Physiological changes and carbohydrates dynamics of Chardonnay grapevines affected by reduced irrigation and recovering regimes



FINAL REPORT to GRAPE AND WINE RESEARCH & DEVELOPMENT CORPORATION

Project Number: GWT 1110

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1. Aim of the travel

The GWRDC grant "GWT 1110" was intended to be used to partially cover travel costs to:

- Asti and Alba (Italy) for the 17th International Symposium, GiESCO 2011.
- The "Istituto Agrario San Michele all'Adige" (Italy) to meet Dr Duilio Porro
- The "Department of Biotechnology", University of Verona, to meet Prof Mario Pezzotti
- The "Ente CRA" (Council for Research and Experimentation in Viticulture) of Conegliano and meet Dr Diego Tomasi and give a seminar
- The Department of oenology and Viticulture, The University of Padua, Conegliano and give a seminar

Note: for the duration of the conference and the after conference study tour, I was jointly travelling with my colleague Dr Cassandra Collins. We had to cancel our visit to "Istituto Agrario San Michele all'Adige" due to cancellation of meeting by Dr Porro. Instead, we met Dr Francesco Iacono that used to work with Dr Porro. Also, due to time constraints we were unable to visit the University of Padua. Other activities that were carried out and were not specified in the original project are described in details in this report.

The aims of this travel were:

- To present results obtained from the GWRDC funded project "UA 08/03" on grapevine physiology and carbon economies under severe water stress and on resilience capacity of grapevines in recovery from severe water stress at the 17th International Symposium, GiESCO 2011 held in Asti and Alba (Italy).
- To obtain feedback and establish networks/collaborations with the international scientific community at the 17th International Symposium, GiESCO 2011 held in Asti (Italy)
- To present results of a novel technique for grapevine water status monitoring using near infrared spectroscopy and to obtain feedback from Italian growers on the acceptability and applicability of this new technique.
- To visit various institutions around Northern Italy and establish collaborations.

2. Executive summary

The main objective of this project was to attend the **17th International Symposium GiESCO** that was held in Asti and Alba, Italy.
The topics of discussion for this year GiESCO meeting included:
• World formation and transfer in viticulture
• Sustainable viticulture and terroir
• Ecophysiology and climatology
• Vineyard and territory management
• Advanced technological viticulture
• Tropical and sub-tropical viticulture
The conference outcomes can be summarised using four key messages and topics to be implemented in future grapevine research: i) adaptation to climate change, ii) sustainability, iii) innovative techniques and iv) focus on rootstocks. Key discussions, interesting conference presentations and possible collaborations will be discussed in detail in this report.

A second objective was the attendance to a study tour to some Northern Italian wine regions (wineries and vineyards), I have also visited Universities and other institution involved in grapevine research in order to gather information about current practices and techniques used in Italian viticulture and to establish possible collaborations with Italian universities and researchers.

The highlights of the study tour were:

- Top wineries are converting their practices towards sustainable practices; an example is the use of "ecosymbiontic viticulture" by Dr Francesco Iacono consisting mostly on using michorizzae in the vineyard to improve grapevine nutrition and to minimise the use of chemical fertiliser.
- Vineyard managers are concerned by the increased incidence of the "Flavescenza dorata" disease
- Due to high rainfall, Italian growers have paid particular attention to vineyard practices that help maintaining a good microclimate of bunches, such as leaf removal, shoots thinning etc...
- The Italian viticulture has invested a great deal of research for selection and adaptation of adequate training systems specific to the type of mesoclimate, variety and soil types.
- There is no particular attention to specific rootstocks even though it is used in 100% of the vineyards. The most used rootstocks are SO4 and Kober 5BB.
- Italy is rich in local varieties. Some of them have been reassessed and some very interesting mono-variety wines are now being produced.
- Most of the vineyards we visited are rain-fed. Many DOC (Denomination of Origin) regulations do not allow irrigation. Therefore there is no interest in water status monitoring techniques yet.
- The majority of vignerons interviewed said that they would not buy any instrumentation to monitor plant water status.
- Most of the research in viticulture is conducted on private commercial vineyards
- Research in Italy responds to the industry needs and in many cases is financed by big wine companies.
- There are many avenues of potential collaboration with Italian researchers in the field of grapevine ecophysiology

Finally, I thank the Grape and Wine Research and Development Corporation (GWRDC) and the University of Adelaide, Faculty Research Committee for supporting this project.

3. Study tour itinerary outline:

Location	Activity	Dates
Franciacorta (Brescia)	Meeting Dr Francesco Iacono and visit to vineyards and winery of the Azienda Agricola Fratelli Muratori	Sept 3
Franciacorta (Brescia)	Visit to the winery "La Montina"	Sept 4
Sud Tirol	Visit wineries and vineyards	Sept 5-6
Verona	Meeting with Prof Mario Pezzotti and Dr Giambattista Tornielli of the Department of Biotechnology, The University of Verona	Sept 7
Verona	Visit to the winery Masi in Valpolicella with Dr Giambattista Tornielli	Sept 8
Conegliano	Meeting with Dr Diego Tomasi and Dr Federica Gaiotti at the "Ente CRA" in Conegliano and visit their experimental vineyards.	Sept 9

4. Project Outputs:

Output	Performance Targets	Date
Submit a paper to the Proceedings of the GiESCO symposium	Paper submitted	Completed April 2011
Paper to be submitted to the Australian Journal Of Grape and Wine Research	Paper submitted to high impact scientific journal	Delayed
Prepare an article and technical notes on the use of NIR for measuring grapevine water status for the "Australian and New Zealand Grape growers and Winemakers"	Paper submitted for the grape growers community in Australia	To be submitted November 2011 (different topic)

Paper submission to the Australian Journal of Grape and Wine Research has been delayed due to ongoing laboratory sample analysis from dormancy 2011. Also, a paper has been submitted (jointly with Dr Cassandra Collins) to the "Australian and New Zealand Grape growers and Winemakers". The article summarises some of what we thought were the most interesting presentation at the GiESCO conference.

5. International Symposium GiESCO

The GiESCO, Group of International Experts of Vitivinicultural Systems for CoOperation, started more than 20 years ago as a group of European researchers interested in viticulture and specifically in trellising and canopy management. Since that time the interests of the group have expanded and now the GiESCO Symposium serves as a forum for the discussion of all aspects of grapevine physiology, vineyard management and other relevant topics.
The international attendance has been progressively increasing and this year more than 200 international researchers, academics, winemakers and grape growers were present.
The presentations were 145 including 64 oral and 81 posters.

A summary of what I believe where the most relevant presentations is presented as follows:

- **Multidisciplinary research to select new cultivars adapted to climate change. Nathalie Ollat et al.**

  This paper focused on the strategies that will be required to create grapevine genotypes better adapted to a future climate change scenario. The paper firstly assessed the state of our knowledge on climate change with an extensive overview of the already observed and expected climate change and their impact on the possible grapevine cultivated area. A paragraph was also dedicated to an accurate description of the plant physiological parameters that are likely to be affected by climate change such as: phenology, photosynthetic capacity, biomass production, grape composition, susceptibility to pests and diseases, etc.

  According to the Authors there are 4 strategies that can be adopted to face climate change and this are:

  1 Modification of cultivation practices, in terms of water use and how irrigation is applied. As an example in this study it is suggested the use of misting sprays to cool down the canopy and organs during hot days or prolonged heat waves.

  2 Adaptation of wine processing. Techniques such as alcohol removal or wine acidification are discussed as corrective treatments in order to keep the style of wine in a changing environment.

  3 Select new cultivars and rootstocks.

  4 Select new winegrowing areas

The paper ended with a review of already existing programs that are active all around the world with the focus of assessing the potential impacts of climate change on viticulture. The authors asserted that the topic is extremely complex and as such in order to have outputs from the programs, these will need to be developed with and interdisciplinary approach.

- **Climatology, ecophysiology, vine performance – A set of strange connections. Schultz.**

In this study 7 growing regions renowned for the cultivation of Riesling (Clare Valley between them) and 4 for the cultivation of Cabernet Sauvignon (Coonawarra between them) are described in terms of climate and vine ecophysiology.
The main result of the analysis was that the climatic conditions in the different zones are very different especially in terms of day-night temperatures amplitude. Although the regions differ deeply in term of climate all of them have a high reputation for quality wine production so the author assert that it is very difficult drawing a clear relationship between climatology and wine performance or wine quality since grapevine shows high eco-physiological adaptation.
In my opinion this talk highlighted the difficulty in predicting the response of grapevines to a

changing climate since, as the author stated "we know too little about the ecophysiological mechanisms playing a role in the translation from climate to quality".

- **Integrative strategies for sustainable viticulture and terroir valorisation. Hunter et al.**

The aim of this paper was to identify possible strategies which should be follow in order to increase the valorisation of the terroir/environment in which the grapevine is grown without jeopardising sustainability. Practising sustainable viticulture means that growth and production require harmony with the environment surrounding it. The authors described briefly various initiatives and programs that have been establish for the wine industry around the world.
The main message that this study wanted to give to the reader is that "*we all need to work towards the achievement of greater harmony between man, wine production, the environment, the ecosystem and biodiversity*".

- **Variation in starch and nitrogen reserve storage by grapevines and measurement by ATR-FT-IR spectroscopy. Smith et al.**

Grape growers are interested in the prediction of yield and canopy growth potential from season to season and the knowledge of overwintering reserves may provide this information. This paper discussed the feasibility of applying Fourier transform infrared spectroscopy as a rapid method for quantifying carbohydrate and nitrogen reserves concentration in grapevine tissues. The authors obtained high correlations between spectroscopy and the above mentioned parameter thus suggesting that Fourier-transformed infrared spectroscopy could provide a rapid and accurate method for monitoring the variations in reserve storage between seasons.
This paper is particularly relevant to my own research as I also developed a near infrared spectroscopy based technique for the prediction of carbohydrate concentration in grapevine tissues.

At the conference I presented a paper entitled: "Physiological changes and carbohydrate dynamics of Chardonnay grapevines affected by drought and drought recovering regimes" (De Bei R., Fuentes S., Pech J., Edwards E., Sullivan W., Cozzolino D., Loveys B., McCarthy M. and Tyerman S.). At the end of my presentation I took a few minutes for talking about my research on the use of NIR spectroscopy for the prediction of carbohydrate concentration in grapevine tissues (trunks and leaves). The analysis of carbohydrate concentration in trunks and leaves is very labour intensive and it involves the use of dangerous chemicals such as highly concentrated sulphuric acid. The main advantages of using NIR techniques over traditional chemical analysis for CHO determination are manly related to the speed of the analysis and the absence of chemical reagents in the procedure. The talk generated lots of interest and positive feedback from various international academics, in particular in regard to the use of NIR.

Possible collaborations arose from this presentation, in particular Professor Javier Tardaguila from the University of La Rioja, Spain, has invited me to visit his lab and work with him for a couple of months on the use of a new Hyperspectral camera for studying grapevine leaf morphology related to water transport. I will have the opportunity to apply my expertise in the field of NIR spectroscopy and data treatment to the use of hyperspectral cameras. We are already planning this visit. Also, Professor Tardaguila is interested in collaborating with the viticulture group of the University of Adelaide on other topics, we already had a videoconference meeting with him and we shared our ideas and we found a few

topics for which we could collaborate. Early career researchers, Dr Nino Pisciotta from the University of Palermo (Italy) and Dr Luca Mercenaro from the University of Sassari (Italy) expressed their interest for collaborating with my group mostly on the topic of potential adaptation of Italian varieties to Australian environment. They are both interested in coming to visit Prof. Steve Tyerman's group at The University of Adelaide.

6. FRANCIACORTA WINE REGION

Franciacorta is a small wine region located in the North-Western part of Italy, in the Brescia Province set in the area delimited by the Valtrompia, the Oglio River, the Iseo Lake and the Po Valley. The history of viticulture in this area is recent, it started around 1960 and only in 1967 the Franciacorta DOC (Denomination of Origin) was established. Nowadays the area for the DOC consists of 700 hectares of Chardonnay, Pinot blanc and Pinot noir and there are 190 producers.

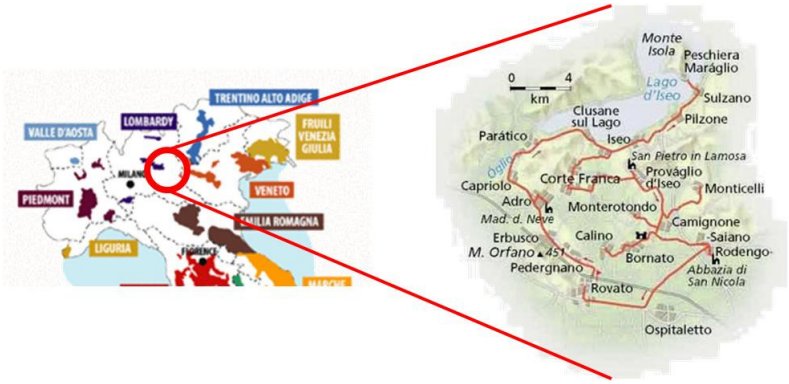


Figure 1: Location and map of the Franciacorta wine region

The Franciacorta area has been one of the first to be zoned in Italy. The pedo-climatic characteristics of the area are very heterogeneous as it extends from approximately 130 to 850 m a.s.l.. The zoning study resulted in the division of the whole area in 6 sub-areas, called vocational units (Vu), homogeneous for climate, soil and grape and wine characteristics. In the 6 Vu the vineyards resulted different for vegetative and reproductive behaviour, grape maturation dynamics and wine sensory attributes.

Meeting with Dr Francesco Iacono and visit to the vineyards and winery of the Azienda Agricola Fratelli Muratori

Dr Francesco Iacono used to be a researcher at the "Istituto Agrario" in San Michele all'Adige (Italy). His main topic of research has been grapevine ecophysiology but he was also manager for the wine sensory analysis lab at the same institute. As a researcher he established international collaborations, including CSIRO at Merbein. In his career he published more than 100 scientific papers. In 2000 he became general director of the Azienda Fratelli Muratori and he contributed to the establishment of the Progetto Arcipelago. Now he is the Vice president of the Arcipelago Muratori and is in charge of 4 wineries in 4 Italian regions and 170 hectares of vineyards. Arcipelago Muratori is a project that brought together four wine estates in Tuscany, Lombardy, Campania and in the Ischia Island.
We visited the estate "Villa Crespia" in the Franciacorta area, where only classic method sparkling wine is produced, the so called FRANCIACORTA.
We met Dr Iacono on Saturday morning and he took us for a visit of 3 of what he considered the most representative estate vineyards. We also did an exhaustive tour of the winery.



Figure 2: Dr Francesco Iacono showing a Chardonnay vineyard.

Dr Iacono explained that the first well known Franciacorta wine was Berlucchi but nowadays there are more than 1000 ha of vineyards for the production of the Franciacorta, most of them are planted with Chardonnay. As said above, Franciacorta has been the first Italian wine region to be zoned and divided in 6 Vu. Fratelli Muratori have vineyards in all of the six zoned areas and because of the distinctiveness of the wines coming from the different zones, they are all labelled differently. Dr Iacono is also adapting vineyard management according to the zones and the wine style. The Fratelli Muratori winery owns about 17 hectares of vineyards, located at altitudes variable from 90 to 300 m a.s.l., the oldest of their vineyards was planted in 1999. The philosophy of the company is doing what Francesco calls "Ecosymbiotic viticulture". Francesco explained to us that only microorganisms are used in the vineyard. The use of herbicide or other chemicals is avoided. Mycorrhizzae are inoculated and then distributed to the soil every 2 years. Fire weed control is used.

All the grapes are vinified without the use of sulphur. This technique is being applied in all of the Fratelli Muratori estates in Maremma (Tuscany), Benevento (Campania) and in the Ischia Island on almost the 50 % of the company vineyards. The company is launching a new label called "TUTTO NATURA", translated "All Nature", for the wines that are coming from Ecosymbiontic viticulture. The philosophy of the "Tutto Natura" is the production of grapes using this unique type of viticulture that is particularly careful to maintaining the microbiological equilibrium within the soil. According to Francesco, "*by activating a complex network of interactions between micro organisms present in the soil and the root system, the vines are increasingly self-sufficient with less nutritional necessities and an almost complete immunity from common diseases*".

The vineyards are mostly trained on a double sided spur-pruned cordon and at least 4 up to 8 clones are used when planting. The most used rootstock is SO4.

From this trip it has been evident that the Italian viticulture is facing an unprecedented spread of what is called "flavescenza dorata", 80% of Francesco's vines are affected by this disease. The cause of the disease is a phytoplasma, once a vine is affected it will soon die and the disease spreads very quickly as it is carried by a sucking insect called "Scaphoideus Titanus". Francesco told us that he has noticed that inoculating the vines with mycorrhizzae is reducing

the presence of flavescenza by at least 50% but there is not scientific research being undertaken to study this effect.



Figure 3: A Chardonnay vine affected by the "Flavescenza dorata" disease.

At the moment the Fratelli Muratori is the only Italian wine estate that uses mycorrhizae in the vineyard. Francesco told us that a research conducted by the CNR (Italian National Research Council) of Pisa has demonstrated that red wines produced from vines inoculated with Mycorrhizae have at least 40% more ORAC (Oxygen Radical Absorbance Capacity) units compare to the control. It is recommended an intake of at least 5000 ORAC units per person per day.

After the visit to 3 vineyards in 2 different areas we went for a visit to the winery. The winery is one of the most impressive I have ever seen. The total surface of working space for the winery is 20000 m in nine floors. This design allows the winery to be completely gravity fed so that the use of pumps and therefore electricity is reduced. Moreover, the winery being underground means that also the need for cooling and heating is reduced to a minimum. This is demonstrating that sustainability is not only limited to the vineyard but also extends to the winery. Interestingly, no fining agents are used in the winery, not even filtration.

As a curiosity, I would like to mention a wine that Francesco is producing from the estate "Rubbia al Colle" in Tuscany, named Rupontino in Barricoccio ®. The characteristic of this wine is the maturation for 24 months in Barricoccio ®, a terracotta container with the same dimensions as a barrique.

We concluded our visit with the degustation of two Franciacorta wines:

1. Numero Zero: named after the first wine made at Villa Crespia Estate. The grapes for this wine are grown in deep morenic soils and the vineyards are located on the hills. This wine is made from 100% Chardonnay, the first fermentation is conducted in wood and the re-fermentation in the bottle lasts for 24 months.
2. Cisiolo: in the Middle Ages this name indicated a sparkling white wine made from red grapes and this wine is made from 100% Pinot Noir grapes. The vines are grown on deep, clay soils. This wine is re-fermented in bottle for up to 45 months in the vintage version.

Visit to the vineyards and winery of La Montina

The winery and vineyards of "La Montina" are located in the North-Western part of the Franciacorta area, just at the foot of the hilly area of Valle Mugnina. The Iseo Lake is only a few km away and this guarantees a peculiar microclimate for the vineyards as the mass of water moderates temperature fluctuations and contributes to the achievement of high quality sparkling wines of high aroma complexity. On a Sunday morning we met the winemaker Rocco Marino who showed us some modern vineyards and also the winery. The total vineyard area is 72 ha located in the six different Vu of the Franciacorta area. The vineyards are predominantly located in hilly areas on calcareous soils. The vines are mostly trained on Guyot with a plant density that varies from 5400 to 7000 plants per hectare for an average production of 10t per hectare. On average the winery produces 450000 bottles per year. The method for the production of La Montina Franciacorta wines uses only Chardonnay, Pinot Blanc and Pinot Noir. The grape is harvested manually in crates of 18/20 kg. Characteristic of the wine is the natural re-fermentation in the bottle that has to be for non less than 18 months for the base wine, 30 months for the vintage wines and up to 60 months for the reserves. Since 1999 the owners have introduced the vertical press **Marmonier**. This press is very rare and it is the only one present in the Franciacorta area. The press is 3 m in diameter but only 120 cm deep so that the grapes get pressed really gently, without breaking the skin to much and the must drips through a thin layer of grapes.



Figure 4: The Marmonier press at La Montina winery

This winery is gravity fed. The musts, ready for fermentation, are divided in either stainless steel tanks or barriques depending on the quality of the grapes and the vineyards from where they comes from. 7 months after harvest the base wines are bottled and ready for the “tirage”. In this phase yeasts and sugar are added so that the wine starts a new fermentation but this time in the bottle. The bottles are piled up in special containers in galleries underground. After the maturation period variable according to the wine style from 18 to 60 months, the bottles are ready for the “rémuage”. This operation consists in manipulating the bottle, mechanically in this case, so that the lees settle in the neck of the bottle. After chilling the bottles, the neck is frozen, and the cap removed. The pressure in the bottle forces out the ice containing the lees, and the bottle is quickly corked to keep the CO_2 in solution. Some syrup (dosage) is added to maintain the level within the bottle.
Interestingly the winery spaces are used for Art exhibitions and during the visit we walked along corridors filled with paintings and sculptures.



Figure 5: Sculpture located in “La Montina” winery front yard

7. SUD-TIROL WINE REGION

The Trentino-Alto Adige/Südtirol area is located in north-east Italy. This wine region is renowned for the German and Austrian influences on the wine industry due to the region's long history under the rule of the Austrian-Hungarian Empire. Because of its unique history and location (at the foot of the Alps and the Dolomites), in this wine region a wide variety of grapes are grown and most of them are not usually seen in other parts of Italy. These varieties include Muller-Thurgau, Schiava, Lagrein, Sylvaner, Riesling and Gewurztraminer.

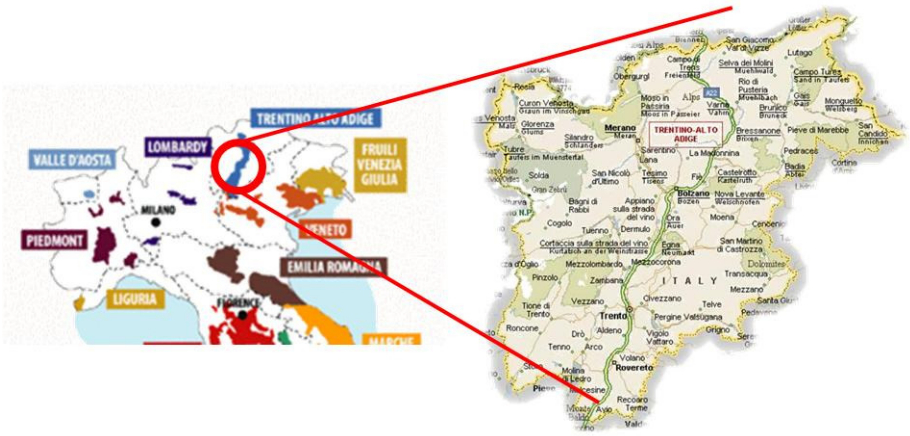


Figure 6: Location and map of the Sud-Tirol wine region

Peculiar to this area is the location of the vineyards, mostly on steep, often terraced, hillsides. Another peculiarity is the high presence of cooperative wineries. Fifteen cooperative wineries produce almost 70% of the region's wine. The remaining 30% is produced by wine estates and independent winegrowers. In this wine region some varieties are still grown on Pergola training system, highlighting the strong influence of tradition in this little niche of the Italian viticulture.



Figure 7: Vineyards located on a hillside in the Sud-Tirol wine region.



Figure 8: Schiava vines on a Pergola training system.

We visited 2 wineries:

Hofstatter: The Hofstatter wine estate produces some of the most well know South Tyrol's wines. The vineyards are located on slopes on both sides of the River Adige meaning a wide range of soils and microclimates. The estate owns a total of 50 hectares of vineyard at elevations between 250 and 750 m. We visited the vineyards and then tried the Pinot Noir wines that come from the Mazon area. This Pinot Noir is the flagship of the Hofstätter wine estate.

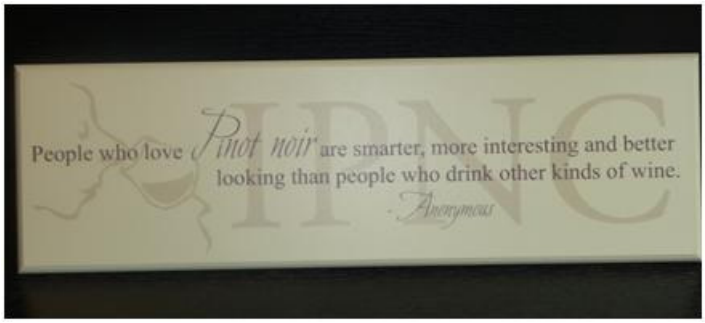


Figure 9: Plaque located at the entrance of the Hofstatter winery.

The vineyards are located on mountainside terraces on the eastern side of the Adige Valley, facing west so that they benefit of the evening sun. Particular of this side of the valley is that the Ora wind blows often, keeping bunches dry and healthy.

Tramin: this winery is one successful example of cooperative winery. Grapes are grown by 270 growers. The number of growers is reflected in the wide range of wines that the Tramin winery offers. The wines can be divided in 2 categories, the blends and the single variety wines. The winery is famous for its Traminer and Gewurztraminer wines.



Figure 10: Modern architecture of the Tramin cellar door and winery

8. VALPOLICELLA WINE REGION

The area for the production of the Valpolicella wine is located in the Northern part of the Verona Province in the Veneto region. The Region presents a mild to cool continental climate that is influenced by the proximity to Lake Garda. This wine region is particularly renowned for the production of the Amarone wine.

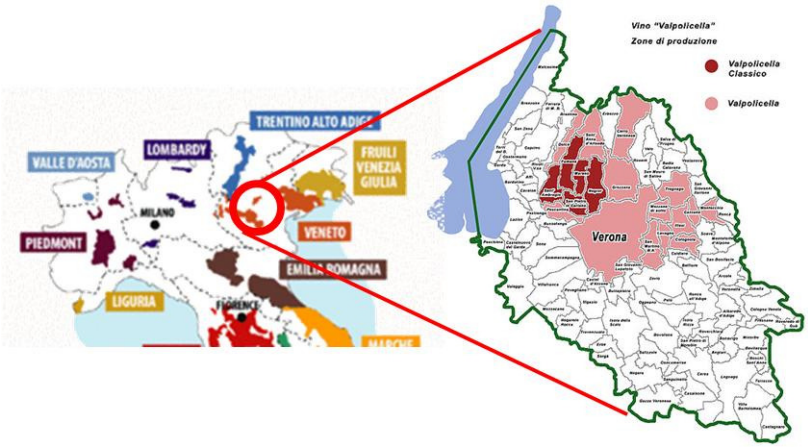


Figure 11: Location and map of the Valpolicella wine region

We met **Prof Mario Pezzotti** and **Dr Giambattista Tornielli of the Department of Biotechnology, The University of Verona.** The main reasons for visiting this group were to look at their research facilities, instrumentation and trials set up and also discuss about possible collaborations with interchange of students between the University of Verona and the University of Adelaide. We visited the modern centre for enology and viticulture located in San Floriano, in the heart of the Valpolicella area. This centre was born to answer to the needs of the wine industry in the area and also it is meant to establish a link between industry, teaching and research. The centre is equipped with state of the art laboratories and instrumentation. All the wine chemistry, molecular biology and viticulture research is carried out in this centre. Also the centre owns an experimental vineyard where a collection of both varieties and rootstocks are grown. This research group has strong links with the industry in particular with one of the major wineries in the area, MASI Agricola, with which they collaborate on both viticultural and enology projects. They accompanied us to a visit of this winery on our second day in Valpolicella.



Figure 12: With the researchers of the University of Verona.

MASI Agricola is probably the most known winery in the Valpolicella area, particularly renowned for the Amarone wine. The estate has properties also in Argentina, 100ha in Mendoza, where they grow Corvina and Pinot grigio varieties on the traditional Valpolicella training system, the Pergola Veronese. Originally the grapes produced at the Argentinean estate were crushed there and the must transported to Italy for vinification but now the whole process is completed there. They produce an Amarone style wine in Argentina. Other properties are in Friuli (40ha) and Tuscany (200 ha).
Because the winery is mostly known for the Amarone wine, the whole visit focused on the production of this great Italian wine. We were lucky enough to do our visit in the middle of harvest time for the estate so that we could see the selection process of the grapes for the production of Amarone. The grapes that form the blend of the Amarone wine are Rondinella, Corvina, Molinara, and Corvinone. Molinara is not required anymore by the criteria of the DOC but Masi still uses a 5-10% of this variety in its Amarone because they consider it very important for the floral aromas. Characteristic of the vinification of Amarone wine is that all the grapes are dried before being crushed. For the drying process bamboo racks are still used as it used to be done in ancient time. Other materials have been tried but without success. The drying process takes about 4 months in a temperature and humidity controlled room.

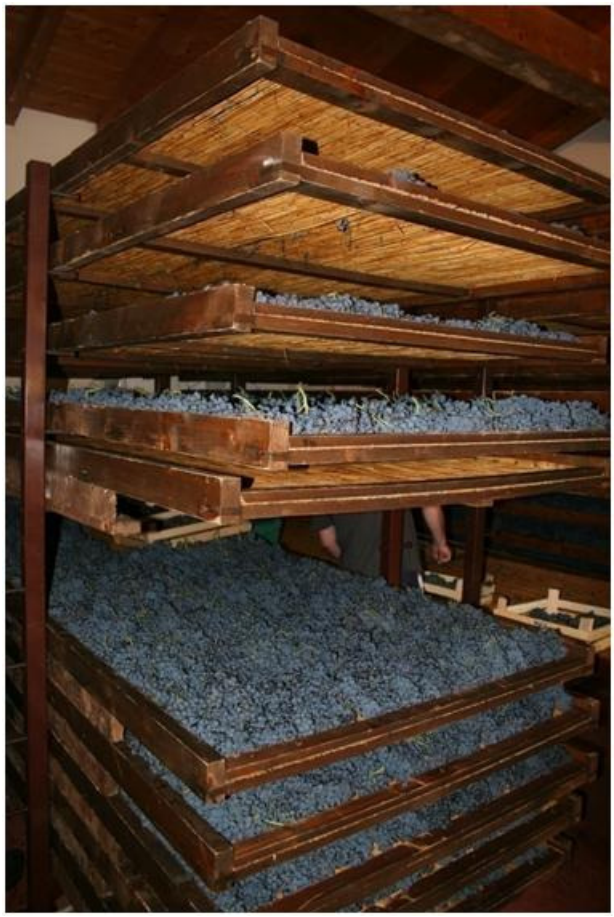


Figure 13: Corvina grapes starting the drying process on bamboo racks.

The fermentation for Amarone happens at low temperature (14°C) and lasts for 40-45 days. Selected yeasts (Saccharomyces Bayanus) are used. Maceration lasts 40 days.
A peculiar style of wine, called Recioto, is produced by stopping the Amarone's fermentation when it reaches 14% vol. This is a sweet style wine but unfortunately has only a local market.
Amarone is aged in what is called "Fusto Veronese" that is a special 600L barrel.
Masi estate has also been the first producer for the Ripasso wine that they named Campofiorin. Ripasso is made with a double fermentation process, for this wine, part of the grapes for Amarone, in December, are lightly crushed and add to the tank with finished Valpolicella. With this process the fresh semi-dried grapes start a new fermentation, that is a second alcoholic fermentation and this one will last for about 12 days with natural yeasts.

The winery adopts an interesting approach for deciding the blending of their wine as it is carried out by 12 people that are from completely different backgrounds: agronomists, oenologists, marketing and business people. This same group of people assess the wines that are produced in the estate's experimental winery where 50L microvinifications are conducted.
Another characteristic of the estate is the focus on local varieties; one of the wines produced by Masi is made of 100% variety Oseleta.
At the end of the visit we have been invited to try the Amarone wine, Recioto and Oseleta.

9. PROSECCO WINE REGION

The area for the production of the DOCG Prosecco wine is locate in the Veneto Region, about 50 km from Venice, in the most hilly part of the Treviso Province, between the small towns of Conegliano and Valdobbiadene. The area covers about 20000 hectares and vineyards are located at altitudes between 50 and 500 m a.s.l., mostly on the Southern facing hill slopes. The landscape of the area has been so deeply marked by viticulture and the vignerons creating such a beautiful landscape that in recent years the producers have applied for the area to become a UNESCO World Heritage Site. In Conegliano there is Italy's first Oenological School and also first Research Institute for Viticulture that we visited during this study tour.

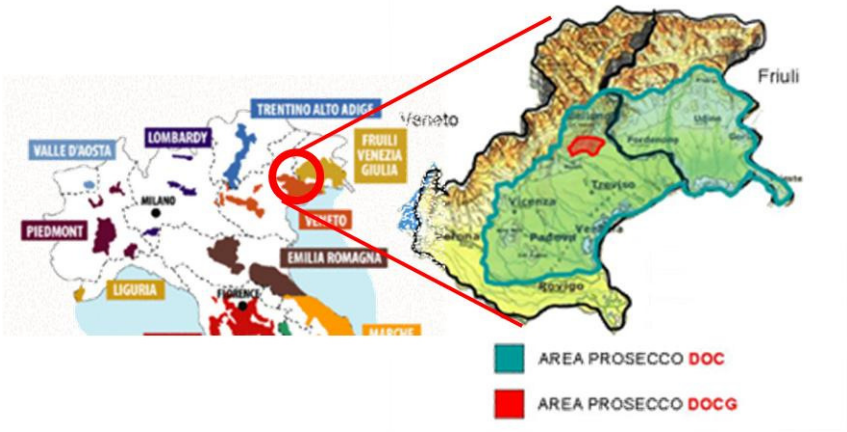


Figure 14: Location and map of the Prosecco wine region

The reason for visiting the Prosecco wine region was meeting **Dr Diego Tomasi** well known Italian researcher in grapevine ecophysiology at the CRA (Council for research and experimentation in Viticulture). His name is related to the zoning studies of some of the most recognised Italian wine region being the Prosecco area his first. Diego invited both me and Dr Cassandra Collins to give a seminar for the staff of the research institute. Cassandra and I presented an overview of our research activities at the University of Adelaide and we received positive feedback from the Italian researchers and also some possible field of collaboration was highlighted. Dr Tomasi is planning a visit to Steve Tyerman's group at the Univeristy of Adelaide next year. After the seminars Dr Tomasi and Dr Gaiotti took us for a visit to their compost trial in the Piave area.

The trial is being conducted in a private vineyard of variety Raboso property of Dr Giuseppe Cescon that made sustainability his philosophy for both vineyards and winery.

The compost trial has been running for almost five years and in the last season the first effects on the vines started to be evident. The treatments correspond to different levels of compost application either under vine or in the row, either incorporated into the soil or left on the surface. Two different types of compost are used: one is made of composted pruning wood, the other is mixed with manure. The owner of the vineyard has installed in his property a modern system for producing energy by burning the pruning wood from all his vineyards.

This system is not only providing enough energy to run the whole winery but also gets used for domestic energy needs in his house. Another system he is using to promote sustainability in his vineyard is a sprayer for pesticides treatments that catches and reuses the extra spray that would fall on the ground otherwise. Giuseppe said that with this system he sprays 70% less product in a calendar year.
We tried his 100% Raboso wine, a very structured wine, with intense tannins and bright aromas of black cherry and leather. The Raboso variety appears as a valuable one to be introduced to Australian wine industry as it maintain high acidity at harvest (up to 10g/L).
We left the Piave area and moved to a visit to one winery for the production of Prosecco wine. We stopped on our way for a visit to one of the most impressive landscapes created by the cultivation of grapevine, the Cartizze area, where the Prosecco cru Cartizze DOCG is grown.



Figure 15: Terraces on which the Cartizze variety is grown

We finished our study tour with a visit to the Fasol Menin winery, where only two Prosecco wines are made, Prosecco Brut and Prosecco extra dry. This winery, as the La Montina one in Franciacorta, is another example of union between wine production and art, the common rooms at the winery have been designed to house art exhibitions, concerts, and literary meetings in promotion of the area and its culture. The Prosecco wine is produced using the method Charmant so the second fermentation is carried out in big steel containers with the addition of sugar. The winery, being new, is equipped with state of the art facilities.

10. Outcomes and conclusions

Attendance at the GiESCO symposium provided the opportunity to meet the most prominent researchers in the area of viticulture, grapevine physiology and climatology applied to grapevine. The conference has been the perfect forum for discussion with experienced scientists, I have been able to gain positive feedbacks about my work and also gather new ideas to be applied in this coming season in Australia. Networking with leaders in the field of grapevine physiology and water relations allowed me to share ideas and visions and possible field of collaboration with Spanish and German scientists were found. Also, my research work has already been published in the conference proceedings through a peer-reviewed panel of international scientists.

The study tour of the various Northern Italian wine regions was a great opportunity for discovering the variety of Italian wine styles and viticultural landscapes. It was evident that Italian growers but also wineries are increasingly adopting sustainable practices and they consider sustainability as a positive change. Since most of the vineyards are rain fed, Italian vignerons pay particular attention to vineyard canopy management being the choice of training system of major importance. Most of the vineyard management operations are conducted manually since many vineyards (all the one we visited) are small in size and located in steep slopes making it impossible to mechanize operations. Since irrigation is not allowed in most of the DOC areas, growers are not interested in any kind of plant water status monitoring.

Many possible filed of collaboration were found with Italian, Spanish and German researchers.