Impact Objectives

- Improve and design agricultural practices with the aim of maximising berry quality, durable resistance to pests and diseases, and adaptation to climate change
- Design, develop and test innovative agronomic systems integrating new agricultural practices and taking into account the variability of constraints met by European vineyards grown under a wide range of environments
- Diversify grapevine varieties with regard to desirable adaptive traits by building on tools and knowledge developed through international genomic initiatives and on the germplasm collected in previous European projects

The building blocks of Europe's wine industry

__Dr Anne-Francoise Adam-Blondon__ is Deputy Director of the Genetics and Plant Breeding Department at the __French National Institute for Agricultural Research (INRA)__. Below, she discusses her involvement in a project that is seeking to help Europe's viticulture sector deal with the challenges it faces in the future

Why is improving agricultural practices to support adaptation to climate change an important subject for the industry to address?

Climate change is already causing modifications in the quality of the vintage in many European vineyards. Wine quality and wine specificities are key to competing well in markets. It is therefore important for growers to find ways to adapt to these changes. These adaptations should be sustainable at different levels – economically, environmentally and technically.

In what ways do you propose to combine innovation in vineyard management and genetic diversity in practice to achieve the desired outcomes?

The InnoVine (Combining innovation in vineyard management and genetic diversity for a sustainable European viticulture) project has screened large panels of genetic resources. The aim is to provide breeders with new sources of genetic resistance to foliar diseases, and producers with sets of grapevine varieties – or Tempranillo clones, which are characterised by their modes of adaptation to drought stresses. Another output of this work is the improvement of screening methods for disease resistance.

We have improved the models underlying decision support systems (DSSs) to take genetic diversity, including new resistant varieties, into account. The consortium has also experimented with different ways of manipulating the plant canopy at various stages of development to test and understand its effect on berry composition and disease development. Finally, we have studied the environmental impact of using new varieties that are tolerant to diseases and of new practices in the vineyard.

How important has the relationship with industry been to achieving the outcomes of this project?

It has proved important in different ways. Firstly, they brought us their questions during the design of the project; secondly, they have an important involvement in the experiments carried out in the project, using their own fields but also in providing clone collections; thirdly, they have been instrumental in the testing and development of many monitoring tools and DSSs.

Can you explain how you have engaged with young researchers throughout the course of the InnoVine project?

There were several postdocs and PhD students engaged in the project – some of whom were very talented and produced some of the most original results of the project. Teaching about new approaches and technologies in Master's classes was also another way to create interest among new generations on the subjects addressed by the project.

What does this final year of the project hold for the consortium and what types of activities will the partners focus on?

All the partners are currently finishing or have finished collecting their last year of results. We are now focusing on analysing the whole set of results and drawing our conclusions from them. The consortium has been quite active so far in terms of dissemination (at least 26 papers have been published already, four of which involve a collaboration between at least two different partners), and I think these activities will continue for some time after the project has been completed.

Towards a sustainable European viticulture sector

*The four-year **InnoVine** project was established in 2013 to address the challenges associated with climate change the European wine industry will face in the future. The findings will help winegrowers adapt their processes and compete with the other wine-producing countries*

Climate change represents one of the most significant challenges facing the world of the future. Indeed, as temperatures rise and increasingly fluctuate over time, the stresses this will place on crop production and their varieties will be considerable. As such, individuals and industries responsible for production are tasked with developing effective means of meeting the challenges sooner rather than later. The EU wine industry is a major economic sector – one that produced around 60 per cent of the entire world's production in 2010 and 2011 – and, as with any industry reliant on maintaining areas of production, it can expect to face several key issues and challenges associated with climate change.

It is widely expected that the effects of climate change will dramatically affect the balance between the area of production and grape varieties, in addition to changing the impact of pests and diseases in vineyards across Europe. In the context of climate change, some of the key challenges currently facing Europe's viticulture sector include the unwanted evolution of wine quality, the sustainability of the vineyards because of environmental and pathogens-related stresses, the need to seriously reduce the use of pesticides on crops, and to be mindful of the importance of meeting consumers' demands – which, while changeable, do not necessarily fit with the long-term plantings and investments associated with producing wine.

For these reasons, it is essential that winegrowers find ways of competing with other wine-producing countries around the world, whilst respecting the environment and other concerns.

THREE DISTINCT LEVELS OF APPROACH

With the above in mind, the InnoVine (Combining innovation in vineyard management and genetic diversity for a sustainable European viticulture) project was established in 2013 and is due to end later this year. InnoVine involves a total of 27 different partners from seven European countries, all of whom are working together to determine the best methods for preserving and developing the viticulture industry in the context of climate change. The strategic goal of the project is to support the European wine industry by matching consumers' demands for top quality wines and food safety, citizens' requests for eco-friendly production methods, and winegrowers' technical needs in a climate change background.

Accordingly, the project has adopted a three-level approach. First, the plant level – where the improvement and design of agricultural practices will maximise the quality of the berries whilst imbuing them with durable resistance to pests and disease, and adaptation to climate change; second, the vineyard level – where innovative agronomic practices and systems will be designed, developed and tested; and third, the breeding level – where grapevine varieties will be diversified to give them desirable adaptive characteristics.

THE IMPORTANCE OF MONITORING TOOLS

InnoVine's Project Coordinator is Dr Anne-Francoise Adam-Blondon, who helped facilitate the collaborations throughout

We have provided tools for the management of the vintage quality, such as identification of zones in the vineyards that have homogeneous behaviour in terms of phenology and vigour

the project, part of which led to a key area of focus, namely the need to provide monitoring tools and decision support systems (DSSs) to help facilitate the actions and decisions made by growers. This support was thought of in terms of two different, but interlinked, objectives of management. 'We have provided tools for the management of the vintage quality, such as identification of zones in the vineyards that have homogeneous behaviour in terms of phenology and vigour, implementation in a DSS of a model for the early detection of drought stress and high throughput collection of yield and colour indicators mainly based on imaging at different scales and near-infrared tools,' explains Adam-Blondon. 'We have also developed mildew disease management tools based on epidemiological models that were improved during the project for instance by including the effect of the developmental stage of the plant and the effect of the variety being genetically partially resistant to disease.'

In addition, the effect the disease had on yield was also included, with the DSSs capable of proposing treatments and treatment doses to minimise the deleterious effects. These DSSs rely on environmental inputs and so a system has been developed to manage the data gathered from multiple sensors, atmospheres and soils. Monitoring tools have also been developed to improve the assessment of flower numbers, berry colour and composition, plant physiological states, and the number of missing plants in a given vineyard. Ultimately, the aim is to aid the collection of data that will improve the prediction power of the DSSs or assist the growers in making decisions relating to the treatment, pruning and harvesting on vineyards.

AN EXTRAORDINARY SERIES OF ACHIEVEMENTS

As the project nears completion, an impressive number of results have been achieved so far by the partners involved in InnoVine. Indeed, there have been so many that it would be impossible to list them all here, but to provide some idea of the scale of experiments involved, some 1,361 tests involving 862 accessions have been completed for downy mildew, 727 tests involving 669 accessions for powdery mildew, and 330 tests involving 110 accessions for black rot. These tests have led to the identification of 35 promising sources of resistance to downy mildew and 20 to powdery mildew, mainly from the Caucasus region, as well as 24 promising accessions for resistance to black rot. These results will be valuable resources for the ongoing grapevine breeding programmes at the level of input genetic material but also at the level of the strategy for a sustainable management of the resistance genes.

'Overall, the experiments performed in InnoVine confirmed that changes in leaf area to fruit weight ratio impacted on cluster and berry development,' notes Adam-Blondon. 'This restricts fruit-set, loosens cluster compactness, and reduces cluster weight, crop load and the susceptibility to bunch rot – as well as impacting on the speed of berry ripening.' The InnoVine project will also contribute to a better documentation of the impact of various stresses alone, or in combination, on grapevine physiology and berry composition. Its originality is to combine experiments and mathematical modelling that will enable a better understanding of the underlying physiological mechanisms of adaptation. For example, the experiments have shown that under carbon limitation, the grape berry can manage the metabolic fate of carbon in such a way that sugar accumulation is maintained at the expense of secondary metabolites responsible for colour and aromas. This offers some clues on how climatic conditions that would lead to this carbon limitation may ultimately impact the enological potential of grape berries.

Ultimately, European viticulture will have to make significant progress in lowering its impact on the environment. The InnoVine project has helped develop DSSs to assist with this and, just as importantly, has led to the emergence of resistant varieties of high quality. The introduction of more resistant varieties in vineyards should not be underestimated; it can be thought of as a change of paradigm for European viticulture.

Project Insights

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INNOVATION IN VINEYARD