

# **DRYLAND VITICULTURE: AN OVERVIEW OF THE SOUTH AFRICAN SITUATION**

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requirements for the diploma of Cape Wine Master**

## **SUMMARY**

Dryland viticulture is becoming increasingly more challenging, given the realities of global warming and the current financial climate. Not all *terroirs* are suitable for the dryland cultivation of wine grapes. *Terroir* is defined as “*the total natural environment of a viticultural site*”. This includes **climate** (heat, sunshine, rainfall and frost), **soil**, **aspect** (sunshine, temperature, sun strength and drainage) and **location** (Stevenson, 2005).

In order to understand dryland vine cultivation, the viticulturist requires a good knowledge of the *terroir* variables and their influence on the particular site. Most vineyards in the European Community are farmed dryland and irrigation is often frowned upon by these winemakers. This research briefly explores the main parameters for successful dryland viticulture, with particular focus on South Africa’s dryland vineyards. Approximately 15% of South Africa’s vineyards are currently farmed dryland and 90% of these vines are grown in Malmesbury, Stellenbosch and Paarl, earning these regions special mention throughout this dissertation. The wines and winemaking of dryland grapes, together with the financial side of dryland farming are also discussed in this study.

## **DECLARATION**

I, Jan Nicolaas Briers-Louw, declare that this research report is my own, unaided work. It is submitted in partial fulfilment of the requirements for the diploma of Cape Wine Master to the Cape Wine Academy. It has not been submitted before for qualification or examination in this or any other educational organisation.

Signed: \_\_\_\_\_

Dated: \_\_\_\_\_

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# 1. INTRODUCTION

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**Dryland viticulture** (synonyms: dry-farmed vines, dry-grown vines, un-irrigated vines, rain-fed vines, naturally hydrated vines) refers to the cultivation of vines that rely entirely on natural rainfall as a source of water. It is also a term which is often used as a marketing angle by producers in regions where vines are mostly irrigated.

Irrigation in viticulture is the process of applying additional water in the cultivation of grapevines. It is considered both controversial and essential to wine production. Some wine regions do not allow this practice while others cannot exist without irrigation of their vines.

In most Old World wine regions, natural precipitation is seen as the only water source that will not detract from a vineyard's terroir characteristics. Some critics see irrigation as an unduly manipulative practice that can potentially result in decreased wine quality due to high yields stimulated by increased artificial irrigation. Few vineyard practices are criticised more than irrigation, especially in France, where it is believed that only dryland viticulture can produce superior wines (Robinson, 2006).

Some of the world's finest wines (Bordeaux, Burgundy, Barolo, Champagne, Chianti, Rioja etc.) are made almost exclusively from dry-farmed vineyards by achieving a symbiosis between grape variety and terroir (Berry Bros & Rudd, 2013).

Dryland viticulture still dominates in Europe and many European countries have illegalised the use of irrigation or created circumstances where wine from irrigated vines does not conform to the criteria of the legislation of the particular country/region. For example, Certificate of Origin wines which generally fetch higher prices than wines that do not have this classification (Rose, 2005).

Some regions in the Old World (Europe) which experience a combination of uniform rainfall and a Mediterranean climate are practising dryland viticulture, but these regions could raise their wine quality if drip irrigation in limited quantities were allowed (Robinson, 2006).

Historically, irrigation has been banned by the wine laws of the EU, although single countries, such as Spain, Austria and Sicily have changed their regulations in recent years. The governing body of French wine, the *Institut National des Appellations d'Origine* (INAO), has also been reviewing its regulations (Joseph & Payne, 2007).

Irrigation is essential when practising viticulture in areas with very dry climates. In many New World regions such as California (Central Valley), Australia (Murray-Murrumbidgee) and South Africa, irrigation is practised extensively. Many dryland vineyards in these regions are highly regarded for the quality of their grapes. It is for this quality that some wineries are willing to pay a premium which will ensure that these vineyards remain profitable (Robinson, 2006).

Due to the fact that there is no regulation in Australia on irrigation of vineyards for winemaking, the industry has evolved from mostly dryland to predominantly irrigated vineyards over the past 50 years. The main reasons for this are to limit the influence of dry years on quality and yield and to ensure that grape production remains economical by maintaining or increasing yields (Rose, 2005).

Approximately 58% of the total area under wine grape vineyards in South Africa currently receives drip irrigation. Other forms of irrigation (dryland included) have decreased drastically since 1996. Most vineyards in South Africa are irrigated as this produces a higher and more consistent yield of grapes (Van Wyk & Van Niekerk 2012).

Grapevines are hardy plants and they require very little water to survive. The grapevine's largest need is for sufficient sunshine, and it is able to flourish with minimum needs of water and nutrients. However, normal ripening can be seriously influenced by excessive water stress, as photosynthesis almost comes to a standstill under conditions of water stress. Eventually a loss of some, or in serious cases all of the leaves will be observed. In areas where its water needs are not fulfilled naturally, the availability of irrigation meant that viticulture could still be supported (Robinson, 2006).

Ben Rose, principal consultant of Performance Viticulture, says that dryland viticulture relies on the amount of water stored in the soil, plus topping up with rainfall during the growing season, to provide the vineyard with enough water to overcome its evapotranspirational requirements for that season. Obviously it is successful if the grapes meet the maturity composition required by the winemaker, and the yield parameters of the grower. (Rose, 2005)

All viticulturists should strive to limit water losses in dryland- and irrigated vineyards to a minimum. Water can be lost in various ways, including evaporation, transpiration, run-off, leaking dams and irrigation systems etc. With pressure mounting on global water resources, we might see policy changes around the allocation of agricultural water in the not too distant future.

## 2. THE MAIN PARAMETRES FOR DRYLAND VITICULTURE

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Not every viticultural site is suitable for successful dryland grape growing. The three main parameters of dryland viticulture are the stored soil water available to the vines, the water use of the particular vineyard and the balance of the vine (Rose, 2005).

### 2.1 STORED SOIL WATER AVAILABLE TO THE VINES

There are two components that soil consists of, namely solids (soil particles and organic material) and pores (containing liquid & air). The solids to pores ratio differs for each type of soil as well as texture. Soils with smaller particles can hold more water, but the vine has to work harder to utilise the water. When the pores fill up with water, almost all the air is displaced and the soil becomes saturated, known as Saturation Point (Rose, 2005).

By allowing a saturated soil to drain freely, the ratio of soil water to air will equilibrate to be called Field Capacity (FC). Vineyards in South Africa's coastal region are usually at FC during budburst. FC can range from 17% water in sandy soils to 35% in clay soils. Some of this water will not be available for use by the vines. When a vine gets to the point where no more water can be removed from the soil, it reaches Permanent Wilting Point (PWP) and will be seriously damaged (Rose, 2005).

It is essential that a soil has reached its field capacity at bud burst to guarantee maximisation of the available stored soil water for the vines throughout the season. In cases where Field Capacity cannot be reached solely by rainfall, water from drainage lines can be diverted by "furrow-style" channels during winter rainfall. This extra water has proven to have a very positive influence at the time of harvest (Rose, 2005).

If the Plant Available Water (PAW) is depleted, the soil water status will change from Field Capacity to Permanent Wilting Point (PWP). The amount of PAW, together with further top-ups by seasonal rain, is known as the Total Seasonally Available Soil Water. The PAW forms a limited percentage of the soil volume of any given soil type. The amount of Stored Soil Water available to the vines will be enhanced by practices that increase the soil volume available to the vines. According to Rose (2005), these soil volume enhancing practices may

include the rooting depth, choice of rootstock, depth to layers that are impermeable for vineyard roots, soil substructure (clay or lime), planting density of the vines as well as the root development and distribution.

In humid maritime climates such as the Médoc and cool humid climates such as Burgundy, dryland vines do not usually experience water stress from flowering to *veraison* because of an adequate supply of soil water (White, 2009).

## **2.2 WATER USE OF THE PARTICULAR VINEYARD**

Rose (2005) defines the water use of a vineyard as “*the total loss of water from the particular soil.*” This loss is equal to the sum of transpiration of water by the vines, evaporation of water from the soil and transpiration of water by cover crops, weeds and mid-row swards.

Evaporation is greatest on hot, windy, dry, sunny days, and is greatly reduced when clouds block the sun and when air is cool, calm, and humid. Evapotranspiration (ET) is the sum of evaporation and plant transpiration from the earth’s land surface to the atmosphere. The water use of a vineyard can be measured or determined by means of evaporation data or evapotranspiration data (Rose, 2005).

Generally, insufficient winter rainfall is stored in the soil to prevent water stress in grapevines in the hot summer months of growing regions with a Mediterranean climate, such as the Coastal Region of South Africa (Laker, 2004).

Plant water status is indicated by various plant physiological parameters such as: rate of transpiration, rate of photosynthesis, leaf water potential, stomatal resistance or conductance (Laker, 2004).

When working with unirrigated vineyards the ideal is to limit water loss as far as possible, whether this loss is through transpiration by other plants or evaporation from the soil. The philosophies of the winemaker and/or viticulturist, as well as the environment and the particular site of the vineyard will determine the best management option to limit water loss as far as possible. (Rose, 2005)

Soil management in dryland vineyards should strive to store and conserve all rain water to be available for uptake by vine roots. Scientifically based knowledge is required about the relationship between soil-water-plant-climate to optimise the management practices of soil and water in order to balance vegetative growth, yield and quality (Laker, 2004).

Leaf water potential is a widely recognised method of determining plant water status, and is applied extensively in viticultural research. Leaf water potential approaches equilibrium with soil water potential before sunrise to reach the maximum daily value. Leaf water potential decreases quickly after sunrise to reach a minimum value after noon, and recovers from late afternoon and during the night (Laker, 2004).

The three main factors involved when water stress develops are: rate of transpiration, rate of water movement from the soil to the roots and the ratio of soil water potential to leaf water potential. All three factors are influenced by the conditions of the soil and/or atmosphere (Laker, 2004).

### **2.3 BALANCE OF THE VINE**

When it comes to balance of the vine, dryland vines share the same principles as irrigated vines. To ripen a specific yield, a certain leaf area is required to fulfil the photosynthetic requirement of the vine in order to ripen that yield. It is this ratio of crop load to leaf area, that will determine to what extent inputs are required to minimise or optimise stress levels (Rose, 2005).

To meet certain winemaking parameters, dryland vineyards are treated differently from irrigated vineyards. In order to change the water requirement of unirrigated vineyards the size of the vine and its yield are manipulated at different stages. The yield of dryland vineyards are manipulated by pruning the vineyard in winter to allocate a certain yield, suckering all unwanted shoots in spring and removing excess bunches in early summer to maintain the balance between the required yield and the plant available water (PAW). The stress levels of irrigated vineyards are manipulated by using different irrigation patterns at different stages (Rose, 2005).

## **2.4 DETERMINING THE SUITABILITY OF A POTENTIAL VINEYARD SITE FOR DRYLAND VITICULTURE**

The suitability of a certain site for dryland viticulture is dependent on optimising the relationship between Total Seasonally Available Water (TSAW), the water use of a particular vineyard and the balance of the vines. This means that sites with less TSAW will require vineyards with lower water use in order to have balanced vines. Not every region is ideal (or cost effective) for dryland viticulture as it is dependent on the relationship between these factors, together with time, labour and economic limitations (Rose, 2005).

### 3. CLIMATE

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Climate can be defined as the long-term weather pattern of an area, and an extremely important variable in the wine-making equation (Robinson, 2006). These weather conditions include temperature, precipitation and wind that characteristically prevail in a particular region. Mediterranean climate can be defined as a climate type characterised by warm, dry sunny summers and mostly mild, wet winters. This sort of climate occurs throughout the Mediterranean basin, on the West coast of USA, in Chile, southern and south-western Australia, the Black Sea and the Western Cape Province of South Africa (Robinson, 2006).

#### 3.1 TEMPERATURES

South Africa's vineyards are situated between 27° and 35° S – in a warmer growing zone than most European vineyards situated between 34° and 52° N. The Cape's climate is, however, cooler than its location suggests. The vineyards of the Cape's coastal area are situated less than 50 kilometres away from the sea, between the latitudes of 33.5° – 35° S. The further one goes inland, away from the ocean, the higher the temperatures, especially to the north. Rising temperatures are, however, limited by higher altitudes. Cool ocean breezes and regular morning fog also help to lower temperatures. The south easterly wind, more commonly known as the "Cape Doctor", has a significant reducing influence on temperature without bringing rain and can lower the temperature by several degrees (Swart & Smit, 2006).

### 3.2 RAINFALL / PRECIPITATION

Rainfall is a component of the climate which affects grapevines in many and conflicting ways. For vines depending directly on rainfall there needs to be enough rain, at the right times, to promote adequate growth and to avoid severe water stress during ripening. The effects of irregular rainfall are moderated to the extent that the soil has sufficient depth and water-holding capacity and is well enough drained for the vine roots to survive at depth (Robinson, 2006).

The minimum rainfall required annually for commercially adequate yields is around 500mm in cool viticultural climates, rising to about 600 to 750mm in warm to hot climates. The amount of rainfall in European wine regions is quite varied. Rioja in Spain receives 300-500mm while the Bordeaux region in France receives up to 950mm annually. Parts of southern Switzerland and the Vinho Verde region in northern Portugal have annual rainfall totals that exceed 1700mm (Robinson, 2006). In the coastal region of South Africa where winter rainfall prevails, dryland viticulture is possible due to the extraordinary drought resistance of the grapevine (Van Zyl & Weber, 1977).

The Western Cape has a long-term average annual rainfall of about 600mm, ranging from 465mm/a in the drier areas to 693mm/a in the wetter areas. Only 30% of the average rainfall occurs during the growing season (September – March), which means that the Western Cape receives at the most 180mm during this time compared to the 375mm of Montpellier and 439mm of Bordeaux (Saayman & Van Zyl, 1976).

### 3.3 PREVAILING WIND

#### The influence of the South-Easterly wind

The south easterly wind, more commonly known as the “Cape Doctor”, is the prevailing wind during the summer months in the wine regions of the Cape. The South-Easter makes its first appearance during early spring (August and September) and usually lasts until late summer and early autumn (March and April). The speed of the South Easter is directly proportional to the pressure gradient that exists between the South Atlantic High Pressure System (SAH) and the low pressure trough over the interior of South Africa. The South-Easter is generally not a blustery wind such as the North-Wester and generally is fairly uniform in speed. It is most active in late spring during the month of November, when gale-force South-Easterly winds have been known to last for up to a week on end. Although the South-Easter is usually associated with fair weather, it occasionally happens in spring and autumn months that this wind, accompanied by a cut-off low, can cause heavy precipitation over the Western Cape. When this wind reaches gale force speeds, it can cause major damage to young, poorly located or trellised vines and is sometimes referred to as a “black south-easter”. The black South-Easter usually occurs during spring and autumn. The Laingsburg flood of January 1981 was an example of this (First Weather, 2013).

As the South-Easter funnels through the mountains of the Cape Winelands, its effects seem to vary from place to place. South-, east- and south-east facing slopes tend to be more exposed to the effects of this wind. The south-easterly wind is known for drying the vineyard leaves and grape bunches, inhibiting the growth of vine diseases and cleaning the air by dispersing pollution; hence the name “Cape Doctor”.

The South-Easter has a significant reducing influence on temperature without bringing rain and can lower the temperature by several degrees (Swart & Smit, 2006). Orientating vineyard rows, especially trellised vines, parallel to the direction of this wind can further reduce the temperature at meso- and micro climate levels, as a result of better ventilation between vines.

### 3.4 CLIMATE CHANGE / GLOBAL WARMING

Global warming refers to the rise in the average temperature of Earth's atmosphere and oceans since the late 19th century, and its projected continuation. Global warming has been accepted by many as an inconvenient reality, with worldwide observations being consistent. Climate change is a reality, the impacts of which can increasingly be felt in South Africa. According to studies on climate change of the traditional South African winelands, the South African wine industry has already been affected by global warming and this impact will continue in future. Significant trends in rainfall and air temperature are pointed out by research (Vink, Deloire, Bonnardot & Ewert, 2012).

Over the period 1967-2000, twelve weather stations located in the South Western Cape were studied and significant increases were found in minimum (around +1°C for December to March) and maximum temperatures for almost every month of the year. Very warm days have become warmer and have occurred more regularly over the past decade, especially in the months of January, April, and August (Vink, Deloire, Bonnardot & Ewert, 2012).

According to studies on the expected climatic conditions for South Africa in future, temperatures are expected to increase throughout the South Western Cape with areas next to the coast being the least influenced. Typical temperatures are expected to increase with ~1.5°C at the coast and 2-3°C inland of the coastal mountains by 2050 (Vink, Deloire, Bonnardot & Ewert, 2012).

Rainfall projections, based on 30-year Global Climate Models, for mid- century (2046 - 2065), for the Stellenbosch, Paarl and Franschhoek wine regions, show diminished winter rainfall, especially in early winter. In general, warmer and drier conditions can be expected for vineyards (Vink, Deloire, Bonnardot & Ewert, 2012).

Western Cape wine regions have a very wide diversity in soil type, soil depth and climate (mainly at meso-climate level). This diversity, together with the proximity of the Atlantic and Indian oceans, enables growers to plant many different cultivars. It has become necessary to experiment with the tolerance of different cultivars towards temperature and/or drought as well as their disease tolerance or resistance (Vink, Deloire, Bonnardot & Ewert, 2012).

To survive climate change it is essential that climate at different scales is understood in order to adapt correctly according to the viticultural potential of a particular site. This includes a better understanding of macro-climate (regional climate), meso-climate (climate at vineyard level), micro-climate (climate at plant level) (Vink, Deloire, Bonnardot & Ewert, 2012).

Worldwide, a decline in the length of intervals between the main phenological stages of the vine has been noticed, with bud break to bloom, *veraison* or harvest dates shortening respectively by 14, 15 and 17 days. Over the last 30-50 years, phenology of the vine shows a 3-6 day declining response for every 1°C temperature rise over all locations and cultivars (Vink, Deloire, Bonnardot & Ewert, 2012).

When adapting the training system to drier conditions, the yield per vine and per hectare will reduce and might impact on the profitability of grape production. This may also impact on the type and style of wine that can be produced (which also influences profitability). In dryland vineyards, the climatic conditions of the specific terroir unit will influence the choice of pruning and training systems and dictate the yield per vine and per hectare. Climate change will eventually lead to volatility in the characteristics that identify different *terroirs* (Vink, Deloire, Bonnardot & Ewert, 2012).

### **3.5 THE EFFECT OF ATMOSPHERIC CONDITIONS ON THE WATER STATUS OF DRYLAND VINEYARDS**

*“The soil-water-plant-atmosphere continuum can be described as a water stream flowing from a source of limited capacity and variable potential to the atmosphere” (Hillel, 1971).*

The degree of opening of the stomata can indicate plant water stress as water deficits affect the stomata. The stomatal behaviour is also affected by light intensity, concentration of CO<sub>2</sub>, hormones and temperature. The rate of photosynthesis in grapevines reaches a maximum level under low water stress conditions. An increase in water stress causes a decrease in transpiration, photosynthesis and stomatal opening in grapevines. Water stress does not only cause a lower uptake of CO<sub>2</sub> as a result of stomatal closure, but can also inhibit CO<sub>2</sub> fixation (Laker, 2004).

According to Laker (2004), grapevine water status is mainly affected by radiation, wind, temperature and vapour pressure deficit (VPD).

#### **3.5.1 Radiation**

In the middle of the day (10:00 – 16:00), sunlit leaves have a lower leaf water potential than shaded leaves. When comparing sunlit and shaded leaves, a mean leaf water potential of -1.3 MPa in sunlit leaves and -1.0 MPa in shaded leaves can be noted (Van Zyl, 1987). When radiation increases, whether it is by higher intensity or longer exposure, the temperature of especially exposed leaves will rise (Laker, 2004).

#### **3.5.2 Temperature**

Temperature has an impact on all physical processes, enzyme reaction, membrane permeability, and transport processes that govern plant growth and development. Some impacts are very dramatic, whilst others are more subtle. Vines photosynthesize optimally at leaf temperatures between 25°C and 30°C (Laker, 2004)

### 3.5.3 Vapour pressure deficit / Humidity

Vapour Pressure Deficit, or *VPD*, is the difference (deficit) between the amount of moisture in the air and how much moisture the air can hold when it is saturated. Once air becomes saturated, water will condense out to form clouds, dew or films of water over leaves. If a film of water forms on a plant leaf it becomes far more susceptible to fungal infections and grapes can start to rot. On the other hand, as the *VPD* increases the plant needs to draw more water from its roots. Unlike relative humidity, vapour pressure deficit has a simple nearly straight-line relationship to the rate of evapotranspiration and other measures of evaporation. In most plant species, including *Vitis* species, a reduction in stomatal conductance is caused when *VDP* increases above a certain threshold (Laker, 2004).

### 3.5.4 Wind

It has been reported that wind has a very small influence on the water status of many different plant species, including *Vitis vinifera*. However, (Freeman, 1982) reported that stomatal conductance and transpiration decrease when wind speeds exceed 3 m/s. It requires wind speeds above 3 m/s to reduce transpiration and stomatal conductance significantly. Stomatal closure due to wind can limit photosynthesis and uptake of carbon dioxide ( $\text{CO}_2$ ) in various plants even in the presence of sufficient soil water (Laker, 2004).

## 4. THE SOILS OF DRYLAND VINEYARDS

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In regions with a Mediterranean climate and therefore hot, dry summers, as experienced in the Western Cape region of South Africa, the most important quality of a soil is its ability to supply the grapevine with sufficient water throughout the growing season (Laker, 2004).

St-Estèphe, on the Left Bank of the Gironde River in Bordeaux, is said to make qualitative progress year on year. In dry years, soil water is retained by the more clayey soils to provide a freshness that blends very well with the general meatiness of the St-Estèphe style (Spurrier, 2013). The newly promoted Southern Rhône commune, Rasteau, outperforms surrounding communes in dry summers as sufficient soil moisture is retained by the high clay content of the subsoil (Livingstone-Learmont, 2013). This highlights the importance of soil as a *terroir* variable.

### 4.1 SOIL FEATURES AND SOIL TYPES FOR DRYLAND VINEYARDS

Vineyard performance is influenced by soils, different aspects and altitudes and the proximity of the ocean. In certain dryland areas the average annual rainfall is less than 300mm and many of the above factors play an important role in the sustainability of vineyards (B. Oberholzer– Personal communication, 2013).

#### 4.1.1 The vital soil features for successful dryland viticulture

The texture is most important because it determines the water-holding capacity of the particular soil. Sandy soils usually drain very well and are not suited for dryland vine cultivation. Soils with very high clay content and strong structures usually hold the water at high pressure making it difficult for vine roots to extract the water. Grape cultivation on sandy soils mostly involves intensive irrigation in order to achieve production goals (B. Oberholzer– Personal communication, 2013).

The soil depth is the next most important soil feature. The deeper the soil (that is >900mm – together with a homogenous texture throughout the soil profile), the better it will buffer the vineyard through times of drought (B. Oberholzer– Personal communication, 2013).

Soils that compact easily are usually high in sand fractions. Typically granite and sandstone parent material are prone to this feature. Thus water infiltration will be at a low and runoff of rain water is the outcome. Brackish soils form a crust on the soil surface which also makes it prone to runoff of rainwater (B. Oberholzer– Personal communication, 2013).

#### **4.1.2 The most common soil types in South African dryland vineyards**

Oakleaf soils with homogeneous texture at great depths have the highest suitability for dryland vine cultivation. These soils are most common in dryland vineyards and occur on almost every farm in every region. Oakleaf and Tukululo soils have no serious structure development, but may include stones from alluvial or colluvial origin. There are many variations of this soil type, distinguishable by colour, texture, depth and structure (B. Oberholzer – Personal communication, 2013).

Glenrosa soils are characterised by weathering shale parent material. If the material is soft, weathered and/or layering is vertically positioned, it will favour root penetration to greater depths. A net of roots will form on the surface of the rock and will make any water and nutrients thereon available to the vineyard. Glenrosa soils are limited to the depth where parent material can be seen in a 1,5m deep profile-hole. These soils are normally found on top of the low hills of the Swartland and Agter Paarl and show clear characteristics of the parent material, whether it is granite, sandstone or shale (B. Oberholzer – Personal communication, 2013). These low hills were often referred to as “tortoise shells” by the older generations.

The Robertson district is known for its lime-rich soils. Although most vineyards in this area are irrigated, some blocks are dryland cultivated. Dominant soil types are the soft calcareous Brandvlei and Augrabies soils. These soils induce moderate vigour and yields. They have relatively good water holding capacity, with the free lime also providing important calcium ions (B. Oberholzer – Personal communication, 2013).

The south east footslopes of the Paardeberg consist mainly of highly weathered Malmesbury shales. This region is one of the prime wine-growing terroirs and ideal for bushvines like Chenin blanc. The well weathered shales provide good effective depth and good water retention. Even in low rainfall years, these shale soils “harvest” the water to see the vineyards through the warmest summer times. Drought tolerant rootstock cultivars spread

their roots to great depths and in doing so help the vines to buffer themselves against the high temperatures. (B. Oberholzer – Personal communication, 2013)

## 4.2 SOIL WATER STATUS

The availability of soil water is dependent on the quantity of water present, together with the force by which the particular soil retains this water. Both the water-holding capacity of the soil and the plant-available water, are influenced by the depth, texture and structure of the soil (Laker, 2004).

Soil water potential is therefore the ability of a particular soil to supply water to plants. “Field water capacity” forms the upper limit of total “plant available water” (PAW) and is accepted to be  $-0.01$  MPa. “Permanent wilting point” ( $-1.5$ MPa) forms the lower limit of PAW where vine roots are no longer able to extract water from the soil due to soil water being held at very high soil matric potentials (Laker, 2004).

Where soils lack sufficient water-holding capacity, irrigation must be considered, especially in regions with dry summers such as the Western Cape of South Africa. This limitation can also be overcome partially by aiming for optimal root densities through the controversial use of narrower plant densities to utilise soil water more efficiently (Laker, 2004)

Soils with a high plant available water-holding capacity per unit soil depth, that are also deep and well-drained, will allow deep and abundant root distribution that will buffer the vine against drastic changes in the supply of plant available water. This will protect the vine against water stress by limiting the effect of occasional droughts. This will also support the vine throughout the season in regions with winter rainfall, such as the Coastal region of South Africa, by preventing the development of serious water stress. As a result, a more consistent vineyard performance as well as wine quality will be ensured from vintage to vintage. Inferior vineyards will show much more variation in years that are not as favourable, while top vineyards will produce consistently good quality, regardless of vintage variation (Laker, 2004).

Root growth is promoted in clay loam soils under conditions of mild water stress rather than wetter or drier conditions. Under conditions where soil water is ample, considerably fewer fine roots will develop than in a soil with lower water content. A well-developed root system will support the vine through times when soil moisture is limited. Shallow soils have a limited potential rooting depth and can easily be waterlogged by heavy precipitation. The limited water-holding capacity of these soils may cause the soil to lose moisture quickly to reach levels where plants develop water stress. When the normal precipitation deviates only slightly, the water status of shallow soils will rapidly decrease from a water-logged condition to being dry. These soils are mainly found against, or on top of steep slopes, and therefore serious water-logging is not common due to lateral drainage and surface run-off. Irrigation should be considered in vineyards where these soils are found (Laker, 2004).

Effective soil depth determines the ability of a soil to supply sufficient water and nutrients to the vine. The buffer capacity of a soil to bridge malnutrition or drought is determined by the depth of the particular soil. When soils are prepared deeply to increase the effective depth, this will also increase the water-holding potential in the root zone of that soil. In Mediterranean regions, viticulture is practiced successfully in shallow soils, especially where vineyards are terraced to maximise soil depth and minimise erosion. According to Laker (2004), 600mm to 1000mm is the optimum preparation depth of vineyard soils. Soils prepared more than 1000mm deep can cause excessive vegetative growth as more nitrogen is absorbed by the more developed root system (Laker, 2004).

Effective soil depth can be limited by factors such as fluctuating water tables, solid or weathered bedrock, excess salts and pH levels. A very high pH normally suggests a high ratio of sodium adsorption, and has a negative impact on physical soil conditions, while a low pH is associated with aluminium toxicity. Effective soil depth is also limited by sub-surface soil compaction and has a negative impact on vines as the compaction seriously restricts root growth. Only limited amounts of water are available to the vine, as roots are restricted to a thin layer of soil which makes vines very drought sensitive. This is also the case in profiles that contain ample water under the compacted layer which cannot be penetrated by the roots to utilise the available water. These conditions also restrict the shoot growth of vines. The disadvantageous impacts of soil compaction can be minimised by deep tillage (Laker, 2004).

## **4.3 SOIL PREPARATION, CULTIVATION & TILLAGE**

### **4.3.1 The influence of soil preparation and cultivation practices on dryland vineyards**

In general the limited depth and poor physical structure of most grapevine soils require intensive soil preparation. Restrictive layers are broken up to depths of 800 – 1000 mm to make large soil volumes available for root growth. This will give the soil a better buffer ability against the influence of unfavourable climatic and nutritional conditions (B. Oberholzer – Personal communication, 2013).

The emphasis should be on alleviating soil compaction, i.e. to increase porous space and reduce bulk density. Texture is without any doubt the most important soil characteristic, seeing that many other soil characteristics derive from it. Texture provides the building blocks for structure and any soil preparation and cultivation actions that destroy structure should be banished (B. Oberholzer – Personal communication, 2013).

Effective soil preparation with the appropriate implements is able to create a homogeneous root medium, which promotes uniform root distribution throughout soil depth. As a result manipulations above the ground, such as pruning, trellising, plant width and crop load, can be flexible. The general recommendation is to loosen grapevine soil with subsoil problems to a depth of at least 800mm so that the soil appears homogeneous (B. Oberholzer – Personal communication, 2013).

### 4.3.2 Tillage

In established vineyards, correct soil tillage is essential for sustained economic production. Such tillage practices involve soil management to ensure optimal root growth conditions for the grapevine. In vineyards established on well prepared soils, this optimum soil condition must be maintained by following the correct tillage practices. Soils are normally cultivated to limit run-off caused by crust formation, maximising water infiltration and minimising erosion. The soil type, root distribution and weed status of a vineyard will influence the choice of a tillage practice.

Many examples exist of tillage operations that are performed mainly out of tradition (Greenland, 1978). It is unfortunately not widely known that regular tillage may harm the soil as a growing medium for roots, rather than improving it (Greenland, 1977). The soil structure may slowly break down, even if the soil is only tilled occasionally to control moisture consuming weeds mechanically. Over an extended period, this practice may not only cause a subsoil tillage pan to develop but also surface layer pulverisation (Van Huyssteen & Weber, 1980), both impacting negatively on water storage. According to many researchers, soil moisture cannot be conserved by clean cultivation, whilst a mulch cover of plant residues on untilled soils will be much more effective in conserving soil moisture.

In dryland vineyards, the storage of winter rainfall in the soil must be maximised for as long as possible to overcome the dry season. Tillage practices should enhance productive transpiration through the vine and minimise unproductive evaporation from the soil (Van Huyssteen & Weber, 1980).

Corrective tillage is practised to eliminate the restricting effect of soil compaction on root growth in the 15-60cm soil layer in existing vineyards. This practice is used where vineyards are established on soils that were loosened to an insufficient depth prior to planting or where soils have re-compacted. This is normally done by ripping between vineyard rows with a ripper implement that can break compacted or restrictive layers (B. Oberholzer – Personal communication, 2013).

## **4.4 SOIL MOISTURE CONSERVATION IN DRYLAND VINEYARDS**

The storage of winter rain in the soils of dryland vineyards must be maximised for as long as possible to overcome the dry season. This includes the use of black plastic mulch, organic mulch, minimum tillage and cover crops. The value of a good mulch is of vital importance, since it limits water losses through run-off and evaporation.

### **4.4.1 Black Plastic Mulch**

Various studies have proved that vine growth is greatly increased by the use of black plastic as mulch when the vines are planted, especially under dryland conditions. Among the advantages of using black plastic mulch is the conservation of soil water, less soil compaction, soil temperatures are more uniform, there is less leaching of fertilizers, better weed control, and a higher survival rate and increased growth of young vines (Van der Westhuizen, 1980).

The use of black plastic film as a mulch during the early stages of vine growth, particularly in conditions with limited soil water certainly enhances the development of the young vines. This practice will bring them into productivity at least one year earlier. The plastic film reduces the evaporation from the soil to conserve soil water (Van der Westhuizen, 1980).

Black plastic mulch reduces leaching of fertilizers such as nitrogen. The soil under the plastic mulch has a better physical structure due to the elimination of sun, rain and compaction. Temperatures under the mulch are also milder and more stable. All these advantageous effects contribute to better development of the roots. Stronger top growth of vines in the first two years after establishment will allow these vines to be trellised much earlier than unmulched vines (Van der Westhuizen, 1980).

The higher survival rate of young vines with plastic mulching will minimise replanting costs. The plastic film can be covered with soil to control weeds for a longer period which will result in a notable saving in labour costs (Van der Westhuizen, 1980). According to the VinPro labour guidelines, this should take 24-30 man hours/ha (VinPro Cost Guide, 2013).

#### **4.4.2 Organic mulch**

Cover crops can be mowed in spring and thrown sideways to form a mulch under the vines. Other organic mulches includes cereal straw, compost and bark chips. At a planting density of 2000 vines per hectare, the viticulturist would require about 50m<sup>3</sup> of mulch for an under vine strip of at least 25cm wide and 5cm deep. Mulches have various beneficial effects, but can be seen as a fire hazard during the summer months. Mulches suppress weeds and reduce soil evaporation by shading the soil. Mulches prevent raindrops from impacting directly on the soil surface, thereby maintaining soil structure and water infiltration. Mulches encourage biological activity, especially of earthworms through the added organic matter and by keeping the soil moist. Furthermore, mulches supply nutrients that should be accounted for in the fertilizer program (White, 2009).

The positive influence of organic mulch on soil evaporation is more important when the vines are dormant and in spring to early summer before the canopy is fully developed. When less than 10% of the vineyards surface is shaded by the canopy, at least 70% of the total ET is soil evaporation. When the canopy is fully grown and more than 50% of the vineyards surface is shaded, only a small fraction of total ET evaporated from the soil (White, 2009).

#### **4.4.3 Minimum Tillage**

Various minimum tillage practices contribute positively to the conservation of soil water as opposed to the negative effect of conventional tillage. Minimum tillage practices include the use of straw mulch and chemical weed control. A straw-mulch does not only preserve soil water up to six weeks longer than herbicides, clean cultivation and swards, but it also supplies adequate amounts of easily available water to produce stronger and healthier vines with higher yields than with herbicides, clean cultivation and swards. Chemical weed control also preserves soil water more effectively than permanent swards that cause heavy transpiration losses, resulting in the depletion of soil water at crucial times when vines need water most urgently (Van Huyssteen & Weber, 1980).

#### 4.4.4 Cover crops

Cover crops are mainly planted to manage soil fertility, soil quality, water, weeds, pests, diseases, fibre and biodiversity (Lu, 2000).

Cover cropping is important to prevent erosion and to preserve the tilth of the soil. Raindrops hit bare soil and splatter fine particles. This breaks down soil aggregates and seals the surface of the soil so that water runs off, instead of penetrating the soil profile. Erosion then is likely to happen. Cover crops absorb the energy of the raindrops and protect soil aggregates from breaking down. Water can seep into the soil profile between the aggregates. Water storage is then improved, and soil is protected. Cover crops create favourable conditions for root growth by preventing the soil from becoming too cold in winter or too hot in summer. When cover crops are mowed or cultivated into the soil, the decomposing mulch releases nutrients that increase the organic matter and the fertility of the topsoil (Fourie, 2000).

Since dryland vineyards usually are tilled, a seedbed is already prepared. A cover crop (grain species or nitrogen fixing broadleaf species) can be sown in the work row in winter and controlled in the growing season of the vine to create a mulch. It is important to realise that any crop growing in the work row during the growing season of the vine will compete vigorously with the vine for water and nutrients and cause grape production to decrease, drastically in the case of dry land viticulture (Fourie, 2000).

Permanent cover crops are not recommended in dryland vineyards, or those receiving minimal irrigation, because soil water needs to be conserved during summer. In these vineyards, winter cover crops, which can be mowed or cultivated into the soil is favoured. Evapotranspiration (ET) and the risk of late frost damage to vines can be reduced by keeping the mid rows well mown or free of vegetation in spring and early summer (White, 2009).

Cover crops also stand central to a responsibly integrated weed control strategy and will be discussed in more detail under the heading, “weed control”.

## 5. THE EXTENT OF DRYLAND VITICULTURE IN SOUTH AFRICA

### 5.1 TYPES OF IRRIGATION IN THE SOUTH AFRICAN WINE INDUSTRY

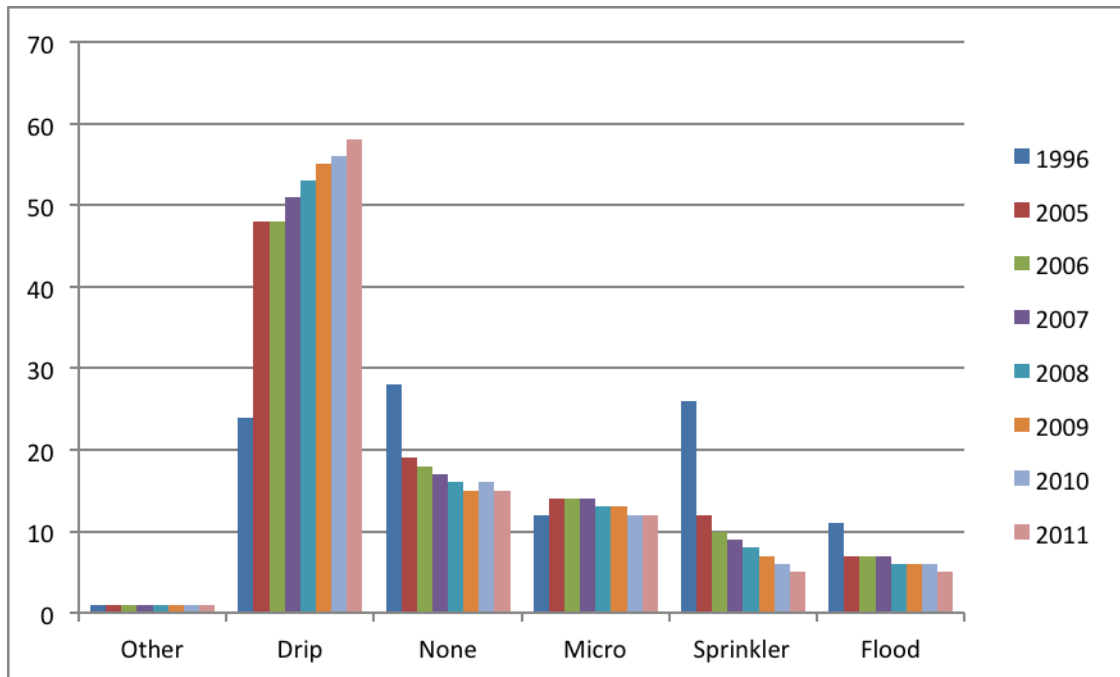


Fig 5-1: Percentage of types of irrigation in the South African Wine Industry (VinPro Cost Guide, 2013)

According to Fig 5-1, approximately 58% of South Africa's total area under wine grape vineyards currently receives drip irrigation. Other forms of irrigation (dryland included) have decreased drastically since 1996.

Drip irrigation is the only category that seems to show a growing popularity. The second most important category, ahead of micro, sprinkler and flood irrigation, is dryland farming or no irrigation. About 15% of South African wine grape vineyards are currently not equipped with any form of irrigation.

## 5.2 SOUTH AFRICAN DRYLAND PLANTINGS PER DISTRICT

Table 5-1: South African dryland plantings (ha) per district (SAWIS, 2012)

DISTRICT	2008	2009	2010	2011	2012
MALMESBURY	7661	7299	7203	6746	6469
STELLENBOSCH	4446	3545	4129	3899	3747
PAARL	3915	3764	3642	3581	3523
OLIFANTSRIVER	416	547	554	566	545
ROBERTSON	107	137	221	338	318
WORCESTER	204	193	214	206	246
BREEDEKLOOF	130	163	184	164	147
KLEIN KAROO	98	89	104	120	84
ORANGE RIVER	55	67	52	71	61
<b>TOTAL HECTARES</b>	<b>17032</b>	<b>15804</b>	<b>16303</b>	<b>15691</b>	<b>15140</b>
<b>Malmesbury+Stellenbosch +Paarl as a % of Total hectares</b>	<b>94%</b>	<b>92%</b>	<b>92%</b>	<b>90%</b>	<b>91%</b>

According to Table 5-1, more than 90% of South Africa's dryland vineyards are planted in Malmesbury, Stellenbosch and Paarl. This figure decreases annually, from 94.07% in 2008 to 90.75% in 2012, and could be the result of either dryland vineyards being uprooted and in some cases replaced by irrigated vineyards or dryland vineyards being equipped with irrigation.

South Africa's dryland plantings decreased by 11.11% (1893 ha) from 17031 ha in 2008 to 15139 ha in 2012.

Malmesbury's dryland plantings decreased by 15.56% (1192 ha) from 7660.83 ha in 2008 to 6469 ha in 2012. This region shows the second largest decrease (%) in dryland vineyards over the last 5 years.

Stellenbosch's dryland plantings decreased by 15.71% (699 ha) from 4446 ha in 2008 to 3747 ha in 2012. This is the region with the largest decrease (%) in dryland planting over the last 5 years.

Paarl's dryland plantings decreased by 10.03% (393 ha) from 3915 in 2008 to 3523 ha in 2012. Paarl is the only major dryland region to show a below average decrease in hectares.

Although the more arid regions inland of the coastal mountains (Olifants River, Worcester, Robertson, Breedekloof and the Klein Karoo) comprise less than 10% of South Africa's dryland vineyards, most of these regions show a year-on-year increase in plantings of dryland vineyards, with Robertson's dryland plantings increasing by almost 200% during the period between 2008 and 2012.

## 5.1 THE FIVE MOST PLANTED GRAPE VARIETIES IN SOUTH AFRICAN DRYLAND VINEYARDS

Table 5-2: The five most planted grape varieties in South African dryland vineyards (SAWIS, 2010)

Variety	Chenin blanc	Cabernet Sauvignon	Sauvignon blanc	Shiraz	Pinotage
Hectares	3514.83	2561.55	2067.38	1792.03	1745.04

Chenin blanc, Cabernet Sauvignon, Sauvignon blanc, Shiraz and Pinotage are by far the most widely planted grape varieties in SA dryland vineyards, followed by Cinsaut with 427 ha (mostly planted in Paarl) and Merlot with 403 ha (mostly planted in Stellenbosch).

### 5.1.1 Chenin blanc

This grape variety was probably introduced to the Cape by Jan van Riebeeck and the Dutch settlers, as early as 1655, or by the Huguenots fleeing France in 1685 (National Library of South Africa). Either way, it has been grown in SA for more than three centuries. Today, Chenin blanc is the most widely planted (white) grape variety in SA dryland vineyards with just over 3500 hectares. In Malmesbury, Paarl, Olifants River and the Breedekloof, this is the most widely planted dryland grape (Tables 5-3, 5-5, 5-6, 5-9).

### 5.1.2 Cabernet Sauvignon

Cabernet Sauvignon is the most widely planted red grape variety in SA dryland vineyards with just over 2560 hectares. This is the most widely planted red grape in all three of the major dryland districts, namely, Malmesbury, Stellenbosch and Paarl (Tables 5-3, 5-4, 5-5).

### **5.1.3 Sauvignon blanc**

The largest plantings of dryland Sauvignon blanc are found in Stellenbosch and this is also the most widely planted dryland grape in Stellenbosch with 907 hectares (Table 5-4). Sauvignon blanc is also (by a narrow margin) the most widely planted dryland grape in Worcester (SAWIS, 2010).

### **5.1.4 Shiraz**

This grape variety has seen an unmatched growth (globally and locally) in plantings and popularity over the last decade, with 50% of SA plantings being younger than 10 years. The majority of dryland plantings of Shiraz occur in Malmesbury, Paarl and Stellenbosch (SAWIS, 2010). Shiraz is the most widely planted red grape variety in Worcester (Table 5-8).

### **5.1.5 Pinotage**

The majority of dryland plantings of this local grape variety occur in Malmesbury, Paarl and Stellenbosch (SAWIS, 2010). Pinotage is the most widely planted red grape in the Olifants River and Bredekloof (Tables 5-6, 5-9). Depending on the choice of rootstock and terrain, Pinotage vines do well under dryland conditions in areas where the rainfall is more than 500 mm per year, as well as with supplementary irrigation in areas with less than 500 mm of rain per year. In dry and warm ripening years, vines with low production levels (less than 8 ton/ha) are more readily able to ripen the grapes than vines with higher production levels (Pinotage Association, 2013).

## 5.2 THE FIVE MOST PLANTED GRAPE VARIETIES PER DISTRICT IN SOUTH AFRICAN DRYLAND VINEYARDS

### 5.2.1 Malmesbury

Table 5-3: The five most dryland planted grape varieties in Malmesbury (SAWIS, 2010)

Variety	Chenin blanc	Cabernet Sauvignon	Shiraz	Pinotage	Sauvignon blanc
Hectares	1640	1212	987	803	750

This largest dryland region in SA also happens to have the largest plantings of Chenin blanc, Cabernet Sauvignon, Shiraz, Pinotage, Sauvignon blanc as well as Chardonnay (260ha).

### 5.2.2 Stellenbosch

Table 5-4: The five most dryland planted grape varieties in Stellenbosch (SAWIS, 2010)

Variety	Sauvignon blanc	Cabernet Sauvignon	Chenin blanc	Merlot	Pinotage
Hectares	907	690	605	403	386

Although Sauvignon blanc is most widely planted here, Stellenbosch has the largest plantings of dryland Merlot in SA.

### 5.2.3 Paarl

Table 5-5: The five most dryland planted grape varieties in Paarl (SAWIS, 2010)

Variety	Chenin blanc	Cabernet Sauvignon	Cinsaut	Pinotage	Shiraz
Hectares	1050	585	427	406	336

Paarl has the second largest plantings of dryland Chenin blanc, Pinotage and Shiraz in SA. Dryland plantings of Chenin blanc in Paarl are almost double (or more) that of any other grape. It is also here where the largest dryland plantings of the initially most planted red grape, Cinsaut, occur.

### 5.2.4 Olifants River

Table 5-6: The five most dryland planted grape varieties in Olifants River (SAWIS, 2010)

Variety	Chenin blanc	Pinotage	Palomino	Sauvignon blanc	Grenache noir
Hectares	99	83	51	48	46

Chenin blanc is the most planted dryland grape in this mass production orientated district, followed by the South African variety, Pinotage.

### 5.2.5 Robertson

Table 5-7: The five most dryland planted grape varieties in Robertson (SAWIS, 2010)

Variety	Chardonnay	Chenin blanc	Colombar	Sauvignon blanc	Shiraz
Hectares	41	36	33	31	29

Dryland plantings in Robertson are dominated by white grapes, with Chardonnay having the largest plantings with 41 hectares.

### 5.2.6 Worcester

Table 5-8: The five most dryland planted grape varieties in Worcester (SAWIS, 2010)

Variety	Sauvignon blanc	Shiraz	Chardonnay	Pinot noir	Chenin blanc
Hectares	45	44	36	31	15

Sauvignon blanc is the most planted grape in Worcester by a narrow margin and could soon be over taken by the very popular Shiraz.

### 5.2.7 Bredekloof

Table 5-9: The five most dryland planted grape varieties in Bredekloof (SAWIS, 2010)

Variety	Chenin blanc	Pinotage	Colombar	Sauvignon blanc	Chardonnay
Hectares	47	33	29	22	8

Chenin blanc is the most widely planted dryland variety in the Bredekloof. Although Pinotage is the second most planted here, dryland plantings in the Bredekloof are dominated by white grapes.

### 5.2.8 Klein Karoo

Table 5-10: The five most dryland planted grape varieties in Klein Karoo (SAWIS, 2010)

Variety	Colombar	Chenin blanc	Sauvignon blanc	Cabernet Sauvignon	Muscat d' Alexandrie
Hectares	22	18	12	12	7

Dryland plantings in the Klein Karoo are dominated by white grapes. This is the only district where Colombar is the most planted dryland grape.

### 5.2.9 Orange River

Table 5-11: The five most dryland planted grape varieties in Orange River (SAWIS, 2010)

<b>Variety</b>	Sultana	Colombar	Sauvignon blanc	Pinotage	Chenin blanc
<b>Hectares</b>	28	10	8	5	5

Dryland plantings in the Orange River are dominated by white grapes. Sultana makes up almost 50% of all dryland planting in this region.

## 6. VITICULTURAL PRACTICES IN DRYLAND VINEYARDS

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Information on practices in unirrigated vineyards is very limited, because dryland viticulture relies on the same principles as those of irrigated vineyards, but with a much lower tolerance for errors. It is therefore very important for the viticulturist to understand and know the terroir of these dryland vineyards extremely well in order to produce fruit of exceptional quality.

### 6.1 PRUNING OF DRYLAND VINEYARDS

In the winter months, vines are pruned for various reasons, of which crop load allocation is probably the most important one in dryland vineyards. Pruning can also manipulate the shape of vines for different types of trellising. The viticultural cycle seems to be restarted by winter pruning, when the number and position of fruit bearing spurs are selected to find the perfect balance between the vine and its terroir.

Father and daughter winemaking team and dryland specialists, Howard and Christobelle Anderson from Anderson winery in Rutherglen, Australia says, *“winter-pruning is critical in determining how much the vine will grow in the spring. If too many buds are left and there is a wet spring, the vine will grow vigorously and be at risk of having too much canopy and fruit to sustain over a dry summer. In this case the vine will not be able to ripen the grapes properly. Shoot thinning helps, but the vine has already expended that energy on growing an unwanted shoot, rather than on ripening the grapes.”*

Many dryland vineyards in South Africa are still bush vines. These vines are generally pruned to have 4-6 arms, with two spurs each, which are mostly pruned short to between 1 and 3 buds. In South Africa’s trellised dryland vineyards, the double cordon method of trellising seems to be favoured. These vines are generally pruned to have 8-12 spurs each and are normally pruned short to between 1 and 3 buds per spur.

According to the VinPro’s recommended labour guidelines it should take 86-160 man hours per hectare for clean pruning of bush vines and 45-55 man hours per hectare for short pruning. This adds up to a total pruning time of 131- 215 man hours per hectare for bush vines (Van Wyk & Van Niekerk, 2012).

In some cases, trellised vines take longer to prune and can also be more expensive to prune. It takes 30-37 man hours per hectare to pre prune, 105-120 man hours per hectare for clean pruning and 42-62 man hours per hectare for short pruning. This adds up to a total pruning time of 177- 219 man hours per hectare for trellised vines (Van Wyk & Van Niekerk, 2012).

## 6.2 CANOPY MANAGEMENT OF DRYLAND VINEYARDS

Canopy management can be described as *“a portfolio of vineyard management techniques used to improve vineyard yield and wine quality, and to control vine diseases, especially where vines are of high vigour”* (Robinson, 2006).

According to the Department of Environment and Primary Industries, Victoria, Australia, canopy management is critical because it can be used to improve airflow through the canopy which reduces levels of humidity (ANON, 2010). Canopy management also reduces levels of shading in the canopy and improves the application efficiency and distribution of chemical spray in the canopy. In order to change the water requirement of rain-fed vineyards, the size of the vine and its yield is manipulated at different stages to meet certain winemaking parameters (ANON, 2010).

The recommendations regarding canopy management and vine development may differ because of differences in *terroir* at farm level and different grape varieties, together with the choice of rootstock. Bush vines may be considered on lean soils or under dryland conditions, where growth could be insufficient to justify a trellis system (Van Schalkwyk & Schmidt, 2009).

John Munch, the winemaker at Le Cuvier Winery, Paso Robles, California, says that *“dry-farmed vines are very self-regulating, and the fruit is often superior from these vineyards because natural water availability frequently causes a good balance: If the grower over-crops, the vines will shut down and turn to raisins. If the vine is under-cropped, you get a lot of suckering.”* (McGourty, 2010)

Desuckering or shoot thinning is the viticultural practice of removing unwanted young shoots from the trunk, cordon or head of the vine. This vineyard practice shouldn't be left too late and is recommended to be done when shoots are 20-40cm in length (Robinson, 2006).

Bush vine vineyards, as they are referred to in Australia, California and South Africa, are usually trained to be in the shape of a wine glass. These free standing vines, referred to as *gobelet*, in France, are best suited to low-vigour vineyards in drier climates (Robinson, 2006). The buds and shoots in the centre of these vines (the inside of the glass) are normally removed by suckering. Any shoots, other than those developing on the positions allocated during winter pruning, should be removed as soon as possible to limit the water use of the particular vine. Bush vines are normally suckered to 2-3 shoots per spur, depending on the vigour of the vineyard.

In South Africa, the double cordon vine training system seems to be favoured in trellised dryland vineyards. Any shoots, other than those developing on the positions allocated during winter pruning, should be removed as soon as possible to limit the water use of the particular vine. Big canopies usually have a higher water usage and therefore unwanted shoots are removed by suckering. These canopies with higher water usage can be further managed by performing timeous tipping and topping actions.

Tipping is the viticultural practice where 10-20cm of the tips of the most vigorous shoots are removed. Doing this at flowering can result in better fruit set (Robinson, 2006). Topping is a more severe form of tipping where unwanted shoot growth of about 30cm is normally removed. This unwanted shoot growth can decrease the effectiveness of spraying and cause shading within the vine (Robinson, 2006).

### 6.3 VINE DENSITY/SPACING IN DRYLAND VINEYARDS

Vine spacing can be defined as *“the length and width of the soil surface available to each individual vine while focussing on optimal utilization of available water and nutrients in the soil and vigour to produce good quality grapes.”* The optimal vine spacing for any vineyard depends on the factors that influence growth and yield (Robinson, 2006).

Vine spacing has a definite influence on soil water content and plant water status. Archer & Strauss (1989) showed that higher root densities of narrower plantings caused soil water content to deplete more rapidly. This has a negative influence on leaf water potential and will cause stomatal closure which will affect the rate of transpiration negatively. This means that vines with a narrower spacing ripen their fruit under higher levels of water stress than vines with a wider spacing (Archer & Strauss, 1989).

High vine densities as a result of narrow vine spacing can have far reaching consequences in dryland vineyards. In years where rainfall is below the long term average, soil water will be depleted by high root densities. This may cause excessive water stress and can consequently also influence grape quality and yield. Photosynthesis may also be negatively influenced by conditions of excessive water stress. The viticulturist must be familiar with these effects to make a wise decision regarding vine spacing prior to planting (Archer & Strauss, 1989).

According to Champagnol (1979), a lack of soil water is the main factor that limits root development and growth and except for physical and chemical soil differences, it is also the common limiting factor in dryland vineyards. There is little consensus of opinion about the adjustment to plant spacing under dryland conditions. Perold (1926) suggested that vines planted in shallower or drier soils as well as a warmer and drier climate must have a correspondingly wider spacing. However, Champagnol (1979) indicated that the maximum area effectively used by the vine is directly correlated to soil moisture and fertility. A drier soil with less fertility therefore has a smaller utilisable soil area and volume available for the vine. On these soils, closer spacing will allow efficient use of soil moisture and nutrients available to the vine (Archer & Strauss, 1989).

In Spain, vines have wide planting widths in many regions, such as Galicia, Yecla and La Mancha. Spanish viticulture has developed to adapt to the extreme and varied climate of most regions. In these regions, the poor fertility of the soils and the threat of droughts resulted in wide vine spacing to minimise competition for resources between vines. *Marco real* is a widely adopted system that involves having a vine spacing of 2.5-4m in all directions. These regions that are located mostly in the centre and South of Spain, have some of the lowest vine densities in the world that often vary from 900-1600 vines per hectare. This vine density is less than 1/8<sup>th</sup> of densities commonly found in other wine regions such as Burgundy and Bordeaux. After droughts severely reduced Spanish yields in 1994 and 1995, the use of irrigation became more popular. In 1996, irrigation was legalised in all Spanish wine regions with many regions quickly adopting the practice (Robinson, 2006).

Grapevine performance under dryland conditions is determined by the volume of soil effectively used by the vine rather than the potential soil volume available and therefore yields will increase as plant density increases until the available soil is fully utilised. Unirrigated soils mainly differ in terms of physical and chemical properties and therefore also in terms of the availability and accessibility of soil water and nutrients (B. Oberholzer–Personal communication, 2013).

## **6.4 WEED CONTROL**

In practice, any other plant than vines found in the vineyard after budding is seen as a weed. This is also the case when cover crops, which have lots of advantages during the winter months, are still alive when the vines start to bud.

Summer growing weeds have various negative effects on vines of which the following are most important: Weeds compete for soil water and nutrients, excrete toxins in the soil, enhance pests and diseases and complicate the harvest process. It is important to limit the competition for soil water and nutrients in dryland vineyards to the minimum, especially between budburst and ripening (Fourie, 2000).

It is highly recommended to follow a weed control strategy where chemical, mechanical and biological methods are responsibly integrated to control weeds in dryland vineyards. The timing of these actions is very important to prevent weeds from growing out of control and spreading their seeds (J. Fourie – Personal communication, 2014).

### **6.4.1 Chemical weed control**

Chemical weed control is cheaper and less time consuming than mechanical weed control. There is less damage to the roots of the vine, more effective control of weeds and no competition for water from weeds. Chemicals can be used to control weeds around drippers and sprinklers in irrigated blocks. Chemicals can be harmful to the operator and the environment if not used correctly. Herbicide sprays can drift into the vines causing temporary or permanent damage. Weeds can develop resistance to the action of herbicides (Mildura, 2004).

The viticulturist, together with the chemical advisor, should monitor the weed status of each vineyard before applying chemicals and three weeks after the application, the effectiveness of the chemicals should be determined. It is crucial to monitor the weed status of dryland vineyards during berry development and to control any weeds competing with the vines for water and nutrients (J. Fourie – Personal communication, 2014).

#### **6.4.2 Mechanical weed control**

This is the oldest form of weed control and includes the use of discs, ploughs, as well as weeding with spades or forks. Mechanical weed control also includes pulling out some weeds by hand. Mechanical weed control is fairly easy to apply. It controls weeds immediately. Annual and certain perennial weeds can be controlled. The roots of the uprooted weeds dry out quickly in warm, dry weather and limit re-growth of vegetative reproductive perennial weeds. In areas with low rainfall during summer, weeds can be controlled by a single mechanical cultivation in late spring. Mechanical weed control is quite costly (more expensive than chemical control) as regular repetition of this practice is required for it to be effective. An ideal seed bed is created for weeds to germinate. Some perennial problem weeds can be propagated by mechanical weed control. Shallow vine roots are damaged by most implements used for mechanical control of weeds. When top soils are regularly cultivated, the soil will be compacted, pores in the soil will be destroyed and less organic material will be present. Pulverisation of the top soil takes place and the soil loses structure, resulting in the formation of a crust on the soil surface. This crust is less penetrable for rain water, resulting in run-off that will not only cause erosion, but a loss of water that could have been stored in the soil (Fourie, 2000).

Black plastic mulch is a mechanical weed control method. The use of black plastic mulch controls weeds that compete with the vines for water and nutrients and therefore restricts water losses, especially in the first season after planting the vines (Van der Westhuizen, 1980).

### 6.4.3 Biological weed control

#### Cover crops

Cover crops control most weeds effectively by competing for soil water and nutrients (Fourie, 2000). Fourie also says that the use of cover crops in dryland vineyards is crucial to limit this competition by weeds, to limit soil water losses by protecting the soil from the baking sun and to add organic matter to the soil. Cover crops must be established shortly after harvest. This will allow seeds to germinate when the climate is favourable and autumn rains come, resulting in a longer growing season to produce more plant material. An ideal cover crop must germinate rapidly with a good germination percentage. Different cover crops are selected according to their characteristics for different scenarios. Medics are recommended as the ideal cover crop for new dryland plantings and should be planted full-surface in every row to control weeds. Where dryland vines are planted after the winter it is recommended to plant the cover crop the previous autumn to allow a longer growing season, produce more organic material and control weeds more effectively before the vines are planted. On soils with a higher clay percentage it is recommended to plant oats, rye and triticale (a hybrid of wheat and rye) or a mixture of these grains and should be planted full-surface in every row to control weeds. Cover crops should be controlled chemically between late-winter and early-spring to limit competition with vines for water and nutrients. The viticulturist should use the soil water status to decide the timing of chemical control of cover crops. It is also recommended to flatten the cover crop with a roller after chemical control to form a layer of organic matter in the mid-row or to project the organic matter sideways to form a mulch under the vines (J. Fourie – Personal communication, 2014).

## 7. ROOTSTOCKS

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A rootstock can be defined as the plant forming the root system of a grapevine to which a fruiting variety, or scion, is grafted. Rootstocks are mainly used to overcome pests and diseases in the soil and for their tolerance to certain soil conditions (Robinson, 2006).

After many French vineyards were destroyed around 1880, by the devastating root louse, phylloxera, the use of rootstocks for grapevines became common.

Dry-farmed vines must have rootstocks that promote deep root growth to allow the vines to search out water. Drought tolerant rootstock cultivars spread their roots to great depths and in doing so help to buffer the vines against the high temperatures. (B. Oberholzer – Personal communication, 2013)

### 7.1 FACTORS THAT INFLUENCE THE CHOICE OF ROOTSTOCK

The choice of rootstock is influenced by various factors. The factors below the soil surface include the water-holding capacity of the soil, the effective depth of the soil, the pH-value of the soil and the fertility of the soil. Above the soil surface, the natural vigour of the scion (e.g. Shiraz and Cabernet Sauvignon are naturally vigorous), the type of trellising to be used and the production goals of the particular vineyard can also influence the choice of rootstock. It is important to take all of the above mentioned factors into consideration when making a decision between the different rootstocks.

When one matches the particular site with appropriate grape varieties, clones and rootstocks, it helps to establish the profitability, potential productivity, and wine quality of the vineyard. A vineyard's full potential can be realised by the combination of good management practices and favourable weather- and climatic conditions (Jones & Hellman, 2002).

In dryland vineyards, preference is given to 140 Ruggeri, especially on low vigour potential soils, with 110 Richter, 99 Richter and 1103 Paulsen also considered good options (Saayman, 2010).

## 7.2 DROUGHT TOLERANCE OF ROOTSTOCKS

Dr. Andy Walker, noted professor and rootstock breeder at the University of California, Davis, says we need to think about more appropriate vigour for our vineyards. We may not have as much irrigation water available in the future for a variety of reasons. There are two strategies that could be used to deal with this problem. The first is typical of rootstocks with *Vitis riparia* parentage. They induce a short cycle of growth, the crop ripens before the water supply in the soil is used up. The second approach is a deep root system that can more effectively find water deeper in the soil profile. These vines are usually more vigorous and grow later into the growing season, resulting in later ripening. (McGourty, 2010)

According to Dr. Walker, drought tolerance as a specific genetic trait may not exist. What is known is that some rootstocks have more acute rooting angles, larger root systems and a longer vegetative cycle (McGourty, 2010).

*Berlandieri-rupestris* hybrids have the best drought tolerance, and include 110 Richter and 140 Ruggeri, followed by 1103 Paulsen and 99 Richter. Species and hybrids of *Vitis riparia* have a short growth cycle and a low tolerance towards dry soil conditions (Robinson, 2006).

Tables 7-1 to 7-4 indicate the different levels of tolerance / resistance towards certain factors that could influence the normal functioning of the vine negatively. Although these rootstocks are not the only ones found in dryland vineyards, they are the most common. This information only serves as a guideline and cannot be guaranteed in all situations.

### 7.2.1 99 Richter (99R)

Table 7-1: Resistance of 99 Richter towards the following restrictive factors (Lelienfontein Vine Growers – Personal communication, 2013)

<b>Drought</b>	<b>Phylloxera</b>	<b>Nematodes</b>	<b>Phytophthora</b>	<b>Wet</b>	<b>Lime</b>	<b>Salinity</b>
Average - High	Low - Average	High	Low	Low	High	Low

99R was developed in 1889 by the Frenchman, Frans Richter (Archer, 1984). It is a cross between *Vitis berlandieri* x *Vitis rupestris*. This rootstock was imported to South Africa for the first time in 1929.

99R has high vigour and high production potential and thrives on medium to high potential soils (Hutton, Clovelly), dark coloured soils (Oakleaf) and well drained shale and granitic soils (Glenrosa and Swartland). 99R has a short vegetative cycle and loses its leaves in early mid-season. This rootstock has low resistance to phytophthora, wet soil conditions and salinity. It is not as widely used in European vineyards as in South Africa.

### 7.2.2 110 Richter (110R)

Table 7-2: Resistance of 110 Richter towards the following restrictive factors (Lelienfontein Vine Growers – Personal communication, 2013)

<b>Drought</b>	<b>Phylloxera</b>	<b>Nematodes</b>	<b>Phytophthora</b>	<b>Wet</b>	<b>Lime</b>	<b>Salinity</b>
High	High	Average	High	Average	High	Average

110 Richter was also developed in 1889 by the Frenchman, Frans Richter (Archer, 1984). It is a cross between *Vitis berlandieri* x *Vitis rupestris*. This rootstock was imported to South Africa for the first time in 1929, together with 99R. 110R has average to high vigour, but not as much as 99R. 110R is considered for the same soil types as 99R, especially where soils are shallower with less soil water available to the vine. This rootstock is recommended for hillsides or dry-farmed sites where drought is likely. On deep fertile sites 110R can promote too much vigour in scions, causing vegetative characters in wines and poor bud fruitfulness. Potassium deficiency on heavy soils has also been reported. 110R can be relatively slow to establish, but its vigour increases as the vines develop. This rootstock is susceptible to root-knot and dagger nematodes, but has good phylloxera resistance. In contrast with the low phytophthora resistance of 99R, 110R has a high resistance to this root rot pathogen.

### 7.2.3 1103 Paulsen (1103P)

Table 7-3: Resistance of 1103P towards the following restrictive factors (Lelienfontein Vine Growers – Personal communication, 2013)

<b>Drought</b>	<b>Phylloxera</b>	<b>Nematodes</b>	<b>Phytophthora</b>	<b>Wet</b>	<b>Lime</b>	<b>Salinity</b>
High	High	Average	Average - Low	High	High	Average

In 1882, 1103P was selected by Paulsen in southern Italy for its strong drought tolerance and its ability to grow well on lime-based soils (Archer, 1984). 1103P is a cross between *Vitis berlandieri* x *Vitis rupestris*. The above mentioned rootstock was imported to South Africa in 1962 for its high resistance towards dry and wet soil conditions.

This rootstock promotes strong vigour to scions, especially on fertile soils (heavy clay-loam) with ample water. 1103P seems well suited to dryland vineyards, and it is reported to be more drought tolerant than 110R. Although 1103P is susceptible to root-knot and dagger nematodes, it has good phylloxera resistance.

#### 7.2.4 140 Ruggeri (140Ru)

Table 7-4: Resistance of 140Ru towards the following restrictive factors (Lelienfontein Vine Growers – Personal communication, 2013)

<b>Drought</b>	<b>Phylloxera</b>	<b>Nematodes</b>	<b>Phytophthora</b>	<b>Wet</b>	<b>Lime</b>	<b>Salinity</b>
High	High	Average - High	Average - Low	Average	Very High	Average

140Ru, a cross between *Vitis berlandieri* x *Vitis rupestris* was created by Ruggeri in Sicily. This rootstock was imported to South Africa from Italy in 1964 to add to the choice of locally available drought tolerant rootstocks.

140Ru has a high resistance to drought with a very high vigour. This rootstock performs well in drier, limestone-rich soils. In shallower clay-based soils 140Ru performs just as well as 110R and better than 99R and 101-14 Mgt. Ruggeri also does very well in deep and dry sandy soils. This shows that the above mentioned rootstock performs well in a variety of soil conditions.

Italians consider 140Ru to be one of the most drought tolerant rootstocks, but it is too high in vigour for deep soils with moderate to high fertility. This rootstock is best suited to dryland sites with shallow soils. 140Ru has good phylloxera resistance, is reported to have moderate resistance to root-knot nematodes, and good tolerance to lime-based soils.

## 8. THE WINES & WINEMAKING OF DRYLAND FRUIT

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Most winemakers would agree that there is a difference between grapes and wines from irrigated vineyards and those from dryland vineyards. Grapes are different in terms of physical appearance, while wines have different organoleptic profiles and analytic values.

### 8.1 THE PHYSICAL APPEARANCE AND CHARACTERISTICS OF DRYLAND GRAPES

Dryland fruit differs from irrigated fruit in terms of physical appearance. Terroir plays an important role – the amount of water available during the development and ripening stages will play a role in determining the size of the berries and bunches.

The berries and bunches tend to be smaller than grapes from similar vines (cultivar, rootstock and region) that were irrigated. Dryland fruit also tends to have thicker skins. The colour, tannin and most of the flavour comes from the skins of the grapes, so when making premium wines this can be desirable. The cells inside the berries tend to be more numerous but smaller than those of irrigated grapes. White grapes are generally a bit more yellow in colour due to more exposure to direct sunlight, while the colour of red grapes is very much the same or even more intense. Some grape bunches from dryland vineyards have raisins and sunburnt grapes in between the healthy berries. (C. Du Plessis, F. Van Niekerk, A. Louw, S. Du Toit & C. Cutting, 2013 – Personal communications)

## **8.2 THE ORGANOLEPTIC PROFILE OF WINES FROM DRYLAND FRUIT**

Grapes from dryland vineyards will usually create wines in a more serious style. The colour, tannin and most of the flavour comes from the skins of the grapes. The smaller size of the dryland berries together with their thicker skins result in a higher ratio of skins to juice. Wines tend to be bold and complex with good extract and tannin (from the skins) and concentrated flavours. This will also depend on how the grapes are treated by the winemaker. Of course these serious wines are not necessarily to everyone's taste, but they do give an indication of the importance of the vineyards to the final wine (C. Du Plessis, F. Van Niekerk, A. Louw, S. Du Toit & C. Cutting, 2013 – Personal communications).

## **8.3 THE ANALYTIC VALUES OF DRYLAND FRUIT AND ITS WINES**

Many factors have an influence on the analytic values of grapes and wine. The most common analytic values used to determine the ripeness levels of grapes are sugar levels (°Balling in South Africa), total acidity (TA indicated in grams per litre) and pH. Some wineries also test for free amino nitrogen, malic acid and total extract.

### **8.3.1) Sugar levels, Total acidity and pH**

The sugar levels of dryland fruit tend to rise more quickly during the final ripening stage as a result of limited soil moisture available to these vines. The acidity in wine is an important component in the quality and taste of the wine. It adds sharpness to the flavours and is detected most readily by a prickling sensation on the sides of the tongue and a mouth-watering aftertaste. A wine with too little acidity will taste flabby and flat, with less defined flavours (Robinson, 2006). The total acidity (TA) in dryland grapes is usually a bit lower due to less growth in the shoots at a late stage compared to irrigated vines. In warmer and drier years the pH is normally a bit higher due to water stress. In very dry years or after heat wave conditions, it is not uncommon to see a pH as high as 4 with a TA as low as 4 g/L. Winemakers often refer to these as "4x4 wines". Such wines will in most cases require acid and pH adjustments which will on the one hand add to winemaking costs, but on the other hand create a more suitable wine analysis to enhance ageing potential, colour stability, sulphur-efficiency, microbial stability and oxidative stability (C. Du Plessis, F. Van Niekerk, A. Louw, S. Du Toit & C. Cutting, 2013 – Personal communications).

### **8.3.2) Free Amino Nitrogen**

Free Amino Nitrogen (FAN) is a measure of the concentration of individual amino acids and small peptides which can be utilized by wine yeast for cell growth and proliferation. Together with ammonia, FAN makes up the measurement of Yeast Assimilable Nitrogen (YAN) that can be measured prior to the start of fermentation (Fugelsang & Edwards, 2010). Except for the fermentable sugars (glucose and fructose), nitrogen is the most important nutrient needed to carry out a successful fermentation that does not end prior to the intended point of dryness or shows the development of off-odours and related wine faults. To this extent winemakers will often supplement the available YAN resources with nitrogen additives such as diammonium phosphate (DAP) (Zoecklein, Fugelsang, Gump & Nury, 1999). The quantity of FAN that winemakers will see in their grape musts depends on a number of components including grape variety, rootstock, vineyard soils and viticultural practices (such as the use of fertilizers, irrigation and canopy management) as well as the climatic conditions of particular vintages. The typical wine grape will have anywhere from 22 to 1242 mg of nitrogen per litre derived from free amino acids (Sara, 1996). Under dryland conditions, especially in very dry years or after a heat wave, fruit generally has lower levels of FAN than irrigated grapes and will require higher doses of the preferred nitrogen source to be added for utilization by wine yeast for cell growth and proliferation (C. Du Plessis, F. Van Niekerk, A. Louw, S. Du Toit & C. Cutting, 2013 – Personal communications).

### **8.3.3) Malic acid**

Malic acid, along with tartaric acid, is one of the principal organic acids found in wine grapes. Its chemical structure allows it to participate in enzymatic reactions that transport energy throughout the vine. Its concentration varies depending on the grape variety, with some varieties, such as Barbera, Carignan and Sylvaner, being naturally deposited to high levels. As the vine progresses through the ripening stage, malic acid is metabolized in the process of respiration, and by harvest, its concentration could be as low as 1 to 9 g/L. The respiratory loss of malic acid is more pronounced in warmer climates and under conditions of very limited soil water. When all the malic acid is used up in the grape, it is considered “over-ripe”. Winemakers must compensate for this loss by adding acid at the winery in a process known as acidification (Robinson, 2006).

### **8.3.4) Dry Extract**

Dry extract refers to the solid part of the wine — the powder that would be left if all the water and alcohol from a wine are removed. This is an extremely technical term, but it's fairly easy to see how dry extract relates to the body of a wine: The more dry-extract, the heavier, thicker or bigger the wine. Generally, the solids of a white wine lie around 15 to 20 grams per litre, while red wines are closer to 20 to 30 grams per litre. Not many winemakers test the dry extract of their wines, although it is a required analysis for export to some countries. The term “extract” is often used to explain the popularity of riper wines, because higher dry extract can balance or even hide higher sugar and alcohol levels in wine.

### **8.4 THE TREATMENT OF DRYLAND FRUIT IN THE CELLAR**

Although the basic principles of winemaking remain the same, most winemakers agree that dryland fruit has to be treated a little differently in the cellar. Some grape bunches from dryland vineyards have raisins and sunburnt grapes in between the healthy berries. For top quality wines, hand sorting is required to remove these overripe berries in order to prevent or limit an overripe, jammy character in the wine. It is recommended that the acidity (and pH) be adjusted as soon as possible in the winemaking process, should this be required. Pre- and post fermentation maceration is normally not required as it is very seldom that these wines will lack colour and fruit character. There are more tannin in the grapes and therefore too much skin contact should be avoided on white grapes as well as over-extraction in red wine fermentation. White wines tend to become very phenolic as a result of extended maceration or even fermentation on the skins. When choosing between different yeast strains, it is important to keep in mind that juice of dryland fruit has different concentrations of glucose, fructose and other nutrients such as free amino nitrogen (C. Du Plessis, F. Van Niekerk, A. Louw, S. Du Toit & C. Cutting, 2013 – Personal communications).

## 9. FINANCE

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This chapter focuses mainly on the Malmesbury area, South Africa's predominantly dryland wine producing district. The information in this chapter was supplied by the VinPro production plan and serves only as an industry guideline.

The profitability of South African wine producers, and especially dryland vineyards, has been under enormous pressure over the past few years due to rising input costs, as well as low and decreasing profit margins. With this in mind, VinPro's Agro-economic service annually reveals financial indicators that are accepted and used throughout the wine industry as a trusted benchmark.

VinPro uses financial data which they receive from farms to determine the average financial situation of those farms. The financial situation of the "Top 33%" farms is given separately. These top achievers are selected according to highest nett farming income (NFI). Top achievers' annual cash expenditure of R22 054/ha for dryland vineyards was at least 7% lower than irrigated vineyards at R23 834/ha during the 2012 production year. In the same year, top dryland achievers made provision for replacement at R8 815/ha, 2% higher than the industry average of R8 606/ha for irrigated vineyards. Total production cost of the top dryland achievers amounted to R30 869/ha compared to the industry average of R32 439/ha, which was 5% lower (Van Wyk & Van Niekerk, 2012).

Table 9-1: Production cost of dryland wine grapes, 2012

<b>MALMESBURY - DRYLAND COST STRUCTURE</b>	<b>Average (Rand/Hectare)</b>	<b>Top 33% farms (Rand/Hectare)</b>
<b><u>DIRECT COST</u></b>		
Seed	98	73
Fertilizer	834	457
Organic Material	62	47
Pesticide Control	1454	1092
Herbicide Control	403	432
Repair & Binding Material	160	255
<b><i>Subtotal</i></b>	<b>3011</b>	<b>2356</b>
<b><u>LABOUR</u></b>		
Supervision	574	1203
Permanent Labour	2932	2681
Seasonal Labour & Contract work	2682	3085
<b><i>Subtotal</i></b>	<b>6188</b>	<b>6969</b>
<b><u>MECHANISATION</u></b>		
Fuel	1469	1069
Repairs, Parts and Maintenance	1236	962
Licences & Insurance	308	192
Transport hired	688	587
<b><i>Subtotal</i></b>	<b>3702</b>	<b>2810</b>
<b><u>FIXED IMPROVEMENTS</u></b>		
Repair & Maintenance	326	47
Insurance	139	104
<b><i>Subtotal</i></b>	<b>465</b>	<b>151</b>

<b><u>GENERAL EXPENDITURES</u></b>		
Electricity	552	589
Water Costs	356	823
Land-, Property- and Municipal Taxes	94	90
Administration	738	422
<b><i>Subtotal</i></b>	<b>1740</b>	<b>1924</b>
<b><u>TOTAL CASH EXPENDITURES</u></b>	<b><u>15105</u></b>	<b><u>14210</u></b>
<b><u>PROVISION FOR RENEWAL</u></b>	<b>6253</b>	<b>7709</b>
Vineyards	4254	5215
Fixed Improvements	433	571
Loose Assets or Production means	1565	1924
<b><u>TOTAL EXPENDITURES</u></b>	<b><u>21358</u></b>	<b><u>21919</u></b>
<b>AVERAGE AREA PLANTED (ha)</b>	<b>143</b>	<b>138</b>
<b>AREA IRRIGATED (%)</b>	<b>39</b>	<b>85</b>
<b>AVERAGE AGE COMPOSITION (%)</b>		
0-3 years	7.03	9.37
4-7 years	14.94	11.96
8-15 years	61.19	58.79
16-20 years	11.32	12.03
20+ years	5.53	7.85
<b>AVERAGE YIELD (Ton/Hectare)</b>	<b>6.36</b>	<b>7.6</b>
<b>CASH EXPENDITURES (Rand/Ton)</b>	<b>2375</b>	<b>1870</b>
<b>TOTAL EXPENDITURES (Rand/Ton)</b>	<b>3358</b>	<b>2884</b>

## **9.1 THE MOST IMPORTANT FACTORS INFLUENCING PRODUCTION COSTS FOR WINE GRAPES IN THE SWARTLAND**

Production cost has a direct influence on profitability and requires purposeful management to avoid over-spending or under-investing. It is advised to manage every vineyard according to its expected income or the specific wine goal that vineyard is farmed for. Precise management of production cost is very important for dryland producers as yields (and therefore potential income) cannot be manipulated upwards by conveniently using irrigation. Annual total production cost – excluding tax, interest and entrepreneurial remuneration – consists of two components, namely cash expenditure and provision for renewal.

### **9.1.1 Total Cash Expenditures**

This amount is made up of the sum of direct -, labour- and mechanisation costs, fixed improvements and general expenditure. This cost was as low as R7 820 per hectare in 2004 on the average Swartland farm, but due to rising inflation has increased to R15 105 per hectare in 2012 (Table 9-1). The Total Cash Expenditure of the Top 33% of farm is slightly lower at R14 210 per hectare. The top achievers show slightly lower cash expenditure, possibly due to more efficient cost management (Van Wyk & Van Niekerk, 2012).

Although the purchase of cover crop seed is an added expense, the higher production of quality grapes, stimulated by cover crop cultivation, increases the net income per hectare (Fourie, 2000).

### 9.1.1.1 Labour costs

Labour costs currently make up 41% of the Total Cash Expenditures on the average farm in the Swartland and as much as 49% on the Top 33% of farms. According to the VinPro studygroup, one permanent worker is required for every 10.64 hectares of vineyard or every 65.15 tonnes of grapes (Van Wyk & Van Niekerk, 2012).

With labour costs making up almost half of all costs on the normal farm, this is unfortunately the first cost to look at when the farm needs to streamline its cost structure in order to survive financially in an increasingly challenging global financial climate. These percentages will almost certainly continue to escalate after the recent implementation of a drastically changed minimum wage for the agricultural sector. However, one has to keep in mind that many permanent workers receive more than the current minimum wage of R105/day. Many farmers mechanise or lay off workers to compensate for the increase in labour costs. The current politically motivated climate of unrest among labourers in the agricultural sector, especially in the Western Cape, together with the increasingly popular habit of striking in South Africa could result in more adjustments to the minimum wage in the near future. As part of improved general cost management, labour is managed more efficiently by means of, inter alia, mechanisation where possible, and where manual labour is required, by making use of more skilled labourers.

Efficient labour management on the farm is of utmost importance as labour costs form the largest part of the total annual expenditure of a wine farm. This includes management of managers too. Proper planning from management's side is essential to limit wasted man hours. (Example: If a team of twelve vineyard workers takes a lunch break of five minutes more than the allowed time, one man hour has been wasted. At the current minimum wage of R105 per nine hour day, this will cost the farm at least R11.67 for the one man hour lost in those 5 minutes.)

For more detailed labour norms, as supplied by VinPro to the South African Wine Industry, see Table 9-2. The information serves only as an industry guideline and may vary from one viticultural site to another. It is recommended to stay within the limits of these norms or even to improve thereon in order to maintain economic sustainability.

Table 9-2: Labour norms

Type of Action	Man hours per hectare
<b>Vineyard uproot</b>	
Bush vines	40-55
Trellised vineyards	1100-1400
Field clearing	23-30
Field clearing (tractor)	25-35
Uproot old vines	23-30
Remove vines from site	25-35
<b>Establishment (All activities)</b>	
Year 1	900-1300
Year 2	1000-2400
Year 3	1000-1500
<b>Establishment (Specified activities)</b>	
Plant posts	320-380
Strain wires	70-90
Install irrigation	170-200
Erect trellis system (medium to large)	1200-1700
Sow cover crop seed	3-5
Plant vines	160-185
Lay plastic covering	24-30
Green shoot development	230-300
Winter cane framework	110-125
Crop control	65-80
<b>Other activities</b>	
Pre-prune for trellising	30-37
Clear pruning for bushvines	86-160
Clear pruning for trellising	105-120
Short pruning for bush vines	45-55
Short pruning for trellising	42-62
Collective pruning (blunt and clear)	90-145
Intensive offset	45-80
Extensive offset	24-45
Plant shoots	20-36
Top shoots	15-25
Remove leaves	20-30
Crop control	65-80
Harvest of bush vines (man hours per ton)	11-15
Harvest of trellis (man hours per ton)	9-11

Source: VinPro Production Plan 2012

### **9.1.1.2 Direct costs**

Direct cost consists of seed, fertilizer, organic material, pesticide control, herbicide control, repair- and binding material. The direct costs have increased more than inflation for the last nine years, however the percentage of total cost, ranging between 18% and 22% of the Total Cash Expenditure, have been stable. Currently direct costs make up 20% of the Total Cash Expenditure of Swartland farms. Pesticide control is the largest direct cost, making up 9.63% of the Total Cash Expenditure on the average farm in the Swartland and 7.68% on the Top 33% of farms. Herbicide control is another big direct cost, making up 2.67% of the Total Cash Expenditure on the average farm and 3.04% on the Top 33% of farms. Both herbicide and pesticide cost vary according to the specific season. Above average wet seasons have higher levels of disease incidence and therefore require more sprays and preventative measures. Fertiliser is another big direct cost, making up 5.52% of the Total Cash Expenditure on the average farm and 3.22% on the Top 33% of farms. There is a positive correlation and the amount of fertilizer used and the yield per hectare. One of the many production practices used to increase the average yield, this is crucial in accomplishing higher turnovers for long term sustainability (Van Wyk & Van Niekerk, 2012).

### **9.1.1.3 Mechanisation**

Mechanisation currently makes up 25% of the Total Cash Expenditure of farms in the Swartland. Fuel costs currently make up 9.73% of the Total Cash Expenditure on the average farm in the Swartland and 7.52% on the Top 33% of farms. The cost of fuel is not expected to become cheaper in future, partly due to the weakness of the South African Rand. The average farm in the Swartland spends 8.18% of its Total Cash Expenditure on Repairs, Parts and Maintenance while the Top 33% of farms spend 6.77%. The total cost of mechanisation is expected to increase in future as machinery becomes more popular than manual labour for the execution of various vineyard operations. According to the VinPro study group, one tractor is required for every 31.92 hectares of vineyard or every 201.80 tonnes of grapes (Van Wyk & Van Niekerk, 2012).

#### **9.1.1.4 Fixed improvements**

Fixed improvements consist of Repairs and Maintenance as well as Insurance. The average wine farm around Malmesbury spends R465 per hectare on fixed improvements (Table 9-1). This is three times more than the Top 33% of farms. Just over 70% (R326 per hectare) of this amount is spent on Repairs and Maintenance while only 30% pays for insurance. The Top 33% of farms only spend R151 per hectare on fixed improvements. Almost 70% of this amount pays for insurance while only 30% is spent on Repairs and Maintenance.

#### **9.1.2 Provision for renewal**

During the production process, producers do not only use that which is purchased annually in order to produce a crop; machinery and implements are also required. Over a period of time tractors, machinery and other means of production are “consumed”. Even vineyards and buildings deteriorate and need to be replaced. The “deterioration” and “consumption” of such items are part and parcel of the costs of the production process. Taking into account the fact that the purchase value of an item needs to be replaced in the course of its lifetime – as well as the fluctuating nature of inflation – sufficient provision has to be made for replacement. By using the principle “provision for replacement”, a larger amount is recovered than in the case of “depreciation”. To a certain extent this addresses the problem of rectilinear depreciation in value and ensures that the running concern is maintained. When calculating provision for replacement, items are written off against replacement value over various periods. Buildings are written off over 60 years, vineyards over 20 years, and moveable assets/means of production over 7 - 15 years (P. Van Niekerk, 2013 – Personal communication).

The Top 33% of farms around Malmesbury make greater provision for renewal at 35.17% of the Total Expenditure as opposed to 29.28% on average farms. The average Swartland farm provides for R6 253 per hectare for renewal, while the Top 33% of farms allocate R7 709 per hectare (Table 9-1). Around 68% of these amounts are allocated towards the renewal of vineyards (Van Wyk & Van Niekerk, 2012).

### **9.1.3 Total Expenditure** (Total Cash Expenditure + Provision for renewal)

The Total Production Cost in the Swartland is R21 358 per hectare for the average farm and R21 919 per hectare for the Top 33% of farms (Table 9-1). This amount escalates roughly by 6% per annum and was as low as R10 772 in 2004 (Van Wyk & Van Niekerk, 2012). This increase is mainly due to a slightly larger 2012 crop, as well as exceptionally high increases in the cost of electricity and fuel. Most of the other cost components increased more or less in line with inflation.

The Total Expenditure of the average farm in the Swartland is R3 358 per ton, calculated at the average of 6.36 ton/hectare, while the Top 33% of farms only spend R2 884 per ton, calculated at the average of 7.60 ton/hectare (Table 9-1). The Total Expenditure of the average farm around Malmesbury is 16% (R474 per ton) higher than the Top 33% of farms to produce a ton of grapes (Van Wyk & Van Niekerk, 2012).

The capital outlay required to establish a vineyard and to bring it into productivity escalates annually and it is therefore important to limit the unproductive stage after planting to the minimum (P. Van Niekerk, 2013 – Personal communication).

## 9.2 THE PROFITABILITY OF THE TOP 33% OF FARMS AROUND MALMESBURY

Table 9-3: The profitability of the top 33% of farms around Malmesbury (Van Wyk & Van Niekerk, 2012)

	2005	2006	2007	2008	2009	2010	2011	2012
<b>Production (Ton/ha)</b>	5.66	6.39	6.3	8.21	7.66	8.41	7.87	7.6
<b>Income (R/ton)</b>	3601	3186	3000	2983	3637	3143	3190	3597
<b>Bruto income (R/ha)</b>	20382	20359	18900	24490	27859	26436	25113	27346
<i>min</i> <b>Total Cash Expenditure (R/ha)</b>	9701	9699	9632	10872	13089	11973	13121	14210
<b>Bruto Margin (R/ha)</b>	10681	10660	9268	13618	14770	14463	11992	13137
<i>min</i> <b>Provision for renewal (R/ha)</b>	3545	3385	3603	3770	5228	5839	6516	7710
<b>Netto Farm Income (R/ha)</b>	7136	7275	5665	9848	9542	8624	5477	5427
<b>Interest earned on Capital</b>	7.00%	7.44%	4.82%	9.02%	6.08%	4.62%	2.02%	1.58%

### **9.2.1 Production**

The average production for this area is 7.26 t/ha for the period from 2005 to 2012. An increase in production can be observed from 2008 onward. When one observes the annual decrease in income, from 2005 to 2008, together with the sharp increase in production after 2007 (Table 9-3), one can see that these farmers adapted their yields to compensate for the lower income (Van Wyk & Van Niekerk, 2012).

### **9.2.2 Income**

The average Income for this area is R3 292/ton for the period from 2005 to 2012 (Table 9-3). Grape prices decreased drastically after 2005, reaching their lowest level in 2008 at R2 983/ton (Van Wyk & Van Niekerk, 2012).

### **9.2.3 Total Cash Expenditure**

The average Total Expenditure for this area is R11 537/ha for the period from 2005 to 2012 (Table 9-3). Total Expenditure remained quite stable between 2005 and 2007, but increased drastically after 2008 (Van Wyk & Van Niekerk, 2012).

### **9.2.4 Provision for renewal**

The average Provision for renewal for this area is R4 950/ha for the period from 2005 to 2012 (Table 9-3). Provision for renewal remained quite stable between 2005 and 2008, but increased sharply from 2009 (Van Wyk & Van Niekerk, 2012).

### **9.2.5 Nett Farm Income (NFI)**

The average NFI for this area is R7 374/ha for the period from 2005 to 2012 (Table 9-3). Despite peaking at just under R10 000/ton in 2008, the NFI is currently at its lowest level for the last eight years with only R5 427/ton (Van Wyk & Van Niekerk, 2012).

### **9.3 WHAT SETS TOP PERFORMERS APART?**

The following short-term technical practices have improved the profitability of individual wine producers over the past three to five years:

#### **9.3.1 Pruning methods**

Van Wyk & Van Niekerk (2012), says that in an attempt to increase production, wine farmers try to achieve a higher bud load during pruning by means of various methods of pruning. The vigour of the vine determines the number of buds allocated – more vigorous grapevines will have more spurs or longer bearers, thus a higher bud load. The different wine objective of each block will determine the method/system of pruning.

#### **9.3.2 Canopy management practices**

According to Van Wyk & Van Niekerk (2012), canopies are managed to accommodate vegetative growth without losing fertility or quality. There is considerable focus on sunlight penetration within the canopy, and suckering techniques, topping and leaf removal are performed to prevent grapevine canopies from becoming too dense and infertile. Producers also attempt to save on labour by eliminating or down-scaling certain practices. By allowing certain grapevines to sprawl in order to ensure sufficient aeration and light penetration, shoots do not need to be tucked into wires as required with vertical shoot positioning systems (VSP). The latter practice could be responsible for canopies becoming too dense unless proper suckering takes place.

### **9.3.3 Fertilisation and irrigation**

Van Wyk & Van Niekerk (2012) says that wine farmers apply their fertilisation and irrigation practices according to specific wine objectives as a result of the great impact of vigour on yield. Fertilizer comes in many different forms ranging from organic (compost, dry chicken manure etc.) to chemical (chemically produced liquid or pellets with a specific ratio of nitrogen, phosphorus and potassium) of origin. The growth and yield in premium blocks are moderate and in balance, whereas bulk wine blocks are more vigorous in order to accommodate larger canopies and yields. Irrigation and fertilisation are adjusted accordingly. Blocks with high yields often have well-drained soils, deep soil preparation, increased nitrogen content and abundant water (not too much as there is a risk of drowning). Regulated Deficit Irrigation (“RDI”) is applied only if it is justified by the price of the wine.

## 10. MARKETING “DRYLAND”

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Graham Knox, a very well-known figure on the South African wine scene, with a reputation as an acclaimed producer, marketer, wine guru and writer for nearly 40 years, says marketing is about drawing attention. In successful marketing, you draw attention to your advantages and benefits. The first and most obvious of these is “difference” especially in such a competitive and overtraded and similar market as that of 750ml bottles of wine (G. Knox, 2013 – Personal communication).

In wine there are few opportunities to put a qualitative difference on the label. The South African Wine and Spirits Board rules make most of these illegal. To the consumer, most wine brands are identical (Brand, Variety or Blend name, Vintage, Origin) where the differences do not equal advantage or benefit. In recent years, many brands have used vineyard names (or something that looks like a vineyard name) implying that they are single vineyards, to draw attention. This can only be successful with small volumes (G. Knox, 2013 – Personal communication).

“Dryland” offers similar opportunities and has the advantage that bigger volumes can carry the label. The use of “dryland” can work the way “bushvines” is used on labels: It differentiates and indicates ‘something special’. To the consumer, both are obscure technical terms (What do they mean? Is there a benefit to me?). This requires a ‘hand-sell’, a one-to-one explanation. However, on the positive side, they are both differences suggesting extra quality (G. Knox, 2013 – Personal communication).

Knox says, the biggest opportunity will come with the creation of a club of dryland producers. Consumers follow trends and one outlaw does not make a trend. When half a dozen go off the tried and tested path and open new territory, and it looks interesting, consumers follow. The best recent and local example is the ‘Swartland Revolution’ where half a dozen producers with serious volume constraints have turned a negative ‘Swartland’ into a positive. Just as strong a case can be made for dryland (G. Knox, 2013 – Personal communication).

## 11. CONCLUSIONS AND RECOMMENDATIONS

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Not all terroirs are suitable for the dryland cultivation of wine grapes. Dryland viticulture makes sense when cultivated on fertile soils with good water-holding capacity. A high water table makes it even more feasible since the roots are always near water and this might even result in unwanted extraordinary vigour.

Suitability for dryland viticulture is dependent on optimising the ratio between Total Seasonally Available Water, the water use of a particular vineyard and the balance of the vines. Not every region is ideal (nor cost effective) for dryland viticulture, as it is dependent on the ratio between these factors, together with time, labour and economic limitations.

The location, establishment and management of the particular vineyard, together with the choice of grape variety, grafted on a rootstock that can tolerate heat and drought will become progressively more important in dryland vineyards as climate change proves itself to be an inconvenient truth. There is no doubt that this will involve a few challenging decisions regarding the viability of some grape varieties as well as the suitability of other varieties with a low international demand. It is almost a certainty that drought-tolerant rootstocks will become progressively more important in dryland vineyards. Regulated deficit irrigation, drip systems and other techniques of water conservation are also likely to be utilised.

Cultivar-terroir adaptation will become increasingly more important against the backdrop of climate change/global warming. Dryland farmers should consider planting varieties that ripen earlier, while there is still soil water available to the vines, in order to avoid excessive water stress towards the end of the season. Sufficient rainfall is an obvious necessity for sustainable dryland farming.

It is recommended that planting dryland vineyards on marginal soils is avoided as yields could be too low to make financial sense for the farmer. This is a mistake that could cost the producer dearly. Consult a soil scientist and a viticulturist before investing in a new dryland vineyard.

It is highly recommended to follow a weed control strategy where chemical, mechanical and biological methods are responsibly integrated to control weeds in dryland vineyards. The timing of these actions is very important to prevent weeds from growing out of control and spreading their seeds.

Vineyard owners need to determine the profitability of each vineyard block and manage it according to the expected income per hectare (income per ton times the expected yield per hectare). For various reasons, some vineyards become unprofitable. In the case of such vineyards, uprooting is recommended.

Efficient labour management on the farm is of utmost importance as labour costs form the largest part of the total annual expenditure of a wine farm. This includes management of managers too. Proper planning from management's side is essential to limit wasted man hours.

The application of fertilizer is one of the many production practices used to increase the average yield per hectare. This is crucial in accomplishing higher turnovers for long term sustainability.

Many of South Africa's dryland producers sell their grapes to large wineries. These large companies offer no or very little compensation for the qualitative characteristics of grapes from dryland vineyards. Dryland grapes are not always better than irrigated grapes, especially where irrigation is well managed, but theoretically lower yields result in more concentrated wines. Although yields are lower (berries and bunches are fewer and smaller) and flavours are more concentrated than those of irrigated vines, the same price per ton of grapes is paid. Growers can try to negotiate a long term contract with a cellar or company where price is related to quality.

Marketing and driving “Dryland” as a brand could give a boost to the value of dryland grapes, making the cut throat business of dryland grape production more rewarding and therefore financially sustainable. However, this will require action from a few like-minded companies and individuals that focus on quality wines from dryland vineyards. It is necessary to educate the consumer, as many are not aware of the fact that some vineyards are grown without any irrigation. The Wine and Spirits Board could also have a positive influence by promoting and strictly regulating the use of words such as “dryland” and “old vines” on wine labels in the same manner as “vintage”, “varietal”, “origin” and “single vineyard”. This will add to the credibility of these words when used by marketers as a unique selling point.

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## **APPENDIX A – Questions for structured interviews**

### **Soil science – Braham Oberholzer**

1. Which soil features are important for the success of dryland vineyards?
2. What are the most common soil types on which dryland vineyards are planted.
3. What is the influence of soil preparation and cultivation practices for dryland vineyards?
4. Where do Oakleaf and Glenrosa soils occur in the winelands?
5. What are the main soil types in the Agter Paarl?

### **Winemaking – Albertus Louw, Stephan du Toit CWM, Francois van Niekerk, Carla Cutting, Charl du Plessis**

1. Are grapes from dryland vines any different? (Y/N)
2. How does the grapes differ in terms of physical appearance
3. How does the wine from dryland fruit differ in terms of :
  - Organoleptic profile
  - Analytic values (Sugar levels, TA, pH, FAN, Malic, Extract)
4. Would you treat dryland fruit differently in the cellar? (Y/N)
  - 4.1 If yes, how and why?
5. Any other observations or comments

### **Marketing “dryland” – Graham Knox**

- 1) Do you believe that “dryland” wines have a place in the market?
- 2) What is your opinion on using “dryland” as a marketing angle?

## **Weed control and cover crops in dryland vineyards – Dr. Johan Fourie**

- 1) What strategy should the viticulturist follow to control weeds in dryland vineyards?
- 2) What is your opinion on a weed control strategy where a combination of chemical-, mechanical- and biological control is used?
- 3) How important are cover crops in dryland vineyards?
- 4) Which cover crops are recommended for dryland vineyards?
- 5) What strategy should the viticulturist follow to control cover crops and prevent competition for soil moisture after budding of the vineyard?

## **APPENDIX B – Definition of terms**

**Climate** - *“The long-term weather pattern of an area, and an extremely important variable in the wine-making equation.” (Robinson, 2006)*

**Cover crops** - *Cover crops are crops planted primarily to manage soil fertility, soil quality, water, weeds, pests, diseases, biodiversity and wildlife in agro-ecosystems, ecological systems managed and largely shaped by humans across a range of intensities to produce food, feed or fibre. (Lu, 2000)*

**Gobelet** – *A form of vine-training system that has been in use since Roman times (Robinson, 2006).*

**Mediterranean climate** - *“A climate type characterised by warm, dry sunny summers and mostly mild, wet winters (Robinson, 2006).*

**Rootstock** - *The plant forming the root system of a grapevine to which a fruiting variety, or scion, is grafted (Robinson, 2006).*

**Terroir** – *A French word describing the controversial and important concept of the total natural environment of a viticultural site (Robinson, 2006).*

**Véraison** – *a French term used to describe the intermediate stage of grape berry development and the start of ripening when grapes change from hard green berries to softened and coloured grapes (Robinson, 2006).*

**Institut National des Appellations d'Origine** - *The governing body of French wine*

## **APPENDIX C – Abbreviations**

**AOC** Appellation d'origine contrôlée

**ET** Evapotranspiration

**g/L** Grams per litre

**FAN** Free Amino Nitrogen

**NFI** Nett Farm Income

**R/ha** Rand per hectare

**R/t** Rand per ton

**YAN** Yeast Assimilable Nitrogen

**99R** 99 Richter

**110R** 110 Richter

**140Ru** 140 Ruggeri

**1103P** 1103 Paulsen