

VINEYARDS



Achieve Great Wine – Every Year

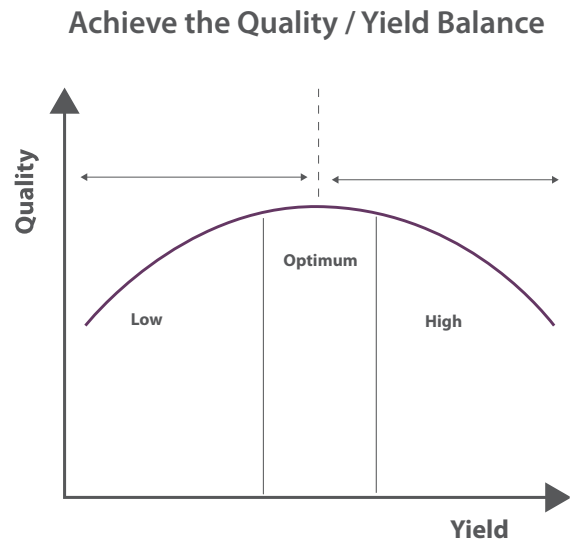
Growing Great Wine

If you manage a vineyard, you are not just growing grapes. You are in fact growing the final product – *wine*

Growing great wine is about getting the balance of quality and yield right. You need to find the optimum balance based on the desired end product.

The target depends on whether you are growing table & bulk wine, good-medium quality wine, or high quality wine.

Drip irrigation gives you more control to achieve the *optimum* yield / quality balance, every year.



Wine Market Segments

There are 3 wine market segments, with 70% of the global production being for table and bulk wine.



The goal in most regions is to increase wine quality in a repeatable process every season. Wine grape quality improvement can be achieved through Reduced Deficit Irrigation (RDI) techniques, combined with drip fertigation which is covered later in this brochure.

Case Study: The Financial Challenges of Growing Bulk Wine in Australia

As shown in the table below, there is a significant difference in the grape price based on grape quality.

Quality	Grape Price (AUD)	Domestic Retail Price (AUD)	Export FOB Price (AUD)
A	>\$2,000/ton	>\$30/bottle	>\$10/litre
B	\$1,501 - 1,999/ton	\$15 - 30/bottle	\$7.50 - 9.99/litre
C	\$601 - 1,500/ton	\$10 - 15/bottle	\$5.00 - 7.49/litre
D	\$301 - 600/ton	\$7 - 10/bottle	\$2.50 - 4.99/litre
E/F	<\$300/ton	<\$7/bottle	<\$2.50/litre
Bulk wine is allocated to its quality segment - D/E/F.			

Grape price by grape quality classification (A-F).

In a report compiled for the Winemakers Federation of Australia¹, it was found that:

- Vineyards producing A & B quality groups are profitable on average
- 47% of vineyards producing C quality grapes are *unprofitable*
- 84% of vineyards producing D quality grapes are *unprofitable*
- 70% of vineyards producing E/F quality grapes are *unprofitable*

In 2014, it was reported that less than 15% of all Australian wine grape growers made a profit!²

To be profitable, a business strategy is required to minimize the risk of poor seasons for lower quality grapes where profit margins are already thin. This is also combined with increasing the quality of grapes to reach higher grape prices.

Drip irrigation is instrumental to achieving these goals.

¹ Wind Industry Report - Australian Grape and Wine Authority 2013

² Australian Broadcasting Commission, 8 April 2015



Myth Busting: Irrigation Reduces Grape Quality

FALSE

In some regions, there is a historical view that vineyard irrigation increases yields and conversely reduces quality.

Naturally, if the crop is over irrigated, you will end up with large fruit with low sugars. However, numerous pieces of research, and the demonstrated success of 'new world' wines where irrigation is standard practice, show that irrigation, when managed correctly, actually improves the quality of wine.

Irrigation ensures the vine receives sufficient water during the budding and flowering period, but is then reduced during the ripening period to allow the vines to develop the grape bunches instead of foliage.

Drip irrigation, when coupled with drip fertigation that delivers nutrients directly to the roots of your crop, can allow you to improve the quality of your grapes.



"... growers and winemakers should have no worries or fears that drip irrigation applied during véraison and through harvest will dilute fruit flavors or negatively impact wine grape quality... Late season drip irrigation can help prevent berry dehydration and potential loss of yield, and keep vines healthy and prepared for winter."

Grapes and Irrigation Myths Debunked.
Dr. Yun Zhang. & Melissa Hansen.
Wines & Vines (March, 2018)

Reduce your Dependence on Weather

Reduce the impact that adverse weather has on your crop.

Viticulture is extremely sensitive to changes in temperature and rainfall.¹

Therefore, consider the following:

- In many traditional wine growing regions, temperatures are increasing while rainfall is decreasing.
For example, in the wine producing area of Côtes-du-Roussillon-Villages in Southern France, temperatures have been increasing since the mid-1980s and are projected to increase further. Additionally, research has found that precipitation is becoming more variable, and lower in summer with further droughts expected.²
- One year of high water stress will adversely impact several years of future harvest.
- Too much water stress results in a decline of the oenological potential of grapes – less sugar in the grapes resulting in reduction in aromas, acidity and color stability. If soil moisture from winter and spring rains is depleted and no supplementary irrigation is available, you increase risk of lower quality wine.
- As young vineyards require additional water, they are more susceptible to weather unpredictability.

If you do not irrigate, you leave your grape crop to chance as the weather around the world is generally becoming less favorable and more and more unpredictable. The result is inconsistent yields each year as you are reliant on climatic conditions. In very poor years, you can severely damage your vines for future years.

1. Gladstones J (2011) Wine terroir and climate change.

2. Lereboullet, Anne-Laure & Beltrando, Gérard & Bardsley, Douglas & Rouvellac, Eric. (2014). The viticultural system and climate change: coping with long-term trends in temperature and rainfall in Roussillon, France. Regional Environmental Change.



Drip irrigation gives you greater consistency of production every year compared to relying on unpredictable rainfall that results in variable production outcomes.

Year	1	2	3	4	5
Rainfall	Low	Normal	Very Low	Normal	Low-Normal
With Irrigation					
Without Irrigation					

"Drip irrigation can be an efficient technique to compensate for an increased water deficit in Mediterranean vineyards... Syrah can maintain yields during periods of 2 – 4 °C increase in average temperature, provided that the vines are irrigated."

Brisson N, Pieri P, Lebon E (2011) On the interest of introducing irrigation and changing practices tomorrow in some French vineyard areas. Acta Hort 889(4): 167–174.



Climate change causes France to adopt irrigation in vineyards for survival.

Excerpts from Irrigazette Magazine, August 2018

Irrigating the Vineyards of the Var Region (Provence Rosé Wine, France)

A weakening of the vine stock, aroma loss and deterioration, a reduction in the acidity of the wines, excessive tannins and loss of yield, with serious repercussions for several years' harvests, even leading to the phenomenon of a dieback in the vineyards of the south of France, *are just some of the consequences of the increased level of water stress over the last few years.*

In the face of the recent higher temperatures, the frequency and intensity of the droughts, the vineyards have

come up with a number of possible adaptation options: replacing the more sensitive vine varieties with more resistant ones, improving the physical properties of the soil or *using well-managed irrigation techniques. Without adaptation, the quality of the controlled designation of origin (AOC) wines will suffer...*

The challenge facing the industry today is the sustainability of the vineyard, which has an economic impact on the whole of the

wine industry. *Irrigation is the main mechanism used in the alleviation of plant water stress.*

In view of this fact, the Company Canal de Provence, in partnership with the wine-growers' associations and Chamber of Agriculture, *is planning to develop its irrigation networks throughout the area concerned, i.e. about 20,000 ha over the whole Var region.*

Irrigation Delivers Optimum Quality

Depending on the characteristic of wine you wish to achieve, different irrigation programs are required.

An irrigation program combined with a fertigation program and other crop management techniques will determine your yield and quality balance.

As the table below shows, even in traditional dryland regions such as the south of France, when the relevant ET (evapotranspiration) calculations are made considering current average rain falls, irrigation is required in order to achieve optimum yields.

Average water requirements for red wine in the south of France

Characteristics	Bud burst - flowering	End of flowering – beginning of véraison (berry green growth stage)	Véraison (beginning of sugar loading and anthocyanins bio-synthesis)	End of véraison – mid maturation	Mid-maturation – ripening (harvest)	Over ripening	W ₀ mm (theoretical example of a soil water content at bud burst)	Rain (mm, during the vegetative cycle)	Vineyard mean ET* (during the vegetative cycle)	% Vineyard mET	Irrigation (mm)	Mean Yield (tons / hectare)
Vegetal, weak concentration, high acidity							80	100	500	≥0.6	≥300	≥25
Fruity, weak concentration, balanced							80	100	500	0.5 – 0.6	250–300	18 – 22
Fruity, mid concentration, balanced							80	100	500	0.5	≥250	18' – 12
Fruity, mid to high concentration, balanced							80	100	500	0.4 – 0.5	≥200	18' – 12
Balanced/ Unbalanced, high concentration, high alcohol, jam							80	100	500	0.2 – 0.4	100–200	6-8
Astringent, unbalanced, excess of alcohol							80	100	500	0.2	0–100	< 5

Vine water status	Predawn leaf water potential, PLWP (bars)
No water stress	0 to -3
Medium water stress	-3 to -6
High water stress	< -6

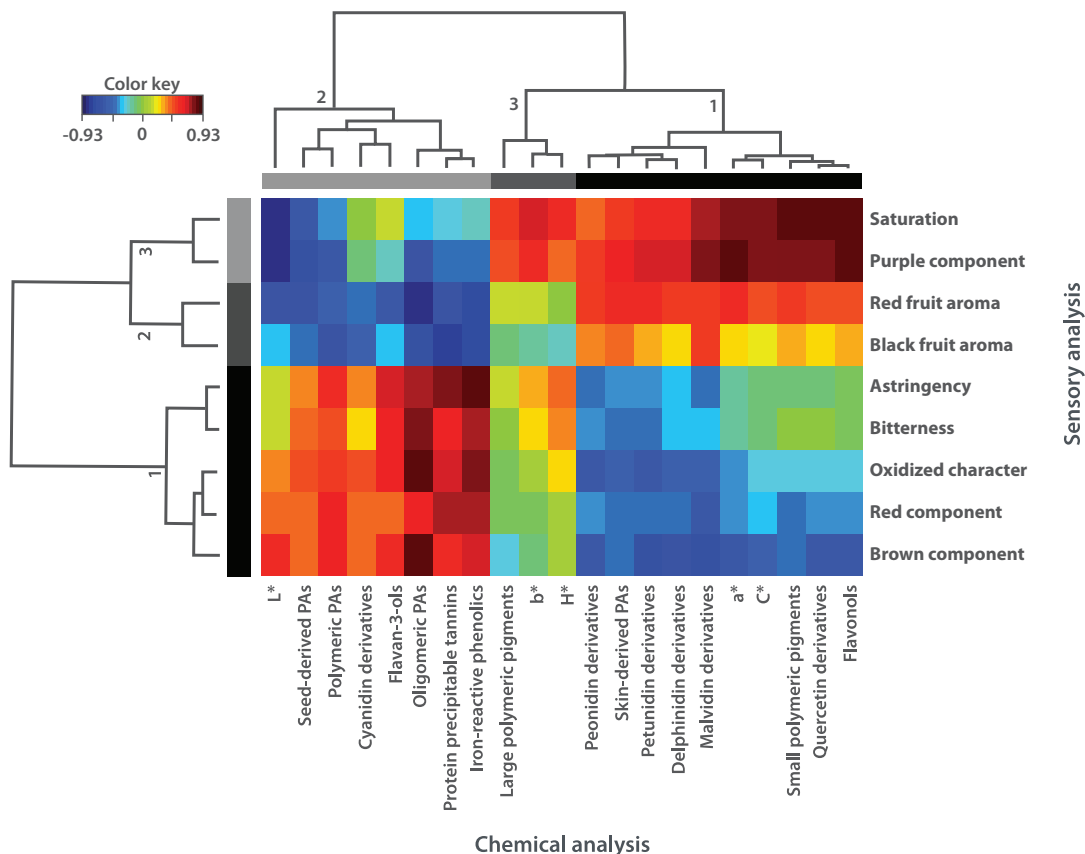
* Vineyard ET = Climatic ET x 0.9H/E
Source: Prof. Alain Deloire

In today's climate, irrigation is critical for success, even in areas that used to be able to rely on just rainfall.

Greater Control

Producing great wine requires precision control of water and nutrients.

Drip irrigation gives you control of both.



Correlation analysis between the chemical attributes of grapes and the sensory components of wine.

Casassa, Larsen, Beaver, Mireles, Keller, Riley, Smithyman, Harbertson. Sensory Impact of Extended Maceration and Regulated Deficit Irrigation on Washington State Cabernet Sauvignon Wines. (2013)

Water: Water is controlled through drip irrigation lines based on high quality hydraulic design. The Rivulis design team can develop an irrigation and hydraulic system that ensures uniformity of water application to every plant in your vineyard.

Nutrients: Control nutrients via drip fertigation. This is the process where fertilizer is injected directly into the irrigation system and is delivered to the vines as part of the irrigation process. This application allows precise rates of fertilizer to be applied and reduces waste. Feeding roots grow healthy and close to the dripper for maximum intake.

Growing great wine grapes requires the right balance of macro, secondary and micro nutrients. Drip irrigation gives you the best control to develop and implement the right fertigation program.

Common nutrients applied to wine grapes

Macro nutrients	N (Nitrogen)	P (Phosphorus)	K (Potassium)	
Secondary Nutrients	Ca (Calcium)	Mg (Magnesium)	S (Sulfur)	
Micro Nutrients	Fe (Iron)	Cu (Copper)	Zn (Zinc)	B (Boron)
	Mn (Manganese)	Mo (Molybdenum)	Cl (Chloride)	



Although it is beyond the scope of this brochure to prescribe every variable of water and nutrients, here are a few examples of how drip irrigation can provide greater control of your grape production:

- Easy and accurate application of nitrogen, potassium, phosphorus, calcium and other micro elements. As these elements are key drivers for your crop, any variation will impact the crop significantly. Drip irrigation makes it easy to develop and implement a fertigation protocol based on the grape you want to achieve. With the ability to create different irrigation zones, subtle differences of fertigation prescription can be applied to each block (and even areas of blocks) based on different varieties, soil and other factors.
- Irrigation Scheduling. Drip irrigation provides options that you do not have if you just rely on rain fall. You can calculate your water application to develop different variations of grape. For example, in a study of three drip irrigation treatments in the Napa Valley, different irrigation schedules achieved different sensory attributes of the grapes. For vines with higher levels of irrigation, the sensory attributes were more vegetal aromas. For vines with strong deficit irrigation treatments, the grapes had more fruity aromas and flavors¹.
- In the Cognac region in France, the white wine needs the correct acidity and nitrogen balance. With drip fertigation, growers found they can double the amount of nitrogen in their grape.

¹ M. Chapman, Dawn & Roby, Gaspar & E. Ebeler, Susan & Guinard, Jean- Xavier & Matthews, Mark. (2008). Sensory attributes of Cabernet Sauvignon wines made from vines with different water status. *Australian Journal of Grape and Wine Research*. 11. 339 - 347.

Two Fertigation Periods

Vineyards have two distinct fertigation periods – one before harvest, and one after. Each fertigation regime has unique requirements.

The variance of regimes can be most clearly seen with the application of nitrogen which is used to control the plant vigor.

As the table below shows, the most important time of application of nitrogen is post-harvest. This regime is significantly different than pre-harvest. In-fact in many instances, the only application of nitrogen is post-harvest.

Without drip irrigation, you need to wait for winter rains before nitrogen application. With drip irrigation, you can apply nitrogen immediately after harvest which is vital for a healthy plant reserve for the following season, especially in moderate – high vigor applications.

Drip fertigation is the most efficient tool for post-harvest fertigation, which in turn leads to improved yield and quality the next season.

Typical Nitrogen Fertigation Program

Vigor to Achieve	Post harvest (N kg/ha)	Budburst (N kg/ha)	Post Flowering (N kg/ha)	Total (N kg/ha)
High vigor (shoot length >120 cm)	40	20	0 – 20	60 – 80
Moderate vigor (ideal shoot length 80 – 120 cm)	40	0	0	40
Low vigor (shoot lengths < 80 cm)	0 – 20	0	0	0 – 20



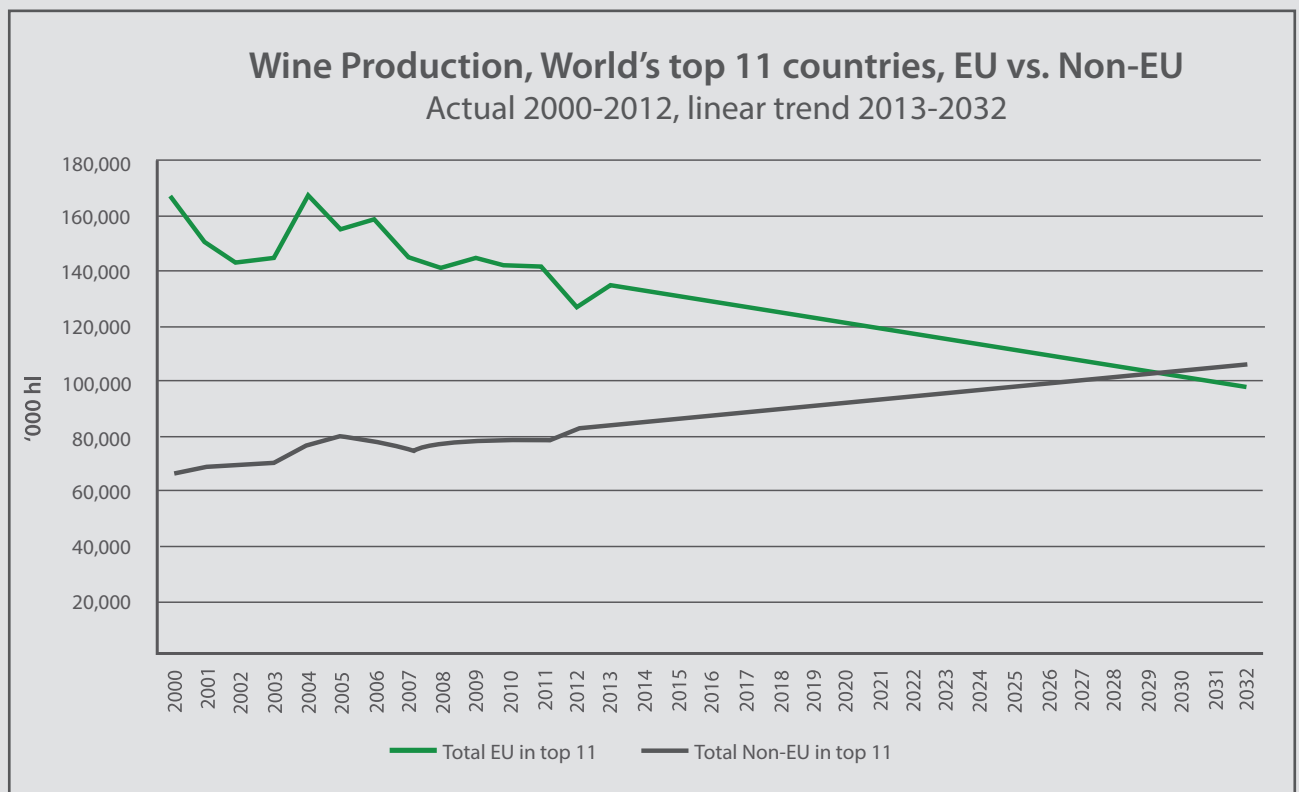
Irrigate to Remain Competitive: Old World vs New World Production

Europe ('Old Word' Production)

- Represents 76% of total wine grape area
- However, only 10% of vineyards are irrigated
- Irrigation adoption increasing rapidly to remain competitive globally and due to climate change

Outside Europe ('New Word' Production)

- Growing rapidly. Bringing increased competition to the market
- Over 90% irrigated!
- Forecast to overtake 'Old World' production volume by 2030



Graph from Winemaking & Viticulture (June, 2013)



Regulated Deficit Irrigation: Striking the quality x quantity balance

Irrigation scheduling for vineyards uses a different approach (and formula) compared to most crops.

If you are growing table grapes, or many other crops, bigger fruit = greater yield = greater revenue.

Therefore, the goal is to maximize yield. The standard formula to calculate irrigation requirement for maximum yield is: $ET_c = ET_0 \times K_c$

For wine grapes you don't want maximum yield. You want to reach the optimum balance of quality and yield for the market you want. This is achieved through Regulated Deficit Irrigation (RDI).

The formula for vineyard irrigation is therefore: $RDI = K_s \times K_c \times ET_0$

- K_s : The estimate of RSI required (changes at different intervals)
- K_c : Crop coefficient
- ET_0 : Evaporation + transpiration

Regulated deficit irrigation: Water stress is implemented intentionally during specific growing stages

Vineyards require a moderate level of water deficit. The goal is to maintain vegetative growth and good sugar accumulation.



Table Grapes Irrigation
Goal: Maximum Yield. Big fruit
Irrigation Formula: $ET_c = ET_0 \times K_c$



Wine Grapes Irrigation
Goal: Optimum quality x quantity balance
Irrigation Formula: $RDI = K_s \times K_c \times ET_0$

To demonstrate another example of the impact of RDI, the photos below show the significant difference of fields irrigated with and without RDI protocol.



Without regulated deficit irrigation



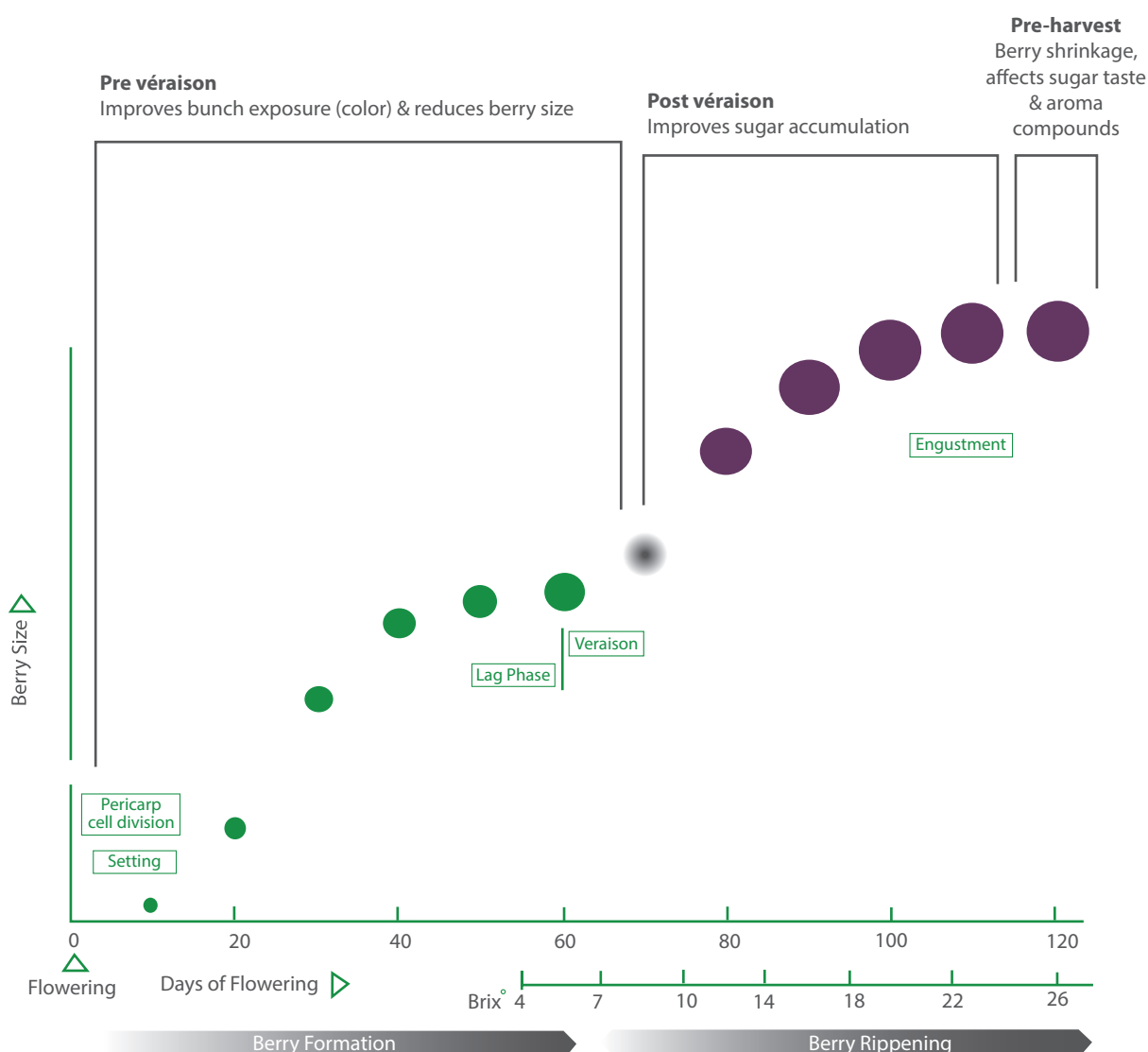
With regulated deficit irrigation

Know RDI method changes throughout the growing season

The irrigation protocol must vary throughout the season to meet the wanted objectives for the final grape.

The graph below shows the impact RDI can have on various stages of the crop cycle.

It is through RDI using drip irrigation, that you can finely tune your crop.



Recommended Drip Irrigation Systems

There are three common drip irrigation systems that you can install based upon your needs.



**Drip Line
Suspended on
Wire**

The most common irrigation method for vineyards.

Advantages:

- Does not interfere with machinery
- Appearance

Disadvantages:

- More expensive for installation
- Increased weeds near the vines
- Needs to install a “drop stopper” so that water falls directly below the dripper and does not run along the length of the tube

Recommended Drip Line:

- Rivulis D5000 PC or Hydro PC
- 40 – 45 mil wall thickness
- 1.0 – 2.2 lph drippers with 0.4 – 1.0 m spacing depending on soil type

Economical solution for drip irrigation of vineyards

Advantages:

- Most easy and economical to install
- Drips fall directly under the dripper

Disadvantages:

- Interferes with machinery
- Increased weeds near the vines

Recommended Drip Line:

- Rivulis D5000 PC or Hydro PC
- 40 – 45 mil wall thickness
- 1.0 – 2.2 lph drippers with 0.4 – 1.0 m spacing depending on soil type



**Drip Line on
Surface**



**Drip Line buried
Subsurface (SDI)**

Many pesticides and herbicides are now forbidden. A subsurface drip irrigation system irrigates direct to the root zone and minimizes moisture on the surface reducing the need for pesticides and herbicides.

Advantages:

- Most efficient water and fertilizer application
- Does not interfere with machinery
- Water not applied on the surface so reduced weeds and plant disease from moisture

Disadvantages:

- Most expensive system to install
- Requires careful monitoring and maintenance regimes

Recommended Drip Line:

- Rivulis D5000 AS (Anti-siphon to prevent soil suck back)
- 40 – 45 mil wall thickness
- 1.0 – 1.5 lph drippers with 1.0 meter spacing depending on soil type

Recommended Drip Lines

Drip irrigation provides uniformity across years of production due to less reliance on rainfall.

However, just as important, is uniformity across the field. You do not want uneven water and fertilizer applications where some vines receive too much treatment, and others receive too little. For a high quality harvest, you need uniform application to all vines. This is achieved through Pressure Compensating (PC) Drip Lines.

PC Drip Lines contain drippers that each have a flow regulating membrane. This membrane compensates for changes in pressure across the line so that every dripper emits the prescribed water flow per hour.

As the diagram below shows, over a slope of five meters, the pressure increases by 26% toward the bottom of the slope. Without a PC drip line, the result would be that vines at the lower end of the slope would receive 25% more water and nutrients than those at the highest elevation. With PC drip lines, all vines receive the same water regardless of the pressure.

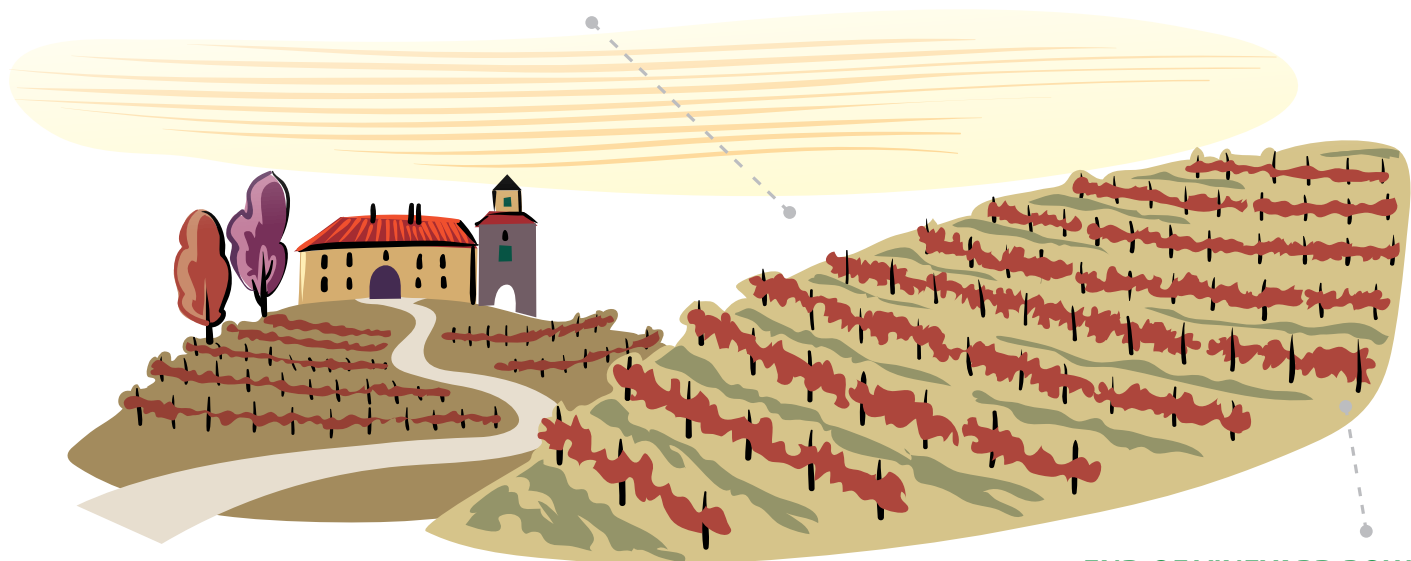
START OF VINEYARD ROW

ELEVATION: 5.0 m

PRESSURE: 1.5 bar (the pressure at start of lateral)

ACTUAL FLOW RATE FOR 2.0 l/h NON-PC DRIP LINE: 2.0 l/h

ACTUAL FLOW RATE FOR 2.0 l/h PC DRIP LINE: 2.0 l/h



END OF VINEYARD ROW

ELEVATION: 0.0 m (variation -5.0m)

LATERAL LENGTH: 125 m

PRESSURE: 1.9 bar (increased pressure due to gravity)

ACTUAL FLOW RATE FOR 2.0 l/h NON-PC DRIP LINE: 2.5 l/h (+25%)

ACTUAL FLOW RATE FOR 2.0 l/h PC DRIP LINE: 2.0 l/h (constant)

It is not just sloping ground, pressure also fluctuates across blocks due to friction of the tube. For vineyards where precision is critical, PC drip lines are a must.

Rivulis has the widest range and highest quality pressure compensated drip lines available. Options include cylindrical, flat and on-line drippers, anti-siphon and no-drain options (for subsurface irrigation), and a wide range of flow rates and diameters.

Rivulis D5000 PC/AS

The world's most advanced PC drip line with anti-siphon (AS) option available for sub-surface application.



Rivulis Hydro PC/PCND

Trusted for over 20 years. Dependable and robust cylindrical dripper with PCND option for pulse irrigation.



Eurodrip Olympos PC/AS

Uniformly delivers water over extra-long run lengths and sloping ground.



Eurodrip PC2

Dependable cylindrical PC drip line for uniform flows for a wide range of multi-season applications.



Rivulis D4500 PC/AS

Ensure crop uniformity over a wide range of conditions with this flow regulating drip line. Available with an anti-siphon option for sandy conditions where soil-suck back is a risk.



Rivulis R5000 PC

Combining the expertise of Israel and Greece research and development teams, Rivulis R5000 PC is the newest cylindrical drip line offering.





Case study outcomes are for information purposes only and actual results may vary. This literature has been compiled for worldwide circulation and the descriptions, photos, and information are for general purpose use only. Please consult with an irrigation specialist and technical specifications for proper use of Rivulis products. Because some products are not available in all regions, please contact your local dealer for details. Rivulis reserves the right to change specifications and the design of all products without notice. Every effort has been used to ensure that product information, including data sheets, schematics, manuals and brochures are correct. However information should be verified before making any decisions based on this information.