

Wine4Cast –

Spatio-temporal prediction of viticulture productivity for multi-actor usability



Mário Cunha, FCUP
Associate Prof. With habilitation, FCUP
Investigador INESC TEC
mccunha@fc.up.pt







International Organization
of Vine and Wine
Intergovernmental Organisation
www.iov.int

WEBINAR IBÉRICO

O conhecimento ao serviço do setor
vitivinícola ibérico

03 DE DEZEMBRO ONLINE


















1

TEMA | Spatio-temporal prediction of viticulture productivity for multi-actor usability

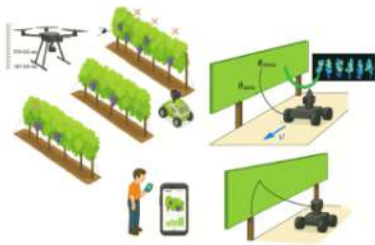
Predict the storm before the wind

When technology makes the difference.

- What is the usefulness of forecasts in viticulture?
- How accurate and how early can we be?
- What is the spatial and temporal scale of the prediction?
- What methodologies and technologies are available?
- What is the current outlook for predictions?



Observatório de Chichen Itzá, México



Wine4Cast:











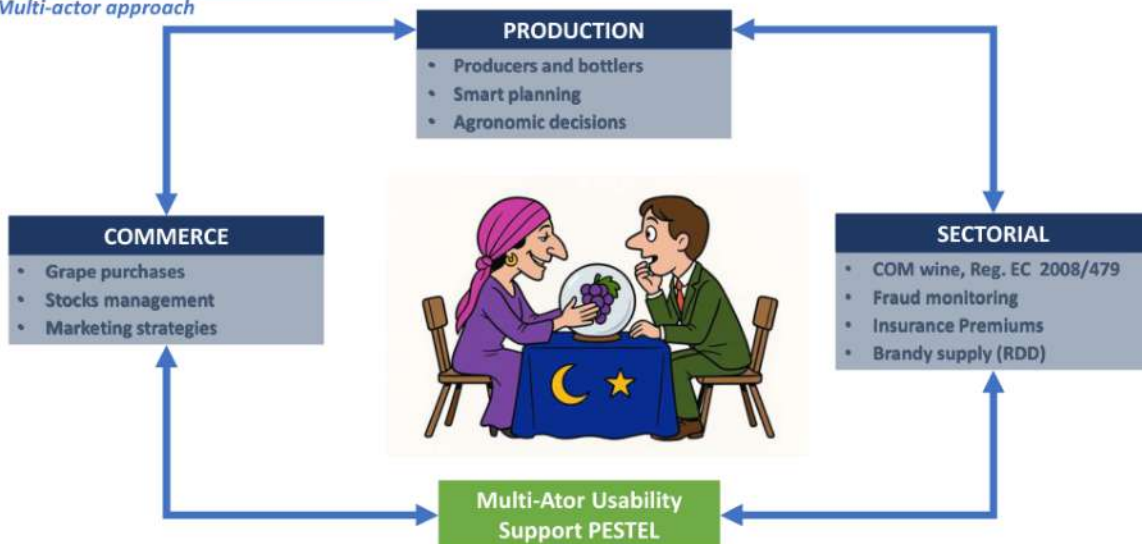


Mário Cunha FCUP/INESCTEC

2

Wine forecast

Multi-actor approach



PESTEL - Political, Economic, Social, Technological, Environmental and Legal

Mário Cunha FCUP

3

Wine Forecast foundations

Productivity components

	How accurate can we get?	How early can we be?
	Yield variation explanation	Time window
	Bunches/vine 60% (cv. > 35%)	Since bud dormant; 2 nd leaves developed (BBCH 12)
	Berries/Bunch 30% (cv. >5-7%)	After flowering (BBCH 65)
	Berrie' weight 10% (cv. >8%)	After berry pea (BBCH 75)
$\text{Yield (kg/ha)} = \text{Vines/ha} \times \text{bunches/vine} \times \text{Berries/Bunch} \times \text{berries mass (kg)}$		

Cunha et al. 2016. European Journal of Agronomy

Mário Cunha FCUP

4

Multi-dimensional approach

Spatio-temporal dimension of the prediction? Integrate approach

Yield forecast approaches and technologies

Spatial (Production level)	Temporal (Time window)	Approaches/Technologies
Wine company/parcel	Bud dormant (17 months)	Forcing, Bud Tomography
Wine company/parcel	Since visible inflorescences	Digital Phenotyping (micro)Drones, Smartphone, Robot
Wine company/parcel	Harvest	Harvester, "Sharpmetrix"
(Sub)Regional	Since flowering period	Airborne pollen Satellites images
(Sub)Regional	Long –term projections (> 100Y)	Climate time series (daily data >100 Y + climatic scenarios)

Complementary Information from different types of wine forecast

Mário Cunha FCUP

5

Wine4Cast Technologies

 Wine4Cast

I. PARCEL LEVEL

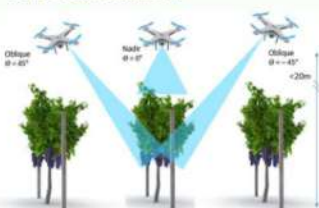


1.1. Ultra precocious prediction. Based on bud fertility



1.2. Components of productivity – digital phenotyping

I. 2.1 Drones oblique fly



1.2.2. Smartphones/C. multiangle/robot



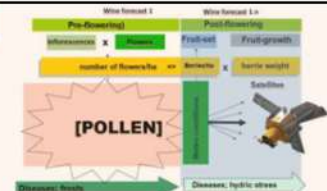
1.2.3. Productivity maps



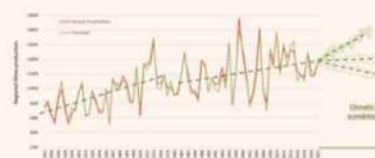
Mário Cunha FCUP/INESC TEC

II. (Sub)REGIONAL

II. 1 Pollen + satellites



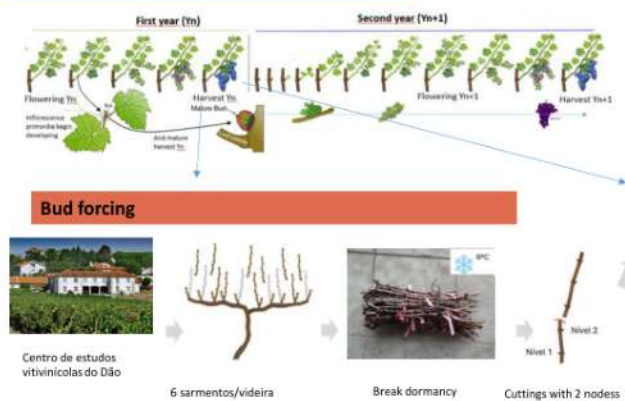
II. 2 Climate Scenarios



6

I1. Ultra-Precocious – “Forcing”

FORCING. DÃO 2023 – variety Jaen



- Destructive Approach
- Up to 12 months before harvest
 - Productivity forecast
 - Pruning decisions



CENTRO Wine4Cast

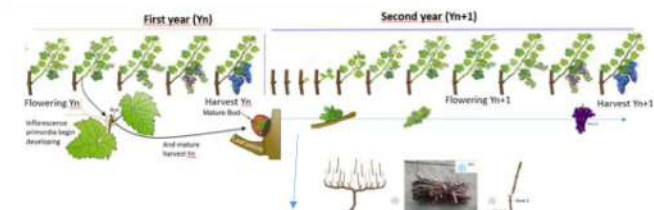
Mário Cunha FCUPVINESC TEC

et. al. Cunha, M. 2025. Revista APH

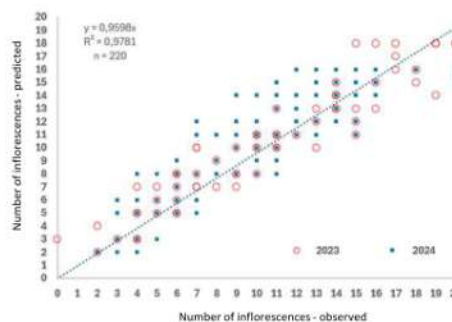
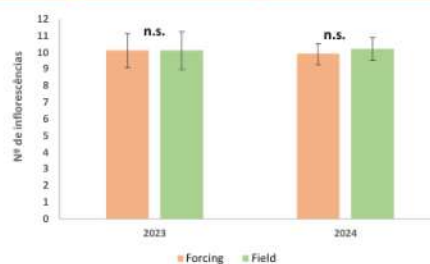
7

I1. Ultra-Precocious – “Forcing”

Bud forcing– 2023 e 2024 – Variety Jaen



CENTRO Wine4Cast



et. al. Cunha, M. 2025. Revista APH

Mário Cunha FCUPVINESC TEC

8

I1. Ultra precociuos – “tomografias”

From Lab to Field

Tomography of dormant bud (non-destructive)

mutipoint hyperspectral sensor - “Tomography”

From Light to Yield

Spectral data vs fertility of the dormant bud



Wine4Cast

Moreira, G. PhD results, FCUP, INESC TEC, Wine4Cast, BudScan 4M



Wine4Cast II

Mário Cunha FCUP/INESC TEC

9

I2. Components of productivity

Digital phenotyping - inflorescences

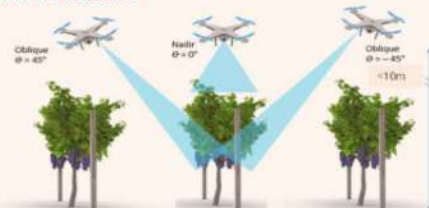
Shoots <50 cm (Pheno stages I-J)

Wine4Cast



I2.1 Drones

- RGB image, oblique fly, <10m
- +++++ occlusion



I2.2 Smartphone sticks

- RGB image
- Multiangle, 360° cameras
- <<<< occlusion



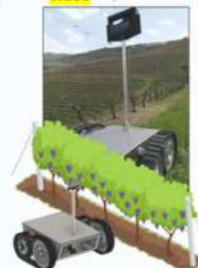
Video



I2.3 Robot “Orioo”

- Versatility
- Affordable costs
- High throughput
- 360° camera

Video



Video



Wine4Cast

Mário Cunha FCUP/INESC TEC

10

Components of productivity

Results – Camera 360° - (multiangle)

Digital phenotyping of inflorescences

Multi-variety results – Dão Region

Variety	nb grapevines	Direction	Observation	Multiangle	NMAE (%)
Jaen	71	NNW to SSE	495	461	6,9
Jaen	71	SSE to NNW	495	433	12,5
Jaen	74	NNW to SSE	510	523	2,6
Jaen	74	SSE to NNW	510	501	1,8
Jaen	74	Mean	510	512	0,4
Alfrocheiro	72	NNW to SSE	997	962	3,5
Alfrocheiro	72	SSE to NNW	997	1051	5,4
Alfrocheiro	72	Mean	997	1007	1,0
Alfrocheiro	74	NNW to SSE	970	1007	3,8
Alfrocheiro	74	SSE to NNW	970	1038	7,0
Alfrocheiro	74	Mean	970	1023	5,4
Total					
Amostra	802	---	8421	8518	4,6

Wine4Cast

Centro de estudos do Dão, Mireira, G. PhD results, Wine4Cast

- Images from different angles (multiangle)
- AI Algorithms:
 - Detection, Occlusion, avoiding double counting
- Mapping of productivity components

Video



Mário Cunha FCUPVINESC TEC

11

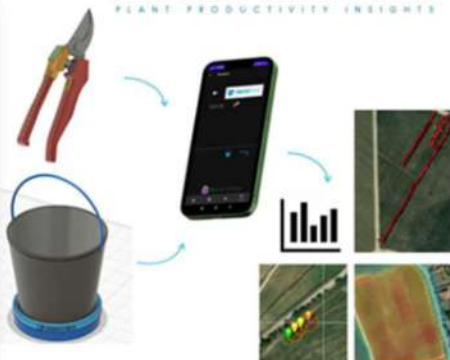
I.2.3. Productivity maps

Sensorized scissors

- Sensor system adapted to any scissors
- Automatic weighing bucket,
- Coordinate by mobile phone processing (GNSS, data processing and mapping)



SHARPMETRIX
PLANT PRODUCTIVITY INSIGHTS



Main operations:

- Number of grapes
- Weighting/Counting
- Geolocation data



Applications

- Productivity maps
- Vineyard Operation management

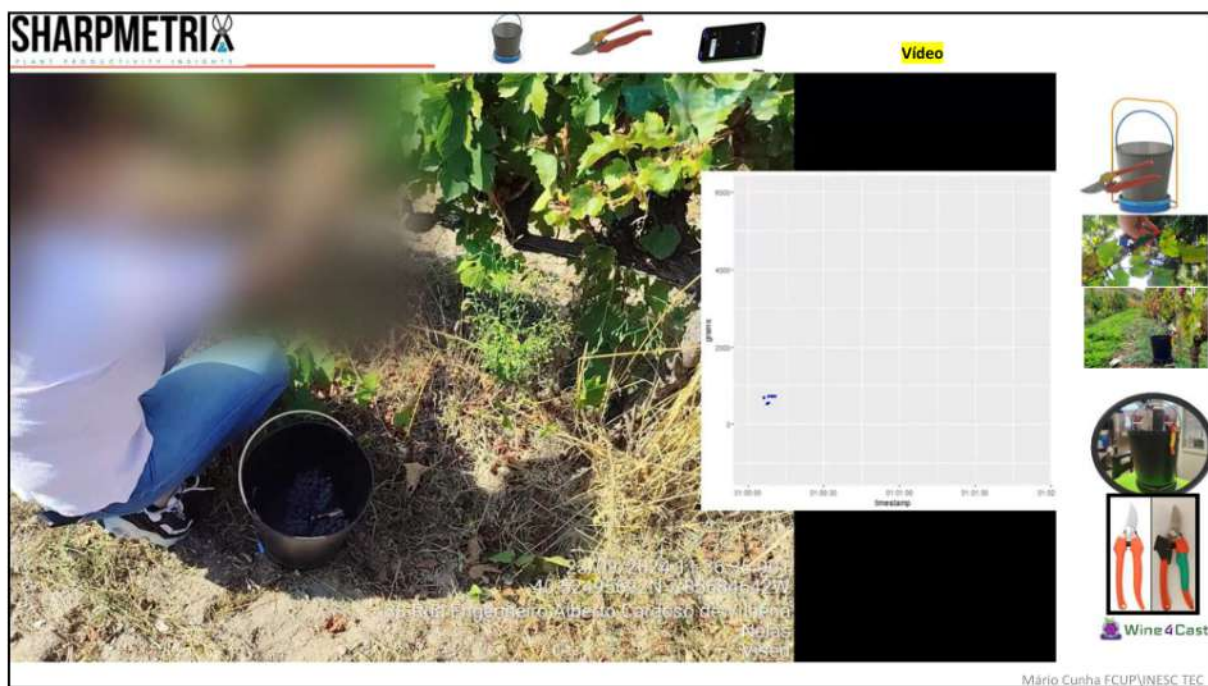
Wine4Cast

SHARPMETRIX is a trademark of SHARPMETRIX. All rights reserved. SHARPMETRIX is a registered trademark of SHARPMETRIX. All rights reserved. SHARPMETRIX is a registered trademark of SHARPMETRIX. All rights reserved.

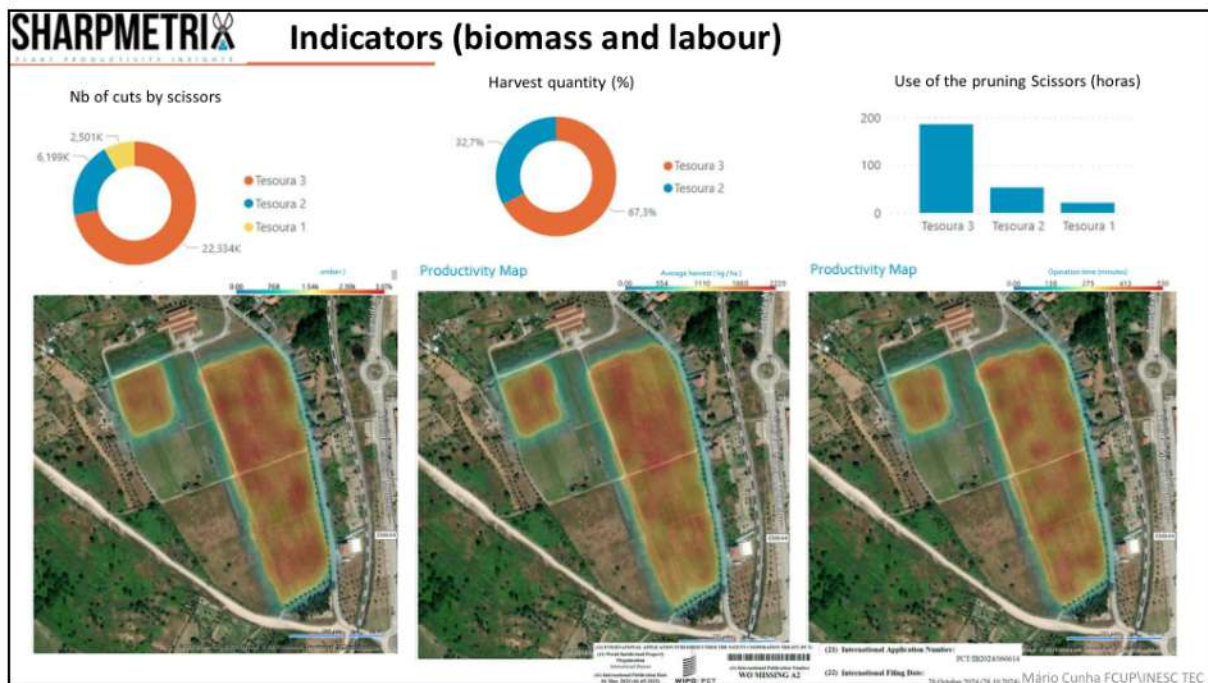
WO 2025/088592 A2 — Add-on Monitoring Apparatus for a Cutting Tool, Respective Cutting Tool, Monitoring System and Method.

Mário Cunha FCUPVINESC TEC

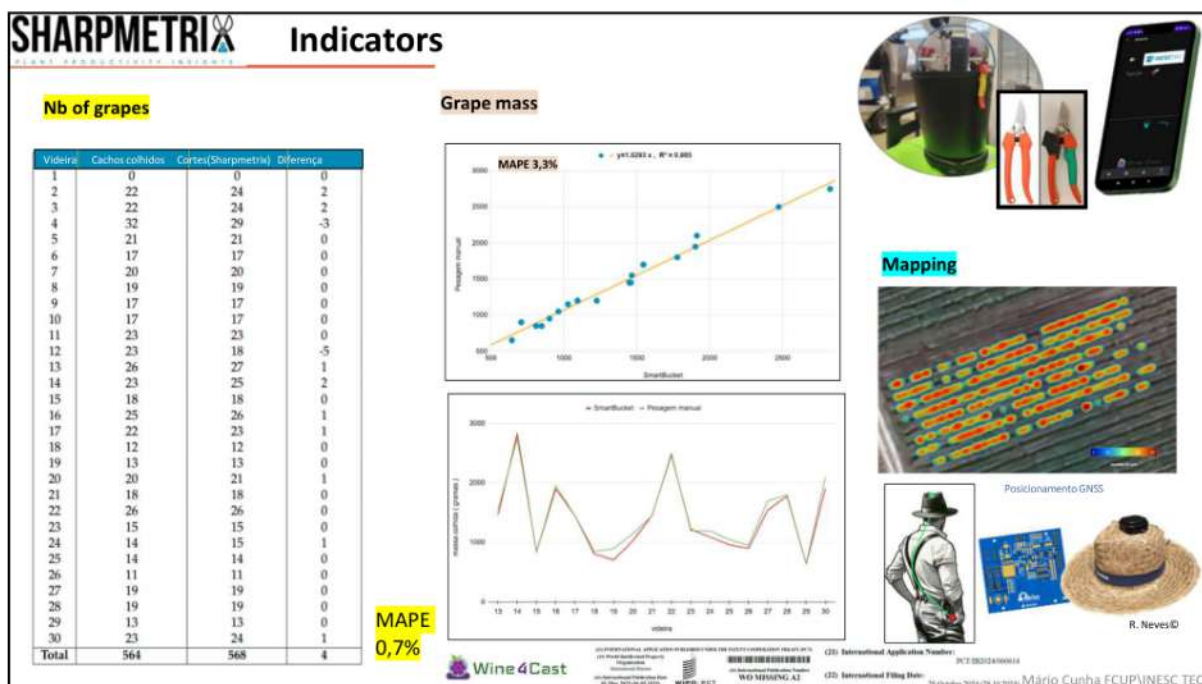
12



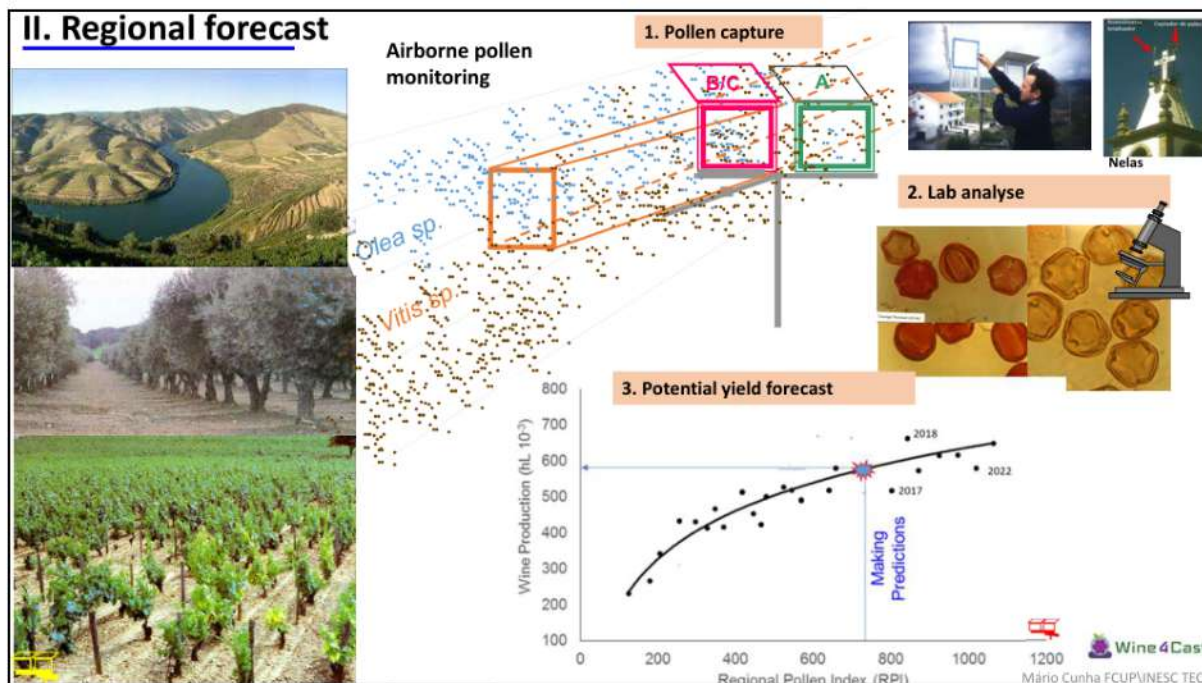
13



14



15



16

II. Regional forecast

Airborne pollen-based – Dão wine region (Example)

Airborne pollen sample



Airborne pollen monitoring



*Cunha, et. al. 2000. Ciência e Técnica Vitivinícola,

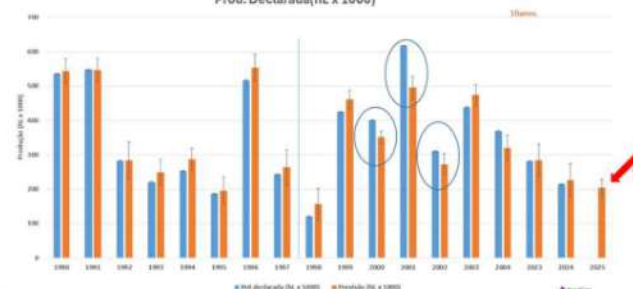
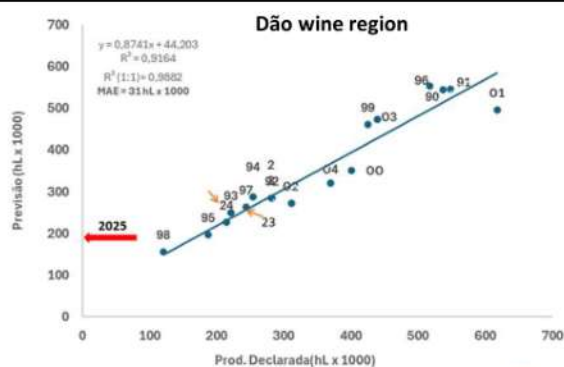
Mário Cunha FCUPVINESC TEC

17

II. Regional forecast

Baseadas no pólen atmosférico – região do Dão

Amostragem Polínica no Dão



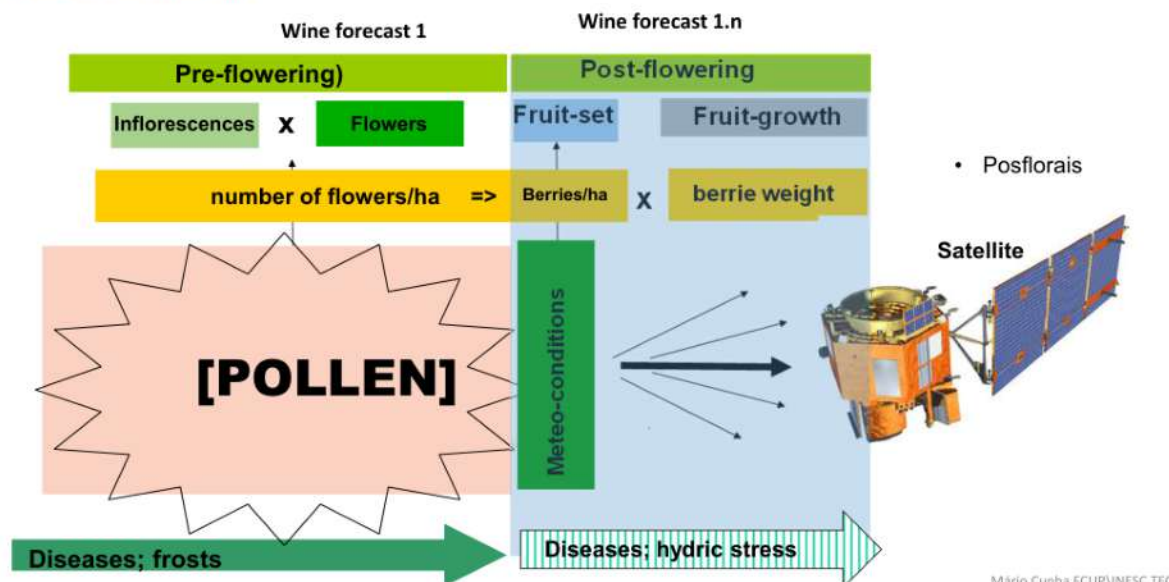
et al. Cunha, 2016. European Journal of Agronomy <https://doi.org/10.1016/j.eja.2015.10.008>

Mário Cunha FCUPVINESC TEC

18

II. Regional forecast

Airborne pollen + Satellites



19

Wine4Cast –

Spatio-temporal prediction of viticulture productivity for multi-actor usability

Mário Cunha, FCUP
Associate Professor with habilitation, FCUP
Investigador INESC TEC

mccunha@fc.up.pt

WEBINAR IBÉRICO
O conhecimento ao serviço do setor vitivinícola ibérico

03 DE DEZEMBRO ONLINE

Mário Cunha FCUPVINESC TEC

20