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VineAlert – An Economic Impact Analysis

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Executive Summary

This report shows the economic impact of the VineAlert system in combination with wind machines and its potential benefits to Ontario grape growers through reducing the negative impacts of freeze injury.

Weather conditions during dormant periods, production volumes, and sales levels from 2000 to 2009 are presented to demonstrate the economic impact of wind machine introduction.

Cost savings from wind machine fuel, vine renewal and replacement costs, and sales losses were calculated. A cost analysis shows that use of the VineAlert system in combination with wind machines can potentially help Ontario Grape Growers avoid $13.8 mil in lost sales in the year of a cold weather event, $11.7 mil in lost sales for subsequent years, and $29.1 mil in vine renewal and replacement resulting from damaged or dead vines. An additional savings of $1.0 mil per year can be realized using the VineAlert system to reduce wind machine run time.

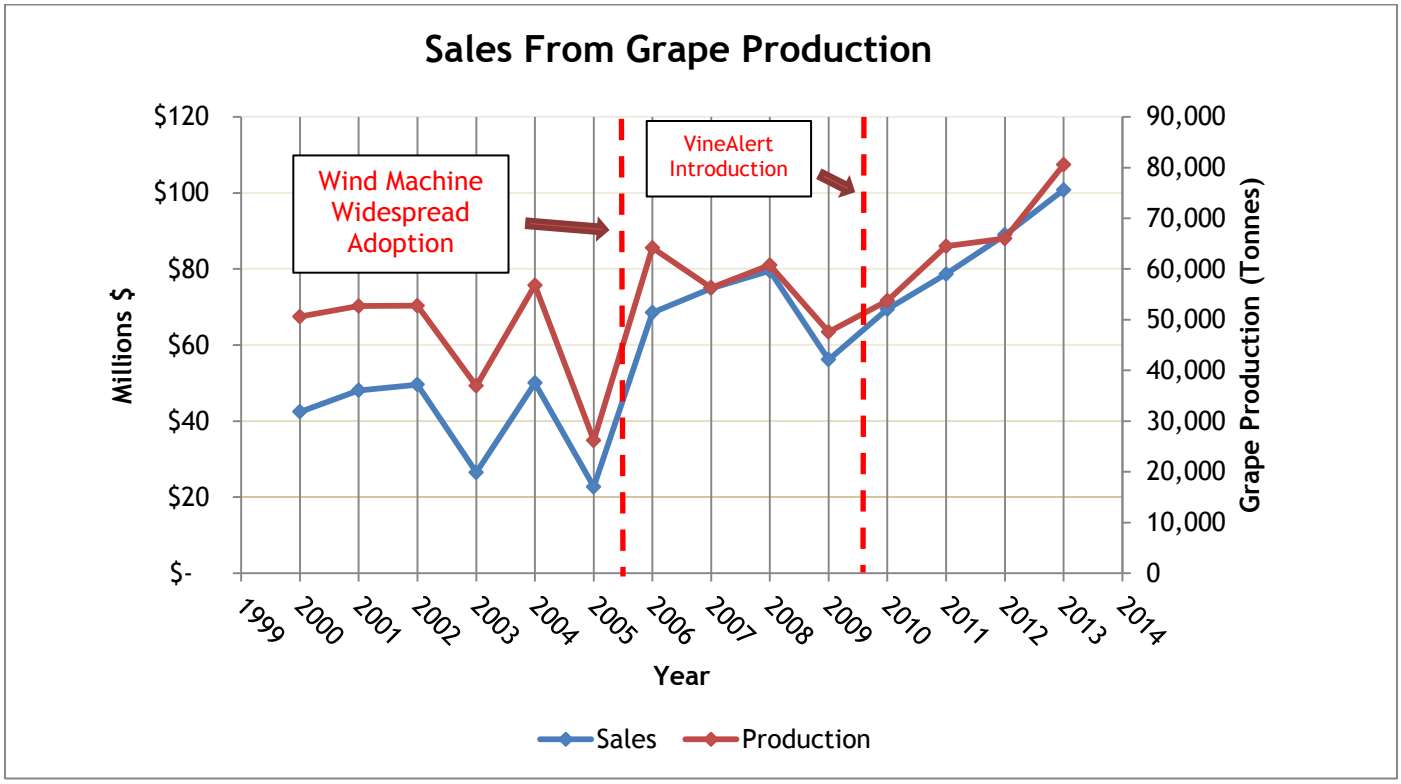
The combination of avoiding lost sales and renewal/replanting costs plus the additional savings of reduced operating costs for wind machines allows Ontario Grape Growers on average a potential total savings of $55.7 mil if they use the VineAlert system in combination with wind machines.

There are approximately 640 wind machines in Ontario vineyards. Therefore, VineAlert in combination with wind machines allows a grape grower on average a total savings of $87,088 per machine.

Southern Ontario's climate and cold event mitigation

Southern Ontario experienced considerable fluctuations in ambient air temperature during the dormant periods of 2003, 2005, 2009, and 2013. Vines are susceptible to cold temperature injury when the temperature goes below the minimum cold hardiness temperature. Factors that contribute to the bud hardiness are cultivar type, regional climate, and response to ambient temperature. The severe winters of 2003 and 2005 resulted in a 47% and 57% reduction in sales respectively (Annual Reports, n.d.). This is an example of weather conditions that damaged nearly 90 % of vineyards in Ontario (VanSickle, n.d.). 2009 was another cold winter that resulted in a 29% loss in grape sales (Grape Growers of Ontario, Annual Report, 2013).

In the hope to mitigate some of the losses caused due to temperature fluctuations and extremes, a limited number of grape growers started using wind machines in 2002. After the cold winter events of 2003 and 2005, the technology became more widely adopted by the grape growing community. This was a contributing factor in boosting the average grape sales for 2006 – 2009, an increase to $69.8 million from $39.9 million for 2000-2005 (Annual Reports, n.d.).



Wind machines, however, have not been able to entirely stabilize annual production levels. The 2009 winter caused another 29% loss in grape sales to the growers.

Table 1

	2005	2006	2007	2008	2009
Grapes sales (in $K)	22,700	68,533	74,936	79,520	56,150
%change	-55%	202%	9%	6%	-29%

In addition, running a wind machine involves substantial operating costs. According to the February 2008 report of Ontario's Ministry of Agriculture, Food and Rural Affairs (OMAFRA), the following are guidelines for the temperature levels at which a grape grower turns on a wind machine (Fraser, Slingerland, Ker, Brewster, & Fisher, 2008).

Table 2: Potential air temperatures at vine level when one could expect a wind machine to operate in Ontario

Month (s)	Air Temperature (winds<6 km/h)	
Winter (December)	-10C to -12C	(14F to 10.4F)
Winter (dormant season) January and February	-17C to - 20C	(1.7F to -4.0F)
Winter (March)	-10C to -12C	(14F to 10.4F)
Spring (April and May)	0C to 1C	(32F to 33.8F)

Before the introduction of VineAlert in 2010, grape growers estimated actual cold hardiness temperature of their vines. They used a combination of historical bud hardiness values, the OMAFRA's recommendations, and their own judgment. Cold hardiness temperature varies across different periods and vine cultivars such as Chardonnay, Merlot, Syrah, etc. The VineAlert system provides Ontario grape growers with up-to-date cold hardiness temperatures by variety and by location. This alerts grape growers to turn on their wind machine when ground temperature is close to a vines' cold hardiness temperature. By knowing the actual cold hardiness temperature, grape growers can drastically reduce the run time for wind machines resulting in a significant cost savings.

VineAlert Cold Hardiness: Economic Impact Analysis

The VineAlert system uses a database that contains current and historical information on cold hardiness temperatures for cultivars at different locations throughout the Niagara Peninsula, Lake Erie North Shore, and Prince Edward County. The system provides grape growers with up-to-date information on the bud Hardiness Level.

The following analysis assesses the economic impact of wind machines in combination with VineAlert during a season with a cold weather event.

Although it is not feasible to obtain data for the exact number of vines that died or were damaged during a cold weather event for any given year, the following assumptions were made in preparing this analysis:

A cold weather event results in (on average):

- 5% Vine death requiring replanting
- 20% Vine damage with no crop in the year of damage requiring vine retraining and renewal
- 75% vine damage, where through pruning mitigation, vines remain at 100% production levels. Pruning mitigation leaves more buds to make up for the lower bud survival numbers.

Vine death (requiring replanting) and vine injury (requiring retraining) estimates are conservative and consider all *V. vinifera* grapes produced in Ontario. Some Cultivars may sustain higher injury levels or incur higher recovery costs.

When determining the recovery cost from Vine death, the following assumptions were used:
For vines that died and required replanting, the crop production and additional costs for the year in which the cold event occurred (Year 0) and the years following (Years 1-5) the cold weather event were:

Year	Crop Production	Additional costs
0	0% - vine death	Removal costs
1	0% - replant year	Replant, retraining costs
2	0%	Retraining costs
3	25%	Retraining costs
4	50%	Normal costs
5	100%	Normal costs

When determining the recovery cost from Vine damage, the following assumptions were used:
For vines that were damaged and required retraining, the crop production and additional costs for the year in which the cold event occurred (Year 0) and the years following (Years 1-2) the cold weather event were:

Year	Crop Production	Additional costs
0	0% -renewal/retraining	renewal costs
1	75%	additional pruning, renewal costs
2	100%	normal

The following general assumptions were used when determining the acreage, total number of vines, yield, and sales of *V. vinifera* grapes:

Total number of vineyard acreage in Ontario	16,000
Total number of acres covered by Wind Machines	8,000
Total number of wind machines in Ontario	640
4.5 tonne/acre yield revenue*	$6,912
# of vines/acre (9 x 4 spacing)	1,210
Sales per *V. vinifera* vine*	$5.71

*based on 4.5 tonne/acre, average revenue for white and red *V. vinifera* is $6,912/acre. (*Establishment and Production Costs for Grapes in Ontario. 2009 Economic Report*. Ontario Ministry of Agriculture, Food, and Rural Affairs) with 1210 vines/acre, the sales per *V. vinifera* vine equals $5.71.

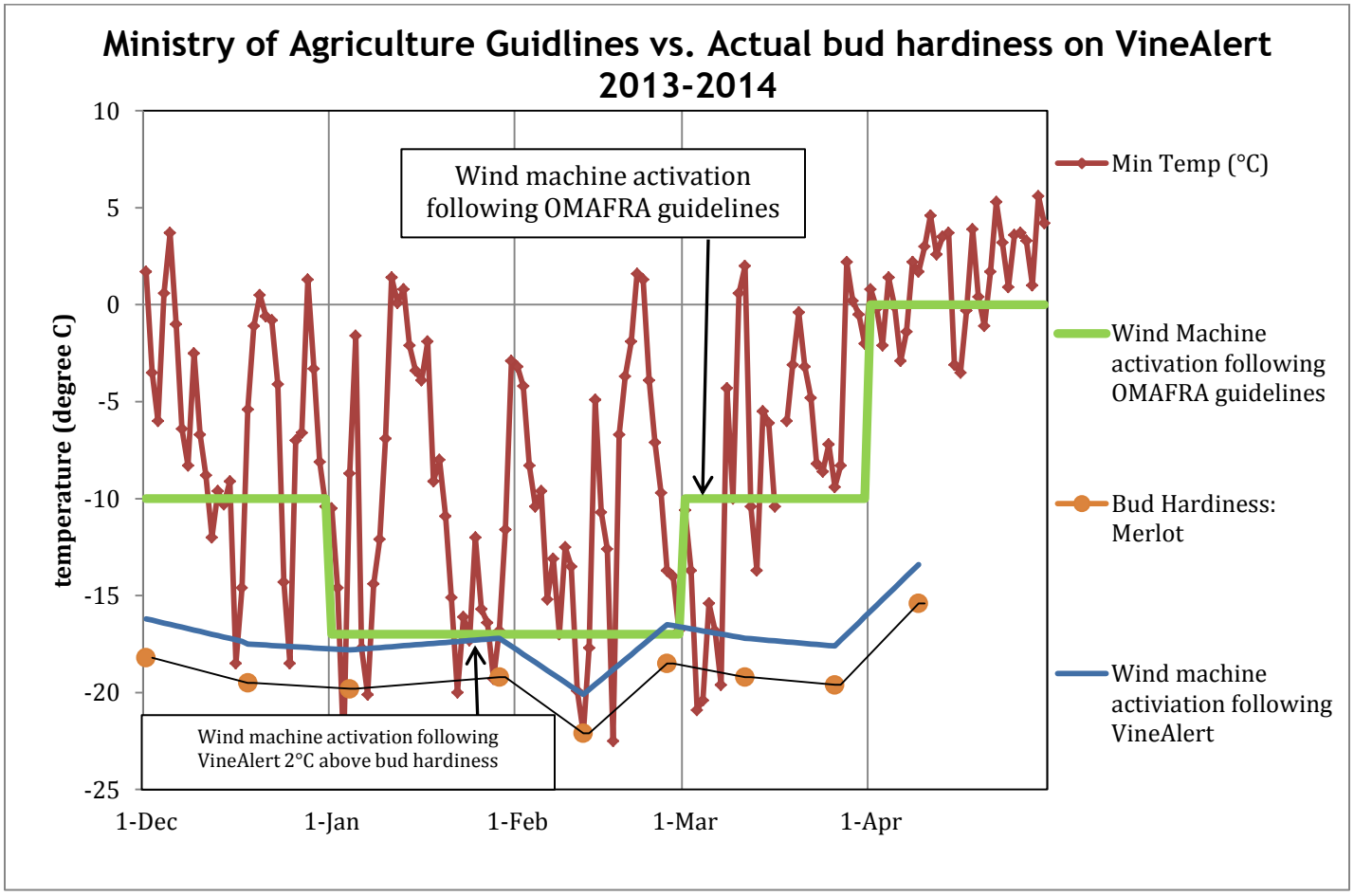
The following assumptions were used in determining the savings related to wind machines in combination with VineAlert:

Total number of acres covered by Wind Machines	8,000
Total number of wind machines in Ontario	640
Wind machine minimum operating time	3-4 Hours
Wind machine operating cost	$40-$60 / hr

Cost savings in running wind machines using VineAlert:

A wind machine, once turned on, operates for 3-4 four hours minimum (Appendix A). Based on the actual temperature levels in the Four Mile Creek sub-appellation of the Niagara Peninsula for the past 4 years (Weather Innovations, 2014) and the temperature levels at which a grape grower turns on a wind machine recommended by the OMAFRA guidelines (Fraser, Slingerland, Ker, Brewster, & Fisher, 2008), a grower turned on one wind machine an average 18 times /year or 55-73 hours /year over the last four years. Each machine costs $40 - $60 per hour to run resulting in $1,620 -$4,380 in fuel costs per machine per year (Appendix A). If these costs are multiplied by 640 wind machines currently installed in vineyards in Ontario, this tells us that grape growers spent between $1.4 -$2.8 mil to operate wind machines (Appendix B) following OMAFRA guidelines. However, following VineAlert guidelines, grape growers spent $364,800 – $729,000 to operate wind machines (Appendix C). Therefore, growers saved $1 mil – 2.3 mil when using VineAlert to determine when to turn wind machines on (Appendix D).

Based on the actual temperature levels in the Four Mile Creek sub-appellation of the Niagara Peninsula and the temperature levels at which a grape grower activates their wind machine, for 2013-2014, a grower should have turned their wind machines on only 12 days whereas following the OMAFRA guidelines, the wind machines would have been turned on 36 days. The activation point for wind machines using the VineAlert system is 2 °C above the bud hardiness temperature (see figure below).



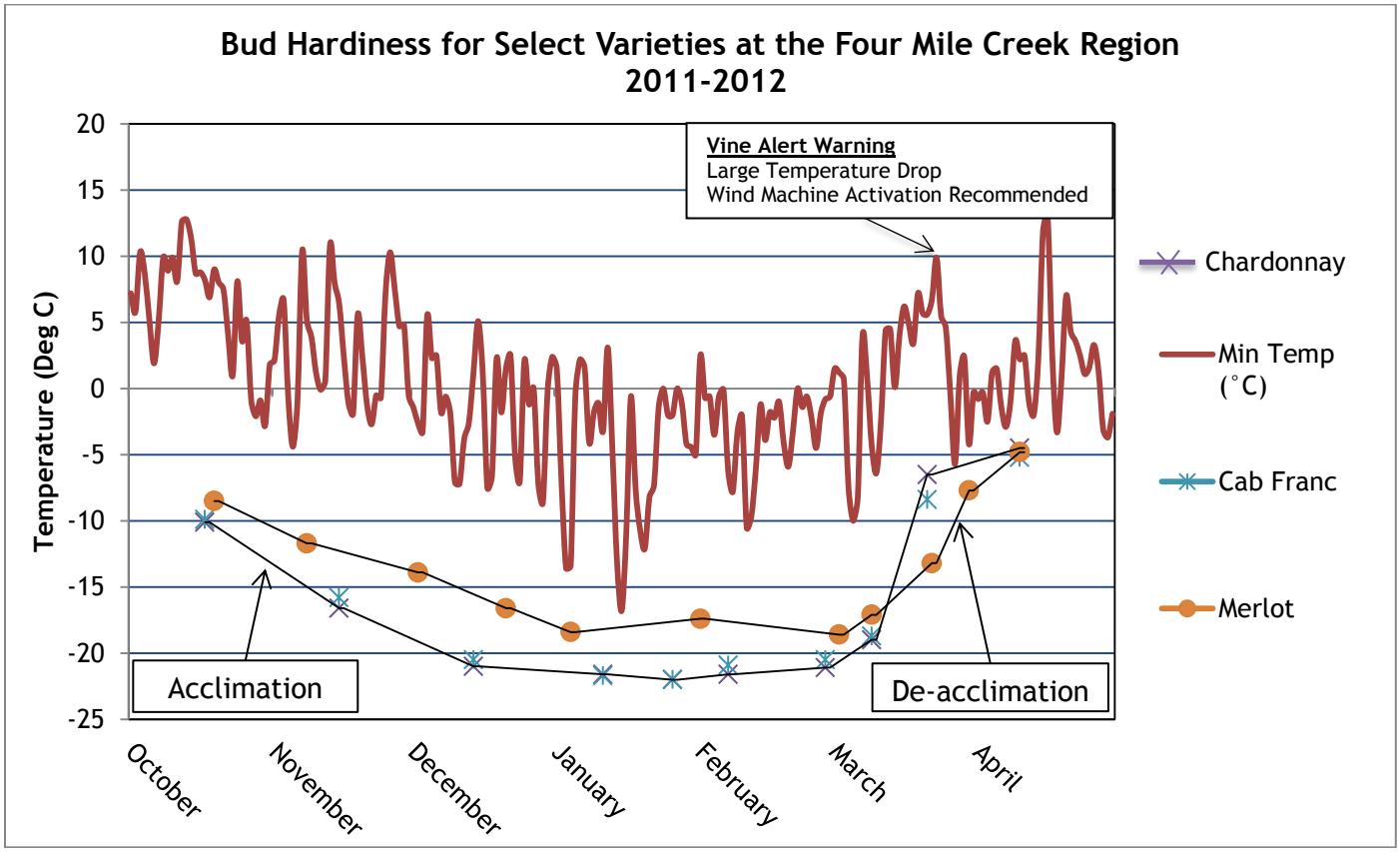
The distance between the green line and the blue line is the difference between the OMAFRA Guidelines for turning on wind machines and VineAlert's recommendation for turning on wind machines. This reduced wind machine run time saves growers $1 mil –$2.3 mil per year. Merlot is used for this comparison as it is the least cold tolerant among cultivars and therefore will give a conservative estimate of the savings in running wind machines using VineAlert versus OMAFRA guidelines.

The above graph does not show the October to November acclimation period because there were no ministry guidelines for this period. However, the acclimation and de-acclimation periods are critical because temperature fluctuations during these periods can drop below the bud hardiness temperature which is descending or ascending. The graph below shows the acclimation and de-acclimation data for Four Mile Creek for 2011-2012.

Crop loss from Vine Death and Vine Damage in the year of the cold weather event and during subsequent years during Vine re-establishment

In addition to savings on wind machines, growers can potentially avoid crop loss from vine death or vine damage using VineAlert coupled with wind machines. If during the dormant period for any given year grape vines experience temperature fluctuations where the minimum temperature drops below their current bud hardiness level, (See Figure below), they will suffer damage. Vines that are exposed to temperatures below their current hardiness temperature can die or be severely damaged causing crop loss.

For example, a cold event that results in approximately 16% crop loss due to freeze injury can translate into $13.8 million in lost sales in the year of damage and $11.7 million in lost sales for subsequent years as the vines come back into full production (Appendix E). The total $25.5 million sales loss can potentially be turned into savings for the growers with wind machines if they have access to updated bud hardiness information. This savings is based on the same cold event that results in crop loss due to 5% vine death and 20% vine damage (Appendix A).



Additional Saving from avoiding Vine Death and Vine Retraining

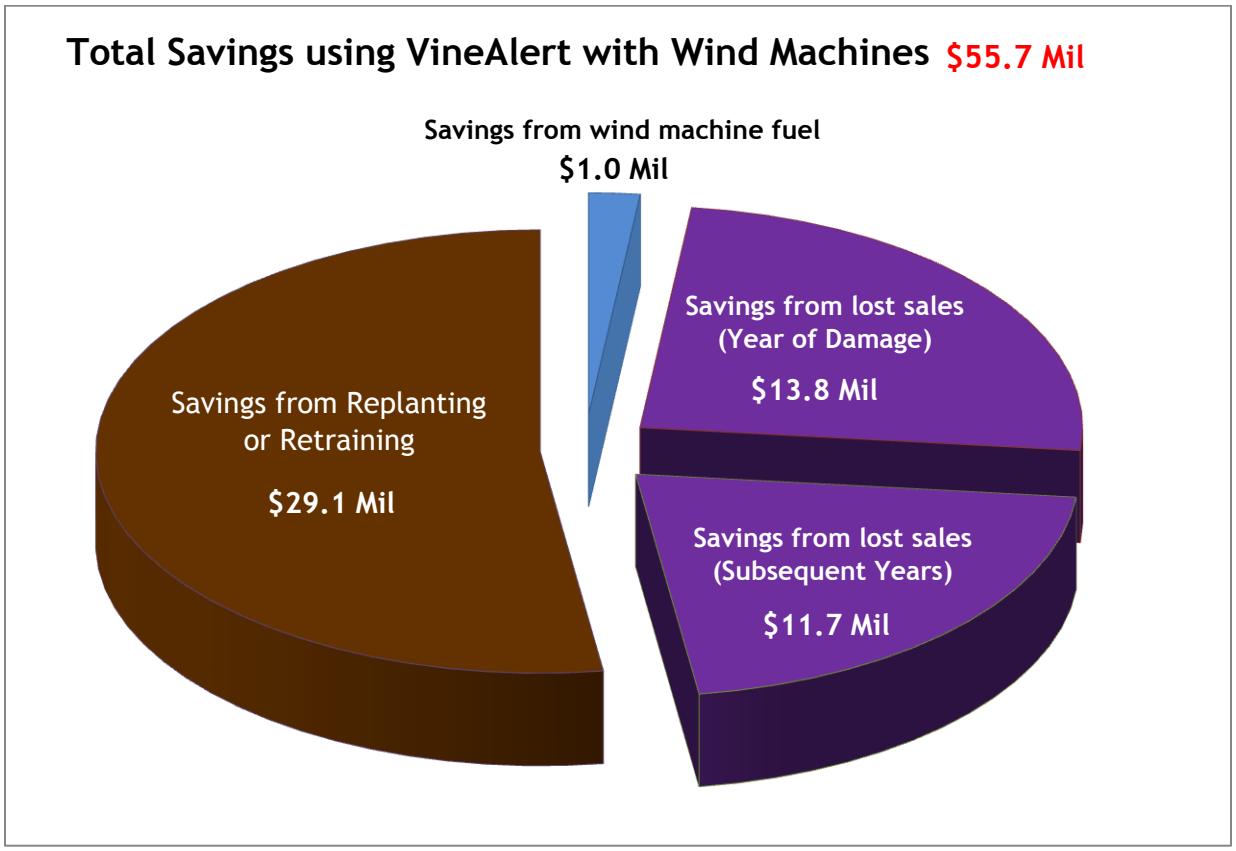
Dead vines must be replaced with new ones. It takes five years before new vines come into full production. Growers lose sales, in the year of exposure where the vine died and during the 4 subsequent years after the vine is replanted, until the vines come into full production. The annual costs over the subsequent 5 years when vines die and are replaced with new ones are outlined in Appendix F and total $20 mil.

Vines that are moderately damaged can be retrained without replacement. These vines take three years from the time of the cold event to return to normal balance and production level. Meanwhile, growers will lose revenue during that period. Growers are subject to the costs outlined in Appendix G when vines are damaged and trunks have to be retrained for plant renewal, which costs $9.1 mil over the subsequent 2 years.

By using the VineAlert system in combination with wind machines, Ontario grape growers can avoid a total cost of $ 29.1 mil in vine replacement and retraining costs over the subsequent 4 years after the cold weather event based on this example.

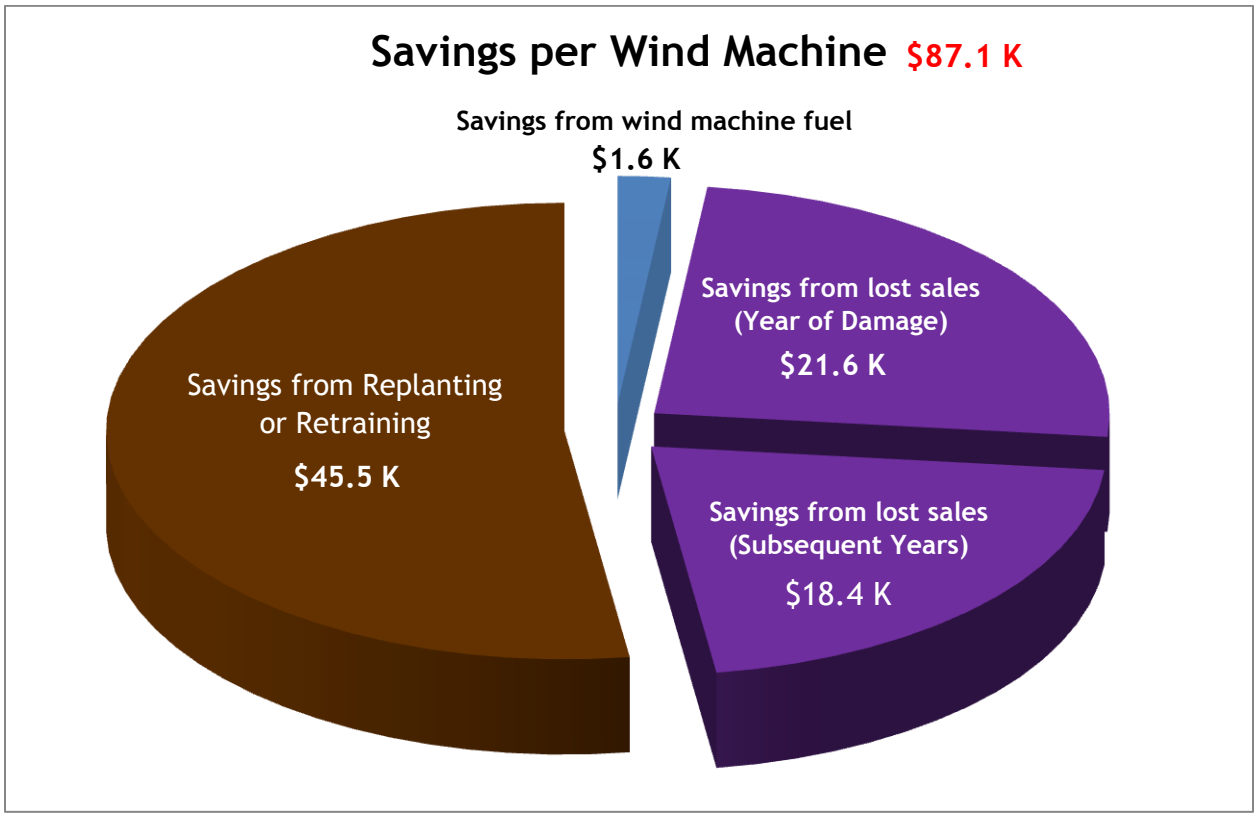
Total Economic Impact from a Cold Weather Event

A combination of avoiding lost sales and retraining/replanting costs plus the additional savings of reduced operating costs for wind machines would have allowed Ontario Grape Growers on average a potential total savings of $55.7 million if they used the VineAlert system in combination with wind machines.



Savings per Wind Machine

There are approximately 640 wind machines in Ontario vineyards. Therefore, VineAlert in combination with wind machines would have saved a total of $87,088 per machine.



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Appendix A: Assumptions

A cold weather event results in (on average):

- 5% Vine death requiring replanting
- 20% Vine damage with no crop in the year of damage requiring vine retraining and renewal
- 75% vine damage, where through pruning mitigation, the vines remain at 100% production level

Vine death (requiring replanting) and vine injury (requiring retraining) estimates are conservative and consider all V. *vinifera* grapes produced in Ontario. Some Cultivars may sustain higher injury levels or incur higher recovery costs.

Crop loss in *V. vinifera* due to winter injury	
# of vines/acre (9 x 4 spacing)	1,210
# of dead vines/acre (5%)	60.5
# of vines requiring retraining (20%)	242
Total Ontario vineyard acreage with wind machines	8,000
Total # vines requiring replanting	484,000
Total # vines requiring retraining and renewal	1,936,000
Total number of vines requiring replanting or retraining/renewal	**2,420,000**

When determining the recovery cost from Vine death the following assumptions were used:

The crop production and additional costs for the year in which the cold event occurred (Year 0) and the years following (Years 1-5) the cold weather event were:

Year	Crop Production	Additional costs
0	0% - vine death	removal
1	0% - replant year	replant costs
2	0% -	year 2 costs
3	25%	year 3 costs
4	50%	year 4 costs
5	100%	normal costs

When determining the recovery cost from the Vine damage the following assumptions were used:

The crop production and additional costs for the year in which the cold event occurred (Year 0) and the years following (Years 1-2) the cold weather event were:

Year	Crop Production	Additional costs
0	0% -renewal/retraining	renewal costs
1	75%	additional pruning costs
2	100%	normal

The following assumptions were used in determining the savings related to wind machines in combination with VineAlert:

Total number of acres covered by Wind Machines	8,000
Total number of wind machines in Ontario	640
Wind machine minimum operating time	3-4 Hours
Wind machine operating cost	$40-$60 / hr

Appendix B: Wind Machine usage costs following OMAFRA Guidelines VineAlert

	3 hrs/run	4 hrs/run
2010-2011 wind machine hours	51	68
2011-2012 wind machine hours	39	52
2012-2013 wind machine hours	21	28
2013-2014 wind machine hours	108	144
Average hours per machine per year	**54.75**	**73**
Cost per hour	$ 40	$60
Cost per machine per year	**$ 1,620**	**$4,380**
# of wind machines in Ontario	640	640
Total average cost per year	**$1,401,600**	**$2,803,200**

Appendix C: Wind Machine usage costs following VineAlert

	3 hrs/run	4 hrs/run
2010-2011	9	12
2011-2012	0	0
2012-2013	12	16
2013-2014	36	48
Average hours per machine per year	**14.25**	19
Cost per hour	$ 40	$ 60
Cost per machine per year	**$ 570**	**$ 1,140**
# of wind machines in Ontario	640	640
Total average cost per year	**$364,800**	**$729,600**

Appendix D: Fuel Cost savings when running wind machines with VineAlert

	3 hrs/run	4 hrs/run
Wind machine usage cost per year without VineAlert	$ 1,401,600	$ 2,803,200
Wind machine usage cost per year with VineAlert	$ 364,800	$729,600
Cost Savings per year	**$ 1,036,800**	**$ 2,265,600**

Appendix E: Sales loss

Crop loss in *V. vinifera* due to winter injury	
# of vines/acre (9 x 4 spacing)	1,210
# of dead vines/acre (5%)	60.5
# of vines requiring renewal (20%)	242
Total Ontario vineyard acreage with wind machines	8,000
Total # vines requiring replacement	484,000
Total # vines requiring renewal	1,936,000
Total number of vines requiring replanting or retraining	**2,420,000**

Year 0 crop loss from dead and damaged *V. vinifera* vines where neither will yield a crop	
4.5 tonne/acre yield revenue*	$6,912
Sales per vinifera vine*	$5.71
Total number of vines damaged	2,420,000
Total sales loss in the year of damage	**$13,818,200.00**

* based on 4.5 tonne/acre revenues for white and red *vinifera* with plantings of 1210 v/acre (OMAFRA, 2009
Establishment and Production Costs for Grapes in Ontario. 2009 Economic Report. Ontario Ministry of Agriculture, Food and Rural Affairs.

Year	5% Vine Death		20% Vines Damaged		Total
	Crop Production Loss	Sales losses	Crop Production Loss	Sales losses	
Year 0: The year of the cold event	0%	**$2,763,640**	0%	**$11,054,560**	**$13,818,200**
Year 1: The year of replanting (vine death) or renewal/retraining	0%	$2,763,640	75%	$2,763,640	$5,527,280
Year 2	0%	$2,763,640	100%	$0	$2,763,640
Year 3	25%	$2,072,730	100%	$0	$2,072,730
Year 4	50%	$1,381,820	100%	$0	$1,381,820
Year 5	100%	$0	100%	$0	$0
Total sales losses for the subsequent years		**$8,981,830**		**$2,763,640**	**$11,745,470**
Total sales losses for the year of the cold event		$2,763,640		$11,054,560	$13,818,200
Total sales losses for the subsequent years		$8,981,830		$2,763,640	$11,745,470
Total Sales losses		**$11,745,470**		**$13,818,200**	**$25,563,670**

Appendix F: Cost of dead vines

Additional production costs for replanting including vine replanting costs, increased hand labour costs for vine removal, new vine establishment, and weed management over the first 4 years following winter injury

Year 0				
Operation costs: Hand	Labour hrs	Labour costs	Machine costs	Total Costs
Removing vines	20	248	144	392
Total Hand Labour	20	248	144	392
			Total	**392**
Year 1				
Variable costs				Total/acre
Replacement vines				250
Operation costs: Hand	Labour hrs	Labour costs	Machine costs	Total Costs
Replacing vines (5%)	13.2	228	144	372
Weed Control: Hand Hoeing	8	$99		$99
Summer training, tying, trunk est	20	248		248
Total Hand Labour	41.2	575	144	719
			Total	**1131**
Year 2				
Variable costs				Total/acre
Replacement vines (2%)				100
Operation costs: Hand	Labour hrs	Labour costs	Machine costs	Total Costs
Replacing vines (2%)	4.4	76	48	128
Weed Control: Hand Hoeing	8	$99		$99
Summer training, tying, trunk est	20	248		248
Total Hand Labour	32.4	423	48	475
			Total	**575**
Year 3				
Variable costs				Total/acre
Replacement vines (2%)				100
Additional costs				
Operation costs: Hand	Labour hrs	Labour costs	Machine costs	Total Costs
Replacing vines (2%)	4.4	76	48	128
Weed Control: Hand Hoeing	4	$50		$50
Summer training, tying, trunk est	10	124		124
Total Hand Labour	18.4	250	48	302
			Total	**402**

Year 4 and 5 use normal production costs for mature vineyard.

Estimated total additional costs/acre for replanting vines in mature vineyard

Year	Additional cost/acre
Year 0: Removal	392
Year 1: Replant	1131
Year 2	575
Year 3	402
Year 4	0
Year 5	0
Total cost per acre over 5 years	**2500**
Total number of dead vines/acre	**60.5**
Cost per vine	**41.32**
Total number of dead vines	484,000
Total replanting/retraining costs	**19,998,880**

Appendix G: Cost of Damaged Vines

Assumptions: Additional production costs for retraining/renewal include increased hand labour costs for pruning, retraining, tying, and trunk establishment within the first 2 years following winter injury

Additional production costs for retraining/renewal

Year 0				
Additional costs				
Operation costs: Hand	Labour hrs	Labour costs	Machine costs	Total Costs
Weed Control: Hand Hoeing	8	$99	$0	$99
Summer training, tying, trunk est.	20	248	$0	248
Total Hand Labour	28	347	$0	347
			Total	**347**
Year 1				
Custom Pruning - $.46/vine (based on Martinson & White, 2005)				448
Operation costs: Hand	Labour hrs	Labour costs	Machine costs	Total Costs
Weed Control: Hand Hoeing	8	$99	$0	$99
Summer training, tying, trunk est.	20	248	$0	248
Total Hand Labour	28	347	$0	347
			Total	**795**
Years 2-5 Normal costs for mature vineyard				

Estimated total additional costs/acre for renewing/retraining 20% vines in mature vineyard

Year	**Additional cost**
Year 0: Renewal/retraining	$347
Year 1: additional pruning	$795
Year 2	0
Year 3	0
Year 4	0
Year 5	0
Total cost per acre over 5 year period	$1,142.00
Total number of damaged vines/acre	242
Cost per vine	$4.72
Total number of damaged vines	1,936,000
Total renewing/retraining costs	**$9,136,000**