Report for
New Zealand Winegrowers

The economic effects and financial impact of GLRaV3

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Nimmo-Bell & Company Ltd

1 Introduction

New Zealand Winegrowers has requested that Nimmo-Bell undertake this study with the objective being to determine the economic effects and financial impacts of GLRaV3 in New Zealand.

There are two components of the project:

1. To access real information and data (from two sites identified) and undertake an economic analysis of the financial impact of infection on the quantity and quality of grapes produced and the productive life and value of the vineyard or block.

2. Establish a monitoring regime to measure the impact of GARa-V3 infestations and the efficacy of control measures employed. This should be a long-term monitoring programme.

2 Project background

Two vineyards identified have experienced such significant deterioration of both quality and quantity of grapes from blocks infected with the GLRa-V3 that the decision has been taken to remove all the vines, and treat and fallow the land before replanting.

On the other hand some varieties, known to be infected with the virus, continue to produce grapes that yield premium wines.

There is considerable divergence of opinion as to methods of transmission and the effectiveness of various measures of management and control.

The completion of this economic analysis will contribute significantly to the overall objective of controlling the spread and hence the impact of GLRa-V3 through providing a greater knowledge of the possible economic impacts.

3 Methodology

We have worked with the two vineyards identified, one located in Hawkes Bay and the other in Marlborough, to gather data on the impact the virus has had on infected blocks, and where possible compare this with uninfected blocks of a similar nature (i.e. where a similar volume of comparable quality grapes would be expected). Data was collected from two vineyards for the period from 1998 through to 2005. There are a number of factors that make interpreting this data difficult, including climatic conditions over the period for which data was available. Discussions with vineyard managers allowed some clarification of the impact of these other factors.

Literature relating to virus spread and impact has been reviewed to provide additional information. This literature is not extensive and does not all relate directly to New Zealand vineyard production. It does however provide a guide to support the findings from the individual vineyards considered. Further information was sought from industry sources such as consultants and New Zealand Winegrowers representatives.

Using the vineyard data collected and the information available from the literature review and industry sources (including consultation with Dr Roderick Bonfiglioli and Dr David Jordan), cash flow forecasts have been prepared for a 20 year period for two varieties. A net present value (NPV) has been calculated for a range of scenarios to demonstrate the productive value of a vineyard under various management options.

Comparison of the NPVs is used to determine the loss in value of the vineyard which equates to the cost of the virus in today's dollar terms. In undertaking such an analysis a suitable discount rate needs to be identified. This has been set at 9 percent, this being a long term return that most vineyard operators would accept.

Using this methodology, the analysis has looked at the options for controlling the spread of the virus or replacement of infected vines to determine the most economically efficient actions available.

Insufficient data is available to consider all of the scenarios based on actual results or research findings. For example, there is no data available that demonstrates the spread of the virus where individual infected vines are removed when detected. The data available on the virus spread does however suggest that removal of these individual infected vines would significantly slow the spread of the disease. Where required, assumptions have been made as to the likely spread of the disease given the response considered.

The analysis considers two varieties, Sauvignon Blanc grown in Marlborough and Merlot grown in Hawkes Bay. The financial model has been constructed around a number of key variables which are able to be changed to demonstrate the impact. It is therefore possible to consider other varieties, spread rates and virus impact. The two varieties considered in this report are provided as examples only and are based on industry average data, and virus assumptions resulting from the vineyards examined, literature reviewed and discussion with industry participants.

4 Treatments considered

For the two varieties considered we have looked at three options for treatment of an infected block. These are:

1. No treatment until the virus has spread to the point that it is no longer economic or practical to produce grapes from that particular block. At this time all vines are removed and the Vineyard is replanted.
2. Removal of infected vines as they are detected.
3. Removal of infected vines as they are detected along with the vines immediately either side of the infected vines in the same row.

In addition to the above we have considered the financial impact of leaving the ground from which vines are removed fallow for a period of 1 year. Therefore there are a total of six treatment options considered. We have presented these as treatments one to three, with two options under each.

5 Overarching assumptions

In addition to the specific inputs used for each treatment and variety considered there are a number of overarching assumptions the analysis has been based on. These include:

- Average production figures have been used for the base case scenario rather than any actual production data collected from vineyards. Use of actual data was considered at length however difficulties arose in accounting for seasonal variations and other factors impacting on yield and the impact this had on the resultant cost.
- Vines will be replaced using the existing infrastructure. Where infrastructure is replaced as part of vine replacement it is assumed that this is done for commercial reasons other than the impact of the virus (e.g. to reduce row spacing), and is therefore not a cost associated with the virus.
- Removal costs have been estimated based on discussions with industry participants.
- Vineyard operating costs vary significantly between vineyards and have been based on the most recent MAF viticulture monitoring report. These have been adjusted where vines have been removed and replaced.

6 Inputs used

In order to assess the impact we have used a range of inputs. Values for these inputs have been determined from vineyard data supplied, literature reviewed and discussions with other industry sources. Production and cost data has also been sourced from MAF monitoring data. Table 2 below summarises the key inputs for the analysis undertaken.

It should be noted that in many cases there are some significant assumptions included in the analysis. These assumptions have been necessary due to the lack of actual data available. In many cases the analysis would benefit from improved data collection and we have highlighted the opportunities for this in section 10 below.

6.1 Baseline data

Baseline data has been used for each variety considered. On the revenue side this includes the number of vines per hectare, the expected yield from vines from planting through until maturity, and the expected price for grapes from uninfected vines. Expenditure levels have been based on MAF farm monitoring data for an average vineyard and are in line with those indicated by the vineyard managers. For a fully producing vineyard operating costs have been included at $8,329 per hectare (based on MAF vineyard monitoring data).

6.2 Virus spread

While the vineyard operators were able to provide data related to blocks infected with the virus and estimates of the level of infection, the rate of spread was not in most cases available. It was also noted that the spread may be heavily influenced by climatic and other factors. For example, it was felt that where vines had been affected by frost, the virus was significantly more prevalent in the following year. This tends to suggest that a vine weakened by frost may be more susceptible.

It is generally accepted that spread is affected by the source of the infection. That is, where the source is from infected plant material the spread is likely to be across a larger area of the block (which in turn may make it less easily managed) than where it is from a neighboring infected block (where spread may be more concentrated in one area of a block).

Virus spread rates have been estimated based on literature reviewed and discussion with vineyard owners and other industry participants. There is little solid evidence to allow spread rates to be accurately determined.

Spread rates of up to 63% within five years have been recorded in cabernet sauvignon and the Auckland region in the early 1990s (Jordan, 1993). These rates of spread are supported by the data collected for the Hawkes Bay Merlot block. While spread in white varieties may be less readily detected and visual symptoms less obvious, it is likely that spread rates are similar. Having said this, there may well be some variety influence on spread.

There is no available data to support spread rates under the various treatment options considered. In making an estimate of these it has been assumed that the spread is controlled by individual vine removal, however is not eradicated immediately. It has been assumed that infection continues to spread under these scenarios for a number of years however at a substantially reduced rate. The spread rates used in this analysis are provided in table 2 below.

6.3 Yield drop due to infection

Yield data was collected from infected blocks as well as neighboring comparable blocks. While useful as a guide, this data requires a significant amount of interpretation due to other factors affecting yield, particularly climatic factors. For example, blocks that have been affected by frost may have shown declines in yield in the year of the frost as well as in the following year. Finding blocks that are directly comparable is made more difficult in that if they are located next to each other there is a reasonable chance infection may have spread into both. Yield data collected is provided in table 1 below. It should be noted that the data for un-infected Hawkes Bay Merlot is based on estimates of what would have been expected from a similar block based on others within the vineyard.

Table 1: Examples of yields in infected blocks versus expected yields or based on comparable blocks for the two varieties considered in the analysis.

Marlborough Sauvignon Blanc	1998	1999	2000	2001	2002	2003	2004	2005
Yield (T/ha) clean	15.8	13.8	6.4	9.1	16.3	Frost	15.1	12.4
Yield (T/ha) infected	10.6	13.7	6.8	5.8	12.7		11.2	12.5
Difference %	-33%	-1%	+5%	-36%	-22%		-26%	+1%
% vines with virus	n/a	n/a	n/a	n/a	n/a		n/a	60%
Comments	No virus spread data has been collected for this block however estimates put the infection at 60% in 2005.							
Hawkes Bay Merlot	1998	1999	2000	2001	2002	2003	2004	2005
Yield (T/ha) clean			3.17	Frost	5.46	5.13	8.76	9.9
Yield (T/ha) infected			3.17		5.8	3.23	6.37	5.25
Difference %			0%		+6%	-37%	-27%	-47%
% vines with virus			1%		8%	15%	22%	
Comments	2000 was the first harvest for this block and it was removed after the 2005 harvest.							

Literature reviewed suggests a wider range of yield reductions associated with the virus, resulting from trials and monitoring work. This range is from zero through to over 70%. It has been estimated that in the absence of leaf roll virus German wine sector production might increase by up to 60% (Scheu, cited by Over de Linden and Chamberlain). Over der Linden and Chamberlain (1970) maintained that gains in New Zealand could be of a similar magnitude.

Yield drops are likely to be variety, location and season dependant. There is currently insufficient data available to allow an accurate prediction. For the purposes of this analysis we have assumed drops of up to 35 percent for Sauvignon

Blanc and 60 percent for Merlot. Evidence suggests that the drop in yield from individual vines which become infected is likely to increase over time as the virus has an increasing effect on the vine. The yield reductions above have been assumed to occur in the fourth year of infection.

6.4 Quality reduction due to infection

Research has shown that in red varieties there is a significant decline in sugar levels as well as red pigmentation and levels of anthocyanins where vines are infected. While there is some thought that the quality drop due to infection in white grapes is minimal research has shown that sugar levels are often significantly reduced (Over de Linden and Chamberlain, 1970) in both red and white varieties. These findings are supported by French research which saw quality reductions in both red and white varieties (Walter and Legin) associated with virus infection (type not defined). Further, discussion with the owner of an infected block of Sauvignon Blanc in Marlborough confirmed that grapes from this block were generally discounted in price as a result of the presence of the virus.

Research also suggests that total acidity increases (TA) with the presence of the leaf roll virus. This is supported by the data collected for Hawkes Bay merlot. TA measures were not available for the Marlborough Sauvignon Blanc.

Degree Brix at harvest has a significant bearing on the price paid for grapes. Understandably data collected shows that there is a seasonal variation in brix and harvest date. Research supports the vineyard data collected, with the presence of the virus resulting in lower brix and / or a delayed harvest dates.

While brix is reflected in price, harvest date is generally not. The financial impact of delayed harvest is difficult to quantify however the level of risk increases as crops are left longer on the vine. This is particularly important where the harvest “window” is shorter. No attempt has been made to quantify this factor.

6.5 Price

The price is usually a reflection of the quality of grapes, however is also impacted on by contract pricing, supply and demand, variety (and the impact the virus has on quality) and the wine in which the grapes are used. In the case of a winery growing its own grapes the price is equivalent to what similar fruit could be purchased for in making the particular quality of wine. It is likely in many cases that there are price points and therefore the price: quality relationship is unlikely to be linear. Where these price points are is highly variable. Therefore for the purposes of the analysis we have assumed a linear relationship. This may understate the cost in some cases and overstate in others however should provide a reasonable indicator of the price discount.

Based on the discussions with vineyard owners we have assessed a price discount of 10 percent (or approximately $200 per Tonne) for the Marlborough Sauvignon Blanc fruit from vines that are 60 percent infected. For the Hawkes Bay Merlot we have assumed a price discount of 10 percent (or approximately $150 per Tonne) based on approximately 20 percent of vines being infected. The lower per tonne price reduction in Merlot reflects the lower prices paid for grapes. The same percentage reduction in price at a lower level of infection for Merlot reflects the greater impact the virus has on the quality of red grapes as opposed to whites.

For the purposes of the analysis we have assumed a 10 percent reduction in the price for Sauvignon Blanc and 15 percent reduction in the price for Merlot for those grapes that come from an infected vine. These discounts are a variable in the model constructed.

6.6 Vine removal

Where virus infection levels within a vineyard are significant, total vine removal and replacement is likely to be the only feasible option. Practically, once the number of vines requiring removal exceeds 30%, this is thought by vineyard managers to be the preferred option.

Roguing is likely to be an effective control measure where infection rates are relatively low and the primary source of infection is either within the vineyard or able to be controlled. Where infection is being spread from a neighbouring property, roguing will provide an effective treatment and preventative measure against spread within the vineyard however is unlikely to prevent further infection being introduced. Success will depend on the ability to identify infected vines soon after infection occurs (and prior to spread of infection from these vines). Difficulty in identifying infected vines at the time of removal (especially where vines become infected in the latter part of the growing season) is likely to mean that roguing will not be 100 percent effective even if the primary source of infection is controlled.

Removal of vines either side of those infected when roguing is likely to further reduce secondary spread within the vineyard. Despite the fact that vines neighbouring those which are infected may appear to be free of the virus, this is commonly where new infection will be found. Reasons that infection is subsequently found in these vines includes non presentation of virus symptoms at the time of original vine removal and subsequent infection from remaining vine material not thoroughly removed or destroyed.

There is no evidence to support spread rates under roguing scenarios, and these will be very reliant on the primary source of infection. For the purposes of this analysis estimates have been made based on early identification of infection and the fact that secondary infection is likely to be reduced where additional clean vines are removed also.

6.7 Capital expenditure

Capital expenditure associated with removal and replacement of vines has been included in the analysis. Removal costs have been estimated at $2.00 per vine, with new vine establishment included at $10.00 per vine ($5.00 per plant and $1 for planting and $1 for training).

6.8 Utilising this data

Utilising the information available is made difficult by the gaps in data available, interpreting seasonal variances in vineyard data collected and issues such as supply and demand with respect to price. It does however provide some basis for the assumptions made in the analysis. Verification or otherwise of these assumptions would require the collection of more specific data which could come from the monitoring programme proposed.

Table 2 below shows the inputs used for the two scenarios modeled. These are variable inputs. As such they are able to be altered to look at variations on the scenarios presented.

Table 2: Inputs used in the analysis

Sauvignon Blanc	**Total**	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**Year 6**	**Year 7**	**Year 8**
Baseline (No infection)									
Vines per hectare	2,100								
Expected price for grapes without infection	$2,200								
Expected yield from newly planted vines (T/ha)		0	2.5	9.9	11.2	12.4	12.4	12.4	12.4
No treatment									
Vines newly infected		2%	4%	6%	8%	11%	16%	22%	31%
Treatment 1 (Total vine removal in year 6)									
Vines newly infected		2%	4%	6%	8%	11%	16%	0%	0%
Treatment 2 (Removal of infected vines annually)									
Vines newly infected and removed		2%	4%	4%	4%	2%	2%	0%	0%
Treatment 3 (Removal of infected & neighbouring vines annually)									
Vines newly infected and removed		2%	2%	2%	1%	1%	1%	0%	0%
Other parameters									
Yield drop per vine due to infection		10%	18%	25%	35%	35%	35%	35%	35%
Price discount for grapes from an infected block[1]	15%								
Percentage of neighbouring vines removed that are infected[2]	50%								

[1] Note that this percentage is applied to the grapes from infected vines only. e.g. if 20% of vines are infected that the discount will be 20% times 15% times the baseline price.
[2] i.e. fifty percent of vines removed as neighbouring infected vines are also infected, effectively reducing the total number of vines to be removed.

Merlot	Total	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8
Baseline (No infection)									
Vines per hectare	1,850								
Expected price for grapes without infection	$1,850								
Expected yield from newly planted vines (T/ha)		0	0	6	9	10	10	10	10
No treatment									
Vines newly infected		2%	4%	6%	8%	11%	16%	22%	31%
Treatment 1 (Total vine removal in year 6)									
Vines newly infected		2%	4%	6%	8%	11%	16%	0%	0%
Treatment 2 (Removal of infected vines annually)									
Vines newly infected and removed		2%	4%	4%	4%	2%	2%	0%	0%
Treatment 3 (Removal of infected & neighbouring vines annually)									
Vines newly infected and removed		2%	2%	2%	1%	1%	1%	0%	0%
Other parameters									
Yield drop per vine due to infection		10%	20%	40%	60%	60%	60%	60%	60%
Price discount for grapes from an infected block[3]	20%								
Percentage of neighbouring vines removed that are infected[4]	50%								

[3] Note that this percentage is applied to the grapes from infected vines only. e.g. if 20% of vines are infected then the discount will be 20% times 20% times the baseline price.

[4] i.e. fifty percent of vines removed as neighbouring infected vines are also infected, effectively reducing the total number of vines to be removed

6.9 The impact of the discount rate used

The cost of the virus is in the cost of foregone income and vine replacement. The fact that these costs are spread over time means that the total impact of the virus in today's dollar terms is less than the actual cost that will be incurred when vines are replaced or income foregone. To account for this the future cashflows are discounted using a discount rate. The choice of rate has an impact on the cost of the virus.

A lower rate results in a higher cost of the virus. While this may seem perverse it is logical when consideration is given to the fact that with a higher discount rate the shorter term is more important than the medium or longer term. In other words, an investor who requires a higher rate of return (and therefore uses a higher discount rate) is more concerned with the short term, and therefore less concerned with the longer term impact of the virus. The greater the focus is on the short term returns, the less desire there will be to remove infected vines and replant.

A discount rate of 9 percent has been used in this analysis. This is based on discussions with a valuer experienced in vineyard valuation and is an average return being achieved in Marlborough.

7 Results of the analysis

The cashflow model constructed has been used to calculate the cost as a NPV per hectare for a non-virused block, along with the NPV expected from infected blocks treated in various ways. The difference between these NPVs is the cost of the virus under that treatment. The calculated cost of the virus under various treatment scenarios is shown in table 3 below.

Table 3: The cost (NPV/ha) of LRVa3 under various treatment scenarios.

Treatment	Sauvignon Blanc	Merlot
No treatment (Infection continues to spread to 100%)	$57,901	$57,618
Treatment 1 (Total vine removal in year 6)		
No fallow period	$44,688	$37,747
One year fallow	$55,971	$44,773
Treatment 2 (Removal of infected vines annually)*		
No fallow period	$9,643	$8,172
One year fallow	$12,349	$9,899
Treatment 3 (Removal of infected & neighbouring vines annually)		
No fallow period	$11,738	$9,974
One year fallow	$15,232	$12,203

* Removal of infected vines and those either side is assumed to occur after harvest. i.e. Infection is present prior to harvest and vines removed subsequent to harvest.

The results of the analysis shown above clearly demonstrate that there is a significant cost associated with the virus, and that early intervention in the form of annual vine removal is the most effective way of reducing this cost. Further, there is a reasonably significant cost of leaving ground fallow for a year between removal and replacement.

7.1 Annual impact on a per hectare basis

While the total cost of the virus is calculated through using a NPV calculation it is useful to consider what this means on an annual basis for an infected vineyard. The gross and net incomes per hectare for 100 percent infection (based on the assumptions used) and for a clean vineyard are shown in table 4 below.

Table 4: Returns for a clean block versus a 100 percent infected block.

Income and expenditure per hectare	Sauvignon Blanc	Merlot
Clean block		
Gross Income	$27,280	$18,500
Operating expenses	$8,329	$8,329
Surplus	$18,951	$10,171
Infection of 100 percent		
Gross Income	$15,072	$5,920
Operating expenses	$8,329	$8,329
Surplus	$6,743	($2,409)
Difference		
Surplus	$12,208	$12,580

Table 4 above shows that based on the assumptions used in this analysis a vineyard that is 100 percent infected with the virus would see a reduction in annual income of approximately $12,000.

7.2 Discussion of results

The results indicate that individual vine removal on detection is a substantially lower cost way of eradicating the virus provided that it is in fact a successful control mechanism. Assuming no fallow period between removal and replacement, the analysis shows a cost saving (over the total vine removal in year 6) of approximately $35,000 per hectare for Sauvignon Blanc and $30,000 per hectare for Merlot where infected vines are removed annually. Where the treatment sees the removal of infected and neighboring vines the costs saving would be approximately $33,000 per hectare for Sauvignon Blanc and $28,000 per hectare for Merlot.

Not removing infected vines until all vines are removed (treatment 1) is the least cost effective way of responding to virus infection for the infection scenarios considered.

It should be noted that losses from retaining infected vineyards are likely to be significantly greater than the analysis suggests. Infected vines are more susceptible to climatic factors and where there is an oversupply of grapes those of lower quality are likely to be the first rejected or severely discounted. They also provide a source of infection for other blocks.

In comparing the scenarios the following points also need to be noted:

- The rate of virus spread has a significant impact on the overall cost. These results provide analysis for one scenario only for each treatment.
- Improved data on virus spread rates and the ability to influence these through the removal of neighboring vines gathered through monitoring will allow more accurate analysis to be undertaken.
- Changes in the profitability of vineyard operations will have a significant impact on the cost of the virus.

The last of these points raises an important issue. Where profitability is reduced the incentive to implement a monitoring and treatment programme is reduced, as in fact may be the ability to fund it. Failure to implement a programme will however result in greater cost over the longer term and a compounding of the profitability issues.

8 Sensitivity analysis

With each treatment option there are management decisions that must be made which are likely to have an impact on the economic cost of the virus. The key decisions and the impact these have are discussed as follows:

8.1 Timing of removal where all vines removed

The timing of the decision to remove all vines where this is the treatment scenario to be followed (i.e. at what point the decision is made that yields or quality have deteriorated sufficiently to justify removal) will impact on the total cost of the virus. It is important to note that when individual vineyard operators make this decision they will be taking account of other factors such as productivity of the balance of the vineyard, and demand and price for that particular variety. Where the decision to undertake total replacement is delayed there will be an economic cost or benefit depending on the yield, price and discount rate used. In order to demonstrate this we have considered the total replacement option (Treatment 1) based on a one-year delay from that shown in the analysis. The impact of a one year delay is shown in table 5 below.

Table 5: Increase in cost where treatment 1 is delayed by one year (no fallow period included)

Cost (NPV/ha) for Treatment 1 at 9% discount rate			
	Removal as per analysis	Removal Delayed	Percentage change
Sauvignon Blanc	$44,688	$45,104	1%
Merlot	$37,747	$38,455	2%

Cost (NPV/ha) for Treatment 1 at 6% discount rate			
	Removal as per analysis	Removal Delayed	Percentage change
Sauvignon Blanc	$54,504	$56,161	3%
Merlot	$46,068	$47,883	4%

For the scenario analysed under treatment one, there is little effect of delaying vine removal and replacement by one year when considered in today's dollar terms. As in the initial analysis, the impact of discount rate is significant and a longer term view (and lower discount rate) results in a benefit in earlier removal (albeit small), however a shorter term view may see the decision delayed.

8.2 Grape yield and price

Two of the key drivers in determining the economic impact of the virus, unsurprisingly, are grape yield and price. To demonstrate the impact of these we have re-run the forecasts for each treatment (excluding the fallow periods) based on a 10% increase in gross income for the entire analysis period for each variety, with results provided in table 6 below.

Table: 6: Cost per hectare (NPV/ha) where gross revenue increases by 10 percent

	S.Blanc	**Merlot**	**S.Blanc**	**Merlot**	**S.Blanc**	**Merlot**
	Base Case		G .Rev. +10%		% Change	
Treatment 1	$44,688	$37,747	$48,338	$40,783	8%	8%
Treatment 2	$9,643	$8,172	$10,405	$8,782	8%	7%
Treatment 3	$11,738	$9,974	$12,651	$10,705	8%	7%

Results of this sensitivity analysis demonstrate that where grape prices are higher there is greater incentive to replace infected vines earlier.

8.3 Discussion on sensitivity analysis

While the sensitive variables show an impact on the individual treatment scenarios, these are small when compared with the overall cost. The results clearly show that the greatest influence on the cost is the implementation of a progressive infected vine removal programme. A monitoring and treatment programme that allows the early identification and removal of vines is the most cost effective way of treating the virus.

It is important to note that the small changes in cost associated with delayed vine removal are likely to understate the true cost. The true cost is likely to be higher due to the likes of seasonal factors and demand and supply having the potential to amplify the impact of the virus where decisions are delayed.

9 Other costs of the virus

In addition to the directly quantifiable costs associated with the virus there are other costs that need to be taken into account when considering the overall impact and the response to be implemented. These include:

Virus vector control
Mealybugs have been identified as a major vector of the virus and there is now considerable effort by many vineyard operators to control mealybug populations and prevent spread of the virus. While very real costs can be attributable to the virus they have not been included in the analysis undertaken as they are considered a preventative measure as opposed to a response to virus infection. Notwithstanding this, there is likely to be a significant cost to the wine industry associated with vector control.

Lack of quality grapes and lower yields – impact on brand or company growth
A reduction in the quality of grapes harvested has the potential to impact on the quality of wine produced and therefore the value of the company brand and prices received for wine. In many instances wineries are producing for more than one label. In these cases the poorer quality grapes are used in a secondary label wine with a lower market price. This lower market price is reflected in what the wineries are prepared to pay for the grapes and is therefore included in the analysis undertaken. The lack of quality grapes may however prevent a winery from expanding premium labels.

The impact of lower volumes of grapes being available for processing is difficult to determine given the growth that has occurred within the industry over recent years. In many cases new plantings have allowed increased production, despite the likely reduction in quantity associated with the presence of the virus. While production quantity has lead to less wine for sale this is reflected in the lower quantity paid for and is therefore accounted for in the analysis. There may however be an impact on the profitability of a winery. The difficulty in determining this is associated with the growth that has occurred and uncertainty associated with how this additional wine may have been marketed.

<u>Management costs</u>
Irrespective of the treatment options undertaken, and even where no treatment has been undertaken, there are likely to be additional management costs associated with the virus. These are associated with planning and decision making, managing the impacts of lower volumes and quality, and marketing of grapes. The ability to quantify this impact is inherently difficult and it has not been included in the analysis.

<u>Not extracting value from better quality grapes from older vines</u>
While there is some anecdotal evidence, there is little solid proof as to at what age grape vines produce the highest quality grapes. If it is suggested that the premium grapes come from older vines, then the virus is likely to have an impact on the quality of grapes produced where vine longevity is reduced. Again, this impact is inherently difficult to quantify and is not been included in the analysis.

<u>Delayed harvest</u>
Presence of the virus not only reduces quantity and quality, it also has an impact on the ability to ripen fruit for harvest. Harvest dates are often therefore later, with a corresponding increase in risk of loss and damage.

10 Key data that will improve future analysis

This analysis has been undertaken based on a limited amount of data available and has made a considerable number of assumptions relate to the spread and impact of the virus. Despite the fact that much of the data is based on estimates it provides a good gauge of the quantum of losses (which are significant) that are likely under the treatment scenarios considered and the relativity of these. Additional data collection will assist in providing more accurate assessments of the cost of the virus. The following data has been identified as being beneficial to more closely monitor and to provide additional analysis in the future:

<u>Detailed spread data</u>
- Virus spread rates if left un controlled (i.e. no vine removal)
    - May need to assume "normal" mealy bug control
- The impact of removing infected vines on spread through remaining vines
- The impact of removing infected vines and neighbouring vines on spread
- The impact of leaving ground fallow for a period (1 or 2 years)
- The impact of infection source on the above (i.e. has the infection come from a neighbouring block or infected plant material)

<u>Improved yield data</u>

- Yield per infected versus clean vines over time (i.e. how does yield per vine decline as the time from initial infection increases)
- The impact of vine age on yield differences and quality issues?
- The effect of climatic events on virus impact (e.g. Does frost mean greater loss?)
- The effect of climatic events on virus spread (e.g. Does frost means vines are more susceptible?)

11 Conclusions

Data gathered from the two vineyards considered highlighted the significant cost associated with the virus where the virus is left untreated.

This analysis supports this with a cost (net present value) of the virus where it is left untreated and the vineyard reaches 100 percent infection of approximately $57,000 per hectare for both varieties considered.

The scenarios presented in this analysis quantified the cost associated with various responses in a hypothetical vineyard. In making an assessment of what action to undertake each grower will need to consider a number of variables highlighted as part of this analysis.

It is clear however that early intervention and implementation of a progressive treatment programme will ensure losses associated with the virus are minimised. Regular monitoring and testing for the presence of the virus will be critical in achieving this.

Further, a coordinated approach by industry participants with sharing of information gathered will assist in raising awareness of risks and the chances of early identification.

Monitoring of virus spread on these two properties over the next few years would not only allow the economic impact to be more accurately determined, it will also allow proof of the effectiveness of the treatments implemented. This will be critical to achieving industry buy-in to implementing treatment programmes.

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