Wine Grape Quality Measurement and Benchmarking Group

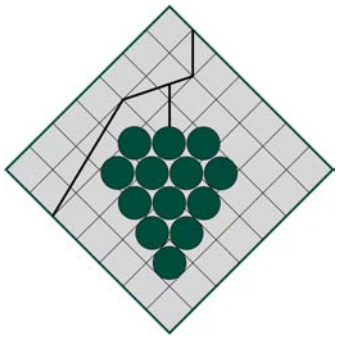
Vintage 2002 Report

A Research Project linking: Myrrhee Consulting Services, Southcorp Wines, Grape and Wine Research and Development Corporation, Patrick Iland, Ross Polglase and Lake Marmal Vineyards.

To research an objective grape quality (composition) index and benchmark vineyard management practices to determine key quality parameters.

September 2002

LAKE MARMAL
VINEYARDS



GRWDC RITA Project no: RT 01/27-3

Written by Luke Rolley.

Executive Summary:

This report outlines the 2002 Vintage Progress of the Wine Grape Quality Measurement and Benchmarking Group. The group comprises a number of vineyards in the Bendigo, Gundagai and Swan Hill regions. The focus of the group is to research objective quality measurement techniques and benchmark quality parameters. To do this we measure different aspects of 1. Vineyard, 2. Berries and 3. Wine. By measuring different stages of wine production we have found key aspects to benchmark and measure quality.

Multiple sites within a vineplot are required for quality measurement due to vineplot variability. Our results appear to have achieved this by randomly choosing three sites x 40 vines, covering 120 vines per vineplot (management unit, usually 5-10Ha). A reduction in sampling sites within a vineplot will provide misleading information on the quality of fruit within that area. One bunch per vine, i.e. 120 bunches per block provided data that produced good quality correlations; therefore large sample sizes are essential for accuracy.

Assessing vineyards over the Bendigo, Gundagai and Swan Hill regions, our results show that the two most important objective measures are Shoot Periderm Development and Berry Size. These were the two most important factors relating to wine quality. Shiraz vines with good Lignification of Shoots and Small Berries were also those producing the highest quality of wine. These measures are likely to provide a great deal of information on the management of the vines over the season, including water management and the application of stress at appropriate times.

In our attempt to relate an objective berry measurement with wine quality we discovered some pleasing relationships. In particular the concentration of phenolic compounds and percentage of skin to berry weight was able to explain approximately 70% of the variation in our predictive model. We are very pleased with these results and feel that they are attributed to good sampling and analysis procedures used in the experiment.

Results and progress amongst the group has been very pleasing. Further research is required to follow up indications form this vintage. We are looking forward to consolidating our techniques and obtaining a data set that will enable an accurate objective assessment of wine grapes.

Assessing Grape Colour in the Field.

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Introduction:

We are very pleased with results we have obtained from research in the 2002 Vintage. There is evidence that we are pursuing the correct measures and techniques for Objective Quality Determination. In addition, we have discovered some key Benchmarks of Quality, which we trust, will be of benefit to those who have participated in the project and their pursuit of high quality and profitable wine grape production.

The final results, cooperation from participants in the project and progress made in understanding quality viticulture must all be regarded as outstanding successes.

The focus of our investigation was Shiraz Wine Grapes in the Bendigo, Swan Hill and Gundagai regions of Victoria and NSW. Fourteen vineyards participated in the trial and some vineyards included a number of vineplots to determine quality variation within a property.

Scope of Report.

This report has been compiled to inform participants and interested parties the key findings from the 2002 vintage. This report has not been written to meet the criteria of a full scientific investigation. This is not consistent with our objectives; instead a concise communication of key findings is the objective of this report.

It will cover basic background information, methodology and results obtained in relation to both Objective Quality Measurement and Benchmarking. The benchmarking information is anticipated to occur at a debriefing meeting following the completion of this report.

Background Information.

Previously the Wine Grape Quality Measurement and Benchmarking Group has been operating with a view to implementing an objective grape quality (composition) technique, benchmarking vineyards and assisting growers to understand quality management parameters, in an informal arrangement. This vintage (2002) was the beginning of detailed scientific investigation and benchmarking.

The objective quality measurement involves a staged process, which attempts to link canopy and fruit characteristics in the vineyard with the wine quality and style. Of particular importance is the link between fruit characteristics (eg berry size, sugar-acid balance, flavour) and final wine quality.

Vineyard assessment is the first stage. We assemble all the growers within a region immediately prior to harvest and measure important attributes of the vines likely to be beneficial or detrimental to quality. This is performed with a vineyard assessment sheet, which was developed by Southcorp Wines in partnership with Pat Iland. We also involve specialist viticulturists and a winemaker so that maximum interaction and feedback on desirable canopy and from the region so that an understanding can be gained how vineyard parameters are affect quality and berry composition.

The second stage of objective quality measurement involves taking (statistically valid locations and quantities) berry samples from sampling sites within a block where assessment sheets were completed. These samples are then sent to Myrrhee Consulting where a grape composition analysis is performed to obtain accurate measures of key components, such as phenolics and anthocyanins. This process attempts to simulate winemaking extraction of key components of grape quality.

The third stage is making wine out of the grapes. The resulting 'Wine Quality' from within and between regions is then used to determine which components measured from the Vineyard and Berry samples were important in influencing quality.

All measurements of canopy, fruit and wine parameters are statistically analysed. This process leads to practical and concrete findings for vineyards involved in the research project. Hopefully with a number of years of data we will have a far greater understanding of vineyard management and how this affects berry and wine composition.

The group encourages networking within and between grape growing regions. Up to now, there have been three regions involved: Bendigo, Swan Hill and Gundagai.

Luke Rolley of Lake Marmal Vineyards and Ross Polglase, a private viticultural consultant, initiated the groups. Over time it has expanded to include key people to bring the project together and find valid outcomes. These people include: (1) Mark Smith, viticulturist with Southcorp Wines (2) Patrick Iland, recently retired from Adelaide Uni and now working as an independent consultant (3) Brenton Dansie, Head of Mathematics at The University of South Australia and experienced with vineyard analysis and statistics (4) Alan Buchanan of Myrrhee Consulting services; Alan is responsible for the grape berry analysis aspect of the project. GWRDC has provided substantial financial assistance to the project.

Together with growers from Bendigo, Gundagai and Swan Hill, this team has carried out a successful vintage of data collection and analysis.

Objectives:

With any investigation it is important to clearly define objectives so that performance can be measured. In the beginning our Quality Measurement and Benchmarking study had to achieve a number of objectives. These include objectives related to the determination of Objective Quality Measurement and also benchmarking. Our focus is Shiraz wine grapes.

The project has main objectives and additional benefits. Some of these additional benefits are focused at long-term results within the industry.

Main Objectives.

1. To research the Vineyard Management Practices that are responsible for Anthocyanin and Phenolic concentrations in grape berries.

2. To determine whether Anthocyanin and Phenolic concentrations are an accurate predictor of Wine Quality.

3. To examine the differences within and between regions for optimal production of Quality Wine Grapes.

Additional Benefits.

- ☺ To facilitate information exchange between Southcorp Growers in regard to Vineyard Management and Cultural Practices.
- ☺ To elevate the profile of participants and demonstrate our commitment to producing quality wine grapes.
- ☺ Provide valuable data to the viticultural industry in relation to quality measurement and benchmarking with the publication of our results.
- ☺ Increased understanding of crop development and quality parameters.
- ☺ Potential to provide our group/industry with an objective wine grape measurement pre-vintage.
- ☺ Allow more streamlined processing of fruit at the winery, as the quality is determined prior to fermentation. Resources can then be preferentially allocated to high quality fruit.

Research Methods:

The Methodology used in our experiment was essentially simple. It involved taking accurate measurements at different stages of wine production. Initially in the Vineyard pre harvest, secondly as berry samples and thirdly as the resulting wine.

Experimental Design.

Careful consideration had to be made to ensure the valid design of the experiment yet maintain useability for participants in the project. The project had to produce statistically valid outcomes otherwise the results are providing little advancement in understanding.

Pat Iland, Mark Smith and Ross Polglase, using experience from previous experimental designs, designed the project.

The design included the utilisation of three sampling sites within a vineplot (management unit within a vineyard); this was to ensure a representative grape sample and also to investigate variation within a vineplot.

Vineplots were selected in the three regions of Bendigo, Swan Hill and Gundagai; sites were then randomly chosen within each vineplot and marked for Vineyard Assessments and Berry sampling. At each of three randomly chosen sites 40 vines were used for the vineyard assessment and berry analysis. Each site was analysed separately and the results averaged for interpretation.

Vineyard Assessments.

Vineplots were assessed as close to harvest as practical. Growers were assembled in each region along with a winemaker and viticulturist(s). The group was then trained in the use of the vineyard assessment sheets and the winemaker used to assist in the description and quantification of flavour related assessments.

The Vineyard Assessment sheet is a good way to describe what has happened in the vineyard for the season. It is also the means used for benchmarking as we can quantify various aspects of the vineyard and find trends for vineyards producing both poor and good quality fruit. The Vineyard Assessment sheet contains both objective and subjective measures. The fact that subjective items must be quantified is a good way of benchmarking properties such as flavour intensity.

The following items were assessed objectively where possible in the vineyard:7

Average Shoot Length.
Cane Trimming
Lateral Shoot Growth from the Base of Canes
Lateral Shoot Growth from the Tips of Canes
Shoot Periderm Development
Physical Leaf Condition
Berry Size
Degree of Berry Shrivel
Description of the Pulp
Intensity of Flavour
Sugar Acid Balance
Fruit Exposure Percentage
Variability of Fruit Exposure
Light Condition in Fruiting Zone
Leaf Layer number at fruiting zone
Seed Lignification
Cropping Levels
Chewiness of Skins
Intensity of Tannins
Mouthfeel Description of Tannins
Colour of Berries
Fruit Condition

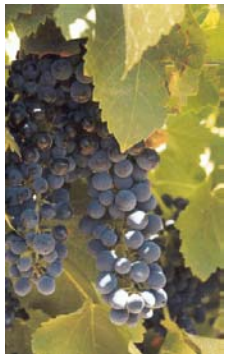
Ross and Luke assessing berries

Berry Analysis.

The berry analysis was conducted at 12.5 Baumé and again at Harvest. Myrrhee Consulting Services performed the analysis, using photometric absorption techniques for measuring anthocyanin and phenolic quantities.

Sampling involved randomly picking one bunch from each vine at a site within the vineplot. That is 40 bunches at each site by three sites per vine plot to give a total of 120 bunches per vineplot for analysis. The three sites were analysed separately and then the results averaged for interpretation. There was also a spare sample stored in the freezer for further analysis if required.

The measurements conducted by Myrrhee consulting services include:
Berry Weight
Skin Weight
Seed Weight
Juice Weight
Baumé
Anthocyanin 520nm extraction from skins.
Phenolics 280nm extraction from skins.
Phenolics 280nm extraction from seed surface.



From these measures relative concentrations and ratios of various components can be derived.

Wine Assessment.

Wine Quality was determined commercially using Southcorp's Wine Grading System. All growers participating in the project were supplying Southcorp Wines and this was beneficial as the same grading system was used across regions. The wine was made from the entire vineplot used in each vineyard; this also leads to a comprehensive and commercial evaluation of the wine. Wine is graded A through to F with each grade being represented by three subsequent grades for example B grade is composed of B1, B2 and B3 grade wine. The exception is A grade where there are five subsets of grading. The fruit and wine in our analysis was spread between A5 and E2, which is a good cross section of wine qualities.

The Bendigo group was also fortunate enough to have wine samples from each vineplot made separately so that a tasting, anthocyanin and phenolic assessment could be conducted on the grape samples post ferment.

Results:

Overall we are very pleased with our results and achievements in the 2002 vintage.

Most participants in the project implemented correct sampling techniques at appropriate times. The selection of random locations and adherence to bunch collection techniques was very pleasing. One shortfall was with the labelling used in Berry Samples, as the grape juice made the writing hard to read. In future we will make some minor modifications but overall our sampling and assessment system worked well.

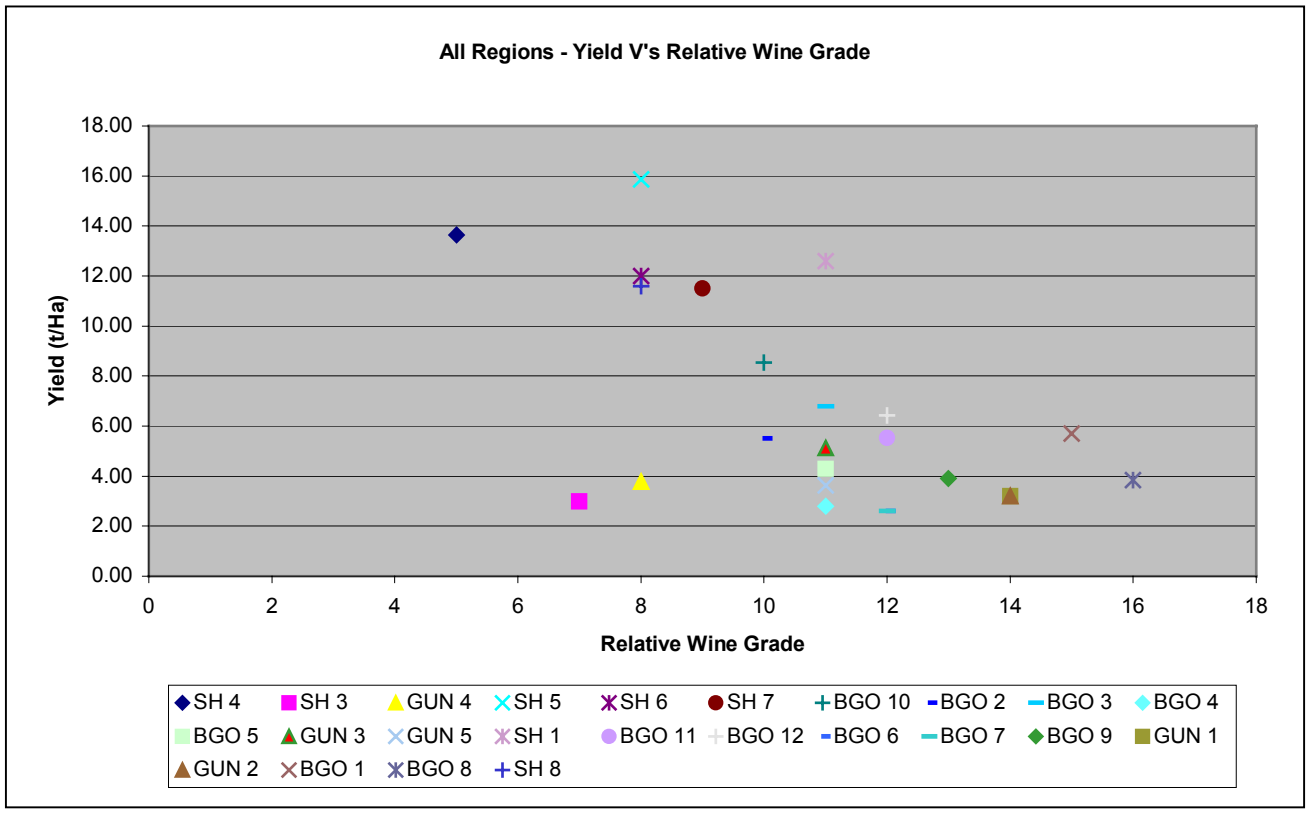
The vineyard assessment sheets were excellent for describing canopy and berry characteristics. Some items on the sheet were more subjective than objective. Regardless, there was benefit in that growers were able to have a winemaker go through the items, and try to quantify previously subjective assessments.

The berry analysis was excellent; Myrrhee Consulting Services provided a prompt and professional service. The analysis techniques used are accurate as they represent winemaking procedures by extracting anthocyanin and phenol from the skins of berries, and phenol from the surface of the seeds.

Launching a project of this size with a view to objectively measure quality could be seen as a hopeful speculation. However by measuring many aspects of vineyard and berry properties we have made a number of statistically valid achievements. The correlations of our measurements with resultant wine quality illustrate that our measures are explaining the components of grape quality; it

would appear as though we are heading in the right direction and measuring the appropriate properties. It would also indicate that our sampling and analytical techniques are providing repeatable and consistent measures correlated with wine grape quality.

Naturally there is still a long way to go with this research, however the initial findings are useful for benchmarking vineyard performance and providing great encouragement and focus for future research.



It would be near impossible to research wine quality and resist the temptation to see what correlations with Yield can be made. This graph illustrates the relationship or lack of relationship between Yield and grade, there did not appear to be a good correlation between Yield and Wine Grade. For the regions sampled, there was also a climatic effect that tended to reduce yield below normal levels.

Vineplot Variability.

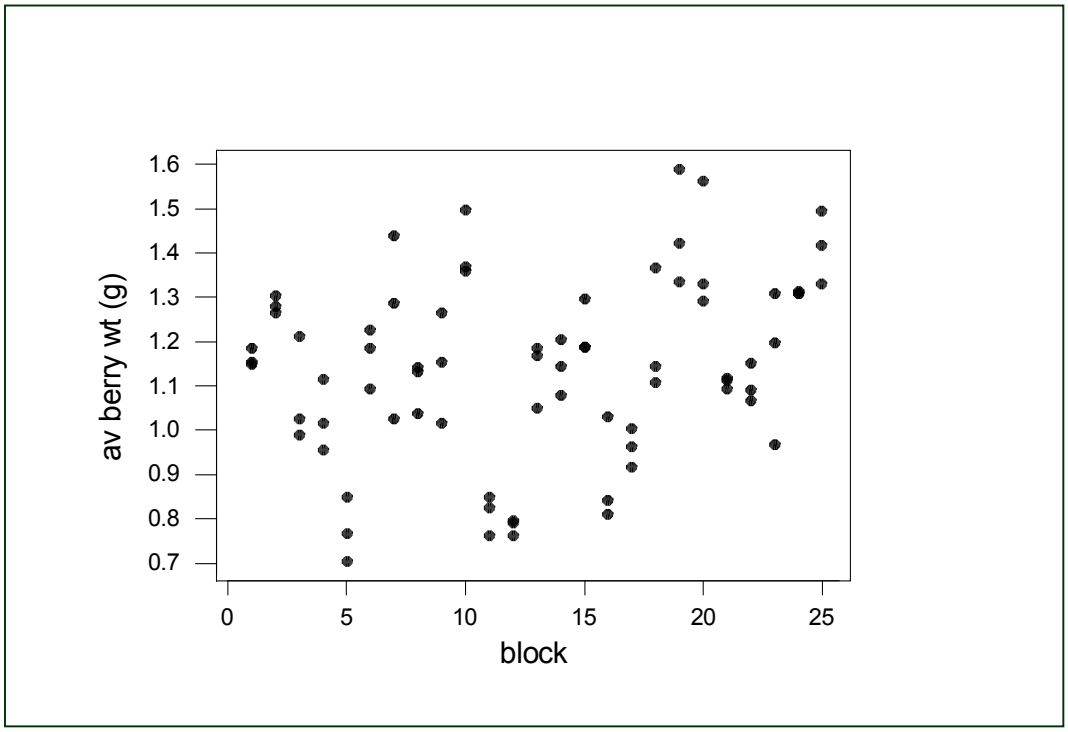
Managing vineyard variability and assessing variance is a common viticultural issue. To investigate this we included scope in our project to assess variability. From within each vineplot we selected three randomly chosen sites for vineyard assessment and berry analysis. From the three samples were able to assess the validity of choosing three sites to represent a block of vines and show that there is significant variation within single management units of vineyard. This confirmed that using three sites was an appropriate representation of a management unit of Shiraz vines.

The following table shows the standard deviation for each measure using the data from the 3 sites in each block sampled at harvest. This is an absolute measure of the variability. In the case of the vine characteristics this is probably the best indicator of the variation because nearly all of the characteristics are measured on a comparable 5 point scale. In the case of the berry characteristics the scales are very different and thus it is not useful to compare standard deviations directly. Through the calculation of average block means, the standard deviation is shown as a % of the Mean. These measures enable more effective comparison of the levels of variation.

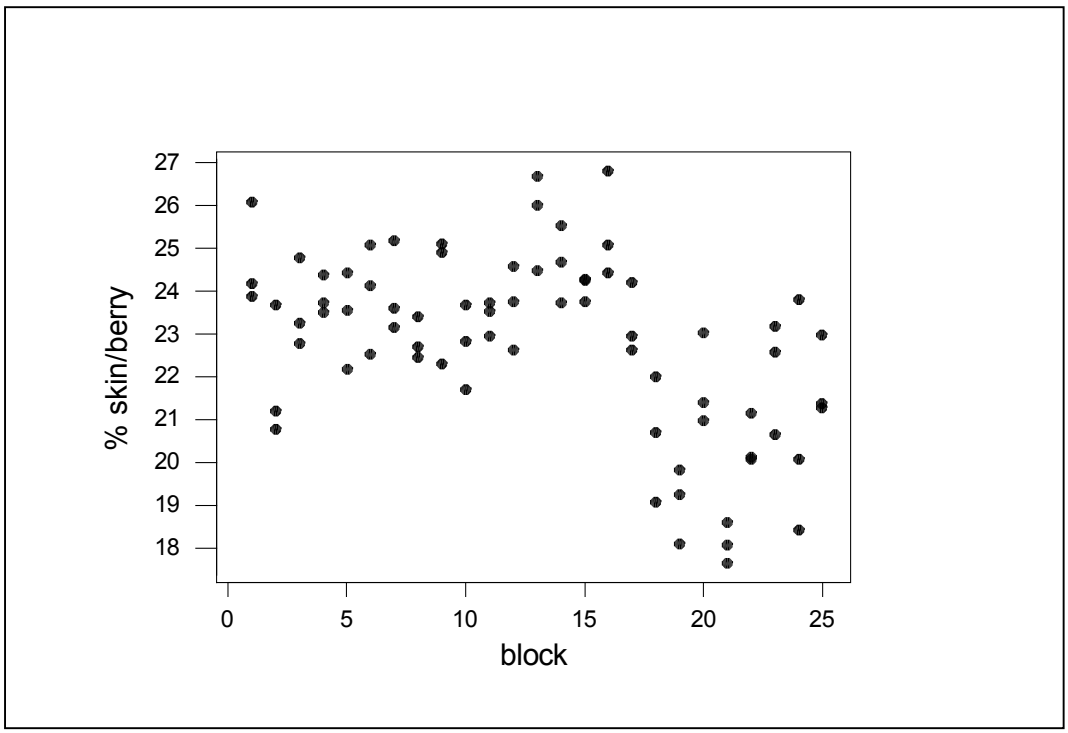
Measure	Average Block Standard Deviation	Average Block Mean	Standard Deviation as % of Mean
av berry wt (g)	0.08	1.14	7.0
av skin wt (g)	0.02	0.26	6.5
av seed wt(g)	0.01	0.06	8.4
juice wt(g)	0.07	0.82	8.4
% skin/berry	1.05	22.80	4.6
%seed/berry	0.44	5.59	7.9
%juice/berry	1.33	71.61	1.9
Baume	0.32	14.17	2.3
antho_skin	5.70	60.42	9.4
phenol_skin	5.45	61.16	8.9
phenol_seed	0.28	1.61	17.5
Shoot Length	0.33	3.06	10.7
Lateral 1st 8	0.00	1.09	0.0
Lateral 2nd 8	0.03	1.03	2.4
Shoot Perider	0.25	1.51	16.7
Leaf Conditio	0.54	2.87	18.8
Berry Size	0.50	3.01	16.4
Berry Shrivel	0.34	1.42	23.8
Pulp Desc.	0.28	2.59	10.9
Flavour	0.34	2.99	11.3
S/A Balance	0.44	1.91	23.1
Exposure	0.33	1.38	23.7
Variability	0.39	1.64	23.5
Light Cond.	0.62	3.98	15.6
Leaf Layer	0.51	4.04	12.7
Lignification	0.43	3.88	11.1
Cropload	0.25	2.00	12.6
Chewiness	0.23	2.44	9.5
Tannin	0.24	2.30	10.3
Colour	0.41	2.50	16.5

Simply, the greater the variation depicted in the right hand column the more variable this measured item will be between sites in a vineplot.

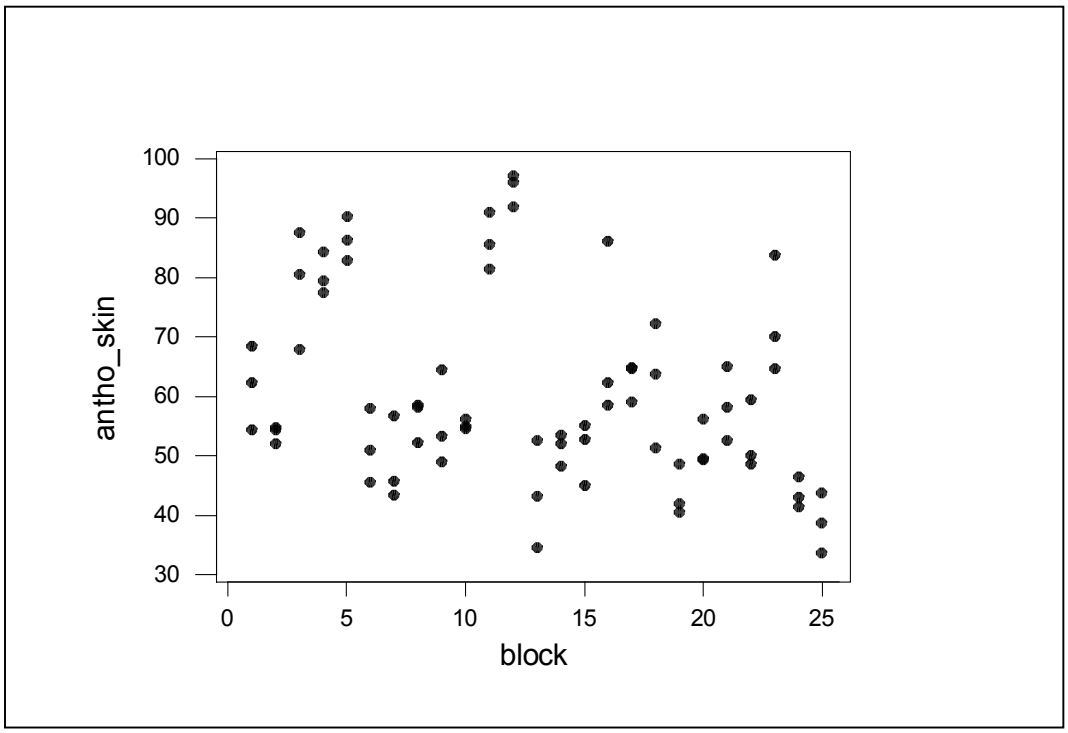
A good way of depicting variation is to plot the variation visually, as shown below. The number across the bottom (x-axis) simply represents one vineplot. The vertical (y-axis) shows the three values form the three sites and how variable they are. This specific diagram shows varying berry weight between the three sampling sites.



From this diagram there would only appear to be a couple of vineyards with Berry Weight uniform enough to select a single sampling site.



This diagram shows the ratio of skin weight to berry weight at each site for 25 vineplots. The data shows enormous variation between sites, typically around 3 % difference.



This diagram represents the concentration of anthocyanin (red colour) in the berries and illustrates the variation between sites in a vineyard.

From this simple investigation it is clear that a number of samples are required to be taken randomly from within each vineplot or management unit. These trends would indicate that if one area by itself were to be assessed the results would not accurately represent what was happening on the vineplot as a whole. Sampling for quality requires assessment at a number of sites.

Bendigo Growers assessing a vineyard pre-harvest.

Vineyard Assessment and Wine Quality.

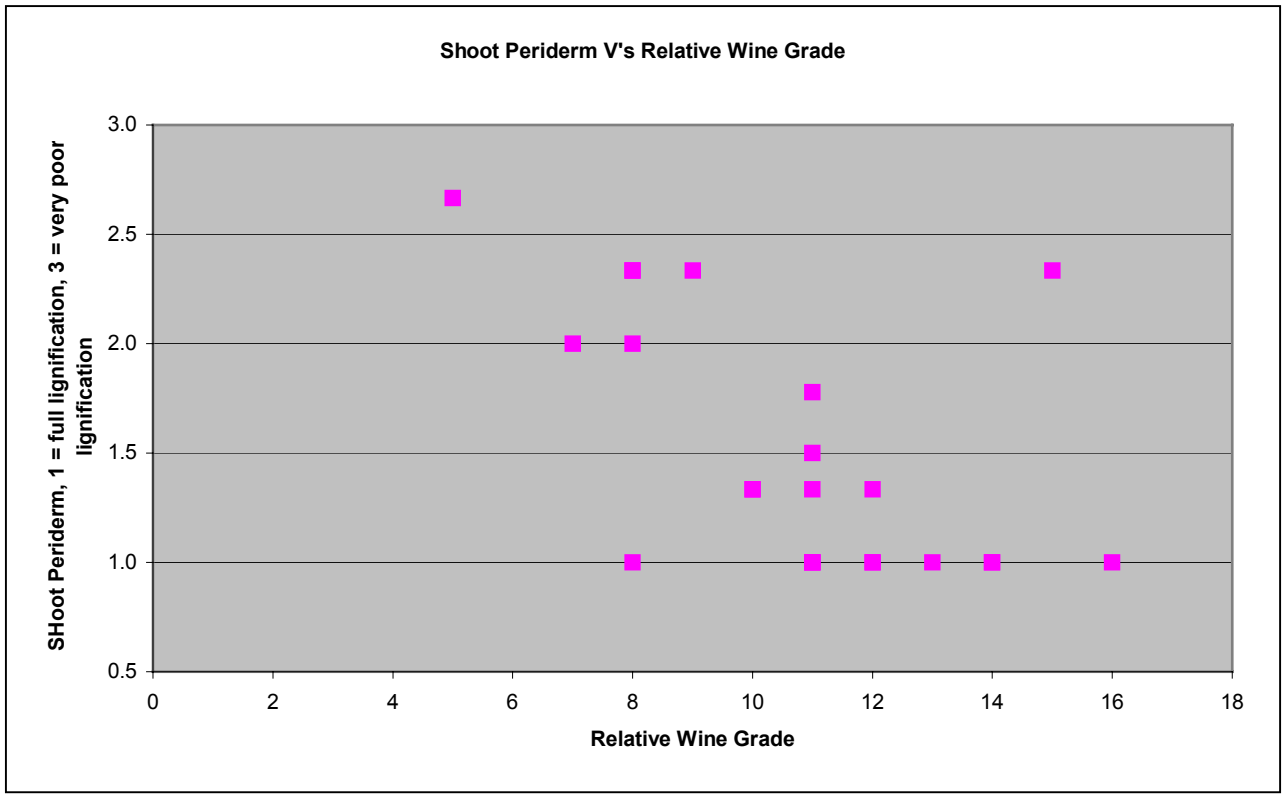
The key aspect of our vineyard assessment sheets was to have some way of quantifying important parameters to benchmark performance. Simple and quantifiable aspects of vine assessments can be valuable tools in obtaining a higher quality product.

Vine Parameter	Correlation with Final wine grade
Shoot Length	-0.10
Lateral 1st 8	0.01
Lateral 2nd 8	-0.46
Shoot Periderm	-0.72
Leaf Condition	0.19
Berry Size	-0.66
Berry Shrivel	0.36
Pulp Desc.	-0.12
Flavour	-0.61
S/A Balance	-0.39
Exposure	-0.31
Variability	-0.55
Light Cond.	-0.25
Leaf Layer	0.00
Lignification	-0.07
Cropload	0.10
Chewiness	-0.42
Tannin	-0.59
Colour	-0.63

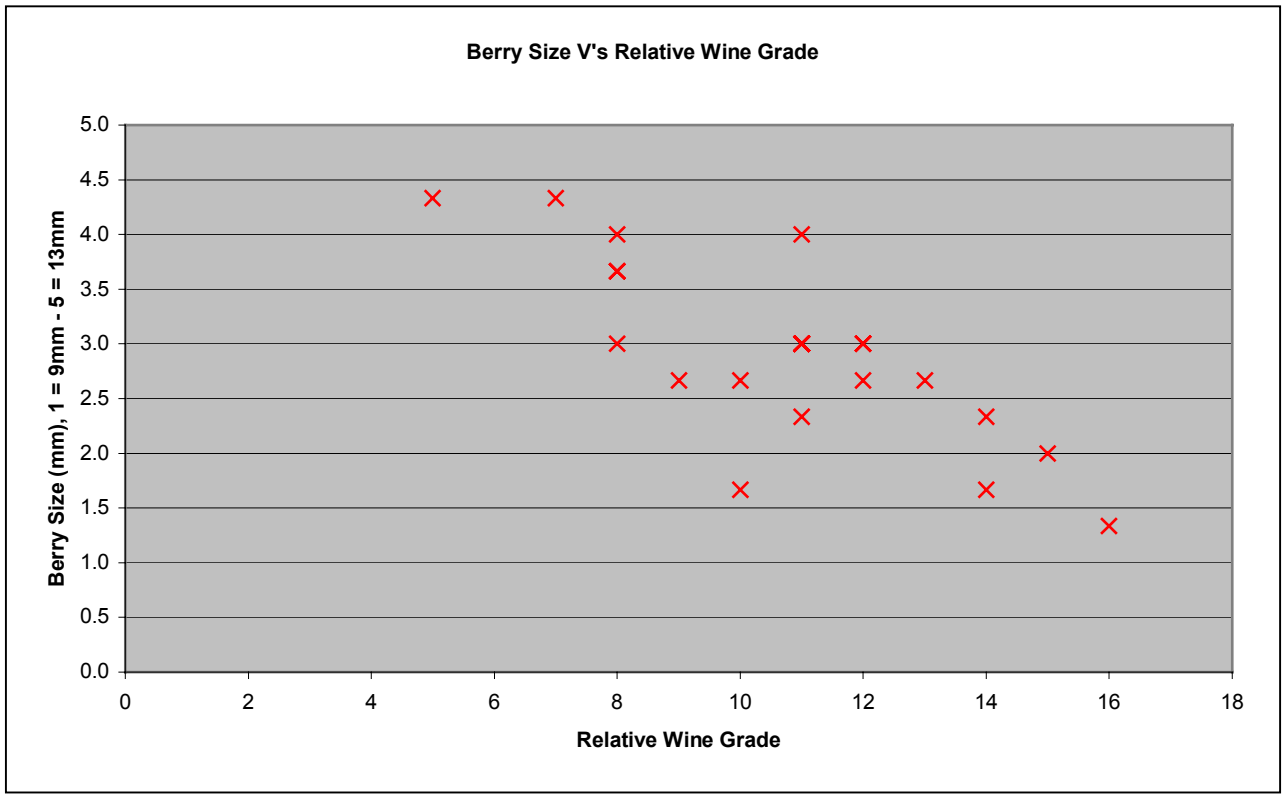
This table shows which of the vineyard characteristics were important in influencing wine quality. The correlation figure represents how strongly individual characteristics were influencing wine quality, there are also likely to be inter-relationships where some variables are strongly associated with others. The figures with the higher correlation value states that as the wine grade increases the so does the quantity of the measured parameter. The important parameters have been highlighted with shades of red. Shoot Periderm and Berry Size were the two most influential parameters associated with wine quality.

These can be simply and objectively used by vignerons to indicate likely quality potential. Periderm development on shoot is likely to be a good indicator as it gives information on the management of the vineyard over the season. Vineplots that have been well managed, vigour controlled, appropriate stresses applied and good water management used will have well lignified canes at the end of the season. Berry size is also a reflection of management's influence on the crop, in particular irrigation.

Negative correlations in the table imply that the nomenclature system used on the assessment sheets was back to front. For example as shoot periderm was decreased, it received a higher score. These positive and negative correlations can be deciphered by looking at the vineyard assessment sheets.



This graph illustrates that vines with fully lignified canes are far more likely to receive a higher wine grade than canes that are poorly lignified.



This graph shows that there is a trend with berry size and wine quality, in that decreasing berry size is likely to give a higher wine quality. This stands to reason as berry size also reveals details of water management during the season and imposing stress at the appropriate times.

Berry Assessment and Wine Quality.

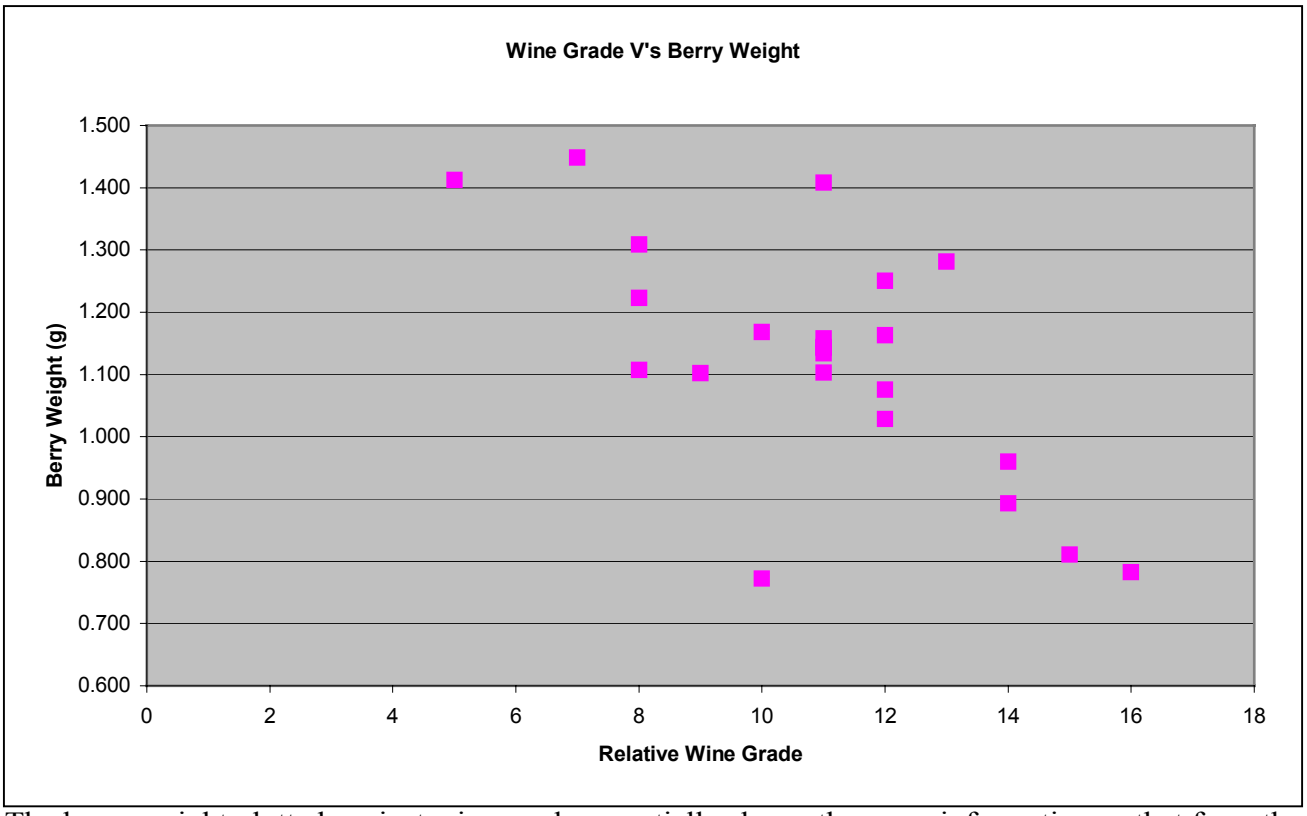
The berry measures are the heart of our aim at objectively determining wine quality. The measures are repeatable, accurate and give relevant information pertaining to wine quality.

We based our wine quality prediction models on the Berry analysis as these results are objective, repeatable and available prior to harvest (just).

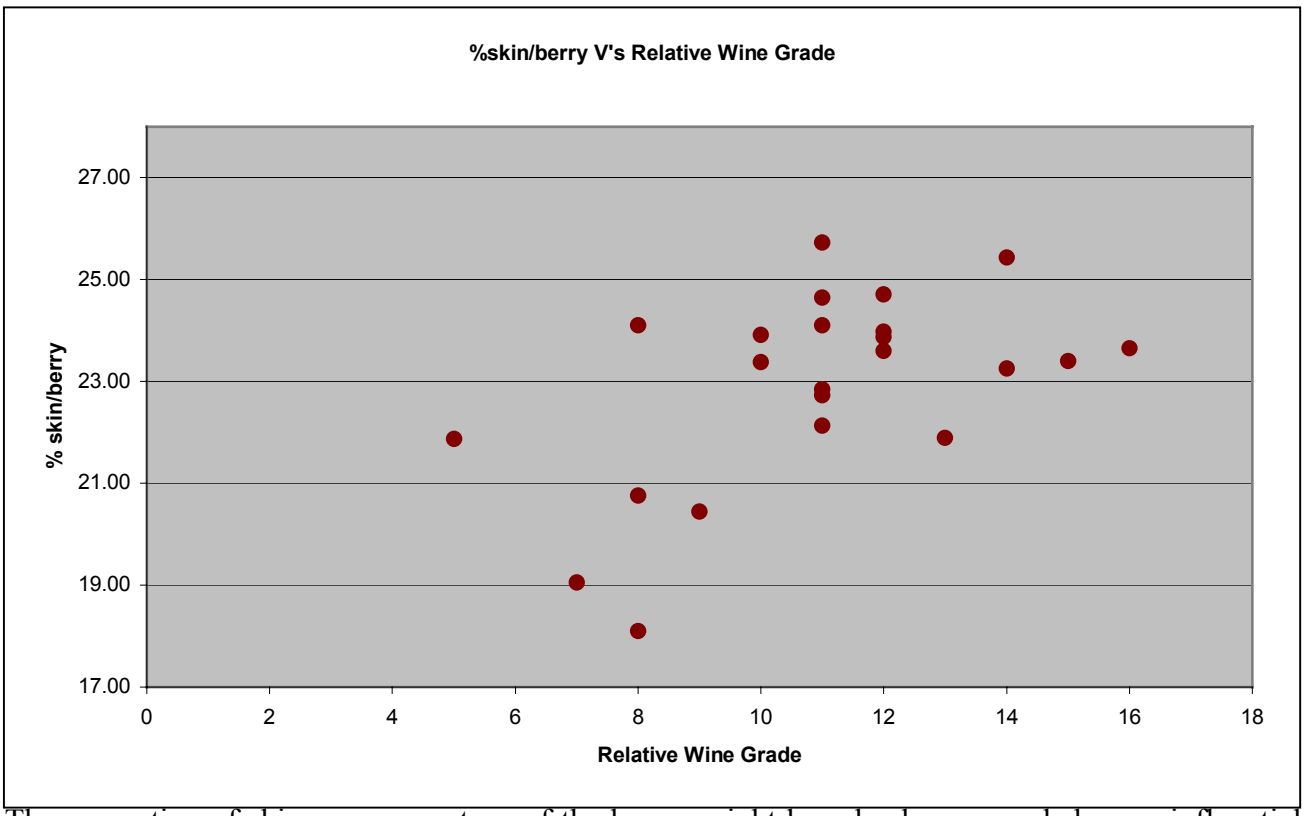
Berry Parameter	Correlation with final wine grade
mean berry weight	-0.67
mean skin weight	-0.38
mean seed weight	-0.20
mean juice weight	-0.71
mean %skin/berry	0.60
mean %seed / berry	0.51
mean %juice / berry	-0.67
mean baume	0.00
mean antho skin	0.68
mean phenol skin	0.59
mean phenol seed	0.36

It is quite intriguing of this data set that most of the aspects measured show some correlation to the final wine quality, the obvious exceptions being seed weight and Baumé. Some of these measures are in fact correlated to each other such as the weights, where the sum of the components equals one, i.e. total berry weight. There also is a strong link between the concentration of phenol and anthocyanin in the skins.

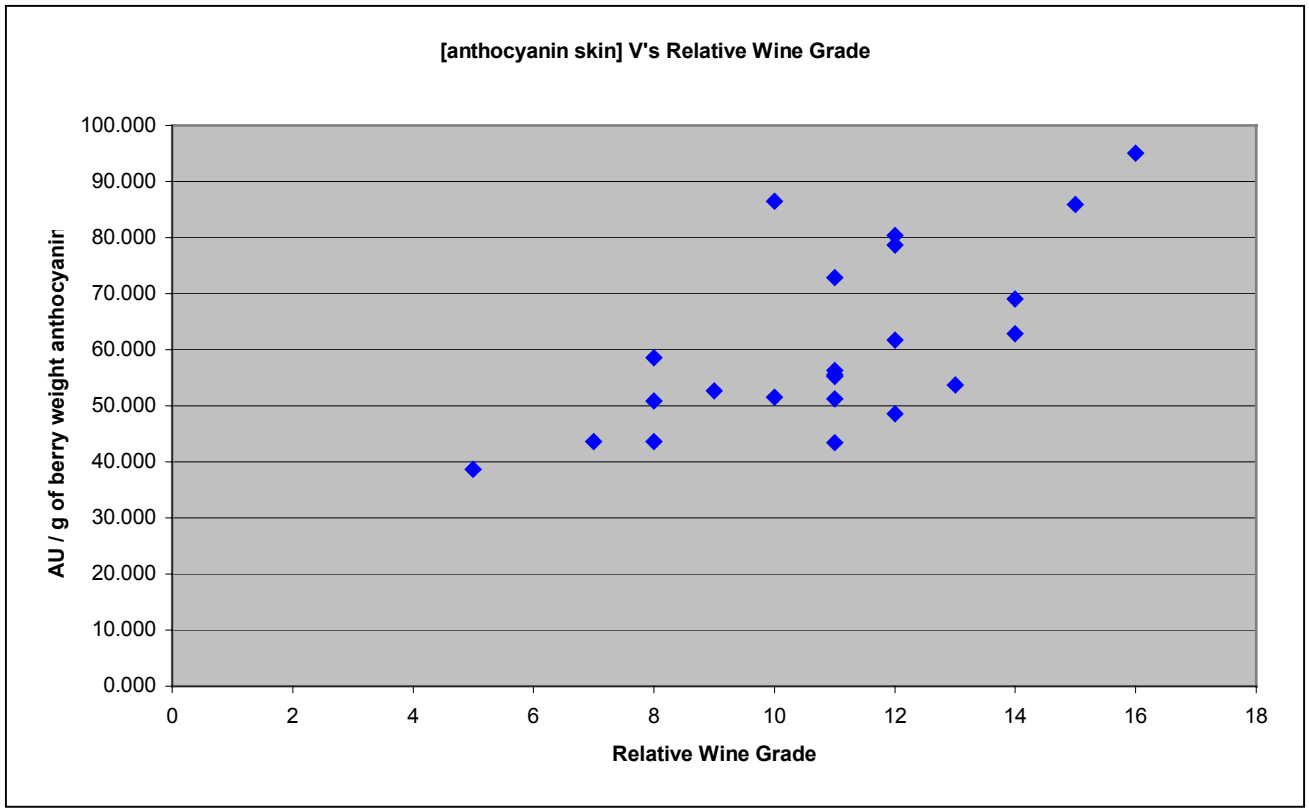
Negative correlations on this table represent (for example) that as berry weight increased the wine grade decreased. Positive correlations show that as (for example # 2) %skin to berry increases so does the final wine grade.



The berry weight plotted against wine grade essentially shows the same information as that from the vineyard assessments where berry size (mm) was plotted against grade. As berry size increases the general trend is that wine quality decreases. This is useful as it objectively assesses what was a subjective assessment.



The proportion of skin as a percentage of the berry weight has also been revealed as an influential precursor to quality, this is likely to be linked to berry size and weight. The berry samples possessing a higher percentage of skin of their weight were likely to produce better wine.



Absorbance Units per gram of berry weight against the Relative Wine Grade shows a basic and expected correlation. Wines of higher colour are generally regarded to be of better quality.

Predicting Wine Quality.

With the utilisation of objective grape composition measures, the ultimate goal is then to predict in advance the resulting wine quality.

With only a small set of data from a single season, it was not our objective to draw conclusive results for objective quality prediction. However the predictions we can make from the measurement taken would illustrate that our research is in the right direction as a great deal of the variability can be explained with our objective measures.

There have been two models used to predict wine quality from the berry analysis, one a linear model simply using the concentration of anthocyanin in the skin. The second a quadratic model using as predictors, phenol in the skin and the ratio of skin to berry.

The statistical research did not use Vineyard Assessments to formulate a prediction model, nor a combination of vineyard parameters and berry analysis. It would hold to reason that the more explanatory variables we include in the prediction, the more accurately we can predict wine quality. We intend to research these relationships in greater detail in the future.

All modelling uses the average spectral and mass measures from the three sites in the vineyard against the relative wine grade, which is our example ranges between 5 and 16.

The first prediction equation shows that we can explain approximately 43.9% of the variation simply by looking at the anthocyanin concentration in the skins.

```
The regression equation is
Final wine grade = 4.25 + 0.114 x [anthocyanin in skin]

23 cases used 2 cases contain missing values

Predictor        Coef       StDev          T        P
Constant        4.248       1.674       2.54    0.019
mean ant      0.11408     0.02674       4.27    0.000

S = 1.965       R-Sq = 46.4%     R-Sq(adj) = 43.9%
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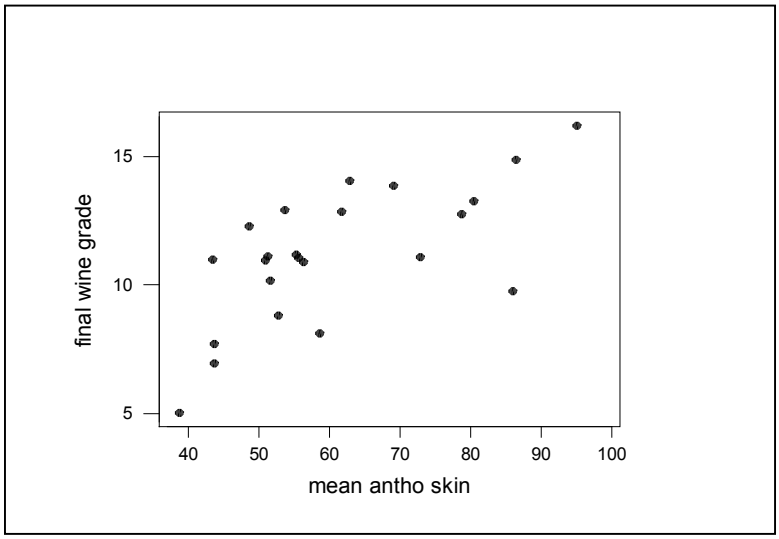

The r-sq of 46% indicates a reasonable fit of the model although the graph indicates that there is still a reasonable amount of variation not explained by the model. For reasonable prediction values of r-sq around 80% are usually regarded as being reasonable, although this of course depends on what the intended use of the prediction is.

Quite a good three-predictor model was obtained with an adjusted r-sq of 68.1%. This model is based on the %skin/berry, and the skin phenol and the square of the skin phenol. The following is the output from this model

```
The regression equation is
Final wine grade = - 24.5 + 0.492 x (%skin/berry) + 0.692 [phenol
in skin] - 0.00453 x [phenol in skin]^2

23 cases used 2 cases contain missing values

Predictor        Coef       StDev          T        P
Constant      -24.461       6.055      -4.04    0.001
mean %sk       0.4918      0.1802       2.73    0.013
mean phe       0.6920      0.1893       3.66    0.002
mean phe    -0.004529    0.001389      -3.26    0.004

S = 1.481       R-Sq = 72.5%     R-Sq(adj) = 68.1%
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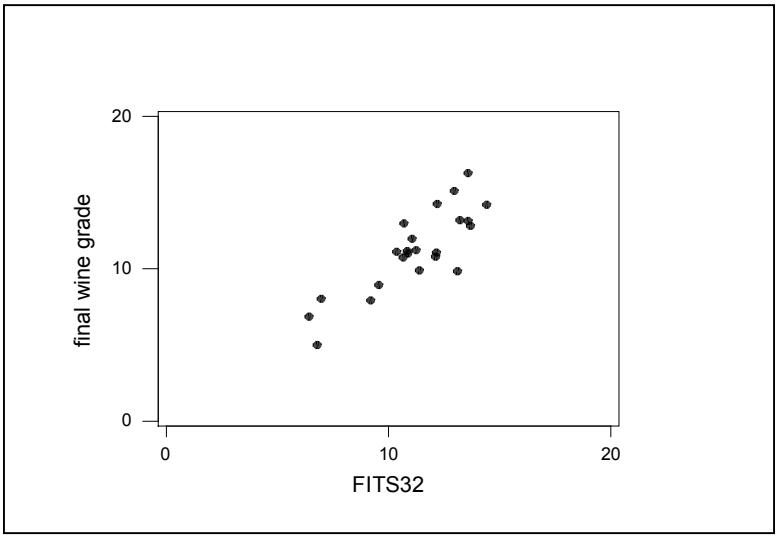
The following plot shows final wine grade v's predicted wine grade for this model. There is a good correlation with an R-squared value of .68, which indicates that we can explain much of the wine grade with our measures of phenolics and ratio of skin to berry.



The table below illustrates the Predicted wine grade against the actual wine grade.

Actual Wine Grade	Predicted Wine Grade	Difference
13	13.2	-0.2
13	10.7	2.3
13	13.6	-0.6
13	13.7	-0.7
15	12.9	2.1
10	11.4	-1.4
12	11.1	0.9
11	11.2	-0.2
11	12.1	-1.1
11	10.9	0.1
10	13.1	-3.1
16	13.6	2.4
11	10.4	0.6
11	12.1	-1.1
11	10.7	0.3
14	14.4	-0.4
14	12.2	1.8
7	6.4	0.6
8	9.2	-1.2
9	9.6	-0.6
11	10.8	0.2
8	7.0	1.0
5	6.8	-1.8

It is clear that for the vineyards sampled in the 2002 Vintage we can explain much of the variation and attribute wine quality to a number of measurable factors.

Budget Report.

The financial report depicted here will be indicative only at the time of printing. It is anticipated that all funds from GWRDC will be required to complete our report printing, and debriefing session. These figures have been estimated in this budget.

WINE GRAPE QUALITY MEASUREMENT AND BENCHMARKING GROUP

RITA Project RT 01/27-3

		GWRDC Budget	GWRDC Expenditure	Date
Statistical Analysis		2000	1745.46	Sep-02
Grape Berry Analysis Subsidy to Growers		3500	3182	May-02
Viticultural Field Assessment		2000	1725	Jun-02
Experiment Advice on Project		3000	3500	Oct-02
Printing & Distribution of Reports		500	740	Sep-02
Data collection & report writing		2000	1532.17	Oct-02
Bank Account Fees			7.5	
Travel & Accommodation			568.05	Oct-02
Season Debrief Meeting			700	Oct-02
Miscellaneous		700		
		13700	13700	
	plus GST	**15070**	**15070**	

Conclusions:

This research project involving benchmarking and objective quality determination techniques, cannot be completed in a single season and encompass all viticultural regions. Data for drawing conclusive results, if only for a particular region must be comprehensive. Our project is not comprehensive within regions and conclusive results unobtainable from a single seasons data. We have obtained some indicative trends relating to simple quality measures in vineyards and highlighted the great potential for objective quality measurement of Shiraz wine grapes.

Benchmarking:

Using the research and analysis of results this season from the Bendigo, Gundagai and Swan Hill regions we have discovered two important objective indicators of quality, i.e. Shoot periderm development and Berry Size. There is also the benefit in that vineyards within these regions are able to determine how they are performing against their neighbours.

The two-benchmark indicators that have settled out in this project are likely to hold a great deal of information within their simple exterior. Both Periderm Development of shoots and Berry size are likely to reveal how the crop was managed during the season with respect to water management and applying appropriate levels of stress to Shiraz Wine Grapes. Vines that have had vigour controlled early in the season, appropriate levels of light exposure, some stress applied to control lateral shoot growth and initiate lignification will have good shoot periderm development and small berries. These two points give a simple summary of what happened to the vines during the season.

Objective Quality Measurement:

Our research project has highlighted some pleasing relationships with potential for objective quality measurement of Shiraz wine grapes. There were pleasing relationships discovered between both wine quality and vineyard assessments and in particular wine quality and the objective mass and spectral analysis from Myrrhee Consulting Services. It can also be concluded that the phenolic and anthocyanin measures are strongly correlated with each other, however and more importantly, either of these measures and wine quality are positively correlated. More comprehensive relationships and predictive modelling can be achieved by including additional information such as the percentage of skin as part of the berry. The most interesting fact in this exercise is that although it is very hard to draw conclusive results with a small dataset from a single season, the amount of variation within wine quality that can be explained by our analysis suggests that our research is comprehensive and accurate, and in time will be conclusive.

Debriefing Sessions:

With the completion of this report we anticipate holding a debriefing session to discuss with the growers the implications of our research, to enable a better understanding of quality and the manipulation thereof in the vineyard. This session will be integral to the process as we can observe the positive and negative aspects of the project and hopefully enable all growers to highlight aspects of their production system that require refinement to achieve higher quality wine grapes.

Future Research:

With the results we have obtained and the correlations found, it is clear that there is potential for expanding and continuing this project. In particular it is anticipated that the following items will lead to more comprehensive analysis and understanding of quality and management thereof:

1. **Sample Size.** It is hoped for the 2003 vintage with appropriate funding from GWRDC to include a group from the Perricoota wine region near Moama in southern NSW. This will allow a more comprehensive sample size and broader range of results for benchmarking.

2. **Small Lot Winemaking.** To comprehensively understand the quality of wine, we believe it is imperative to track 'quality' right through the production process. In order to do this we will again try to correlate our three components of quality. 1. Vineyard Assessment, 2. Berry Analysis and 3. Wine Quality Determination. With the use of small lot winemaking procedures. Preliminary discussions with the National Wine and Grape Industry Centre in Wagga Wagga, suggest that this task can be comprehensively and accurately completed for the 2003 vintage. In determining wine quality we will assess a number of factors, 1. Expert tasting panel and wine scores, 2. Photometric analysis by Myrrhee Consulting Services, 3. Detailed investigation of Tannin distribution of wine samples, and finally a commercial appraisal of the wine samples.

3. **Statistical Analysis.** In the analysis of data for the 2003 vintage there are a number of aspects that would be worthy of further investigation. This includes the combined use of berry and vine characteristics to predict grape quality, tracing flavour components through to the wine samples, benchmarking indicators for the 2003 vintage and of course more work on our predictive model of quality determination.

Use of Information:

Increased understanding of various crop factors and quality components should be shared with other regions. Not only to share the benefits of our research but also the benefits of collaborative research within regions.

There has already been some interest expressed among the Grapecheque network to use our data, wine samples and results in a workshop setting with regional grower groups. By sharing our experience and information we anticipate the inclusion of additional regions in our project.

Acknowledgments:

We would like to acknowledge the following people and organisations as integral to the success of this project:

Brenton Dansie.

Patrick Iland.

Lake Marmal Vineyards.

Myrrhee Consulting Services.

Southcorp Wines. In particular Les Banbury and Michael Schruers.

Regional Group Co-coordinators – John Ward of Bulga Wines and Pete Morath from Gundagai Vineyards were integral in their regions for instructing, collecting and organising growers, berry samples and vineyard assessments.

GWRDC –Fiona Wigg and Deann Glen.

Participating Vineyards:
Bulga Wine Estates, Swan Hill. VIC.
Duralgai Horticulture, Lake Boga. VIC.
Gundagai Vineyards, Gundagai. NSW
Hackett's, Goodnight. NSW.
Hillendale Estate, Tooleybuc, NSW.
Kyeamba Creek, Tumbarumba. NSW
Lake Marmal Vineyards, Lake Marmal. VIC.
Meilman, Euston. NSW.
Mt Moolort, Carisbrook. VIC.
Ormonhill, Rochester. VIC.
Prospect Hill, Bagshot. VIC.
Tipperary Park, Raywood. VIC.

In particular Ross Polglase and Mark Smith for their countless hours spent on the project.

Appendices:

1. Table of Relative Wine Grades used in the analysis of results.
2. Graph of Regional Wine Grades and Yields.
3. Table of Berry Analysis Data.
4. Table Vineyard Characteristic Data.
5. Copy of Vineyard Assessment Sheets.

Relative Wine Grades Table

Graph of Regional Distribution of Wine Grades

Berry Data Set

Vineyard Data Set

Vineyard Assessment Sheets