Constraints and Opportunities in Growing Apples for the Cider Market

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MONTANA GRAPE AND WINE ASSOCIATION
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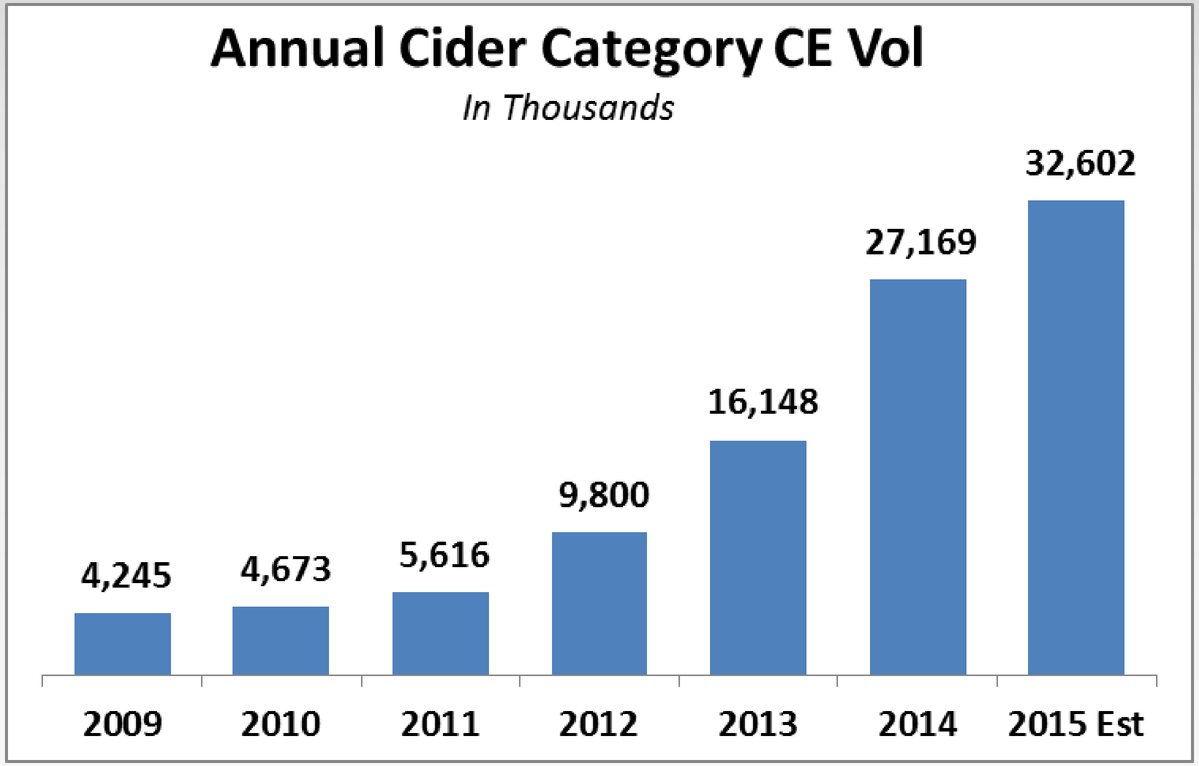
HELENA. MT MARCH 22, 2019

U.S Cider Sales Increasing since 2011

- Substantial increase in cider category around 2012-2014 attracted attention
- Questions:
  - Is this growth sustainable?
  - How can the apple industry respond to this market increase?



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

2014-2016: 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

2014-2016: 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

Production and Prospects in Vermont

- Growth of industry is seen as an opportunity for apple growers and cider makers

- But…
  - Adequate apple price is a threat for growers
  - Adequate fruit supply is a threat for cider makers

Becot, F. A., T. L. Bradshaw and D. S. Conner (2016). "Apple Market Optimization and Expansion through Value-Added Hard Cider Production " HortTechnology **26**(2): 220-229.

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?*

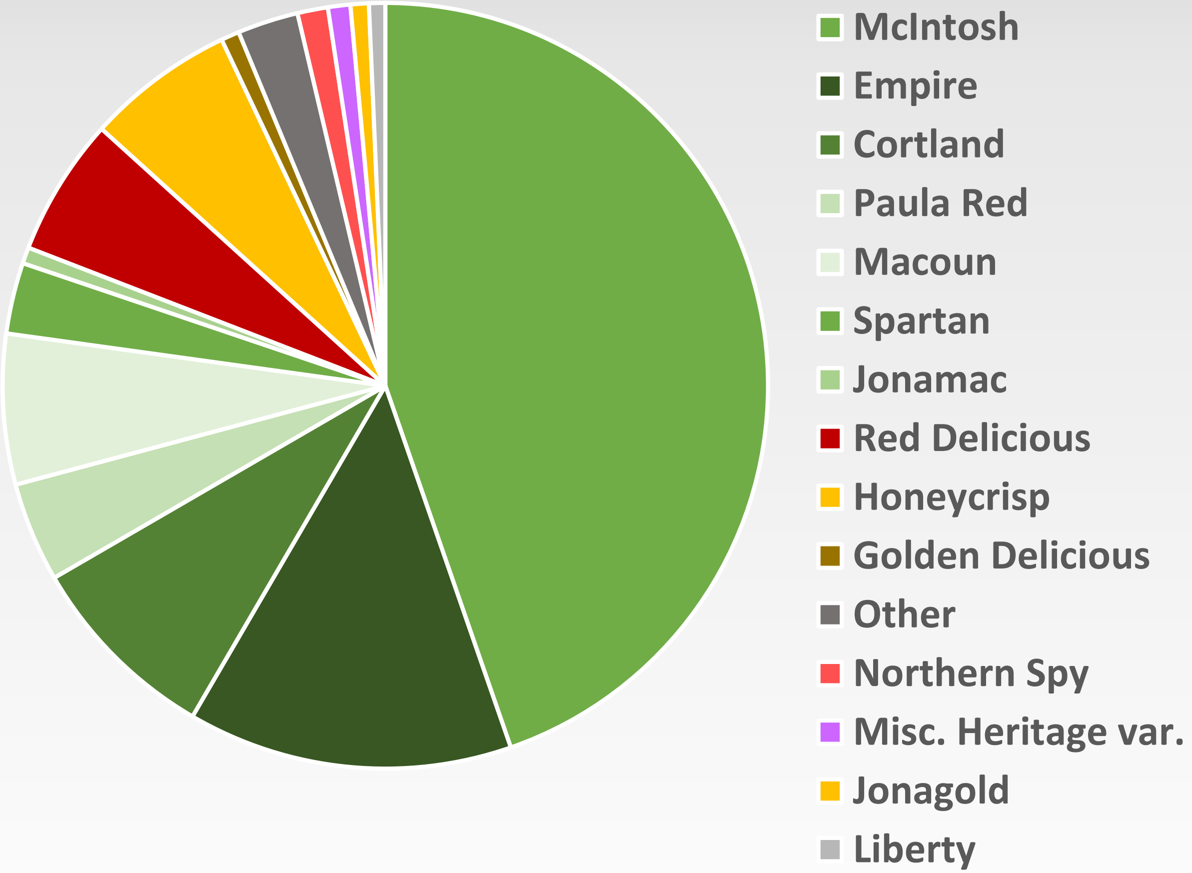
What the Cider Makers Want

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 Reinnette (1)
		Somerset Redstreak (1)
		Stoke Red (1)
		Wickson (4)
		Yarlington Mill (2)

Becot, F. A., T. L. Bradshaw and D. S. Conner (2016). "Apple Market Optimization and Expansion through Value-Added Hard Cider Production " HortTechnology **26**(2): 220-229.

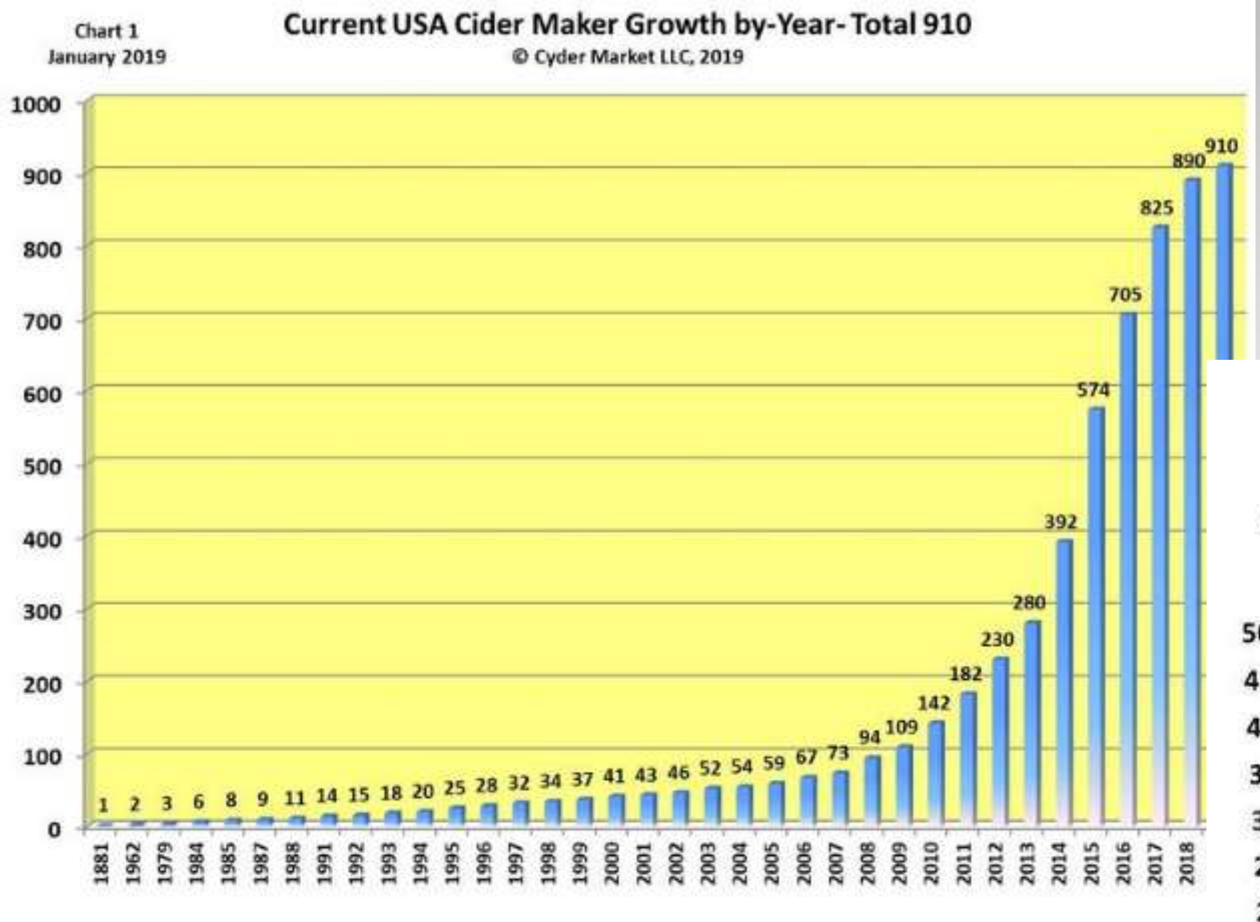
What Vermont orchards are growing

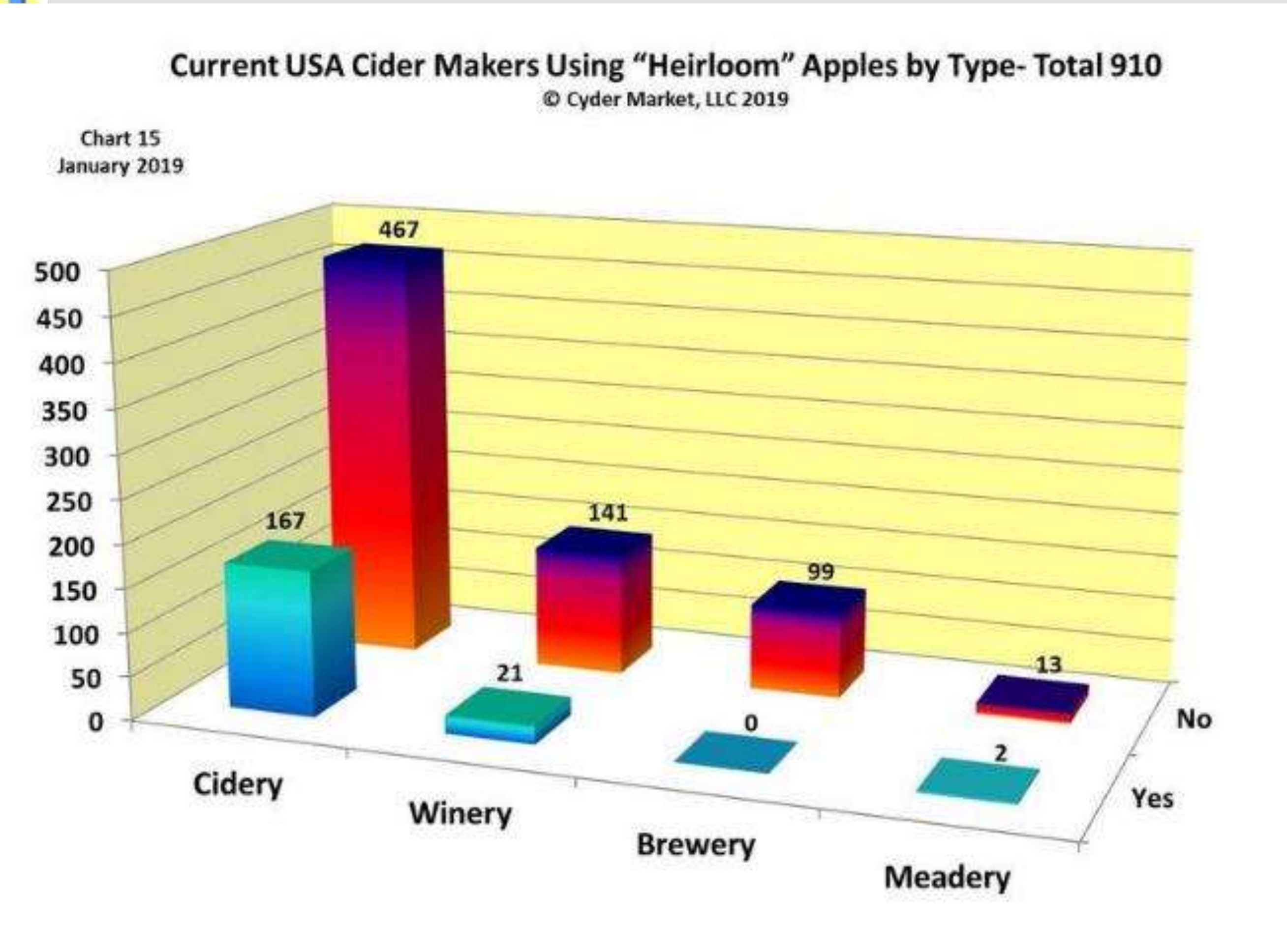
'McIntosh' family	81%
Red Delicious	6%
Honeycrisp	6%
'Desert cider'	7%



VTFGA (2011). Vermont Tree Fruit Growers Association Apple Industry Survey Report. http://www.uvm.edu/~orchard/2011VT_Apple_Survey_Results.pdf.

Continuing trends





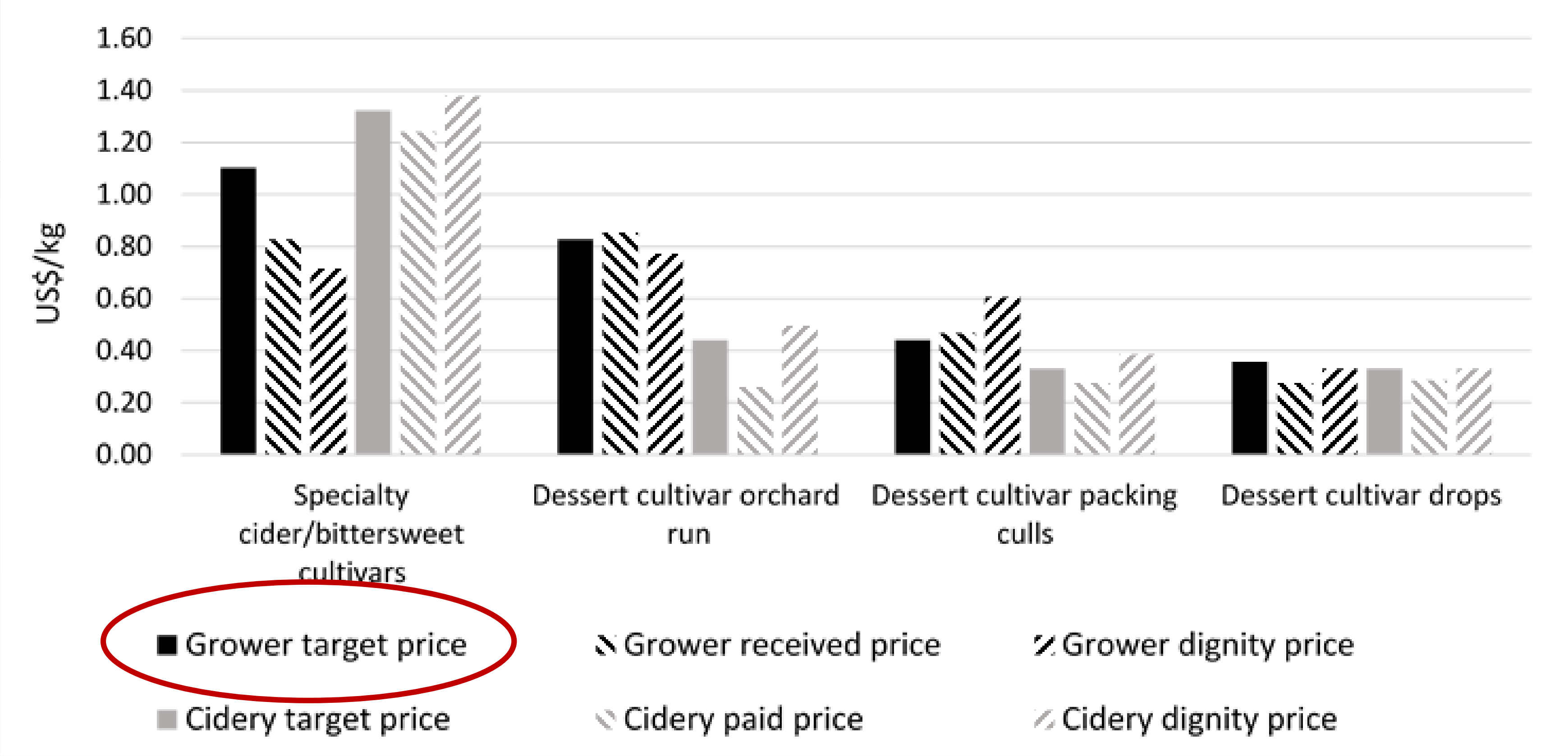


Figure 1. Median prices received and paid for apples to be used in cider production (growers: n = 9 and cideries: n = 5)

Becot, F. A., T. L. Bradshaw and D. S. Conner (2016). "Apple Market Optimization and Expansion through Value-Added Hard Cider Production " HortTechnology **26**(2): 220-229.

2015-16 “Kitchen Table” Surveys

Small scale orchards:

- 11.5 productive acres
- 2015 mean yield 341 bushels per acre

Large scale orchards

- 167.5 productive acres 2015 mean yield 650 bushels per acre.

Generated real cost data for modeling

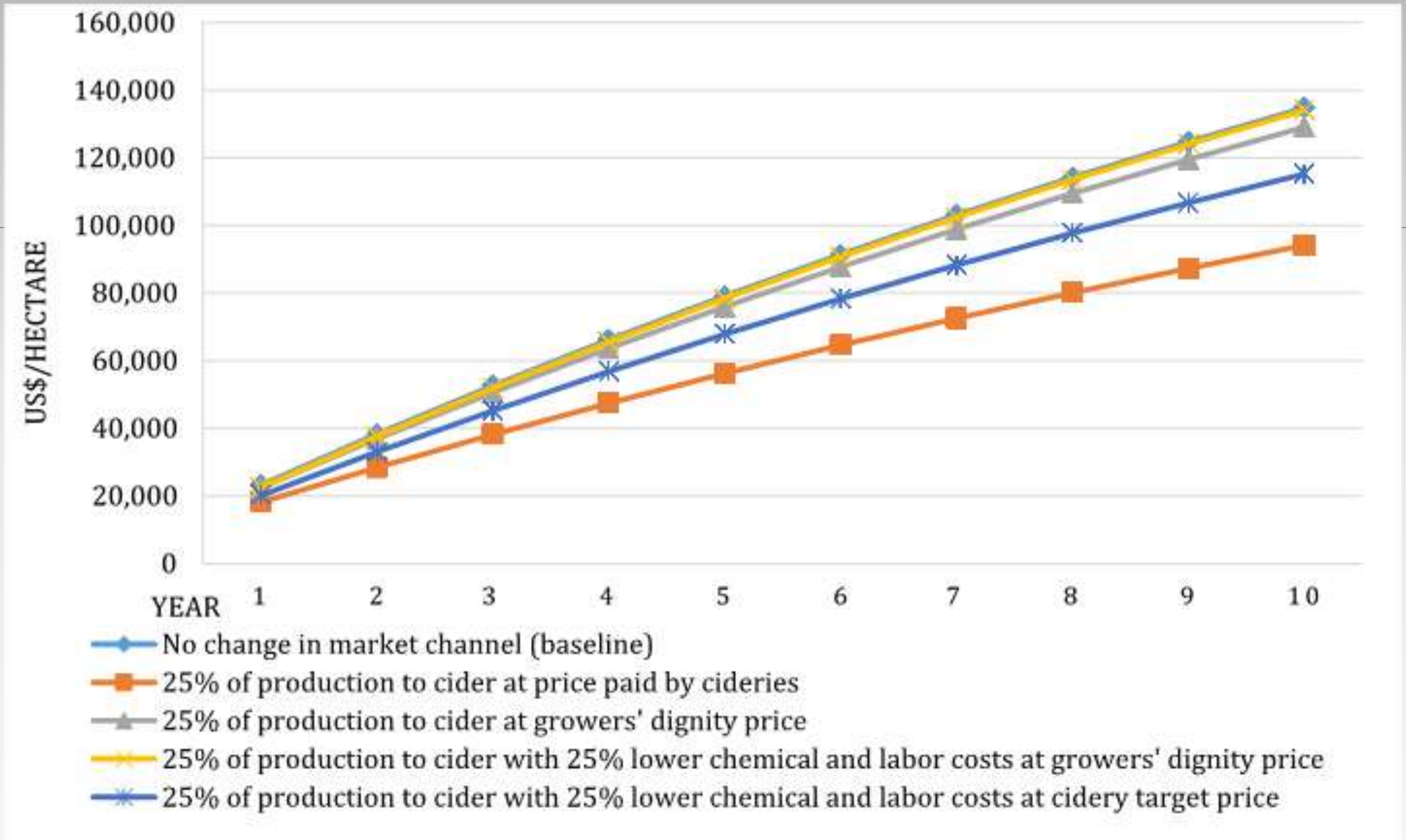
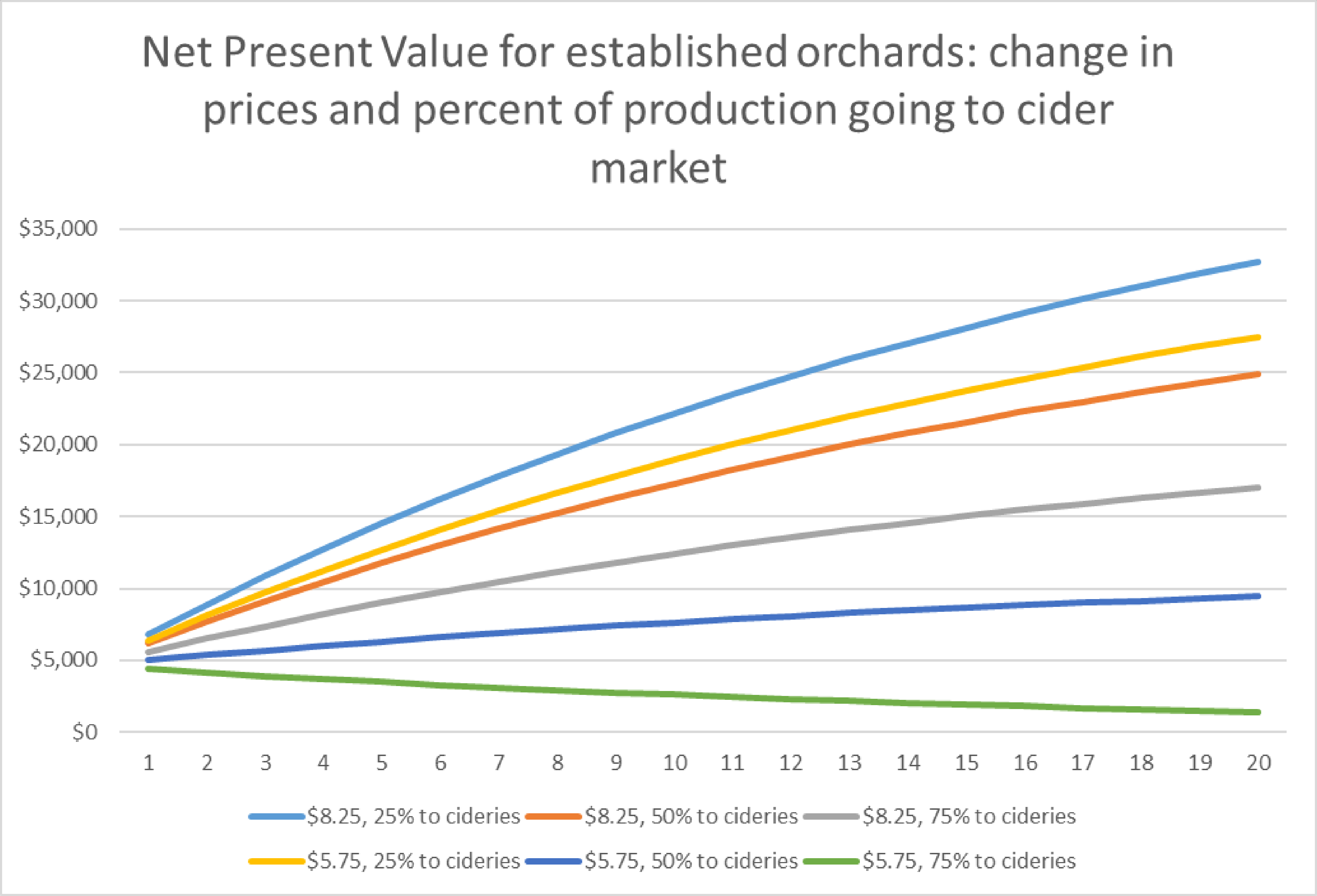


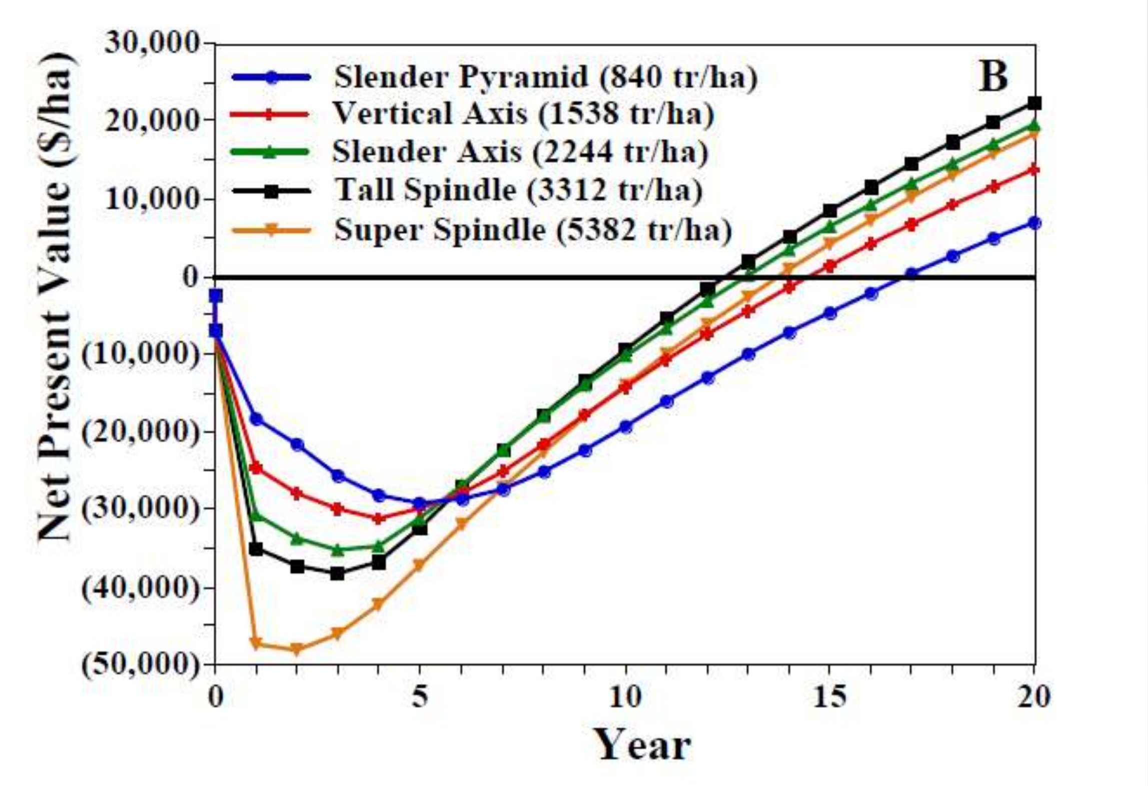
Figure 2. Net present value for small scale orchard selling 25% of the dessert cultivar orchard run production to cider under various price and management scenarios.

Becot, F.A., Bradshaw, T.L., and Conner, D.S., 2016. Growing apples for the cider industry in the U.S. Northern Climate of Vermont: Does the math add up? *Acta Hort*. In press.


Net Present Value for established orchards: change in prices and percent of production going to cider market
$35,000
$30,000
$25,000
$20,000
$15,000
$10,000
$5,000
$0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
$8.25, 25% to cideries
$8.25, 50% to cideries
$8.25, 75% to cideries
$5.75, 25% to cideries
$5.75, 50% to cideries
$5.75, 75% to cideries

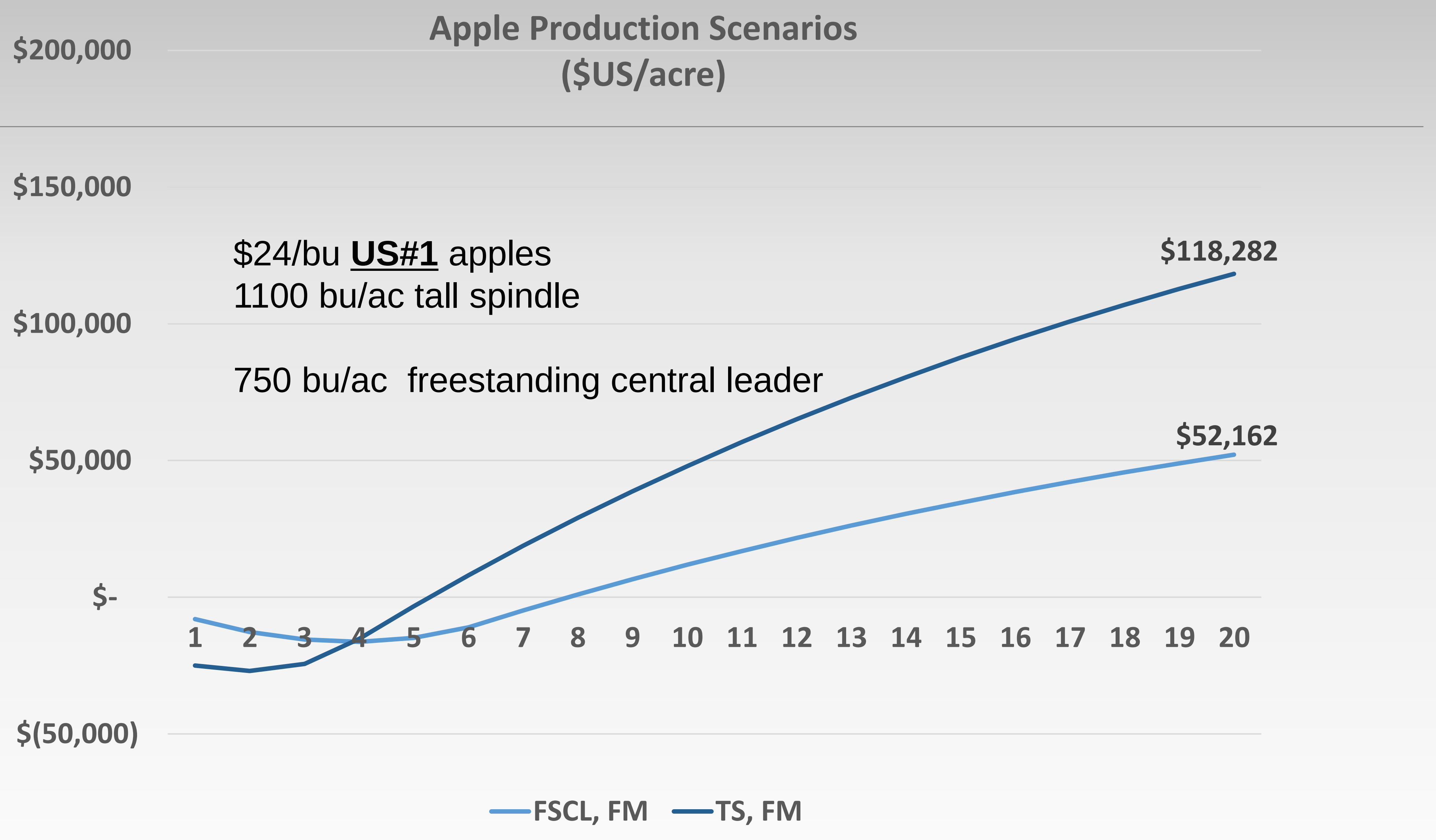
New orchard establishment

Training system	Est Cost	Trees/ac	Mature Yield (bu/acre)
Tall spindle	25000	1000	1100
Vert axe	15000	600	900
Freestand CL	8000	250	750
Standard	4000	100	750
Established Low Density	0	250	750



Robinson, T., A. DeMarree and S. Hoying (2007). "An economic comparison of five high density apple planting systems." Acta Hort 732: 481-489.

500 bu / acre = 22.5 MT/hectare $50,000 / acre = $112,000 / ha



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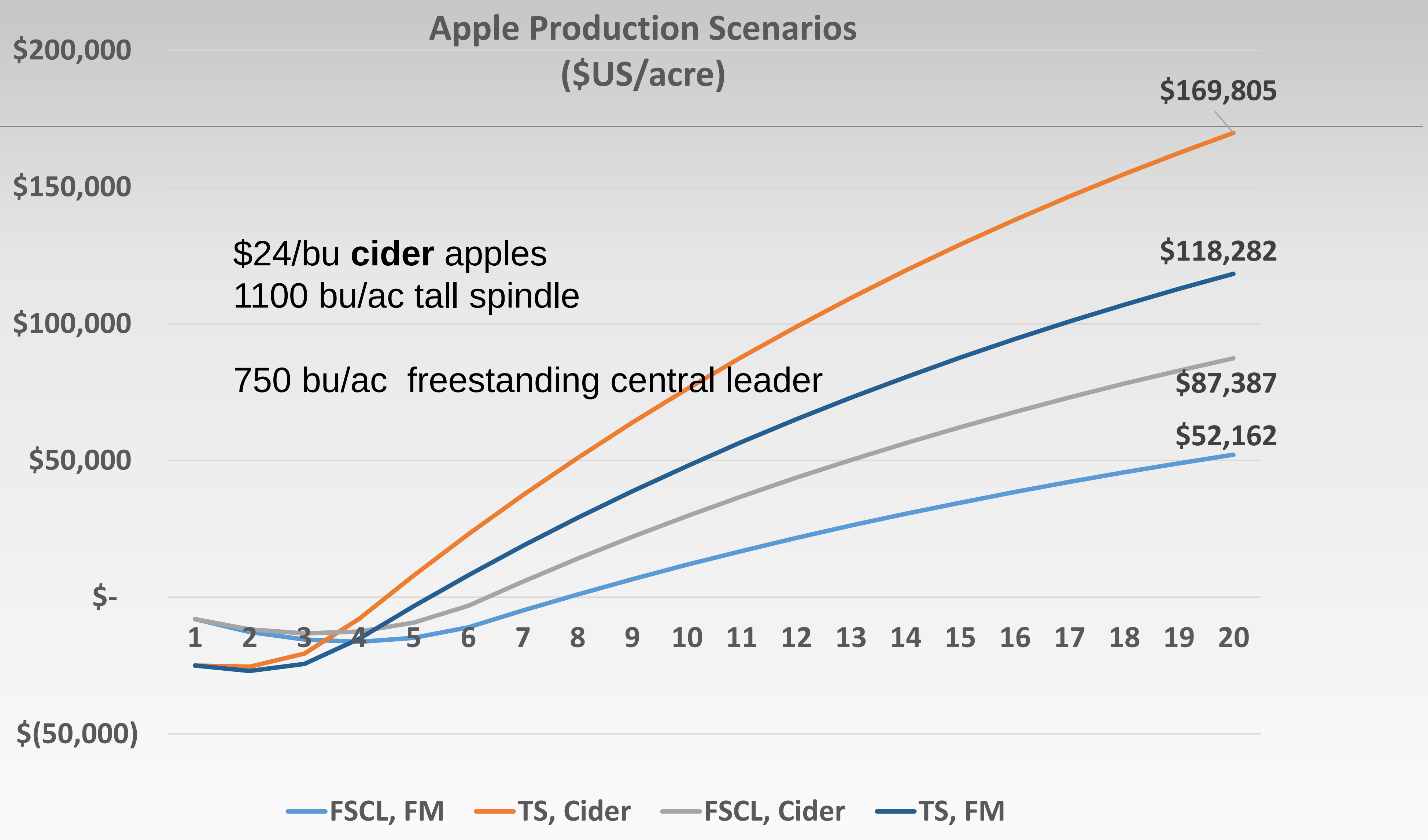

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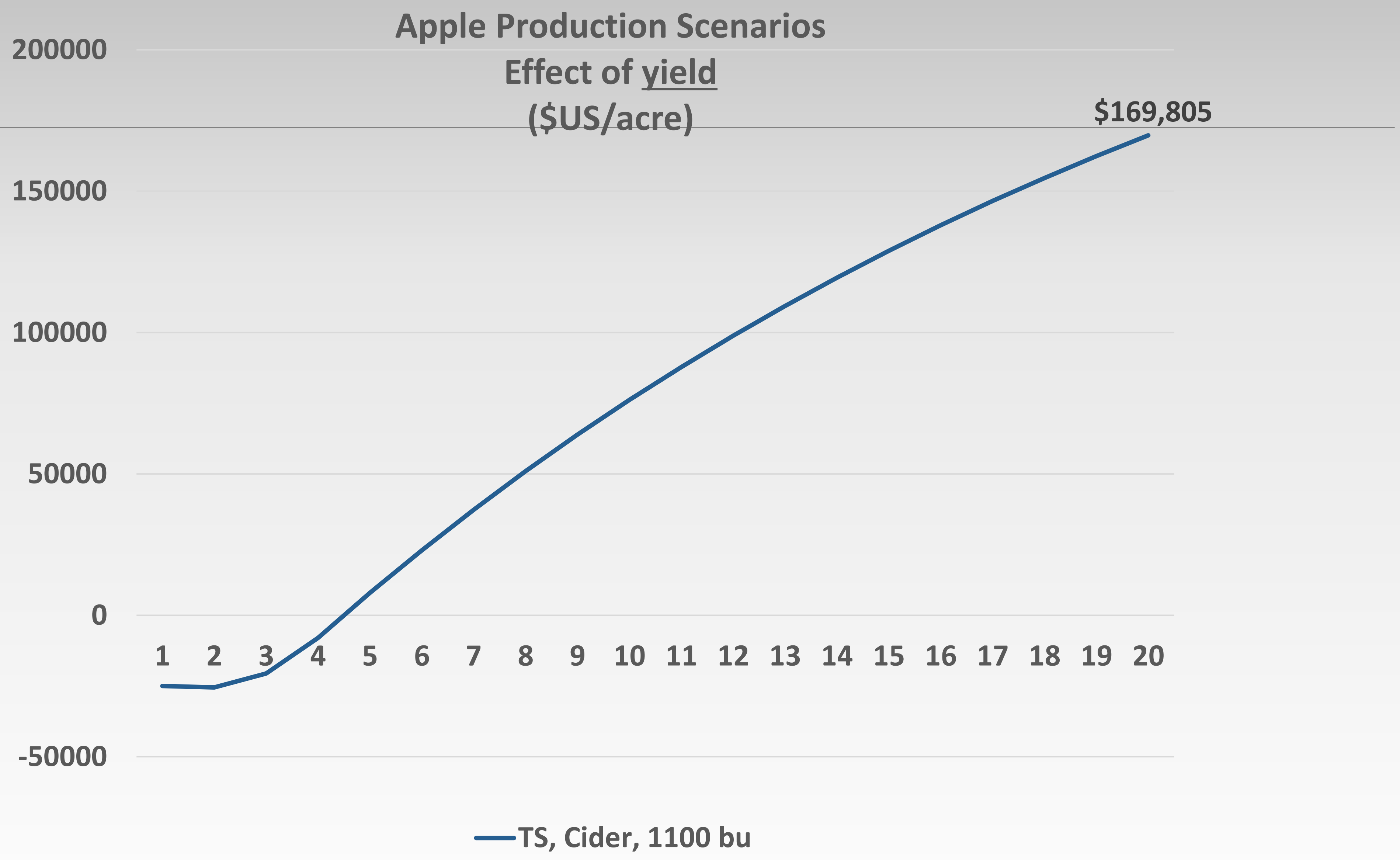

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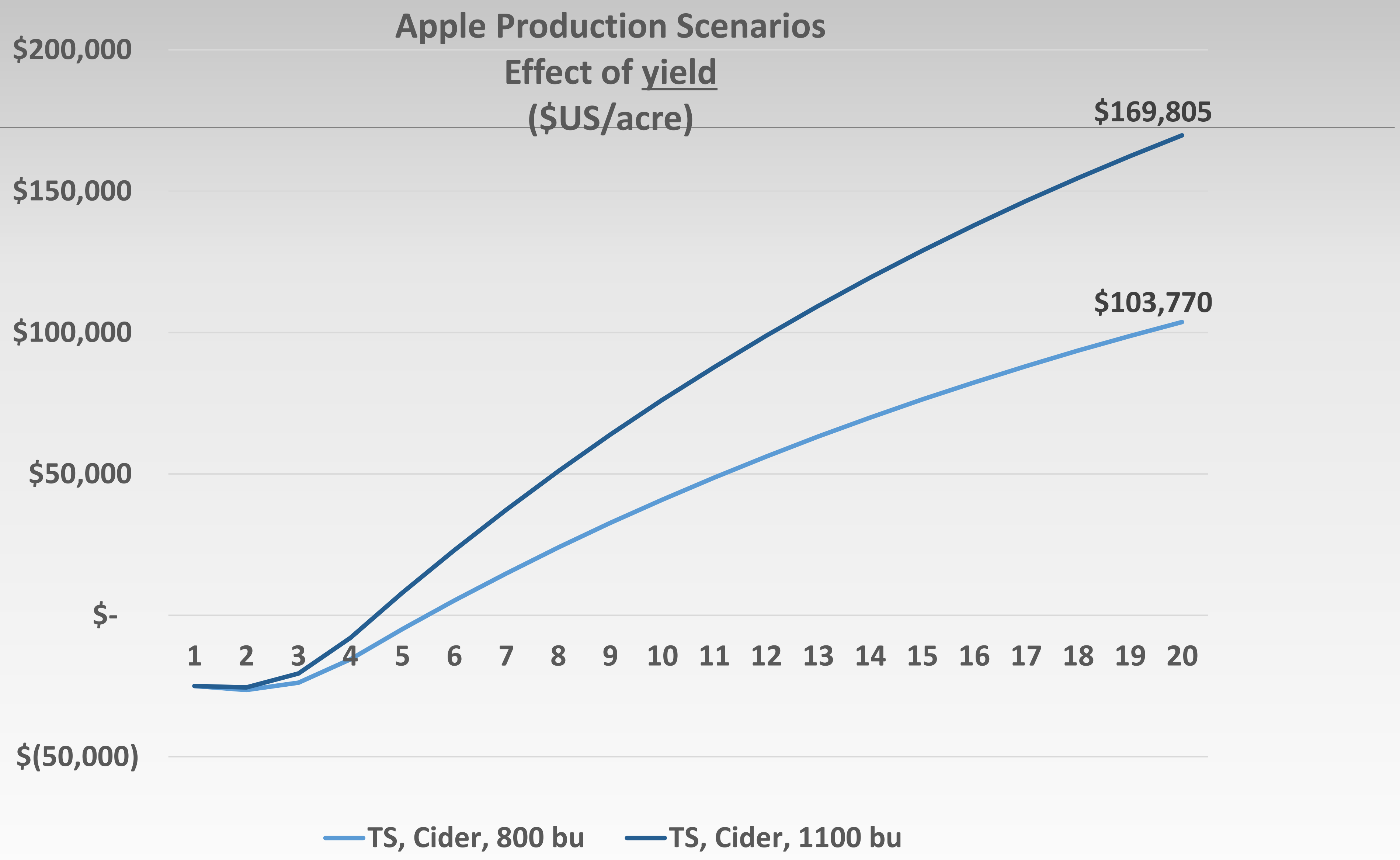

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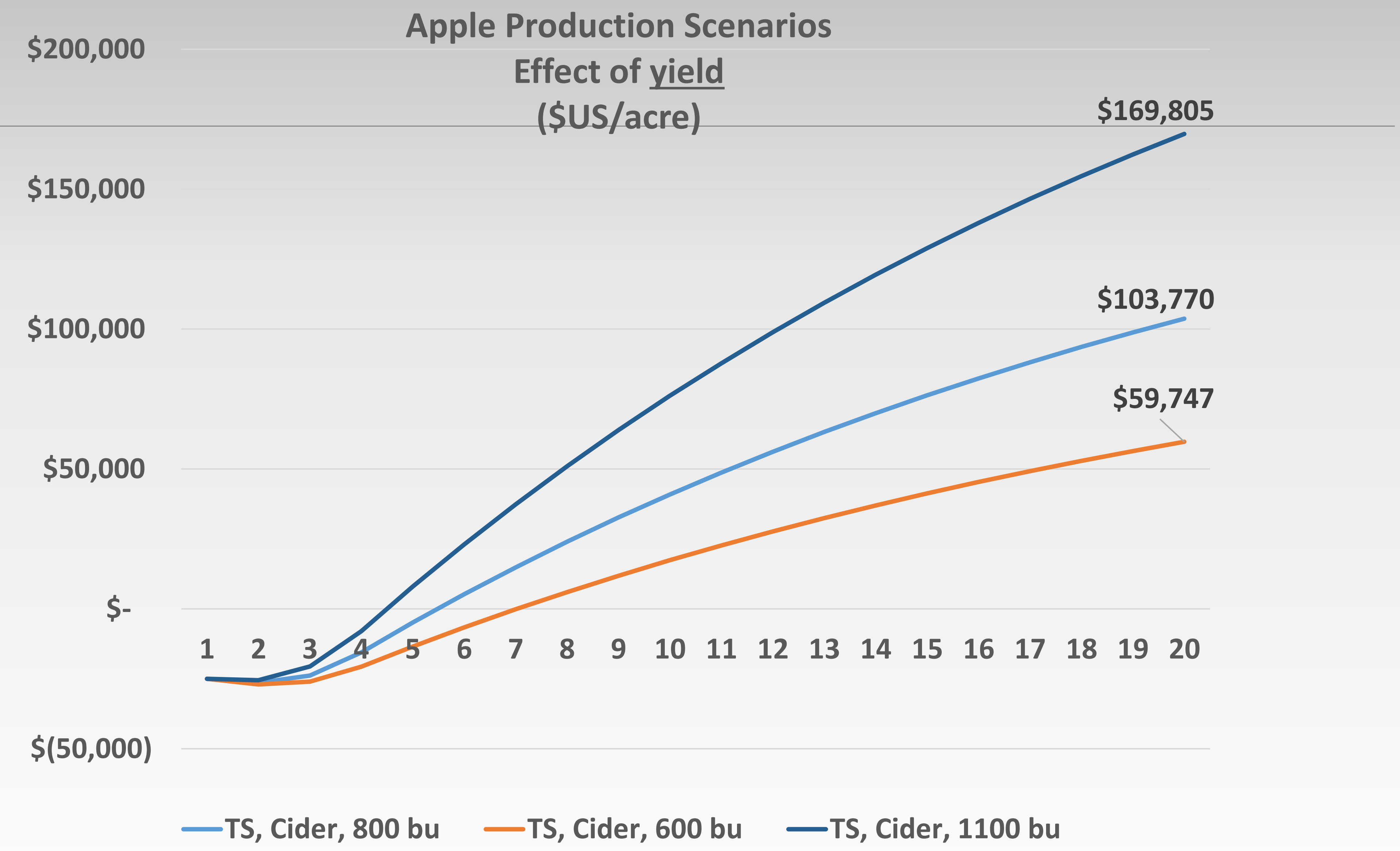

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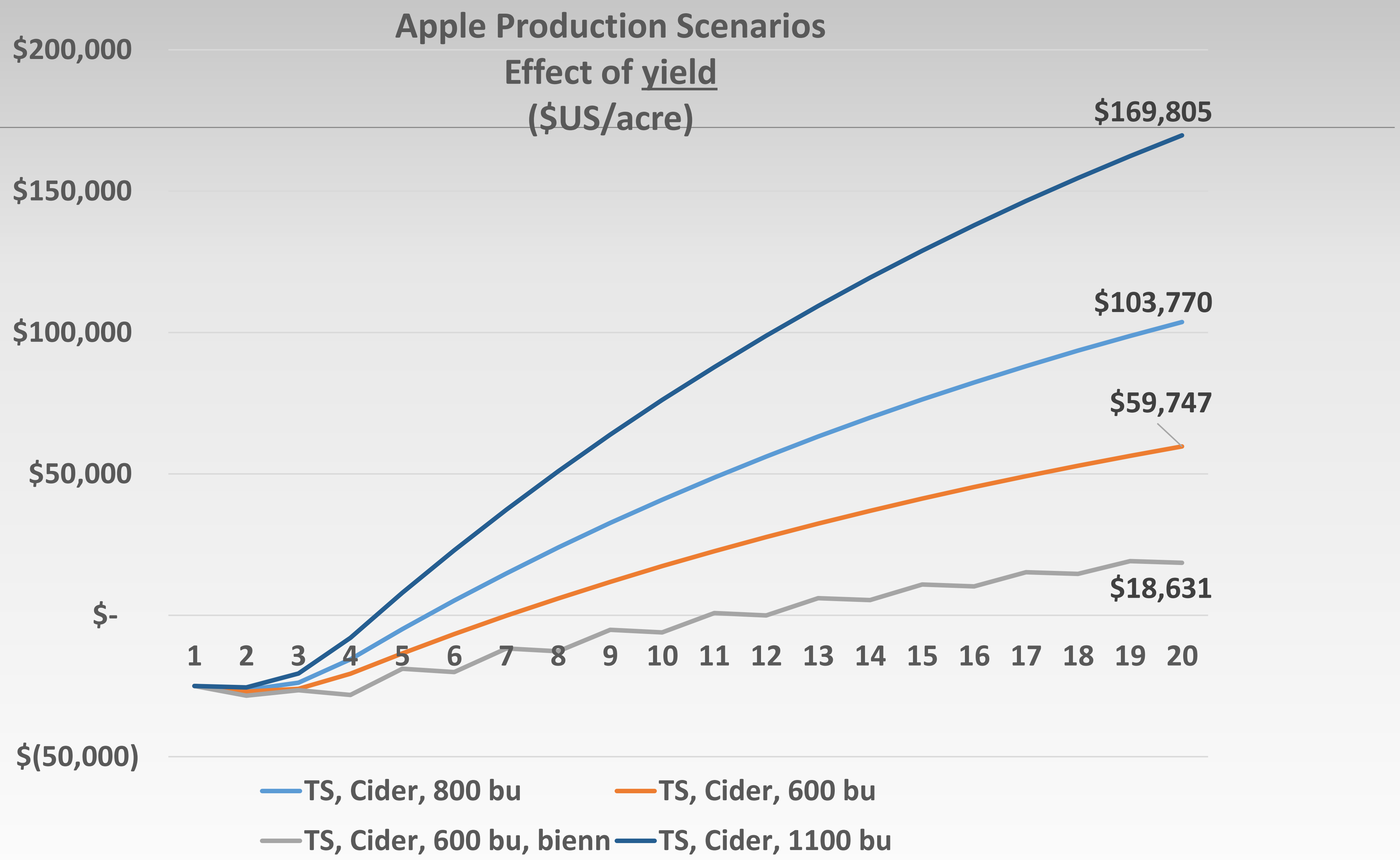

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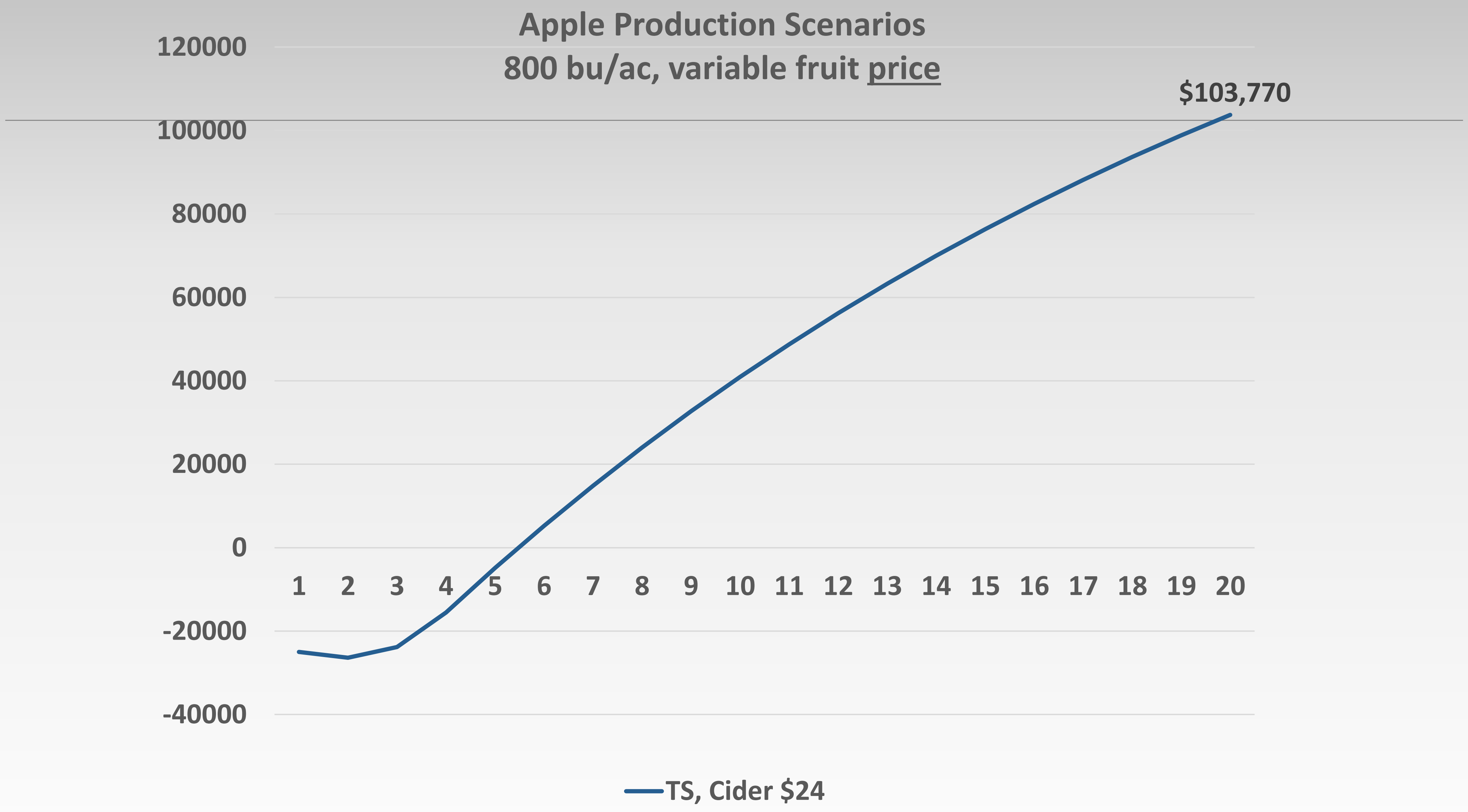

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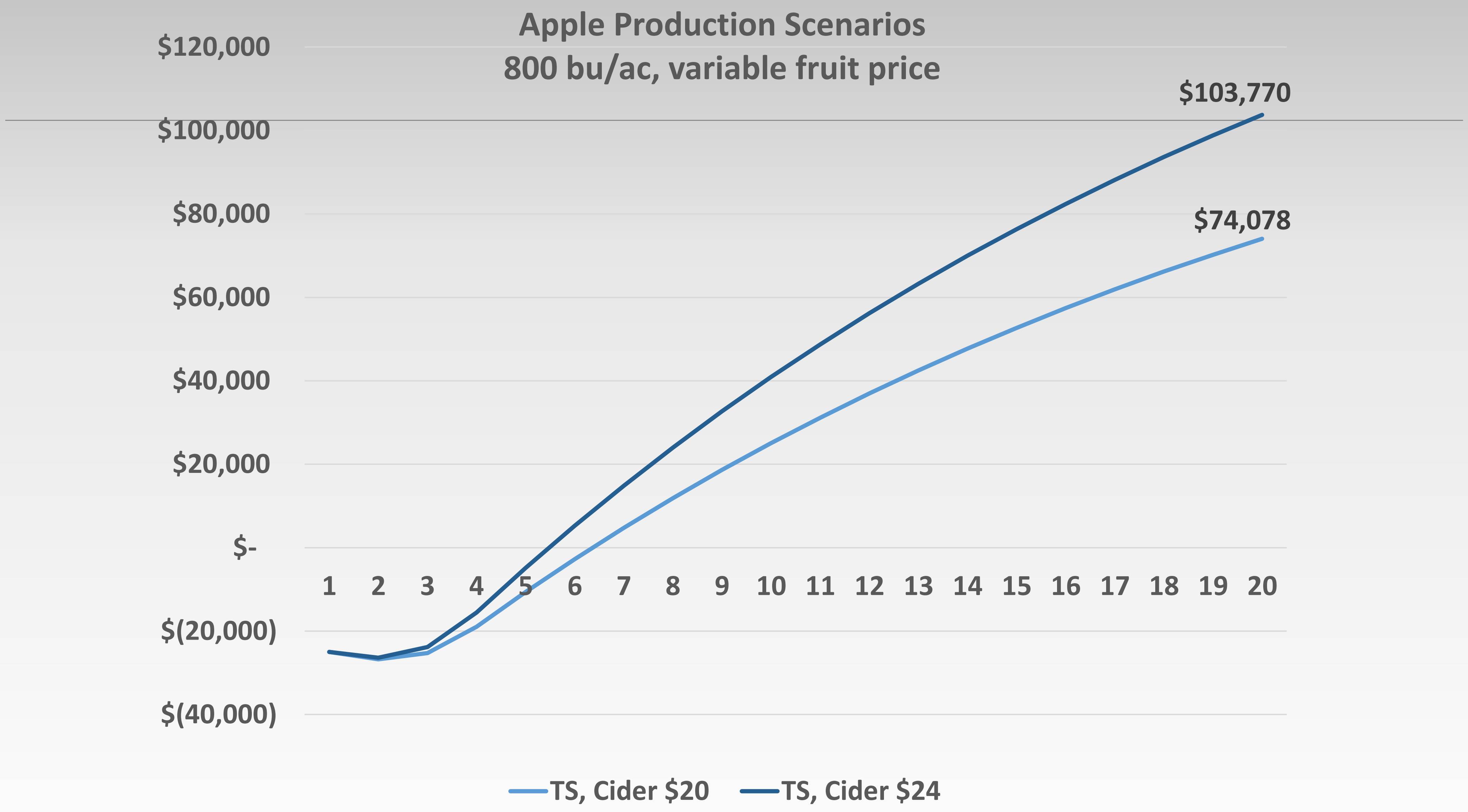

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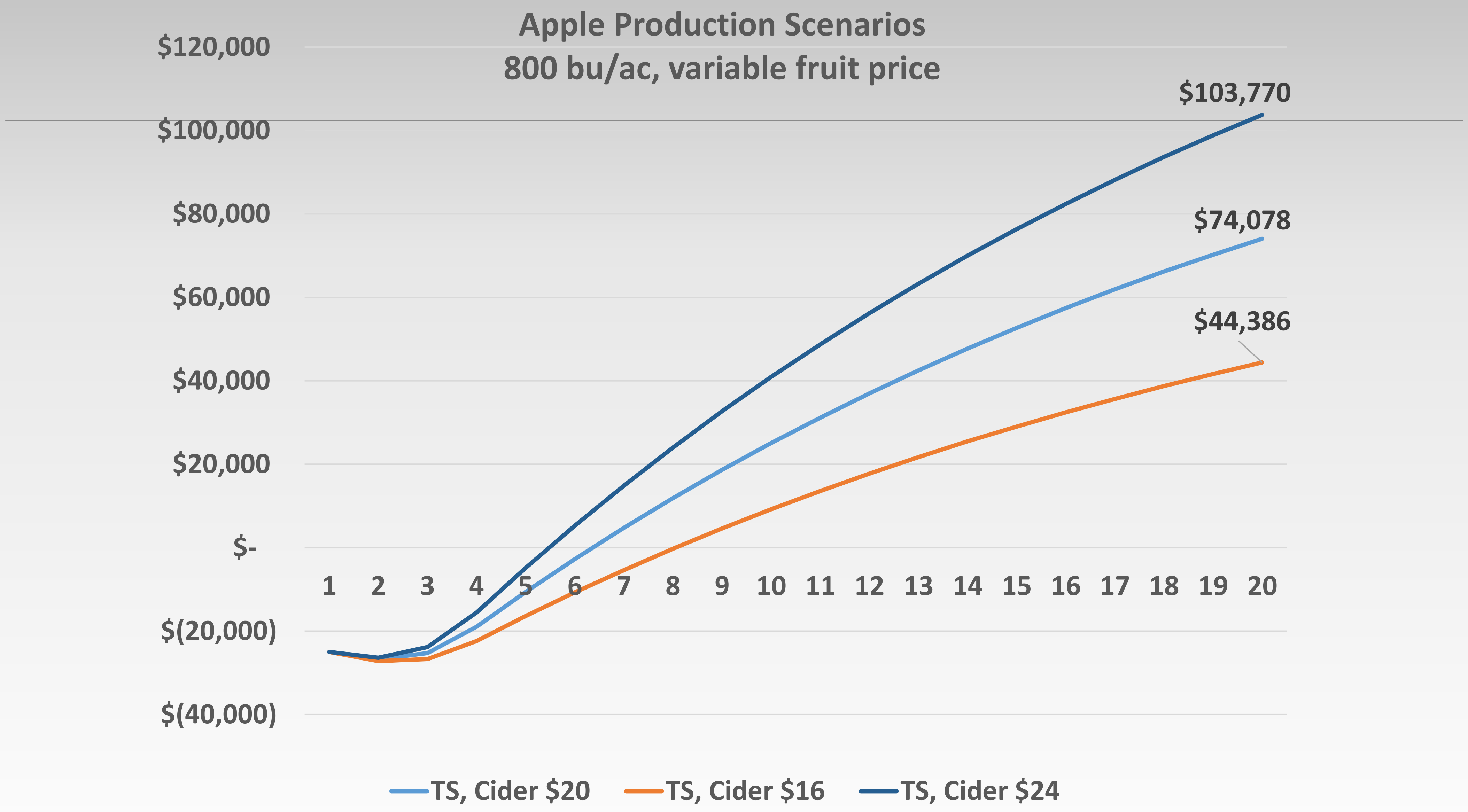

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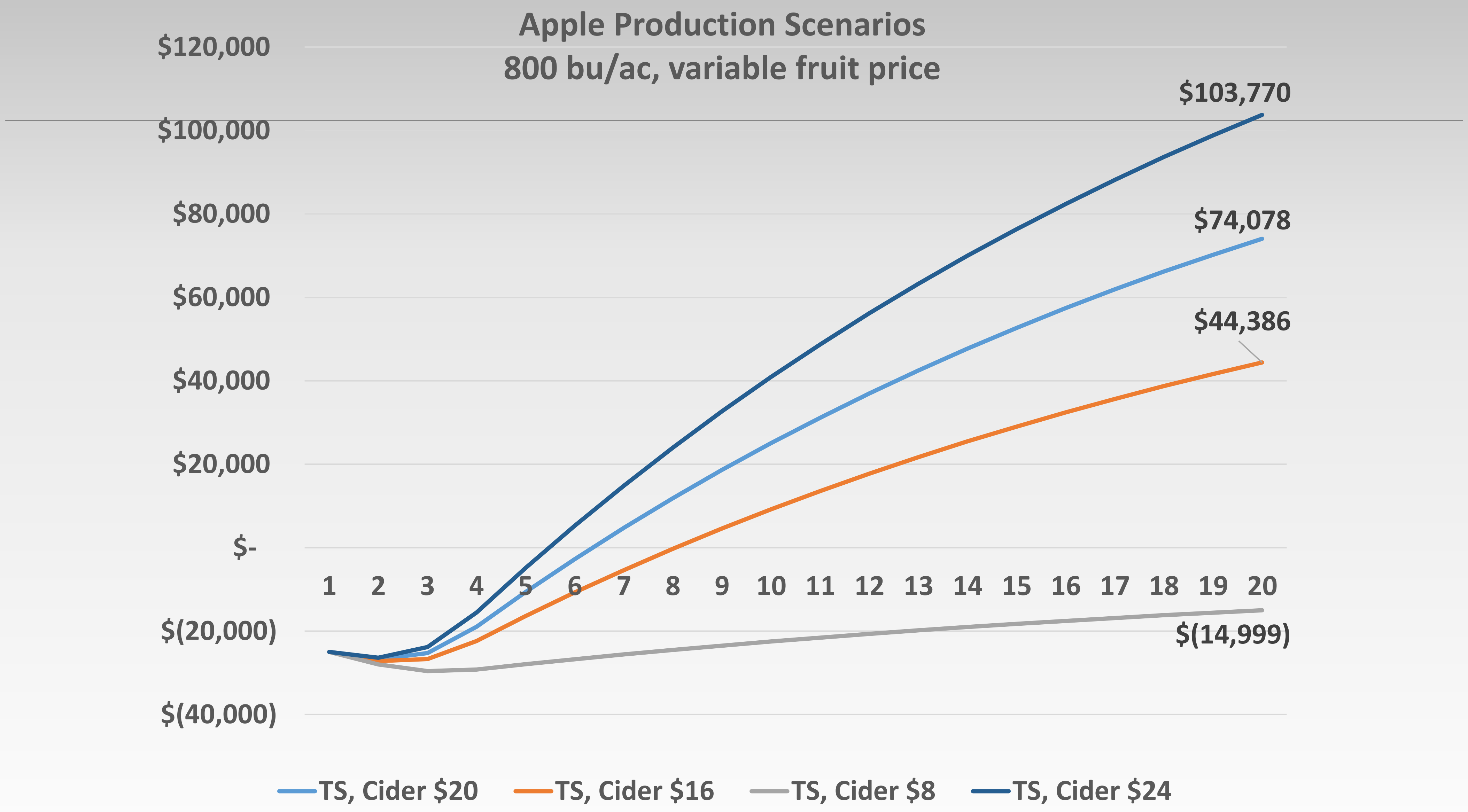

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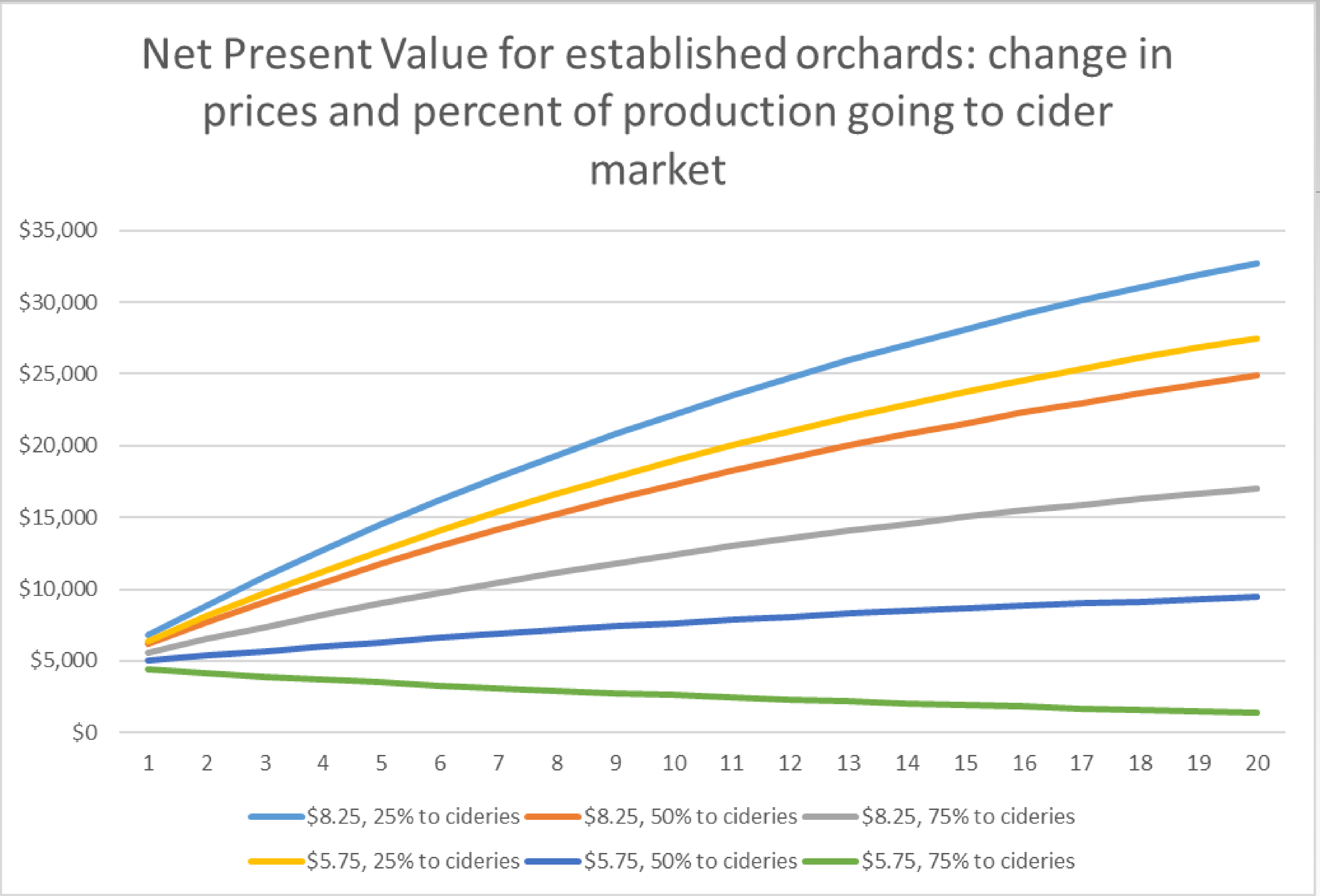

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Take home (for apple growers):

- Lose the rose-colored glasses
- Realistic and attainable yield
- Plan for lost years
- Plan for biennialism
- Get the price you need
- Make a deal

2014-2016: Cider Apple Cultivar Evaluation

Characterize crop yield and juice quality of cider apples either presently or potentially grown in VT

- Field-measurements
- Lab-analysis
- Sensory analysis

Table 2. Juice analysis and hedonic evaluation scores for cider apples evaluated in 2014. Parameters include: soluble solids (SS), pH, titratable acidity (TA), total polyphenols (tannin), yeast assimilable nitrogen (YAN), and subjective cider evaluation criteria (Mitchell, 2009).

Class[z]	Cultivar	Appearance		Aroma		Sweetness		Acidity		Mouthfeel		Flavor	
Sharp	Ashmead's Kernel	3.67	*[x]	3.47	*	2.63		2.97		3.03		3.17	
Sharp	Esopus 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	
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	
Bittersweet	BS Blend[w]	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	
Blend	1	3.28	*	3.14		3.45	*	3.21		3.34		3.34	*
Blend	2	2.53		2.77		2.72		2.79		2.93		2.77	
Blend	3	3.20		3.03		3.10		3.14		3.23		3.03	

[z] Cider apple class based on Lea's (2015) classifications and measured parameters. Blends were commercially blended and adjusted ciders available or intended for retail sale.

[y] Titratable acidity measured in malic acid equivalents, total polyphenols measures in gallic acid equivalents.

[x] Cider quality parameters within each class highlighted with * indicate differences observed between ciders at α=0.05 using non-parametric chi-square test. Parameters were rated 1-5 for desirability in as components in blended ciders where 1=Strongly dislike and 5= Strongly like.

[w] Blend of bittersweet cultivars of European origin collected from non-commercial orchard.

[v] Juice chemistry not conducted on blended ciders prior to fermentation.

Bradshaw, T.L., Kingsley-Richards, S.L., and Foster, J.A. 2018. Apple Cultivar Evaluations for Cider Making in Vermont, U.S.A. Acta Hortic. 1205, 453-460. DOI: 10.17660/ActaHortic.2018.1205.55

Juice analysis including soluble solids (SS), pH, titratable acidity (TA), total polyphenols (Tannins), and yeast assimilable nitrogen (YAN) for three lots of cider apples evaluated in 2015.

Cultivar	Lot[z]	SS (°brix)	pH	TA (g/l)[y]	Tannins (mg /l)[y]	YAN (mg/l)
Ashmead's Kernel	1	18 a[x]	3 d	10.8 a	667 c	166.3 a
Brown Snout	1	18.2 a	3.8 c	4.1 d	2148 b	97.4 bc
Calville Blanc	1	15.3 b	3.1 d	10 ab	728 c	86.3 cd
Chisel Jersey	1	13.1 bc	4.1 b	1.5 e	2408 b	55.4 d
Dabinett	1	13.1 bc	4.2 ab	1.1 e	3656 a	31.8 de
Esopus Spitzenburg	1	15.8 ab	3.1 d	9.3 b	633 c	112.7 b
Harry Master's Jersey	1	12 c	4.3 a	1.2 e	2120 b	36.7 cd
Redfield	1	13.6 bc	3.2 d	6.5 c	3268 a	58.6 c
Yarlington Mill	1	12.2 c	3.8 c	1.7 e	3538 a	8.9 e

[z] Lot 1 = fruit replicates (n=5) collected from one orchard in Addison County, VT; lot 2 = fruit replicates (n=5) collected from one orchard in Chittenden County, VT; lot 3 = single samples (n=1) of promising wild apple cultivars collected from Franklin and Washington Counties, VT.

[y] Titratable acidity measured in malic acid equivalents, total polyphenols measures in gallic acid equivalents.

[x] Values represent mean for of all replicated for lots 1 & 2, and single values for lot 3. Values followed by the same letter within each lot do not differ at α=0.05 using Tukey's adjustment for multiple comparisons.

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Cultivar	Lot[z]	SS (°brix)		pH		TA (g/l)[y]		Tannins (mg /l)[y]		YAN (mg/l)	
Crimson Crisp	2	14.2	ab	3.4	b	8.3	b	1089	a	137.2	b
Crimson Gold	2	13.8	ab	3.4	b	7.9	bc	702	ab	97.1	bc
Crimson Topaz	2	14	ab	3.2	c	12.1	a	617	ab	167.5	ab
Florina Querina	2	14.1	ab	3.5	ab	6.3	c	556	ab	131.8	b
Galarina	2	14.9	ab	3.5	b	8.7	bc	668	ab	234.5	a
Liberty	2	13	b	3.2	bc	8.5	bc	1049	a	117.4	b
Williams Pride	2	10.3	b	3.4	b	5.5	c	439	b	56.2	c
Winecrisp	2	16.2	a	3.6	a	6.1	c	595	ab	68.8	bc

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Cultivar	Lot[z]	SS (°brix)	pH	TA (g/l)[y]	Tannins (mg /l)[y]	YAN (mg/l)
Franklin Cider Apple	3	16.9	2.8	7.8	3557	28.4
MC1	3	9.3	2.9	9	2236	26.7
MC2	3	11.2	3.3	4.2	1215	18
MC6	3	15.1	4.4	1.6	1884	41.1
MC7	3	11.3	3.1	8.7	2335	27
MC8	3	13.3	3.2	10.5	1801	39.7
NC1	3	12.9	4.4	1.4	2367	34.6
NC2	3	14.2	3.3	5.8	1151	74.2

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How many “Cider Apples” do you need?

‘Ideal’ cider blend
(Proulx and Nichols)

- Neutral 30 - 60%
  - Cortland, Rome, G. Delicious, Baldwin
- Tart 10 - 20%
  - Jonathan, Liberty (fresh), Greening, Spy
- Aromatic 10 - 20%
  - Cox, Russetts, McIntosh
- Astringent 5 - 10%
  - Crabapples, Bittersweets

Specific Management Issues with High-Value Cider Apple Cultivars

- Unknown/ unproven yield benchmarks
- Orchard architecture is unsettled
  - Big or small trees?
  - Trellis or freestanding?
  - Mechanical harvest?
- <u>Unique Sensitivity to Disease and Horticultural Problems</u>

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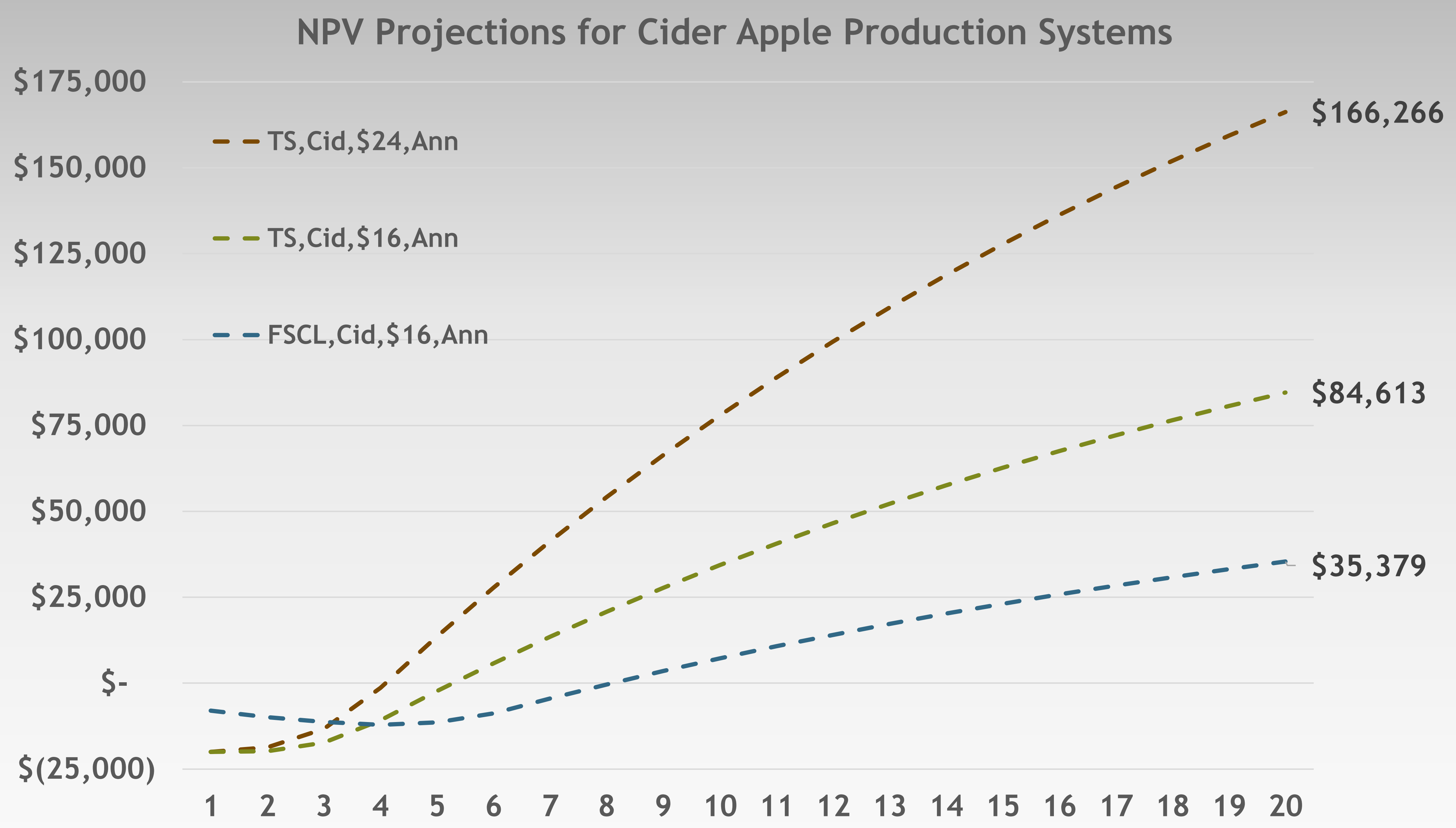
- <u>Biennial production</u>


NPV Projections for Cider Apple Production Systems
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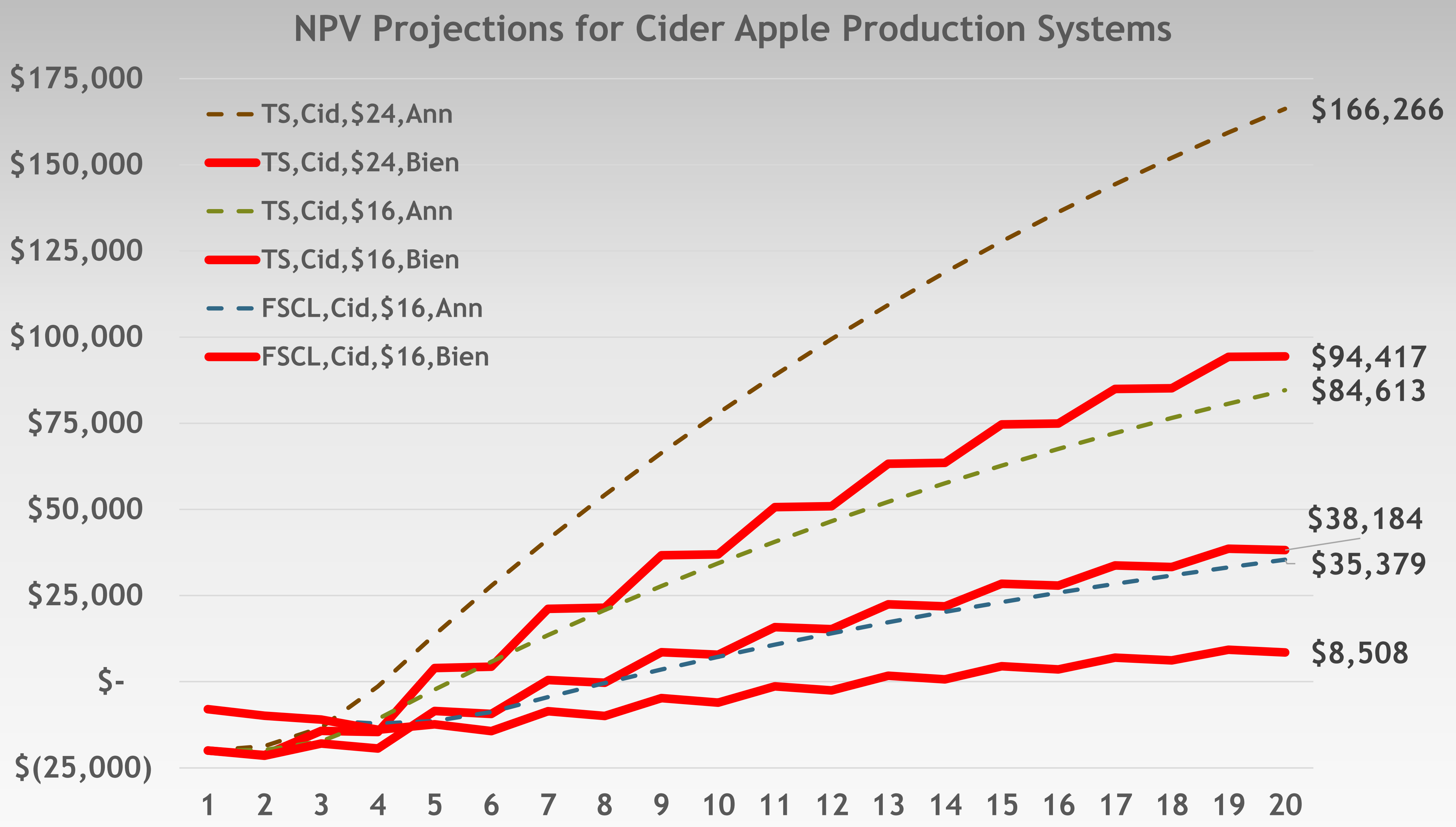
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$94,417
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Specific Management Issues with High-Value Cider Apple Cultivars

- Unknown/ unproven yield benchmarks
- Orchard architecture is unsettled
  - Big or small trees?
  - Trellis or freestanding?
  - Mechanical harvest?
- Biennial production
  - Typically managed by:
    - Cultivar selection
    - Application of PGRs, including carbaryl
  - European cider cultivars don't respond well to carbaryl
  - Can newer return-bloom treatments reduce biennialism and avoid use of carbaryl?

On-Farm Plant Growth Regulator Trials for Crop Load Management

Commercial orchard in Addison County, VT

Two cultivars: ‘Ellis Bitter’, ‘Kingston Black’

- 2011 planting; MM111/M9 interstock

Two years: 2016, 2017

Six treatments:

1. NTC
2. Carbaryl
3. NAA
4. Carbaryl + NAA
5. Ethrel
6. Carbaryl + Ethrel

Table 2. Crop yield and fruit quality for two cider apple cultivars and six plant growth regulator treatments.

		Treatment[z]	No. fruit per tree		Kg fruit per tree		Fruit drop % (kg/kg)		Flesh firmness kg * cm^{-2}		Starch index [y]	
2016	Kingston Black	NTC	84.2		9.7		48.2		8.92		4.72	
		Carb	87.2		11.2		48.2		8.76		5.20	
		NAA	164.0		13.0		42.3		8.13		5.00	
		Carb+NAA	76.8		10.6		46.2		8.48		5.75	
		Eth	76.3		10.3		50.6		8.44		5.95	
		Carb+Eth	86.8		11.7		57.1		7.23		5.50	
		p-value[x]	0.1679		0.8042		0.5546		0.1153		0.1685	
2017	Kingston Black	NTC	1.2	ab[x]w	0.06	ab	93.9		7.76		5.25	
		Carb	0.3	b	0.03	ab	85.7		8.65		2.00	
		NAA	0.8	ab	0.04	ab	66.8		9.93		5.42	
		Carb+NAA	0.5	b	0.03	ab	72.6		7.95		7.00	
		Eth	5.8	a	0.22	a	91.0		8.91		6.03	
		Carb+Eth	0.0	b	0.00	b	-[w]		-		-	
		p-value	0.0210		0.0423		0.7130		0.1238		0.3572	

[z] From table 1.

[y] Relative starch index from Blanpied & Silsby,

[x] P-value for initial F-test at $\alpha=0.05$. For $p< 0.05$, mean values for each treatment followed by the same letter do not differ using Tukey's adjustment for overall of multiple comparisons $\alpha=0.05$.

[w] Missing data where harvest = 0.

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Table 3. Crop yield and fruit quality for two cider apple cultivars and six plant growth regulator treatments.

Year	Cultivar	Treatment[z]	No. fruit per tree		Kg fruit per tree	Fruit drop % (kg/kg)		Flesh firmness kg * cm^{-2}		Starch index [y]
2016	Ellis Bitter	NTC	187.3	ab	15.0	35.3	ab	7.81	a	7.45
		Carb	78.0	b	8.28	49.2	a	6.77	bc	7.24
		NAA	215.0	a	17.64	29.7	b	7.23	ab	7.30
		Carb+NAA	95.5	ab	11.13	34.7	ab	6.43	bc	7.23
		Eth	116.5	ab	10.96	46.8	a	6.55	bc	7.51
		Carb+Eth	102.0	ab	10.73	42.0	ab	6.17	c	7.55
		p-value	0.0138		0.0988	0.0087		< 0.0001		0.2121
2017	Ellis Bitter	NTC	1.0		0.14	20.0		6.55		6.33
		Carb	24.5		2.22	27.0		5.90		6.79
		NAA	0.0		0.00	-		-		-
		Carb+NAA	12.0		1.87	17.0		5.92		7.37
		Eth	0.0		0.00	-		-		-
		Carb+Eth	1.8		0.18	29.2		5.30		7.25
		p-value	0.3889		0.2388	0.9137		0.4924		0.0839

[z] From table 1.
[y] Relative starch index from Blanpied & Silsby,
[x] P-value for initial F-test at α=0.05. For p< 0.05, mean values for each treatment followed by the same letter do not differ using Tukey's adjustment for overall of multiple comparisons α=0.05.
[w] Missing data where harvest = 0.

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Conclusions

- Tree response to PGRS was cultivar-dependent
- Neither cultivar saw a substantial reduction in biennial bearing
- Some suggestion that 'Ellis Bitter' may be somewhat susceptible to carbaryl
- Essentially no effect on juice quality
- Farm more work needs to be done on multiple cultivars, mature trees, differing weather net carbohydrate conditions

Cider Orchard Research: Continued Work

- 2018-2021 Hatch Project
  "Rootstock and orchard architecture selection for unique apple production systems"
- 2019-2022- NECAP: New England Cider Apple Program
  - Continues IPM monitoring on cider apple cultivars across New England
  - Addresses biennial production via PGR, string thinning, and mechanical hedging
  - Coordinates research across New England states
- *New* Cider IPM section in
  New England Tree Fruit Management Guide

Latest Research…

"…the core issue preventing cider-specific apple production in Vermont is on the ***hard cider demand side***, ***rather than on the apple supply side***"
"…

This research project has **identified the *establishment of a hard cider geographical identity as the most promising strategy*** …to tackle both cider-specific apple supply issues and hard cider demand challenges"

Journal of Food Research

The Identity Crisis of Hard Cider

Nicolas Fabien-Ouellet, David Scott Conner

Abstract

In the past 5 years, the hard cider industry in the U.S. has undergone a sudden and dramatic growth period. This boom initially revealed challenges on the cider-specific apple supply side, but issues on the hard cider demand side have also emerged. This mixed methods study conducted in Vermont, a crucial player of the U.S. hard cider industry, addresses the gaps in the literature both on the apple supply side, and on the hard cider demand side. On the apple supply side, fourteen semi-structured interviews demonstrated that neither a long-term formalized contract nor a cooperative model (the two strategic partnership mechanisms used by world's leading industries to manage cider-specific apple production) are appropriate for the current Vermont industry context. On the hard cider demand side, cider makers expressed high interest in working under a geographical indication (GI) label to develop consumers' hard cider literacy and increase demand. This research further indicates that GIs can act as a powerful economic development tool. Introducing hard cider GIs could address current hard cider industry issues on both the supply side and the demand side.

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