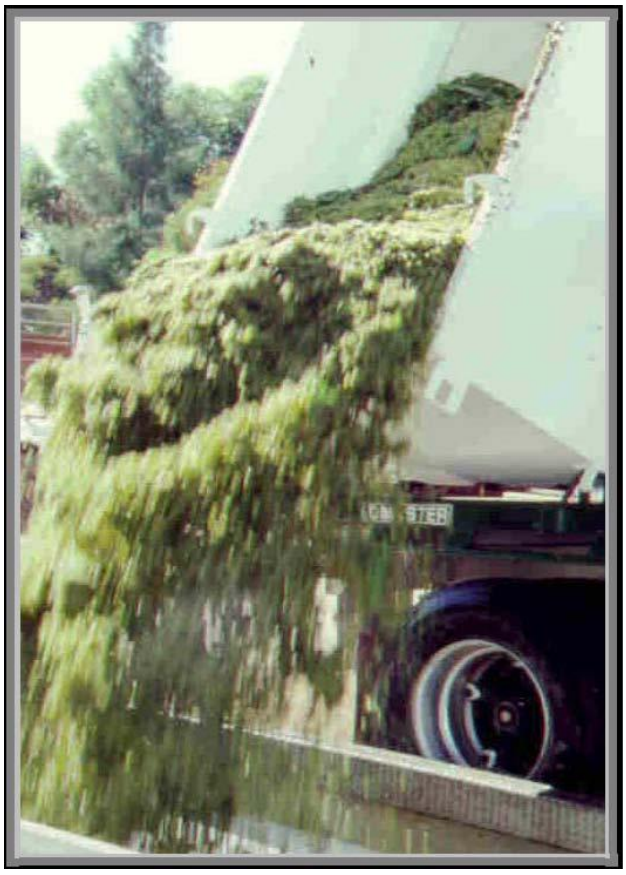
How to forecast

wine grape deliveries



Using Grape Forecaster

State Government Victoria Department of Primary Industries

Grape and Wine Research and Development Corporation

Victoria The Place To Be

How to Forecast Wine Grape Deliveries using Grape Forecaster

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1 Introduction

1.1 Overview

The performance of the Australian wine industry is sensitive to mismatches between expected and actual grape intake. These mismatches generate inefficiencies that result in foregone revenue and extra costs in vineyards, wineries and distribution chains. Winery intake planners seek accurate estimates of likely grape production from vineyard managers at various stages in advance of harvest. However, inaccurate forecasts have been a source of irritation, discontent and conflict throughout the Australian wine industry.

In any grape-growing district in Australia there are some growers who have a subjective 'knack' of supplying accurate forecasts. However, on average, growers supply forecasts that are 33% out. Even experienced vineyard managers who have worked for decades with established patches can find it difficult to forecast production reliably, particularly in patches which where the yield fluctuates greatly from season to season.

A knack developed on one vineyard may not work on another, and the industry needs to be able to train personnel to forecast reliably. Consequently the Grape and Wine Research and Development Corporation (GWRDC) funded the Victorian Department of Natural Resources and Environment (NRE) and the Commonwealth Scientific and Industrial Research Organisation (CSIRO) to develop a reliable, objective, measurement-based crop forecasting system that can be taught to industry personnel. The project, titled '*Crop development, crop estimation and crop control to secure quality and production of major wine grape varieties: A national approach'*, produced a winegrape crop forecasting system for use across Australia.

Introduction

1.2 Introduction to the crop forecasting system

The crop forecasting system and the software described in this manual are designed to produce a series of forecasts for one patch in one season, using objective measurements of yield components. A 'patch' is a group of vine rows that produce the same type of grape and all have the same spacing and vine structure. Forecasts are calculated from measurements made after budburst in the season before harvest. The system does not include techniques for forecasting before budburst.

The system with the Grape Forecaster Software allows forecasters to accumulate valuable historical information about yield components and their variation from year to year.

Key yield components that are measured include:

. • Mean (average) bunches per unit length of vine row

. • Mean number of berries per bunch

. • Mean weight per bunch

. • Mean weight per berry

The accuracy of measurement-based forecasts depends on the accuracy of the inputs to the formulae that are used. In particular, accuracy depends on:

. • Using the correct formula

. • Accurate knowledge of patch dimensions

. • Adequate, unbiased sampling to estimate means of yield components

. • Accurate prediction of components not yet determined at forecasting time

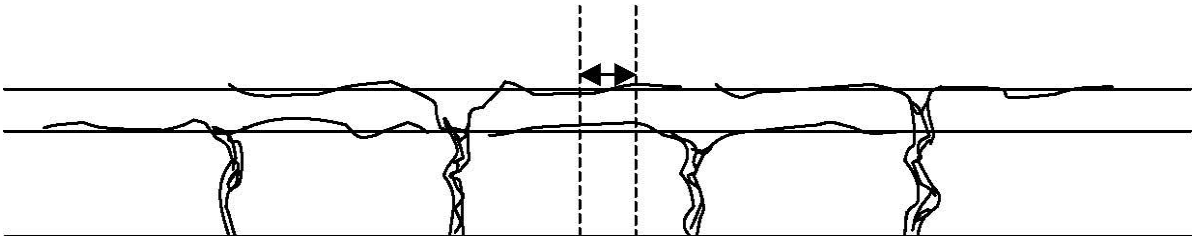
The formulae used in the system are based on generally accepted conventions and also include some new factors. For example, a harvest efficiency factor has been included to allow for how much of the estimated crop on the vine actually gets to the winery.

An accurate knowledge of the dimensions of the patch for which you are going to forecast may seem like an obvious requirement. However, in practice vineyard records are not always accurate or up to date. Allowing for this, one of the first steps of the system is to survey each patch.

The system assists forecasters to eliminate bias and to use reliable numbers in their forecasting calculations. It does this by supporting random selection of things that are measured in the patch and by enabling you to use an appropriate sample size.

Important new features of the system are that it enables forecasters to assemble the information they need to forecast in future seasons. The system also supports performance evaluation and continual improvement.

The forecasting system uses segments of row rather than whole vines as measurement units. A ***segment*** is a ‘slice’ across a vine row, with a known length.



The ideal segment length can vary depending on vine age, training system and pruning type. Recommendations on segment length will be discussed in section 4. By measuring a segment rather than whole vines, the time, difficulty and expense of sampling can be minimised.

As each season progresses, the general approach of the forecasting system is to:

. • Base forecasts on an accurate estimate of bunches per segment

. • Adjust forecasts with estimates of berries per bunch or weight per bunch

. • Fine tune (if necessary) with an estimate of weight per berry

Other features of this system include:

. • Honest quantification of the doubt that surrounds each forecast

. • Statistical evaluation of system performance and continual improvement

Introduction

The forecasting methods described in this manual can be used at a range of times during the season. However, they are usually applied at particular stages. The usual and possible times that the major forecasting activities can be done are summarised in the following table. Each of the activities is related to the sections in this manual.

Activity	***Usual timing***	***Possible times***	***Section***
Patch surveying	When setting up system or if a patch changes	Must be done before anything else	3
Bunch counting	Six weeks after budburst to flowering	Six weeks after budburst to harvest	5
Berry counting	One month after fruit set	One month after fruit set to harvest	6
Bunch weighing	Veraison	Veraison	7
Harvest sampling	Within a week of harvest	Within a week of harvest	8,9,10
Evaluating and analysing	After delivery	After delivery	11

2 Installing Grape Forecaster

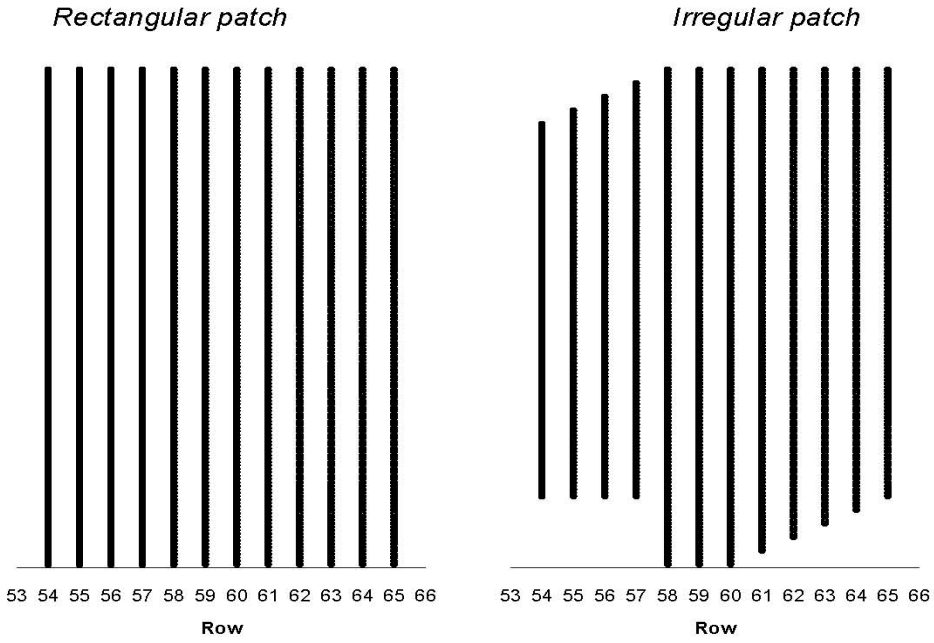
Once you place your Fairport CD in your CD-Rom drive, the CD browser screen and menu for installing all Fairport software programs will automatically appear. Choose to install Grape Forecaster via this menu system. If the CD “autostart” system should fail for some reason, do this,

1. Click on ***Start*** select ***Run***.
2. Type **(CD Drive Letter):\GF\SETUP.EXE** in the ***Open*** box, (eg D:\GF\setup.exe
3. Click “**OK**”

The installation procedure creates the folder called Grapes in the Fairport folder in the Program Files folder (Eg. C:\Program Files\Fairport\Grapes) on your hard disk, then copies the files into that folder. The program files will then be "unpacked" - a process which may take several minutes.

3 Surveying the vineyard

The first step towards accurate forecasts is a survey of the patches of vines that will produce the grapes that will be delivered to the winery. If the information about the size of the patch is incorrect, the forecast will be too. The term 'patch' refers to any area of vines that have the same row spacing, vine spacing and vine structure. Areas of vines with different row or vine spacing or vine training system should be treated as different patches. A patch will usually consist of a group of rows that are next to each other, but may include rows that are separated in space. The workbook allows for patches that are separated in space to be treated as one forecasting unit. There must not be duplicate row numbers. The system works for all patch shapes, whether they are rectangular or irregular.



The information required about each patch includes the:

- Number of rows
- Number of vines in each row
- Row spacing
- Vine spacing

To begin to use the forecasting system, you need to carry out a survey for each patch of vines you are going to forecast. You can do this using a Patch Survey Form that can be printed out from the Reports Menu in Grape Forecaster. When you enter data from the survey in your Grape Forecaster it is used to determine how many vine-spaces are in the patch and the area of the patch. These numbers are used to set up sampling forms and make forecasts.

How to complete a survey of a patch

1. Open the Grape Forecaster and click on the Reports Menu
2. Print out the Patch survey form (print more or copy as needed).
3. On the Patch survey form in the spaces provided record:

. • Name of the vineyard

. • Name of the block the patch is in (if applicable)

. • Name of the patch

. • Row spacing

. • Vine spacing

. • Who carried out the survey

. • Date the survey was carried out

Count the spaces allocated to each vine, not just the vines themselves.

4. In the box provided, sketch a simple plan of the patch.
5. Fill in the table at the bottom of the form.

If the patch does not have the same number of vines in each row, you can break it up into sections. The number of vines in each row in a section should either be the same or increase or decrease steadily from the first to the last row in it. A section could consist of a single row. Label each section with a number. Record the section number, the identifying numbers of the first and last rows and the number of vines in each of these rows into separate lines in the table.

If the patch has the same number of vines in each row, it has only one section. In this case simply record the identifying numbers of the first and last rows and the number of vines in these rows in one line of the table.

NOTE:
While doing the Patch survey you may also complete the Vine Structure form (see Section 4 – Preparing for a Season). This does not have to be done until you are ready to sample, but it is usually convenient to do it when you are in the patch.

When you have completed the survey you can enter the data in your Grape Forecaster.

4 Preparing for a season

The next step towards accurate forecasts is to get ready to make the measurements that the forecasts will be based on. All of these measurements are made by ***sampling***.

The sampling system

A typical patch contains thousands of vines, hundreds of thousands of bunches and millions of berries. It would be impractical to measure or count the entire populations of these things. So we select a ***sample*** to represent the whole population.

The system is designed to work for all types of vine pruning and training. Using the software, you can print out forms that are designed for each type of sampling that you will need to do. These forms specify where you need to make a measurement.

The basic ideas behind the system are:

- The units to be measured are segments and bunches
- The patch is regarded as one long row of vine-spaces
- Each vine-space in the patch has an equal chance of being selected
- Each segment position has an equal chance of being selected.
- Each bunch has an equal chance of being selected

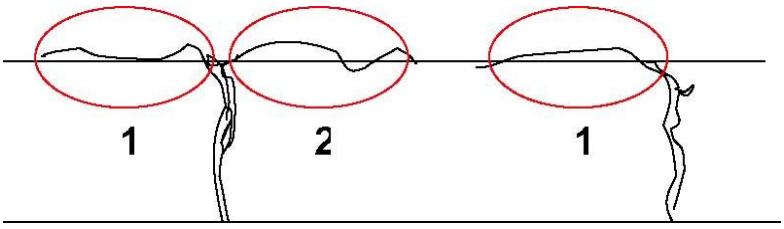
Selecting a position for a segment

A position for a segment needs to be selected randomly within each vine. To cater for both trellised and bush vines the system allows for the vine to be divided (in plan view) into any number of ***sectors***. Each of these can be assigned a number and the numbering system can be used consistently throughout the patch. The software can then select sectors randomly. In trellised vines a spot is also randomly selected from within each sector. The software selects an offset somewhere between the vine trunk and a maximum 'sector length' that you specify.

In trellised vineyard patches, where vines are trained along the row, they are usually divided into 2 sectors either side of the vine trunk. Where vines are trained one way along a wire (e.g. unilateral cordon), there would be only 1 sector.

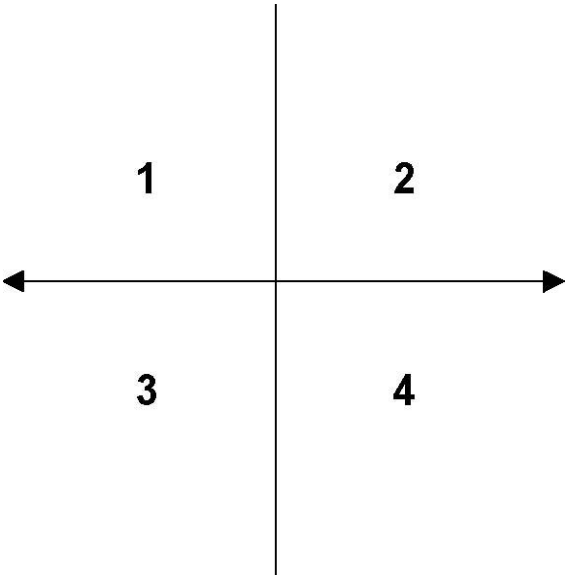
Where vines are trained 2 ways along a row, the sector length would normally be half the vine spacing. Where vines are trained 1 way along a row, the sector length would be equal to the vine spacing.

Sectors in trellised vines (side view)



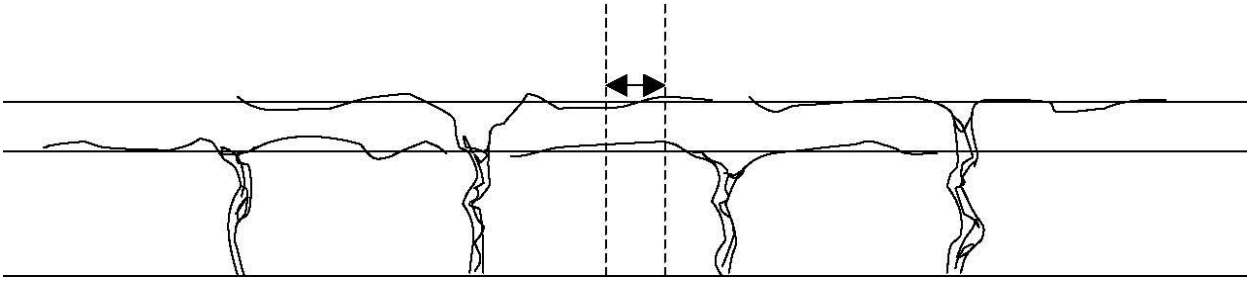
If the vineyard is not trellised, in a bush vine system, the vines can be divided into sectors like sections of a pie, looking at the vine with a birds-eye view. In this case the sector length is irrelevant, so set it to 0.

Sectors in Bush vines (plan view)



Segment length

A segment is a 'slice' of vine row, with a known length.



Research has shown that the length of the 'slice' of vine row in which bunches are counted affects the variation of the bunch count data. In patches with a very uniform distribution of bunches (for example minimal pruned or high-cropping mechanically-pruned vines), using a segment length of approximately 30 cm can be as good as counting whole vines. In addition to this, using a smaller segment can help to eliminate counter error when the numbers of bunches per vine is very high.

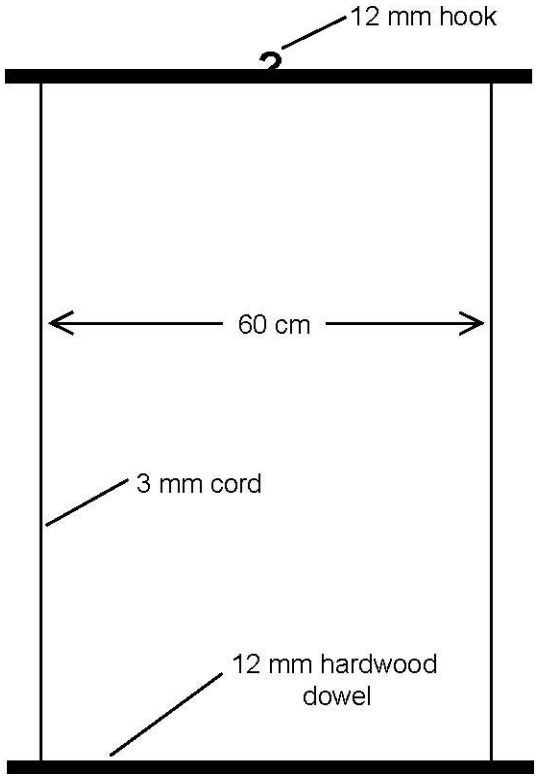
In vertically shoot positioned or vertically split canopy trellis designs a 60cm segment is recommended.

In cane pruned vineyards, with low bunch densities, a 90cm to 120cm segment is recommended.

In young vineyards, where the fruiting wire has not been filled and there is substantial variability in vine growth across a patch, using a whole vine segment would be recommended.

You will determine the segment length used. Factors to consider when selecting your segment length are the time taken to count a given segment and the accuracy you are achieving in bunch counts. Over time, you may alter the length of segment used depending on suitability for your vineyard patches.

An example of a segment frame can be seen on the following page.



Example of a segment frame

Selecting a position to sample a bunch

Whereas segments need to be positioned randomly in space, bunches need to be selected randomly relative to their distribution within the vine, which is affected by the way that the vine is pruned and trained.

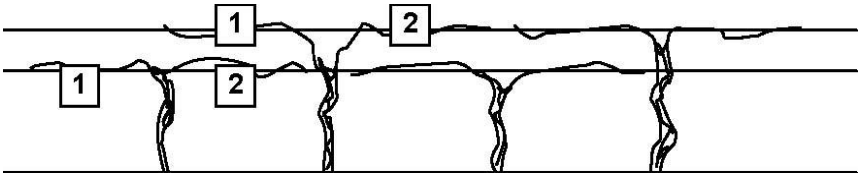
To cater for the enormous variety of pruning and training methods that are in use, the bunch sampling system is based on a division of vines into a number of ***bearers***.

Examples of what is regarded as a bearer for different pruning systems are:

- Spur-pruned vines - permanent cordons.
- Cane-pruned vines - single canes or bundles of canes.
- Mechanically-hedged or minimally-pruned vines - underlying permanent structure.
- Bush vines – arms, spurs or short canes.

Each of these can be assigned a number and the numbering system can be used consistently throughout the patch.

Example of bearer numbering



The software can then select bearers randomly. In trellised vines a spot is also randomly selected from within each bearer. The software selects an offset somewhere between the vine trunk and a maximum 'bearer length' that you specify.

Calculating what sample size to use

From a sample you can calculate a ***mean*** (average). This is only a ***sample mean***, not the true or ***population mean***. Calculating a mean from a sample is a way to estimate the true mean, but it will not be exactly right. Unless you count every bunch in every segment or measure every bunch in a patch, there will always be a degree of uncertainty or ***doubt*** surrounding an estimate of the true mean. However, you can reduce this doubt by **increasing the sample size**.

In order to work out how much doubt surrounds your estimate of a mean, you need to know the ***variation*** of measurements of segments or bunches in the patch. The software calculates this from deviations of each measurement from the sample mean. When you know the patch's variation and you specify a ***tolerance of doubt*** you can calculate the ***Best Sample Size***.

If your sample size is too small your forecast will contain more risk of inaccuracy. On the other hand, if your sample size is too big you may be wasting time and money on unnecessary measurement. So, for an optimum balance between accuracy and efficiency, you should tailor the sample size to each patch, depending on its variation and your tolerance of doubt.

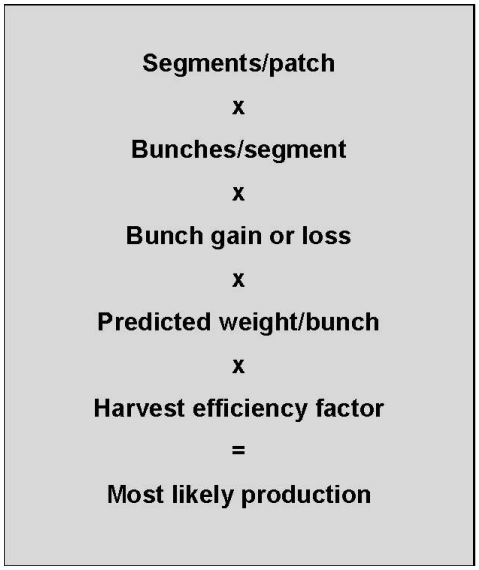
5 Forecast - bunch counts

Timing

Many wineries seek an early indication of expected grape deliveries some time between budburst and flowering. Crop forecasts can be made at this stage, based mainly on an estimate of the number of bunches (flower clusters) in a patch. Although bunches are usually counted before flowering, they can be counted at any time until harvest. Forecasts made after flowering are also based on bunch counts (see Sections 6 and 7). It is better not to count bunches until approximately six weeks after budburst because many bunches are not visible until then. However, as the canopy and bunches grow, the slowness and difficulty of counting increases because it gets harder to find bunches and untangle them from each other. You will need to choose the best time for you.

Formula

The formula used to make a forecast based on bunch counts is:



Components of the formula

The mean ***bunches/segment*** is estimated from counts of the number of bunches in a sample of segments in a patch. In order to convert from bunches/segment to bunches/patch you need to know the number of ***segments/patch***. The software calculates this by dividing the total row length of the patch by the segment length.

In theory the number of bunches in a patch shouldn't change much from about a month after budburst until harvest. However, in practice, more bunches are usually counted at harvest than before flowering. Some bunches may not be seen at the earlier counting time and some can form on summer laterals. Bunches can also be lost due to factors such as hail damage, bunch stem necrosis, disease, or deliberate removal for crop control purposes. Whatever the causes of changes in the number of bunches may be, you need to use a ***bunch gain or loss factor*** to predict bunches/segment at harvest.

In order to estimate the total weight of fruit that will be present in the patch just before harvest, you need to multiply the total number of bunches in the patch by a ***predicted weight/bunch***. Finally, you need to include a ***harvest efficiency factor*** to allow for losses of weight that may occur between the vine and the winery.

Clearly there is some doubt surrounding all the numbers that you use in your calculations. It is important that forecasters and wineries face the fact that no forecast can be 100% accurate. You can only expect to estimate the ***most likely production*** from a patch.

5.1 Setting up a bunch counting form

Setting up a sampling form

Use the New Sampling Button to create sampling spots.

Enter the Variation and the Tolerance of Doubt.

If you do not know the Variation of bunches/segment in the patch, you will not be able to

use the Sample Size Calculator. In these circumstances, we suggest using an initial sample size of 30 segments. Alternatively, you may wish to refer to Table 1 in the Appendix.

We suggest a Tolerance of Doubt of 15%. You may wish to tolerate less or more.

Note the best sample size and decide on the sample size that you will use.

We suggest using a sample size that is a little more than the calculated best sample size. For example, if the calculated best sample size is 18 we would round up to 20.

5.2 Counting bunches and recording the results

When you have set up a sampling form you can take it into a patch and use it to find where to count. You can then count the number of bunches in each segment and record the counts on the form.

Equipment

- Bunch Counting form set up for the patch as described in section 5.1
- Clipboard
- Measuring tape (in centimetres)
- Segment frame or ladder
- Pencil

Procedure

For each segment:

1. Look up the row number and the vine-space number in the row. Go to the vine.

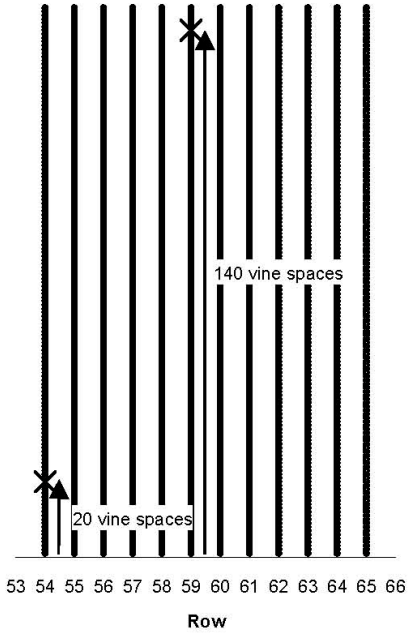
If you lose count of the vine number as you go down a row, don't worry too much. The main thing is to avoid human bias.

If you land on a missing or weak vine, still go to the trunk or where it would have been.

Example

specified that segment number 1 is at Row 54, Vine 20.

To find the 'vine address' of segment number 1 you would find Row 54 in the patch and go down the row, counting the spaces allocated for each vine (including misses) until you reach Vine 20. (See the following diagram, which also shows the location of segment number 10 at Row 59, Vine 140).



2. Look up the sector number and offset to measure from the vine trunk. Take note of where this spot is.

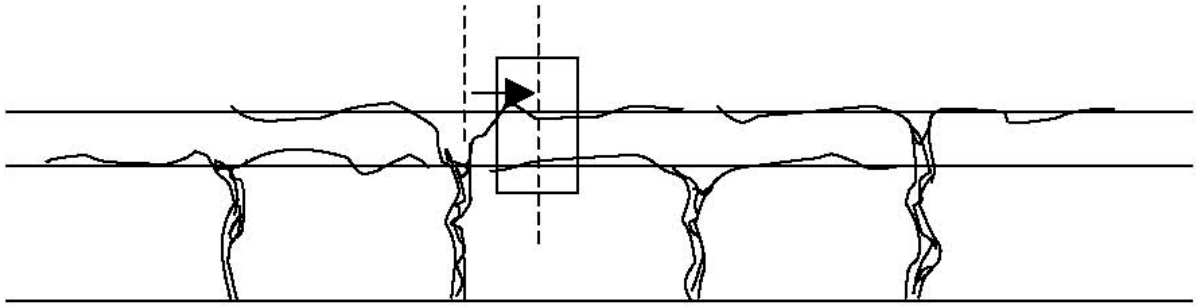
3. Hang the segment frame over the canopy so that its centre is in line with the spot, at right angles to the row direction.

It doesn't matter if the segment overlaps into the next vine.

Example

If it was specified that the spot for segment number 1 is in Sector 2,78 cm from the trunk. You have decided that Sector 1 is always to the South in the North South rows. You are using a 60cm Segment Frame.

Looking at the vine from the East, Sector 2 would be on your right. Using the tape, you would find a “spot” 78cm to the right of the trunk and set up the Segment Frame with its centre in line with it.



In the case of bush vines, you do not need a counting frame. Simply count bunches that are in the sector.

4. Count all the bunches in the segment.

Take your time. Work systematically along cordons or canes, looking at each shoot as you go. Scan each shoot from the base up. Try not to miss bunches or double-count.
A ***bunch*** is a stalk with **one or more flowers or berries** on it.
Only count bunches that have **the base of the stalk** inside the segment.
Usually there will only be 0, 1 or 2 bunches on a shoot, but there can be 3 or more. If you

find a tendril as you scan upwards you can stop looking at that shoot, because there will be no more bunches above it.
Count all bunches on all bearers at any position in the canopy within each segment.

5. Record the count in the ‘Bunches’ column on the Bunch counting form.

If there are no bunches in the segment, record the count on the form as a zero. This could occur due to low fruitfulness, a missing vine or bare wire.

5.3 Estimating bunches/segment and checking the sampling

When you've returned to the computer after counting bunches in a patch, you can enter the data recorded on the bunch counting form into the Grape Forecaster. From this data the software will calculate an estimate of mean bunches/segment and how many more segments would need to be counted if the amount of doubt exceeds your tolerance.

5.4 Predicting bunch gain, weight/bunch and harvest efficiency

Once you have surveyed and sampled as described in previous steps, you can expect your estimate of the total number of bunches in the patch to be reliable. However, you still need to predict three more things that cannot be known for sure until the crop is harvested and delivered. These are:

- The extent of gain or loss of bunches between bunch counting time and harvest
- The mean weight per bunch at the time of harvest
- The efficiency of harvesting and transporting with respect to loss of crop weight

Predicting a bunch gain or loss factor

An allowance for potential bunch gain or loss can be made by multiplying the estimate of bunches/patch by a bunch gain factor.

Prediction	Bunch gain or loss factor
Loss of bunches	0 to 1
No change in bunches	1
Gain of bunches	more than 1

A comparison of the estimates of bunches/segment made a month after budburst and just before harvest will reveal any bunch gain or loss if it has occurred (See later Sections of this manual). In your own patches, you can build up a history of bunch gain or loss that can guide you in future. Examples of bunch gain or loss factors and their seasonal variation are provided in Table 2 in the Appendix

Predicting weight/bunch at harvest

The crop forecasting system assumes that ***weight/bunch*** includes both the berries and the stalk.

At present predictions of weight/bunch at harvest are made with reference to historical records. Examples of weight/bunch and its seasonal variation for some major wine grape varieties are provided in Table 3 in the Appendix as an initial guide. You will need to build up an historical record for each of your own patches (See Section 12).

Weight/bunch varies from season to season, so predicting it from historical records builds doubt into a forecast. It would be better to predict weight/bunch from some early measurement of flower cluster size. This is the subject of current research and development. If a better way to predict weight/bunch is developed, it will be incorporated into the crop forecasting system as soon as possible.

Predicting harvest efficiency

There are losses of weight throughout the harvest and delivery process. For example, when machine harvesting, stalks are left behind, bunches near posts or outside the range of beaters are missed, fruit and juice is lost during transfers to bins, and water evaporates from bins in the vineyard, during transport and at the winery. Consequently, you need to multiply the weight of fruit that you forecast will be present in the patch at the time of harvest by a harvest efficiency factor. The harvest efficiency factor works like the bunch gain factor, except that it is always less than or equal to 1.

Conditions	Harvest Efficiency Factor
Meticulous hand harvesting very close to the winery	1.00
Hand harvesting, with transfer to a distant winery	0.95
Very efficient machine harvesting with small transport losses	0.90
Inefficient machine harvesting with transport losses	0.85

In your own patches, you can build up a history of harvest efficiency and its seasonal variation that can guide you in future (See Section 12). Examples of harvest efficiency factors and their seasonal variation are provided in Table 4 in the Appendix.

5.5 Calculating most likely production and yield

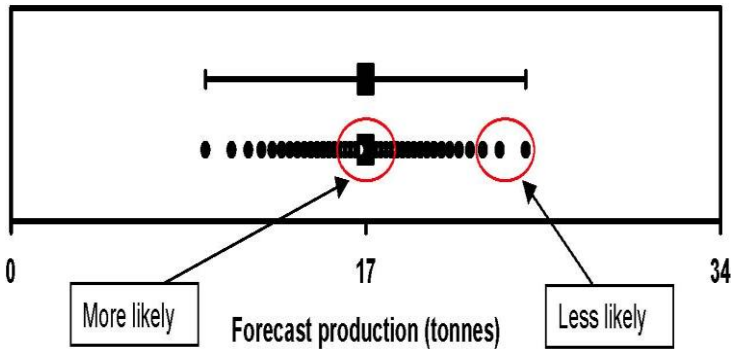
When all the previous steps have been completed, the most likely production is calculated using the formula described on Page 5-1.

5.6 Understanding the range of doubt

The doubt around a forecast is produced because of the fact that all of the numbers that go into the forecasting formulae are derived from samples. If you take a different sample from the same population, its mean will be different.

You can be 95% sure that the actual production will be in the range of doubt calculated by the software. In the example below, the forecast is 17 tonnes ± 7.7 tonnes. The range would be 9.3 tonnes to 24.7 tonnes. While this may seem to be a large range of doubt, it is more likely that production will be in the middle of the range than near the limits. This is summarised in the following figure. The bar represents the range of

doubt. The most likely production is represented by the square in the middle of the bar. The density of dots below the bar represents the likelihood of the patch producing a particular tonnage.



6 Forecast - berry counts

Timing

Typically, wineries base most of their intake planning on forecasts provided by growers about a month or two before harvest. By this time, fruit set is complete, and you have an opportunity to improve the prediction of weight/bunch at harvest, based on a measurement of berries/bunch.

A lot of berries fall off in the first few weeks after flowering, so they are usually counted about a month after flowering. Although they can be counted at any time until harvest, the timing will be governed by the need to meet winery deadlines.

Formula

The formula used to adjust the prediction of weight/bunch at harvest is:

Berries/bunch

x

Berry loss

x

Predicted weight/berry

=

Predicted weight/bunch

The revised estimate of weight/bunch can then be substituted into the formula that was used to make a forecast based on bunch counts.

Components of the formula

The mean number of ***berries/bunch*** can be estimated by counting berries in a sample of bunches from a patch.

Berries tend to fall off as the bunch develops, even after the first month, so we use a ***berry loss factor*** to allow for possible changes between the time of berry counting and harvest.

Finally, in order to predict weight/bunch, we need to multiply our prediction of berries/bunch at harvest by a ***predicted weight/berry***. We can't know for sure what this will be, but we need to make a realistic assumption.

6.1 Setting up a bunch sampling form

The same principles that apply to selecting a sample of segments in which to count bunches also apply to selecting a sample of bunches in which to count berries. Our aim is to collect a sample that represents the whole population of bunches in the patch.

Procedure

Use the 'Grape Forcaster' as described in Section 5.1 to decide on the sample size that you will use.

If you do not know the Variation of berries/bunch in the patch, you will not be able to use the Sample Size Calculator. In these circumstances, we suggest using an initial sample size of 60 bunches. Alternatively you can refer to Table 5 in the Appendix as a guide.

Print out the form.

6.2 Sampling bunches

When you have set up a bunch sampling form you can take it into a patch and use it to find the positions from which bunches should be picked.

Equipment

. • Bunch sampling form set up for the patch as described in section 6.1
. • Plastic bags (25cm x 20cm freezer bags are recommended)
. • Permanent marker pen
. • Measuring tape (in centimetres)
. • Snips or secateurs
. • Carrying bucket
. • Eskie with ice (if the weather is hot)

Procedure

Before you go to the patch, write the patch name, date of sampling and bunch identification numbers on the bags with the pen (e.g. 1 to 60 if your sample size is 60).

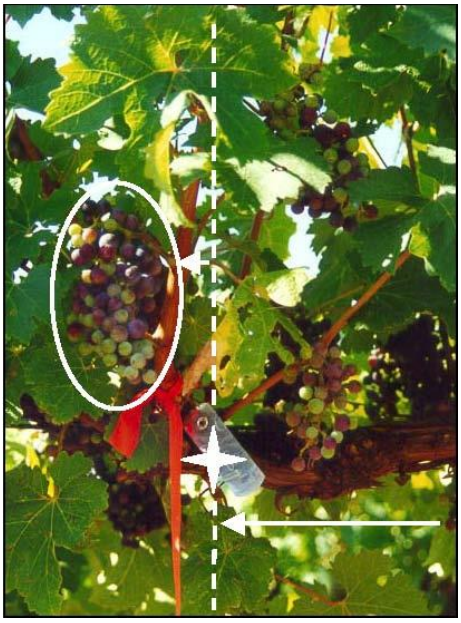
For each bunch:

1. Go to the vine, bearer and spot at the offset from the trunk specified in the bunch sampling form.

On the selected bearer measure the offset from the trunk to locate the specified 'spot' on the arm.

Imagine a vertical line or plane that goes through the spot and right through the rest of the canopy.

2. Select the bunch nearest to the plane running through the spot.



Select the bunch that has the base of its stalk nearest to the imaginary line or plane.

A ***bunch*** is a stalk with **one or more berries** on it. Don't overlook small bunches.

3. Snip off the selected bunch at the base of the stalk, put the bunch in the bag labelled with the bunch identification number, seal the bag and transport it in the bucket.

Bunches in plastic bags 'cook' in direct sunlight. Keep them shaded and cool, using an esky if necessary. Bunches in sealed bags can be stored in a refrigerator for a week or two. If they need to be stored for longer periods, they can be frozen.

6.3 Counting berries and recording the results

When you've picked a sample of bunches from the patch you can count how many berries are on each bunch.

Equipment

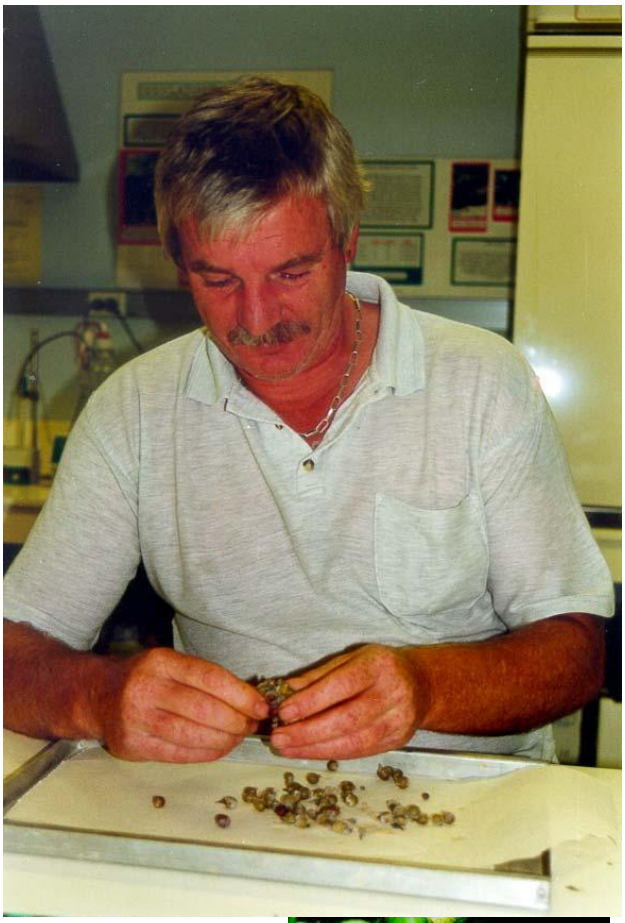
- Work bench and chair
- Tray or suitable container for removed berries
- Absorbent paper towels
- The copy of the bunch sampling form that you used to sample the bunches
- Pencil or pen
- Bin

Procedure

If the bunches have been stored, get them out of storage.

The berries are easier to count if the bunches are still frozen (but your fingers can get cold!).

Find a comfortable position to count.



The tray and paper towels will help to keep your hands and the bench top clean and dry. For each bunch:

1. Take note of the identification number on the bag.

2. Remove the bunch from the bag (keep the bag nearby while you count). OPTIONAL: You may wish to weigh each bunch, as described in Section 7.3.

3. Remove the **normal** berries from the bunch, counting them as you go.

Don't count any smaller 'chickens' (as distinct from 'hens'). At veraison these are about 3 to 4 mm diameter and average about 0.2 g. They usually do not have a viable seed and stay green for longer.

Don't count 'shot' berries. These have a diameter of about 1 mm and are tiny, green and hard.

'Shot' berries and 'chickens' tend to fall off before harvest, so we don't count them. Normal berries usually hang on, but at some sites these too fall off before harvest. The way that we allow for a loss of normal berries is described in Section 6.5.

4. Write the number of normal berries that you have counted in the line that corresponds with the bunch number in the 'Berries' column on the bunch sampling form.

OPTIONAL: You may wish to weigh the removed berries, as described in Section 7.3.

5. Dispose of the removed berries, the remaining stalk and the used bag in the bin.

6.4 Estimating berries/bunch and checking the sampling

When you've returned to the computer after counting berries, you can enter the data recorded on the bunch sampling form into Grape Forecaster. From this data the software will calculate an estimate of mean berries/bunch and how many more bunches would need to be counted if the amount of doubt exceeds your tolerance.

6.5 Predicting berry loss and weight/berry

When you have sampled bunches and counted berries as described in this manual, you can expect your estimate of mean berries/bunch to be reliable. However, to predict the weight/bunch at harvest you will still need to predict two more things. These are:

- The proportion of berries that may still be lost between berry counting time and harvest
- The mean weight per berry at the time of harvest

Predicting a berry loss factor

An allowance for berry loss can be made by multiplying the estimate of berries/bunch by a berry loss factor. Examples of factor values for different levels of berry loss are:

Predicted berry loss	Berry loss factor
none	1.0
20 %	0.8
50 %	0.5

A comparison of the estimates of berries/bunch made at berry counting time and again just before harvest will reveal any berry loss if it has occurred. In your own patches, you can build up a history of berry loss that can guide you in future. Examples of berry loss factors and their seasonal variation are provided in Table 7 in the Appendix. The default value in the software is 0.93 with a seasonal variation of 19%.

Predicting weight/berry at harvest

To allow for possible hand harvesting of whole bunches, the crop forecasting system assumes that weight/bunch includes both the berries and the stalk. Consequently the value for ***weight/berry*** that the system uses is equivalent to the total weight of the bunch divided by the number of normal berries on the bunch. Generally this will be about 5% higher than the values for weight/berry obtained by removing a sample of berries and weighing them separately.

At present, predictions of weight/berry at harvest are made by referring to historical records. You will need to build up an historical record for each of your own patches (See Section 12). Examples of weight/berry at harvest and its seasonal variation are provided in Table 8 as an initial guide.

In most patches, weight/berry varies little from season to season, so it is hard to improve on using using an historical mean. Most of the seasonal variation in grape yield comes from bunches/segment and berries/bunch. Consequently, priority should be given to ensuring that your system predicts these components as well as it can. However, in the future it may be an advantage to include a method for predicting weight/berry at harvest from some earlier measurement.

6.6 Calculating most likely production and yield

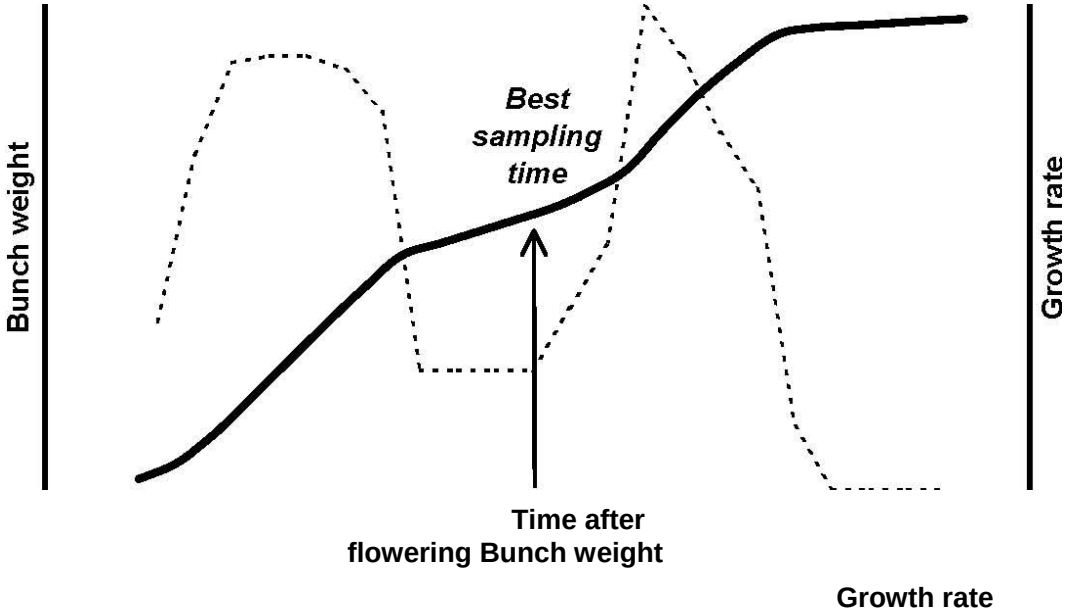
When all the previous steps have been completed, weight/bunch at harvest can be predicted using the formula in Section 6 and the forecast of most likely production can be adjusted by substituting the result in the formula in Section 5.

7 Forecast - bunch weights

It is well established that weight/bunch at harvest can be predicted satisfactorily from earlier berry counts (as described in Section 6). An alternative, but less well-proven method of predicting weight/bunch at harvest is to weigh bunches at an earlier stage of bunch growth and then multiply by a factor.

Timing

A typical pattern of bunch growth over time is shown in the figure below. After flowering bunches grow quickly for about a month or so. Then the growth rate slows down for a few weeks. After veraison bunches grow rapidly until the fruit is mature. Growth usually slows down as harvest approaches, and weight/bunch may even decrease.



Weight/bunch at harvest can be predicted from a measurement of weight/bunch at the onset of veraison. This is the time when the first berries begin to soften and colour. At this stage most of the berries won't have reached veraison and will be growing more

slowly than at earlier or later stages. This is a good time to measure because it is repeatable from year to year and any variation in timing will have less impact on the measurement.

Formula

The formula used to adjust a forecast based on bunch weights at veraison is:

Weight/bunch at veraison

x

Weight gain factor

=

Predicted weight/bunch

The revised estimate of weight/bunch can then be substituted into the formula that was used to make a forecast based on bunch counts.

Components of the formula

Mean ***weight/bunch at veraison*** can be estimated by weighing a sample of bunches from the patch. This is multiplied by a ***weight gain factor*** to predict weight/bunch at harvest.

7.1 Setting up a bunch sampling form

Set up and print out a Bunch sampling form as described in Section 6.1.

The only difference is that weight/bunch at veraison tends to be slightly more variable than berries/bunch at berry counting time, so the Best Sample Size may be a little larger.

7.2 Sampling bunches

Sample bunches as described in Section 6.1.
You may wish to use the same sample of bunches for bunch weighing and berry counting.

7.3 Weighing bunches and recording the results

When you've picked a sample of bunches from the patch you can weigh them.

Equipment

. • Work bench and chair

. • A calibrated set of scales with a range up to 1 kg and a precision of 1 g or better

. • The copy of the bunch sampling form that you used to sample the bunches

. • Pencil or pen

. • Bin

Procedure

Set up as described in Section 6.3, with the addition of the weighing scales.
If the bunches have been stored, get them out of storage.
For each bunch:

1. Take note of the identification number on the bag.
2. Remove the bunch from the bag (keep the bag nearby while you weigh).
3. Weigh the bunch, at least to the nearest gram.

   A precision of ± 1 g is sufficient for crop forecasting.
4. Write the weight of the bunch in the line that corresponds with the bunch identification number in the 'grams' column on the bunch sampling form.

OPTIONAL: You can count berries as described in Section 6.3. You can also weigh the removed berries separately, but this is not necessary for forecasting.

5. Dispose of the bunch and the used bag in the bin.

7.4 Estimating weight/bunch and checking the sampling

When you've returned to the computer after weighing bunches, you can enter the data recorded on the bunch sampling form into the software. From this data the software will calculate an estimate of mean weight/bunch and how many more bunches would need to be counted if the amount of doubt exceeds your tolerance.

7.5 Predicting weight gain

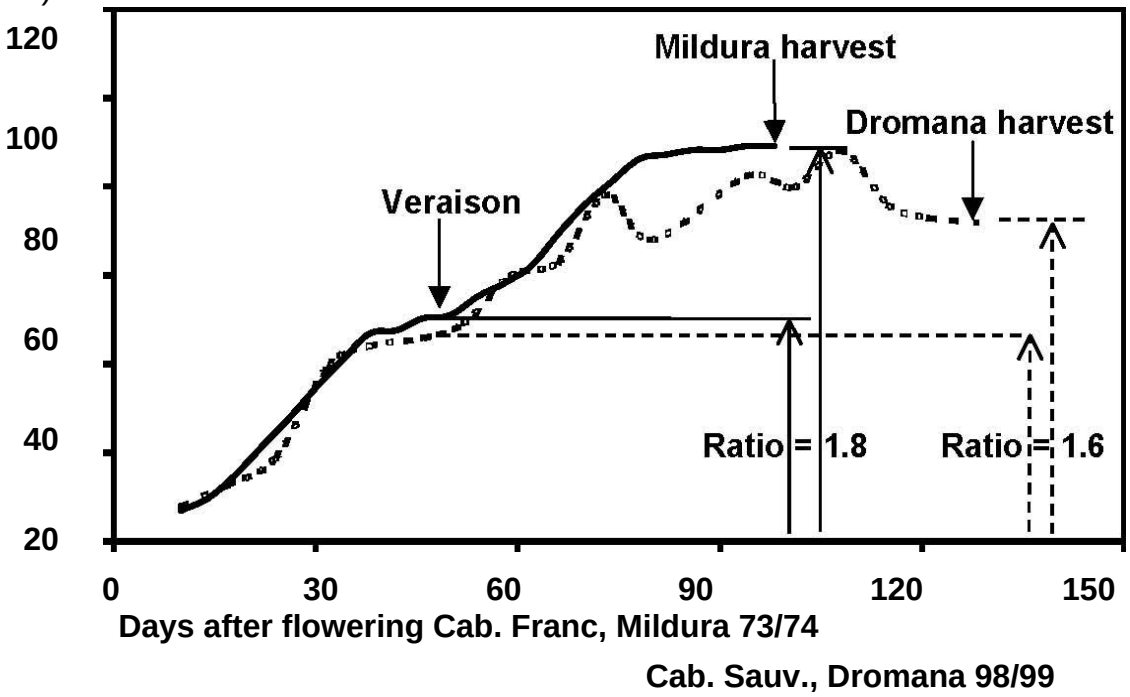
When you have sampled and weighed bunches as described in this manual, you can expect your estimate of mean weight/bunch to be reliable. However, to predict the weight/bunch at harvest you will still need to predict how much weight will be gained between bunch weighing time and harvest.

Predicting a weight gain factor

An allowance for weight gain between bunch sampling time and harvest can be made by

Weight/bunch (g)

multiplying the estimate of weight/bunch by a weight gain factor. The weight gain factor is the ratio between weight/bunch at harvest and weight/bunch at bunch sampling time (usually the onset of veraison). For example a typical weight gain factor is approximately 1.8 (e.g. Cabernet Franc at Mildura in the graph). However, in some patches weight/bunch may vary as harvest approaches, so that the choice of harvest time will greatly affect the actual weight gain factor (e.g. Cabernet Sauvignon at Dromana).



In your own patches, you can build up a history of weight gain that can guide you in future. Examples of weight gain are provided in Table 9 in the Appendix. .

7.6 Calculating most likely production and yield

When all the previous steps have been completed, weight/bunch at harvest can be predicted using the formula in Section 7 and the forecast of most likely production can be adjusted by substituting the result in the formulae on Section 5.

8 Harvest yield components

Sampling for the purpose of measuring actual yield components at harvest does not need to be combined with sampling for the purpose of making a pre-harvest forecast. However, these two distinct processes are usually synchronised because it is operationally efficient.

The formulae that are used to make forecasts in advance of harvest all include yield components that need to be predicted at the time of forecasting.

The forecast based on bunch counts included:

. • Bunch gain factor

. • Weight/bunch at harvest

. • Harvest efficiency factor

The adjustments with berry counts or bunch weights also included:

. • Berry loss factor

. • Weight/berry at harvest

. • Weight gain factor

You need to measure yield components at harvest to be able to calculate the actual values for each of these components. These actual values can then be used to build an historical record and to improve forecasting in following seasons.

These yield components can all be obtained by non-destructive counting of bunches and the destructive sampling of a relatively small number of bunches.

Timing

Ideally, yield components should be measured as close to harvest as possible. However, you may need to measure them earlier in order to provide a winery with a pre-harvest forecast. In this case, measurements should be made within a week before harvest.

Components

The yield components that you should measure routinely at harvest each season are:

. • bunches/segment

. • weight/bunch (including berries and stalk).

If you adjust forecasts with berry counts you should also:

. • measure berries/bunch

. • calculate bunch weight/berry

You may also wish to measure the weight of the berries on each bunch (without the stalk) and calculate a weight/berry as an indicator of berry size, but this is optional.

Options for combining sampling operations

The best sample size for bunches is usually not a convenient multiple of the best sample size for segments, so it may be simpler to keep bunch sampling separate from

bunch picking and/or counting. However, to save time, you could sample bunches from the ones you pick and/or count in each segment. The number you sample from each segment would need to be sufficient to ensure that you exceed the best sample size for the patch.

8.1 Setting up a bunch counting form near harvest

You need to count bunches in a representative sample of segments in the patch. The procedure is basically the same as at the earlier bunch counting stage.

Procedure

If you are going to pick segments, use the procedure described in Section 10.1 instead of this one, then go to Section 8.2.

1. Decide on the sample size that you will use.

Usually the Variation of bunches/segment at harvest will be similar to the earlier bunch counting time, so a good guide is the best sample size calculated in the 'DATA – Bunch counts' sheet. We suggest using a sample size that is a little more than this.

If you have no prior guide, we suggest using an initial sample size of 30 segments.

2. Set up and print out a bunch counting form. Use the procedure described in section 5.1.

8.2 Setting up a bunch sampling form near harvest

You need a representative sample of bunches, primarily to measure weight/bunch.

Procedure

1. Decide what sample size to use.

Usually the best sample size for estimating mean weight/bunch and berries/bunch at harvest will be similar to the earlier bunch sampling time, but it can be different.

If you have weighed bunches at an earlier stage, you can use the best sample size calculated in the 'DATA – bunch weights' sheet as a guide.

The best sample size for weight/bunch is usually greater than berries/bunch. If you have not weighed bunches earlier, but have counted berries/bunch, you can estimate the best sample size at harvest by multiplying the best sample size calculated in the 'DATA – berry counts' sheet by a factor of 1.1.

If you have measured both weight/bunch and berries/bunch earlier, choose the higher sample size. We suggest using a sample size that is a little more than the calculated one.

If you have no earlier bunch weight or berry count data, we suggest using an initial sample size of 60 bunches.

If you intend to combine bunch sampling with bunch counting or segment picking, select a number of bunches that is a multiple of the number of segments.

8.3 Counting and sampling bunches

When you have set up the sampling forms you can go to the patch, find where to count and sample bunches and record the counts.

Equipment

. • Bunch Counting form set up for the patch as described in section 8.1

. • Bunch sampling form set up for the patch as described in section 8.2 (if needed)

. • Clipboard

. • Measuring tape (in centimetres)

. • Segment frame or ladder

. • Pencil

. • Plastic bags (25cm x 20cm freezer bags are recommended)

. • Permanent marker pen

. • Snips or secateurs

. • Carry bucket

. • Eskie with ice (if the weather is hot)

Procedure

If you are keeping the bunch counting and bunch sampling processes separate:

1. Take the bunch counting and bunch sampling forms set up as described in Sections 8.1 and 8.2 into the patch.

2. Follow the procedures described in Sections 5.2 and 6.2 to record bunch counts and samplebunches.

If you are combining bunch sampling and counting:

1. Take the bunch counting form set up as described in Section 8.1 into the patch.
2. Count bunches per segment (See Section 5).
3. Select, remove and store the number of bunches that you have decided to sample from each segment.

The method for determining the number of bunches to sample from each segment is described in Section 8.2.

The sampling procedure is basically the same as described in Section 6.2, except that the nearest bunches

to one end of each segment should be selected. Decide which end of the segment to sample from and be consistent throughout the patch. When you label the bunch sample bags, it may help to include the segment number. If you are combining bunch sampling with segment picking:

1. Take the segment picking form set up as described in Section 10.1 into the patch.
2. Select, remove and bag the number of bunches that you have decided to sample from each segment (as described above for combined bunch counting and sampling).
3. Pick and count bunches in each segment as described in Section 10.2. Include the sampled bunches in the recorded count.
4. When you carry the fruit removed from each segment to the scales and weigh it, include the sampled bunches.
5. Store the sampled bunches as described in Section 6.2

8.4 Weighing bunches, counting berries and recording results

When you've picked a sample of bunches from the patch you can weigh bunches. If you intend to adjust forecasts with berry counts in future seasons you can count berries. If you want a measure of berry size you can weigh the removed berries separately, but this is optional. The sample can also be used to make a very accurate maturity assessment.

Equipment

. • Work bench and chair

. • A calibrated set of scales with a range up to 1 kg and a precision of 1 g or better

. • The copy of the bunch sampling form that you used to sample the bunches

. • Pencil or pen

. • Tray or suitable container for removed berries

. • Absorbent paper towels

. • Bin

Procedure

Set up as described in Sections 6.3 and 7.3.
If the bunches have been stored, get them out of storage.
For each bunch:

1. Take note of the identification number on the bag.
2. Remove the bunch from the bag (keep the bag nearby while you weigh).
3. Weigh the bunch as described in Sections 7.3.
4. Write the weight of the bunch in the line that corresponds with the bunch identification number in the 'grams' column on the bunch sampling form.
5. If you have no need to count berries, go to step 8.

6. Remove and count berries as described in Section 6.3.

7. Write the number of berries in the line that corresponds with the bunch identification number in the ‘Berries’ column on the bunch sampling form.

OPTIONAL: You can weigh the removed berries, as described in Section 7.3.

OPTIONAL: You could use the bunches or removed berries for maturity assessment.

8. Dispose of the bunch and the used bag in the bin.

8.5 Estimating bunch components and checking the sampling

When you’ve returned to the computer after weighing bunches and counting berries, you can enter the data recorded on the bunch sampling form into the software. The software will then calculate estimates of actual mean weight/bunch, berries/bunch and weight/berry at harvest. It also calculates how many more bunches would need to be counted if the amount of doubt exceeds your tolerance.

8.6 Estimating bunches/segment and checking the sampling

When you’ve returned to the computer after counting bunches, you can enter the data recorded on the bunch counting or segment picking form into the software. The software will then calculate an estimate of actual mean bunches/segment at harvest. It also calculates how many more segments would need to be counted if the amount of doubt exceeds your tolerance.

If you have picked segments and counted bunches while you did, use the procedure described in Section 10.3 instead of this one.

9 Forecast - yield components

A forecast a week to a few days before harvest can be very accurate and very valuable to both the winery and the vineyard for harvest and intake planning. During the week before harvest there is usually very little change in the weight of the crop, so we can use the following formula to make a forecast

Segments/patch

x

Weight/segment

x

Harvest efficiency

=

Most likely production

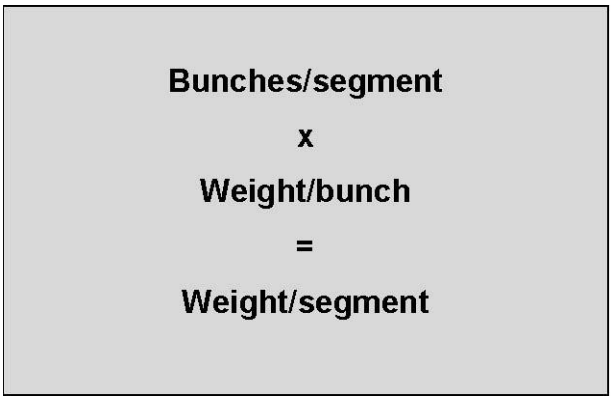
:

As at earlier stages, we still need to predict a harvest efficiency factor, but the accuracy of a forecast made at this time will be almost entirely dependent on how well we sample to estimate a mean ***weight/segment***.

There are two methods that you can use to estimate weight/segment:

1. Calculate weight/segment indirectly from data collected in the course of routine sampling near harvest, using the following formula:

2. Pick all the fruit from a sample of segments and calculate weight/segment directly. This method will be covered in Section 10.



Forecast - yield components

The 'harvest sampling' method provides less reliable forecasts, but it is quicker, cheaper and makes use of information that should be collected anyway, particularly if you plan to adjust forecasts using berry counts.

The 'segment picking' method produces more accurate forecasts. While you are picking the bunches from each segment you can count them, so you do not need to count them separately. The bunch count is usually more accurate too, because it is easier to avoid double-counting or missing bunches. In addition, weight/bunch can be estimated by dividing weight/segment by bunches/segment, and this estimate of weight/bunch is more reliable than the estimate obtained from bunch samples. You can also save time by taking a sample of bunches from the segments you pick and count, as described in Section 8.3. However, picking is relatively slow and the fruit must be stored, added to a harvest in progress, used for some other purpose or discarded.

These advantages and disadvantages are summarised in the following table:

Method	***Advantages***	***Disadvantages***
Harvest sampling	Quicker Cheaper Uses data collected anyway	Forecast is less reliable Estimates of bunches/segment and weight/bunch less accurate
Segment picking	Forecast is more reliable Estimates of bunches/segment and weight/bunch more accurate	Slower More expensive Fruit disposal

You will need to decide which method suits you best. We suggest that you pick segments for at least one season before deciding whether you need to or not.

As explained in Section 8, the bunches/segment and weight/bunch data that should be measured routinely can be used to produce a forecast near harvest.

10 Forecast - segment weights

A very reliable forecast can be made by picking and weighing the fruit from a sample of segments in the week before harvest.

While it is operationally efficient to combine picking with counting and sampling, the only information you actually need to make a forecast is weight/segment.

10.1 Setting up a segment picking form

You need a representative sample of segments, primarily to measure weight/segment.

Procedure

1. Decide what sample size to use
2. Print out the form.

10.2 Picking segments and recording the results

When you've set up the segment picking form you can use it to find where to pick in the patch. You can also use it to record bunch counts and specify bunch sampling spots.

Equipment

For each picker:

• Segment picking form set up as described in Section 10.1 (picker's guide).

• Clipboard and pencil (optional).

• Measuring tape (in centimetres).

• Segment frame or ladder.

• Snips or secateurs.

• Picking bucket(s).

• Chalk. At a convenient location as close to the patch as possible:

• Segment picking form set up as described in Section 10.1 (for recording).

• Clipboard and pencil.

• Reliable weighing scales with a range up to 20 kg and a precision of 10 g or better.

• A tared weighing container

• Water in a container and a rag.

• A bin or other container(s) for the picked fruit.

Procedure

Set up the scales, tared weighing container, master recording sheet, etc next to a bin or similar container(s) at a central location as close to the patch as possible.

For each segment:

1. Use the segment picking form to find the spot to set up the segment frame as described in Section 5.2.

2. Pick all the bunches in the segment, counting them as you go.

   OPTIONAL: You can take a sample of bunches from the segment, as described in Section 8.3.

If you do it is usually convenient to remove and bag the sampled bunches before you pick the rest of the segment.

Include the sampled bunches in the count.

3. Put the picked bunches in the picking bucket.

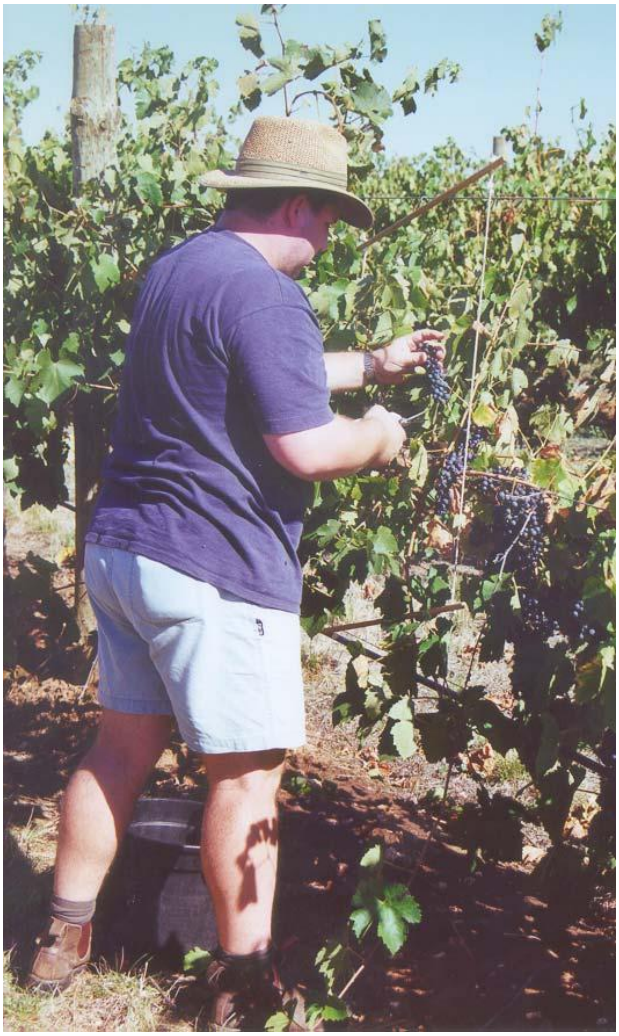
   If you have sampled bunches, put them in the bucket first.

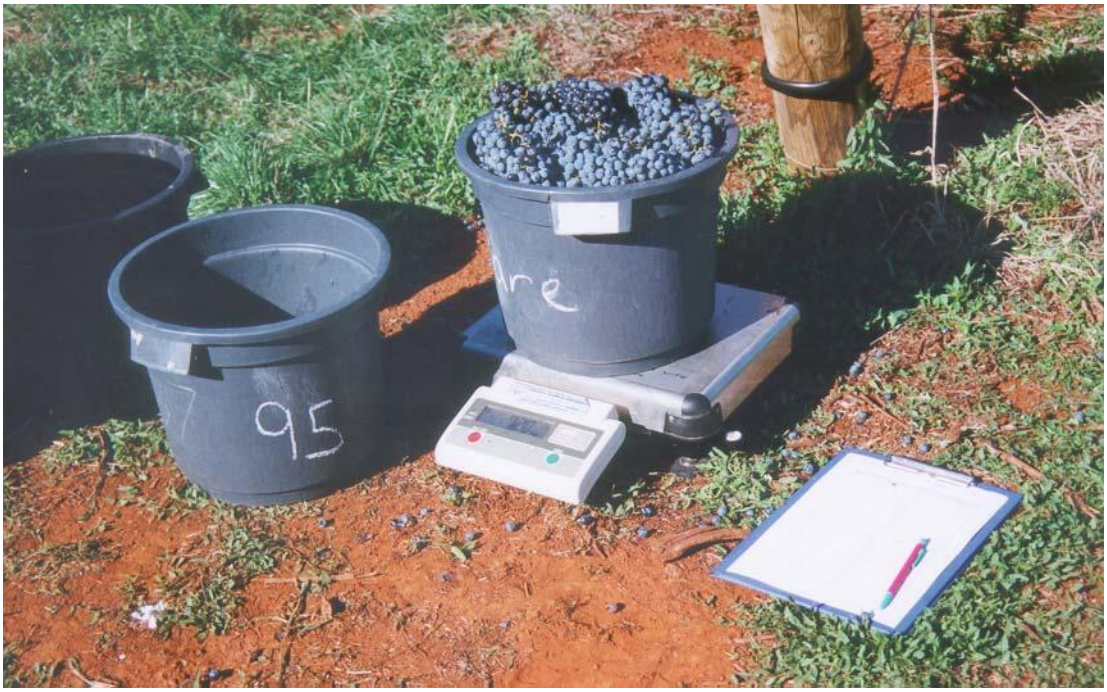
4. Write the segment identification number and the number of bunches that you counted on the bucket with the chalk

   If you have sampled bunches, include them in the recorded count.

5. Take the bucket full of fruit to the weighing scales.

6. Tip the fruit into the tared container and weigh it.
   If you have sampled bunches and put them in first, they should come out on top.





7. Write the bunch count in the ‘Bunches in segment’ column and the weight in the ‘Kilograms in segment’ column on the Segment picking form.
8. Tip the weighed fruit out of the tared container into the bin

   If you have sampled bunches, store them first (don’t tip them into the bin!).
9. Rub the chalked numbers off the bucket with a wet rag and go to the next segment.

It will usually be better for a team to pick segments. It is usually better to have a number of people picking, counting and leaving full buckets at each segment. One other person can carry, weigh, record numbers and keep the pickers supplied with de-chalked buckets.

10.3 Estimating weight/segment and checking the sampling

When you’ve returned to the computer after picking segments, you can enter the data recorded on the Segment picking form into the software. From this data the software will calculate an estimate of mean weight/segment and how many more segments would need to be picked if the amount of doubt exceeds your tolerance. It will also calculate mean bunches/segment and weight/segment.

10.4 Calculating most likely production and yield

When an estimate of weight/segment near harvest has been calculated a forecast of most likely production can be made using the formula described in Section 9.

11 Performance Review

When the crops in each patch in the vineyard have been harvested and delivered to the winery, the performance of the forecasting system can be assessed by comparing the forecasts made at each stage with the actual deliveries.

Measures of performance that can be used are:

. • the difference between forecast and actual production (tonnes)

. • this difference expressed as a percentage of actual production

. • this percentage difference expressed as an absolute (eliminating the '+' or '-')

The ***difference*** in tonnes measures the size of the impact of any forecasting inaccuracy on the winery. Obviously, higher-producing patches will have a bigger total impact.

The ***percentage difference*** enables comparison of forecasts at different stages in different patches. It can be positive or negative, so it indicates over- or under-estimates.

Forecasting is to some extent a game of odds. A good system can produce an inaccurate forecast in one patch in one year, just by chance. However, over many patches and seasons its true performance should become apparent. Therefore, the performance of your system should be assessed across as many patches as possible.

One measure of the performance of a system over many patches is the ***average percentage difference***. This average can indicate whether there is an overall bias in the system towards under- or over-estimation. However, it can give you a misleading impression of the accuracy of the system because the under- and over-estimates, which both have adverse impacts on wineries, tend to cancel each other out.

This problem can be overcome by averaging the absolute percentage difference. The ***average absolute percentage difference*** gives you a measure of how far out, on average, your forecasts were. A smaller number indicates better performance.

11.1 Evaluating performance at each forecasting stage

When you know the actual tonnage that was delivered to the winery from the patch, you can compare it to the forecasts that you made at stages throughout the season. You can then see how accurate each forecast was.

It is important to consider differences between forecast and actual production in relation to the amount of doubt surrounding each forecast of most likely production. This is indicated by the ± figures in the 'Performance Evaluation' sheet and the vertical bars in the Performance chart.

If the range either side of the forecast is large, the software is telling you that, based on the data you have given it, there is a lot of doubt about the accuracy of the forecast. Factors that increase doubt include higher measurement variation, smaller sample sizes and higher seasonal variation of factors predicted from long term means.

Using data you give it, the software tells you that there is a 95% chance that the actual production will be somewhere in the range of doubt around each and. So it should not

be surprising if the actual production you enter into the software falls within this range. However, if actual production falls outside the range, it is likely that there were some real differences between what you expected and what actually happened.

The first thing to check should be whether the record of actual production is correct. Sometimes there can be mix-ups during harvest or at the winery. You need to be sure that the weight of all the grapes, and only the grapes, that were harvested from the patch was recorded accurately. After this, you can use the Analysis charts and 'Analysis of predictions' sheet to probe the reasons for inaccurate forecasts (see Section 11.3). This allows you to evaluate the performance of your forecasting system at each stage and prioritise your efforts to improve it in the future.

12 Preparing for next season

In future seasons, you will need to predict the following components at various stages:

. • Bunch gain factor

. • Weight/bunch

. • Berry loss factor

. • Weight/berry

. • Weight gain factor

• Harvest efficiency factor as a basis for doing this you will need to keep historical records of the actual values for each of these and calculate long term means and seasonal variation.

Appendix

Table 1. Bunches per 60 cm segment counted before flowering in patches in Victoria, 1997/1998-1999/2000

Vineyard	Region	Variety	Vintage	Mean	Variation (%)
Barooga (Southcorp)	Southern New South Wales	Cabernet	1999	38	43
			2000	12	45
			2000	33	32
		Chardonnay	1999	32	45
			2000	36	28
		Shiraz	1999	13	44
			2000	24	30
Briarston	Yarra Valley	Cabernet	1998	14	25
		Chardonnay	1998	15	15
Brown Brothers	North East	Shiraz	1998	25	25
Chambers	Rutherglen	Cabernet	1998	24	28
			1999	27	27
			2000	19	24
		Chardonnay	1998	21	23
			1999	26	32
			2000	23	29
		Shiraz	1998	15	19
			1999	23	28
			2000	16	38
Dromana Estate	Mornington Peninsula	Cabernet	1999	19	22
			2000	18	25
		Chardonnay	1999	13	25
			2000	19	25
Lusatia Park	Yarra Valley	Cabernet	1998	19	22
Mt Helen	Strathbogie Ranges	Cabernet	1999	23	40
			2000	15	33
			2000	23	40
		Chardonnay	1999	20	38
			2000	13	44
		Shiraz	1999	14	52
			2000	13	44
Paringa Estate	Mornington Peninsula	Cabernet	1998	35	22
		Chardonnay	1998	32	23
		Shiraz	1998	34	15
			1999	22	26
			2000	26	18
Red Hill Estate	Mornington Peninsula	Chardonnay	1998	21	18
Yarra Ridge	Yarra Valley	Cabernet	1998	19	13
			1999	24	25
			2000	18	27
		Chardonnay	1998	16	18
			1999	29	19

Table 2. Bunch gain factors in Victoria, 1997/1998 - 1999/2000.

Vineyard Southcorp Barooga	**Region** Southern New South Wales	**Variety** Cabernet S. Chardonnay Shiraz	**Years** 2 2 2	**Mean** 1.50 1.24 1.29	**Variation (%)** 12 13 16
Chambers Lakeside	Rutherglen	Cabernet S. Chardonnay Shiraz	3 3 3	1.33 1.05 1.33	19 7 14
Dromana Estate Mount Helen	Mornington Peninsula Strathbogie Ranges	Cabernet S. Chardonnay Cabernet S. Shiraz	2 2 2	1.06 1.41 1.47	15 25 41
Paringa Estate Yarra Ridge	Mornington Peninsula Yarra Valley	Shiraz Cabernet S. Chardonnay	3 3 3	1.02 1.13 1.16	7 24 15
Mean			2.5	1.25	17

Table 3. Weight per bunch (g) in patches in Victoria, 1997/1998 - 1999/2000.

Vineyard	Region	Variety	Years	Mean	Variation (%)
Southcorp Barooga	Southern New South Wales	Cabernet S.	3	84	11.3
		Cabernet S.	1	105	
		Chardonnay	3	79	14.1
		Shiraz	3	64	11.4
Chambers Lakeside	Rutherglen	Cabernet S.	3	105	0.2
		Chardonnay	3	125	14.0
		Shiraz	3	130	15.4
Dromana Estate	Mornington Peninsula	Cabernet S.	2	76	1.8
		Chardonnay	2	86	39.3
Mount Helen	Strathbogie Ranges	Cabernet S.	3	76	13.6
		Cabernet S.	1	44	
		Chardonnay	2	103	42.0
		Shiraz	2	89	4.7
Paringa Estate	Mornington Peninsula	Shiraz	3	66	36.3
Yarra Ridge	Yarra Valley	Cabernet S.	3	51	2.5
		Chardonnay	3	75	8.9

Table 4. Harvest efficiency factors in patches in Victoria, 1997/1998 - 1999/2000.

Vineyard Southcorp Barooga	**Region** Southern New South Wales	**Variety** Cabernet S. Chardonnay Shiraz	**Years** 3 3 3	**Mean** 0.92 0.96 0.74	**Variation (%)** 14 14 24
Chambers Lakeside	Rutherglen	Cabernet S. Chardonnay Shiraz	3 3 2	0.93 0.96 0.81	11 9 9
Dromana Estate Mount Helen	Mornington Peninsula Strathbogie Ranges	Cabernet S. Chardonnay Cabernet S. Shiraz	1 1 2 2	0.94 0.96 0.80 0.81	 19 18
Paringa Estate Yarra Ridge	Mornington Peninsula Yarra Valley	Shiraz Cabernet S. Chardonnay	2 2 2	0.95 1.03 1.04	27 24 4
Mean			2.2	0.91	16

Table 5. Berries per bunch counted after fruit set in patches in Victoria, 1997/1998 -1999/2000.

Vineyard	Region	Variety	Vintage	Mean	Variation (%)
Barooga (Southcorp)	Southern New South Wales	Cabernet	1999	84	57
			2000	113	67
			2000	147	49
		Chardonnay	1999	101	46
			2000	105	34
		Shiraz	1999	89	49
			2000	91	52
Chambers	Rutherglen	Cabernet	1998	167	45
			1999	93	58
			2000	92	49
		Chardonnay	1998	126	33
			1999	122	59
			2000	117	47
		Shiraz	1998	118	42
			1999	103	52
			2000	82	48
Dromana Estate	Mornington Peninsula	Cabernet	1999	82	61
			2000	82	55
		Chardonnay	1999	49	63
			2000	78	46
Mt Helen	Strathbogie Ranges	Cabernet	1999	73	54
			2000	138	40
			2000	82	47
		Chardonnay	1999	61	63
			2000	94	47
		Shiraz	1999	72	38
			2000	66	53
Paringa Estate	Mornington Peninsula	Shiraz	1999	41	50
			2000	72	51
Yarra Ridge	Yarra Valley	Cabernet	1999	59	62
			2000	76	49
		Chardonnay	1999	71	57
			2000	85	52
Mean				92	51

Table 6. Weight per bunch near veraison in patches in Victoria, 1999/2000. Table

Vineyard	**Region** Southern New South Wales	**Variety**	**Vintage**	**Mean** 70	**Variation (%)** 67 48
Barooga		Cabernet	2000 2000	76	
		Chardonnay Shiraz	2000 2000	44 44	54 71
Chambers	Rutherglen	Cabernet Chardonnay Shiraz	2000 2000 2000	66 122 93	57 59 55
Dromana Estate Mt Helen	Mornington Peninsula Strathbogie Ranges	Cabernet Chardonnay Cabernet	2000 2000 2000 2000	75 93 34 22	59 43 53 49
		Chardonnay Shiraz	2000 2000	52 27	46 55
Paringa Estate Yarra Ridge	Mornington Peninsula Yarra Valley	Shiraz Cabernet Chardonnay	2000 2000 2000	48 37 58	61 52 52
Mean				60	55

7. Berry loss factors in Victoria, 1997/1998 – 1999/2000.

Vineyard	**Region** Southern New South Wales	**Variety**	**Years**	**Mean**	**Variation (%)** 22 5 14
Southcorp Barooga		Cabernet S. Chardonnay Shiraz	2 2 2	0.95 0.95 0.91	
Chambers Lakeside	Rutherglen	Cabernet S. Chardonnay Shiraz	3 3 3	0.90 0.82 0.92	30 6 7
Dromana Estate Mount Helen	Mornington Peninsula Strathbogie Ranges	Cabernet S. Chardonnay Cabernet S. Shiraz	2 2 2 2	0.96 1.10 0.98 0.95	3 11 38 32
Paringa Estate Yarra Ridge	Mornington Peninsula Yarra Valley	Shiraz Cabernet S. Chardonnay	3 2 2	0.80 0.95 0.95	31 47 5
Mean			2.3	0.93	19

Table 8. Weight per berry (g) in patches in Victoria, 1997/1998 – 1999/2000.

Vineyard	Region	Variety	Years	Mean	Variation (%)
Southcorp Barooga	Southern New South Wales	Cabernet S.	3	0.97	10.9
		Chardonnay	3	0.82	5.8
		Shiraz	3	0.80	6.6
Chambers Lakeside	Rutherglen	Cabernet S.	3	1.23	21.5
		Chardonnay	3	1.23	8.4
		Shiraz	3	1.46	6.3
Dromana Estate	Mornington Peninsula	Cabernet S.	2	1.02	5.2
		Chardonnay	2	1.22	13.2
Mount Helen	Strathbogie Ranges	Cabernet S.	3	0.83	3.9
		Chardonnay	2	1.12	4.3
		Shiraz	3	1.21	3.1
Paringa Estate	Mornington Peninsula	Shiraz	3	1.09	5.3
Yarra Ridge	Yarra Valley	Cabernet S.	3	0.82	15.9
		Chardonnay	3	1.03	11.0

Table 9. Weight gain factors in patches in Victoria, 1999/2000.

Vineyard	Region	Variety	Weight gain factor
Southcorp Barooga	Southern New South Wales	Cabernet S. Chardonnay Shiraz	1.35 1.59 1.28
Chambers Lakeside	Rutherglen	Cabernet S. Chardonnay Shiraz	1.61 0.98 1.17
Dromana Estate Mount Helen	Mornington Peninsula Strathbogie Ranges	Cabernet S. Chardonnay Cabernet S. Cabernet S. Chardonnay Shiraz	1.02 1.17 1.96 2.01 1.50 2.20
Paringa Estate Yarra Ridge	Mornington Peninsula Yarra Valley	Shiraz Cabernet S. Chardonnay	1.42 1.39 1.39
Mean			1.46