AGRICULTURAL UNIVERSITY OF ATHENS

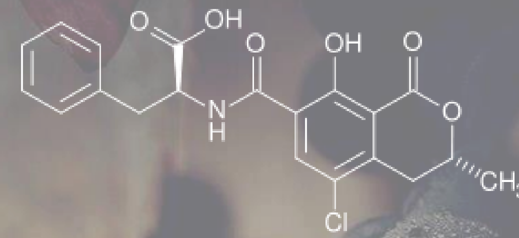
School of Plant Sciences - Department of Crop Science
Laboratory of Plant Pathology

Implementation of integrated and innovative precision agriculture management strategies to reduce the occurrence of ochratoxins along the vine value chain products: grapes, raisins/currants and wine

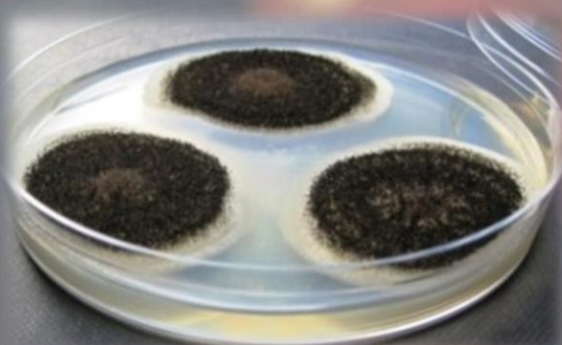
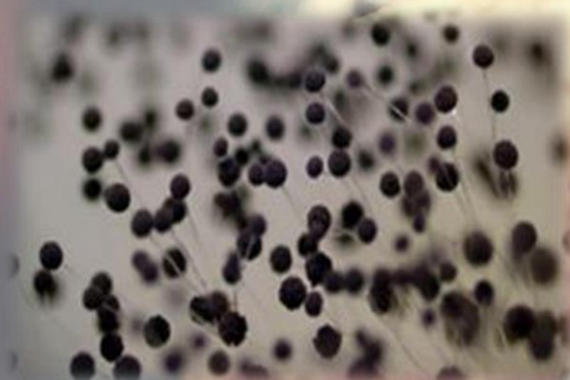
OchraVine Control

OchraVine Control project will offer an inexistent innovative, sustainable and integrated smart ICT solution
(OchraVine Control DSS)
considering fungal, host and environmental indicators that affect ochratoxin (OTA) contamination
along the vine grape-wine value chain.

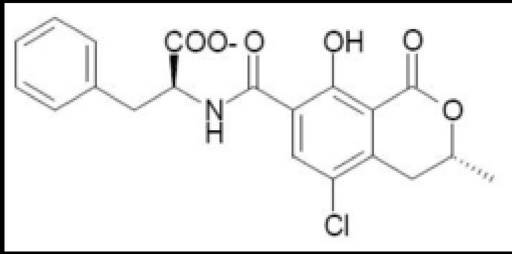
Aspergillus carbonarius - Ochratoxin A



- The frequency of the presence of *A. carbonarius* is dependent on the maturation stage, the temperature and the humidity of the vineyard.
- Produces the mycotoxin ochratoxin A, a nephrotoxin responsible for nephropathy in pigs and probably humans


Ochratoxin A



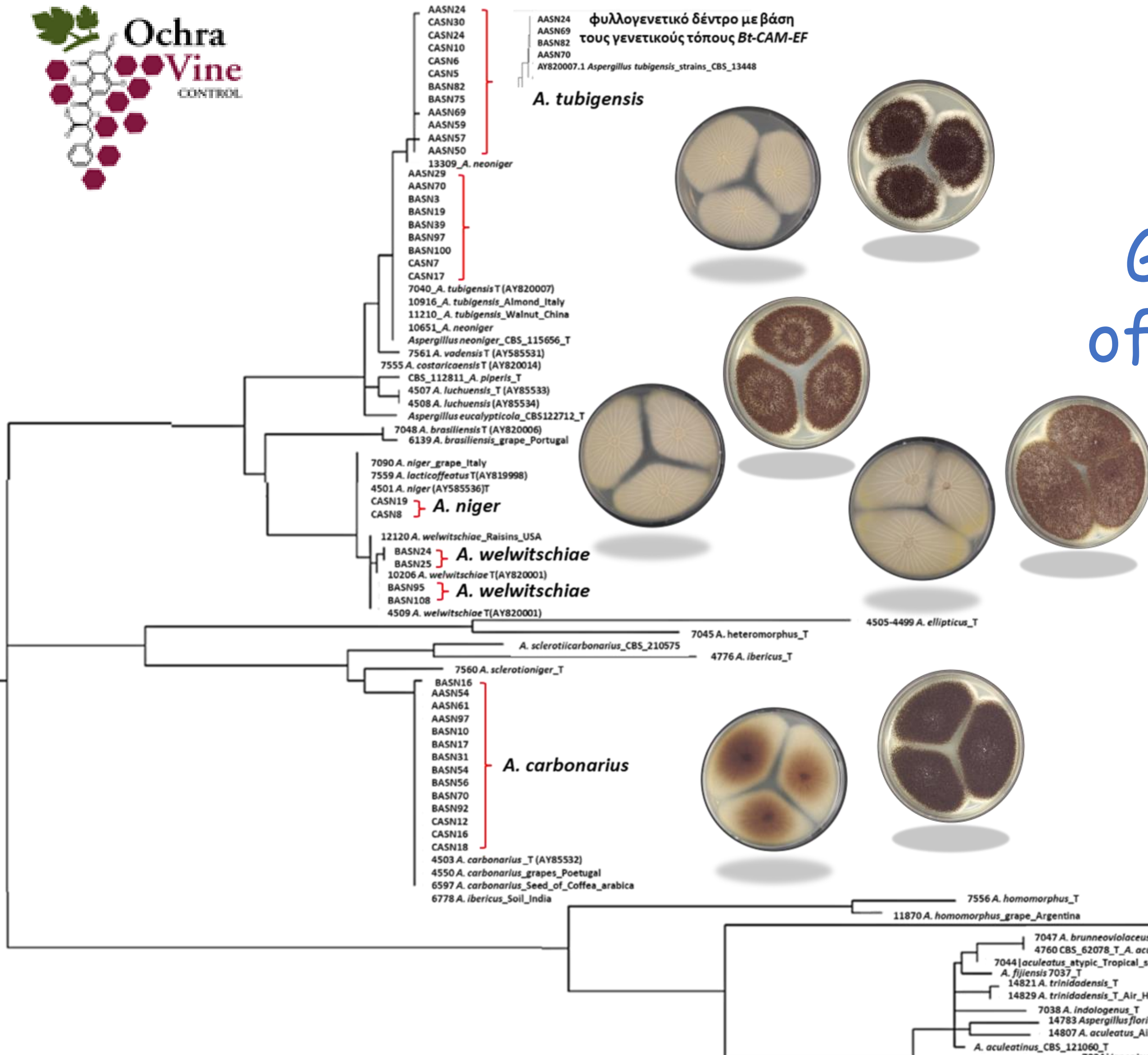
- Carcinogenic (Class 2B, IARC), nephrotoxic, teratogenic, immunocompromised and potentially neurotoxic attributes
- Produced mainly by*Aspergillus ochraceus*, *A. carbonarius*, *A. niger* και *Penicillium verrucosum*
- High levels in grapes, cereals, grains of coffee, cocoa, dry fruits (i.e. raisins/currants)
- Samples from grapes as well as raisins/currants, grape juices and wines from southern Europe have been found frequently contaminated with OTA
- Red wine is the second major source of human exposure to OTA, followed by the cereals and preceding coffee and beer
- EU: 2-10 ppb (μg/kg)
- OTA is one of the most important mycotoxins that are responsible for food rejection

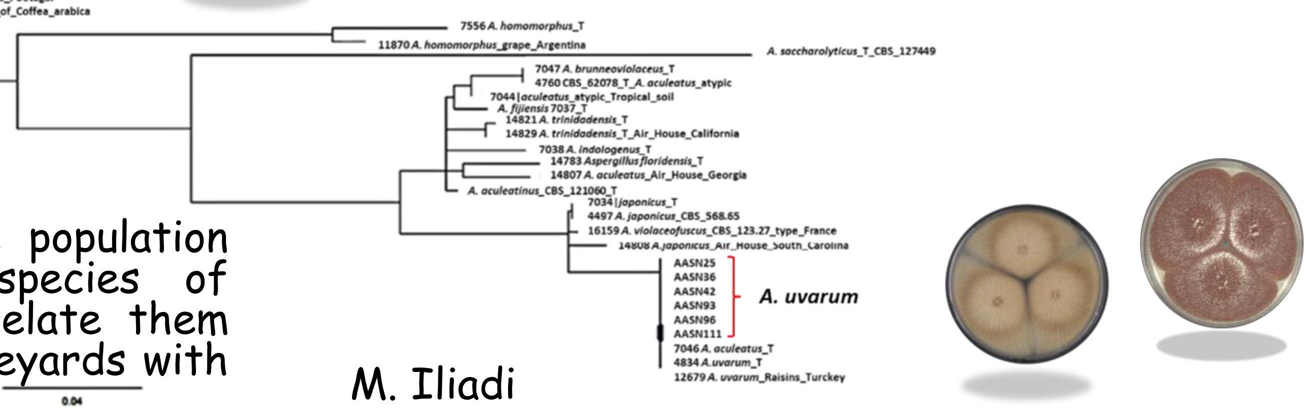
OchraVine Control objectives

1. Identify pre-harvest indicators for the development of the OTA predictive model
   - fungal, pest, host , environmental indicators and agricultural practices
2. Develop a rapid OTA detection system and sustainable pre-and post-harvest OTA management strategies
   - *OchraSensor*, IPM strategy, Post-harvest model
3. Develop an integral solution for the OTA risk contamination control along the vine chain
   - *OchraVine Control* Decision Support System (DSS)

Isolation of *Aspergillus* spp. in Greece

Genetic analysis of *Aspergillus* spp. isolations





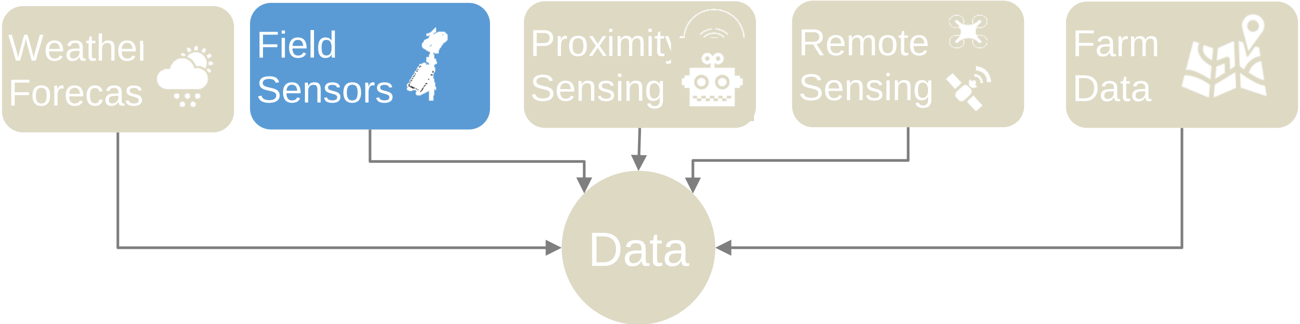
The goal is to identify the population levels and possible new species of *Aspergillus* spp. and to correlate them with the levels of OTA in vineyards with varied climatic conditions

M. Iliadi

Environmental indicators affecting the occurrence of OTA producing fungi and OTA emergence

- **Collect environmental data** (air and soil temperature, air and soil humidity, precipitation) to be used in correlation studies with the **disease epidemiology and OTA biosynthesis**.
- **Retrieve real time weather data from mobile and local central weather stations** to use as input for warning models.

Gaiatron Atmo

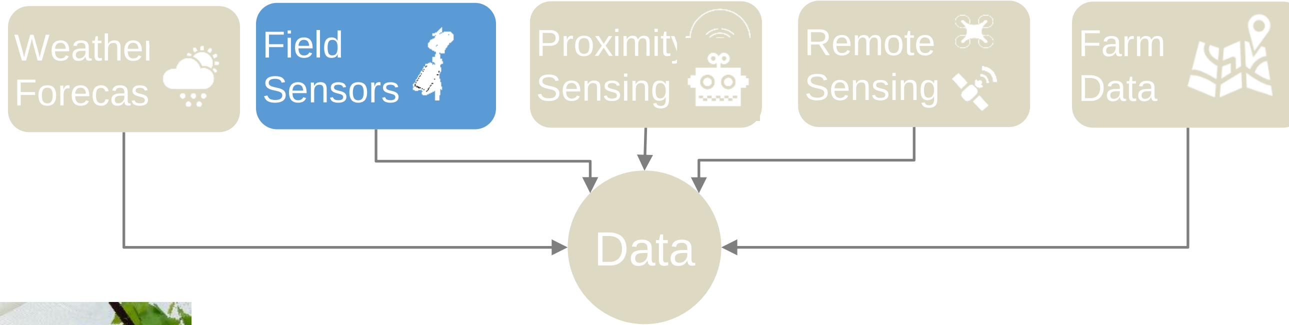


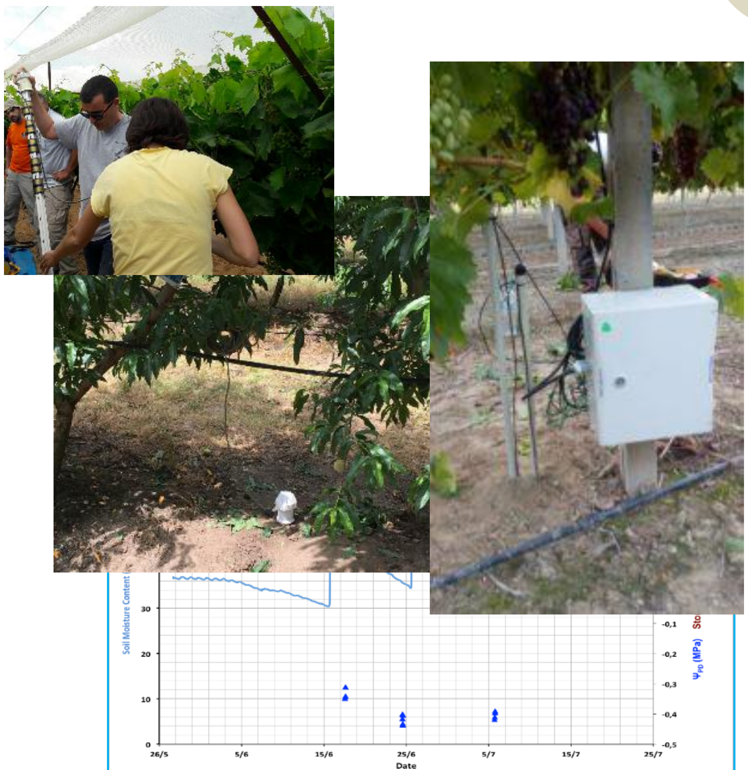
- Parameters being monitored involve:
  - **ambient temperature,**
  - **humidity,**
  - **solar radiation,**
  - **leaf wetness,**
  - **rainfall volume,**
  - **wind speed and direction,**
  - **barometric pressure in real-time.**
- Offer configurable data transmission and data process rate
- Data processing/fusion involves several pre-processing steps including data cleaning, normalization, fusion
- Raw and processed data storage in databases
- Current Status: 24/7, 10min, 41 stations (January 2018)

NEUROPUBLIC Information Systems & Technologies

gaiasense

Gaiatron Soil





- Parameters being monitored in real-time:
  - **soil temperature (multi-depth),**
  - **soil humidity (multi-depth)**
- GAIAtrons Soil have the same operational features with GAIAtrons Atmo (both in data transmission and data processing)
- Current Status: 24/7, 10min, 18 stations (January 2018)

Grapevine Datasets and Agricultural practices

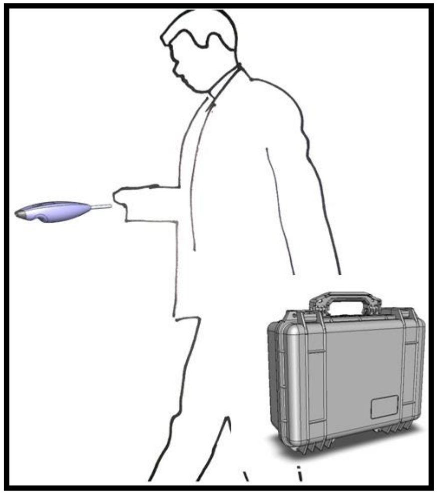
- Spatial data, topographical and elevation mapping
- Geo-referenced apparent soil electrical conductivity (ECa)
- Canopy characteristics and vegetation indices
- Yield mapping

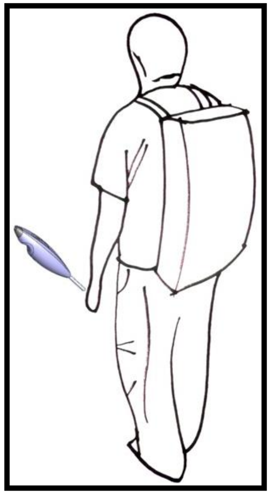
A. Kasimati, V. Psiroukis and S. Fountas, AUA

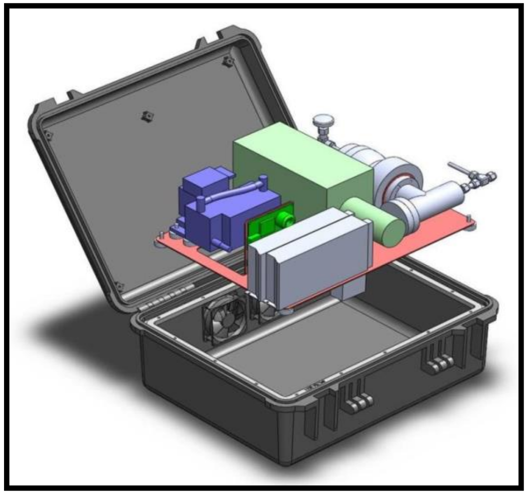
Development of sensor systems for OTA detection in grapes

Portable Mass Spectrometry

Demands:
- In-field usage
- Low weight
- Compact size
- Low power
- Low cost
- Reliability







Representative applications:

➢ Industry: water and air quality, food and beverage quality, energy, automotive, space exploration, etc.

➢ Security: homeland security, military, aviation, transportation, etc.

➢ Medical and clinical: point-of-care disease diagnosis, pharmacology, immunology, regulation, etc.

Q Technologies
innovative mass spectrometry systems

Miniaturisation of Mass Analysers

Miniaturised analysers: quadrupole mass filter, ion trap and time-of-flight

Advantages of miniaturisation:

- Reduced vacuum demand
- Lower weight
- Smaller size
- Lower cost
- Lower voltage requirements
- Lower power consumption
- Higher mass range
- Increased number of applications

Q Technologies
innovative mass spectrometry systems

OchraSensor Results

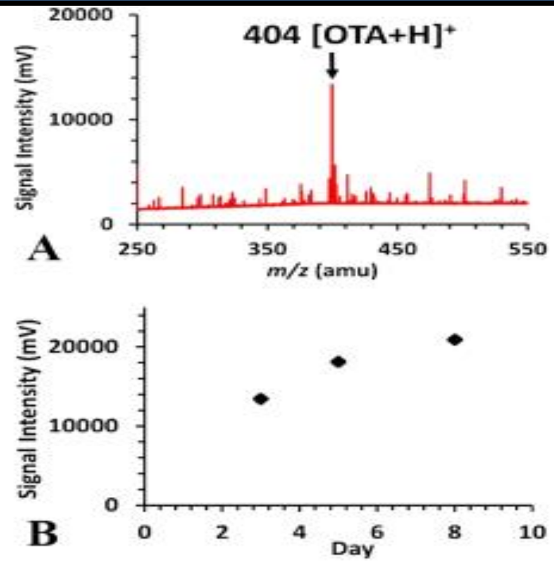


Figure 1. (a) Representative ESI-ToF mass spectrum (in the positive ion production and detection mode) of a diseased grape producing OTA in day 3 after the infection and (b) time evolution of the signal intensity of the m/z 404 during a period of 8 days after the infection.

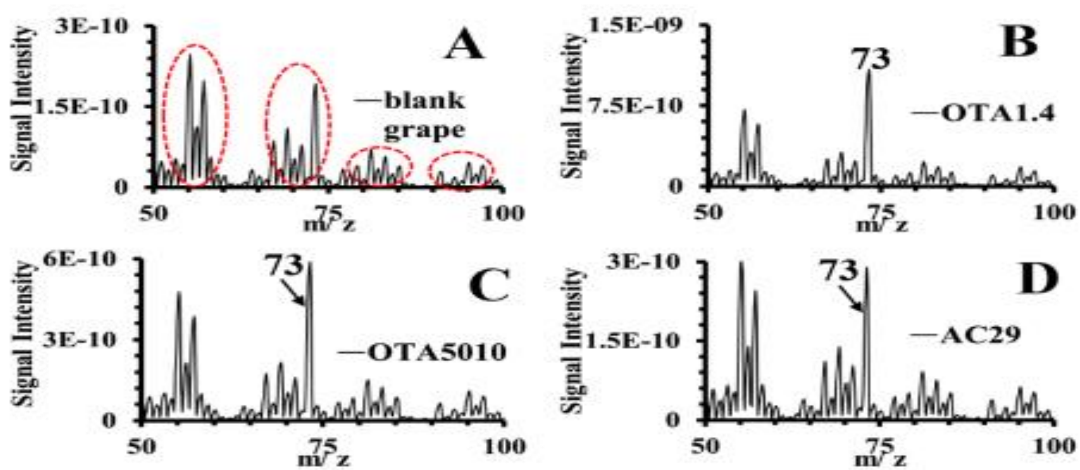


Figure 2. Representative mass spectra of the various strains of *A. carbonarius* at the first day of the infection experiments.

Scientific Reports | (2020) 10:21179

Pre-harvest model for grape berries

Consists of two pillars:

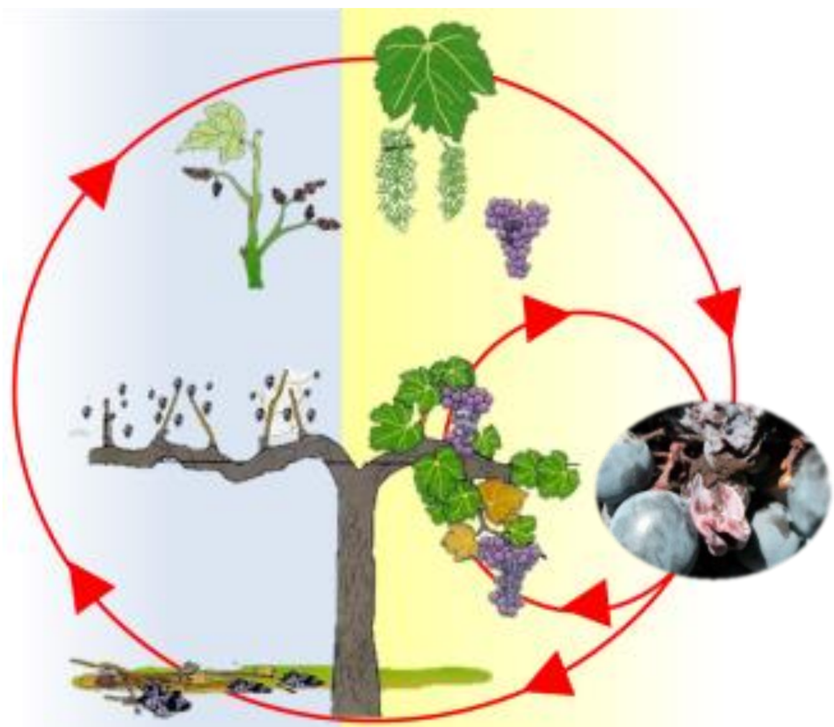
1) Mapping of emergence risk of fungi based on dynamic modelling approaches
2) Monitoring of fungi/mycotoxin occurrence in high risk regions using innovative crowd sourcing tools

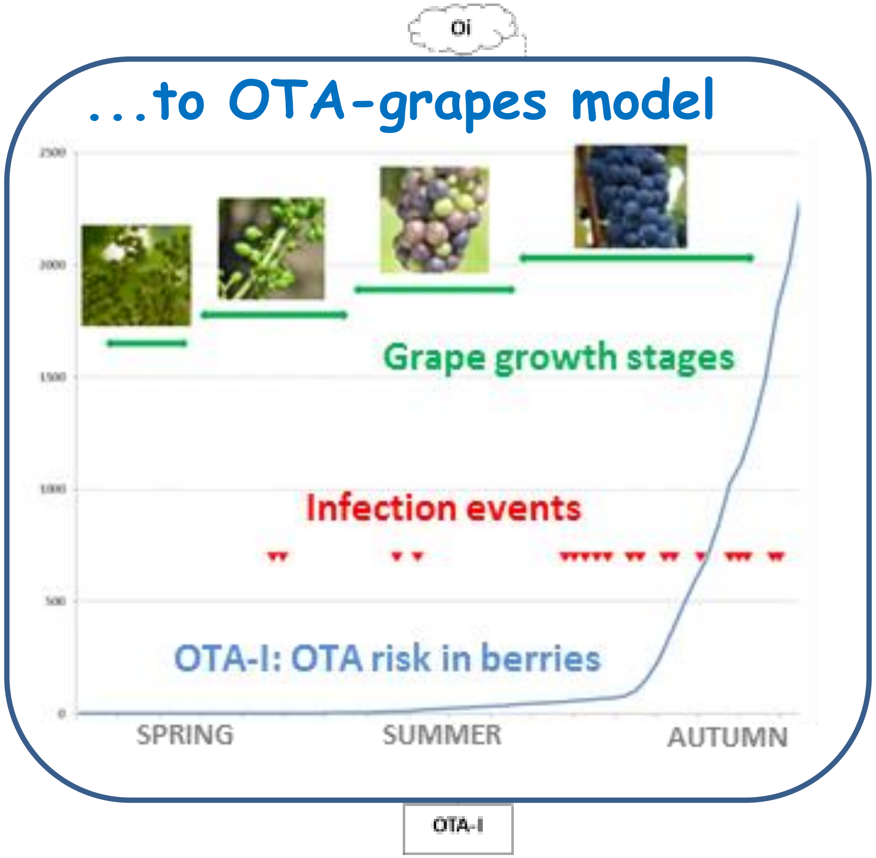
The predictive model will be extended to post-harvest stages (raisinis/currants, wine)

UNIVERSITÀ CATTOLICA del Sacro Cuore

OTA_grapes predictive model

From *A. carbonarius* infection cycle… …relation diagram…





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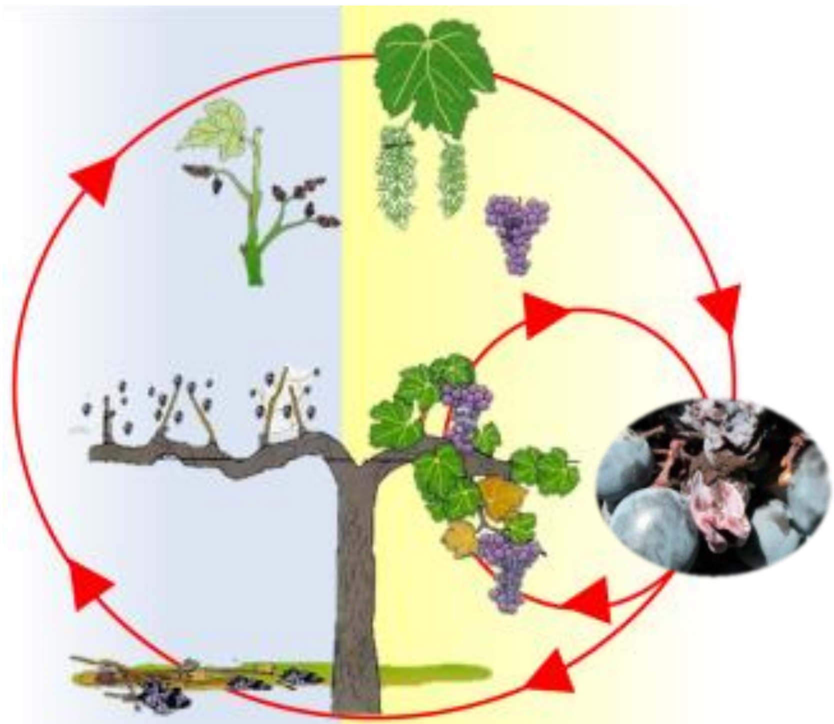
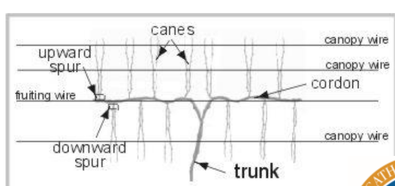
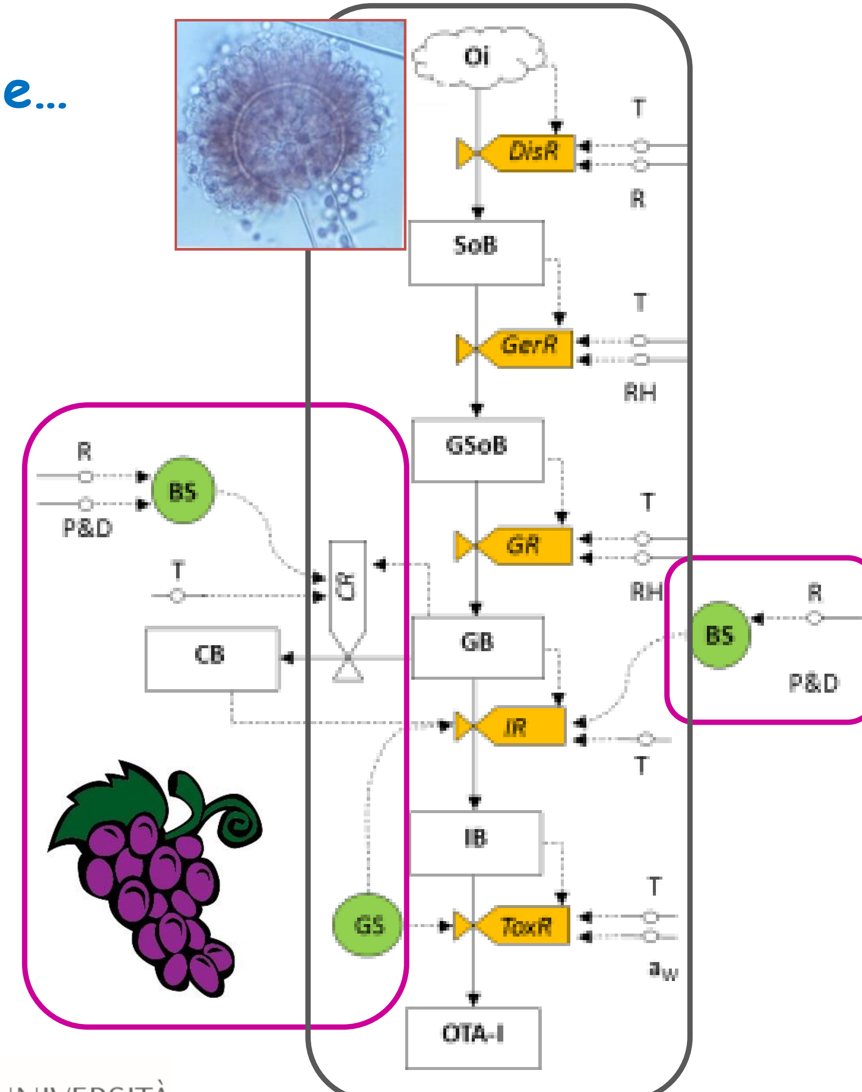
Battilani & Camardo Leggieri, 2015

OTA_grapes predictive model

From *A. carbonarius* infection cycle…



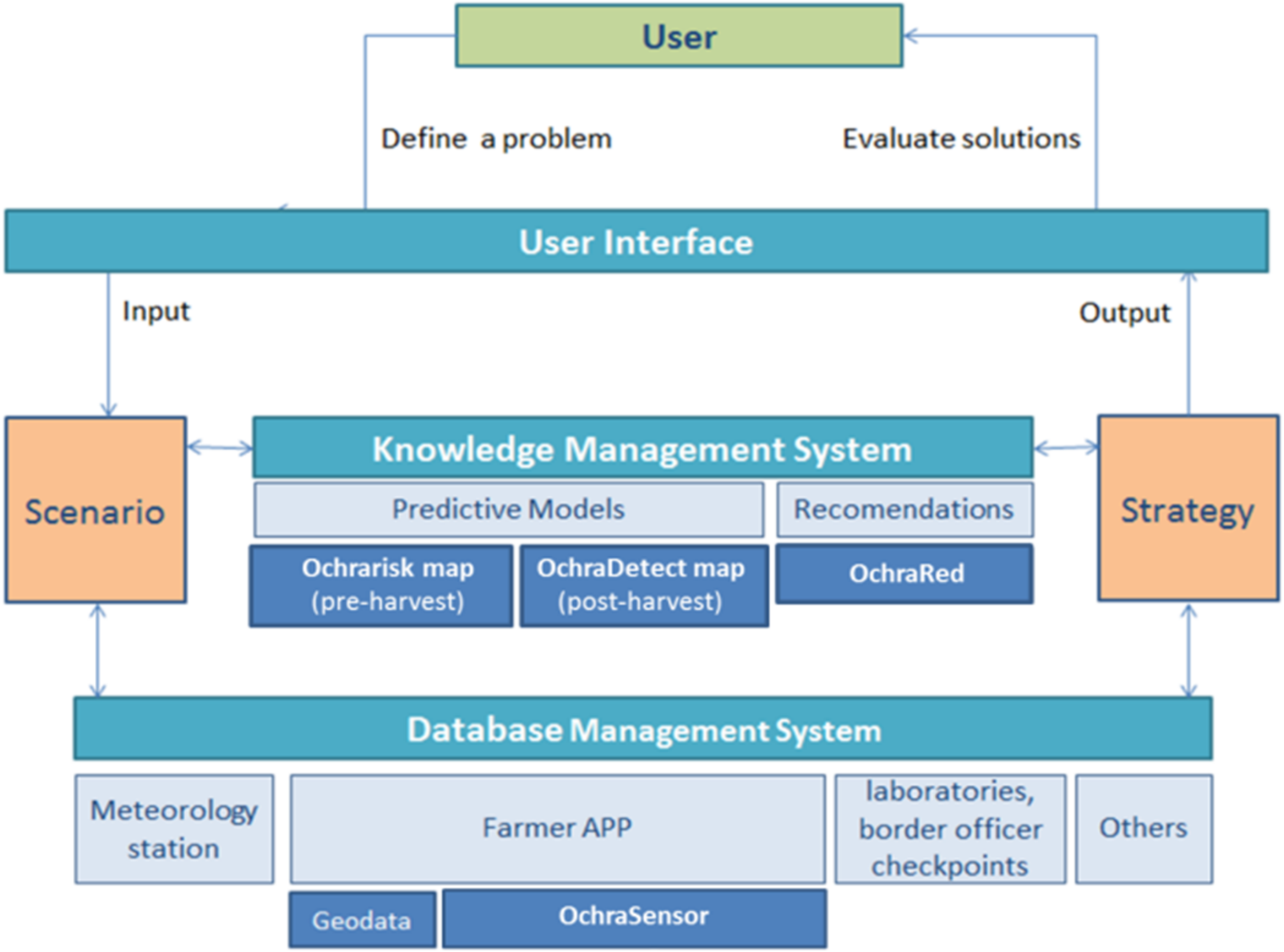




http://www.ochravine.eu/

Battilani & Camardo Leggieri, 2015

Development of the *OchraVine Control* DSS Architecture



AGENSO

Development and validation of Pre- and Post-Harvest Models and the OchraVine Control Decision Support System

A. Pre-harvest model for grape berries

B. Post-harvest model for raisins and currants

C. Post-harvest model for wine

Development and validation of the *OchraVine Control* Decision Support System

Business modelling & LCA

PAD
Process Analysis & Design
Consultancy Services

Business modelling & LCA

- Translation of the vision of OchraVine-DSS into **sustainable business models.**
- **LCA (Life Cycle Assessment) analysis** for the determination of the environmental impact through the grape to wine chain.
- **LCC (Life Cycle Cost)** methodology for the economic evaluation of the selected case studies.
- Validation of any **positive ecological and environmental impact** that the proposed technologies will offer against current practices.

Synergies between VISCA and OCHRAVINE CONTROL

VISCA
VINEYARDS INTEGRATED SMART CLIMATE APPLICATION

Ochra Vine
CONTROL

Connection of VISCA DSS with the Ochravine DSS

OTA will be significantly affected by the climate change

Acknowledgments

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Ochra Vine CONTROL

European Commission

HORIZON 2020

The EU Framework Programme for Research and Innovation

syngenta DUPONT ΑΛΦΑ Nufarm BASF The Chemical Company AGROLOGY ΠΑΠΑΟΙΚΟΝΟΜΟΥ


http://www.ochravine.eu/