Evaluating the Potential for Precision Mechanization in U.S. Wine Grape Production

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TEXAS A&M AGRILIFE EXTENSION

Project Team

Assessing Viticulture Production Practices for Robotic Technology Development

- Funded by USDA-NIFA AFRI Agricultural Economics & Rural Communities program.
- Texas A&M AgriLife Extension Service
  - Dean McCorkle, Ag. Economics
  - Ed Hellman, Viticulturist
  - Rebekka Dudensing, Ag. Economics
  - Dan Hanselka, Ag. Economics
- Collaboration with RE2, Inc.
  - Keith Gunnett, Chief Technology Officer
  - Reeg Allen, Director of Business Development

Advisory Groups

Production Efficiency Committee of the National Grape & Wine Initiative

Texas Wine & Grape Growers Association

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TEXAS A&M AGRILIFE EXTENSION

Project Goals

1) Evaluate vineyard labor costs by production task.

2) Assess the economic viability of wine grape vineyards using current production practices and technology (using Monte Carlo simulation model).

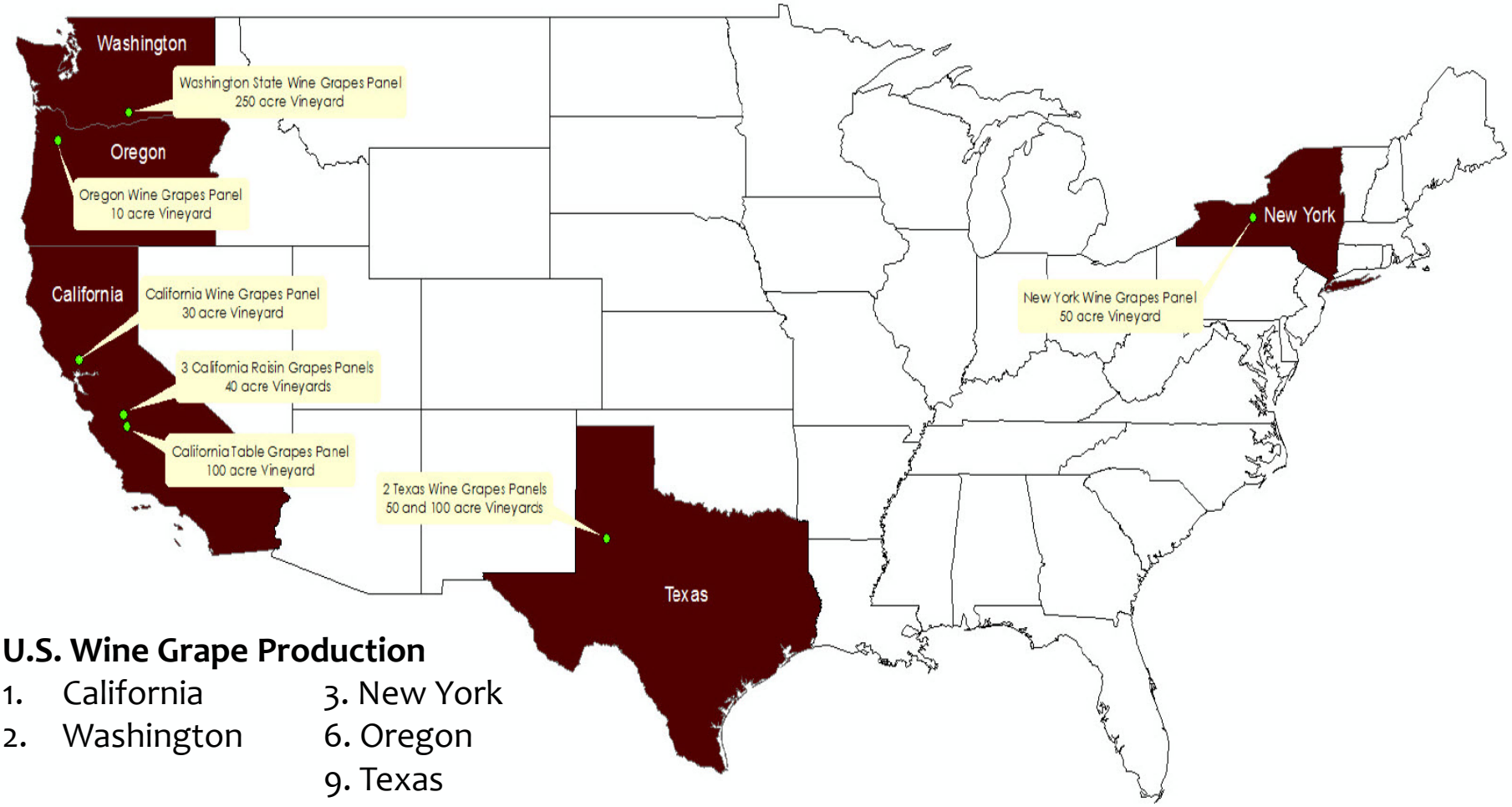
Advancements in Robotic Technology

- Becoming more common in defense, health care, manufacturing, and agriculture
- Enhanced dexterity, control, superior imaging, computer vision, reliability, speed, and greater precision
- Surgical robots have revolutionized surgical procedures
- Military and industrial use of unmanned vehicles
- Cars without drivers (Google, others)
- Robotic pruner
  - At least 2 in development stages
    - France
    - California

Will robotics replace humans vineyard workers?

Texas A&M AgriLife Extension

Representative Vineyard Panels (U.S.)



U.S. Wine Grape Production

1. California
2. Washington
3. New York
6. Oregon
9. Texas

Tasks Potentially Suitable for Precision Mechanization

- Pruning
- Shoot positioning
- Pulling brush
- Shoot & cluster/fruit thinning
- Sucker removal
- Raising & lowering catch wires
- Crop (yield) estimation
- Precision weed control
- Harvesting and in-row fruit transport (table grapes)
- Crop health, disease, and pest monitoring/control

Representative Vineyard Summary Data

	Texas Wine Grapes 50 ac.	Texas Wine Grapes 100 ac.	WA Wine	OR Wine	NY Wine	CA Wine
Acres	50	100	250	10	50	30
Production Stage	4th year	4th year	4th year	4th year	4th year	4th year
Deterministic Yield	6.0	4.0	4.0	3.0	4.5	4.5
Price ($/ton)	$1,600	$1,600	$1,600	$2,600	$1,550	$6,240
Crop Insurance	MPCI 65/100	MPCI 65/100	CAT 50/55	N/A	MPCI 65/100	CAT 50/55
Beginning Assets	$758,529	$1,403,479	$3,691,881	$413,728	$794,013	$4,489,691
Long-Term Debt	$255,563	$519,657	$1,117,019	$160,344	$284,840	$3,190,065
Equipment Debt	$83,707	$166,428	$366,688	$60,522	$96,379	$49,287
Establishment Cost Debt	$186,231	$372,461	$1,074,796	$71,563	$286,612	$308,895
Owner Operator Cash W/D	$70,000	$70,000	$130,000	$0	$35,000	$130,000

Cash flow projections include estimate of federal income and self-employment taxes.

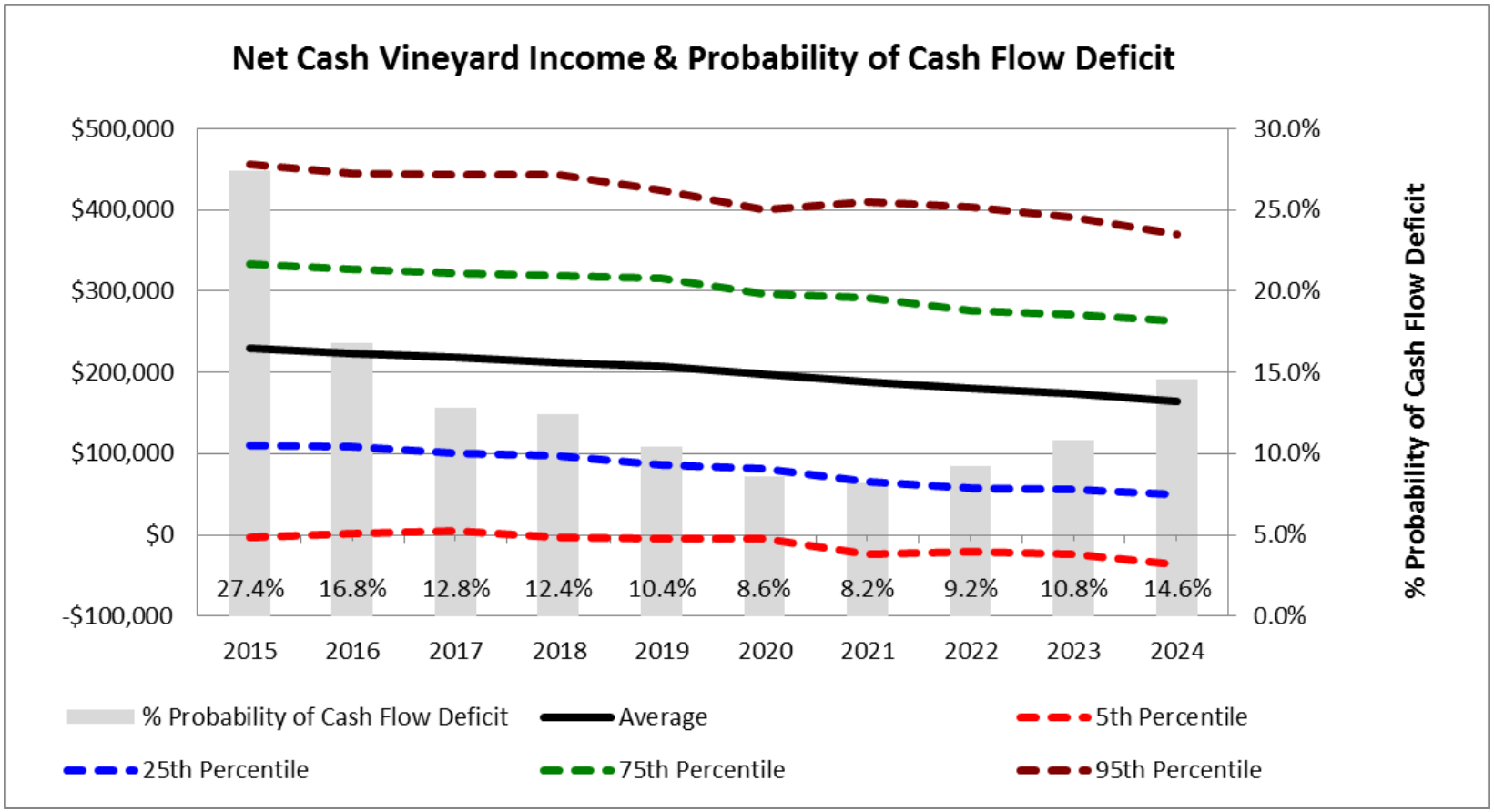
Production Cost Budget Summary

Vineyard Practice	TX Wine 50 ac.	TX Wine 100 ac.	WA Wine	OR Wine	NY Wine	CA Wine
Number of Acres	50	100	250	10	50	30
Budgeted Yield (Tons/ac.)	6.00	4.00	4.00	3.00	4.50	4.50
Budgeted Price ($/ton)	$1,600	$1,600	$1,600	$2,600	$1,550	$6,240
TOTAL GROSS RECEIPTS	**$9,658**	**$6,458**	**$6,400**	**$7,800**	**$6,975**	**$28,080**
OPERATING COSTS						
Floor Management - Dormant Season	$38	$38	$92	$0	$180	$0
Pruning	$1,268	$1,209	$270	$942	$1,064	$1,499
Canopy Management	$529	$529	$318	$2,015	$660	$1,614
Floor Management - Growing Season	$78	$78	$92	$252	$88	$174
Weed Management - Vine Row	$479	$293	$401	$70	$270	$83
Irrigation	$50	$50	$260	$86	$0	$169
Chemical/Pest Control	$279	$225	$379	$604	$800	$639
Harvest	$892	$630	$337	$1,051	$458	$1,497
Miscellaneous Costs	$188	$188	$148	$176	$117	$88
Cash Overhead Costs	$837	$805	$768	$496	$660	$2,174
TOTAL CASH COSTS	**$4,637**	**$4,045**	**$3,065**	**$5,692**	**$4,296**	**$7,937**
Non-Cash Overhead Costs	$1,719	$1,717	$2,242	$4,269	$1,650	$8,740
TOTAL COSTS	**$6,356**	**$5,762**	**$5,307**	**$9,960**	**$5,946**	**$16,677**
NET RETURNS ABOVE CASH COSTS	**$5,021**	**$2,413**	**$3,335**	**$2,108**	**$2,679**	**$20,143**
NET RETURNS ABOVE TOTAL COSTS	**$3,301**	**$696**	**$1,093**	**-$2,160**	**$1,029**	**$11,403**

Stochastic Simulation Model (Monte Carlo)

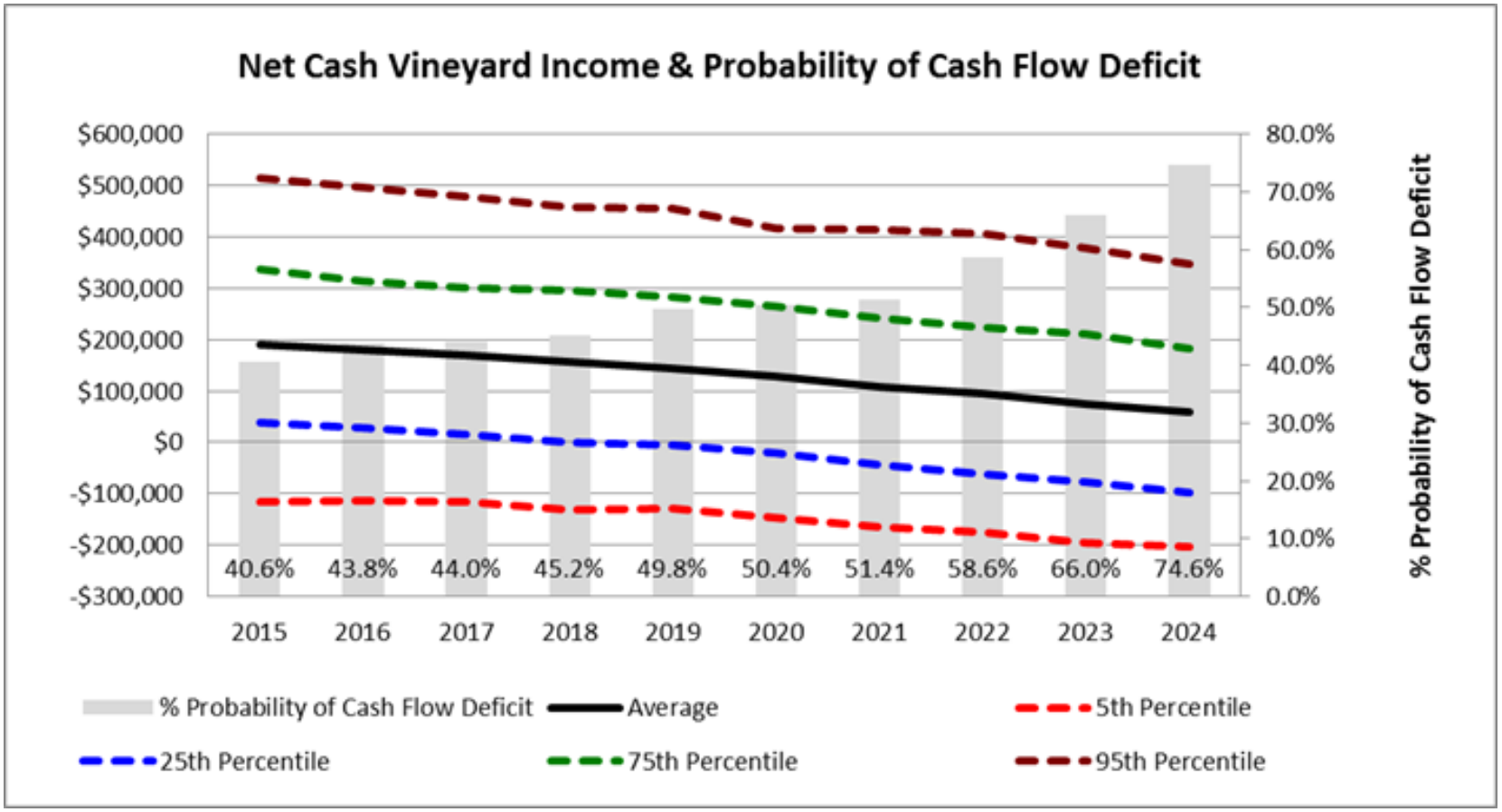
- Stochastic variables
  - Yield (all rep. vineyards)
  - Price (all rep. vineyards except WA and CA)
- Key Output Variables
  - Net Cash Vineyard Income
  - Net Vineyard Income
  - Probability of Cash Flow Deficit
  - Real Net Worth

Texas 50 ac. Projections



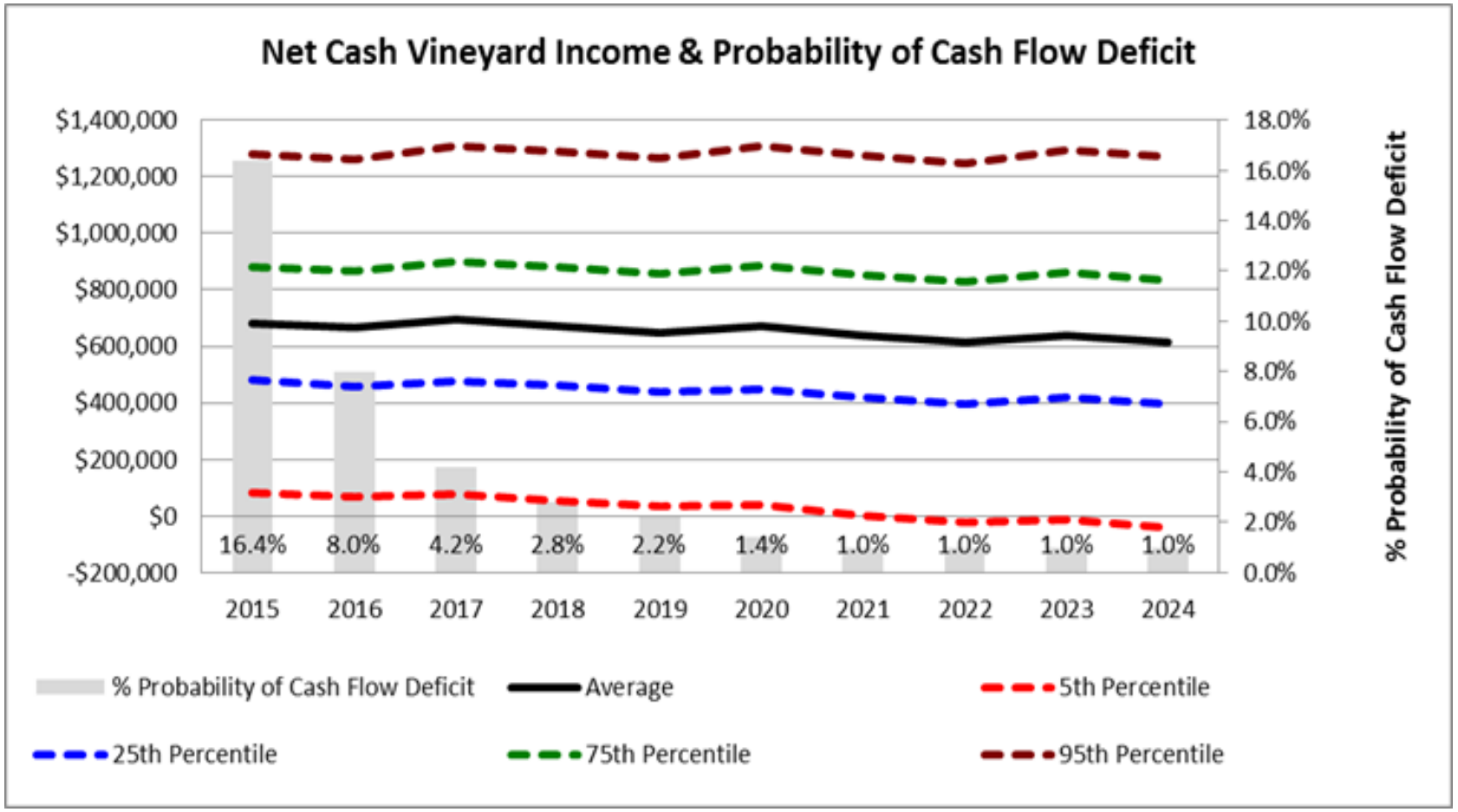
Financial condition: Good

Texas 100 ac. Projections



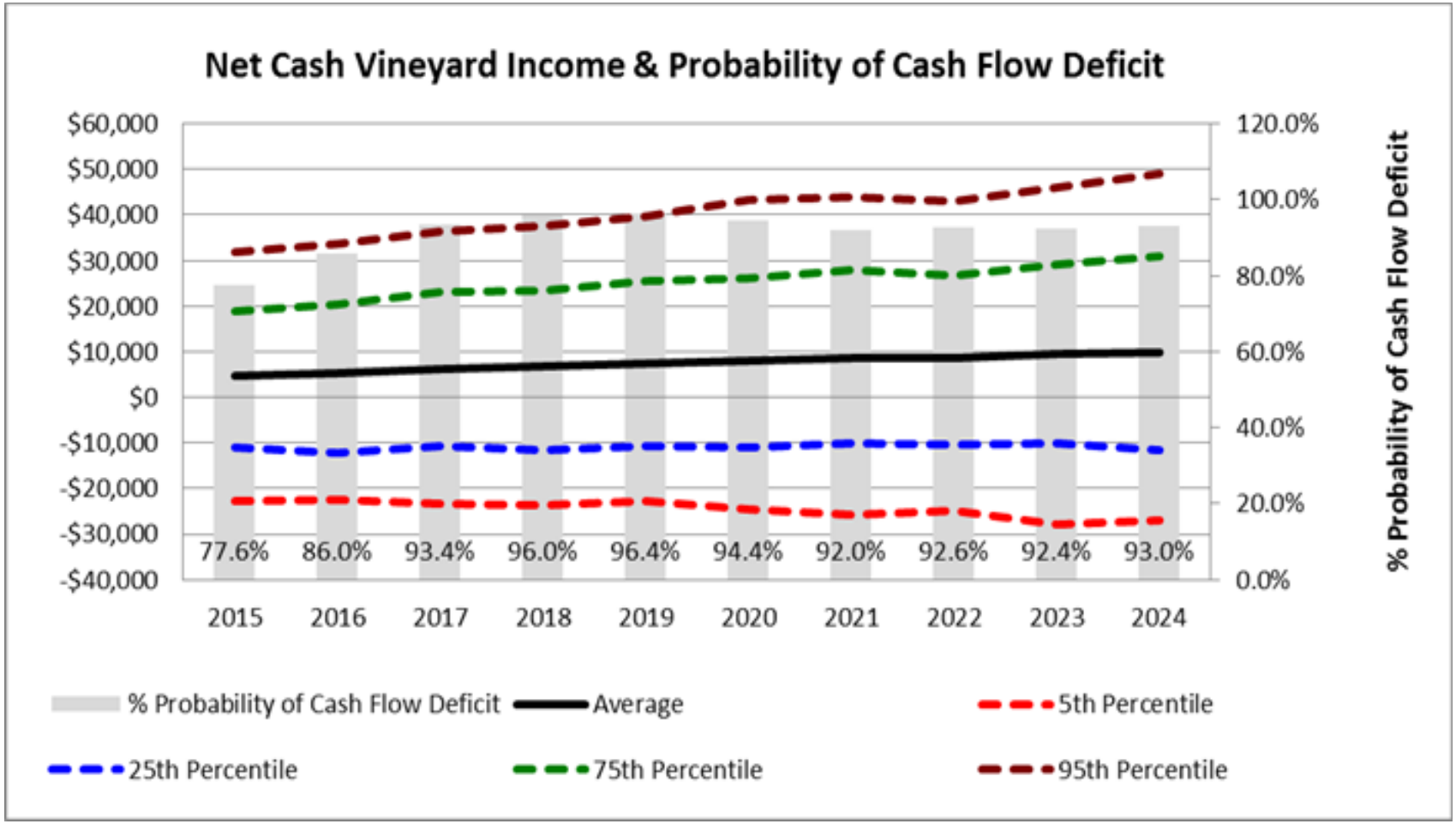
Financial condition: Poor

Washington Projections



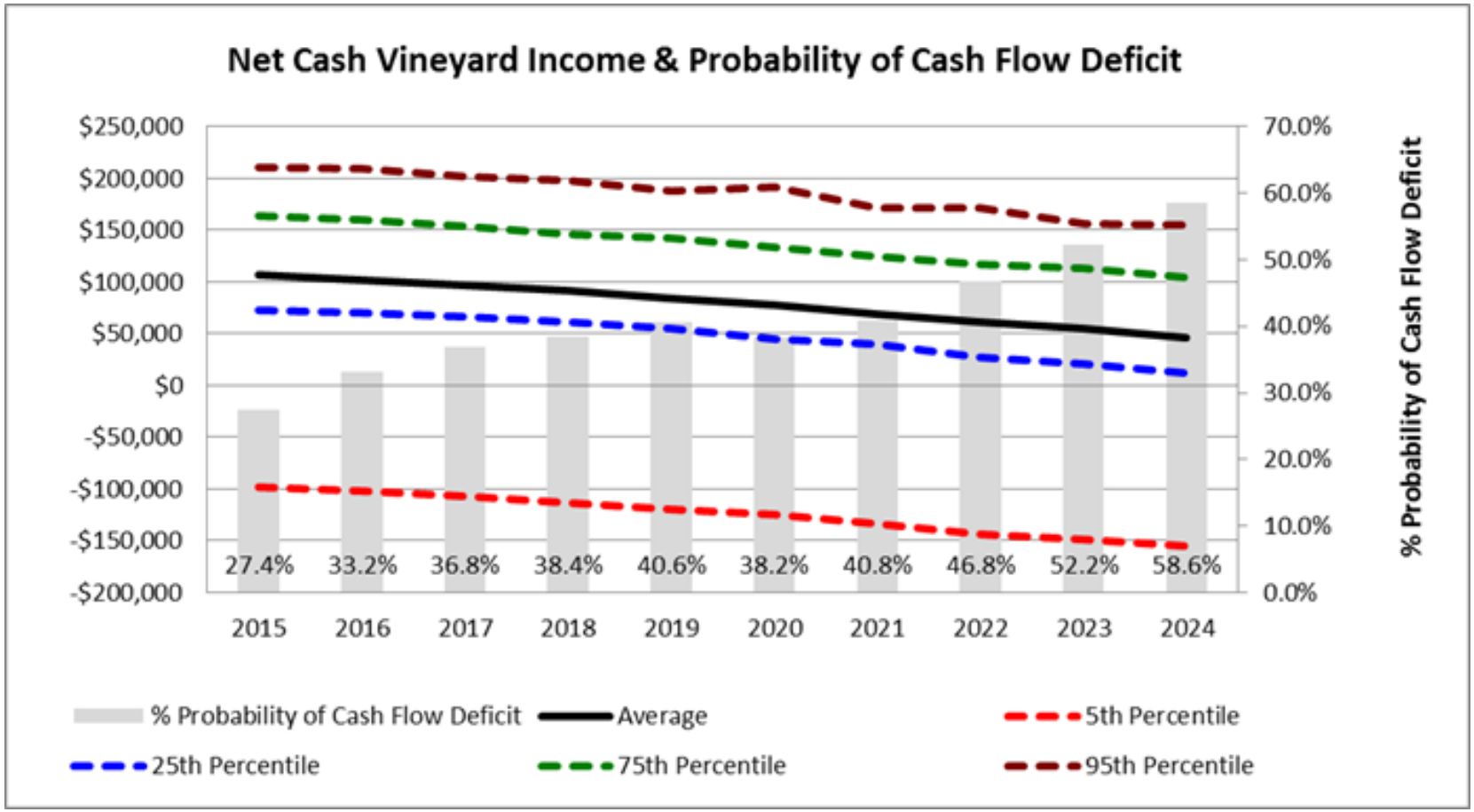
Financial condition: Good

Oregon Projections



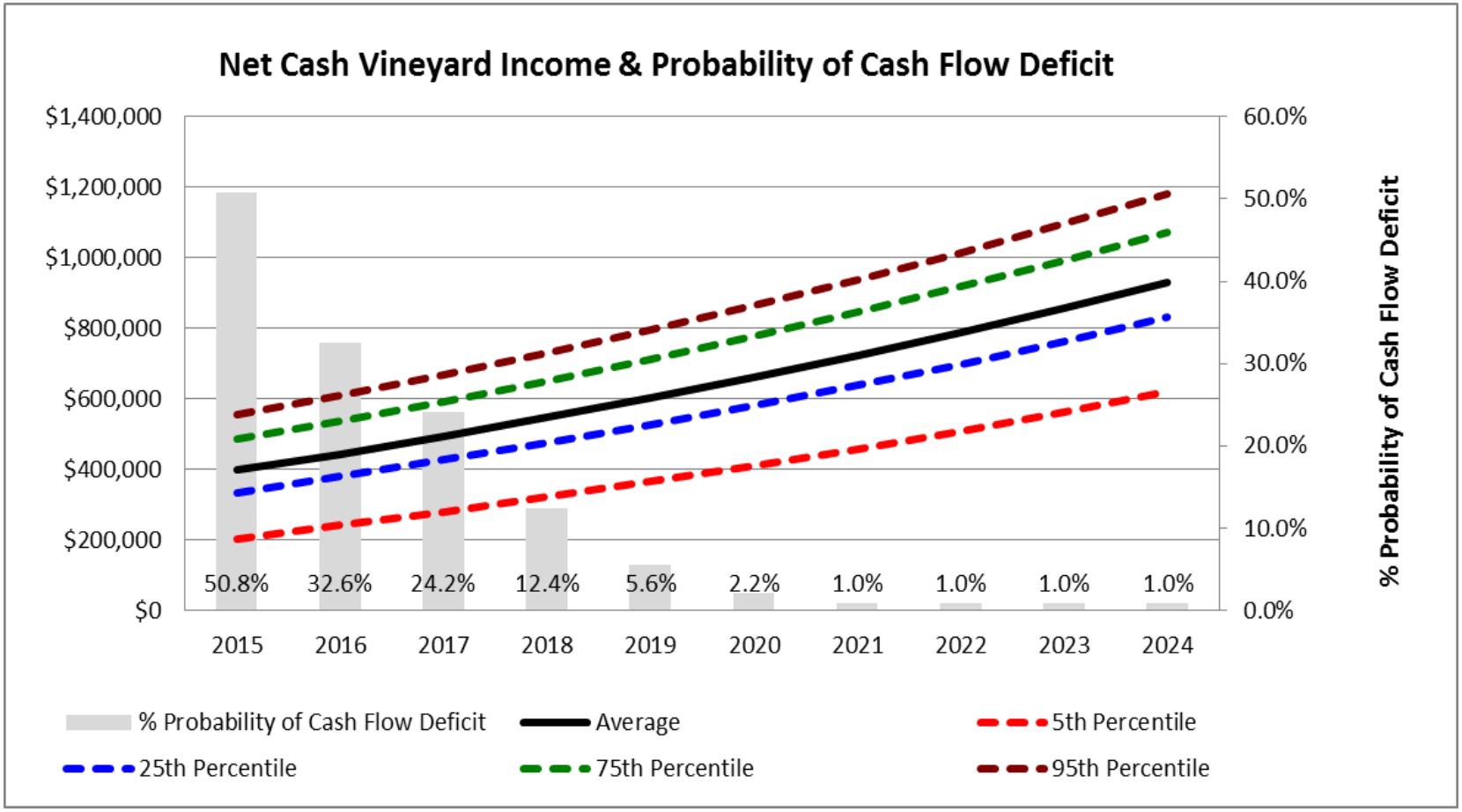
Financial condition: Poor

New York Projections



Financial condition: Marginal (on the verge of poor)

California Projections



Financial condition: Good

Equipment Operator and Field Labor Costs by Production Task Category for Potential Robotic Technology Development (2015)

	TX Small Wine	TX Large Wine	OR Wine	WA Wine	NY Wine	CA Wine
Floor Management - Dormant Season	$12.25	$12.25	$0.00	$16.80	$92.50	$0.00
Pruning	$707.13	$648.98	$883.00	$206.50	$837.69	$1,123.20
Canopy Management	$499.29	$499.29	$1,923.00	$486.00	$637.99	$1,568.00
Floor Management - Growing Season	$36.75	$36.75	$117.00	$29.40	$12.95	$84.00
Weed Management - Vine Row	$318.36	$132.28	$28.00	$74.90	$55.50	$28.00
Irrigation	$0.00	$0.00	$56.00	$110.00	$0.00	$71.28
Chemical/Pest Control	$36.76	$36.76	$316.00	$49.00	$53.67	$224.00
Harvest	$171.88	$171.88	$630.00	$25.00	$300.00	$1,393.97
Total Labor Costs per Acre	**$1,782.42**	**$1,538.19**	**$3,953.00**	**$997.60**	**$1,990.30**	**$4,492.45**
Total Vineyard Acres	50	100	10	250	50	30
Total Vineyard Labor Costs	**$89,121**	**$153,819**	**$39,530**	**$249,400**	**$99,515**	**$134,774**
Equipment Operator Labor Cost per Acre (1)	$480	$480	$395	$172	$315	$392
Equipment Operator Labor Costs (1)	$23,993	$47,986	$3,950	$43,050	$15,773	$11,760

(1) Equipment operator labor costs are not in addition to total vineyard labor costs (it is included in total labor costs)

Texas 50 ac. Labor NPV

Texas 50 ac. Rep. Vineyard Costs & NPV for Top 10 Prod. Practices

Vineyard Practice	Cost/ac.	NPV per ac.	NPV Total
Finish Spur Prune	$523.35	$4,641	$232,062
Shoot Positioning/green tieing	$290.75	$2,578	$128,924
Hoeing/Hand Pulling	$232.60	$2,063	$103,139
Pull/Rake Brush	$102.10	$905	$45,273
Sucker Removal - manual	$93.04	$825	$41,256
Bin Handling and Hauling	$81.68	$724	$36,218
Harvest Support Labor (unskilled)	$69.78	$619	$30,942
Pre-Prune (mechanical)	$61.26	$543	$27,164
Post-emergent Herbicide	$49.01	$435	$21,732
Move Catch Wires Up	$46.52	$413	$20,628

Texas 100 ac. Labor NPV

Texas 100 ac. Rep. Vineyard Costs & NPV for Top 10 Prod. Practices

Vineyard Practice	Cost/ac.	NPV per ac.	NPV Total
Finish Spur Prune	$465.20	$4,126	$412,555
Shoot Positioning/green tieing	$290.75	$2,578	$257,847
Pull/Rake Brush	$102.10	$905	$90,546
Sucker Removal - manual	$93.04	$825	$82,511
Bin Handling and Hauling	$81.68	$724	$72,437
Harvest Support Labor (unskilled)	$69.78	$619	$61,883
Pre-Prune (mechanical)	$61.26	$543	$54,327
Post-emergent Herbicide	$49.01	$435	$43,464
Move Catch Wires Up	$46.52	$413	$41,256
Move Catch Wires Down	$46.52	$413	$41,256

Washington 250 ac. Labor NPV

Washington Rep. Vineyard Costs & NPV for Top 10 Prod. Practices

Vineyard Practice	Cost/ac.	NPV per ac.	NPV Total
Cluster Thinning	$238.00	$2,111	$527,666
Finish Spur Prune	$148.50	$1,317	$329,237
Cordon/Shoot Thinning	$132.00	$1,171	$292,655
Irrigation Management	$110.00	$976	$243,879
Move Catch Wires Up	$55.00	$488	$121,940
Green Thinning	$50.60	$449	$112,185
Tie Cordons	$44.00	$390	$97,552
Fungicides	$42.00	$372	$93,118
Move Catch Wires Down	$33.00	$293	$73,164
Mowing Vineyard Floor	$21.00	$186	$46,559

Oregon 10 ac. Labor NPV

Oregon Rep. Vineyard Costs & NPV for Top 11 Prod. Practices

Vineyard Practice	Cost/ac.	NPV per ac.	NPV Total
Contract Manual Harvest	$630.00	$5,587	$55,871
Disbudding	$420.00	$3,725	$37,247
Cluster Thinning	$420.00	$3,725	$37,247
Sucker Removal - manual	$350.00	$3,104	$31,039
Cane Prune	$324.00	$2,873	$28,733
Move Catch Wires Up	$280.00	$2,483	$24,831
Tie Cordons	$252.00	$2,235	$22,348
Tie Canes (Cane-trained)	$252.00	$2,235	$22,348
Cordon/Shoot Thinning	$210.00	$1,862	$18,624
Bird & Rodent Control	$154.00	$1,366	$13,657
Fungicides	$126.00	$1,117	$11,174

New York 50 ac. Labor NPV

New York Rep. Vineyard Costs & NPV for Top 10 Prod. Practices

Vineyard Practice	Cost/ac.	NPV per ac.	NPV Total
Cane Prune	$485.07	$4,302	$215,088
Contract Manual Harvest	$300.00	$2,661	$133,025
Tie Cordons	$274.92	$2,438	$121,904
Shoot Positioning/green tieing	$182.23	$1,616	$80,804
Cordon/Shoot Thinning	$131.10	$1,163	$58,132
Move Catch Wires Up	$104.88	$930	$46,506
Move Catch Wires Down	$104.88	$930	$46,506
Sucker Removal w/ Herbicide	$91.77	$814	$40,692
Trellis Maintenance and Repair	$55.50	$492	$24,610
Take-Away (de-hilling)	$55.50	$492	$24,610

California 30 ac. Labor NPV

California Rep. Vineyard Costs & NPV for Top 10 Prod. Practices

Vineyard Practice	Cost/ac.	NPV per ac.	NPV Total
Contract Manual Harvest	$1,393.97	$12,362	$370,866
Finish Spur Prune	$842.40	$7,471	$224,121
Color Set	$388.80	$3,448	$103,440
Move Catch Wires Up	$367.20	$3,256	$97,694
Sucker Removal - manual	$324.00	$2,873	$86,200
Pre-Prune (mechanical)	$280.80	$2,490	$74,707
Cluster Thinning	$216.00	$1,916	$57,467
Cordon/Shoot Thinning	$216.00	$1,916	$57,467
Fungicides	$168.00	$1,490	$44,696
Irrigation Management	$71.28	$632	$18,964

Moving Forward

- Refine tasks that are most appropriate for precision mechanization
- Define robotic systems/subsystems needed
- Identify and research technology gaps (vision)
- Derive range of prices for new technology that would encourage adoption by growers

Questions & Comments
Thank you

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