Potential impact of *Xylella fastidiosa* subsp. *pauca* in European olives: a bio-economic analysis

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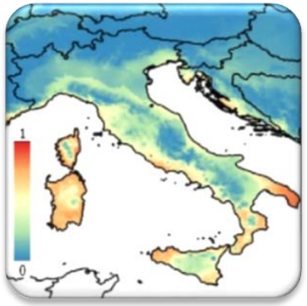
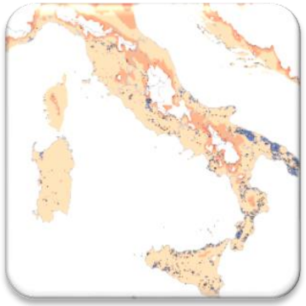
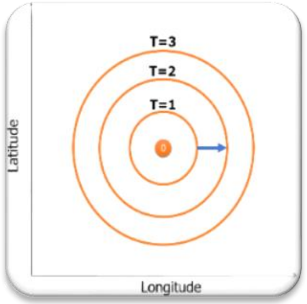
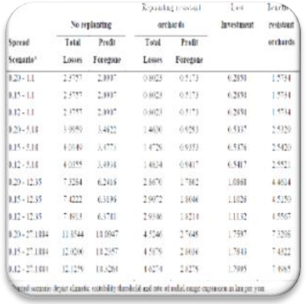
Objective









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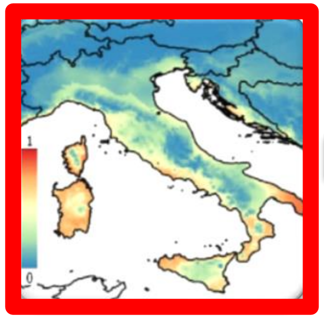
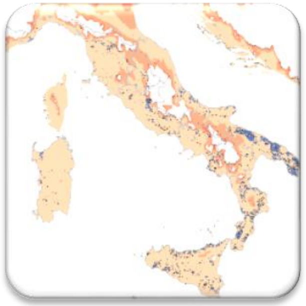
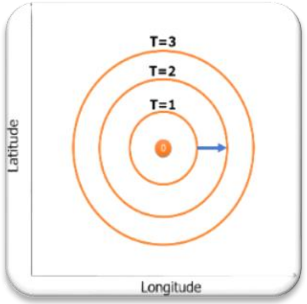
- The study aims to provide a first exploration of the potential direct economic impact of Xf on olive production in Europe

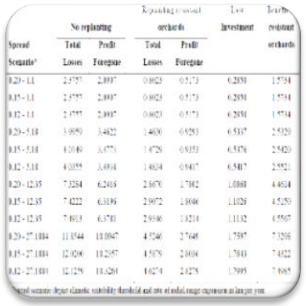
- Four steps:
  - Predict the climatic suitability for Xf in Europe
  - Convert the prediction to a binary map and include spatially explicit information on olive production sites
  - Simulate the potential spread of Xf (over 50 years)
  - Estimate the resulting economic impact of Xf

Climatic Suitability Map









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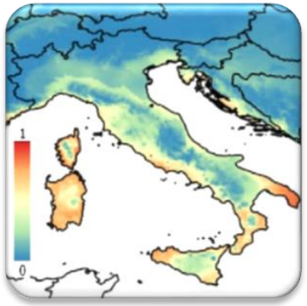
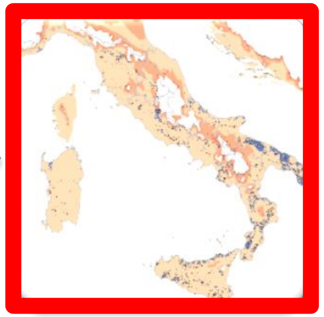
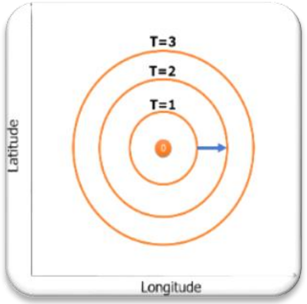
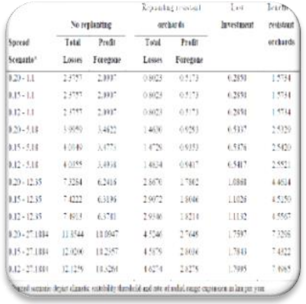
- Species Distribution Models (SDMs) to predict the area of potential establishment by finding statistical correlations between Xf's distribution and environmental factors
- Generate an ensemble prediction by combining results from multiple SDM type models weighted by their relative performance (EFSA PLH Panel, 2019)
- For this purpose the following data were used
  - Presence records of Xf from the host database (EFSA, 2018)
  - Local datasets on Xf outbreaks from national authorities
  - Records of Xf in Porto, Tuscany and Hula Valley (from EPPO)
  - Climate data for the period 1979-2013 (Karger et al. 2017)

Binary Suitability Map









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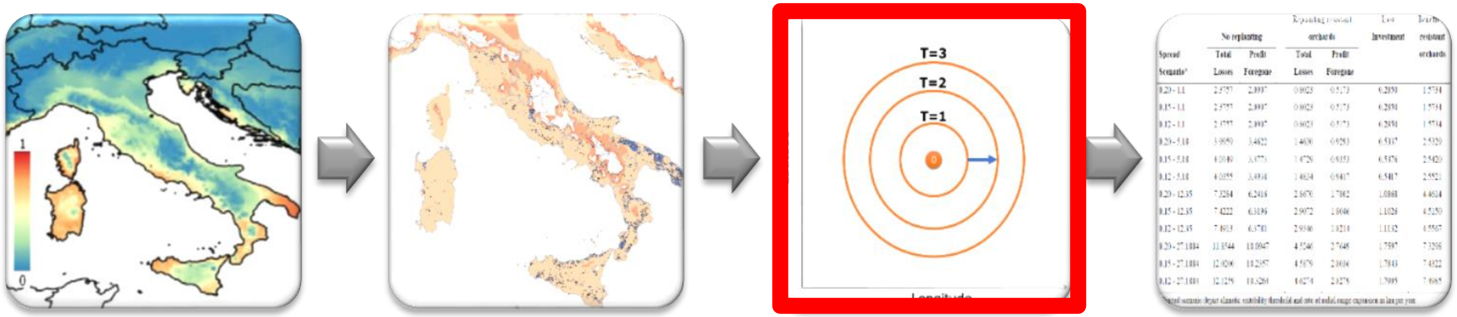
- Convert the continuous score into a binary prediction (suitable or not-suitable) using different thresholds (EFSA PLH Panel, 2019)
  - Predict all but 5% of Xf presence to be suitable
  - Maximize the sum of the accuracy of predicting occupied sites to be suitable and unoccupied sites to be unsuitable (i.e. sum of sensitivity and specificity)
  - Minimize the difference between the accuracy of predicting occupied sites to be suitable and unoccupied sites to be unsuitable (i.e. minimum difference between sensitivity and specificity)

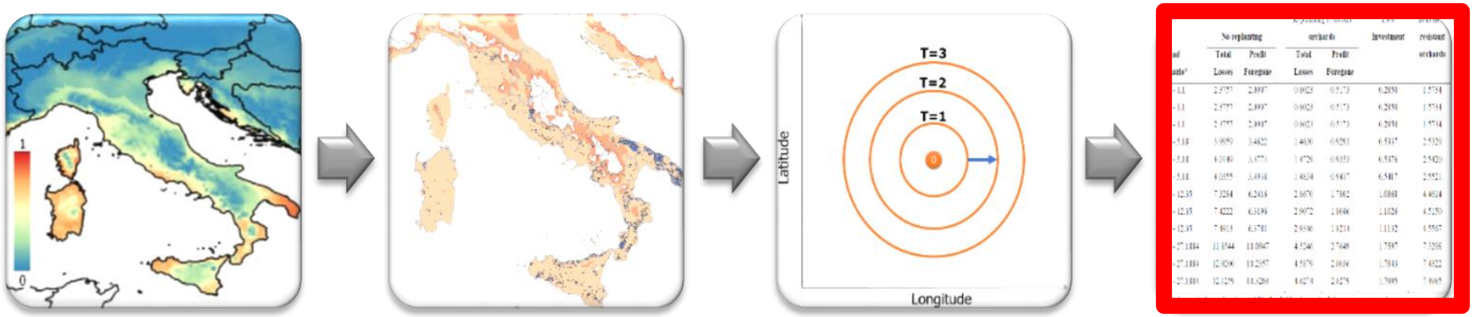
- Spatially explicit information on production sites from the CORINE land cover map

Spread Model



- We simulate spread following a radial range expansion
- The zone currently classified as infected is used as a starting zone
- We simulate spread beyond the current extent
- We make use of the by EFSA elicited distribution for the *mean distance of disease spread* (EFSA PLH Panel, 2019)
  - 5% quantile corresponds to 1.1 km per year
  - 50% quantile corresponds to 5.18 km per year
  - 95% quantile corresponds to 12.35 km per year

Economic Model



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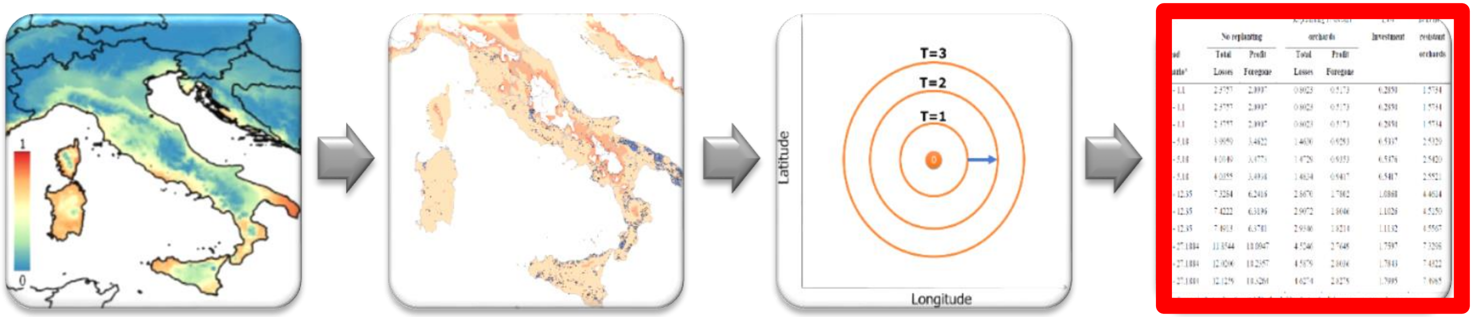
- Italy, Spain and Greece (around 95% of the European production)

- Six olive production systems
  - Rainfed-Traditional *(around 38 %)*
  - Irrigated-Traditional *(around 9.5 %)*
  - Rainfed-Intensive *(around 38 %)*
  - Irrigated-Intensive *(around 9.5 %)*
  - Rainfed-High-Density *(around 4 %)*
  - Irrigated-High-Density *(around 1 %)*

- The systems differ in terms of yields, operational costs, establishment costs, longevity, full-bearing age, etc.

Economic Model



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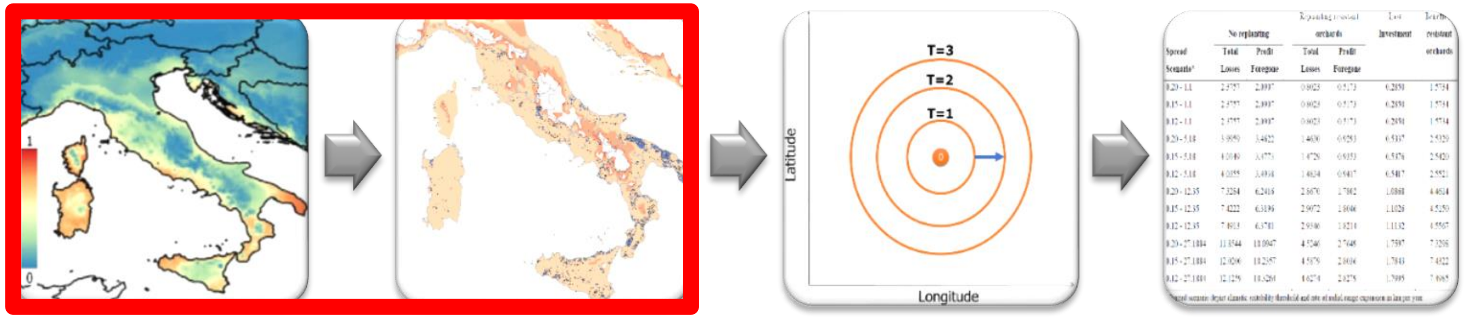
- Main direct economic impacts:
  - The yield (cost) of infected orchards decreases (increase) at a rate of 10% per year
  - Economic value of the orchard computed as the present value of lost annuities for the remaining life time (in case no infection had occurred)

- Damage determined for two scenarios:
  - No replanting after trees died off
  - Replanting with a resistant variety

- Total damage computed as ***total present value*** over a 50 year time horizon

Results



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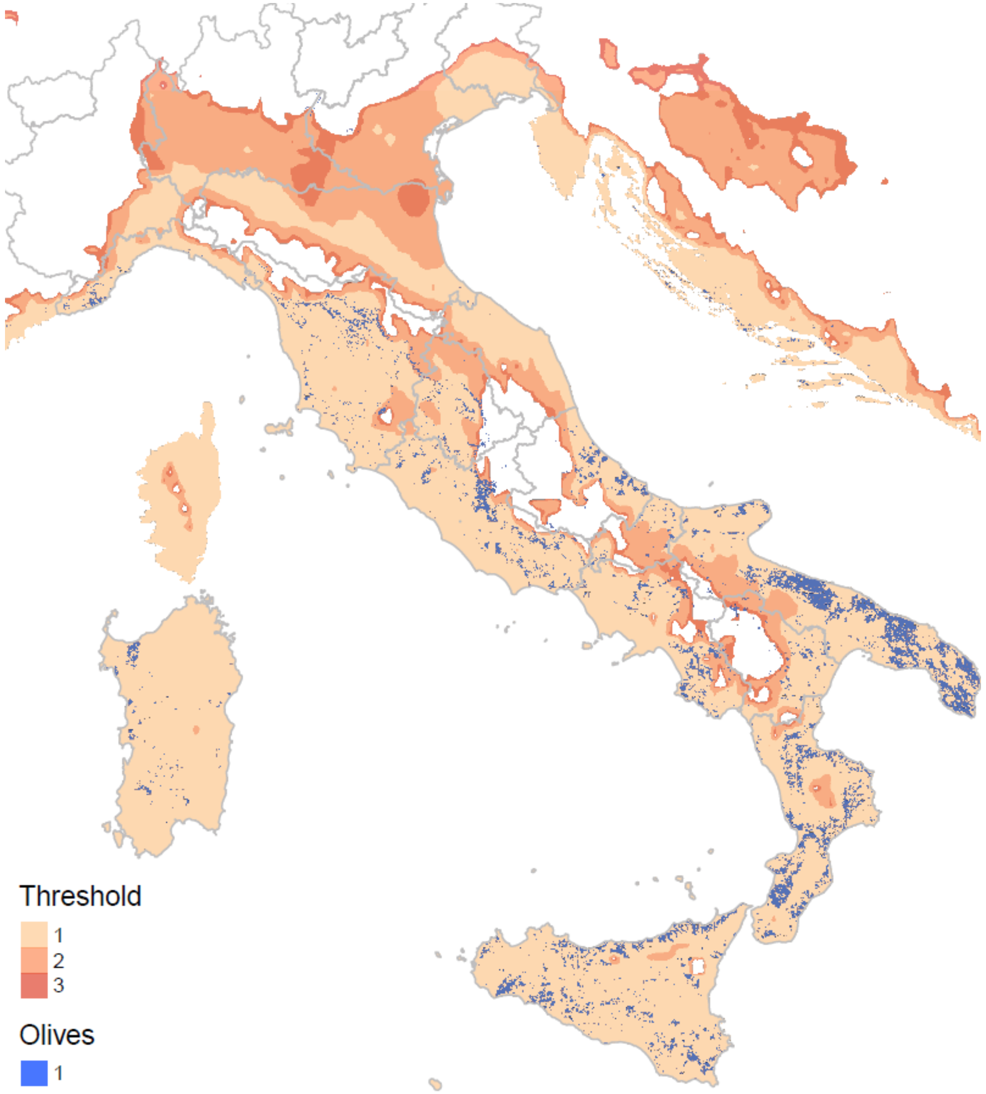
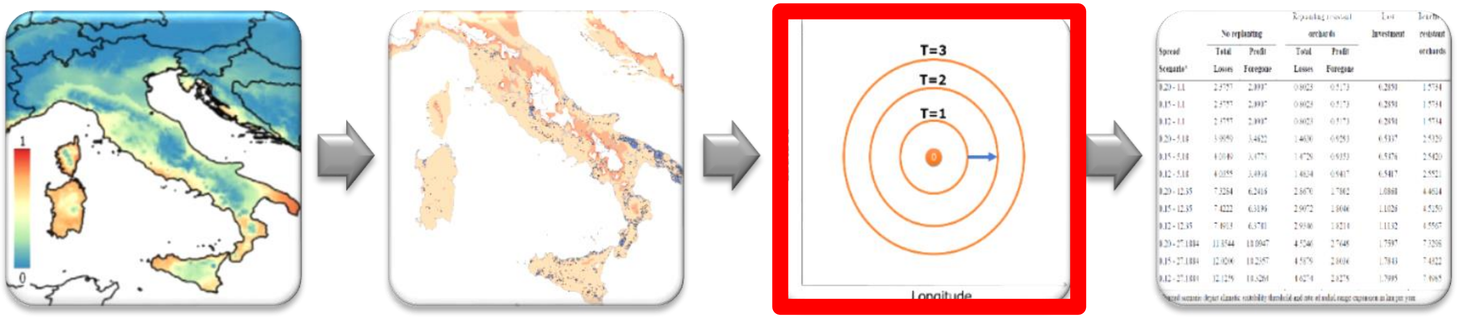
- The percent of the national production areas within suitable territory is not very sensitive to the chosen threshold
  - Italy between 92.5% to 95.4%
  - Greece between 88.6% to 89.5%
  - Spain between 85.8% to 98.5%



Results



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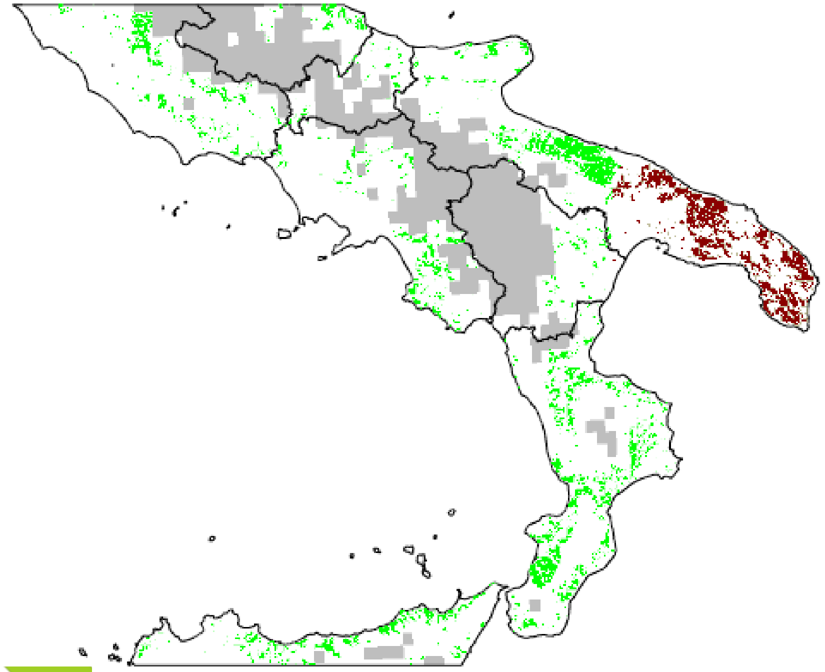
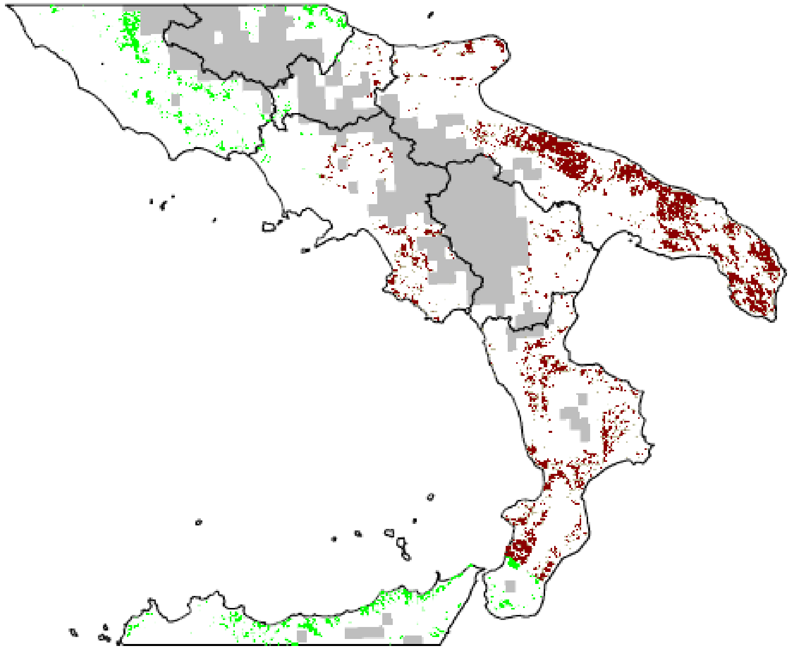
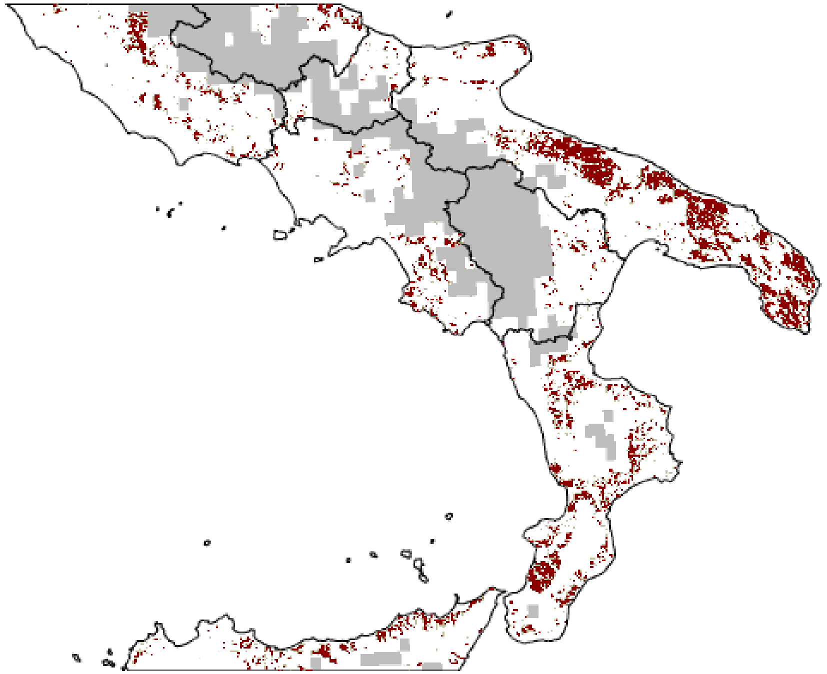
t=50, rr=1.1km



t=50, rr=5.18km

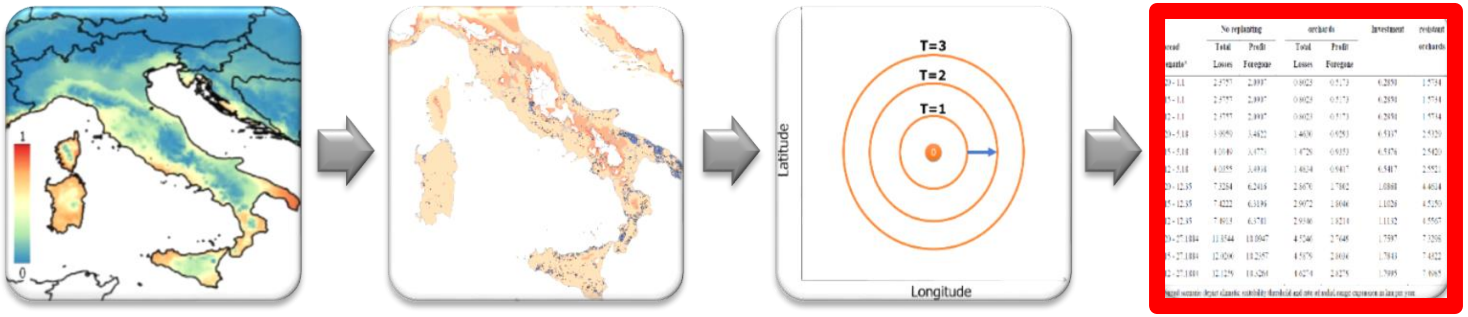


t=50, rr=12.35km



- The share of the Italian area of production infected is sensitive to the rate of radial expansion (19% to 88% of the Italian area of production invaded at t=50)

Results



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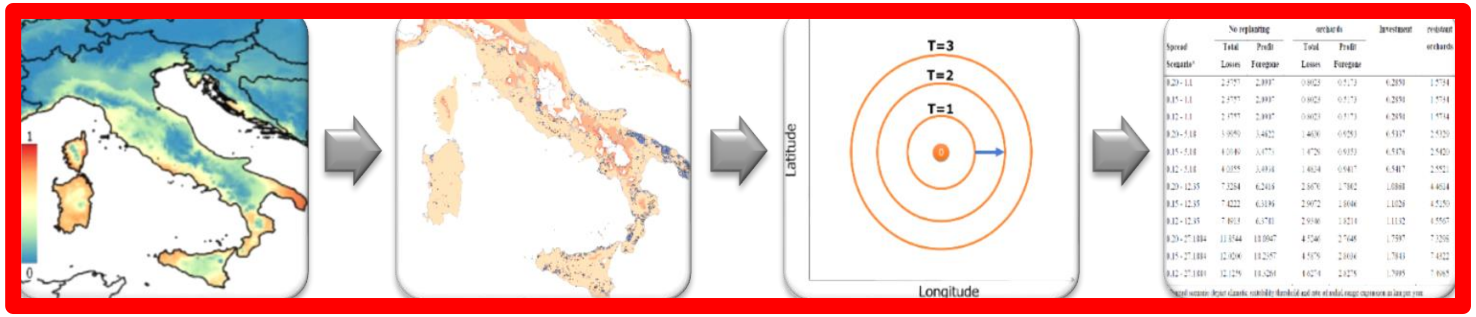
Potential direct economic impact over the course of 50 years in billion Euro

Rate of Radial Range Expansion	No replanting		Replanting resistant orchards		Lost Investment	Benefit of resistant orchards
	Total Impact	**Profit Foregone**	**Total Impact**	**Profit Foregone**		
1.1 km per year	2.38	2.09	0.80	0.52	0.29	1.58
5.18 km per year	4.02	3.48	1.47	0.94	0.54	2.55
12.35 km per year	7.42	6.32	2.91	1.81	1.10	4.51

Discussion



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- Impacts do not depend critically on the uncertainty about climatic limits

- Uncertainty in the rate of dispersal sensitively influences total impacts
  - Vector control and host removal to reduce rate
  - 5.18 km ⟹ 1.1 km savings of 0.67 to 1.64 bn Euro over 50 years

- Clear benefit of resistant orchards (potentially in the billions of Euro)

- Irrespective of the rate of expansion and despite our very conservative economic assumptions, impacts can be classified as *unacceptable*

- A European transition to a resistant/tolerant orchard population would require nurturing costs over several years that might require financial support

Conclusion

- We derive insights from modelling work on climatic suitability, potential spread and economics

- Irrespectively of the rate of dispersal and our economic scenarios, present value impacts over 50 years are sizable and warrant actions from regulators and the public

- The analysis indicates clear economic savings that could be secured if the spread rate is reduced and resistant varieties are breed

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Thank you for your attention

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