WINERY DESIGN CRITERIA FOR THE PRODUCTION OF VALUABLE WINE (DOC)

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CSBE100706 – Presented at Section II: Farm Buildings, Equipment, Structures and Livestock Environment Conference

ABSTRACT Today the market requires wines with particular and constant organoleptic (flavor, acidity, etc.) and aesthetic characteristics (color, etc.). These wines depend not only on the quality of the grapes, but also by how they are collected, transported and processed in the wineries. We have performed a research in the province of Viterbo (Italy) where some wines have received the recognition of "value wines" (DOC). Examining the areas of grape production and some wineries, the research carried out has allowed the development of some general criteria for design of wineries:

1. The winery must be located in a central position with respect to areas of production so it takes less than 30 minutes to transport the grapes.
2. If the grape farms are spread on the territory, it is necessary to establish stations for wine-pressing and to transport the product with refrigerated cars or to refrigerate the grapes before the transportation.

The winery must be designed to allow:

1. the cooling of the grapes when the temperature is above 20-25 ° C;
2. the unloading as soon as possible;
3. the immediate pressing of the grapes;
4. every day full receipt of the must into a suitable number of wine fermenters;
5. the protection of the wine apparatus from solar radiation.

These are the first important rules elaborated for a correct winery design for valuable wine production.

Keywords: Layout Wineries, Vineyards, Transport systems, Wines DOC.

INTRODUCTION In Italy, the viticulture and the winemaking technology has reached levels of excellence recognized throughout the world.

Now the wines "made in Italy" for their quality have reached the level of the most famous French wines and the opening of new markets in the Far East has given a further incentive to Italian production.

But the consumers are always looking for new products having special organoleptic and
aesthetic characteristic for mating to dishes increasingly refined. Also the average Italian consumer, accustomed to drinking anonymous not tasteful wines that are homemade, has changed its taste and now directs his choices more toward wines of guaranteed quality.

In accordance with this trend, the oenologists are trying to retrieve the local varieties of grapes typical of small areas of our country that in time past have been used to produce wine for mass consumption.

Recently, it was shown that with these vines it is possible produce grapes for making high-quality wines on condition that these grapes are grown and transformed with special care in appropriate facilities.

In the areas where are grown these grapes, there is not always an tradition for production of fine wines because farmers have always chosen the production of low-priced wines or wines that could be used to correct wines produced elsewhere.

It is known that in the past time the red Italian wines having very high alcohol content were used for cutting Italian and foreign wines.

Various commercial and political reasons have changed this trend in many areas of Italy so wine producers are turning to high quality productions.

However, in some limited areas of Italy, the tradition continues to resist and the farmers prefer to yield grapes for large consumer wines.

In these areas, however, can achieve an appropriate conversion if you follow two paths simultaneously: the first concerns the organization of farms that produce the grapes and the modernization of farming techniques and the second concerns the modernization of wineries.

Unfortunately, in some Italian areas as those existing in the province of Viterbo, the tradition and the poor productions of grapes is a serious obstacle to the renewal of cultivations and of wineries.

We have carried out a search in this province to study the characteristics of wineries, of viticultural farms and of the wine-making techniques for producing some typical indigenous wines that may have a commercial success.

1. MATERIALS AND METHODS

The research has been focused on some typical wines of the Viterbo province who received recognition DOC (Denomination of Controlled Origin): Aleatico of Gradoli, Grechetto of Vignanello and the red and white Vignanello, that are produced in the areas of Fig. 1.
The total production of these wines varies around 15,000 hl / year in front of a wine provincial production of over 400,000 hl. These data indicate that these wines will disappear, if nothing is done for restructuring of the entire production chain.

One reason for this small production of wine was due to limited production of grapes due to the unprofitability. The wine growers prefer to cultivate the grapes for ordinary wine, which is easier to sell.

Indeed, throughout the province of Viterbo, compared to about 730 ha of vineyards invested for production of DOC wines, there are about 4100 ha invested screw for producing common wines. Specifically, in towns where these DOC wines are producted, the total area planted to vineyards amounts to over 1300 ha, almost all as a secondary crop, while the surface of vineyards for DOC wines, is little more than 161 ha (less than 12.5%).

A second reason is the difficulty of producing fine wines into local wineries which not always are suitable.

The research began with an inventory of vineyards in production areas and with the analysis of the distribution of farms on the territory. This investigation showed, first, a large fragmentation of vineyards on the territory.

Two thirds of vineyards have an extension of less than 1.00 ha and cover about 37% of the area planted with vines. The vineyards extending more than 1.00 ha are only 33% of the total, but cover 72% of the area planted with grapes.

Overall, the area planted with vines for the production of these wines is equal to 161 ha, less than 20% of the area under vines for wine DOC of the province of Viterbo and the relationship between this surface with the municipal SAU is equal to an insignificant value of 0.89%.

This very small surface is distributed on n° 141 farms of which only n° 36 farms have an extension lesser than 1.00 ha and well n° 63 farms have an extension lesser than 0.50

### Table 1. Town and surface of vineyard for Aleatico di Gradoli

<table>
<thead>
<tr>
<th>Town</th>
<th>Vineyards (ha)</th>
<th>Vineyards for DOC (ha)</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gradoli</td>
<td>104.27</td>
<td>15.20</td>
<td>14.58</td>
</tr>
<tr>
<td>Grotte di Castro</td>
<td>80.30</td>
<td>1.60</td>
<td>1.99</td>
</tr>
<tr>
<td>Latera</td>
<td>47.39</td>
<td>0.45</td>
<td>0.95</td>
</tr>
<tr>
<td>S. Lorenzo Nuovo</td>
<td>49.92</td>
<td>5.00</td>
<td>10.02</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>281.88</strong></td>
<td><strong>22.25</strong></td>
<td><strong>7.89</strong></td>
</tr>
</tbody>
</table>

### Table 2. Town and surface of vineyard for Vignanello vines

<table>
<thead>
<tr>
<th>Town</th>
<th>Vineyards (ha)</th>
<th>Vineyards for DOC (ha)</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bassano in Teverina</td>
<td>47.05</td>
<td>20.97</td>
<td>44.57</td>
</tr>
<tr>
<td>Corchiano</td>
<td>158.95</td>
<td>25.29</td>
<td>15.91</td>
</tr>
<tr>
<td>Fabrica di Roma</td>
<td>86.38</td>
<td>4.60</td>
<td>5.33</td>
</tr>
<tr>
<td>Gallese</td>
<td>64.58</td>
<td>34.32</td>
<td>53.15</td>
</tr>
<tr>
<td>Soriano nel Cimino</td>
<td>158.99</td>
<td>4.05</td>
<td>2.55</td>
</tr>
<tr>
<td>Vignanello</td>
<td>311.20</td>
<td>23.41</td>
<td>7.52</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>281.88</strong></td>
<td><strong>22.25</strong></td>
<td><strong>7.89</strong></td>
</tr>
</tbody>
</table>
These farms are dispersed into the territory and are sited in peripheral position in relation to the main roads and to the wineries.

The next phase of the research has been towards the analysis of major wineries producing quality wines that exist in the province of Viterbo. Almost all of these wineries were built in the fifties and later adapted for the new machines and for the new production requirements. Only one winery is of recent construction.

All the visited wineries follow the same flow diagram of processing (Fig. 2).

The farmers carry the grape primarily in bulk quantities into agricultural and industrial trailers and only rarely into small wooden or plastic boxes (Fig. 3).

The grapes, before it is accepted by the wineries, undergoes some checks and then is discharged into the loading hoppers for being pressed (Fig. 4).

The fermentation of grape must goes on or into old tanks made with masonry or into the modern stainless steel tanks (Fig. 5), even of the new generation, all fitted with equipment to control the temperature of the grape must. The stainless steel fermentation tanks, in more than one case, have been placed outdoor without any protection from the weathering.

Similarly, at several wineries the tanks for the storage of wine after fermentation were disposed outdoor. The bottling of and the ageing the wine in small oak barrels (barriques) is performed at all wineries.

Figure 2 Flow diagram of the winemaking process

Figure 3 Transport grapes

Figure 4 Loading hopper
2. CONSIDERATIONS ON THE RESULTS Research results allow us to draw some considerations about the state of the production of fine wines in the province of Viterbo.

The territorial analysis has dramatically highlighted the existence of numerous small vineyards, distributed over the territory in a piecemeal mode and often distant from the wineries.

This situation certainly does not encourage the development of these wines and can cause problems for the same survival of viticulture in these areas.

The small size farm prevents any type of improved crops and of cropping systems because, often it is led by an old farmer or by a farmer part-time and both no longer have the will and convenience to make investments that will improve the production.

Also the quality of the product delivered to the winery from these farmers is not always free from defects (mold, dried grape, leaves, etc.) (Fig. 7), and it is difficult for these people to make a sorting of the grapes before loading on means of transport because of their cultural inertia.

Moreover, these small farms are distributed on territory so nebulous, often are very distant from the wineries and they are always mixed with other cultural realities which have different needs.

The modest grape production does not allow use of efficient and fast means of transport and the consequence is that the grape reaches the winery partially crushed. Also the fermentation processes are already in place favoured by the overheating of the mass (Fig. 8).

In these conditions it is very difficult to control the quality of wine.

A second consideration concerns the way in which the grapes are received by the winery.

Only two wineries are equipped for making a
qualitative selection of the grapes while in the other, the controls are limited to determine the weight and the sugar content of grapes, even with primitive tools (Fig. 9). No check is performed on the temperature of the mass of grapes.

Because of the distance and of the precariousness of the means of transportation, as mentioned above, often the grapes reach the wineries after several hours from the time of harvest. The temperature of the mass of grape loaded on means of transportation is inevitably affected by the temperature of the grapes at harvest (the harvesting is made during the days of warm months and during the hottest hours of the day), by the outside air temperature and by the exposure to solar radiation during the transport is, and to a lesser extent, by the fermentations, which inevitably end up to be triggered.

Indeed, at the late August and during the month September, in the examined areas of the Viterbo province, the temperatures peaks reach values above 30° C and the maximum value of the solar radiation is of the order of 600 W/m². A grape that has a temperatures around 30° C produces a grape must having about the same temperature that is higher than recommended for a good fermentation not only for white wines but also for red wines.

Also the subsequent actions for cooling the grape must does not always ensure a good result because in the meantime it may have been lost or altered some typical components of grape.

The situation becomes even more dangerous if the grape must is then made fermenting into tanks placed outdoors without any protection from solar radiation and from the effects of climate.

In the examined territory, there is the belief that the climate allows the fermentation of grape must into tanks sited outside without any problem because the heat capacity of grape must is such as to protect him from the effects of the sun and outside air temperature. Undoubtedly this solution is very economic only for the installation cost but it is certainly more expensive to control the temperature of the grape must especially for white wines. But there are limited margins safeties.

Similar considerations can be made for the placement of the tanks for the storage of wine after the fermentation stage.
The outside tanks are definitely at high-risk both for high and low temperatures outdoor air both for the effects of solar radiation. Only with the large tanks we can rely on the heat capacity of the wine, but in the process of emptying, the risks that we run on wine quality are very high. The heat capacity of a small volume of wine and a significant development of the external walls of the tank do not guarantee a good preservation of the product.

3. CRITERIA FOR A CORRECT DESIGN  

The recovery and enhancement of this heritage in wine requires a radical restructuring of the production chain from farms to processing plants according to some criteria that we consider essential to try to improve the quality of the production of premium wine in the areas examined. These criteria surely will be valid also for other similar situations.

First, with regard to size of farms, the consortia of protection for these wines should implement some initiatives to promote:

- the merging of the particles;
- the expansion of areas planted with vines;
- the improvement of crops with the introduction of modern cultivation techniques;
- encourage the agricultural credit;
- ensure a stable price of grapes,

in order to promote increased production in these territories of these fine wines and a greater commercial spread.

This consortium of protection should also execute an efficient control of grape before, during and after the harvest regard to both in the health status of the acini both the degree of maturation, both the conditions of arrival of grapes at the winery.

The choice of the cultural practices and, above all, of the period of harvesting should no longer be left completely to the free initiative of farmers, to avoid creating congestion in the unloading phase in wineries and to avoid having to work simultaneously grapes having a different ripeness. It is known that some organoleptic qualities depend on the ripeness status of grapes at the time of the crushing.

Considering the spatial realities of the vineyards and of the wineries, the transport of grapes from the farm should be done as rapidly as possible to minimize the time during which the grape stands on the means of transportation and it is exposed to external agents.

Therefore, the means of transportation should be of modest capacity for avoiding a loading height which may cause crushing of the grapes of lower layers. For very ripe grapes and with delicate skin, the transport should be done into small crates and the wineries should be equipped to receive this type of load.

You could organize some collection centres which should be at barycentric position...
respect to the farms when the size of the farms did not allow the use of small and fast vehicles. In these centers the small producers can transport the grapes as soon as possible after harvest and the grapes should be cooled to about 10°C and loaded on insulated and protected means of transportation.

When production of the surrounding areas allows, in these centers it could also provide for the treading of the grapes in a manner that reduces transportation costs not only of the grapes but also the by-products (stalks).

The transport of grape must having a temperature around 10 °C does not lead any risk, it is cheaper and the quality of the wine draws big advantage.

The grape transported directly to the winery must necessarily pass, before being sent for processing, through a very careful selection in order to discard products with alterations over certain limits and for ensuring a high quality of wine. The mass temperature of the grapes should be monitored at arrival in the winery and if necessary, should be done a rapid cooling before the pressing of grapes. This purpose, the unloading stations should be equipped with systems for the distribution of pulverized dry ice or with other suitable equipments capable of rapidly lowering the temperature of the mass.

3.1. LOCATION OF THE FERMENTATION TANKS
The latest technology for the wine's fermentation requires the use of suitable stainless steel containers fitted with systems for controlling the temperature of the grape must.

These containers stainless steel, called "fermentini", offer a number of obvious benefits to both the control the temperature of the grape must, especially for white wines, both for the health check both for final disinfection.

The optimal location of these containers should be near the machineries for crushing and pressing grapes, inside the winery, in rooms that are ventilated rooms and protected from solar radiation for avoiding the air overheat.

So it will possible achieve a double advantage: you save energy for controlling the temperature of the grape must and the wine runs less risk of being damaged by high temperatures.

The total capacity of these tanks for fermentation must be choose according to the average daily production of grape must and to the grapes' varieties that are conferred at winery. At end of the day all these tanks for fermentation should be filled completely to avoid adding other grape must the next day. Otherwise you should have recourse to the

Figure 10 Outdoor storage tanks
inhibition of fermentation by lowering temperature of mass with a waste of artificial energy.

The next step involves the storage of wine in suitable containers for the completion of fermentation and for performing all the processes of clarification, cutting and polishing of wine. These operations require more decants of wine in tanks of fewer capacity for avoiding leaving the wine in contact with the air.

The most rule convenient is to install a number of tanks for a total volume of not less than at least 1.5 times the capacity of the winery.

These tanks should have different capacities so that the wine does not remain in contact with the air for a long time.

The location of these tanks can only be inside the buildings where it is more simple to maintain control of climatic conditions so that the wine is not subjected to thermal shocks that have a damaging effect on the final quality (Fig. 10).

Therefore, these environments should be without windows or with window screens, should have a large volume, should be sited on the cold side of the winery and should have a heat and sound insulation.

In summer, if it cannot possible to control the air temperature in these rooms with passive methods, it is required to use air conditioning because the wine that is at immediate contact with the walls of metal containers can undergo a substantial change in its temperature. If this happens, the quality of wine would be at risk.

Finally, when it is expected wine aging in containers made of wood (barrels, barrels, etc..) or in bottles, this operation can only be done in the classic cellars or "caves", that are, underground rooms, without windows, soundproof and thermally insulated (Fig. 11).

The aging the wine that is done by placing the containers in different environments, such as those which are used for processing or for simple storage, does not give good results and it is ill-suited to fine wines.

The monitoring of climatic conditions in the areas of wine aging is crucial to do slowly take on the characteristic taste of the wine grape variety of origin enriched by the aroma that the wood barrel gives him.

It takes time and especially the wine must not suffer thermal and mechanical shock.

**CONCLUSIONS** The exploitation of indigenous agricultural resources, such as vines,
that give niche productions but that have a potential market for their typical flavours, it is a necessity to prevent loss of this genetic material and to allow farmers higher profits.

This is the case of some grape varieties typical of some areas in Italy that have always produced wines that were characteristic but they are been outclassed by the most famous wines and have been overwhelmed by the abandonment of the countryside.

The cultivation of these vines continues only for the affection of old farmers to the tradition, but only on small parcels of land.

Some farmers have shown that by working with appropriate techniques these grapes they are able to produce wines of quality which can penetrate the market.

However, the development program should include the restructuring of agricultural production facilities, when they are pulverized at the territory, the reordering of the carriers system and the restructuring of the wineries to the modern standards which are requested for making a correct grape processing so as to enhance the typical characteristics of these wines.

It will be difficult, in the absence of this program or of other similar that viticulture in these areas can survive for a long time, squandering potential assets for lack of initiatives.

REFERENCES
A. Bosi, 1982, Impiantistica enologica, Edagricole- Bologna
E. Peynaud, 1976, Enologia e tecnica del vino, Edizione italiana, AEB Brescia