Problem addressed: phytosanitary treatments in viticulture

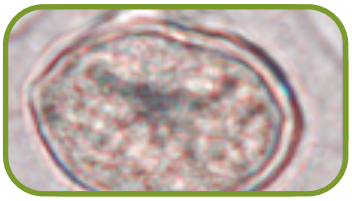
Grapevine fungal diseases (among which powdery mildew, downy mildew and botrytis present a higher incidence) are endemic in the entire territory of the Iberian Peninsula and its appearance depends on climatology. These diseases weaken the vines and affect the production, harvesting, transformation and selling processes as well as the final consumer. Great losses in the production between 20 and 80% may occur, as well as a decrease in quality and increased production, harvesting and transformation costs.

The treatment with phytosanitary products following prefixed schedules or only based on meteorological conditions is the conventional procedure to fight against those diseases. However, this practice usually results in an excessive use of phytosanitary products, which implies an increase in the production costs, the appearance of resistances and a higher risk of air, water, soil and grape pollution.

Powdery mildew

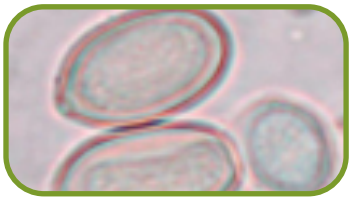
Caused by ***Uncinula necator*** fungus, it affects all grapevine green organs: leaves, shoot and bunches. The latter are vulnerable from fruit-setting to veraison. At first, a greyish colour appears in the grapes, which will soon be filled with an ashen dust formed by conidia.

Downy mildew



Originated by ***Plasmopara viticola*** fungus, downy mildew affects grapevine leaves, young sprouts, stems and bunches. Bunches may be attacked either before or immediately after the blooming, with the fruit just born or when fully grown (white spots appear which later will get brown and wither - brown rot -).

Botrytis



This disease is caused by ***Botrytis cinerea*** fungus. It can appear in almost every grapevine organ, although bunches suffer the most severe damages, just after the veraison. Grapes get a greyish colour, then darken and after they rot. The infection advances from one infected grape to nearby grapes by contact or injury.

A: Bunch severely affected by powdery mildew. **B:** Bunch with brown rot, due to downy mildew. **C:** Advanced attack of botrytis in a bunch. [Spanish Ministry of Agriculture, Fisheries and Food, 2014].

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Innovative solution proposed by VITICAST

New technologies and viticulture

Current legislation, in its objective of a more rational and efficient use of phytosanitary products, proposed the use of new technologies to achieve this goal. Current fungal diseases prediction models take only into account meteorological forecasting and, in some cases, phenology data. Nevertheless, there are other factors that can influence the risk of disease occurring and that are not currently considered, such as the presence of inoculum in the air.

VITICAST innovation

VITICAST aim is to develop a tool for the forecasting of possible fungal infections which combines meteorological data measured at the vineyard level, the phenological stage of the vine and the concentration of spores and inoculum necessary for the infection to occur.

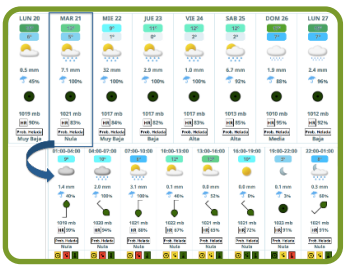
Meteorological conditions

Processing a real-time climate data obtained by a weather station placed by the vineyard makes it possible to develop assessment models for the risk of disease in the crop.

Concentration of spores

Analysis of concentration of spores obtained by an aerobiological collector enables the evaluation of the presence of the pathogen in the environment.

Meteorological prediction



Processing of climate data obtained through a personalized meteorological prediction by the vineyard allows the development of assessment models for the risk of disease in the crop.

Grapevine phenological cycle

Prediction of phenological state of the grapevine allows to adjust the assessment and prediction models for the risk of disease on those stages where the plant is more vulnerable to infection.

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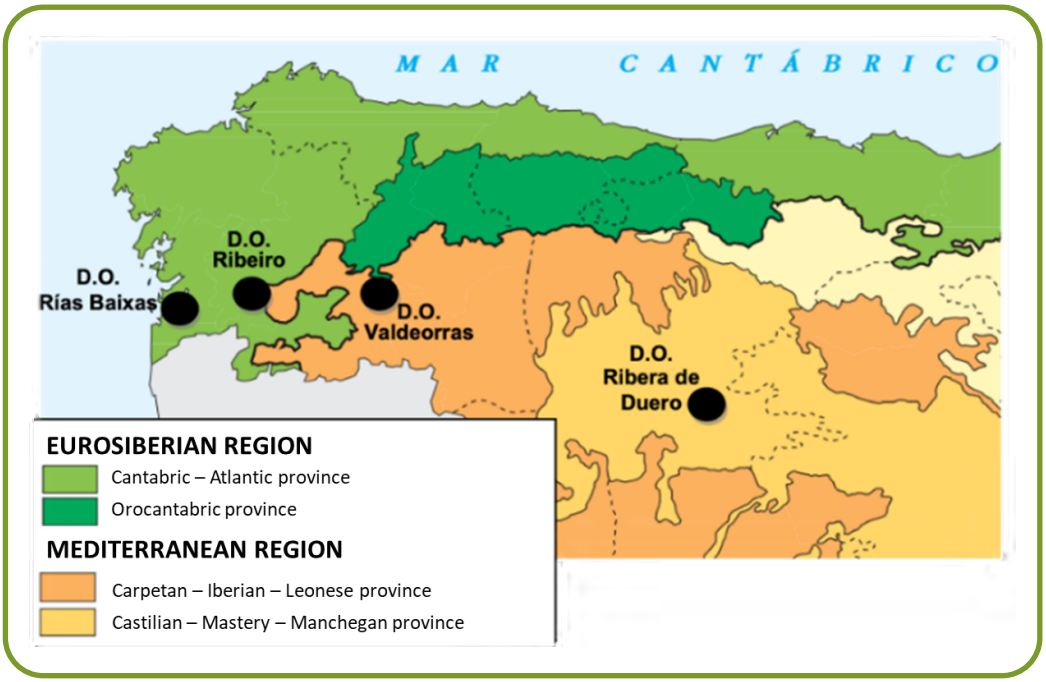
This tool will allow the optimization of the number of phytosanitary treatments applied to the vineyard, which will result in higher quality production, a reduction in operating costs associated with these treatments and greater protection of the environment.

	04/04	05/04	06/04	07/04	08/04	09/04	10/04	11/04	12/04 Now	12/04 Today	13/04	14/04	15/04	16/04
Powdery mildew	32 %	42 %	45 %	45 %	49 %	60 %	129 %	66 %	63 %	63 %	52 %	44 %	163 %	22 %
Downy mildew							100 %					75 %	100 %	
Botrytis	Absent	Absent	Absent	Absent	Absent	Absent	High	High	Absent	Absent	Absent	Absent	High	High

Interface of risk detection of powdery mildew, downy mildew and botrytis, together with the meteorological forecast.

Global warming impact

Given the great sensitivity that the vine has to temperature variations, the trends of the phenological parameters obtained throughout the project are evaluated to assess the impact that the various climate change scenarios predicted by the IPCC (Intergovernmental Panel on Climate Change) will have on the cultivation of the vine in the two bioclimatic regions of the area under study.



Biogeographic regions of the northwest of the Iberian Peninsula and location of the Apellations of Origin (DO, for its acronym in Spanish) under study (Source: Spanish National Geographic Institute).

This analysis is of special interest due to the location of the plots: the border between the two main bioclimatic regions of the peninsular northwest (Eurosiberian and Mediterranean). These border areas are precisely the most susceptible to variations due to climate change.

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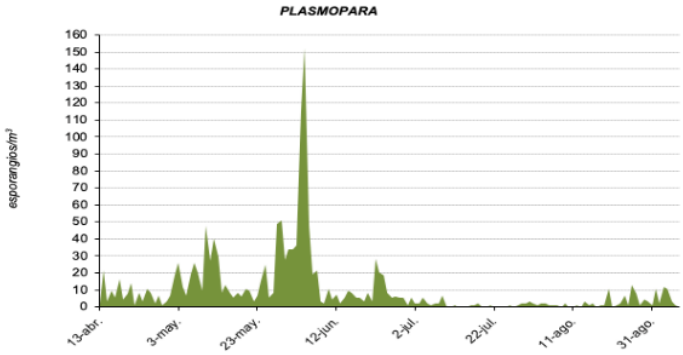
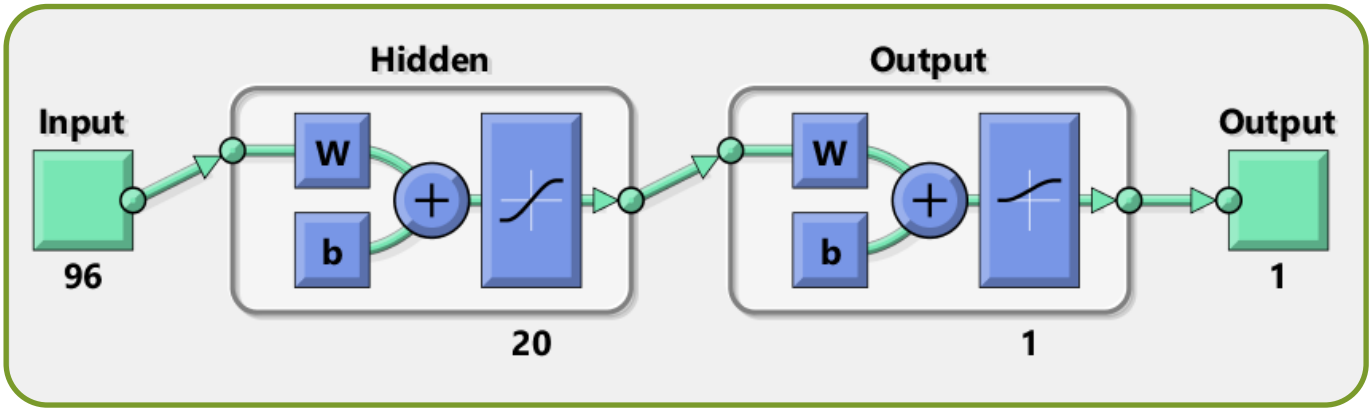
Design of prediction models



Plasmopara viticola spore count.

From the data collected in the plots under study, a preliminary model has been developed using Artificial Intelligence. The inputs to the model are the data measured with the meteorological stations and the output is an indicator of the risk of disease on the specific day. This risk has been evaluated based on the concentration of spores in the air and the information provided by the technicians of the moments in which symptoms of disease have been observed in the vineyard.



Architecture of a neuronal net used in the development of the models.

To fully develop these models, it is necessary to divide the existing information into two groups of data: a group called training, which is used to generate the model; and a test group, to check if the model has learned from the training data.

The performance of the models obtained for each of the three diseases under study (downy mildew, powdery mildew and botrytis) have been measured based on the following parameters: the probability of success, the probability of a false positive (that is, those cases in which risk is detected when actually there is not) and false negative probability (not risk is detected when actually there is).

	Success	False positive	False negative
Downy mildew	95 %	2.5 %	2.5 %
Powdery mildew	94.4 %	5 %	0.5 %
Botrytis	97 %	1 %	2 %

Performance of the generated models for each of the three fungal diseases studied.

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Operational Group Participants

Operational Groups are one of the key tools for the execution of the National Rural Development Programme 2014-2020 for promoting innovation in the agri-food and forestry sectors within the European scope. They gather agents of different profiles with common interests, such as farmers, ranchers, companies, researchers or training and dissemination actors, who are associated to implement an innovation project in order to provide a joint and multi-sectorial response to a problem or need. VITICAST is a Spanish Operational Group with a multidisciplinary team which considers the regions of Galicia and Castilla y León.

PARTNERS OF THE PROJECT

Monet Tecnología e Innovación S.L. – Operational Group Representant

Galician University-Enterprise Foundation (FEUGA)

Winery – Bodega Matarromera S.L.

Winery – Viña Costeira S.C.G.

University of Vigo (Plant, soil and subproducts utilization research group)

Winery – Bodega Hacienda Monasterio S.L.

Estación Fitopatolóxica Areeiro (EFA, Diputación de Pontevedra)

SUBCONTRACTED MEMBERS

University of Santiago de Compostela (Chromatography and Chemometrics research group)

COLLABORATORS

Wine Technology Platform (PTV)

Association of Ribeiro Bottling and Harvesters (ACER)

Galician Association of Viticulture (AGV)

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