Vineyard Management

6

The grape grower has a very simple goal: to produce a healthy crop of ripe grapes suitable for the style of wine the winemaker wants to make. In order to be able to do this it is necessary to apply an understanding of how the environment affects the vine's growth. In this chapter we will look at how decisions over site selection, trellising, training, pruning systems, planting densities and pests and diseases have an impact on the quality and quantity of grapes that can be harvested each year.

SITE SELECTION

When a producer wants to establish a new vineyard the potential site needs to be assessed for its environmental and practical suitability. Suitable grape varieties will need to be chosen.

Environmental conditions – The grape grower can use data to work out the potential site's average temperature, rainfall and sunlight hours as well as the fertility of the soil and how well drained it is. These factors will influence the choice of grape variety as well as the ideal planting density, and systems of training and trellising.

Business considerations – The proximity of a vineyard to the utility infrastructure (power, water, etc.), the availability of a vineyard workforce, the accessibility of a site for machinery, such as tractors and harvesters, and the cost of the land are all important considerations in the financial viability of a site.

Grape variety – The grape variety must suit the climatic conditions of the preferred site. There must also be a demand for the grapes. In EU vineyard areas there may also be legal restrictions on the varieties that a producer can use. This is covered in more detail in section *Label Integrity* in Chapter 11.

PLANTING/REPLANTING

A new vineyard site must be cleared of any existing vegetation as necessary. The fertility of the soil may be tested and fertilisers applied to correct any nutrient deficiencies. Young vines, usually bought pre-grafted from a nursery, are planted either by hand or machine. The young vines are often protected against animals by individual plastic sleeves. Irrigation is also sometimes allowed, even in regions where it is otherwise prohibited, to help young vines establish themselves. The first yield usually comes in the third year after planting.

Although they can be very long-lived, most vines are replaced between the ages of 30 and 50 years old. Some wine estates will use the term 'old vines' or its local equivalent, to denote a wine made from well-established plants. These vines are thought to produce fruit of exceptional quality, often with a greater concentration of flavours. However, the quantity or yield of grapes a vine produces decreases with age and it can be increasingly susceptible to disease. Therefore a balance has to be struck between quality and profitability.

Normally, vineyard land is left fallow (unplanted) for three years or more after the vines are dug up so that it can recover. A grape grower will have a replanting cycle that ensures that as little of their vineyard as possible is out of production at any one time.

MANAGING THE VINE

Training, pruning, trellising and the density of the planting are the main techniques used to manage the vine, and the grape grower will adapt these practices to suit the vineyard's resources: temperature, sunlight, water and soil nutrients. He or she will also take into account practical considerations such as the use of machinery in the vineyard. However, in all cases, the grape grower's goal is to maximise the production of fruit at the desired quality level as economically as possible.

The interrelationship between all of these factors is extremely complex and in this book we will only explore some of the reasons behind the choices that are made.

Vine Training

Vine training typically refers to the shape of permanent wood of the vine and can be split broadly into two

A newly planted vineyard in Australia. The trellis posts and wires, the drip irrigation system and the plastic sleeves used to protect the young vines can all be seen clearly.

categories: head training or cordon training. Importantly, either system can be low-trained, to benefit from heat retained by the soil, or high-trained, to avoid frosts.

Head training – These vines have relatively little permanent wood. Some only have a trunk. Others have a few short arms of permanent wood growing from the top of the trunk. They can either be spur-pruned or replacement cane-pruned.

Cordon training – These vines typically have a trunk with one or more permanent horizontal arms or 'cordons'. The vines are usually spur-pruned.

Cordon training takes longer to establish because of the greater amount of permanent wood. However, the sturdy permanent cordon with shoots positioned along its length makes mechanisation in the vineyard, such as machine harvesting, easier to achieve.

Vines normally have one or two cordons, but cordon training can also be used to create big vine structures where shoots may grow from four or more cordons.

Vine Pruning

Pruning is the removal of unwanted leaves, canes and permanent wood. It shapes the vine and limits its size. Pruning will take place every winter and summer. Winter pruning is an important part of the vineyard calendar and its main purpose is to determine the number and location of the buds that will form shoots in the coming growing season. It is important to make sure that the buds are not close together. This helps with canopy management (see following section *Trellising and Canopy Management*). There are two styles of winter pruning: spur and replacement cane.

Spur pruning – Spurs are short sections of one-year-old wood that have been cut down to only two to three buds. The spurs are either distributed along a cordon of permanent wood (cordon training) or around the top of the trunk (head training).

Replacement cane pruning – Canes are longer sections of one-year-old wood and can have anything between eight and 20 buds. Typically only one or two canes are retained and each cane is tied horizontally to the trellis for support. This type of pruning is most often seen on head-trained vines. Replacement cane pruning is more complex than spur pruning and requires a large skilled labour force to choose suitable canes and train them. It is sometimes referred to as Guyot training; one cane is retained in Single Guyot; two in Double Guyot.

Summer pruning involves trimming the canopy to restrict vegetative growth and direct sugar production to the grape, rather than to the growth of shoots and leaves. It can also involve leaf stripping so that bunches of grapes have optimum exposure to sunshine.

Trellising and Canopy Management

The vine's canopy is made up of all of the green parts of the vine. Managing this annual growth is a very important part of grape growing and grape growers must choose between a number of techniques. The most important choice concerns whether or not to use a trellis. Trellises are permanent structures of stakes and wires that are used to support any replacement canes and the vine's annual growth.

Untrellised vineyards – In some regions, the vines may not have a trellis system and the shoots will hang down often as far as the ground. These are called bush vines and they are typically head-trained and spur-pruned. This system is best suited to warm or hot, dry, sunny regions, such as the Southern Rhône in France and the Barossa Valley in Australia, where the extra shade helps to protect the grapes. In cool or wet regions, the shade can impede grape ripening and the lack of airflow can promote disease. This is avoided in Beaujolais, France, where the shoots of head-trained, spur-pruned vines are tied together at the tips, which helps expose bunches to air and sunlight. This training system is sometimes referred to as *gobelet*. Untrellised vines are not suitable for mechanical harvesting.

Trellised vineyards – Each row of vines requires a line of posts joined by horizontal wires. The vine's canes and shoots are then tied to the trellis. Together, this is known as canopy management.

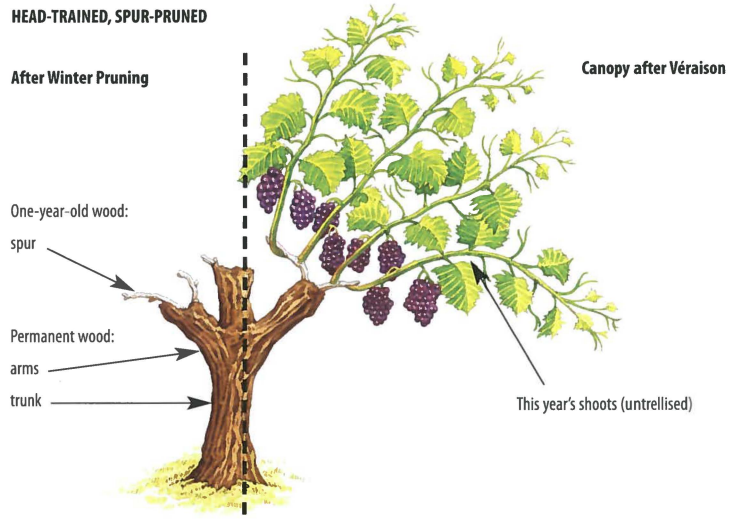
There are three important reasons for doing this. First, the arrangement of the young shoots can be used to control the amount of sunlight that gets into the canopy. In regions with limited sunlight, keeping the shoots apart to create an open canopy maximises the grapes' exposure to sunlight helping the grapes to ripen successfully. However, in regions with intense sunlight, keeping the grapes shaded by leaves may reduce grape sunburn, a problem that can lead to off-flavours. Second, an open canopy can improve air circulation through the leaves and grapes. This is particularly important in wet climates because damp stagnant air can promote fungal diseases. Finally, trellising can aid mechanisation in the vineyard. Positioning the grapes in one area of the vine and the leaves in another means that mechanical harvesting is simplified and the spraying of insecticides or fungicides is more effective.

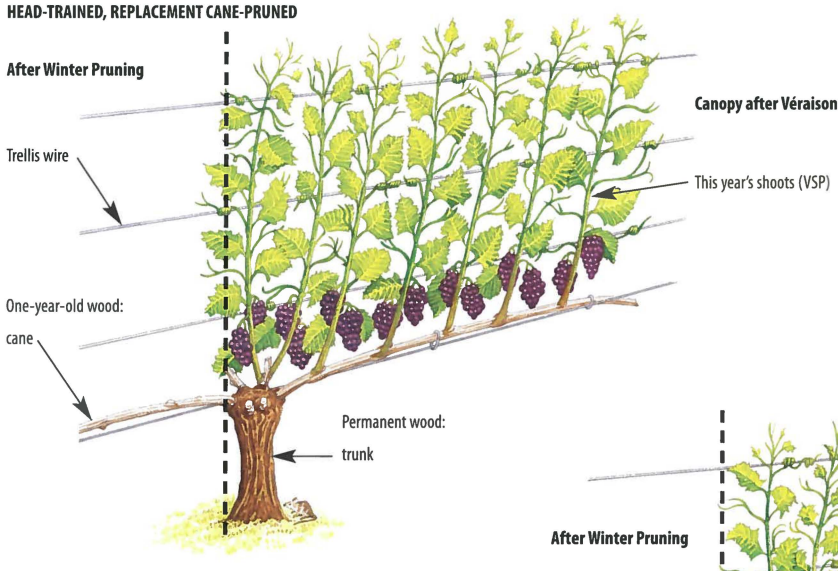
The most widely used system is Vertical Shoot Positioning (VSP). It can be used with replacement cane- or spur-pruned vines. The vine's shoots are trained vertically and are tied in place onto the trellis forming a single narrow canopy. By keeping the shoots apart this system keeps the canopy as open, well aerated and shade free as possible.

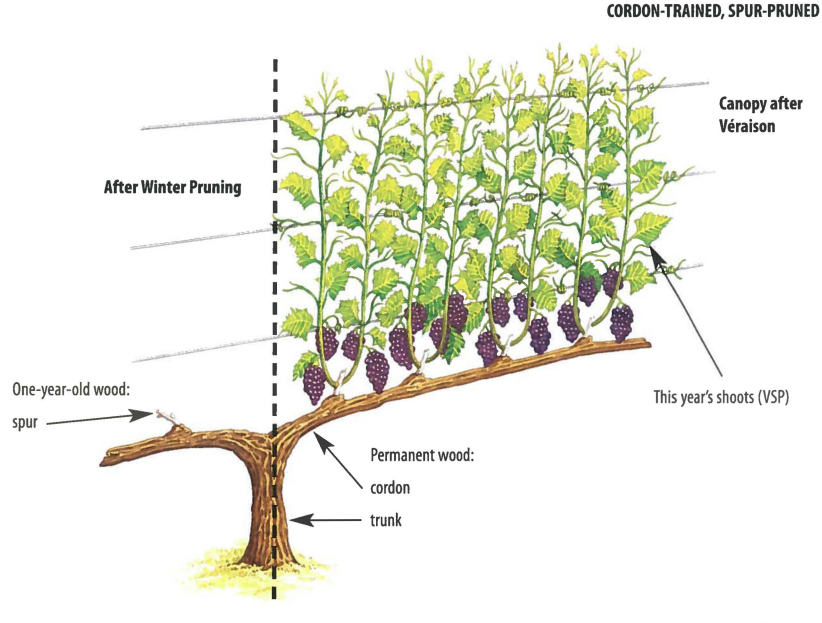
In hot sunny regions VSP can be adapted so that the tops of the shoots are not tied in but flop over creating some shade in the canopy to protect the fruit. A producer would choose to use this system rather than an

VINE TRAINING AND PRUNING

These diagrams show the most common forms of pruning and training. Each one shows the vine after winter pruning on the left and after *véraison* on the right.







untrellised bush vine because mechanical harvesting can be used.

Density

Planting density is the number of vines that are planted in a given area. This is typically expressed as the number of vines planted per hectare. A hectare is an area enclosed by a square with 100-metre sides. Planting densities can vary from as low as 1000 vines per hectare to as high as 10 000 vines per hectare. (Some countries use acres. One acre is approximately 0.4 hectares.)

There are many factors that influence a grape grower's decision regarding planting density. They cannot all be considered here but one very important set of criteria that can, is the availability of nutrients and water.

Very limited water availability – Some regions have very low levels of rainfall or very limited access to irrigation. In these circumstances low planting density can be beneficial, as it allows each vine's roots to take up water from a large volume of soil without having to compete against the roots of neighbouring vines.

Low levels of nutrients and sufficient rainfall – Provided it can access enough water, a vine will thrive in barely fertile soil. Left unchecked it will grow vigorously and produce a lot of green vegetative growth in preference to fruit. In order to counteract this, vines may be planted at a high density. This provides enough competition for resources among the roots to restrict the vine's vegetative growth. Ensuring that the vine has

EXAMPLES OF VINEYARD MANAGEMENT

In order to understand some of the reasons behind the choices that are made in the vineyard, consider the following two examples. Note that in many European wine regions vineyard management is legally controlled and a grower is compelled to use certain options. This factor is not considered here.

EXAMPLE 1

Scenario

This wine region is inland in a hot, very sunny region. Rainfall is very low and there is no or very limited irrigation water available. However, the soil has good water-holding capacity.

Choices and Reasoning

Water availability – This is the most important challenge here because lack of water can kill the vine very quickly. Given that there is little or no irrigation water, the grower must plant at low densities. This will ensure that the vines are not competing for water and that each vine has access to enough water in order to survive.

Sunlight and temperature – The risk here is that the grapes might get sunburned. Therefore it is important that there is some shade in the canopy in order to protect the fruit. A grower might choose to grow their vines as bushes or on a trellis where the top of the shoots flop over. These choices will not give the grower any problems with fungal diseases because the lack of rainfall means that the disease pressure is low.

Low-density bush vines in Spain.

EXAMPLE 2

Scenario

This wine region is close to the coast. It has a moderate climate with high levels of rainfall throughout the year. The soil fertility is low.

Choices and Reasoning

Soil fertility and water – The vine will probably have more than enough resources to survive and the grower needs to introduce some competition between the vines to control their growth. Therefore high-density planting will be the best option.

Growing season rainfall – This presents two important challenges to the grower. First the damp environment is ideal for the growth of fungal diseases. Second the high rainfall means the sky is frequently cloudy, limiting the sunlight. The grower will choose VSP. This will keep the canopy open, which will maximise the amount of light that can enter the canopy and help to keep it well aerated to restrict the spread of disease.

High-density, head-trained, replacement cane-pruned vines in Bordeaux.

the correct number of buds after winter pruning is also important. The vine stores energy in the form of carbohydrates over winter. If there are too few buds then each bud will have access to too much energy and will grow vigorously. On the other hand, if there are too many buds, each one will not have access to enough energy and the vine will struggle to ripen its crop load. When managed correctly this combination of density and pruning makes it easier to maintain an open canopy with all the advantages this confers on fruit quality and disease control. High planting density with strict control of the number of buds on each vine is common in many European vineyards.

High levels of nutrients and sufficient rainfall – Very fertile soils are not suitable for viticulture. However, some vineyard areas, particularly in the New World, are on soils that offer the vines more nutrients than many of the classic European regions. Here high-density planting is often not enough to limit the growth of the vines and another solution has been developed that involves low-density planting using vines with multiple cordons or canes. This system is often able to produce good quality grapes at high yields.

Yields

Yield is a measure of the amount of grapes produced. It may be measured in terms of weight, such as tonnes of grapes per hectare, or volume, such as hectolitres of wine per hectare. It is important for a producer to be able to manage and predict yields. Producers may need to observe legal requirements, such as those that exist in the EU. They may have to meet contractual obligations or the winemaker may simply need to know how much tank space they need to make their wine. Predicting yields is not straightforward. An estimate can be made from the number of buds left on the vine after winter pruning but frost damage, poor fruit set and pests and diseases can all dramatically reduce the final figure.

If yields are going to be too high then they can be reduced by removing immature grapes shortly after *véraison*. This practice, known as green harvesting, is risky because if it is done at the wrong time the vine will compensate for the loss by increasing the size of the grapes that have been retained. This can not only return the yield to the original size but will also dilute the flavours in the remaining grapes.

Yields and Quality

Although traditionally there was a view that high fruit quality could only be achieved by low yields of grapes, it is in fact very hard to make any solid link between quality and yield. There are a number of factors that can affect the relationship between yields and fruit quality, many of which will depend on the individual vineyard site. They are beyond the scope of this book.

MANAGING VINEYARD PESTS AND DISEASES

Vines are susceptible to many pests and diseases, the presence of which may result in a drop in yield and/or reduce the quality of the fruit. Grapes may be lost or damaged by disease or hungry animals. Damage to leaves reduces photosynthesis and limits the vine's ability to ripen its grapes. Some pests and diseases can be controlled; others may kill the vine.

Pests

Phylloxera – This has been discussed in the section *Phylloxera and Rootstocks* in Chapter 4.

Nematodes – These are microscopic worms that attack the roots of vines interfering with water and nutrient uptake. In certain instances they transmit vine viruses. In terms of treatment, prevention is better than cure. Sanitising the soil before replanting and using resistant rootstocks have been found to be successful.

Birds and mammals – They can both consume large volumes of grapes. Furthermore, half-eaten or crushed grapes can lead to an increased risk of fungal disease. Netting is often the best option against birds, whereas protective fencing may be needed to deter mammals such as rabbits, deer or wild boar.

Insects – They feed on both grapes and leaves. The grape grower may choose to treat the problem with regular spraying of insecticides or a more environmentally friendly technique, such as integrated pest management (see section *Sustainable Agriculture* on page 40).

Fungal Diseases

Downy and powdery mildew – These fungi thrive in warm, humid environments and can affect all of the

Netted vines in New Zealand. The nets protect ripe grapes from birds.

THE VINEYARD CYCLE

This diagram shows the annual growth cycle of the vine and the timings of the most common vineyard tasks.

2, 3, 4. Budburst.

1. A vineyard after winter pruning.

Budburst

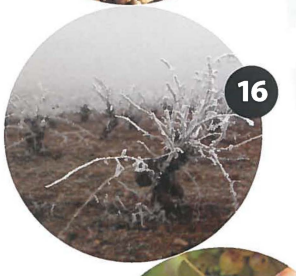
March–April in the Northern Hemisphere
September–October in the Southern Hemisphere

Budburst occurs in the spring. Buds swell and burst, growing into new shoots.

Budburst is the start of the growing season and generally begins when the mean daily temperature exceeds 10°C. The temperature at which budburst occurs depends on the grape variety. Chardonnay and Pinot Noir bud at relatively low temperatures and are called early-budding varieties, whereas Cabernet Sauvignon is a late-budding variety needing warmer conditions.

New shoots can be killed by spring frosts, reducing yields significantly, particularly in early-budding varieties.

Spraying against fungal diseases and pests, if practised, begins at this time.



16. A vineyard in winter before pruning.

15. Hand-harvested white grapes.

14. Ripe white grapes. Note the change in colour post véraison.

13. Ripe black grapes.

Winter Dormancy

December–March in the Northern Hemisphere
July –September in the Southern Hemisphere

As the weather becomes colder, the growing season ends and a period of winter dormancy begins. The shoots become woody and from this point are known as canes. The leaves fall and the vine stores its reserves of carbohydrates in its roots.

In continental climates, winter freeze can kill buds and in extreme cases the vine itself. Earth may be piled up around the vine to provide some protection.

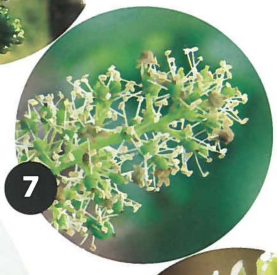
Winter pruning takes place.

Harvest

September–October in the Northern Hemisphere
March–April in the Southern Hemisphere

Ideally the harvest period should be dry. Excess rainfall before harvest can cause grapes to swell, diluting the juice, and due to damp conditions it can increase the risk of rot.

Where practised, spraying must have finished early enough to ensure that there are no harmful chemical residues in the wine.



5. **Early shoot growth.**
6. **An inflorescence before flowering.**
7. **An inflorescence in flower.**
8. **A close-up of an inflorescence in flower.**
9. **Fruit set.**
10. **Immature grapes before véraison. Note that all grapes are green at this stage.**
11. **Black grapes during véraison.**
12. **A vineyard in full canopy.**

Early Shoot and Leaf Growth

March–May in the Northern Hemisphere
September–November in the Southern Hemisphere

Shoots grow rapidly until the vine flowers. Initially this is fuelled by the vine's carbohydrate reserves stored over winter but as the leaves mature they support the growth via photosynthesis. The vine needs a good supply of water and sufficient nutrients early in the season. If practised, shoots are tied to the trellis to ensure the canopy remains open.

Spraying continues as necessary.

Flowering and Fruit Set

May–June in the Northern Hemisphere
November–December in the Southern Hemisphere

When the inflorescences start flowering the vines needs warm temperatures, plenty of sunshine and little or no rain otherwise pollination can be disrupted, reducing fruit set.

Fruit set occurs when a flower starts to develop into a grape. Not every flower becomes a grape and after fruit set unpollinated flowers drop off. If more flowers than normal fail to fertilise this condition is called *coulure*. Grapes can also sometimes form without seeds and remain small. This is known as *millerandage*. Both of these conditions reduce yields and usually stem from cold, cloudy or rainy weather during the pollination period.

Spraying continues as necessary.

Véraison and Berry Ripening

July–September in the Northern Hemisphere
January–March in the Southern Hemisphere

After fruit set there is a period of six to eight weeks during which time the grapes start to grow. Both black and white grapes are green at this stage and the grapes feel hard. *Véraison* signals the point at which the grapes begin to ripen. The grapes' skins change colour: black varieties turn red then purple, whereas white varieties become translucent and golden.

Between *véraison* and harvest, grapes swell and fill with water. During ripening, grape sugar levels rise and the acid levels drop. Colour pigments and flavour compounds also accumulate at this time and tannins develop. Warm and sunny conditions are ideal. Mild water stress inhibits shoot growth and encourages grape ripening.

If required, summer pruning takes place to remove excess foliage ensuring the canopy remains open. Green harvesting (the removal of a proportion of grape bunches) may take place shortly after *véraison* to control yield and improve fruit quality. Not all grape growers use this technique.

Spraying continues as necessary.

green parts of the vine including the leaves and the grapes. If affected, grapes lose their fruity flavours and can give the wine a mouldy bitter taint.

Grey rot – This is caused by the fungus *Botrytis cinerea*. It thrives in damp conditions, and typically attacks grapes. It can taint grape flavours and lead to colour loss in black grapes. In certain conditions and for certain white grape varieties a *Botrytis cinerea* infection can be beneficial as it helps to produce some of the finest sweet wines in the world. In this case the infection is called noble rot. More details can be found in the section *Sweet Winemaking* in Chapter 8.

Fungal diseases can be controlled using chemical sprays (fungicides). Traditionally, powdery mildew was treated with a sulfur-based spray and downy mildew with Bordeaux mixture, a copper-based spray. These treatments are still used but many new chemical treatments now exist. Spraying is usually done by tractor. More sprayings are required in maritime climates, where there is high rainfall during the growing season. All spraying must stop close to harvest time so that there are no harmful chemical residues in the wine.

The risk of fungal disease developing can also be reduced using appropriate canopy management. A dense, shady vine canopy restricts airflow and prevents water from evaporating, creating a humid environment. An open vine canopy allows a greater flow of air, which promotes evaporation and keeps it as dry as possible. This has the added financial and environmental advantages of reducing the usage of chemical sprays which, when used, can reach into all parts of the canopy more easily.

Other Diseases

Viruses – Numerous viruses can infect vines. Most do not kill the vine, but by limiting the vine's ability to function they can dramatically reduce yield and quality. Viruses are highly contagious and persistent, and are usually spread via cuttings or nematodes. There are no treatments or cures. Viruses can only be eradicated by digging up the vines and sanitising the land.

Bacterial diseases – A large number of bacteria can also infect a vine. Many just reduce grape quality and quantity but some can kill the vines. Typically these diseases are spread by small insects called sharpshooters. There are no treatments or cures. Strict quarantine procedures and interrupting the lifecycle of the sharpshooters are the only ways of preventing the spread of these diseases. As with viruses, once a vine is infected the disease can only be eradicated by digging up the vines and sanitising the land.

VITICULTURAL PRACTICES

In the second half of the twentieth century, the use of man-made chemicals in the vineyard to control pests and diseases significantly increased. There was also an increased use of chemical fertilisers. A number of grape growers still rely on regular and systematic applications of man-made chemicals to protect their vines and fertilise their land.

However, the extent of environmental damage that this amount of chemical spraying has caused both in vineyards and the surrounding areas has become an increasing worry to many grape growers, consumers and legislators. In many major vineyard regions there are increasing efforts to reduce the quantity of chemicals used. There are three main options available to grape growers wishing to do this.

Sustainable Agriculture

Man-made chemicals are not prohibited in sustainable agriculture but their use is restricted. Grape growers are encouraged to develop an in-depth understanding of the lifecycles of vineyard pests and monitor weather forecasts so that they can predict and prevent a pest or disease outbreak before it occurs. Rather than simply following a regimented calendar of spraying, this enables them to time the applications so they have the greatest impact. As a result, fewer applications are need.

Integrated pest management is a key part of sustainable agriculture. The predators of certain pests may be encouraged to live in the vineyard to control pest populations naturally. This makes vineyard biodiversity essential. Supporting a range of plants in the vineyard rather than a monoculture of vines can provide habitats for predators of pests and provide nutrients for vines when they are mowed and ploughed into the soil.

Organic Agriculture

Organic agriculture encompasses many of the same concepts as sustainable agriculture; however only a very limited number of the more traditional treatments against pests and diseases is allowed and only in very small quantities. Furthermore, accreditation is required from an organic certification body if the producer wishes to display the organic credentials of their grapes on the label.

There are many certification bodies throughout the world. Although many of these organisations operate on similar principles, the exact standards each one sets may be slightly different. Therefore, and perhaps confusingly, some wines made from organically farmed grapes may have been subject to stricter rules than others. A universal requirement, however, is that the vineyard must undergo a period of conversion working to organic standards before it can be certified.

Biodynamic Agriculture

Biodynamic agriculture is based on the work of Rudolf Steiner and Maria Thun. It adopts organic practices but also incorporates philosophy and cosmology. The vineyard soil is seen as part of a connected system with the planet Earth, the air and other planets. Practitioners adapt their grape growing practices to coincide with the

cycles of the planets, moon and stars. Homeopathic remedies called 'preparations' are used to fertilise the soil, treat diseases and ward off pests. There are also certification bodies for biodynamic agriculture.

HARVEST

Véraison is the point at which the grapes begin to ripen. It is signalled by a change in colour of the grapes' skins; black varieties turn red, then purple whereas white varieties become translucent and golden. As the grapes ripen, sugar levels rise and acid levels drop. Monitoring the rise in sugar levels is a common way of tracking the ripening process. At this time grapes also develop their signature flavours and the tannins in the skins of the grapes become less bitter and astringent.

There is no completely hard and fast rule that states when a grape is perfectly ripe. The ideal balance between sugar, acid, flavour and tannin will vary depending on the grape variety, the climate and, importantly, the style and quality of the wine being produced.

Ideally the harvest begins when the grape grower and/or the winemaker believes that the grapes have the exact qualities they need to create the desired style of wine. However, on occasion, poor weather conditions may cause a grower to bring the harvest forward to save their crop. Hail can destroy grapes and rainfall can cause the grapes to swell excessively and dilute the juice. Winemakers also need to coordinate the arrival of the fruit at the winery to make sure it is not suddenly overwhelmed with fruit it does not have the capacity to process.

Harvesting can be done by hand or machine. The decision to use either method will depend on a number of factors, including how the vineyard is planted, labour availability and cost, the topography of the vineyard, weather conditions and winemaking choices. Note that premium wine can be made from machine-harvested as well as hand-harvested grapes.

Machine Harvesting

Machine harvesters work by shaking the trunk of the vine and collecting the ripe berries as they fall off, leaving the stalks behind. They are not selective, often collecting some unhealthy, unripe and damaged grapes, as well as shaking off bits of leaf, insects and other contaminants, referred to as MOG (matter other than grapes). These unwanted elements can be removed during sorting when the grapes arrive at the winery. However, the scale of some harvesting operations means that this is not always possible.

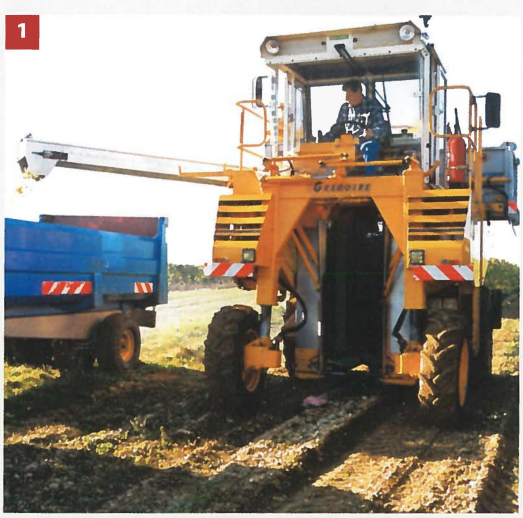
An important advantage of the machine harvester is speed. This may be essential if the vintage is threatened by bad weather, or with certain grape varieties, such as Sauvignon Blanc, that can become over-ripe very quickly. Machines can also work through the night, which allows cool grapes to be brought to the winery. This saves money and energy that would be spent on lowering the temperature of the grapes before fermentation, and it slows down the process of oxidation, which could lead to off-flavours (see section *Oxygen* in Chapter 7).

However, harvesting machines can only be used on flat or gently sloping land and are best suited to varieties whose grapes are not easily damaged and come away easily from their stem. They cannot be used to pick grapes for wine styles that require whole bunches, such as Beaujolais or Champagne.

Hand Harvesting

Hand harvesting (also referred to as hand picking) involves pickers cutting off individual bunches of grapes with secateurs. It is slower and more labour intensive, and for this latter reason it can be more expensive if there is no large workforce to hand.

However, it does allow grape selection to take place in the vineyard; rotten or unripe grapes can be left on the vine. For grapes affected by noble rot, hand picking



HARVESTING

1. Machine harvesting in France. The harvester is able to straddle a row of vines. Beaters hit the trunks of the vines knocking off the grapes, which are caught and transferred to a trailer for delivery to the winery.

2. Hand harvesting in Argentina.

is essential because the onset and level of rot can vary between bunches and even within a bunch, meaning careful selection is needed. Less damage tends to occur to the grapes when they are manually harvested and the grapes can be further protected from damage by being transported in shallow, stackable trays. Unlike machine harvesting, the grape stems are retained. This gives whole, intact grape bunches that can produce a very clean, pure juice when pressed in white winemaking and that are essential for whole bunch fermentations in red winemaking. Hand harvesting may also be the only option on steep vineyard slopes, such as many of those found in the Douro in Portugal, Mosel in Germany, and Northern Rhône in France.