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# Documentation of working time according to product-oriented vineyard cultivation systems

Making profits in vineyards is just possible whether the producer is able to increase yields or improves efficiency by a reduction of working hours. With the help of GPS documentation systems a differentiated view of working intervals and total working time can be recorded and analyzed. Several studies of extensive and intensive vineyard cultivation systems give the following results: individual collected data may differ markedly from literature data. Moreover extensive cultivation systems should be used for basic wine quality production to get a positive business result.

**Keywords**
Working time, viticulture, GPS, extensive cultivation, wide row education, hedge row vineyards

**Abstract**
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The requirements on labour-management in wine business depend on the geology of vineyard sites, size of the cultivated area, employee structure, mechanical equipment and the sales channels of processed products. Grape- or cask wine production is determined by the fix market price of grapes per kilogram and the aim is to reduce the amount of vineyard work to a minimum. Those who bottle their wines determine the price per bottle independently and positive profits result only from the quality of marketing strategies in combination with an optimum price/performance ratio. In that case the yield per hectare has to be in a targeted relation to the desired level of grape quality. A modern range of wines is grouped into basic, premium and super-premium wine segments, so it is not extraordinary that a wine grower has to pursue several work strategies from intensive to extensive treatment.

The aim of the research project is the development of strategic solutions how to produce a wine with a defined quality, based on the individual requirements of the wine grower, at the lowest possible level of working hours and production costs.

## Research projects

The first part of the investigation is about alternative trellis systems for work reduction. The time required for grape production in vineyards with Vertical Shot Positioning (VSP), Single Wire Trellising (SWT) and Hedge Row Vineyards (Hedge) was measured at Müller-Thurgau grapes. With the help of cost analysis after the time documentation in the vineyard, it was easy to find the system of profit maximisation for an average German grape producer. The central issue is the question if the production for those companies should be exclusively for quantity-orientated basic-wines with hedge trellising or if the savings in time, caused by minimized work, even lead to further capacities for making quality-based premium-wines.

A second part of the investigation was about the not yet widespread Alternate Wide Row cultivation (AWR). This strategy skips every third row by alternating the distance of the rows between four and two metres. The vines per hectare get reduced by a third that way and it should be discussed if the work reduction can compensate this loss of plants.

The last study deals with the comparison of “extensive” and “intensive” vineyard treatment to produce cheap basic and expensive premium wines with Riesling and Pinot Noir grapes. Those grape varieties show a strong reaction to any kinds of yield regulations.

## Methods

The documentation of the vineyard work of the different trial variants was supported by the electronic field card index “AgroNet” (Agrocom Company). With the personal digital assistant (PDA) handheld system “PALM iQue 3600®“(Garmin Company) relevant data has been recorded during the work process. After the accurate mapping of the vineyard the PDA recognises the start of the work process when the tractor enters into the vineyard. The recording of working time runs automatically. The simultaneous documentation of setup time, working time, stand still time, transportation time and turn-over time shows on one hand a detailed overview of single working steps, on the other hand an overall coverage of total working hours per

Table 1

*Total cost of the system alternate wide row cultivation (AWR) and ordinary trellis breeding in relation to the wages of the manager [3]*

| **Anbausystem** ***Cultivation system*** | **Werte aus der Literatur [AKh/ha]** ***Values from the literature [h/ha]*** | **Erfasste Werte [AKh/ha]** ***Recorded values [h/ha]*** | **Relation [%]** ***Ratio [%]*** |
|---|---|---|---|
| Gesamtarbeitszeit *Total working time AWR* | 148 | 85 | 0,58 |
| | | | 42 % weniger/*less* |
| Gesamtarbeitszeit *Total working time Spalier/VSP* | 200 | 114 | 0,57 |
| | | | 43 % weniger/*less* |

hectare in a special cultivation strategy. Manual documentation methods are more laborious and require a high level of operator discipline.

A monetary comparison of the different production methods was performed by a structured cost analysis. Working- and machinery-costs can be transfered directly from the PDA work documentation. The extent of these costs largely depending on the hourly wages of the vineyard workers. A skilled worker or the winery manager has to be calculated with at least 15 € $h^{-1}$, a seasonal worker with 8 € payment. [1]

For a qualitative evaluation of the trial variants, grape structure analysis as a practicable method for determining the numbers of grape berries and the weight of the stems had been taken. In addition the so called "Point-square-test" [2] was used for the density- documentation of the leaf surface. With this method the number of leaves, canopy-gaps, exposition of leaves and grapes can be recorded. A loose canopy shows a lower susceptibility for grape rot, because of faster wind drying. Yield analysis was made by a single vine harvest very close to the harvest or a separate total weight of every trial. The degree of grape-ripeness was analysed via spectrometric berry-coloration measurement and the composition of grape constituents (natural sugar, acidity, pH) via "Grape Scan Analysis".

Photometric analysis of yeast available nitrogen showed the amount of nutrients in the must which is very important for a secure and controllable fermentation.

The amount of glycoside linkage of grape flavouring substances to glucose gives information on the aromatic potential of the wines done by Glycosyl-Glucose analysis.

## Results

### AWR versus VSP

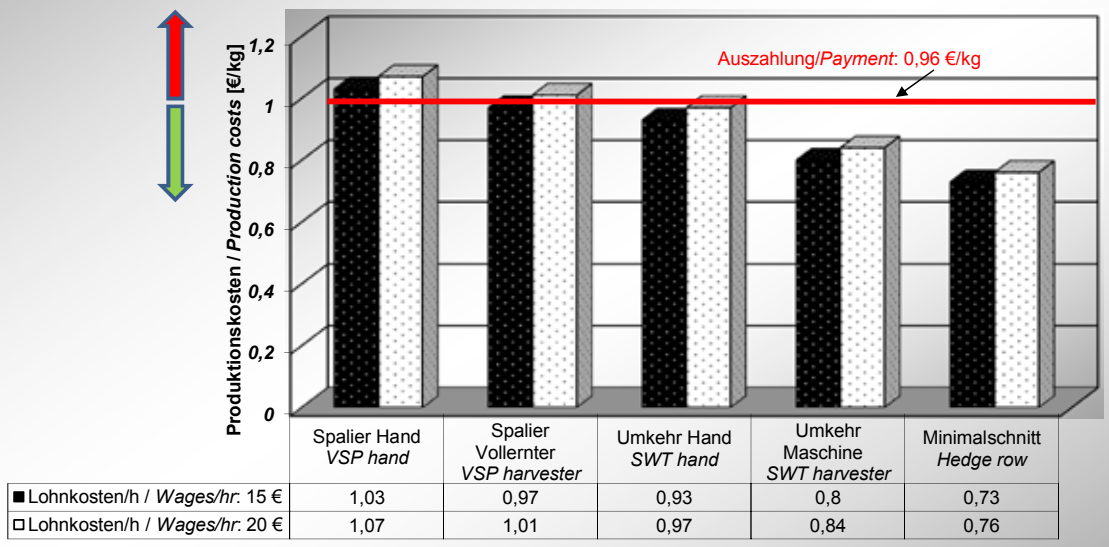
The amount of labour required for AWR trellising was 85.2 h $ha^{-1}$ and 114 h $ha^{-1}$ for VSP, particular relating to the tested winery [3]. Especially the road speed related work operations are done in a shorter amount of time because of the positive vineyard geometry of AWR. If you compare those measurement results with the literature values, the numbers differ considerably. The Association for Technology and Structures in Agriculture in German (KTBL) calculated 148 h $ha^{-1}$ in AWR cultivation and 200 h $ha^{-1}$ in VSP. The individual measurement of the test winery differs with a reduction of 42 % to the literature value (**Table 1**). It seems to be an important sign that individually established working concepts are not always comparable with the "general norm".

At the vineyard evaluation VSP showed a higher incidence in botrytis-infection compared to AWR, although the trellis system showed a looser density of the leaves. In the end of the scoring AWR had the highest amount of nutrients with 296 mg yeast available nitrogen per litre compared to 254 mg $l^{-1}$ in VSP, which is only slightly worse. Grape constituents and aromatic potential of both cultivation systems haven't differed significantly. By reaching the maximum yield per hectare for a quality wine with 10,500 litre in average vintages, the test winery had production costs of 0.73 € $l^{-1}$ in AWR only 0.55 € [3]. With AWR cultivation it is possible to reach the maximum yield per hectare with lower costs, without any loss of quality. The consequences according to the hourly wage of the winery manager are 23.34 € $h^{-1}$ in a AWR system and only 3.50 € $h^{-1}$ in VSP. This is a result of the differing operation costs and a fixed market price for grapes.

### Single wire trellising (SWT) and hedgerow-system (hedge) versus vertical-shoot-positioned trellis (VSP)

In the comparison of three cultivation systems the hand picked VSP is the most time taking variant (429 work h $ha^{-1}$), followed by the hand picked SWT, VSP (harvester) and SWT (harvester). The lowest time required the hedge-system (83.36 h $ha^{-1}$) which only can be picked by machine. A hypothetical hourly wage of 15 € $h^{-1}$ for the winery manager turns into a money-losing operation of 0.01 until 0.07 € $kg^{-1}$ grapes, based on the payment level of a German wine grower company, which was 0.96 € $kg^{-1}$ grapes in 2008 (**Figure 1**). By increasing the hourly wage to 20 € $h^{-1}$, only the variants SWT (harvester) and hedge stay profitable. Hedge even makes a profit of 0.23 € $kg^{-1}$ [4].

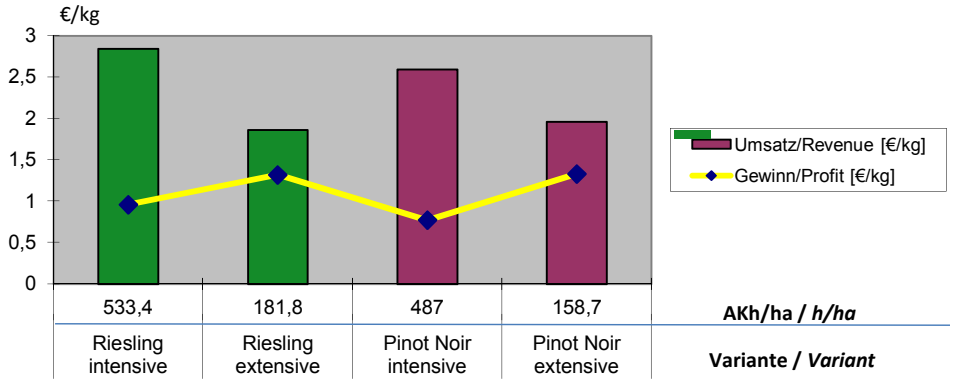
Fig. 1




| | Spalier Hand *VSP hand* | Spalier Vollernter *VSP harvester* | Umkehr Hand *SWT hand* | Umkehr Maschine *SWT harvester* | Minimalschnitt *Hedge row* |
|---|---|---|---|---|---|
| ■ Lohnkosten/h / *Wages/hr*: 15 € | 1,03 | 0,97 | 0,93 | 0,8 | 0,73 |
| □ Lohnkosten/h / *Wages/hr*: 20 € | 1,07 | 1,01 | 0,97 | 0,84 | 0,76 |

*Profitability of different cultivation systems based on the payment level of a German winegrower cooperative*

Fig. 2




*Profit model of an intensive cultivation compared to an extensive one of German grape varieties regarding working time and sales [6]*

## Intensive and extensive treatment

**Figure 2** shows the profit shifting effect of an extensive compared to an intensive treatment with Riesling and Pinot Noir grapes. Higher sale prices per bottle (intensive) generate a higher income per kilogram grapes, but this had been compensated from way higher operation costs. The Riesling "extensive" variant generates additional profits of 10,404.50 € compared to Riesling "intensive", based on the study of the cost analysis. Pinot Noir "extensive" leads to a 10,948.70 € higher profit than "intensive". This is the result of a higher total working hour requirement, caused by additional manual work to increase wine quality. However in all variants the intensive cultivation shows a higher degree of maturity and acidity of the grapes. According to source [5] the differences in must weights of the grapes reach from 10 until 13 °Oechsle (approximately 30 g $l^{-1}$ natural sugar).

Canopies of intensive treatments show less leaf layers so that it is easier to penetrate with plant protection agents and the drying effect of the wind is better, what causes a lower botrytis infection. Especially for the production of red wines with red grapes and fermentation on skins a healthy grape crop is the greatest priority for the wine grower. Even with a low percentage of botrytis berries it is only possible to produce Rosè wines of those grapes.

## Conclusions

Different investigations of working time in vineyards show the great demand for automatically, GPS supported documentation systems, which are often used in agricultural business, much rarer in viticulture. An easier margin accounting, orientated on the cultivation strategy and the ability to comply with the documentation obligation are the advantages of those time saving technological opportunities. The results of individual working time documentations can have a great variation compared to the literature values. In extreme cases the deviation between the measured values and the declared values differed with 42 % [3]. Different distances from the vineyard to the winery, several

vineyard structures (row length, vineyard size, altitudes, supporting materials) and although the competence and level of experience of the workers are responsible for those variations. For the determination of the individual work time reference used for economic calculations it is absolutely essential to do own documentation.

From results to date the VSP cultivation only makes sense if the wine grower uses it for high premium wine production with additional manual work on the vine. For basic wine production VSP is too time taking and expensive. A good basic wine production works with extensive cultivation systems, which can be used for rising profits about 0.38 € $kg^{-1}$. But not many German wine growers are ready to give up their standard VSP cultivation systems. They are afraid of unusual workflows and have optical concerns.

Systems like SWT, AWR and Hedge offer the possibility to cultivate one hectare of vineyards with only 50–80 h $ha^{-1}$. The hourly wage of the winery manager could be increased about 20 € $h^{-1}$ in AWR compared to VSP. In exclusively grape producing companies those extensive cultivation systems should be used area wide.

A good operation strategy for self-marketers could be a "dual cultivation" with intensive and extensive treated vineyards. Extensive vineyards deliver the basic wines and costs can be reduced that way. In addition less time spent on basics generates a potential for release of work capacity. Those time-reserves can be used for the cultivation of a bigger area size with the same amount of man power and there is more time for the concentration on marketing effectively premium qualities, the flagship for those wineries.

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