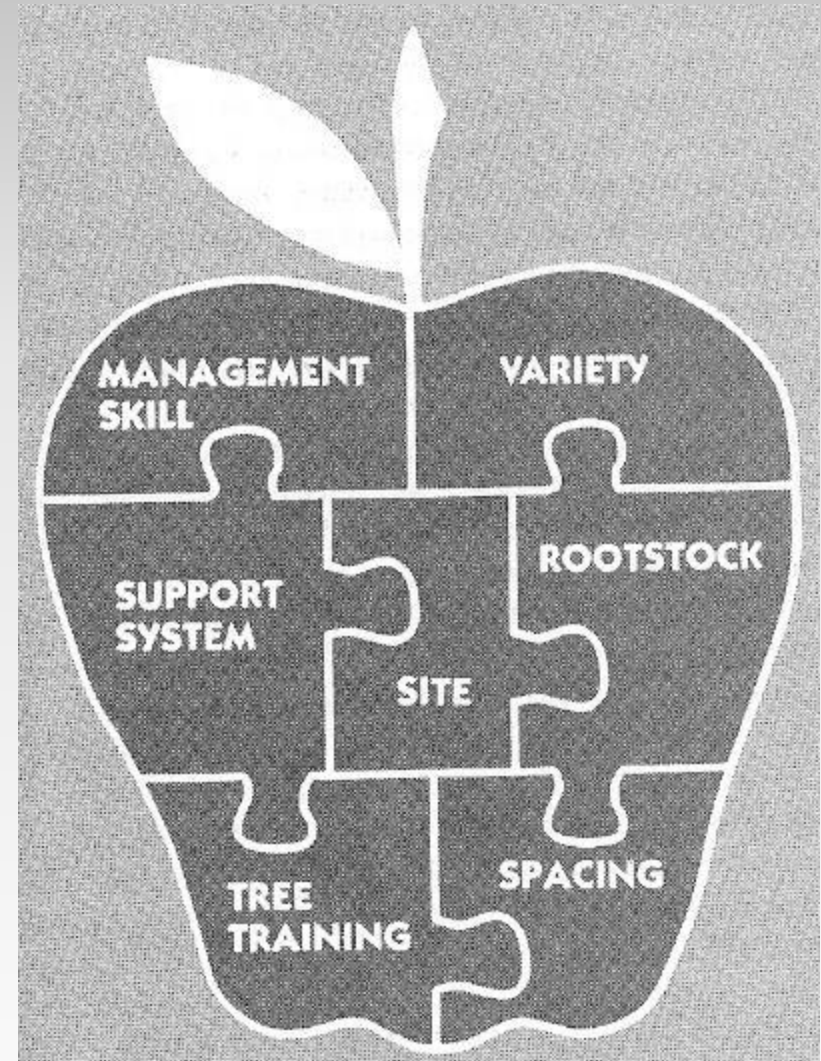
- Specialty cider cultivars

- Heirloom
 - Low-input scab-resistant cultivars
 - Regionally-unique cultivars
 - Bittersweet cultivars
-
- *How do these cultivars perform in Vermont orchards?*
 - *What management strategies can increase supply/profitability/cider quality?*



Orchard Layout and Design

- +Site aspects
- +Orchard spacing (tree and row)
- +Support system
- +Rootstock
- +Variety
- +Training system
- +Management

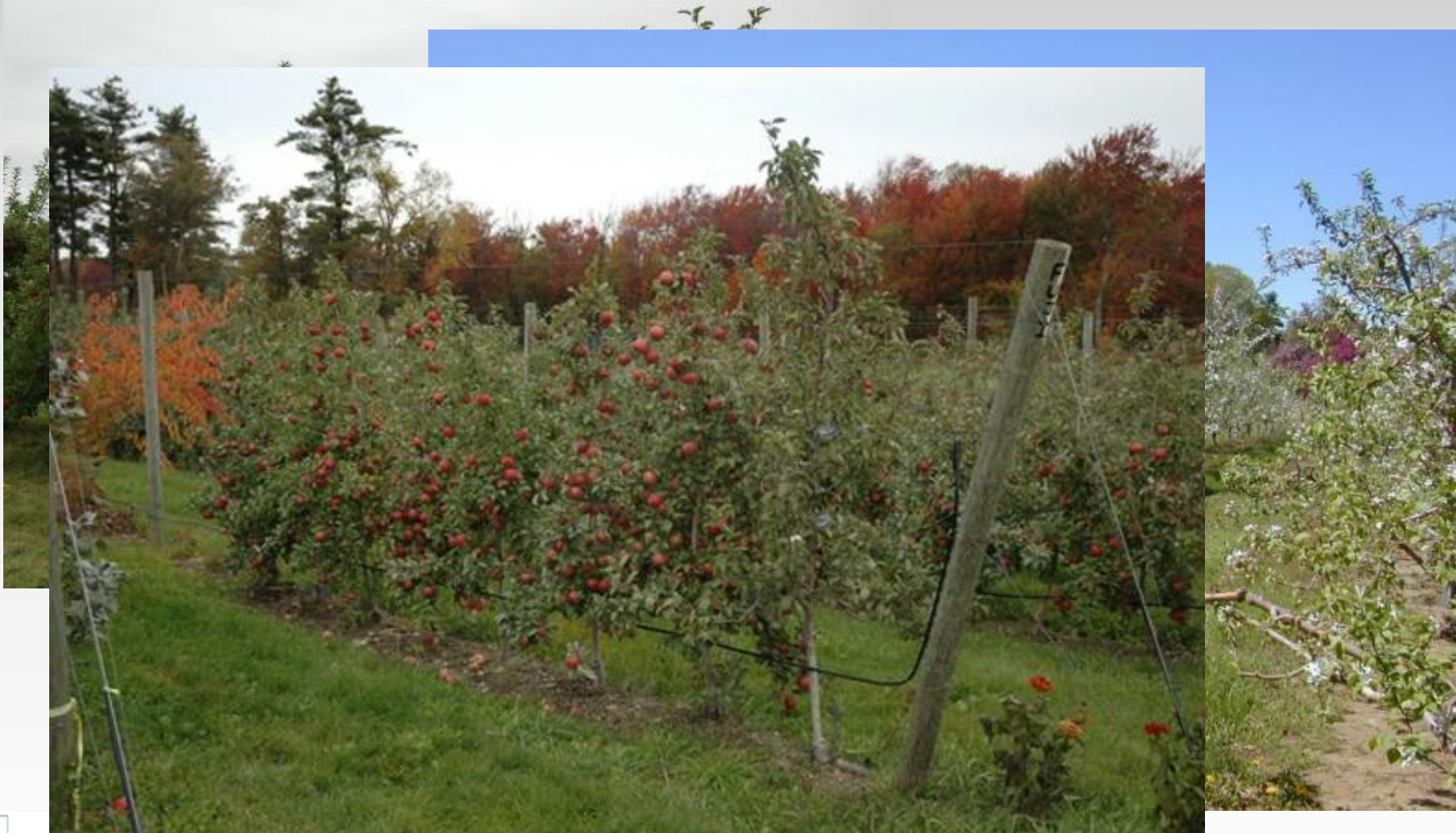


Site

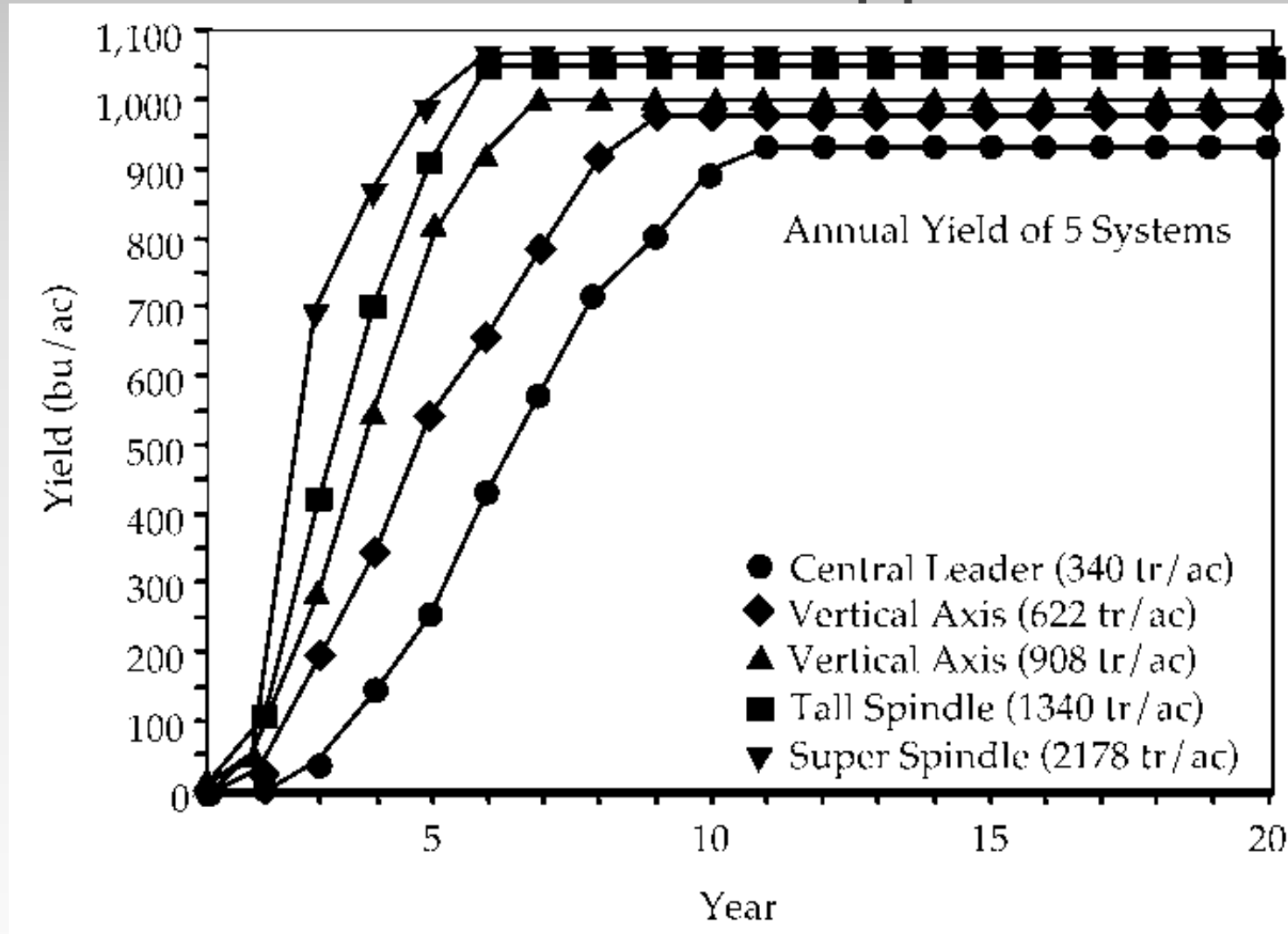
Climate	Topography	Soils
<ul style="list-style-type: none">• Winter Temperatures *• Spring Frosts• Length of Growing Season• Growing Degree Days• Precipitation	<ul style="list-style-type: none">• Relative Elevation*• Nearness to a large body of water*• Degree of Slope• Direction of Slope	<ul style="list-style-type: none">• Drainage• Moisture Holding Capacity• pH• Fertility• Organic Matter



Tree Spacing & Training



The Shift toward Smaller Apple Trees

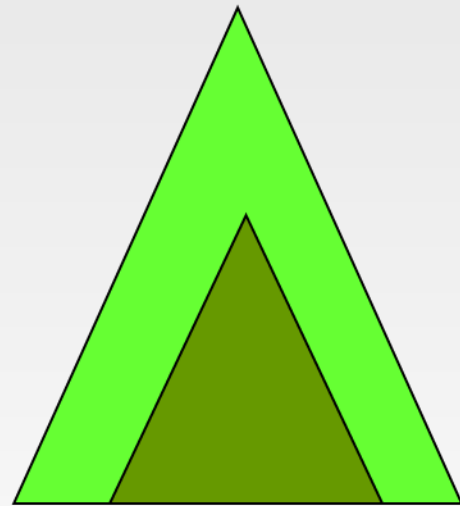


Robinson, Terence, et al. "The evolution towards more competitive apple orchard systems in New York." *New York Fruit Quarterly* 15.1 (2007): 3-9.



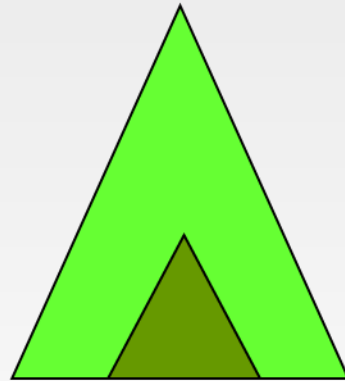
The Shift toward Smaller Apple Trees

Effect of tree size on light exposure



5m

24.45% shade



4m

12% shade



2.5m

1.6% shade



http://www.theenglishappleman.com/journal_120727.asp



Growing cider apples in England Traditional

- Dual enterprise
- 60 trees per acre
- 460 bushels per acre
- 80 year life

- Biodiversity
- Minimum 10 varieties
- No longer economic

Growing cider apples in England Intensive

- 1200 trees per acre
- 1100 bushels per acre
- 15 yr life
- Unsuitable for mechanical harvesting

- High input/high output
- Labour & water intensive
- Requires best soils & climate
- Not economic for cider apples

European Harvest Equipment

Tree shaker



Tuthill Temperley, UK

Harvesters/Sweepers



Weston & Sons Cider, UK



Molaignes, France (G. Holder)



Growing cider apples in England

Commodity production

- 335 trees per acre
- 850 bushels per acre
- 40 yr life
- Fully mechanised harvesting & pruning

- Lower inputs/outputs
- 1 person per 100 acres
- Less favourable soils
- Best economic return

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



Current Status of Cider Apple Sourcing in U.S.

Dual-purpose fruit

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



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?
- Applicability of production systems



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?
- Applicability of production systems



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?
- Applicability of production systems



TWENTY COMMONLY PLANTED CIDER CULTIVARS:

The cider apple cultivars most commonly mentioned for planting in different regions of the U.S. are shown below.

Cultivar	Type	Origin
Ashmead's Kernel	SH	England
Brown Snout	BSW	England
Chisel Jersey	BSW	England
Dabinett	BSW	England
Golden Russet	SH	USA - Heritage
GoldRush	SH	USA - Modern
Harrison	SH	USA - Heritage
Harry Masters' Jersey	BSW	England
Kingston Black	BSH	England
Michelin	BSW	France
Nehou	BSW	France
Newtown/Albemarle Pippin	SH	USA - Heritage
Porter's Perfection	BSH	England
Redstreak, Hereford	SH	England
Roxbury Russet	SH	USA - Heritage
Tramlett's, Geneva ¹	BSH	England
Virginia Crab (Hewes)	BSH	USA - Heritage
Wickson Crab	BSH	USA - Modern
Winesap	SH	USA - Heritage
Yarlington Mill	BSW	England

¹ Unknown variety received from Geneva, NY germplasm repository as Tramlett's Bitter (incorrectly).

Commonly Grown Cider Apple Cultivars In the U.S.

Cider apple 'Dabinett' grown at WSU
Mount Vernon NWREC.



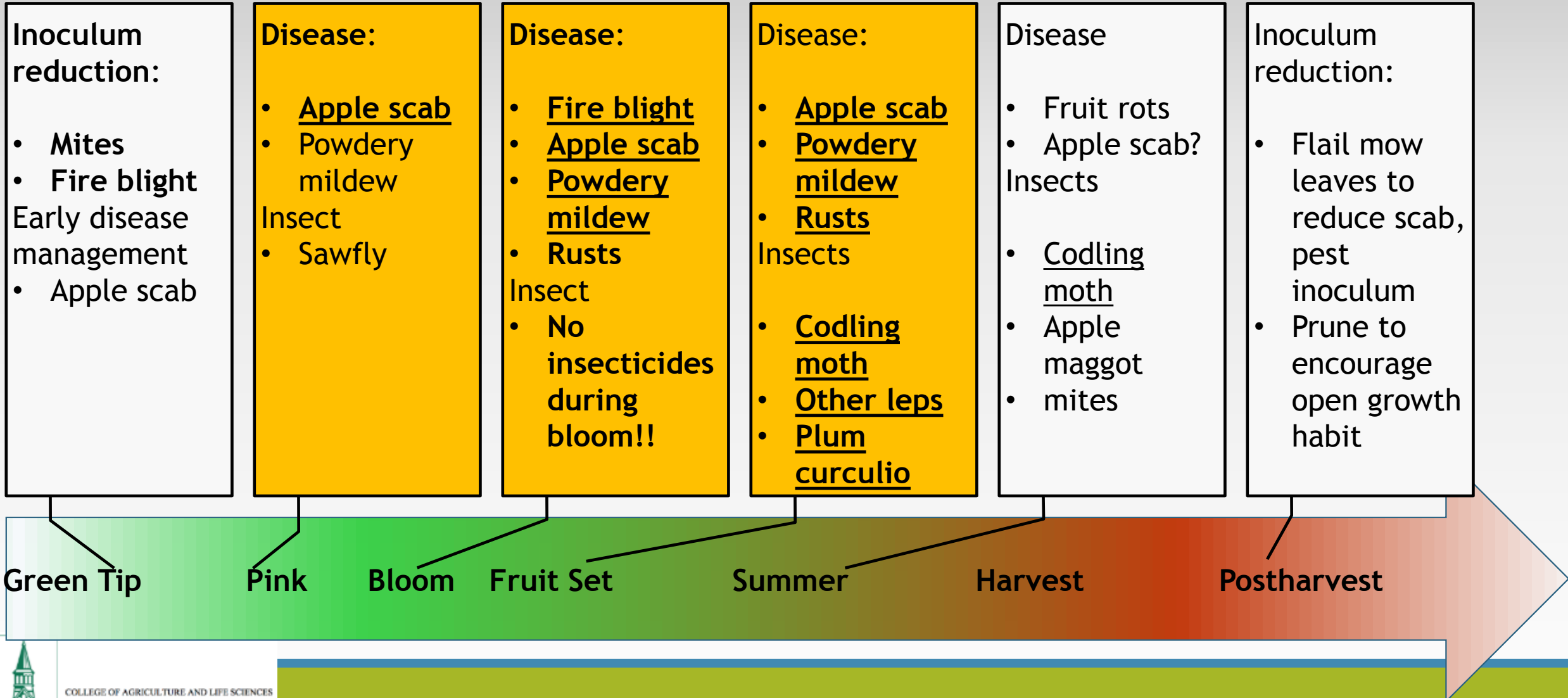
Harrison
 Hewes
 Wickson
 Golden Russet
 Razor Russet
 Topus
 Spitzenburg

- Newtown Pippin
- Stayman
- Winesap
- Liberty

Unique production challenges with bittersweet cultivars



Generic cider apple pest management calendar



Scenario 1: Packout culls from fresh market orchard

Bu/Acre	Packout	Price #1s	Price Cider	Net #1s	Net Cider	Subtotal
500	85%	\$22	\$6	\$9,350	\$450	\$9,800
750	85%	\$22	\$6	\$14,025	\$675	\$14,700
1000	85%	\$22	\$6	\$18,700	\$900	\$19,600



Scenario 2: Cider apple production orchard- Dessert cultivars

Bu/Acre	Packout	Price #1s	Price Cider	Net #1s	Net Cider	Subtotal
500	0%	-	\$8	-	\$4,000	\$4,000
750	0%	-	\$8	-	\$6,000	\$6,000
1000	0%	-	\$8	-	\$8,000	\$8,000



Scenario 3: Cider apple production orchard- Bittersweet cultivars

Bu/Acre	Packout	Price #1s	Price Cider	Net #1s	Net Cider	Subtotal
500	0%	-	\$20	-	\$10,000	\$10,000
750	0%	-	\$20	-	\$15,000	\$15,000
1000	0%	-	\$20	-	\$20,000	\$20,000



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 ²)	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 Juice Lab Results: Cider Orchard

cultivar	Brix	pH	g/L malic acid	% Total Phenols (tannin)	mg/L YAN
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)



Cultivar	Brix	pH	g/L malic acid	% Total Phenols (tannin)	mg/L YAN
Crimson Crisp	14.4	3.37	8.85	0.11	170
William's Pride	10.0	3.42	5.43	0.04	56
Liberty Early Harvest	10.3	3.26	7.46	0.02	100
Liberty Late Harvest	11.1	3.38	5.40	0.03	71
Liberty Ripe Harvest	11.1	3.28	6.70	0.03	72
Liberty (2014)	11.5	3.45	5.72	0.02	57
Topaz	12.4	3.35	9.86	0.06	16
Ashmead's Kernel	18.0	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

cultivar	Brix	pH	g/L malic acid	% Total Phenols (tannin)	mg/L YAN
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



2016 UVM Apple Program

Dr. Terence Bradshaw

- UVM Tree Fruit & Viticulture Specialist
College of Agriculture & Life Science

Dr. Ann Hazelrigg

- Director, UVM Plant Diagnostic Clinic
UVM Extension

Sarah Kingsley-Richards
Jessica Foster

- Research Technicians

Dr. David Conner

- Agricultural Economist
UVM Dept Community Dev & Appl Economics

Florence Becot

- Research Specialist, CDAE

Funding acknowledgements:

Vermont Working Lands Enterprise Fund

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

USDA FSMIP

- Orchard Economic Assessment to Support Vermont Hard Cider Production

USDA Extension Integrated Projects Program

- The Transdisciplinary Vermont Extension IPM Program Addressing Stakeholder Priorities and Needs for 2013-2016

Vermont Agricultural Experiment Station

Vermont Tree Fruit Growers Association

Vermont Hard Cider Company

