Marlborough

Manual for Yield Assessments

Prepared by the Marlborough Focus Vineyard

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Manual for yield forecasting in Sauvignon Blanc grapes.

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Introduction

One of the challenges for the grape industry identified by the Focus Vineyard group is the low accuracy of yield forecasting. Yield forecasting is important for determining future plantings in our fast-growing industry. In the shorter term, there is the necessity for wineries to be able to start the harvest season with some estimate of the tonnage they can expect. Some wineries are already penalising surplus production per hectare with a reduction in the price paid per tonne. Overseas, in areas of over-production, often only the contracted tonnage is bought and the balance is left on the vines or harvested but not purchased.

Most importantly, the New Zealand industry must continue to produce high quality wines that command premium prices internationally. Each vineyard has an optimum production level for the market segment at which the wine is aimed. Mediocre wine cannot be sold as a premium just because it is called Marlborough Sauvignon Blanc.

Some reliable methods for early season yield predictions are needed. At that early stage, crop adjustments are still possible, not overly expensive and can contribute to improving the fruit that is left on the vine. Dropping fruit two weeks before harvest is a waste of resources.

Several methods for yield forecasting are being used around the Marlborough district, not all of them user-friendly.

There is no perfect method, as there are many variables that play a role in determining the size of a crop. Consistency of approach throughout the district will allow feedback to the Marlborough Research Centre, to improve the method further.

The proposed yield forecasting method has been put together after consultation with the majority of the Marlborough wine industry. The system must be sound, but also user-friendly for the staff doing the field monitoring and for the vineyard owners. The ideal situation is where the cost of monitoring is less than the costs that are imposed if the estimates are wrong.

We propose a combination of prediction parameters, based on environmental conditions and field monitoring where the vines give us some early indicators:

1. Temperature and exposure to light during bud initiation
2. The number of nodes laid down at pruning time
3. The number of inflorescences per vine
4. The climatic conditions during flowering

5. The number and weight of bunches, together with the average berry weight at veraison
6. The number and weight of bunches, together with the average berry weight just before harvest
7. The use of a potential cropping factor to allow for carbohydrate storage.

Temperature at initiation is being recorded across Marlborough. Most of this work will be carried out by us at the research Centre and we can provide this information to producers for crop prediction purposes.

The first important practical indicator for the size of the crop is the number of nodes laid down. These should be counted at pruning (do not rely on pruning gangs) but could still be counted at a later stage as long as all nodes are counted, including the ones with the blind buds. Double buds or head shoots should not be included. Only the nodes that start at least one finger thickness (1.5 cm) away from the start of the cane should be counted. It is recommended that this counting be done on 40 randomly chosen plots across the whole block. All nodes on all canes that are between two vine trunks should be included. This should take approx. 30-40 minutes per block. Record the number per plot, not per cane.

How to sample?

Good sampling is the most important aspect of yield prediction. There are several ways to approach this. The Australian Dunn & Martin model requires that block details relating to rows, bays and vine numbers be entered into the programme. The programme then calculates where you should randomly sample and how many samples you should take. This assumes that with sufficient random samples, you will obtain a good overview of the whole block. Depending on the variability of the data, the programme then tells you whether you have taken enough samples, or if you require more. This is undoubtedly a very sound method but also very intensive, costly and complex. Moreover, the use of the computer programme is complicated. For individual growers we therefore suggest a more user-friendly method, one based on a method developed by Stephen Bradley from Delegat's Wine Estate.

Before sampling, you need to be familiar with the lay-out of the block. To take representative samples of the block, walk (or drive) the rows and randomly choose positions for sampling right across the block. To identify the sample area clearly, it is advised to **sample from trunk to trunk**.

The measurements from these two half-vines do not have to be kept separate. This method avoids the time-consuming separation of overlapping shoots from neighbouring vines.

When we choose vines for sampling, we are likely to be biased and we will keep adjusting our choice based on the last few vines, rather than the overall picture. To avoid this bias it is recommended to decide on a particular row, bay and vine before you can see it, even if it turns out to be a replanted vine from last year. By sampling two half-vines, the one-year-old vine counts only for half of one sample. If the next randomly chosen vine is again only one-year-old, you obviously have many one year old vines.

Set the **sample size at 40 plots.** For an average block that is longer than it is wide, we would advise four passes through the block, sampling randomly on both sides of the inter-row, five samples from each side (4 x 2 x 5 = 40). For really long and narrow blocks, the number of passes could be reduced to two, with 10 samples from each row (2 x 2 x 10); for really wide and short blocks, use six to eight passes. Forty measurements give acceptable levels of accuracy for a block of 5 ha or more. Smaller comparable blocks (comparable in age, variety, rootstock, soil type) could be combined. Always make sure that specific parts of the block that are different are represented proportionally in the sampling.

Record the plots you are sampling (row and bay) and return to these plots for all other measurements during the season. These plots will therefore have to be **clearly marked** to enable them to be clearly identified each time.
The number of vineyard blocks you sample depends on how accurate you want your data to be for the whole vineyard. We suggest that for the first year, four or five blocks would be sufficient.

How to record for future reference?

The most important aspect of yield forecasting is being able to compare within years and between years. Each year it is important to compare the early data (node counts, inflorescence count, etc.) with the final yield data. Moreover, to assess the increase in accuracy of forecasting over the course of several years.

It is essential to keep good records (Table 1).
For easy comparison and calculations, recording the data in Microsoft® Excel is ideal. However, accurate, permanent records in any form will do. Use a hardcover exercise book for recording the data in the field. Back in the office; enter the data in any spreadsheet programme for calculations of means and comparisons between measurements.

Have separate sheets for each block and clearly mark the date, vineyard (variety, rootstock), block number, acreage, rows and bays, vine and row distance (to calculate vines/ha) (Table 1). On the same sheet, you can enter all other measurements for this season for each individual block.

Table 1: Example of vineyard record keeping for yield forecasting.

Rowley Vineyard
Variety: **Sauvignon b** Block: **E** Area: **4.3 ha** Spacing: **1.8 * 2.4**

		Date:	12/Sep/06	02/Nov/06	02/Nov/06	21/Jan/07			
Plot	Row	Bay	Nodes	Inflorescence	Shoots				
1	123	5	43	67					
2	123	26	40	75					
3	128	16	39	79					
4	128	30	46	80					
5	135	2	50	83					

In the same way as counting the number of nodes laid down per 2 half-vines; count the total number of inflorescences per 2 half-vines. At the end of October or early November, the inflorescences are clearly visible. At this time, there are not yet too many leaves to hide them, and shoots from different vines are not yet running across each other. This is the best time to count inflorescence numbers, although it is labour-intensive, and will take about 1.5 hour per block. To check on the node count, do a quick shoot count as the inflorescences are counted; this will give an idea of actual shoots compared with count shoots.

Which yield parameters to measure?

In yield forecasting, all kinds of assumptions are made that may be or may not be true for your particular situation. The yield at harvest time is tonnes/ha. This is where the first problem starts: per ha of what? There is a discrepancy in the vineyard hectares in Marlborough between the Marlborough District Council (MDC) maps and the New Zealand Wine Growers' survey. The MDC is interested in the total ha per vineyard, producing or not, while NZWG are interested in actual producing hectares. While this difference may not be much for big vineyards, for small vineyards they can be considerable.

In the case of yield forecasting, it is therefore important to know accurately the number of hectares producing. There are several ways of expressing this. In the past, this was generally expressed in hectares, with the vine and row distance given. For example:

1.8 m vine spacing and 2.4 m row spacing creates an individual vine area of 4.32 m^2 or 2315 vines per ha. i.e. 10,000 m^2 in a hectare divided by 4.32 $m^{2\ per}$ vine = 2315 vines per hectare

Nowadays, more and more companies are talking about metres of vine-row per hectare. In the previous example, with vine spacing of 1.8 m and 2315 vines per hectare:

2315 vines per hectare * 1.8 m spacing = 4167 m vine row per hectare.

Obviously the metres of vine row per hectare change as the distance between rows changes. Changing the vine spacing within a row does not change the metres of vine row per hectare (e.g. with vines planted at 1.8 m, this would again give us 2315 vines per ha. However, if vines are planted closer, say 1 m apart, there would be 4167 vines per ha with the same metres of vine-row.
The planted area in the vineyard can be accurately assessed at any time by simply counting the rows and vines per row. Working this out requires some work and we want to do that only once, preferably at planting, and keep these records in a safe place.

What is the average yield per vine?

Eq 1

Yield = berry weight * berries/bunch * bunches/shoot * shoots/vine * vines/ha

A ***B*** ***C*** ***D*** ***E***

The average number of berries/bunch depends on the conditions during flowering. Under optimum conditions all flowers will be pollinated and produce berries with at least two seeds. The more seeds, the bigger the berry. Hence the average weight of bunches depends on the number of berries and the average weight of these berries. The number of bunches depends on the number of inflorescences on each vine and hence on the weather conditions during initiation. For Sauvignon Blanc, although some shoots will produce even three inflorescences, mostly the average number will be fewer than 2 per shoot. That leaves us with the number of shoots that the vine is producing. Here at least is one parameter over which we have some control at pruning time, by knowing the number of nodes laid down. Without measurements, we have to make assumptions for all the other parameters. But even the number of nodes laid down does not provide an accurate figure for the number of shoots a vine will develop. Depending on environmental conditions, the previous year's crop-load and hence the carbohydrate reserves in the vine at the time of bud-break, the vine can grow more or fewer shoots than the number of nodes laid down. We have to compensate for that with knowledge of the previous year's yield and environmental conditions at bud-break.

The figures in the following examples are real. In one vineyard, we found these variations in yield parameters. The variations per vine can be huge, as shown in Table 2. We know the vines planted per ha but are they all still there? What will be the actual average yield per ha? Are there assumptions based on long-term averages needed for factors we cannot measure, such as a percentage of fruit left around the post and dropping at harvest?

Table 2: Actual values illustrating the wide distribution of yield measurements within one vineyard.

	Node #per vine	Shoot #per vine	Bunches per shoot	Berry #per bunch	Average berry weight	Yield / vine (kg)	Vines / ha	Yield / ha (kg)
minimum	38	35	1	32	0.3	0.34		
mean	41	46	1.6	84	1.4	8.66		
maximum	49	54	1.85	110	1.6	17.58		
See Eq 1		D x	C x	B x	A x		E =	Yield

To be as accurate as possible with yield forecast per ha, we must actually measure the most important parameters.

Measuring bunch and berry weights

Counting flowers on each inflorescence could give us an idea about fruitfulness. I have counted about 30 inflorescences and came to a flower number of between 150 and 300 per inflorescence at the Rowley Crescent Vineyard, but 200-400 at Squire Estate Vineyard. However, counting is very time-consuming and should not become part of a standard yield forecasting protocol. However, it shows that many flowers do not develop into berries as berry counts generally do not exceed 150 berries per bunch in Sauvignon Blanc while berries per bunch vary between 45 and 65 for different vineyards. However, even counting berries is pretty tiresome and off-putting. We therefore use statistical predictions for the number of berries and the berry weight.

In case the terms inflorescence and bunch are confusing, inflorescence normally refers to a developing bunch up to and including flowering, and then after fruit set it is referred to as a bunch.

In order to be able to use counting and weighing data for future reference, it is important to make these measurements at a predetermined, clearly identifiable time. Veraison is a good time. This can obviously be more clearly identified in red grape varieties, but even in white varieties one can identify veraison approximately.

For measurements at veraison, we return to the plots identified earlier, where we counted the buds laid down and the inflorescences per vine. In these same plots, we choose a shoot on a vine randomly. It is very important that this shoot is chosen randomly anywhere on the vine. Some shoot measurements made on 28 December on 4-cane Sauvignon Blanc vines showed a variation in shoot length from 8 cm to 144 cm. the distribution of shoot lengths is shown in Table 3. In this example, if you choose 40 shoots randomly from 40 vines, you can therefore expect on average to

have two shoots shorter than 10 cm, but 14 shoots between 120 and 140 cm. **DO NOT DISCARD THE SHORT SHOOT DATA** they are part of the sample and show you're the variability in the vineyard.

Table 3: Distribution of shoot lengths on 4-cane pruned Sauvignon Blanc vines.

Length (cm)	*Percentage*	*40 Shoots*
0	0	0
10	5	2
20	0	0
40	5	2
60	5	2
80	0	0
100	10	4
120	30	12
140	35	14
160	10	4
>160	0	0

For these measurements, take into the field a bucket and some scales or a spring balance for weighing, some plastic bags and a marker, as well as pen and paper.

Leave the shoots on the vines but remove ALL bunches. If you want to get an indication of variability within the field, you could weigh the bunches of each of the 40 shoots separately. However, to gain a good idea of the block as a whole, put all bunches from the 40 shoots in the bucket and record the total weight.

Randomly take three berries from each bunch (distribute the sampling randomly over each bunch e.g. top, bottom, middle), put these berries in a bag and take them back for accurate weighing. Weigh the total number of berries you have sampled (3 berries per bunch) from all shoots and hence the individual berry weight can be calculated. Without values from previous years, it is difficult to predict yield, although initially some general values can be used. In this case, the weight of the fruit at veraison is approximately half of the weight at harvest. At harvest, the weight of the rachis is approximately 5% of the bunch weight.

For our yield forecasting, we therefore get the following equations:

Eq 2

$$\frac{\textit{total bunch number}}{\textit{40 shoots}} = \textit{bunches / shoot}$$

Eq 3

$$\frac{\textit{total bunch weight}}{\textit{total bunch number}} = \textit{bunch weight at veraison}$$

Eq 4

$$\frac{\textit{total berry weight (3 berries per bunch sample)}}{\textit{total bunch number} \times \textit{3 (3 berries per bunch)}} = \textit{berry weight at veraison}$$

Eq 5

$$\textit{bunch weight at veraison} \times \frac{\textit{harvest berry weight (previous year)}}{\textit{berry weight at veraison}} = \textit{predicted harvest bunch weight}$$

If you don't know your harvest berry weight from the previous year, use [Equation 6]:

Eq 6

$$\textit{bunch weight at veraison} \times \textit{2} = \textit{predicted harvest bunch weight}$$

To get a more exact bunch weight at harvest time, we should subtract 5% weight for the rachis. At bud-break we have determined the number of vines per ha, the average number of canes laid down per vine and the average number of shoots per cane. The number of inflorescences (future bunches) per vine was counted in early November. Knowing the number of bunches / vine gives us a more accurate calculation than previous information on canes and shoots. Together with the predicted harvest bunch weight, we can calculate the predicted yield per ha:

Eq 7

$$\textit{Vines / ha} \times \textit{bunches / vine} \times \textit{predicted harvest bunch weight} = \textit{Yield / ha}$$

However, if the number of inflorescences was not counted earlier, we now have a reasonable estimate of the number of bunches on a vine, after having counted the number of bunches from 40

shoots and using the other parameters on canes and shoots. The calculation will be less accurate but still quite simple [Equation 8]:

Eq 8

Vines / ha x ***canes / vine*** x ***shoots / cane*** x ***bunches / shoot*** x ***predicted harvest bunch weight = Yield / ha***

Over time and by sampling more blocks, the more we know more about the relationships between the veraison measurements and the final harvest measurements, both for berry weight and for bunch weight the better yield forecasts we will obtain.

Harvest

We have discussed the need for yield forecasting. We discussed the counting of nodes laid down, the number of shoots per vine and bunches per shoot and at veraison, the weighing of bunches and berries (3 per bunch). All this work has to be done just to be able to forecast yield. Now of course there is the 6 million dollar question: **How accurate is our forecasting?** There is only one way to find out: do some more sampling!

Finding the relationship between your last sampling at veraison and the tonnage presented to you on the weigh bill from the winery is difficult. We have first to establish the relationship between the numbers and weights of bunches and berries at veraison, and what they were at harvest. To do that we have to repeat exactly the same measurements made at veraison, using the 40 vines or bays where monitored at veraison, and harvest bunches just a few days before the harvester comes through. Again, weigh the bunches and weigh three berries of each bunch. As discussed before, make sure your sampling of both the bunches and the berries is random. If you want to know the weight of the rachis, weigh about 20 bunches, strip them of their fruit and weigh the rachis. [Equation 9] gives the percentage of bunch weight that is rachis and not berries:

Eq 9

rachis weight / bunch weight x 100% = rachis %

Otherwise, calculate with the rachis weight being 5% of total bunch weight. For yield estimates, you will therefore have to deduct 5% of the weight calculated after weighing the bunches, to obtain the estimated yield.

You need the previous years' harvest berry weights to calculate the predicted harvest bunch weight with [Equation 10]:

Eq 10

$$\textit{bunch weight at veraison} \times \frac{\textit{harvest berry weight}}{\textit{berry weight at veraison}} = \textit{predicted harvest bunch weight}$$

Next year, use the average harvest berry weight from the previous seasons to give a better harvest estimate at the time of veraison.

At harvest, we will have to determine the multiplier factor to be used to predict yields in the future. This should be done by comparing the average berry weights at veraison and at harvest. As more years' data are collected, this value will become increasingly accurate.

The harvest bunch weight will be used to calculate the yield for this season, following [Equation 11]:

Eq 11

Vines / ha x ***bunches / vine*** x ***harvest bunch weight = Yield / ha***

While these fruit are being sampled, take the opportunity to assess the fruit for pests and diseases. Is there any potential risk of *Botrytis*? Any mildew visible, bird damage, berry splitting and will these reduce our yield?

This final yield assessment can now be compared with the actual tonnage delivered to the winery. The two figures will not be the same. However, take note of the difference. Over a number of years, the amount of loss/non-pick at harvest (initially should be set at 5%) can be adjusted to reflect your vineyard more accurately. Significantly high losses at this stage might call for harvester adjustments or even a change of contractor.

Figure 1: Growers collecting bunch and berry data and recording these for yield calculations.

Table 4: Example of record keeping and calculation for Rowley Vineyard.

Rowley Vineyard
Variety: **Sauvignon b** Block: **E** Area: **4.3 ha** Spacing: **1.8 * 2.4**

		Date	12 Sep.	02 Nov.	02 Nov.	15 Feb. (veraison)	15 Feb. (veraison)	3 April (harvest)	3 April (harvest)	3 April (harvest)	3 April (harvest)	10 April
Plot	Row	Bay	Nodes laid down /vine	Inflorescent count /vine	Shoot count /vine	Bunch weight (g)	Berry weight (g)	Bunch weight (g)	Berry weight (g)	Disease loss (%)	Harvest loss (%)	Tonnage delivered
1	123	5	43	67	39	75	0.92	125	1.85			
2	123	26	40	63	74	69	0.89	110	1.92			
3	128	16	39	71	80	58	0.82	101	1.84			
4	128	30	46	78	79	59	0.95	117	1.79			
5	135	2	50	83	78	70	0.79	113	1.90			
etc.												
Total			41	71	76	61	0.89	115	1.89	8%	5%	71.0

Equation 12 is an example worked using the data in Table 4.

Eq 12

Vines / ha x ***bunches /vine*** x ***harvest bunch weight = Yield / ha – Disease/Bird loss – Harvest loss***

10,000/(1.8*2.4 m) x 71 x 0.115 = 18,900 kg – 8% – 5% = 16.5 T/ha x 4.3 ha = 71 tonne

It will be clear that we are suggesting a minimum data recording programme. The more accurate data required, the more intensive sampling is also needed: Take more samples, count more berries for weight, count the actual bunches that develop, and so on.

Actual yield forecasting done at Stembridge Vineyard

Actual measurements taken at the field day and later just before and at harvest, have been used for the calculation of the yield at Stembridge Vineyard (Table 5). All participants at the field day together measured 29 vines. Although some of the measurements should have been made earlier in the year (node count and inflorescence count [=bunches/vine]), measuring them at veraison did not make them less reliable, but only harder to measure. The dates in this table are approximations of the time when the parameters (orange colour) should be measured. All yellow highlighted values are assumed values based on past experience. The calculations change at the time the assumed values become actual measurements. As can be seen, this season the estimate changed over time, but was very accurate already at veraison.

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Table 5: Actual parameters measured (orange cells) during the season and used together with assumed values (yellow cells) to calculate the anticipated yield, and eventually the actual yield of 16 tonne/ha, at Stembridge Vineyard, 2007.

						assumed values							
Date	ACTION	Area (ha)	Vines/ha	Vine #	Node # /vine	Shoot # /vine	Inflorescence /shoot	Bunch wgt (g) at veraison	Berry wgt (g) at veraison	Bunch wgt (g) at harvest	Berry wgt (g) at harvest		Yield (kg)
15/07/2006	Desktop exercise	3,57	1666		40	40	1,8	60	0,9	120	1,9	14 394	51 387
01/09/2006	Pruning	3,57	1666	29	40,0	40	1,8	60	0,9	120	1,9	14 394	51 387
15/10/2006	Node count	3,57	1666	29	40	47,8	1,8	60	0,9	120	1,9	17 201	61 408
15/11/2006	Inflorescence count	3,57	1666	29	40	47,8	1,75	60	0,9	120	1,9	16 723	59 702
20/02/2007	Veraison	3,57	1666	29	40	47,8	1,75	40,96	0,61	120	1,9	17 780	59 702
03/04/2007	Pre-harvest	3,57	1666	29	40	47,8	1,75	40,96	0,61	123,1	1,8	17 155	61 245
05/04/2007	Harvest	3,57	1666	29	40	47,8	1,75	40,96	0,61	123,1	1,8	16 011	57 160