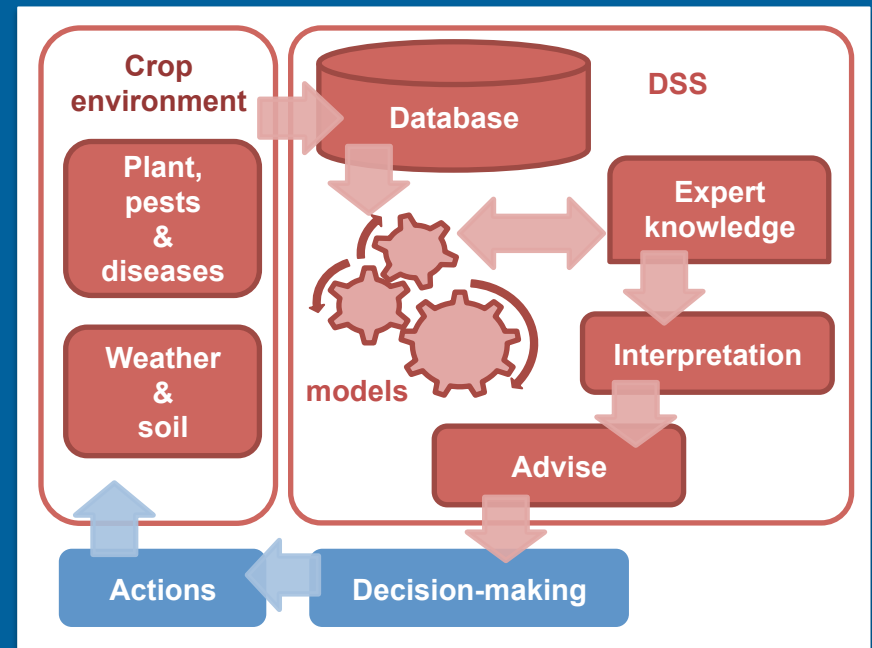


# Decision Support Systems for IPM





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## IPM in the EU

### European strategy for PPPs (*Pesticide Package*)

Regulation  
1107/2009/EC: placing  
PPPs on the market

Directive 2009/127/EC:  
machinery for pesticide  
application

Regulation 396/2005/  
EC:  
MRLs in food and feed

*Authorisation*

*Use*

*Control*

**Directive 2009/128/EC:  
sustainable use of  
pesticides**

Regulation 1185/2009/  
EC:  
statistics on pesticides





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## DIRECTIVE 2009/128/EC

Art 5  
Training



Art 8  
Equipment



Art 14  
IPM

Art 6  
Sales

Art 13  
Handling  
& storage

Art 11  
Water

Art 7  
Info &  
awareness





### Annex III, IPM Principles:

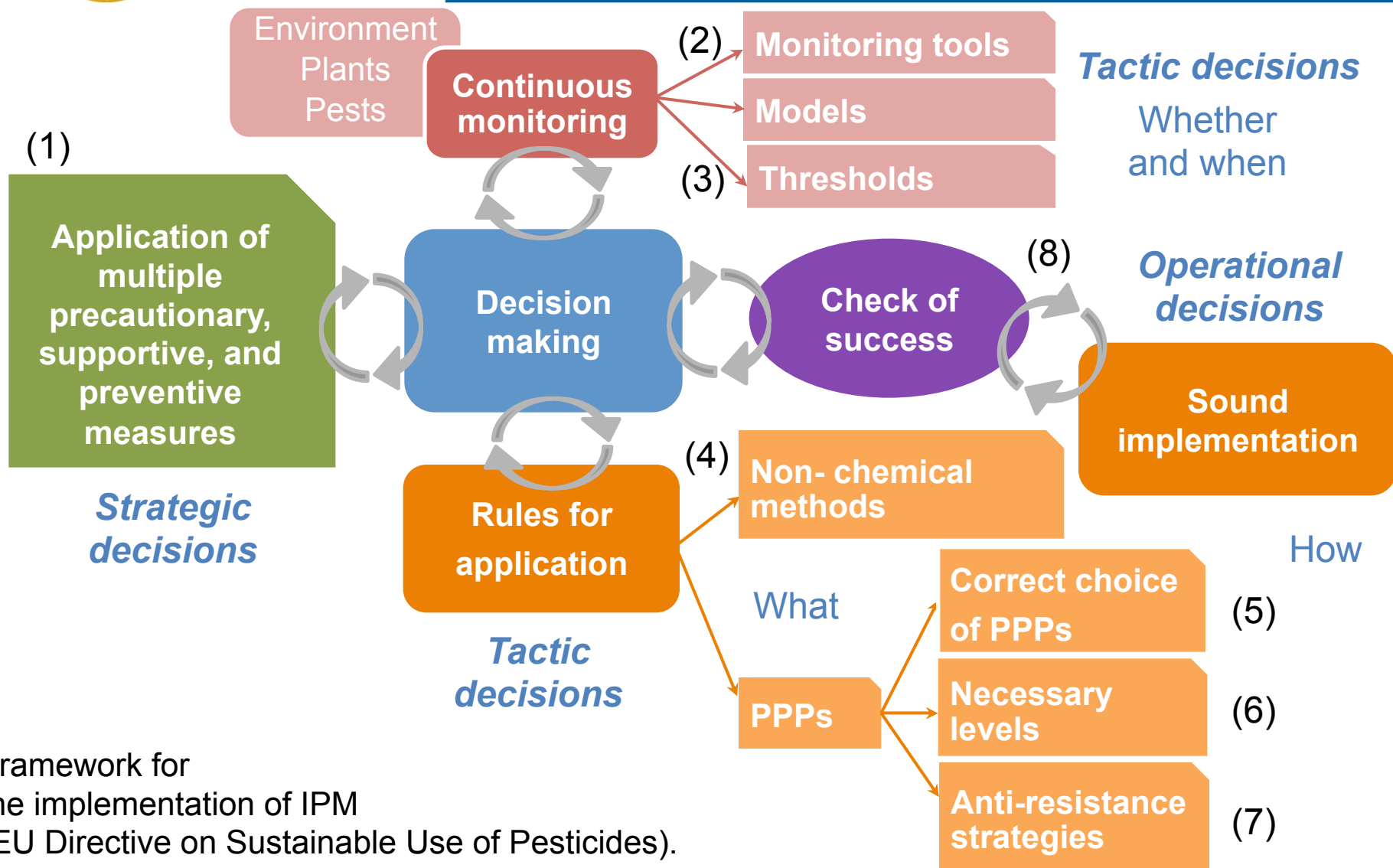
- (1) Measures for prevention /suppression of harmful organisms
- (2) Tools for monitoring
- (3) Threshold values as basis for decision-making
- (4) Non-chemical methods to be preferred
- (5) Target-specificity and minimization of side effects
- (6) Reduction of use to necessary levels
- (7) Application of anti-resistance strategies
- (8) Records, monitoring, documentation and check of success





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## IPM principles





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## IPM and decision-making

### Questions to be addressed:



- ▶ Is there a real risk of infection?
- ▶ Is the plant susceptible to infection?
- ▶ Is the plant already protected by a previous fungicide spray?
- ▶ What fungicide should I use, and at what dose?
- ▶ Is the environment suitable for the fungicide application?



### Multiple modeling approach

- ▶ Plant disease models &
  - ▶ Crop growth models
  - ▶ Fungicide models (PhMoA, rainfastness, absorption, etc. )
  - ▶ Dose calculation models (e.g., tree-row volume)
- ▶ Multiple decision criteria (e.g., fuzzy decision method)





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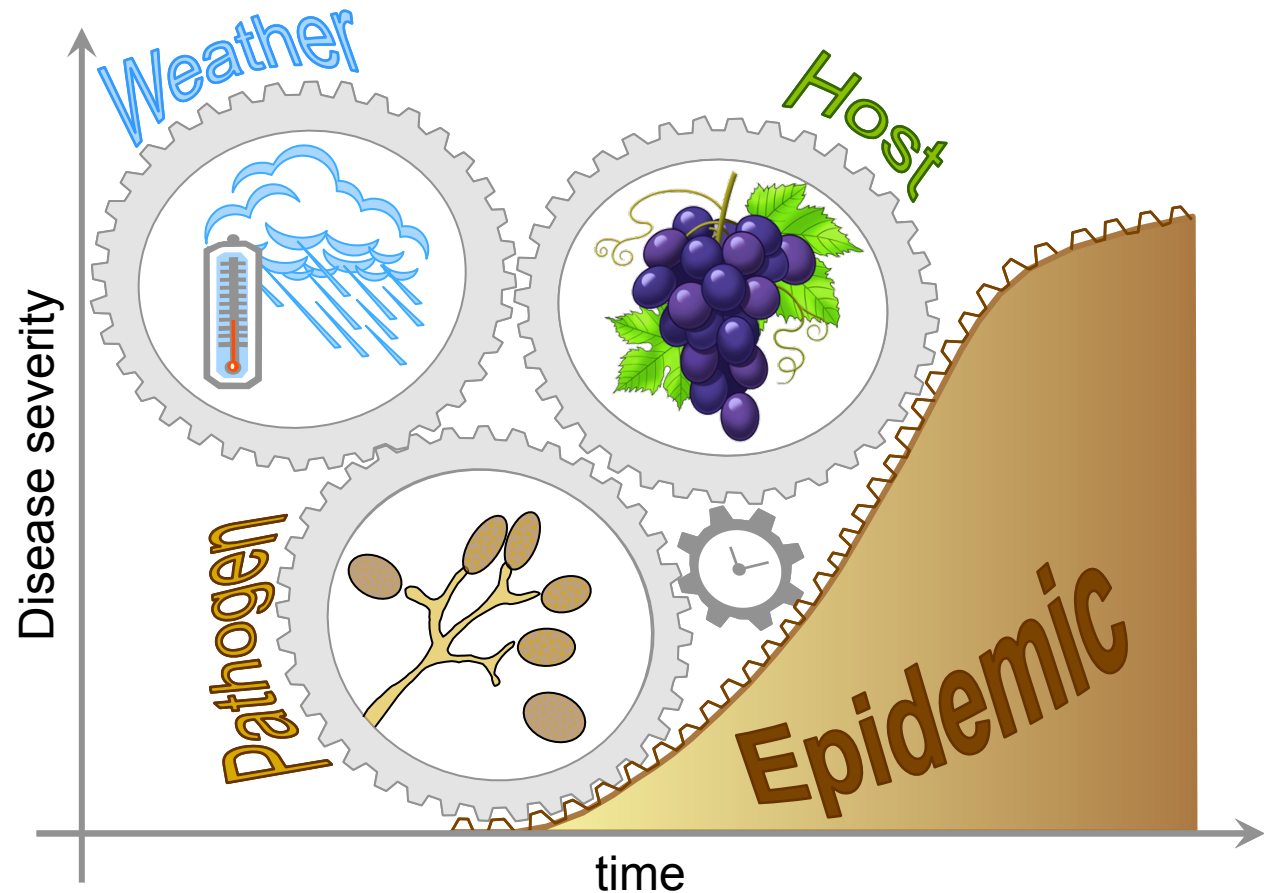




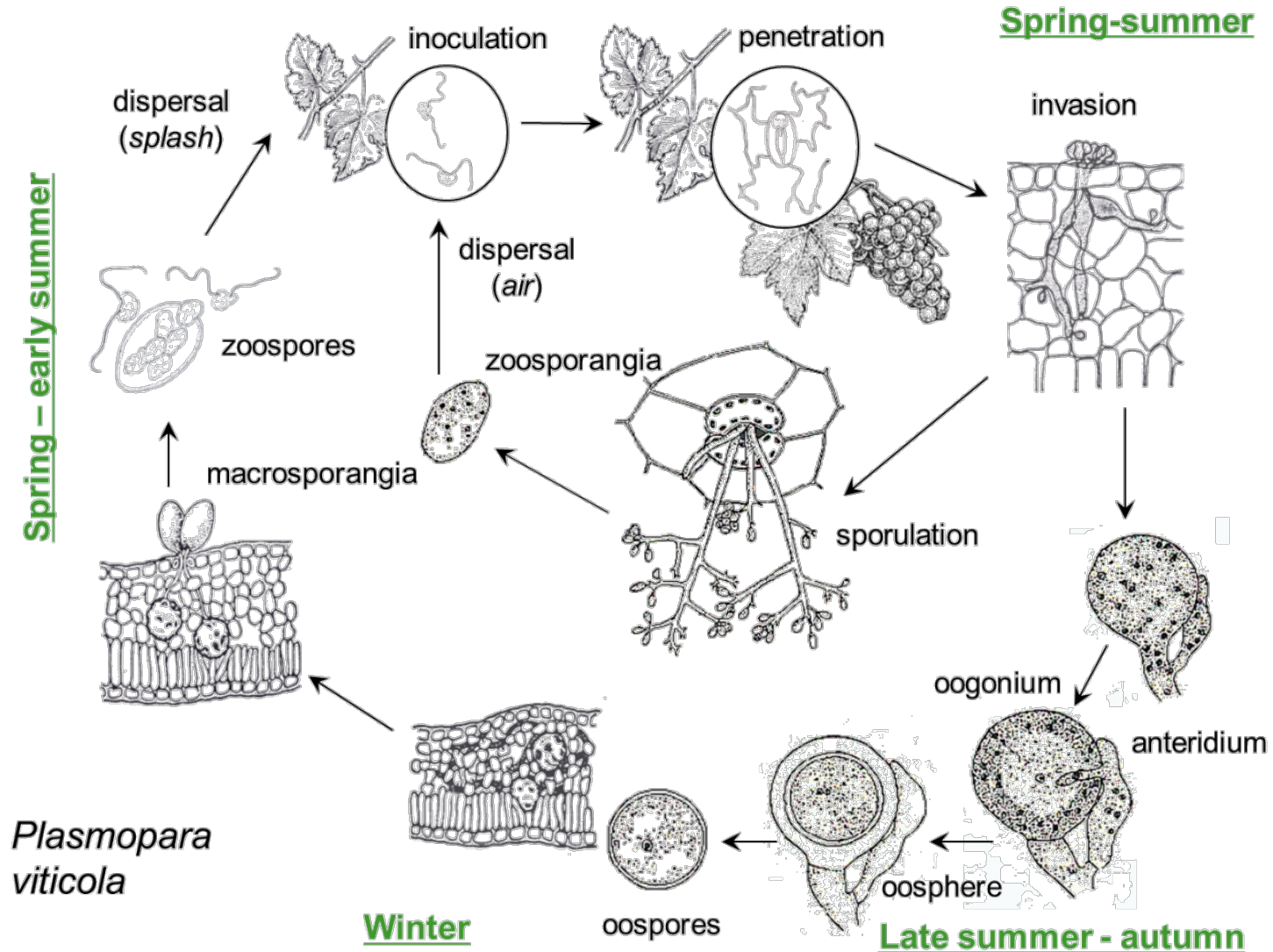
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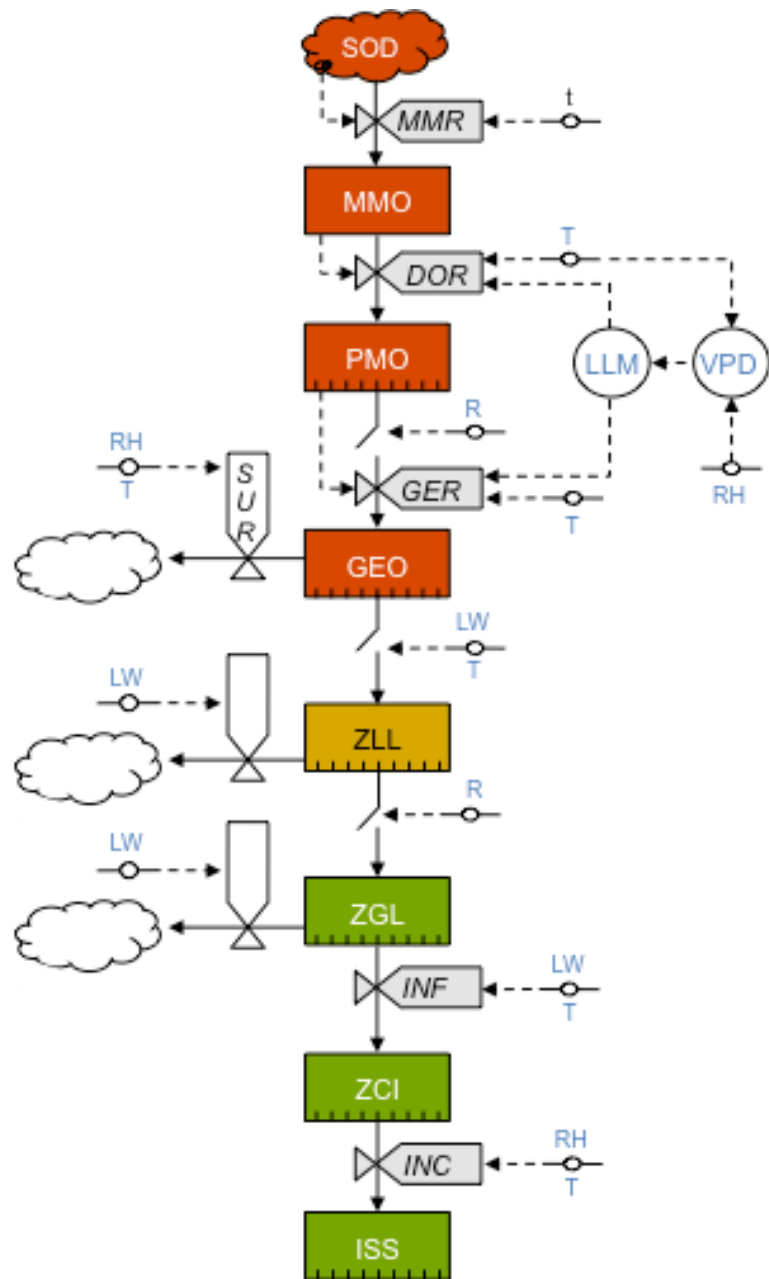
## Plant disease models

A **plant disease model** is a simplification of the **relationships between a pathogen, a host plant**, and the environment that determine whether and **how an epidemic develops** over time and / or space.



## An example: grape downy mildew





Oospores (seasonal dose)

Morphologically mature oospores

Physiologically mature oospores

Germinated oospores

Zoospores in the leaf litter

Zoospores on grape leaves

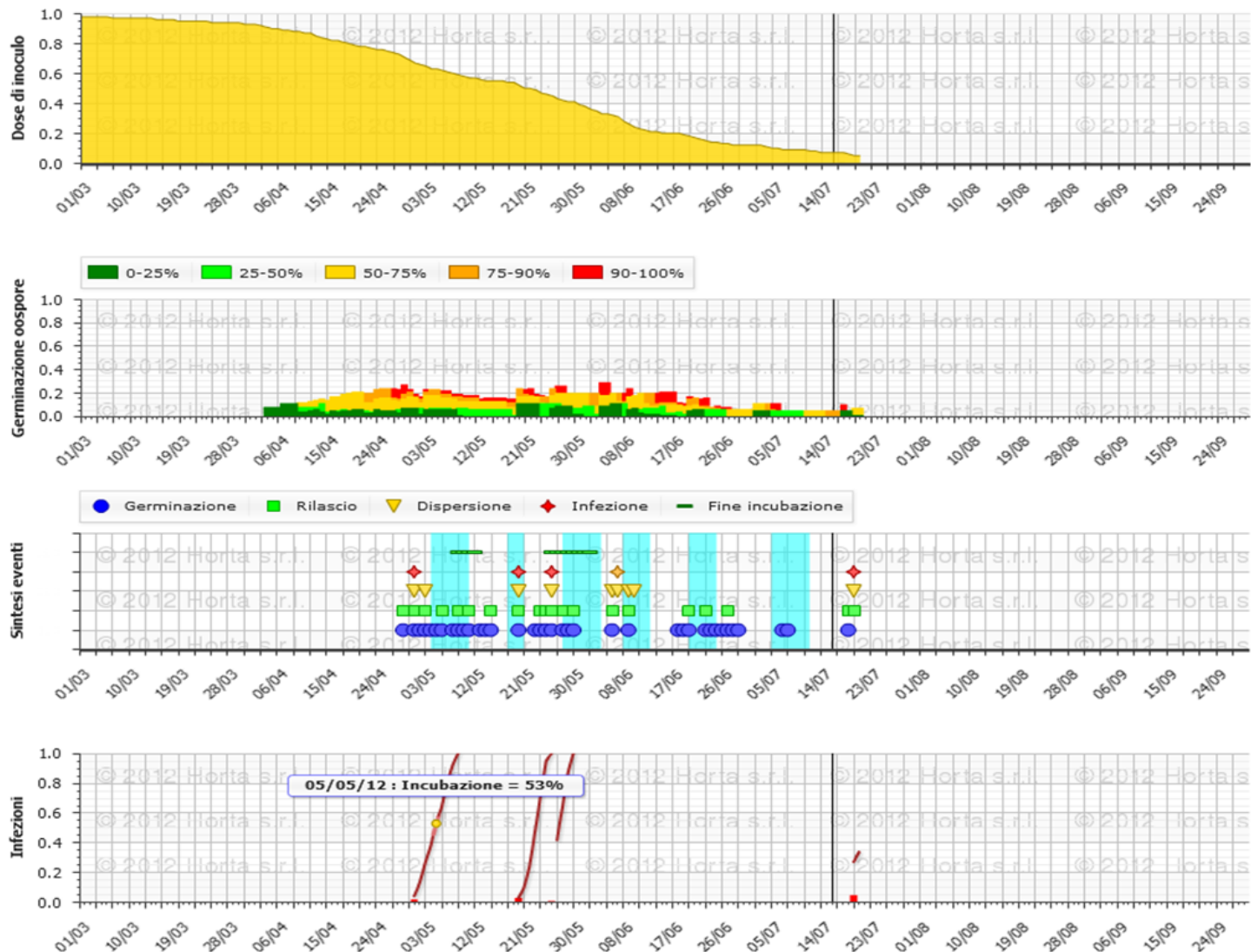
Zoospores causing infection

Infection sites showing symptoms



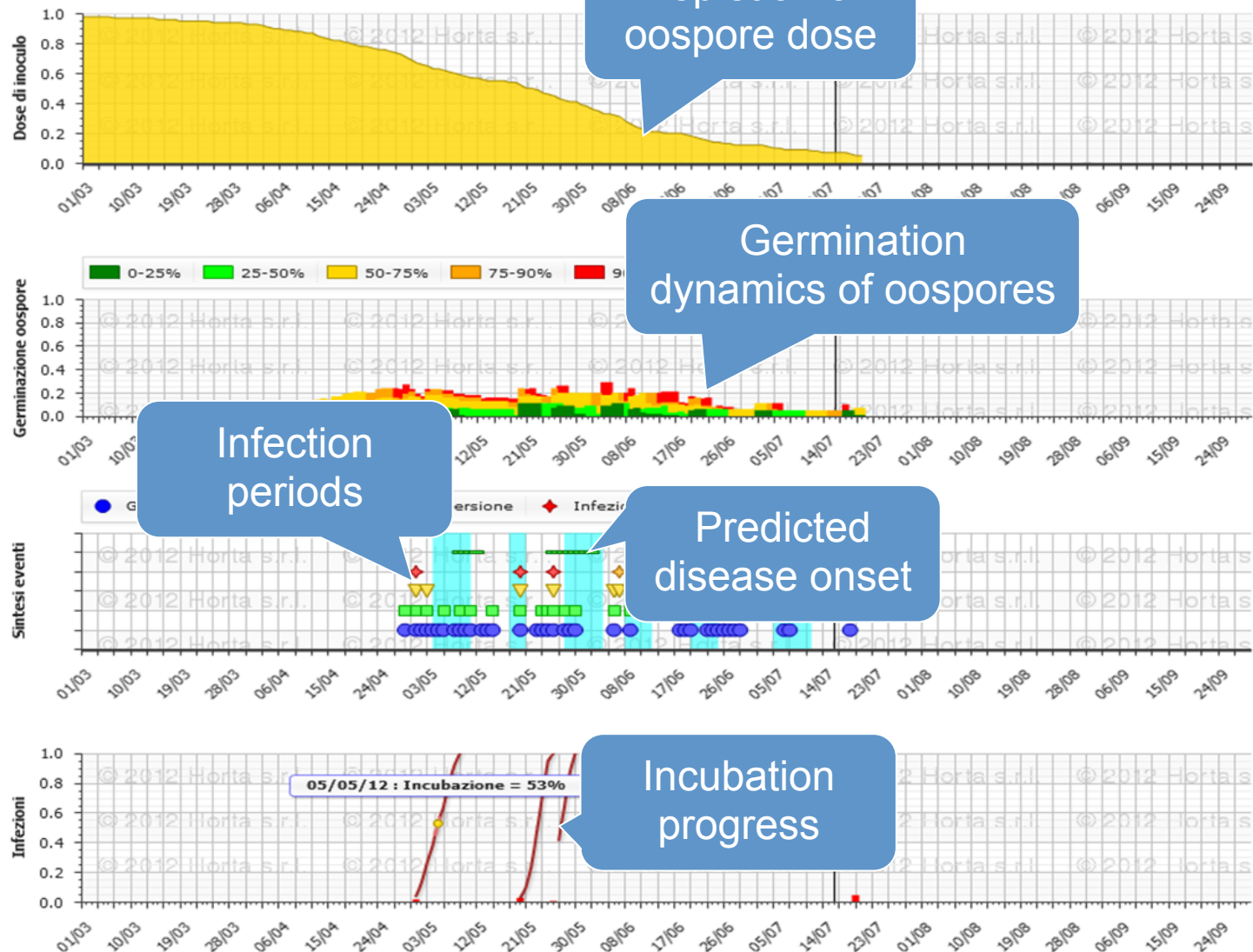


## Model output





## Model output





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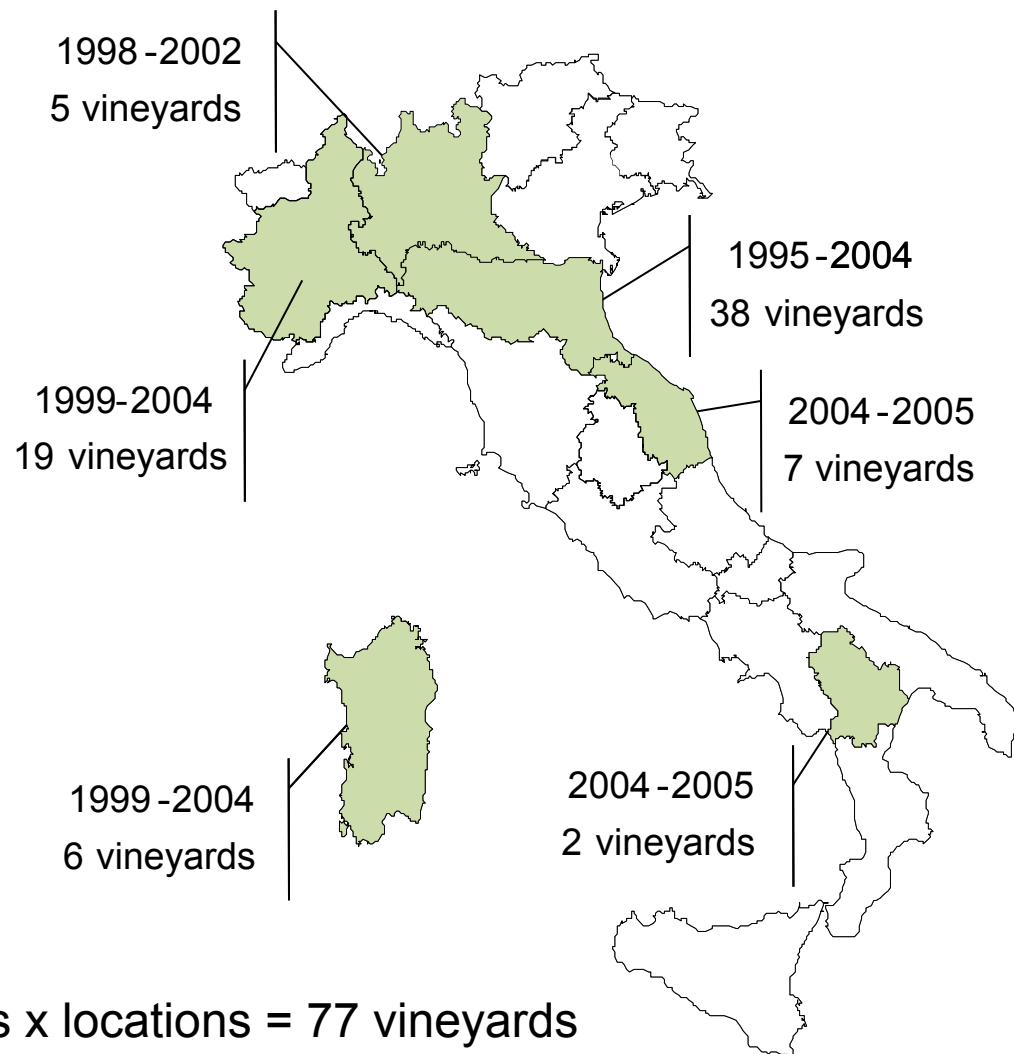
## Validation vs real data

Infection

Predicted

Observed

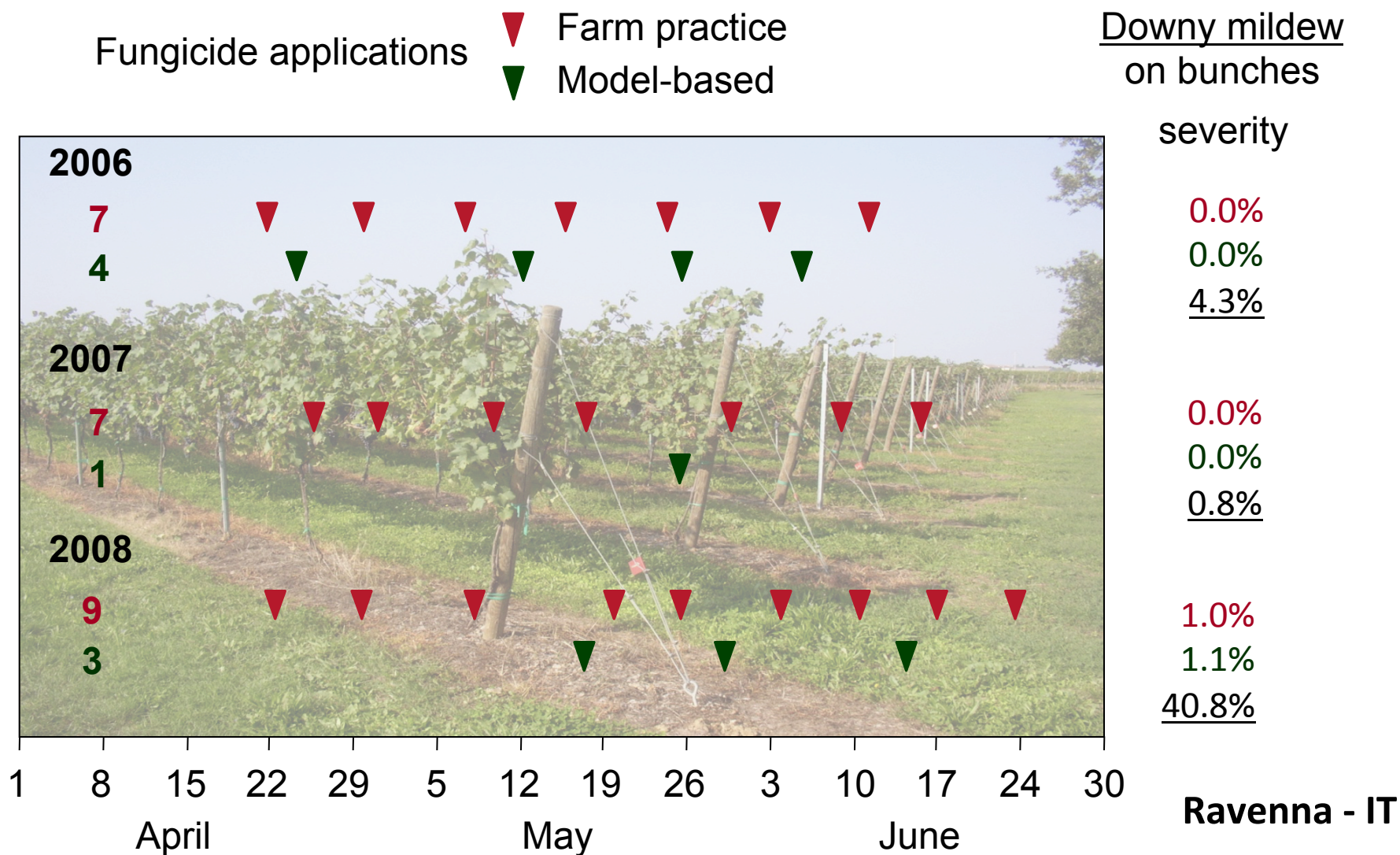
	Predicted	
	No	Yes
No	73%	10%
Yes	0%	17%





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## Evaluation of utility





# Multiple modeling approach

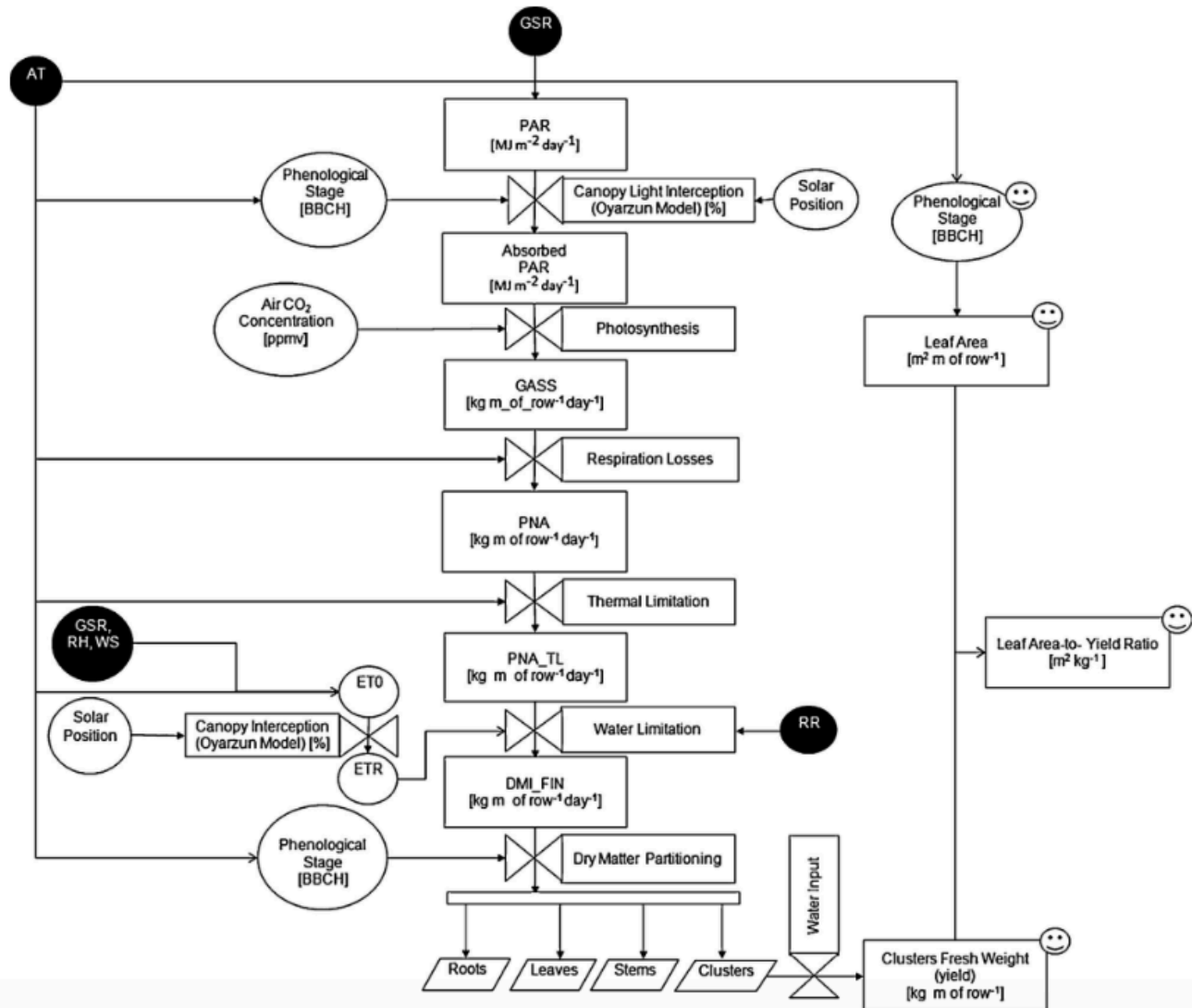
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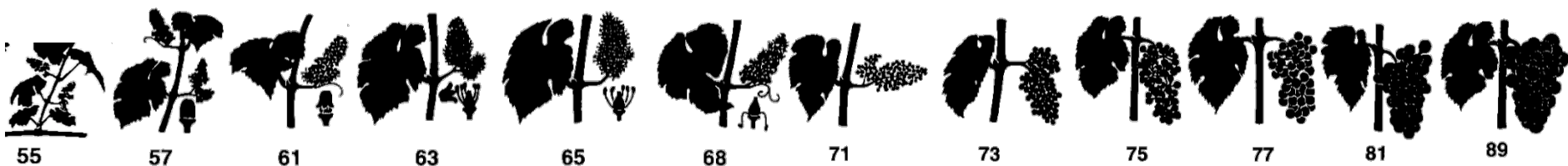
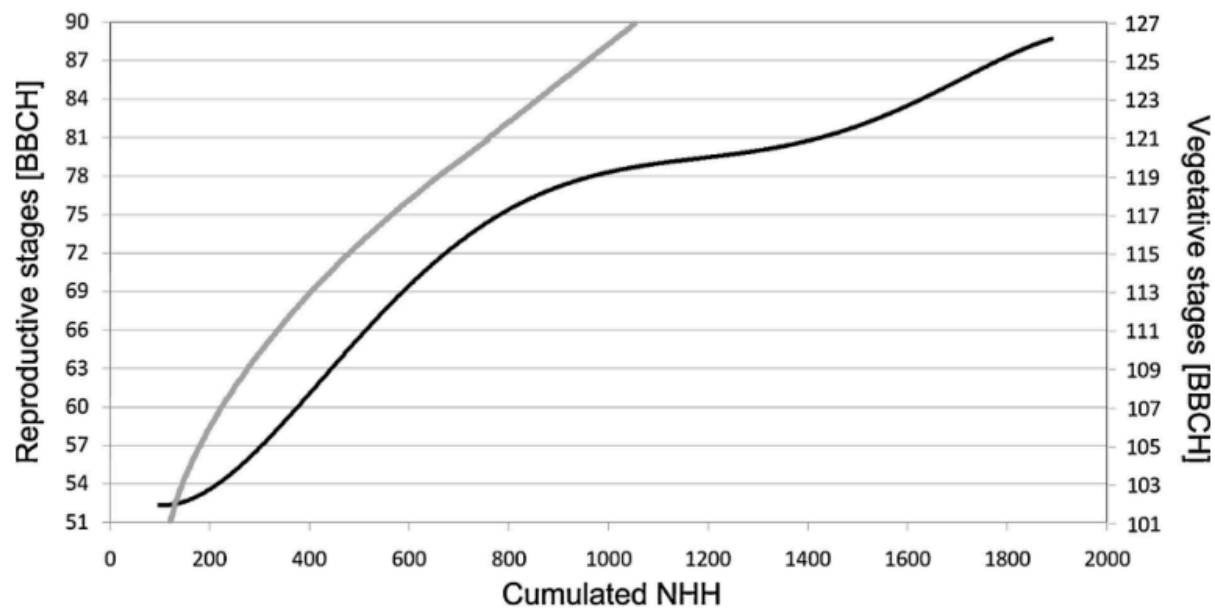
## Crop growth models





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## Crop growth models







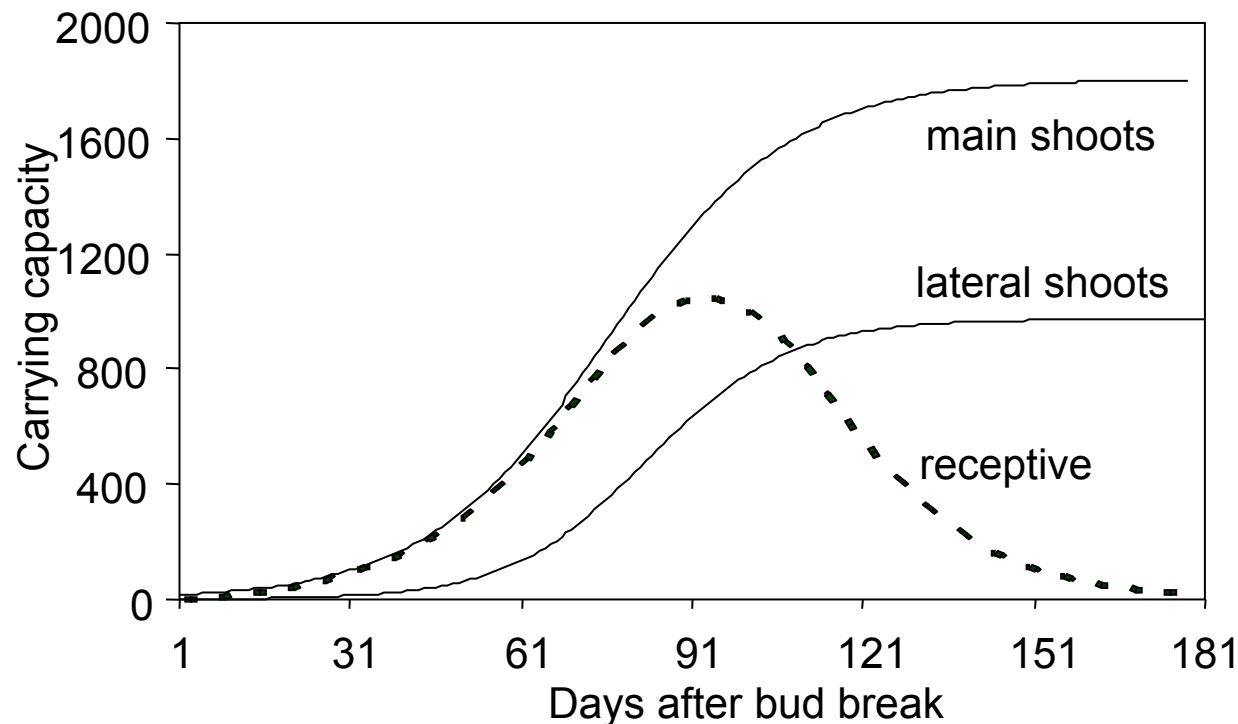
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## Crop growth models

Carrying capacity =  $(LAI * 10000) / LS$  = max n of lesions a plant (leaf) can hold

LAI = Leaf Area Index ( $m^2$  leaf /  $m^2$  soil)

LS = leaf area occupied by a lesion ( $cm^2$ )





### Multiple modeling approach

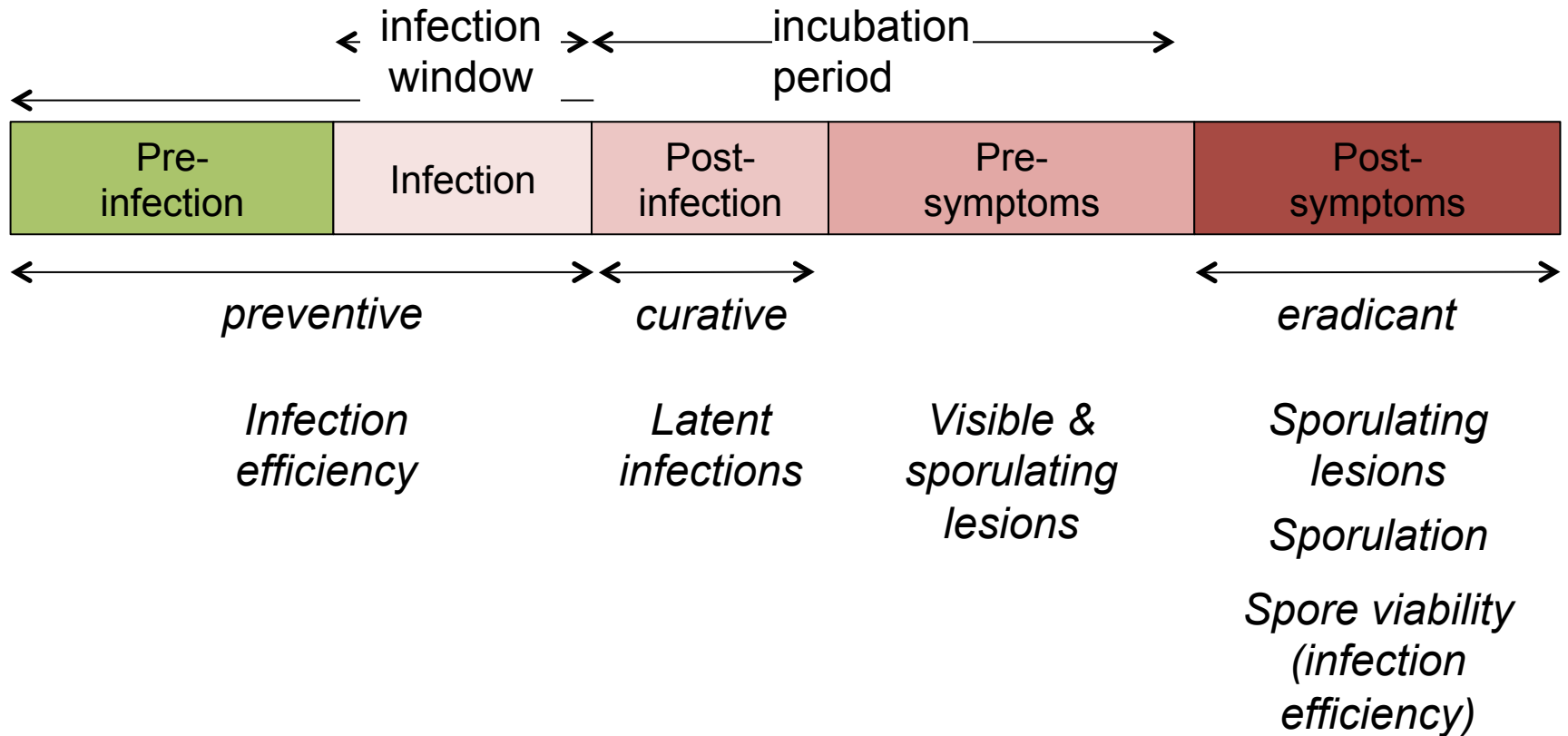
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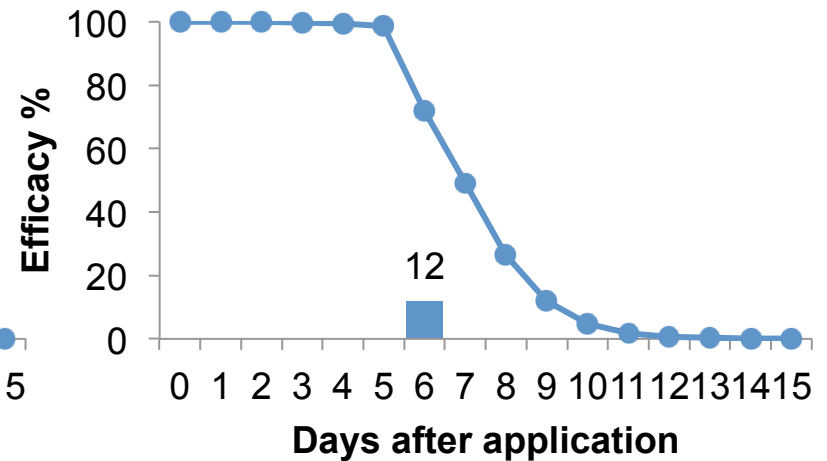
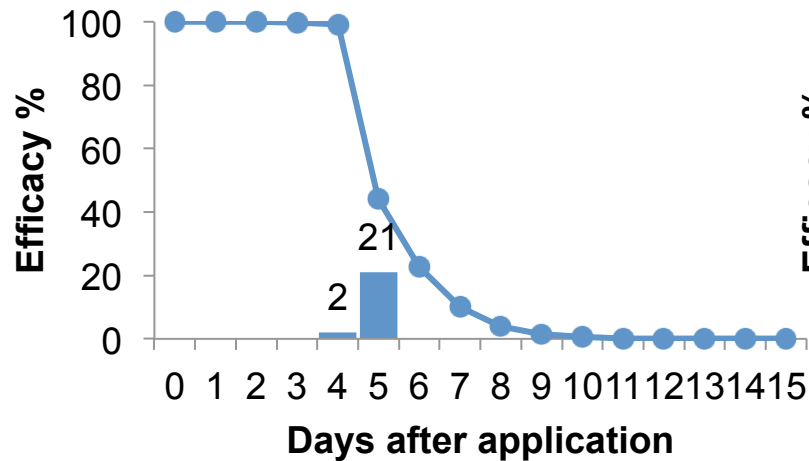
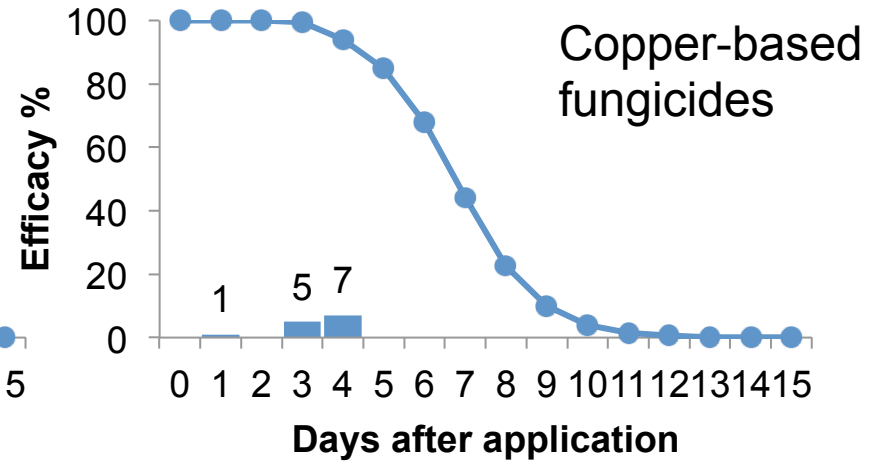
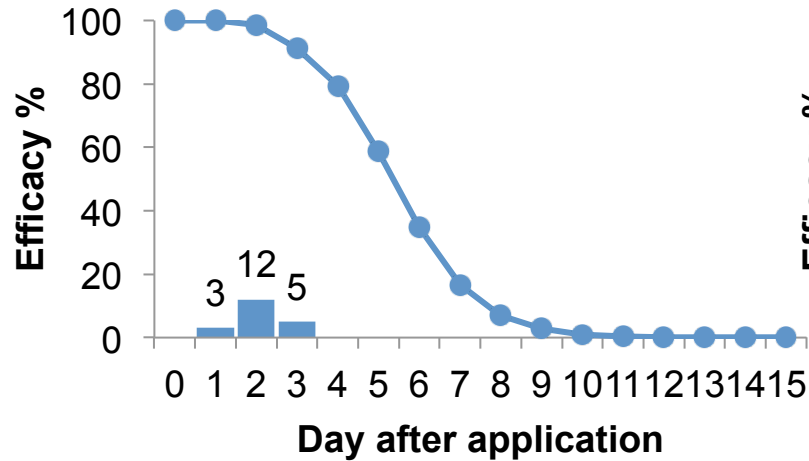
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## Fungicide models





## Fungicide model output





# Multiple modeling approach

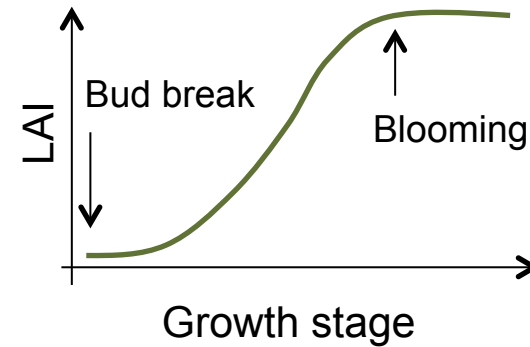
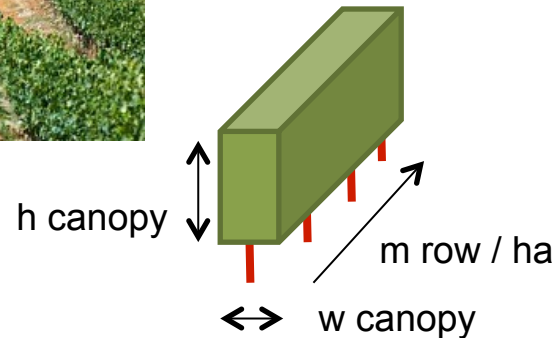
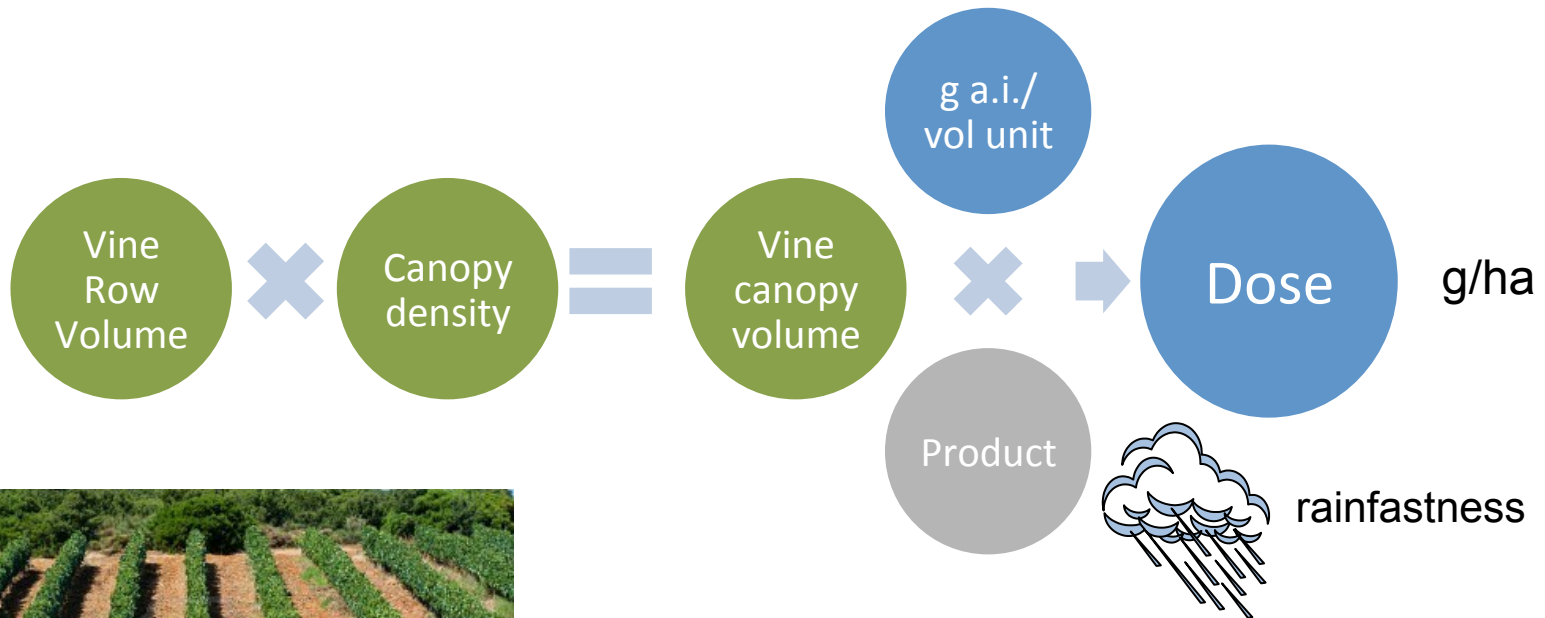
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## Dose calculation models





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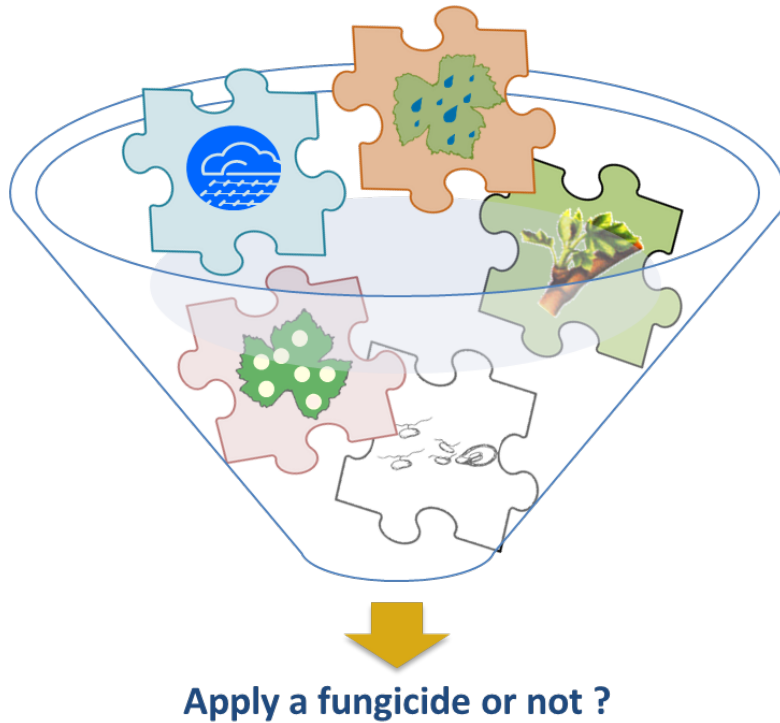




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## Multiple decision making

### Multi-criteria decision



weather forecasts  
decision-making  
bayesian analysis  
fungicide application  
sustainable viticulture  
plasmopara viticola  
vite.net  
infection efficacy  
sustainable use of pesticides  
fuzzy control rules  
grape downy mildew  
decision support systems  
phenology

Use fuzzy logic rules  
to reproduce the expert  
reasoning



## Fuzzy logic validation: grape downy mildew

Treatment (Fuzzy)			
		Yes	No
Treatment (Expert)	Yes	151	0
	No	21	2582

TPP = 1  
FPP = 0.008  
FNP = 0  
TNP = 0.992

J (Yuden index) = 0.985  
Overall accuracy = 0.992

Posterior probability that:

both the experts and the fuzzy recommend a treatment = 0.878

neither the experts nor the fuzzy recommended a treatment = 1

the experts do not recommend a treatment but the fuzzy does = 0.122

the experts recommend a treatment but the fuzzy does not < 0.0001



# Multiple modeling approach

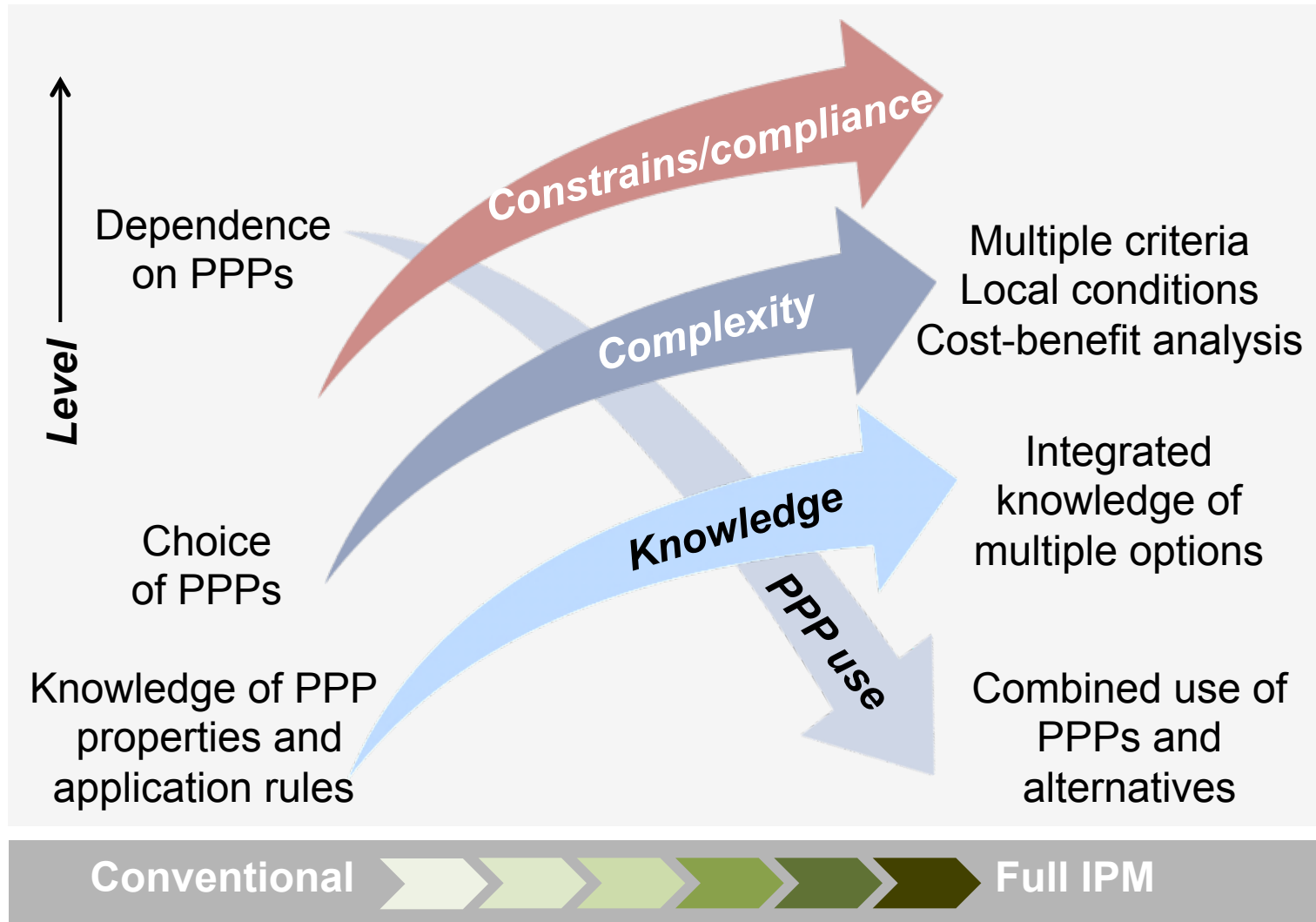
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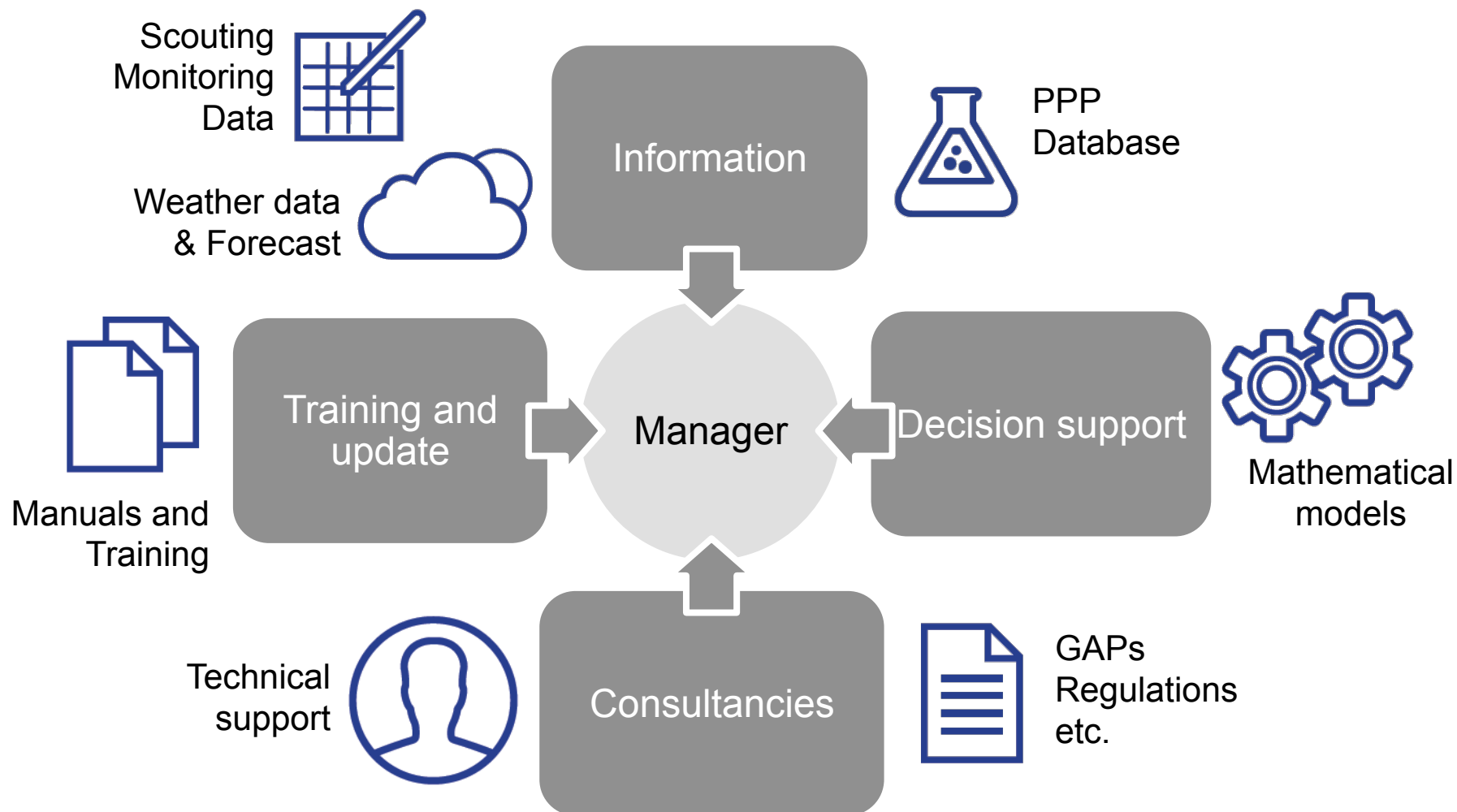
## Complexity in IPM





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## Sustainable viticulture: support





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## Sustainable viticulture: support

Scouting  
Monitoring  
Data



Weather data  
& Forecast



Information

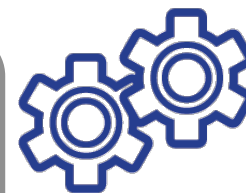


PPP  
Database

Training and  
update

Manager

Decision support



Mathematical  
models

Consultancies

GAPs  
Regulations  
etc.



Manuals and  
Training



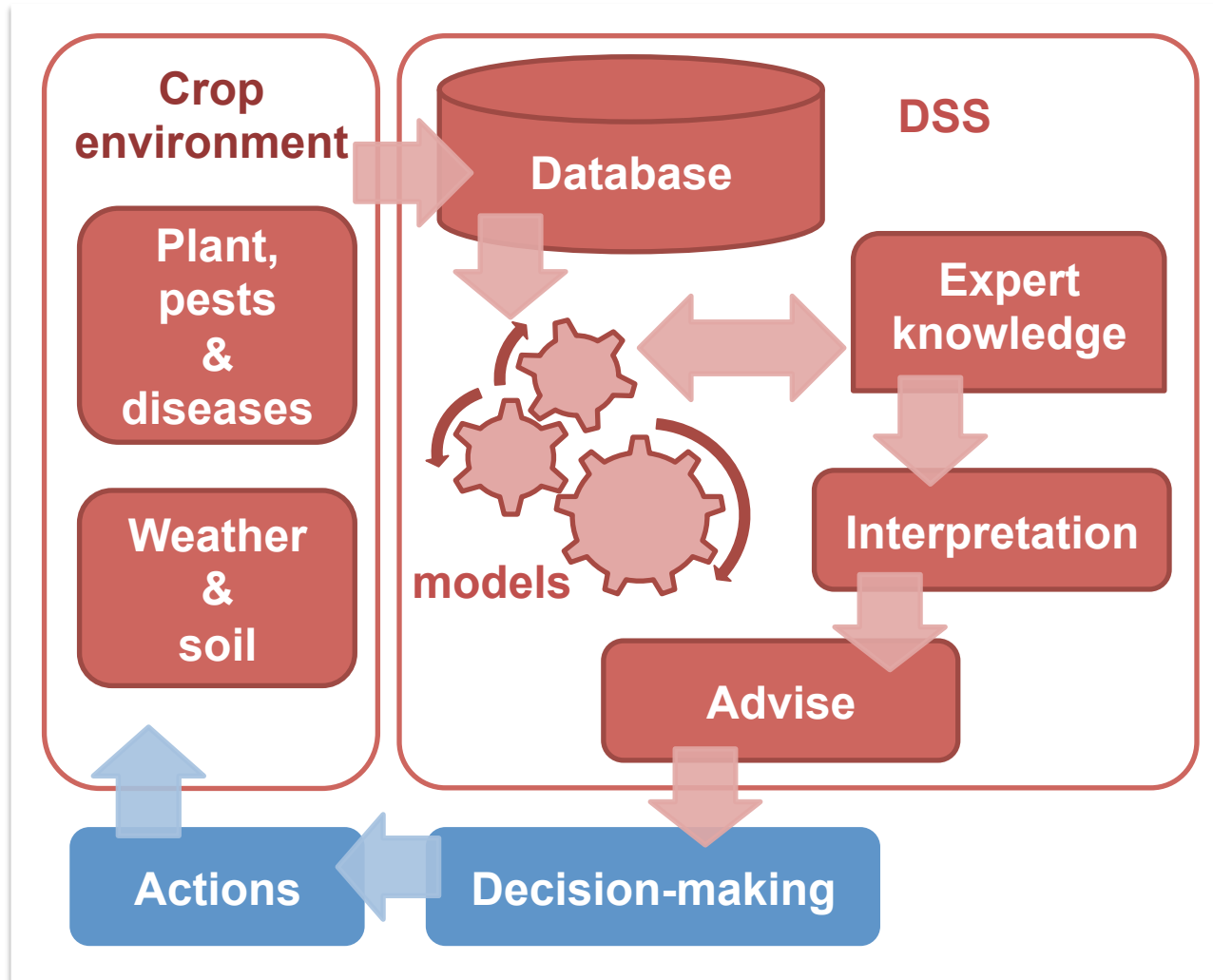
Technical  
support



**Decision support systems**



## Decision Support Systems







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DSSs



**Vite.net®**

**HORT@**  
— From research to field —



Epicure PTO



Wineo – remotely sensed images for precision viticulture





**Thank you for your attention**