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Intra-Plot Variability of the Vineyard in the Priorat Region (Spain). A Documentary Analysis

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ABSTRACT

Each vine in a plot has particular vigor and depends on several factors such type of rootstock, soil properties, water and nutritional status of the plant. The grape quality produced by different vineyards vigor is heterogeneous (working conventionally area) which creates a general loss of quality of the harvest. So managing the heterogeneity of the effect in a plot represents a particular interest in increasing the quality of the harvest and the maximum qualitative expression of a plot. This work clearly shows that the technique of effective management of the vineyard Mas Martinet Assessoraments is able to effectively master the intra-plot variability in the length of vine shoots and grape quality in a parcel.

Keywords: intra-plot variability, vigor management, quality of the grape.

INTRODUCTION

The variability of the vineyard block is a phenomenon encountered in viticulture that characterizes the heterogeneity of the vegetative expression of all plants as part of a plot and resulting in the heterogeneity of the quality of grapes from vines different vigor (Trought, 1997; Dixon, 2010).

The intra-field variability from Bramley and Hamilton (2004) has existed since people began to cultivate the vine. Structural differences of soil and the heterogeneity of drainage water in a plot resulting special effect for each strain thus creating a heterogeneous vegetative expression (Acevedo et al., 2007; Rousseau, 2008). Even plants located one next to the other may experience differences in their vegetative expression of the order of 3 to 10 times or even more times. This means that the plots of all sizes can have a more or less intra-field variability. Variability results in a different behavior for each plant physiological and morphological and qualitative characteristics of the clusters can consequently not be homogeneous.

Yet if asked to oenologists the characteristics of the grapes they would like winemakers provide them, we would observe that the most important criteria are the consistency of clusters and impeccable health status (Johnstone, 1999, Bramley, 2011; Stein, 2011). Including the homogeneity of the grape quality is critical in understanding the real potential of qualitative production. Dixon (2009) indicates that the vinification of uniform clusters provides a qualitative advantage and the ability to make complex assemblies.

According to some studies (Cortell, 2007 and 2008; Bramley, 2011), the vineyards of low vigor give small clusters, with a loose structure and small bays. Often these characteristics are synonymous with quality in the cluster for the production of high-end wine; first through a larger ratio between the skin and the pulp and secondly through better ventilation is required to prevent the development of disease (Pérez, 2007). However, the strong vigor vines generally produce more heavy bunches with a compact structure and larger bais (Cortell, 2007). Clusters of this type often have a late maturity and are more affected by diseases such as gray mold (Hed, 2009).

According to Pérez (2007) the great wines (vintages) are the result of the sum of the conditions of the year that the vines of different vigors one parcel produce clusters with distinct characteristics (ºBe, TA, pH, etc.), but with low dispersion in the composition of the berries in a cluster thanks also reduced moderate compactness.

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By modeling this situation, vine small vigor would produce clusters where the change in wealth berry sugar is 14% to 16% by potential alcoholic strength (TAP). The separate fermentation of the grapes give a wine with rich color aspects nose of black fruits walls well as prune and jam. On the palate round and supple tannins with low acidity. Similarly, the average vigor of vines produce clusters (TAP variation of 13% to 15% berries) whose winemaking give a wine of medium intensity color and tasting descriptors like fresh black fruit on the palate tannins lively and good acidity. The same way, the strong vigor of vines produce clusters (TAP variation of 12% to 14% berries) which give a wine vinification of moderate intensity color and tasting descriptors like fresh red fruits in astringency and slightly higher acidity mouth.

Thus, the harvest of the whole plot at one time will cause a blend of different clusters according to the intra-field variability. That is to say, the success of a plot slept off, complexity, and harmony strongly depends on the variability of the plot and a great wine is a fruit of a fair balance between different areas of the field.

If the current control technique eliminates the heterogeneity of quality in a parcel, the complexity of the final wine can be questioned because of the absence of the natural assembly of clusters with distinct characteristics. The solution to this problem in this case can be encountered harvesting distributed in 3 (13%, 14% and 15% APR) and vinified separately in order to make complex assemblies.

A heterogeneous plot has vineyards of different vigor that form clusters with different characteristics and thus harvesting over the entire surface of the vineyard at a fixed time would generate a very variable quality harvest. By this means, there is a mixture of clusters that could potentially produce a better quality wine with other poorer clusters. Naturally, only the producer can determine what is good and what is bad in quality according to its own goals, but the ability to choose does give the prospect of meeting a better quality in the end, the consumer also.

This particular choice for producers looking to offer the Precision Viticulture whose main objective is to divide the land into zones of vineyards with more or less the same vigor. That is to say, view the intra-field variability. But if we could reduce this variability, might does one bring the quality of the whole harvest not only consistency but also to better quality.

The technique of controlling the vigor seeks to address exactly these issues that are undoubtedly very important, not only for farmers but also for the subsequent development of modern viticulture (Pérez, 2007).

The subject of the study of vine vigor is born from a simple practical necessity. In the early 90s the company Mas Martinet Assessoraments began his experiments on the construction of new types of ecological vineyard terraces which reduced the visual impact on the landscape in the region of Priorat (Spain). Water retention capacity and the organic matter, being most important of these new buildings compared to traditional terraces, recovering the quality of production in question due to potentially excessive vigor of the plant, which is often considered detrimental to grape quality (Perez, 2007).The field of experience working with old vines showed that the best raw material for high-end wines had the following characteristics: small size berries and less compact cluster. A simple probable degree distribution test (Singleton, 1966) of a loose cluster and a compact cluster gave an idea about the characteristic could indeed become an important indicator of the quality of the cluster (Figure 1).

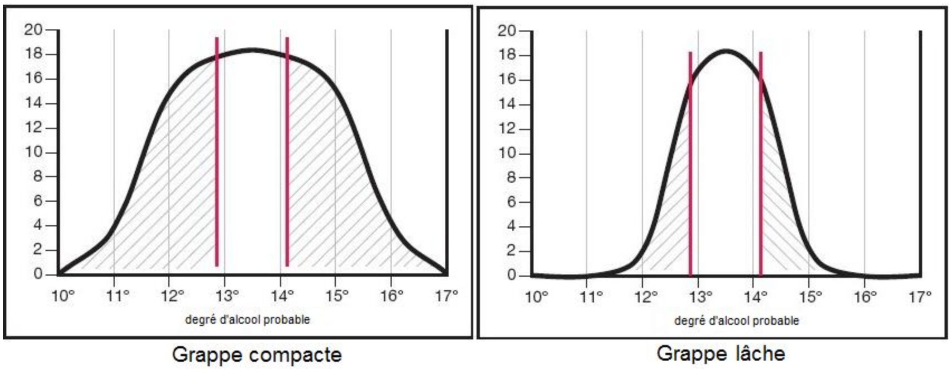

Figure1. *Comparison of the distribution of the likely level of all the windows of a compact cluster and a loose cluster (Perez, 2007).*

This demonstrates very clearly the importance of the variability of grape quality that can be met within the same plot. The compact cluster with the same degree likely means that the loose cluster, contains some of the berries under and over-matured that can potentially be a source of quality loss. On the one hand, the berries have not matured to communicate wine plant characteristics, on the other, the berries matured over-represent the risk of development of botrytis.

Having understood the ideal characteristics in terms of the Priorat region for its raw material, the company Mas Martinet Assessoraments had to develop a plot of terraced management strategy to achieve these objectives. Both lanes were chosen observation and consideration of variables influencing the behavior of the vine. By means of observation, it was noted that rather loose clusters are produced by branches of medium length (90-130 cm), while the compact clusters rather come excessively long shoots, which tend to fall and often are trimmed. These overdrafts are indeed in agreement with the results of investigations of several authors (Archer and Hunter, 2003; Landolt, 2011).

Yet, as noted above, the plants within a plot and hold a different effect if they are worked consistently, the shoots length from one plant to another is very variable, thus promoting heterogeneity and qualitative loss of production (Figure 2).

Thus, the only way to avoid this heterogeneity is to work each strain individually and so that each branch within a parcel is the same length. Through the grapevine compensation mechanism can adapt to environmental conditions, driving style and load (Hunter, 2000; Rousseau, 2007; Landolt, 2011; Stein, 2011).

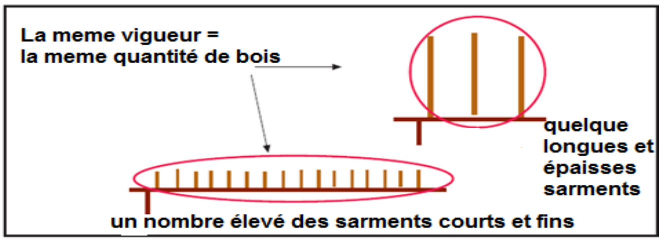

Figure2. *The concept of vigor division based on the vine compensation mechanism*

This mechanism has notably been considered a likely source of the effective fight against intra-field variability. It is known that increasing the burden of vines, twigs become finer and shorter (Rousseau, 2007). However, depending on what factor should the burden be attributed to each vine?. Poling and Wolf (1995) offer packages where the load is dependent on the size of wood weight. For example, for every 0.45 kg of pruning weight must leave 20 buds. Unfortunately, little information on the reasons for choosing these formulas by the authors.

Mas Martinet Assessoraments proposed another formula based on one side on the vine compensation mechanism where the strength of the vine can be divided over a larger number of shoots. On the other hand, these shoots should have a length and maximum leaf area to get the maturity and the morphology of the desired cluster. The shoots length of 1.2 meters appeared optimal for driving method (lyre). This length provides a good leaf area (0.23 m^2) without resorting to trimming branches which is considered by some authors (Bérud, 1997) as a source of quality losses. Archer and Hunter (2003) and Cloete (2008) also propose the optimum length between 1 and 1.6 meters. In Figure 3 can see the relationship between the length of a branch, and the total leaf area of the sheets carried by this branch.

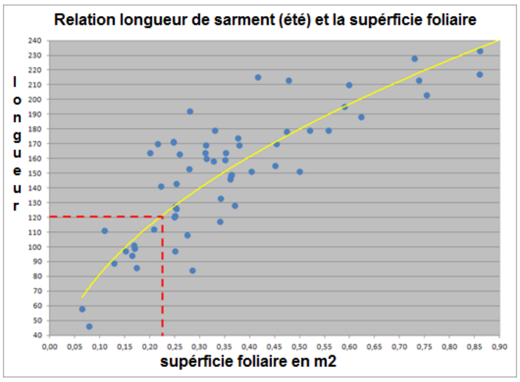

Figure3. *Relationship between the length of branch and leaf area*

Thus, considering the findings of the authors cited a series of assumptions was developed in the early and progressively research:

H1 - Technical control vigor proposed by Mas Martinet Assessoraments for the distribution of the strength of each vine on a number of buds awarded during the height of the formula = Nsar Pbt / 50 is capable of homogenizing the final length the branches of the vines of different vigor. **Nsar:** number of branches that must be developed on the arms plant

Pbt: the size of wood plant weight

50: the weight of a branch of Black Grenache length of 1.2 meters.

H2 - The grape quality and wine produced from vines pruned using the formula mentioned above are

not dependent on the vigor of the plant.

H3 - The chemical and morphological qualities (compactness) clusters are dependent length healthy shoots these clusters.

H4 - The vigor of the plant can be changed (increased or decreased) depending on the load assigned during the height.

To better understand if the choice of coefficient of 50 figured in the formula is reasonable for this study must consider several factors.

It is obvious that the weight of a non-lignified branch is greater than the weight of the same branch lignified (Figure 4). For example, a branch of Grenache length of 1.2 m unlignified weighs on average 50 g. The same branch on rest of the vine becomes shorter (about 1 m) And already weighs 34 g. Logically, in order to obtain a length of 1.2 m branches it will divide the weight of pruning wood per 34 g, not 50. However, the 50 coefficient takes into account the operation of suckering that eliminates some of the vegetation and in the end compensates for differences in weight of woody branches and non-woody.

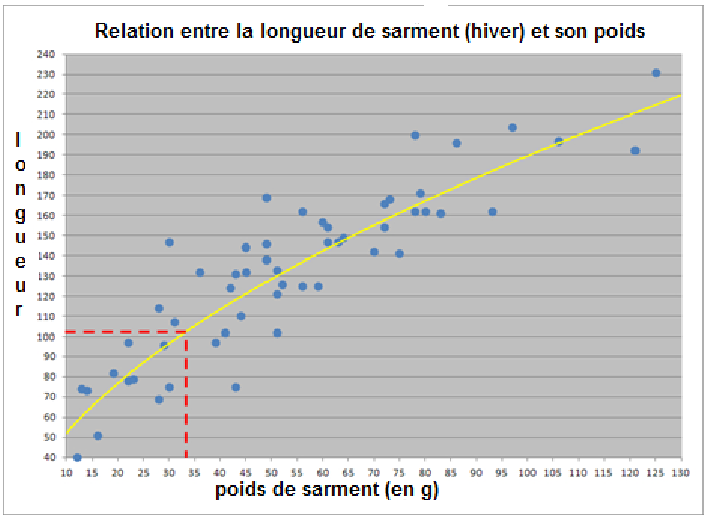

Figure4. *The relationship between the length of a branch, and its weight in winter*

Thus, taking into account these assumptions, the experiments were carried out in 2004 on the terraced plots and showed interesting results that showed the right direction reflections on the possibility of reducing intra-field variability. The charge of vigorous vines could reach 60 buds while the burden on low vines could be as small as 1 or 2 buds. These treatments based on the weight of the pruning of each strain resulted from a side to dispense with trimming and the other to avoid too short shoots. Ultimately, these treatments have significantly reduced the variability of the quality of grapes. Consecutive years, the charge remained the same for each strain.

Over the years, a fall in effect was noted on all the plots treated with the new technique. In order to understand in more detail the response of the vine to the application of the force control technique, quantitative testing was implemented on a plot of 0.42 Ha plain of Black Grenache. The plot had a high heterogeneity and accounted for this particular interest in the study of the impact of the current control technique.

THE VARIABILITY OF THE VINEYARD. THE CAUSES AND CONSEQUENCES ON THE QUALITY OF GRAPES

Although the concept of the vine vigor is widely used in winemaking to describe the growth potential of the vineyard, there is some confusion in the English and French language on this definition. These misunderstandings are indeed the result of a blurred visual perception of the vegetable part of the vineyard which on one hand may be too long, but with little shoots or the other, it may be relatively short, but with a large number of branches. Which of these two plants would be the stronger?.

The vine vigor is assessed by weighing the size of timber (Gallet, 1993; Carbonneau et al., 1992 cited by Barbeau, 2012). If the weight of the vine pruning with a small height of foliage but with a significant number of branches is more important pea vine prunings with a high level of foliage but with a limited number of shoots, it mean that the first vine is stronger although its branches are quite short. It is possible that visually, the second vineyard we appear stronger and stronger as well, but in reality it would not be the case because the vine vigor is defined by the sum of the weights of all the branches of the plant and not by the height of the latter.

It is true that in terms of conduct and uniform treatment of all plants within a plot, some of them express a high force compared to other due to soil composition changes (Bramley, 2003). This high force under the conditions of moderate load of the vine (usually practiced in viticulture) results in excessive height of the canes (Wolf and Poling, 1995) which in turn causes the berries of maturity delays (Barbeau, 2012) and difficulty in microclimatic the foliage of the plant (Landolt, 2011).

Indeed, differences were found between the qualities of the berries from the vines with a different force. Bramley et al. (2011) demonstrated that clear differences exist between sensory and chemical attributes of wines from different areas of the field. Dixon (2009), and Kliewer and Dokoozlian (2005) report similar results confirming that the vines of low vigor have more quality potential that the vines strong vigor.

But what would happen if we put the plants in a heterogeneous land in conditions of high load and a larger trellis?. In this case, the branches of the strong vines that were excessively long reduce their length (Westover, 2013), decrease their secondary leaf area (which according to Barbeau, 2012 year is responsible berries maturity delays) and give smaller clusters and loose (Landolt, 2011). The same way, the vines of low vigor as they would reduce the height of foliage producing more small branches that are harmful to the grape quality due to reduced photosynthetic activity of the latter compared to well developed shoots 1.2 m (Cloete, 2008). In this case, we will get the opposite situation. The vine has been stronger would most quality grapes as low vigor vines.

As seen well, this is not in fact the excessive vigor that is responsible for quality losses, but the uniform management of all the different effect of plants on a plot. Under these conditions, there will always be less efficient vines at the quality of the harvest compared to others and this is probably what is the real cause of the intra-plot variability.

The Variability of the Force Reflects the Heterogeneity of the Soil

Soils in viticulture is a factor of primary importance for the functioning of the vine. It is a source of water and mineral elements that are critical to the growth of the vine, its photosynthetic activity and the potential quality of the production.

At soil level, water is a prerequisite for achieving process nitrogen mineralization and nutrient uptake by the plant (Barbeau, 2012) that are essential for the physiological processes of the vine (Serrano, 2001). In the aerial part of the plant, the water has a regulatory function for the realization of refrigerant in photosynthesis the leaves during periods of excessive heat that can stop the accumulation of carbohydrates (Perez, 2007).

It is commonly accepted that the particle structure of the soil determines the water retention capacity has the greatest influence on the performance of the vine. Some studies have shown the impact of the structure of the soil on the root growth of vine and a good correlation exists between the amount of root and vigor. (Morlat and Jacquet 1993; Dyxon, 2009).

Soil properties may vary laterally on distances as small as a few meters (Hubbard and Rubin 2004; Miles, 2005; Marguerit, 2006) as a result of geological events. This variability of soil eventually lead to the physiological behavior of heterogeneity of the vine and creates an intra-field variability of grape quality. Soil variability remains constant over time and some measures can be implemented to adapt viticultural practices to areas with distinct characteristics (Hubbard and Rubin, 2004; Rampant, 2004). Various tools exist to spatialize soil variability which indeed offers an effective opportunity management plots (Miles, 2005). Yet there is some difficulty in this approach since the structural differences of the soil can be distributed completely chaotic and implementing a distribution strategy of differentiated water, for example, looks very difficult to achieve in practice.

Influence of Driving Style and Planting Density on the Vigor

The driving mode and the foliage of the structure are widely regarded as determinants of the quantity and distribution of the radiation or the transpiration and photosynthesis of the plant (Hatem, 1998). As well as planting density, the driving mode is able to significantly influence the performance of the vineyard, the yield and quality of production.

To understand the influence of the entire control system on the functioning of the vine, it would separately consider the role of each of its elements.

The variable distance between rows (a) and distance between feet (b) determine the planting density is calculated using the following formula: D = 10000 / a * b.

Planting density influences the vigor of the vine (Huglin and Schneider, 1998; Barbeau, 2012) and consequently the duration of the shoot growth and the height of foliage and morphology of the cluster (Arher and Strauss, 1991; Garin 2009). Figure 5 shows graphically the influence of planting density on the growth of branches according to a study conducted by Arher and Strauss (1990).

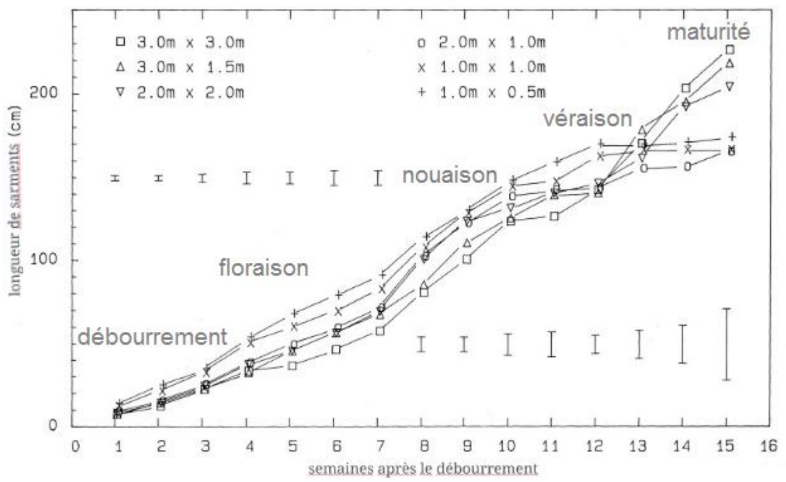

Figure5. *Influence of planting density on the growth of shoots*

With the increase of planting density, vigor decreases due to enhanced competition root systems of plants for water and nutrients. However, the reduction in vigor does not mean lower yields, even on the contrary, it is possible to increase not only the yield but also the quality of the harvest (Ollat, 2005). This advantage can be explained by a decrease of vigor, reduced lateral growth (Archer and Strauss, 1990), decreased bunch weight and a looser structure (Freeman, 1993; Dixon, 2009), better foliage distribution (reduction of gaps between the feet), early growth arrest (Archer, 1990) and a higher ratio (Perez, 2007) SFE / VoR (exposed leaf area / volume occupied by the roots). This last parameter is particularly useful for explaining how early growth arrest through a water depletion stronger ground by denser planting.

The height of the foliage contributes to SFE parameter, widely used in viticulture to estimate the potential quality of production (Garin, 2009). It has been postulated that for the good maturity in the normal conditions of 1 kg of grapes, SFE must be of the order of 1.0-1.2 m2 (Murisier, 1996, Irimia, 2006). The optimum height of the foliage to traditional control systems lies between 1.2 and 1.6 m (Archer and Hunter, 2003; Cloete, 2008).

The distance between the branches is a parameter, which affects the leaves of the microclimate and the interception rate of radiation by leaves. Smart (1988) defined the optimum distance between the branches is around 10 cm. Beyond 10 cm unnecessary voids are created in the trellis and beyond a 10 cm sheet portions and clusters are covered by other sheets which limit photosynthesis and creates the risk of excessive moisture in the foliage.

Finally, the empty spaces in the foliage are undesirable for all control systems due to unnecessary losses of productive space.

The Vigor and the Morphology of the Bunch

The morphology of the cluster, or more precisely its compactness is a very important parameter in quality grape production. Several studies show a strong correlation between the compactness of the cluster and the attack rate by botrytis (Hed, 2009). As it is now recognized that a highly compact structure of the cluster creates variability in composition of its berries (Pérez, 2007). Yet, few studies exist on vineyard practices affecting the morphology of the cluster which can be linked, in fact, the difficulty of estimating the results of treatment due to the cluster development specifics in the vineyard.

For example, the inflorescence that occurred during the current year was already differentiated into effect last year in the latent bud which in turn began dormant in late summer for eventually develop in the spring. This complex reproductive cycle of the vine involves climatic factors over two years which greatly complicates the interpretation of results from the application of different viticultural practices. Light and high temperature, for example, seem to have a positive effect on the induction and development of the inflorescence in the latent bud (in the first year of the cycle), while low temperatures after bud (the next year) promote the extension of the inflorescence and increase the number of flowers (Carmona, 2008).

Not only climatic factors influencing the compactness and cluster size, but also the genetic differences between varieties. Shavrukov and Dry (2004) studied the characteristics of inflorescences varieties that produce more compact clusters (Chardonnay and Riesling) and other grape varieties producing inflorescences generally looser bunches as Sultana and Exotic. From the results of this study, the differences in compactness clusters were mainly related to different cell elongation rate in the internodes of the spine and not to the intensity of cell division. Yet little is known about the mechanisms that promote cell elongation of the spine.

Some work (Weaver et al., 1962; Molitor, 2012) are published on the effect of gibberellic acid on the cluster compactness reduction and as a result, its positive effect on reducing the pressure of *Botrytis cinerea*. Despite its effectiveness, its use is not recommended for grapes for wine production because of its ability to promote the development of tendrils instead of inflorescences (Carmona, 2008). In addition, gibberellins are classified as pesticides and are subject to strict regulation (fidelibus and Vasquez, 2012).

Among the environmental and genetic factors, the morphology of the cluster may be affected by physical treatments vine which represents the most feasible in practical way. Several studies (Zabadal 1992; Cartechini, 2002; Rousseau, 2007; Landolt, 2011) highlight the influence of the severity of size on the morphology of the bunch. The application of minimum size, for example, significantly reduces the length of branches and changes the cluster structure.

Dunn and Martin (2008) conducted a research on the structure of the cluster and Cabernet Sauvignon have shown that reducing the burden of the vine, the number of primary branches (attached to the main axis) decreases less strongly that the number of flowers on the spine which, taking into account the good correlation between these two parameters (R2 is between 58 and 80% in the different conditions), involves a reduction in compactness. However, in this study the difference is not very obvious and deeper studies must be done.

THE BALANCE OF THE VINE

The balance of the vine is a concept that is frequently found in the literature often without indicating between what and what it is reached. Regarding production, the point where the vine reaches a balance (capacity / performance) may vary considerably according to the objectives of the production: maximum concentration, maximum volume or the harmonic composition of grapes. Nobody says what grape composition is needed to produce the most balanced, yet such harmony between the components of the wine is considered by the tasters as an essential attribute in premium wines.

Ravaz index represents an equilibrium between the indicators of the vine and the production volume. The strength of the vine (vigor) is estimated by weighing the size of timber and the production volume is expressed in kilograms. Ravaz = 1 kg performance / kg timber size (Howell, 2001; Stein, 2011). Although this index exists, there is no common opinion of the investigators on the ideal value of the index to set the production balance. Various researchers propose values which may vary from 0-4 (Ravaz, 1904; Reynolds, 2006; Stein, 2011) and 5-10 (Smart 1991 quoted by Stein, 2012). However the ideal value for defining the vine balance does not exist in fact, since as noted above, the balance between the capacity of the vine and the production should be defined according to the objectives of production.

Another important indicator of the line balance is the ratio of leaf area (SFE in m^2) and production volume (in kg). Unlike index Ravaz, authors of different studies are agreements that the minimum for SFE well ripen grape kilogram should be around 1 to 1.2 m^2 (Stein, 2011).

Thus, these two reports, the index of Ravaz and report SFE / Production volume generally represent key indicators of the balance of the vine. Nevertheless, these two indicators alone are not able to define the balance of the vine partially. Other important factors are involved and need to be considered when talking about the balance of the vine. The microclimate and the selected driving mode are other important parameters contributing to the balance of the plant between his physical condition and capacity of production. Smart (1985) showed that the microclimate inside the foliage is a determinant not only of the health of the grapes but also the fertility of buds. To ensure a good production and a favorable microclimate for the production, a distance between the shoots of the vine is recommended around 10 cm (Smart, 1988).

The driving mode is responsible for the balance of the vine and the surface offered to its expression. Some pipes modes like GDC (Geneva Double curtain) and the double tying (Perez, 2007) offer more space for vegetative expression of the plant in relation to other modes of conduct which makes them better able to accommodate a force more important in case of the most fertile soils.

Pruning: An Important Factor in the Expression of Vegetative Plant

Pruning of the vine is an annual event that creates a plant architecture (Winkler, 1974) adapted to the needs of production and maintain over the years. The vine is a creeper which in nature is found in the form of highly developed bush through its power to branch out and to direct growth toward the source of light necessary for photosynthesis and achieving its main purpose - reproduction (Perez, 2007). After domesticated grapevine, the first winemakers understood that pruning is an essential operation to control its shape and facilitate the work of the plot (Jean-Louis Porreye, 2011).

Today the pruning is above all the strongest tool of performance management. Still, good command of the principles of health and balance of the plant can also give the pruner the option to create an architecture of effective plant-level photosynthetic intensity (Smart 1985; Archer, 1990) and reduce the risk of fungal diseases (Smart, 1985). The pruning also influences indirectly the size of grape berries and becomes a unique tool for controlling the balance of the vine, performance, health and productivity.

That is why this should be entrusted only to a skilled workforce, non-seasonal preference and paid based on the time spent by the worker on the plot and not the processed surface for the technique and reflection outweigh timeliness.

There are two main types of pruning: the long and short size. The choice of type depends primarily on the bud fertility of a given variety and goals of production. The long pruning promotes the development of bigger and many inflorescences the middle of the stick which is interesting as a means to increase yields. Compared to the short pruning in 2 eyes, the long pruning is developing a less dense foliage through the development of a single branch each 7-10 cm arm. On the other hand, the long pruning causes a strong heterogeneity at bud break, shoot growth and maturity of the berries according to the positioning of eyes at the wand (Yobregat, 2013).

To reduce the density of the foliage of the vine cut in courçons (short pruning) and thus improve its microclimate (Smart, 1985), de-budding can be practiced in order to let a single branch to expand on each courçon.

The Charge of Vine Buds and its Influence on the Yield and Vigor

The charge of vine granted during the year directly influences the yield size (Smart et al., 1982; Landolt, 2011), indirectly the qualitative characteristics of the vintage (Murisier and Zufferey, 1996; Landolt, 2011) and can affect the vigor of the vine (Byrne and Howell, 1978; Landolt, 2011).

The charge of vine buds determines the number of branches that will grow on the wood of the year n-1 during the current growing season and their length, diameter, number of charged clusters, the weight of clusters and berries (Wolf and Poling, 1995; Murisier and Zufferey, 1996; Landolt, 2011).

The vigor of the vine is also dependent on the load. The optimum load is one that only slightly changes the strength of the vine from one year to the other. Through the grapevine compensation mechanism (Freeman et al. 1979; Myers et al., 2008; Landolt, 2011), the optimal load represents a range of values that can be used by winemakers to adapt the plant to production needs and trellising system used. Too much load reduces the force and the excessively low load increases the force for the next vegetative year.

More charge generally increases the yield, which does not always correspond to a decline in the quality of the harvest (Freeman, 1983). Landolt (2011) assumed that this effect is achieved through the production of vines pruned less severely lighter bunches and small berries more favorable for winemaking. In the study by Byrne and Howell (1978), the wine produced from vines pruned less severely had a color density less compared to wine from vines with a lower load. This loss in terms of color did not stop also to be preferred by the tasting panel.

Unlike fully charged vines, vines pruned more severely tend to produce larger clusters more compact and apparently this can result in more variability in the composition of berries and consequently by qualitative losses. For example, in testing by Murisier and Zufferey (1996), the charge modified from December to June buds has resulted in the 25% drop in performance while the weight of shoots and bunches produced by the vine has increased. In another study (Reynolds, 1994) the load reduction of 40 to 20 shoots resulted in a drop in yield of 15% and an increase in the weight of the bunch and average berry 24% and 4% respectively. Westover (2011) brings together the negative effects of the reduced charge as the high production of lateral shoots per vine, crowding foliage and microclimate alteration of the plant.

The charge is thus a strong regulator of the vine behavior and should be allocated based on the vigor of the plant. Since each vine in a plot holds a special vigor, the charge must be assigned individually each year during the period of the size. Unfortunately, loads the registers of certain appellations severely limit the possible capacity of the vine and in the case of the soil fertility excessive vigor can not be mastered. One of the possibilities to correctly balance the load for these areas is through an increase in planting density which limits the other hand the possibility of mechanization.

Green Operations

The work in the vineyard during the growing season are indispensable for the microclimate control of the plant and for the photosynthetic efficiency. Many studies show the negative effect of overly dense foliage. Archer (1990) reports that the shadow inside the foliage is responsible for the delay of maturity, declining fertility, reducing the degree Brix and concentration of phenolic compounds. The results of other researchers (Dokoozlian and Kliewer, 1996; Pereira et al., 2006; Ristic et al., 2007; Landolt, 2011) are consistent with those of Archer studies. Smart (2012) suggests that exposure clusters favors the accumulation of anthocyanins in red grapes and generally improves the quality of the harvest and the yield by increasing the fertility of buds. The leaves of a less dense foliage receive more solar energy and photosynthesis is high compared to non-exposed leaves in the sun (Archer, 1990). The evaporation rate in the dense foliage is reduced due to less effective ventilation. Therefore, the moisture inside the foliage is high and the risk of development of fungal diseases are more important (Smart, 1985).

The main source of the altered microclimate is crowding vegetable plant parts, which in turn can occur due to poor management of the space between the branches and the high production of lateral shoots (Smart 1985; Barbeau 2011). The choice of branches to push the vegetative year is done during the winter pruning and must be corrected by green operations such as pruning and suckering which consist respectively remove the part of the buds and side shoots. Other green operations such as stripping and scraping can also improve the microclimate by eliminating a portion of the base leaves and lateral shoots that cover clusters.

Among the green every viticultural practices are not beneficial to the foliage of the microclimate and the quality of the harvest. Pinch operations, topping and trimming are to remove some of the top (and sometimes the sides) of the shoot to reduce their height (and the growth of lateral shoots) and prevent them from falling between the lines. Pinching practiced before or just after flowering promotes flowering and fruit set. Yet the increase in berry weight resulting (Gallet, 1993) can affect the quality of the harvest because of the risk of heightened variability of composition of the berries of the compact cluster. The topping is done after flowering and helps fight against sagging. The production of lateral shoots is favored at the moment which can cause crowding of the foliage. Finally, the trimming is used to facilitate the passage of cultivation equipment and treatments and keep the vineyard "clean" and pleasing to the eye. Trimming removes the same time a part of the leaves and reduces sweating which leads in turn the risk of mildew development (Gallet, 1993). Thinning is another operation frequently practiced in the areas of production of premium wines. Dumartin (1990) and Gallet (1993) showed an effect of this practice on the quality of the harvest. The vine thinning 47% gave larger clusters with a higher degree of probability than the control. Yet there are many examples of the effectiveness of thinning is not obvious (Archer, 2013) and even considered harmful because of the unnecessary loss of performance. Archer suggests that this operation should be performed only when suckering was not done in the spring and therefore poorly developed stems produced low-quality grapes. Hunter (2000), Cloete (2008), and Archer (2013) are consistent in indicating that the branch length of 1.2 m may well ripen 2 bunches while poorly developed branches have a reduced photosynthesis and produce clusters apparently less qualitative. In summary, the control number of branches to leave, respect the space between them allows the vines to grow a number of branches of sufficient length to produce a mature and consistent harvest without recourse to thinning.

VIGOR CONTROL TECHNIQUES

Precision Viticulture

The Precision Viticulture (PV) is a modern technique of plot management that is chosen today by a growing number of wineries in the world. The technique is based primarily on the principle that different effect of vineyards produce grapes with distinctive features that can

serve as a way of differentiating the product range. Taking aerial photos, satellite plots near infrared or use embedded tools allows for following treatment mapping within-field variability of the force. The visualization of variability allows establish different areas of force that can be interesting for wine producers to make the separate harvest in order to produce batches of wine with distinct qualities (Bramley, 2005). These cards can also be used for adaptation of viticultural practices, irrigation, fertilization and crop protection products to the characteristics of the areas. Theoretically, this information is of great interest to growers in order to make production more efficient. Thus, in reality the implementation of changes within plots is complicated especially as the areas are smaller and more numerous. Figure 6 shows three plots with the same average performance and variation coefficient same, but with different distribution of homogeneous areas (Tisseyre and Rudnicki, 2008).

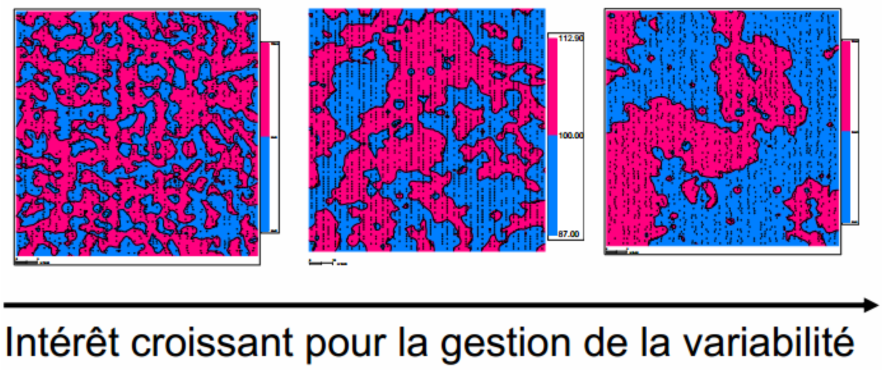

Figure6. *Three parcels with the same average performance and even coefficient variation but with a distribution of different homogeneous areas.*

At the same time, the areas cannot be considered completely homogeneous. Their gross variability is less than that of the entire parcel (Bramley, 2011). However, if corrective variability measures cannot be implemented, there is still the possibility of the separate harvest through harvesting machines equipped with GPS system. The economic interest of the separate vintage tried to demonstrate Bramley in his recent study (2011). He suggested that the price of wine produced from grapes from areas with low vines force can be raised from 1.1 to 1.5 times compared to conventional wine from the harvested (without zoning). According to these calculations, the gain in net profit of selective harvesting for a parcel consists of two areas with 25% of the vines low vigor and 75% of vines strong vigor compared to conventional harvest may reach about 11%. However, calculating this benefit, the researcher did not take into account the separate harvest diversified characteristics of the grape (Rousseau, 2008) and the quality of the lot only harvested areas of high force can potentially be lower compared to the quality of unseparated whole harvest. Thus thinking, recovery calculations assuming lot of quality down from the strong force area compared to the unseparated harvest can result in a drop in prices of 20%, a net profit of loss is obtained 2.4%. Adding the cost of acquiring the necessary materials and services (mapping, equipment, investment in small vessels) can cause strong enough economic damage to the company.

Moreover, attempts to reduce the intra-field variability should be made with caution since fertilization and irrigation reinforced areas of low vigor in order to homogenize the plot will take them to the most important force. This means increased performance in these areas, but at the same time also the largest weight of bunches and berries (Rousseau, 2008) which can result in compact clusters of high and overall quality of the lowest harvest.

However, the use of precision viticulture techniques can be effective in terms of increased yield and quality simultaneously. Since the index NIR / R is correlated with the weight of the vine prunings (Dobrowski, 2008), some georeferenced digital equipped can be developed for tailors to load the vine according to its vigor.

The vigor control technique must be a measurement of complex introduced to the plot in order to balance each plant (force / charge) individually, reducing intra-field variability of growth and quality of grapes and ensure a sustainable functioning of the plot (Pérez, 2007).

Winkler and Poling (1995) in their book offer load each foot vine by its vigor. However, in practice, often settling specifications or banal by simplicity, the load is uniform throughout the plot regardless of the productive capacity of each vine individually.

The pruning weight measurements gives an estimate of the strength of the vine (Winkler, 1974; Bravdo, 1985; Perez, 2007; Stein, 2011)) provided that the branches have not been previously cropped. On the other hand the strength of the vine of the previous year can be an indicator of the maximum effect for the current year and by having this value in kg for each plant, the load can be individually assigned and subsequently controlled by 'suckering.

This work, although it is very expensive, may seem easy to implement. However, in reality, changes in vigor even neighboring vineyards feet can be very important and often traditional pipe systems are not able to accommodate the excessively high charge of vigorous vine in the same time respecting the optimal distance between branches.

To give an example, the vine that produced the previous year the total weight of 2.5 kg branches this year must bear the load of 50 buds (according to the coefficient of weight 50 g of a branch of 1.2 m). The minimum space required for correct placement of the charge on the driving system Royal Cordon would be 2.5 m between the stocks which often is not acceptable for reasons of low density planting and reduced profitability of production. This is especially true if the neighbors are less vigorous vines and do not need a meter of space to express their full potential.

Perez (2007) managed to solve this unseemly non standardized management of the plot. He proposed three control systems that can be compatible with the technical control vigor:

1) "Lyre" is a control system that even with a reduced distance between the vines can provide enough space to have 4 or even more arms a necessary number of branches (Figure 7). It is an effective system in case of annual measure of pruning weight and power of the optimal charging individually for each vine.

Figure7. *Control System the "Lyre"*

2) The new driving system "Circle" for terraced plots where the row can only be worked from one side. The system (Figure 8) is suitable for this type of plantations and offers enough space to accommodate the high load without increasing the distance between the stumps.

Figure8. *The control system "in a Circle"*

3) The most recent system (Figure 9) is indeed the "Lyre" or "Geneva Double Curtain" modernized for maximum use of space and ensure productive at the same time the ability to load the vineyard according to his ability

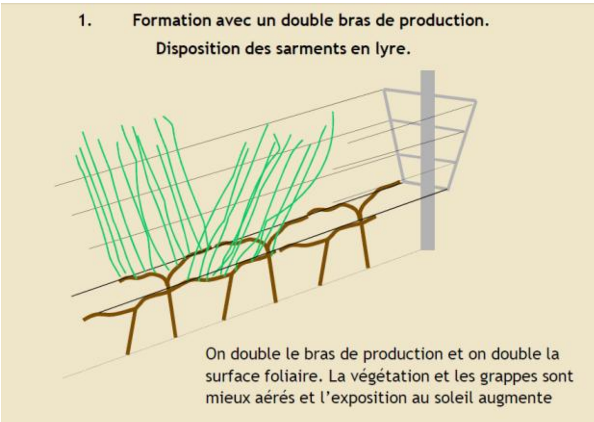

Figure9. *The system "double trellising"*

The main advantage of this system is the ability to minimize the distance between the stem (50 cm) maintaining the length of 1 meter arm. The small distance between the stocks reduced vigor (Gallet, 1993) which makes available to the load of 1 meter from the arms of a more feasible vine. In other words, the weak force reduces the vine to the maximum load and makes the way the decision to tailor easier to do with a glance on the length of the branches. For example, the vines with long branches at the end of the season will be loaded with a maximum of 10-14 buds, while the vines with short branches can be pruned to half of the maximum load. Thus, this system is a simple, cheap and easy to implement in order to balance each vine by its vigor and reduce the intra-field variability.

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