THE AGRONOMIC CHALLENGES OF SUSTAINABLE VITICULTURE

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Vineyard management regards plant manipulation and growing techniques, in the strictest sense, designed to act on environmental resources and especially on soil fertility. Interventions on the plant are related to winter pruning, canopy management and pest control. Growing techniques relate to soil management, fertilization and irrigation. The logic of integration between the various agricultural activities should be guided by the principles of sustainable viticulture, an objective which is to "produce high quality wine grapes through a process that can provide an adequate income (economic sustainability), minimizing the impact of technical cultivation on human health and environmental resources (environmental sustainability)".

The principles of sustainable viticulture were long ago (1996) well summarized dall'IOBC / WPRS[1] in the following points:

√ to promote production systems that respect the environment, are economically viable, and sustain the multiple functions of agriculture, namely its social, cultural and recreational aspects;

√ to secure a sustainable production of healthy grapes of high quality and with a minimum occurrence of pesticide residues;

√ to protect the farmers' health when handling agro-chemicals;

√ to promote and maintain a high biological diversity in the ecosystem of the vineyard and in surrounding areas;

√ to give priority to the use of natural regulating mechanisms;

√ to preserve and promote long-term soil fertility;

√ to minimise pollution of water, soil and air.

With a view to producing grapes of high quality, the definition and regulation of balancing grapevine fruit yield and vine growth of the vineyard is central. This regulation requires the integrated use of all the techniques of cultivation, from winter pruning until the eventual thinning of bunches, adopted in different regional contexts the most appropriate agronomic techniques taking account of the specific vineyard and wine-making model in which one works, and specifically the wine variety grown and the enological objective pursued.

The adjustment of the balance grapevine fruit yield and vine growth for the constant production of high-quality grapes must be considered central to the following three rules (Howell, 2001):

1) for each combination of genotype x environment there is a technique to achieve optimum crop production proper and constant quality grapes;

2) the good growing practices should result from knowledge of the physiology of growth and development of the grapevine;

3) sustainable levels of high quality grapes associated with high productivity can be achieved only through respect of adequate fruit yield and vine growth of a suitable bunch thermal and radiation microclimate.

[1] International Organization for Biological and Integrated Control of Noxious Animals and Plants, West Palearctic Regional Section (IOBC/WPRS)

It should be noted that in general there is a strong convergence between the characteristics of the canopy that allow the latter objective, and the conditions allowing an efficient pest control both on the efficiency in the distribution of pesticides on target organs (leaves and clusters) and in relation to the prevention of the development of plant diseases.

Italian vinicultural scenario, based on models of territory viticulture, with specific genetic conditions (grapes varieties), environmental (soil and climate), and wine-making purposes (type and style of wine) is therefore of great importance to define criteria for the management of the vineyard able to adapt to many contexts and at the same time to allow the maximum expression of quality.

From the agronomic point of view, therefore, the challenges for a sustainable viticulture are numerous and can be summarized as follows:

√ to refine diagnostic models for the evaluation of environmental resources and limiting factors for the grape growing land suitability, to define the most appropriate vinicultural models;

√ to develop vineyard planting systems respectful of soil horizons of the site able to contain any risk of erosion and landslides by efficient flows of ground and surface water;

√ to adopt management techniques for the conservation of soil fertility and consistent with the vulnerability of the site to surface erosion and contamination of groundwater;

√ to set the management techniques of the vineyard canopy in relation to the enological object and diseases control;

√ to develop techniques of fertilization and possible irrigation consistent with the knowledge of grapevine physiology and aimed to increase the quality of grapes.

The methods of precision viticulture, able to monitor the variability of grapevine fruit yield and vine growth ratio in the vineyards, often as a result of soil variability, seem of great importance for the practical application of the principles of sustainable viticulture.

ENOLOGIA PER LA SOSTENIBILITÀ

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Abstract
Il tema della sostenibilità è oggi non solo una scelta filosofica ma sempre più una necessità per garantire che l'attuale benessere sia mantenuto, non solo per le generazioni future ma anche per quelle attuali.
Il concetto di sostenibilità viene ripreso da diverse normative e standard dettati da organismi operanti nel campo della certificazione e integrato e ampliato con l'analisi del ciclo di vita (LCA = Life Cycle Assessment).
Il settore vitivinicolo non può esentarsi da questo approccio visto il suo forte legame con il territorio e non esiste altro prodotto come il vino e soprattutto quello tradizionale e storico, che necessita di questo legame con il territorio che in prima battuta significa "ambiente", ma non solo.
Varie sono le criticità nei confronti della sostenibilità riscontrabili nel ciclo di produzione del vino: da quelle legate alla produzione dell'uva a quelle dovute ai processi di vinificazione, elaborazione, commercializzazione e consumo del vino.
Saranno comunque trattati gli aspetti più squisitamente legati alle fasi della trasformazione e della elaborazione della materia prima uva in vino, quindi tematiche prettamente enologiche e di "cantina" anche se l'approccio rischia di essere riduttivo.
I temi principali della sostenibilità si riferiscono in generale all'impronta ecologica del sistema produttivo (cantina) e più nel dettaglio i consumi energetici (quantità e qualità di energia utilizzata), i consumi di risorse (in particolare acqua, materiali, coadiuvanti, servizi e quant'altro), le emissioni nell'ambiente come i sottoprodotti di lavorazione (in particolare la CO_2 e i reflui in generale).
Le principali Criticità del ciclo di elaborazione del vino:

- Produzione di CO_2: fermentazione alcolica, uso di combustibile fossile (risorsa non rinnovabile) per la produzione di energia elettrica, fermentazione malolattica.
- Uso di acqua come mezzo tecnico (refrigerazione, vapore, ecc.) e di servizio, ma soprattutto quella per le diverse operazioni di lavaggio e detersione dei recipienti, delle attrezzature e degli ambienti.
- Consumi energetici da fonti non rinnovabili.
- Gestione ambientale dei reflui: scarsa loro valorizzazione, senza il loro recupero o riutilizzo anche parziale e processi per il loro trattamento scarsamente efficienti.
- Impiego di materiali ottenuti da fonti non rinnovabili.

Vengono passate in rassegna le varie fasi di processo di vinificazione individuandone le principali criticità e proponendo alcune alternative in grado di dare nell'immediato maggiore sostenibilità al processo.
In particolare i processi a maggiori criticità e le ipotesi di miglioramento dell'impronta ambientale sono così riassumibili:

- Per la elaborazione dei vini bianchi:
  - <u>Illimpidimento del mosto:</u>
    - Chiarifica statica a freddo o dinamica mediante centrifugazione: i due processi impattano negativamente l'aspetto dei consumi energetici; l'alternativa potrebbe essere la flottazione congiuntamente a procedure vendemmiali mirate al ricovero in cantina di uve a temperatura relativamente più bassa.

- Per i vini bianchi e rossi:
  - <u>fermentazione alcolica</u>:
    - Gestione delle temperature; intervenire con sistemi di refrigerazione a basso impatto ambientale e procedure per diminuire le necessità energetiche.
    - Evitare la dispersione di anidride carbonica nell'ambiente: recupero di componenti volatili di pregio e fissazione della CO_2.
  - <u>Affinamento:</u>
    - Migliore sfruttamento delle risorse naturali con la razionalizzazione dell'uso del legno mediante alternative a basso impatto ambientale in grado di garantire cessione dei costituenti pregiati del legno e le condizioni redox dell barrique; cips e gestione alternative del redox (microossigenazione e tecniche elettrochimiche).
    - Condizionamento del redox, gestione precisa della SO_2
  - <u>Movimentazione del vino, taglio/blend di affinamento per l'imbottigliamento:</u>
    - Tecniche che limitano il travaso (operazione dispendiosa per i consumi d'acqua ed altro) ad esempio i tagli in sito, sfruttare al massimo i dislivelli e movimentare senza uso di pompe.
  - <u>Chiarifica/stabilizzazione tartarica:</u>
    - Stabilizzazione tartarica con tecniche alternative al freddo: trattamento con elettrodialisi e altre tecniche a membrana, trattamento con bitartrato a letto fluido, uso di coadiuvanti (mannoproteine ed altri); imprescindibile comunque il disporre di test idonei a stabilire con precisione l'intervento necessario.
    - Alternative ai processi di stabilizzazione tartarica freddo: elettrodialisi, coadiuvanti, risparmio energetico, uso di fonti rinnovabili.
    - Stabilizzazione proteica alternativa allo scopo di eliminare la bentonite ed il suo forte impatto ambientale (e qualitativo): tecniche di deproteinazzione alternativi e in primo luogo test di valutazione della stabilità proteica accurati e precisi, esempi: trattamento deproteneizzante con coadiuvanti alternativi e con sistemi di adsorbimento in colonna.
    - Uso di chiarificanti a minor impatto ambientale o che limitano i consumi energetici e di acqua: chiarificanti vegetali e non della filiera animale, stabilizzanti a freddo, ecc.
  - <u>Filtrazione:</u>
    - Eliminare tecniche di filtrazione ad elevato impatto ambientale e spesso qualitativamente penalizzante (es. filtrazione a strati) comunque tutte le filtrazioni con effetto marcato "dead end", preferendo filtrazione a setti inerti con liquidi a bassa carica che consentono lunghe operazioni di filtrazione e limitati interventi di lavaggio, o meglio ancora filtrazioni a membrana gestita in flusso tangenziale,
  - <u>Sistemi di lavaggio e detersione:</u>
    - Limitare l'uso di acqua con tecniche che necessitano un suo minor impiego.
    - Usare le soluzioni di lavaggio meno inquinate per interventi di pulizia pesanti.
    - Recuperare acqua con tecniche a membrana (NF/OI).
  - <u>Chimica del lavaggio e della detersione:</u>
    - Evitare l'emissione di CO_2: eliminare i detergenti organici, per limitare il BOD e COD.
    - Scegliere principi attivi compatibili con l'ambiente: suolo e piante.
    - Eliminare il sodio e usare il potassio (fra l'altro più compatibile con il vino).
    - Eliminare cloro, nitrati e fosfati.
    - Rendere l'ambiente più sostenibile per il lavoro: meglio acqua ossigenata che cloro ed ozono.

- Imbottigliamento (fase spesso caratterizzata da elevati consumi energetici e di acqua):
  - Scelta di contenitori e chiusure compatibili con l'ambiente e la qualità del prodotto.
  - Sistemi di lavaggio e detersione Cleaning in Place (CIP).
  - Chimica dei lavaggi ed altri concetti già ripresi.
- Valutazione dell'impatto ambientale delle fasi di Post vendita:
  - Packaging.
  - Trasporto.
  - Servizio.
- Disegno della cantina:
  - Captazione ed utilizzo di acque piovane.
  - Gestione termica dell'ambiente e dei processi.
  - Utilizzo di energie rinnovabili. Layout che limiti le movimentazioni con uso di energia elettrica.
  - Locali e corretta gestione dei magazzini.
- Recupero e valorizzazione dei prodotti attualmente considerati come scarti di lavorazione(raspi, vinacce, vinaccioli) e spesso di forte impatto ambientale:
  - Elaborare prodotti di pregio eventualmente destinati ad industrie non enologiche.

E comunque interessante valutare anche i consumi energetici legati alla produzione dei semilavorati e comunque pensare a pratiche ora non concesse ma interessanti sotto l'aspetto del consumo energetico e dell'impatto ambientale. A tal proposito si riportano alcuni dati relativi alla desolforazione chimica dei mosti con perossido d'idrogeno: la tecnica se eseguita con opportune procedure risulta essere di impatto qualitativamente competitivo in comparazione con le tecniche fisiche di desolforazione, può quindi rappresentare una valida alternativa alle tecniche tradizionali ed essere di particolare interesse soprattutto per la produzione di vini quali il Lambrusco e i vini da rifermentazione in generale. Operando con dosi di solforosa più basse rispetto quelle utilizzate per la produzione dei filtrati dolci, è infatti possibile produrre con mezzi limitatati, in termini di investimento e consumi energetici, dei semilavorati di particolare qualità: ovviamente è necessario mettere in atto procedure alternative in grado di assicurare una stabilità microbiologica del prodotto fino al momento della sua desolforazione con acqua ossigenata.

E' comunque imprescindibile e fondamentale non impattare negativamente nella sfera culturale ed emozionale che il vino rappresenta a differenza di altri e senza la quale il prodotto no ha più ragione di esistere.

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ENOLOGY FOR THE SUSTAINABILITY

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The issue of sustainability is now not just a philosophical choice but increasingly a necessity to ensure that the current welfare is maintained, not only for future generations but also to those of today.

The concept of sustainability is taken up by different rules and standards dictated by the organizations operating in the field of certification, integrated and extended with the LCA life cycle assessment.

The wine sector can not be exempt from this policy given its strong relationship with the terroir and there is no other product like wine, and especially the traditional and historic ones, requiring this linkage with the land that in the first instance means "environment".

There are various critical to sustainability found in the production cycle of wine: those relating to the production of grapes than those due to winemaking processes, marketing and consumption of wine.

We will still cover aspects related to the more exquisitely stages of processing and processing of raw material grapes into wine, and wine purely thematic and "store" even if the approach is likely to be reductive.

The main issues of sustainability relate in general to ecological footprint of the production system (wineries), and further the energy consumption (quantity and quality of energy used), consumption of resources (especially water, materials, processing, services and whatever), emissions into the environment as byproducts of processing (in particular the CO_2 and waste in general).

The main critical points of the processing cycle of wine:

- CO_2 production: alcoholic fermentation, use of fossil fuel (non-renewable resource) for the production of electricity, malolactic fermentation.
- Using water as a technical means (refrigeration, steam, etc.). And service, but above all for the various operations of washing and cleaning of containers, equipment and environments.
- Energy consumption from nonrenewable sources.
- Environment management of wastewater: poor exploitation, without their even partial recovery or reuse and processes for their treatment inefficient.
- Use of materials obtained from non-renewable sources.

Looks at the various stages of the winemaking process and identifying its main weaknesses and suggesting some alternatives that can give greater sustainability to the process immediately. In particular, the more critical processes and assumptions to improve the environmental footprint are summarized as follows:

- For the preparation of white wines:
  - Must Clarification:
    - Cold static clarification or dynamic by means of centrifugation, the two processes, negatively impacting the energy consumption, the alternative may be in conjunction with the flotation procedures to shelter in the basement targeted harvest of grapes at a temperature relatively lower.
- For white wines and red wines:
  - Fermentation:
    - Temperature management; action refrigeration systems with low environmental impact and procedures to reduce energy needs.
    - Avoid dispersal of carbon dioxide in the atmosphere: recovery of volatile components of honor, and determination of CO_2.

- Aging:
  - Better exploitation of natural resources with the rationalization of the use of wood by environmentally friendly alternatives that can guarantee high quality of the constituents of the woodwork and redox conditions of the barrel; cips and management and alternative redox (micro-oxygenation and electrochemical techniques).
  - Conditioning of redox, management of SO_2
- Handling of wine, blend for refinement or bottling:
  - Techniques that limit the transfer (expensive operation for the consumption of water and other) such as cuts in site, maximize the difference in height and move without the use of pumps.
- Clarification / stabilization tartaric:
  - Tartaric stabilization with alternatives to cold treatment with elettrodialisys and other techniques on membrane treatment bitartrate fluid bed, use of adjuvants (mannoproteins and others), however, the imperative is to have appropriate tests to establish accurately the necessary intervention.
  - Alternatives to cold tartaric stabilization processes: electrodialysis, processing, saving energy, use of renewable sources.
  - Protein stabilization alternative to remove the bentonite and its strong environmental impact (also qualitative) alternative protein adsorption techniques, but first test for the evaluation of protein stability accurate and precise examples: protein adsorption treatment with adjuvants and alternative systems of adsorption column.
  - Use of fining with low environmental impact or limiting energy consumption and water clarifying plants and animals in the chain, stabilizers cold, etc..
- Filtration:
  - Delete filtration techniques with high enviormental footprint and often detrimental impact on the quality (eg sheet filtration), however all the filtering with marked effect "dead end", preferring inert cartridge filter and liquids at low load, operations that allow long filtration and limited regeneration, or better still managed cross flow membrane filtration.
- Washing and cleaning systems:
  - Limit the use of water by techniques that require a limitated usage.
  - Using cleaning solutions for environmental friendly.
  - Membrane techniques to water recovery (NF / OI).
- Washing and cleaning chemistry:
  - Prevent the emission of CO2: remove organic detergents, to limit the BOD and COD.
  - Set products compatible with the environment: soil and plants.
  - Remove sodium with potassium use (among more compatible with wine).
  - Remove chlorine, nitrates and phosphates.
  - Make the environment more sustainable for the job: better hydrogen peroxide that chlorine and ozone.
- Bottling (stage often characterized by high consumption of energy and water):
  - Selection of containers and closures are compatible with the environment and the quality of the product.
  - Washing and cleaning systems Cleaning in Place (CIP).
  - Chemistry of washes and other concepts already introduced.
- Environmental impact assessment phase of Post sale:
  - Packaging.
  - Transportation.
  - Service.

- Design of the wine cellar:
  - Uptake and use of rainwater.
  - Thermal management environment and processes.
  - Using energy renewable. Layout that limits the movements with the use of electricity.
  - Local and proper management of warehouses.
- Renovation and development of products currently considered as processing waste (stalks, grape, grape seeds) and often with a strong environmental impact:
  - Develop higher-value products destined for other industries than wineries.

Anyway is also interesting to evaluate the energy consumption involved in the manufacture of semi-finished products, thinking at process not allowed at the moment but interesting from the point of energy consumption and environmental impact. In this regard we report some data concerning the chemical desulfurization of musts with hydrogen peroxide: the technique if done with appropriate procedures is reported to be qualitatively competitive impact in comparison with the physical techniques of desulfurization, can therefore represent a viable alternative to traditional and be of particular interest especially for the production of wines such as Lambrusco wine and fermentation in general. Working with doses of sulfur lower than those used for the production of filtered fresh, it is possible to produce means a limited extent, in terms of investment and energy consumption of semi-finished special quality: it is obviously necessary to implement alternative procedures that can ensure microbiological stability of the product until the time of its desulfurization with hydrogen peroxide.

It 'still an essential and vital not negatively impact cultural and emotional sphere that the wine is unlike, others and without which, the product no longer has any reason to exist.

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LE BEST AVAILABLE TECNIQUE (BAT) PER LA SOSTENIBILITÀ DEL PROCESSO ENOLOGICO: L'ANALISI ENERGETICA ED IDRICA COME STRATEGIA PER L'OTTIMIZZAZIONE DELLE RISORSE.

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La Comunità Europea con l'approvazione della direttiva 96/61/CE (ICCP Directive – Integrated Pollution Prevention and Control) del 24 settembre 1996 ha avviato un processo finalizzato al progressivo contenimento dell'impatto ambientale delle produzioni industriali, conformemente ai vari protocolli sull'ambiente approvati in questi ultimi decenni.

Ai fini della sua applicazione sono stati redatti una serie di documenti tecnici di riferimento (Best Available Techniques Reference Documents - BREF) che definiscono le modalità e i termini di applicazione della direttiva in una ampia serie di settori industriali.

Uno di questi, il "Reference Document or Best Available Techniques in the Food, Drink and Milk Industries" (BREF FDM) dell'Agosto 2006, fa specifico riferimento all'industria agroalimentare fornendo precise indicazioni sui livelli di emissioni e di consumo energetico dei processi, nonché sulle "Best Available Techniques" (BAT) indicando con tale termine le "migliori tecniche disponibili ai fini del contenimento dell'uso dell'energia e dell'acqua e dell'impatto ambientale".

A tale scopo le tecniche e le possibili opzioni per l'abbattimento delle emissioni devono essere correlate ai diversi processi al fine di valutarne i benefici ambientali, la fattibilità tecnica e gli aspetti economici.

Il Dipartimento di Ingegneria Agrari dell'Università degli Studi di Milano ha attivato da diversi anni ricerche in tale direzione con lo scopo di validare i dati presenti nei documenti della Comunità Europea con analisi dirette condotte in diverse industrie enologiche. Questo ha permesso di identificare i principali consumi, sia elettrici sia idrici, suggerendo strategie di risparmio e di gestione ottimizzata delle risorse.

Due sono state le linee di ricerca seguite: da una parte si è cercato di identificare i consumi energetici legati al processo enologico identificando le fasi a maggiore intensità energetica mentre dall'altra si sono valutati i consumi idrici mappandoli all'interno del contesto produttivo.

L'analisi dei consumi elettrici è stata condotta suddividendo il processo produttivo in tre macro processi e due ambiti di servizio: la fase di ammostamento, di vinificazione e di imbottigliamento ed i due ambiti legati ai trasporti ed all'energia necessaria per gli impianti di refrigerazione. I valori medi identificati possono essere così riassunti:

- Fase di ammostamento: 1,5 kWh/t;
- Fase di vinificazione: 0,1 kWh/t;
- Fase di imbottigliamento: 1 kWh/t;
- Ambito trasporti: 0,03 kWh/t;
- Energia per refrigerazione: 500 kWh/t.

Le indagini condotte relativamente ai consumi idrici hanno portato ad individuare un valore specifico di consumo pari a circa 10 L acqua/L vino conforme al dato previsto dai documenti comunitari. Interessante notare come, nei casi oggetto di studio, il 20% dell'acqua venga impegnata per il lavaggio delle cassette ed il 50% per quello dei vasi vinari. I consumi idrici, inoltre, sono marcatamente più elevati nel semestre marzo-ottobre (+ 80%) quando si susseguono sia le fasi di fine vinificazione sia di inizio vendemmia.

Le analisi effettuate hanno permesso di evidenziare come il settore enologico presenti dei margini di intervento di sicuro interesse sia per un discorso di comportamento etico nei confronti delle problematiche ambientali sempre più emergenti, sia per un margine di risparmio sicuramente non trascurabile.

In modo particolare sono due gli ambiti di intervento principali: da una parte l'adozione di pratiche comportamentali "virtuose" può portare, in linea con le considerazioni avanzate nel documento comunitario, ad un risparmio del 15% per entrambe le risorse; dall'altra l'adozione di tecnologie avanzate sia per ciò che riguarda la razionalizzazione dell'acqua (sistemi di riciclo dell'acqua reflua, ecc.) sia per il risparmio energetico (uso di inverter sia per la centrale frigorifera sia per il funzionamento delle pompe, impiego di motori ad alta efficienza sulle macchine, ecc.).

Queste considerazioni portano a ritenere come per tutto il comparto enologico sia essenziale mettere al centro queste problematiche per giungere a governare l'intero processo in maniera pienamente sostenibile.

THE BEST AVAILABLE TECHNIQUES (BAT) FOR THE SUSTAINABILITY OF WINE MAKING PROCESS: AN ENERGY AND WATER ANALYSIS AS A STRATEGY FOR RESOURCES OPTIMIZATION

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The European Community with the approval of Directive 96/61/EC (ICCP Directive - Integrated Pollution Prevention and Control) of 24 September 1996 initiated a gradual process aimed at limiting the environmental impact of industrial production, according to various protocols' environment adopted in recent decades.

For the purposes of its application have been prepared a series of technical reference documents (Best Available Techniques Reference Documents - BREF) that define the procedures and terms of the directive in a wide range of industries.

One of these, the "Best Available Techniques Reference Document or in the Food, Drink and Milk Industries (BREF FDM) in August 2006 specifically refers to the food industry by providing precise information on the levels of emissions and energy consumption of processes and on the "Best Available Techniques" (BAT), indicating that term "best available techniques in order to control energy use and water and environmental impact."

To this aim, techniques and options for emission reduction must be related to different processes in order to assess the environmental benefits, technical feasibility and economical aspects.

The Department of Agricultural Engineering of the Università degli Studi di Milano has set up several years research in this direction in order to validate the data in the documents of the European Community with direct analysis conducted in various wine industries. This has allowed us to identify the main consumers, both electric and water, suggesting strategies for saving and optimized management of resources.

Two lines of research were followed: first we tried to identify the energy consumption related to wine making process by identifying the steps to greater energy intensity, while the other measured water consumption were mapped within the context of production.

Analysis of power consumption was conducted by splitting the production process into three macro processes and two service areas: the process of pressing, wine maturing and bottling and the two areas related to transport and energy needed for refrigeration systems. The average values identified can be summarized as follows:

- Phase pressing: 1.5 kWh/t;
- Phase wine maturing: 0.1 kWh/t;
- Phase bottling: 1 kWh/t;
- Transport: 0.03 kWh/t;
- Refrigeration Energy: 500 kWh/t.

The investigations conducted in relation to water consumption have identified a specific value of power consumption of approximately 10 L water / L Wine in accordance with data provided by the EU documents. Interestingly, in the cases under study, 20% of water is committed for washing crates and 50% for that of the tanks. Water consumption are also markedly higher in the six months from March to October (+80%) when both the successive stages of winemaking is starting late harvest.

Analysis undertaken have revealed how the wine industry has some fields for intervention and for an interesting discussion of ethical behavior towards environmental issues, both for a margin of savings certainly not negligible.

In particular there are two main areas of intervention: on one hand the adoption of behavioral practices "virtuous" can lead, in line with the considerations advanced in the EU document, with a saving of 15% for both resources and on the other the adoption of advanced technologies both for what concerns the rationalization of water (water recycling systems, wastewater, etc..) and to save energy (use of inverters for the refrigeration systems and for the pumps, use of high efficiency motors on the machines, etc.).

These considerations lead us to conclude as for the entire wine industry is essential to these issues reach the center to govern the entire process in a fully sustainable way.

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SUSTAINABLE VITICULTURE:
FROM LANDSCAPES TO EFFLUENT TREATMENT

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INTRODUCTION

Like any human activity, the wine industry can cause environmental impacts that need to be understood and controlled. Management of winery effluent, which has been discussed at several international congresses, has been implemented in high-capacity wineries. This now increasingly concerns smaller facilities, where treatment may be individual, collective or combined with a community treatment system.
Moving beyond such specific concerns, the protection of the environment is a technical, legal and societal issue which is gradually being incorporated into most viticultural and oenological technical itineraries. The use of plant protection products and soil management, together with waste and effluent management, are areas that are subject to increasingly stringent restrictions related to the environment and to consumer health. The management and protection of viticultural landscapes, which express the identity of the profession and are part of our heritage, contribute to the multifunctionality of viticulture.
On top of the purely local and regional issues that affect our industry, we are now seeing the emergence of an increasingly global and intergenerational perspective that is especially concerned with air quality, climate change and preservation of biodiversity, together with sustainable development.

1.1 THE CONCEPT OF SUSTAINABLE DEVELOPMENT

It was in 1972, at the United Nations Conference on the Human Environment in Stockholm, that the question of the relationship between economic development and the deterioration of the environment was for the first time placed on the agenda of the international community. After the Conference, the governments set up the United Nations Environment Programme (UNEP), which today continues to play a role in facilitating the implementation of measures to protect the natural environment.
In 1983, when the UN set up the World Commission on Environment and Development, it soon became clear that the deterioration of the environment, which until then had been considered to be a secondary effect of industrial wealth without much importance, was causing serious survival problems in developing countries. The Commission, chaired by Ms Brundtland (Norway), developed the concept of sustainable development. This approach, as opposed to one solely based on economic growth, aims to "meet the needs of the present without compromising the ability of future generations to meet their own needs."

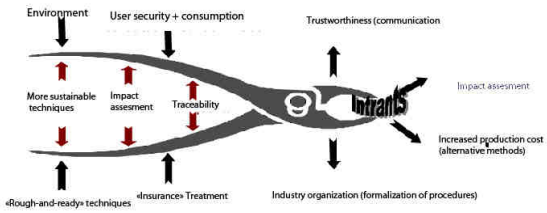
As a direct result of these ideas, the United Nations Conference on Environment and Development held in Rio in 1992 constituted an official recognition of the relationship between environment and development. This laid the foundations of sustainable development, which consists in devising a type of growth that does not adversely affect future generations. The representatives of the 172 states that met at Rio approved five major agreements which aimed to modify the traditional approach to development.

1.2. APPLICATION TO THE WINE INDUSTRY

In this context, the OIV set up a cross-cutting ad hoc group to move forward thinking on this subject. A draft resolution was approved by the member states at the last General Assembly held in Vienna on 9 July 2004. The definition proposed for sustainable vitiviniculture was the following (www.oiv.int):
"Global strategy on the scale of the grape production and processing systems, incorporating at the same time the economic sustainability of structures and territories, producing quality products, considering requirements of precision in sustainable viticulture, risks to the environment, products safety and consumer health and valuing of heritage, historical, cultural, ecological and aesthetic aspects". Adapting the notion of sustainable development to viticulture and to oenology covers different aspects:

- Technical itineraries: as well as requirements related to quality and productivity, every viticultural and oenological itinerary should associate consumer health related aspects with environmental impacts on local, regional and even global scales.
- Organization: modernization has often led to a compartmentalization of issues that disregards the interrelationships between the links in a complex production chain. Environmental analysis, which is the basis of sustainability, justifies a cross-cutting, frequently interdisciplinary, approach which incorporates not only negative but also positive externalities (multifunctionality).

The implementation of the notion of sustainability applied to viticulture should combine an economic approach on the scale of the winery with related financial aspects (externalities) connected with indirect spin-off from the industry (tourism, fire prevention, land-use planning), and possible negative effects (water pollution, run-off, etc). This approach should serve as a basis for obtaining public subsidies (European, national and regional) without which vulnerable viticultural sectors may well disappear.



From a technical point of view, more sustainable techniques should make it possible to reduce the use of inputs while at the same time ensuring product quality, which is the chief concern of producers.
This requires the development of diagnostic tools and decision support, which will often need to be accompanied by the development of consultancy (institutional, networked or private); precision viticulture that aims to optimize technologies according to field conditions (amendments, spraying); and the implementation, whenever possible, of biological and biotechnological methods that make use of natural regulatory mechanisms.
Naturally, it is essential that the management of effluent and waste be integrated within a sustainable approach. This implies that such effluent and waste should be characterized and quantified, that itineraries should be adapted so as to reduce their quantity, and that management systems adapted to local constraints should be implemented.
Other issues which are harder to appreciate because they will take longer to take effect should nonetheless be integrated into a global and intergenerational approach. For instance, potential effects on air quality, climate change and biodiversity will gradually play an increasing role in viticultural and oenological strategies, and in the years to come may well constitute one of society's major concerns, together with an ethical approach to the environment.

CONCLUSION

Viticulture, like any other industry, must adapt to changing times. Although the twentieth century, deeply affected by two world wars, saw the introduction of technology and chemistry into viticultural and oenological technical itineraries, the notion of sustainability, as defined by the Rio de Janeiro Conference in 1992, must now be incorporated into the industry's strategies. The development of decision-making tools and of indicators, the elaboration of alternative methods, improved understanding of complex biological phenomena, and an ever more professional industry are all factors that are likely to contribute in the future to sustainable vitiviniculture. This is all the more necessary given that wine is to a large extent linked to cultural aspirations that increasingly take environmental constraints into consideration.

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PRECISION VINICULTURAL PROGRAM
APPLIED FOR THE SUSTAINABLE RUNNING OF PODERNOVO ESTATE

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Summary
The spacial variability in a vineyard has always been a difficult issue to measure and manage. This variability can bring to differences in both vegetative and productive output which can finally have even a heavy impact on the final production of wine.
Currently, thanks to technology improvement, there are some instruments available as infra red sensors that render it possible to quantify the variability in a very detailed manner. This allows to develop within the farm a technical management both viticultural and oenological with a high degree of precision which is based on the creation of maps objectively showing the vegetative situation of the vineyards.
In this way during the vegetative phase it is possible to specifically modulate the agronomic operations and then during the harvest to treat separately the grapes presenting a similar oenological potential.
The work is then completed by applying specific oenological choices during the wine-making and wine-refining process so to put together in the best possible way both the production targets and the vinicultural potentialities of the companies.
This work is summarizing the results of 4 years of precision vinicultural running of the Podernovo estate in Tuscany.

Inspiring principles
The leading concept can be summarized in the sentence "the wine is produced in the vineyard". This concept has been widely and deeply discussed among the operators and it has also already been applied in the management of the vineyards and wineries in the past, when still the possibility to utilize particular technologies to objectively estimate the vegetative and productive situation of the vines was not known.
This is also demonstrated by the articles illustrating the modular interventions in the vineyards in order to evaluate the response of the vines to different agronomic practices. The formulation of the project of technical running of the vinicultural chain "animavitis" has started from both the agronomic awareness to improve the viticultural variability and an experimental work on the vine-wine combination, born with the target to completely integrate the viticultural and oenological operations in order to more efficiently run the vineyard and its oenological potentialities.
In order to reach this objective it has been necessary to consider the vineyard not simply by single plots of land but by areas of different oenological vocation (concept of "cru") trying to homogenize the unbalanced vegetative areas in order to reach optimum ripening conditions of the grapes.
The completion of the precision viticultural running is realized by the specific oenological setting for each lot so to explore at its best the oenological identity of the production.

Materials and methods
The "animavitis" program is based on the "scanning" of the vineyards in different vegetative phases, by using specific infrared sensors combined with a GPS receiver in order to obtain the maps of the vegetative vigour (so called NDVI).

The advantages of utilizing the infrared sensors on the ground instead of the already known satellite or aerial images are multiple: their minor cost, higher precision, the possibility of utilizing them directly in the farm whenever it is needed and the fact that their extracted data are immediately available in loco for consultation. Moreover the results are more detailed and there are no inconveniences linked to eventually bad weather conditions.
These NDVI maps, after being processed and interpreted from the experts, are used for the definition of the areas with a similar viticultural strength in the vineyard and later on each one of these areas is linked to its

appropriate and optimal conduct of agronomic activities (i.e.: pruning, fertilizing, removal of side-zones, leaves stripping, lopping, treating, soil running, etc.).
On these areas previously obtained during the pre-harvesting period some sampling are conducted in order to define the productivity and the analytical and sensory characterization of the grapes. The analysis of these data is an important support to the final decision on which areas need to be separately put on vinification and which are the best oenological strategies to be applied to each one.
As a consequence the maps become a very important instrument for the analysis of the vineyard and render it possible to determine with high precision which is the strategy that can be used for each situation by evaluating all the qualitative and economical aspects.
The program becomes consequently part of the farm context and is adaptable to each situation trying to take into consideration all the environmental, productive and management factors and integrating these altogether with the actions of the wine "Chain".

Obtained results
In the 4 years of realization of the "animavitis" project in the Podernovo Estate two contemporary important results have been achieved: the improvement of the agronomical managing and of the general situation of the vineyards and the improvement of the wine produced.
The higher cost of the running by areas has been widely paid back by the less work needed to carry on the agronomic interventions in the vineyards, and by the optimization of the fertilizing and treatments (reduced in comparison to the previous period).
This important reduction of the manual interventions has interested above all the usually expensive operations of removal of side-zones, managing of the green areas and pruning that have been resulted to be very much less with respect to when applying the classic plain method.
The agronomic choices have been modified in the years in order to follow the oenological and commercial needs and consequently also the intervention strategies following the targets have been adapted accordingly.
The achieved targets in the years have consequently been varying a lot and particularly: the use of fertilizers has been reduced from 50 to 100%, the use of pesticides, especially botryticides , reduced from 30% to 100%, the treatment of the foliage has seen a reduction of manpower from 20% to 50% and finally the pruning has undergone reductions from 30% to 100%.
The most evident result of the program of differentiate managing per homogeneous areas has been a big improvement in those areas presenting a worse qualitative attitude (too weak or too vigorous) either in the vegetative-productive equilibrium and in the quantity and quality of the produced grapes and consequently wines.
From the oenological point of view the quality pyramid identifying the two kinds of wines produced in the area has resulted to be better characterized. A reduction in the production costs of the second kind of wine, while keeping its quality unaltered, has been reached by a more careful running of the agronomic operations, trying to maintain and push a high quality in the premium areas and contemporary saving operations in the potentially less representative areas.
Harvesting by homogeneous areas has made it possible to obtain a higher quantity of grapes suitable for the production of the first wine, and consequently the characterization of two competitive wines by optimizing their oenological expression, considered a fundamental characteristic in the current time and market situation.
The possibility of dividing and analyzing the vineyard by areas allows identifying the different kinds of grapes in one single plot of land, but also grouping together the lots by interest and need, avoiding to obtain a medium result which is not always satisfying. This factor has been very well enhanced in the farm where the direct relation between the ripening and the vegetative status of the plant has been clearly observed in all the homogeneous areas classified.
Moreover the monitoring of the ripening process in each one of the areas has rendered it possible to broaden the productive and qualitative knowledge at clonal level and consequently allowed to optimize the grape harvesting.
To come to conclusion the use of the infrared sensors for a precise and quick analysis of the vegetative status of the vines has allowed to objectively and widely monitor the situation, so to manage all the viticultural practices and to set the oenological activities more in accordance with the commercial needs of the farm reality. Moreover it has been possible to deepen the production knowledge and rationally utilize the human, economic and environmental resources.

SUSTAINABILITY AND WINE "VALUE CHAIN":
CRITICAL POINTS, OPPORTUNITIES, NEW QUALITY FORMS
(FIRST CONSIDERATIONS FROM A RESEARCH IN PROGRESS)

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In the last period the attention to the topic is noticeably grown up. The climate changes and the driving role held recently by leader countries are just general reason, although important.
In addition, the most recent EU-CAP and OIV guidelines that aroused an in depth-analysis of the topic from the point of view of general directions and the regulations to propose and suggest; on the other hand, the proactive spirit of the most innovative operators that leads to an enlargement of the "Corporate Social Responsibility" idea.
Finally, the growing perception that this subject has not to be quickly placed in the "rules" area (felt only as "restrictions") but also in the one of "opportunities", urges part of the Firms and Stakeholders of the scenario to invest on the subject (at least in "knowledge").

A working team (coordinated by Prof. Attilio Scienza, Milano University-Crop Production Dept., experts from Rosselli Foundation, Torino and the writer - supported by MPS Bank) is carrying on a research focused on those innovative process which target is directed – with different scientific approaches, cultural models and technologies – to raise the "environment-friendly level" in production processes internal to wine-growing firms and the "sustainable level" in interaction and exchanges relationships between the wine-growing firms and the surrounding environment.
The target is the individuation, on the base of real experiences and entrepreneurial innovative approaches, of an illustrative taxonomy of innovation on these topics and the evaluation of the consequently involvements on different levels (firms, territory, wine global system); not only considering the scientific-technologically side but also – although in outline – some organizational, distribution and marketing involvements. To sum up, the favoured approach aim to enlarge the global "view" company/environment. This involve that "intangible" but decisive thing called *"corporate culture"*, its trends, its diffusion level, its consequences. Let's take into consideration just the effort in finding consistent solutions (economical, environmental, social) between logics and interests traditionally far from each other during a long time, and the crucial aspect of related and required professionalism. Professionalism – and specific skills – to be built-up also with creative educational/training processes on the point of view of methods and "tools"

The research is actually an intermediate step: nearly at the end the meetings with firms carried on for a long time in a very open mind situation; first comments starting. It is clear that none anticipations can be given thoughtlessness. However, it is possible to propose "first impressions" on some very general aspects that seem to emerge on the prevailing attitude of the met firms.
In outline and as introductory remarks the following points are underlined.

- Several initiatives are in progress or in planning, new processes are being activated, some relevant results are obtained; nevertheless a kind of "activism" seems to predominate on a more strategic approach; *it seems still common a "punctiform"approach, instead of a more organic and organized strategy* . Overall approaches applied to advanced contests are "studied" just by few big operator but they seem to remain on direct experience borders.
- It is common, as mentioned, the impression of the topic importance for the next years but sometimes *come out a chased trend to think that it is enough to take just few short cuts*, few simple technical works (maybe to gain a rapid visibility); this attitude may have opposite effects to the wished ones, also because the topic is, at this point, in the spotlights.

- An important aspect stood out is a certain difficulty to "see" this kind of innovations extended also downstream of the two principal areas of the "value chain" (viticultural and oenological stage).
  If it is true that there are the major technical engagements and their related investments, it is also true *that to fully exploit the potential of the innovations upstream it is necessary to care the "ecologic footprint" also in downstream steps*: distribution, marketing, communication and related services.

  It might be tough how much "content" more or less "sustainable" can be given (or removed!) to packaging, to bottles (dimension, thickness, energy content); or to the image, maybe through a too bright communication for a slight work done or –on the contrary- an inadequate communication for an important innovation. It is necessary to pay attention to all steps in which the "value-chain" is composed *avoiding to lose, on the downstream way, the value laboriously built upstream.*
- Finally, another raising up aspect is the distance between some more advanced firms in "planning the new" and the "Institutions feedbacks" regarding economical support, organization of meeting and comparisons with producers and other stakeholders involved or might been involved. Here, the work to do to reduce relationship and communication gaps between the different actors is not so little. But the point is very important because an authoritative answer on a long-term period on this crucial subject *cannot be given just from firms side, but a global effort is required which involved other stakeholders and spur them on a growing interaction* (first condition for possible partnerships). This is particularly referred to the local Institutions and to their role on thorough management and on improving of territorial resources and in details to their defence and management of the resources "critical" everywhere now: the water resources, the land/soil resource (and the strong underneath battle in order to their usableness).

The other essential component is obviously the world of "scientific production", technical innovation, experimentation, extension, especially its part more interested in dialogue and effective interaction with the other actors, knowing that to produce real innovation is essential to trigger off efficient transferring know-how processes and quick circuit for the so called "knowledge economy".

These variable attitudes (foreseen in this phase) can be maybe explained in a common deep motivation: the opinion not yet very widespread in facts that ***sustainability will be in the next years a "critical factor of success" of primary importance on global competition****;* and the consequently consciousness that first of all it is crucial to acquire on top and on the whole firm a *larger "vision"* of the matter and formulate *few shared driving "values"* (to be later implemented into projects, experimentations, test, technologies as well as financial resources and their targeted planning).

A critical element on this point to speed up this way to a more generalized consciousness is given to the "*Sustainability Demand"* (sometimes uncertain, faint, and often poor organized but increasing) that comes from citizens, from the huge and versatile world of products consumers or users of services linked to wine system (not to speak of other important sectors).
The related trends, established by recent researches clearly speak out: everything linked with the "green" dimension of the consumption (in all different ways) is more and more object of attention and particular approval (sometimes just in the "declared intentions", but often on real "purchase acts"). The crisis do not seems to call into question these trends, but it underlines more the approaching of consumers to those "actors", firms, "Brands" in general that are considered more reliable, credible (and for this reason authoritative) on the point of view of how much substantially they do in the "green marketing" area, or larger, in the so called "green economy".

Is this a very important point because it can speed up or – if disregarded – slow down the global integration process of "sustainability dimension" in corporate culture and in its value system giving further meaning and thickness to the "Global Quality" concept.

MECCANIZZAZIONE DELLA GESTIONE DELLA CHIOMA NEL VIGNETO:
UNA SCELTA "SOSTENIBILE"?

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Una rapida ricerca in internet dei termini "viticoltura sostenibile" evidenzia una molteplicità di definizioni che, tuttavia, sembrano ruotare intorno a un concetto condiviso: è sostenibile quella viticoltura che, a una irrinunciabile qualità del prodotto, associa resa "remunerativa", contenimento dei costi di produzione e rispetto per l'ambiente e per la salute dell'uomo. Ciò premesso, in che modo è possibile associare sostenibilità e meccanizzazione della chioma in viticoltura?
Paradossalmente, un vigneto sostenibile e quindi "equilibrato" dovrebbe in primo luogo contenere la domanda di interventi meccanici "correttivi". Esempi classici sono quelli riferibili soprattutto alla cimatura dei germogli e alla defogliazione. La prima, quando forzatamente reiterata nel corso della stagione vegetativa, è spesso sintomo di una vigoria eccessiva dei ceppi non di rado dipendente da scelte colturali pregresse discutibili (es. sviluppo di parete troppo esiguo, distanze sulla fila troppo ravvicinate con abbassamento eccessivo del carico di gemme). Per la seconda, "innescata" da una necessità di diminuire la densità fogliare in prossimità dei grappoli valgono essenzialmente le medesime considerazioni.
Nel caso di interventi "indispensabili" (es. potatura invernale) il contributo della macchina alla "sostenibilità" non dovrebbe essere solo quello di una peraltro attesa riduzione dei tempi di intervento e, quindi, dei costi di produzione. In tale ottica, due esempi possono risultare illuminanti. Il primo riguarda la risposta delle viti a cicli di potatura meccanica (Poni et al., 2004) invernale accompagnati da rifinitura manuale che consentono spesso di individuare il limite massimo di produzione di uva che si può raggiungere senza penalizzare in modo significativo la composizione del prodotto. In estrema sintesi, questa combinazione rappresenta il crocevia ideale di "sostenibilità". Un secondo caso, per i quali i risultati sono stati buoni se non eccellenti (Intrieri et al., 2008, Poni et al., 2006) è quello relativo alla meccanizzazione di una operazione di defogliazione meccanica precoce (fioritura) finalizzata in primis a contenere la resa di uva attraverso un prevalente meccanismo di riduzione della quota di allegagione. I positivi effetti di ricaduta di questa tecnica si identificano principalmente in una diminuzione, spesso spettacolare, della compattezza del grappolo con ovvi benefici in termini di tolleranza alle infezioni fungine e in un incremento della qualità organolettica dell'uva legato, nei vitigni a bacca nera, ad un consistente incremento dell'incidenza relativa della buccia sul peso totale dell'acino e, più in generale, nelle viti defogliate, ad un aumento del rapporto tra superficie fogliare e produzione. Quest'ultimo effetto, apparentemente sorprendente ma in realtà verificato con molta consistenza, è spiegabile in funzione di una riduzione di resa (dipendente dalla rimozione, in fioritura, di foglie attive) che è spesso più che proporzionale alla limitazione fogliare connessa alla defogliazione stessa.
Dovendo porre uno sguardo al futuro, è lecito interrogarsi sulla possibile evoluzione dei rapporti tra sostenibilità e meccanizzazione del vigneto. In tal senso, il miglioramento tecnologico delle macchine, che talvolta sfiora la raffinatezza, accompagnato da un diffondersi dei concetti relativi alla viticoltura di precisione sta già dando risultati tangibili: macchine vendemmiatrici in grado di separare, utilizzando sistemi ottici di maturazione "in situ" uve di prima scelta da uve invece meno nobili costituiscono certamente un caso di eccellenza applicativa. Tuttavia, il progresso tecnologico pone traguardi ancora più ambiziosi. Alcuni di questi sono legati all'applicazione di tecnologie di monitoraggio ambientale spesso basate su modalità wireless in grado di fornire, in pratica in tempo reale, una caratterizzazione climatica a livello di meso e microscala che può portare alla messa a punto di "warning systems" (WS) applicabili non solo nel settore della patologia ma anche estendibili, più in generale, alla gestione del vigneto. Il legame esistente tra questi WS e l'impiego delle macchine in vigneto è tutto sommato logico: una recente esperienza condotta da Caffi et al. (2009) dimostra come il numero di trattamenti antiparassitari finalizzati al contenimento della peronospora possa ridursi di oltre il 50% quando il decision tool è costituito dall'applicazione di un

modello meccanicistico di probabilità di effettivo verificarsi dell'infezione rispetto al metodo di copertura a calendario. L'ipotesi è che il medesimo sms con cui il viticoltore è avvertito sulla opportunità o meno di effettuare il trattamento possa essere inviato, ad esempio, anche in merito all'esigenza di dover procedere o meno, a una defogliazione in rapporto allo status, in tempo reale, della densità fogliare e/o della quota di scopertura dei grappoli.

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A quick Internet search with the terms "sustainable viticulture" will enlist a multitude of definitions which, however, seem to converge towards a shared concept: grape growing can be sustained if desired grape composition is achieved at a remunerative yield level, at the lowest production cost and along with management practices respectful of human health and environment. Within such context, a wonder is how can vineyard mechanization and sustainability be associated?
Albeit sounding as a paradox, a sustainable yet well balanced vineyard should first minimize the demand for corrective mechanical interventions. Shoot trimming and leaf removal are pertinent examples. If shoot trimming has to be performed several times throughout the season to control canopy size, this is usually a sign of excessive vine vigor which quite frequently implies inappropriate vineyard choices (i.e. insufficient vertical spread of the canopy, too close in-the-row vine spacing). As for leaf removal the trigger is somewhat the same (excessive foliage density at the cluster level around verasion).
For standard operations such as winter pruning, the contribution of machinery to sustainability should go beyond the expected reduction in the hand labor requirement. Again, two specific examples might help. The first shows how long-term mechanical pruning trials (Poni et al., 2004) usually allow to identify the highest yield beyond which a worsening in grape composition starts to occur. Overall, such combination would represent the ideal "matching point" for vineyard sustainability. A second interesting application deals with early mechanical leaf removal (Intrieri et al., 2008, Poni et al., 2006) primarily aimed at reducing fruit set. Positive carryover effects of such technique are looser clusters less susceptible to rot and improved grape composition which, in reds, is mostly due to an increased relative skin mass growth and, more in general, in the defoliated vines, to a higher final leaf-to fruit ratio. This latter apparently surprising yet quite consistent result is because the yield constraint due to the removal of source leaves at flowering is often more than proportional to the source limitation inherent to the defoliation itself.
Future achievements in sustainability of an even increasingly mechanized vineyard will results from further machine improvement as well as more knowledgeable applications in precision viticulture. An appropriate example is given from new generation mechanical harvesters able to provide "on going" harvest and separation of grape lots as a function of maturity indices. Yet, even more ambitious goals are pursued. One is bound to the spreading of environmental monitoring procedures based on a wireless data transmission able to furnish, in basically real time and at high spatial resolution, very detailed climate patterns at both meso and micro-climate scales. End-products are warning systems (WS) which are forecasted to be enlarged beyond the traditional application field of pest assessment. The link between WS and machine use in the vineyard is rather straightforward: a recent contribution from Caffi et al. (2009) has shown that the number of sprays against downy mildew can be reduced by about 50% when a warning systems to predict infections from weather forecast was applied vs. a traditional grower schedule. The hypothesis is that the same short message sent to grower's mobile phone alarming for the need (or no need) of spraying could also be sent, for example, as a warning for the actual need (or no need) of performing a mechanical leaf removal based on the real time status of leaf density and/or degree of cluster exposure.

IL MIGLIORAMENTO GENETICO DELLA VITE
PER LA RESISTENZA ALLE MALATTIE E LA QUALITÀ DEI MOSTI

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A 200 anni dalla nascita di Charles Darwin (1809-1882), vale la pena di ricordare quanto diceva il padre della teoria dell'evoluzione a proposito degli organismi viventi e cioè che questi accumulano nel tempo mutazioni su cui opera la selezione naturale, favorendo la sopravvivenza degli individui 'più adatti'. La vite non fa eccezione e come altre specie è soggetta in natura ad una pressione selettiva naturale, legata all'evolversi dell'ambiente climatico e biologico che la circonda.
L'uomo tende a selezionare genotipi con caratteristiche superiori e a mantenerli in coltivazione quanto più a lungo possibile, soprattutto quando la moltiplicazione vegetativa - è il caso della vite - permette di superare il problema dell'eterozigosi. Il mantenere il coltura per tempi lunghi gli stessi genotipi crea tradizioni di grande interesse storico e culturale, ma dal punto di vista biologico impedisce a quei genotipi di riprodursi, di evolvere e di adattarsi alle mutate condizioni di vita.
Nel secolo appena concluso, la necessità di difendere le colture da parassiti e patogeni ha favorito lo sviluppo della chimica di sintesi al punto che attualmente nel mondo si stima vengano impiegati circa 10 milioni di tonnellate di presidi fitosanitari in agricoltura.

La situazione è considerata da tempo insostenibile e a partire dalla seconda metà del secolo scorso, per molte specie sono iniziati programmi di *breeding* miranti a introdurre nelle varietà coltivate resistenze a vari patogeni e parassiti, con l'intento di ridurre la pressione sull'ambiente e sulla salute umana dei pesticidi. La vite è forse l'unica specie agricola sulla quale il miglioramento genetico ha operato poco. I risultati sono che attualmente nell'Unione europea, la difesa della vite richiede il 65% di tutti i fungicidi impiegati in agricoltura, a fronte di una superficie investita a vite che rappresenta appena il 3,3 % della superficie agricola complessiva (Eurostat report 2007).
A dire il vero , alcuni programmi di *breeding* miranti ad introdurre resistenze alle tre malattie introdotte dalle Americhe nell'800 (peronospora, oidio e fillossera) sono attivi da oltre 100 anni in alcuni Paesi europei, USA e Canada. I risultati ottenuti finora sono interessanti per quanto riguarda alcune resistenze (Fisher et al 2004), ma meno interessanti per quanto riguarda la qualità dei mosti, a causa dell'elevata eterozigosi del genoma della vite e della conseguente imprevedibilità dei risultati degli incroci (Bavaresco 1990).

Le informazioni acquisite con i progetti di sequenziamento del genoma della vite appena conclusi (Jaillon et al 2007, Velasco et al 2007) sembrano aprire anche per la vite le nuove frontiere della selezione assistita da marcatori molecolari, che promettono di arrivare con poche generazioni di incrocio a risultati più interessanti di quelli ottenuti con le tecniche di selezione tradizionale usate per tutto il secolo scorso.
I risultati più interessanti si hanno per ora sul fronte delle resistenze. Sono stati identificati, mappati e, in alcuni casi, clonati tre geni/QTL di resistenza a peronospora, 2 geni e 4 QTL di resistenza a oidio, 1 gene di resistenza a *Xilella fastidiosa*, 1 QTL di resistenza a fillossera e 1 gene di resistenza a nematodi del genere *Xiphinema* (Testolin et al 2008). Sono già in atto programmi di piramidizzazione di alcune di queste resistenze, che permetteranno di rendere le stesse più durature nel tempo e i marcatori molecolari associati a tali resistenze sono già impiegati per la selezione precoce dei semenzali (Testolin et al 2008).

Per quanto riguarda la qualità dei mosti, il discorso è più complesso perché la qualità dei mosti è il prodotto di centinaia di composti che, in relazione con l'ambiente pedoclimatico, contribuiscono a creare quei binomi vitigno-*terroir*, che hanno fatto grandi alcune viticolture e dai quali non siamo disposti a staccarci se non con una giustificata apprensione.
Anche in questo caso i metodi di selezione stanno facendo rapidamente dei passi in avanti. Consideriamo, ad esempio alcune classi di composti, come gli antociani e i composti volatili.

A differenza di altre specie, in cui gli antociani sono sintetizzati con *pathway* biochimici relativamente semplici, la vite nel corso della sua evoluzione ha subito una esplosione della famiglia delle flavonoide idrossilasi, in particolare le F3'5'H, cioè quelle che convogliano la sintesi verso gli antociani che danno il colore più scuro al vino (delfinidine, malvidine, petunidine). In vite sono state identificate ben 16 copie diverse di questo gene, grazie al recente sequenziamento del genoma. Molte di queste hanno funzioni specializzate in relazione all'evoluzione della maturazione della bacca e delle caratteristiche climatiche (luce, temperature, stress idrico) (Falginella et al 2010). La conoscenza di queste isoforme permette una selezione mirata negli incroci, in funzione del tipo di antociani che si vogliono nel vino.
Un altro argomento affascinante è dato dai composti volatili, che contribuiscono all'aroma dei vini. Questi composti si trovano nell'uva, nel mosto e nel vino a concentrazioni molto basse e questo rende difficile il loro rilevamento con strumenti tradizionali; inoltre, questi composti sono spesso legati ad altri composti (zuccheri, amminoacidi) e ciò complica la loro estrazione dalla matrice in cui si trovano. Lo sviluppo di nuove tecniche di estrazione come la 'Solid Phase Micro Extraction' (SPME) e la 'Stir Bar Sorptive Extraction' (SBSE) così come l'introduzione di strumenti più sensibili come i gas cromatografi accoppiati a spettrometri di massa di nuova generazione hanno permesso di sviluppare metodiche adatte ad analizzare queste matrici complesse, estraendo informazioni su molti composti, in parte non ancora noti. I composti che si ottengono con un'unica estrazione e un'unica analisi sono dell'ordine di un centinaio o poco più, ma si prevede nel giro di qualche anno di arrivare a molte centinaia di composti analizzabili in una singola corsa.

Identificati i composti con metodi di determinazione rapida si aprono due strade: la prima riguarda la selezione degli incroci sulla base dei loro profili aromatici; la seconda, ancor più ambiziosa, riguarda lo studio del controllo genetico di questi composti e la selezione assistita da marcatori molecolari. In altre parole, conoscendo i determinanti genetici di una serie di composti chiave del profilo aromatico, è possibile attraverso marcatori molecolari, associati ai geni che controllano la sintesi di quei composti, operare una prima selezione precoce sui semenzali senza attendere la maturazione sessuale delle piante e la produzione di uva (Di Gaspero e Cattonaro 2009).
Abbiamo citato due esempi di selezione assistita per due componenti importanti della qualità dei vini, il profilo antocianico e il profilo aromatico. Gli esempi potrebbero continuare, parlando di classi particolari di aromi, come i terpeni o le metossipirazine, per le quali l'identificazione dei determinanti genetici è in fase avanzata (Mattivi et al 2008).
Per concludere, vorremmo sottolineare che la vite, che non ha goduto in passato grande attenzione da parte dei genetisti, sta vivendo un periodo di grande euforia scientifica, grazie al progetto di sequenziamento del genoma. Si stanno gettando le basi per un nuovo approccio alla selezione, basata non solo sul fenotipo (valutazioni agronomiche, analisi chimiche, microvinificazioni) ma basata innanzitutto sul genotipo, cioè su tutte quelle informazioni sui geni e i fattori genetici che controllano la loro espressione, che derivano dal progetto di sequenziamento e di annotazione del genoma della vite.
Non è un percorso facile e il lavoro svolto finora è solo una parte molto piccola di quello che è possibile fare con i mezzi e le conoscenze a disposizione attualmente e con quelli che la comunità scientifica metterà a disposizione nei prossimi anni.

IMPROVEMENT OF VINEYARD MANAGEMENT AND CROP PROTECTION
AS FACTOR OF MARKET COMPETITIVENESS

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Grapes and wine production vines are now more and more requested to answer not only the needs of quality and price to meet the demands of the market but must also comply with a series of increasingly stringent standards imposed by legislation aimed at Italian and European environmental protection and health of both consumers and operators of the production chain.
This scenario is also considered that there is a greater and more widespread awareness to the issues of environment and health that increases the demand for products perceived as safer such as organic and biodynamic.

Legislative developments made in 2011 will lead to the entry into force of a new European regulation that will lead to a significant reduction in pest control products in the market, allowing the use of only the most safe for environment and human health. In the implementation phase is also the new Directive on the sustainable use of pesticides, whose rules state that each State should enact, will provide answers about the criticality in the system and affecting the value and use of pesticides, natural contaminations, environmental protection, protection of operators and food security.
In this framework, the ethical aspects of production and their environmental and social sustainability will be increasingly important, to satisfy those needs, the Unione Italiana Vini with the support of the University of Milan and with the help of Bayer CropScience has launched a project with some of the most important of national wine companies with the aim of providing new elements that will increase the competitiveness of the wine companies in domestic and international markets.

The working areas of the project want to focus attention on the fact that the crop protection of the vineyard comes from a series of interconnected factors and has to adjusted to provide flexible answers depending on the site of cultivation and the pursued enological objectives. Moreover the canopy management vines has to reach the proper yield to vigour balance to allow not only better quality of grapes but also to prevent fungal diseases and to optimize the effectiveness of interventions for the application of pesticides. It was therefore defined, also including new technologies for Precision Viticulture, an accurate detection system of the vegetative status of the selected vineyards, made by agronomists of Ager SC - Agriculture and Research, to determine some operational parameters of the canopy of the vineyard and to establish some limits optimal for the best adjustment of the sink-source balance.
On selected vineyards a crop protection protocol was defined by Bayer CropScience technicians, which already responded to the characteristics that will be imposed in the coming years with the entry into force of new EU rules, so for example products for defense against Downy Mildew were low in copper and dithiocarbamates free. They had a toxicological classification as favorable as possible. Moreover much importance has also been directed towards preventing the onset of diseases which could lead to the presence of natural pollutants, such the ochratoxin, in the grapes.
Finally, the grapes and wines from these vineyards, monitored and conducted according to the strategies already described, in comparison with the control normally managed plots, will be analyzed to assess the presence and possible levels of residues and other contaminants from the laboratories of the Unione Italiana Vini.

First results indicate that there is a strong attention from the companies involved to adopt management techniques directed to raising the quality of the vineyard of grapes and wine which enhance both the effectiveness of crop protection protocols of low environmental impact . In the first year of implementation of the project the proper management of the vineyards has led to obtain sound grapes are able to produce healthy and quality wines and may also have a good economic competitiveness.
Thanks to the obtained results will be possible to also develop a "model of integrated management to sustainable grapes and wine production, i.e. a "format" which identifies the critical issues involved in managing the vineyard with regard to hygiene issues on health, safety and quality of the product over, environmental issues and those relating to human health and the protection of the grower during the stages of vineyard management.
This project want to be a great opportunity for wineries and for the entire vinicultural production chain because it allows for an anticipation of both pieces of legislation and market trends by addressing the needs of consumers in terms of food safety and environmental respect. It also wants to be a first step towards certification of the production processes (from the vineyard to the bottle) as a further guarantee of security (food, operators and environmental) and transparency in the ethics of production. Finally, demonstrating the sustainability (understood in its environmental, social and economic) of wine production, it intends to provide objective data for communication to consumers and media in general.