



OÉ Gaillimh
NUI Galway



RESEARCH PROGRAM ON
Climate Change,
Agriculture and
Food Security



Evolutionary Wheat Breeding in Italy: A Farmer-driven Climate Change Adaptation Strategy for Low-input and Organic Agriculture

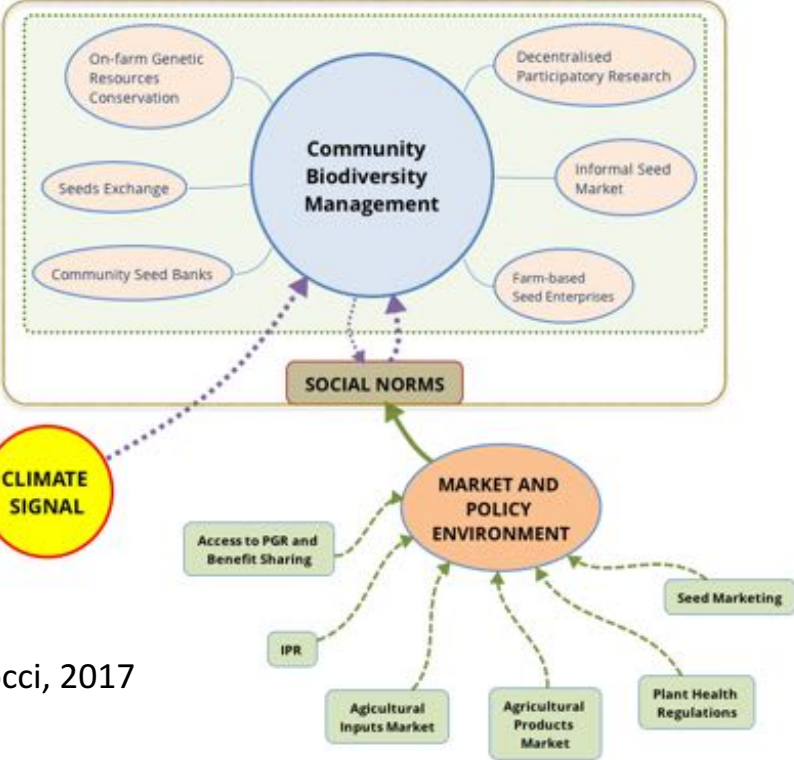


Matteo Petitti

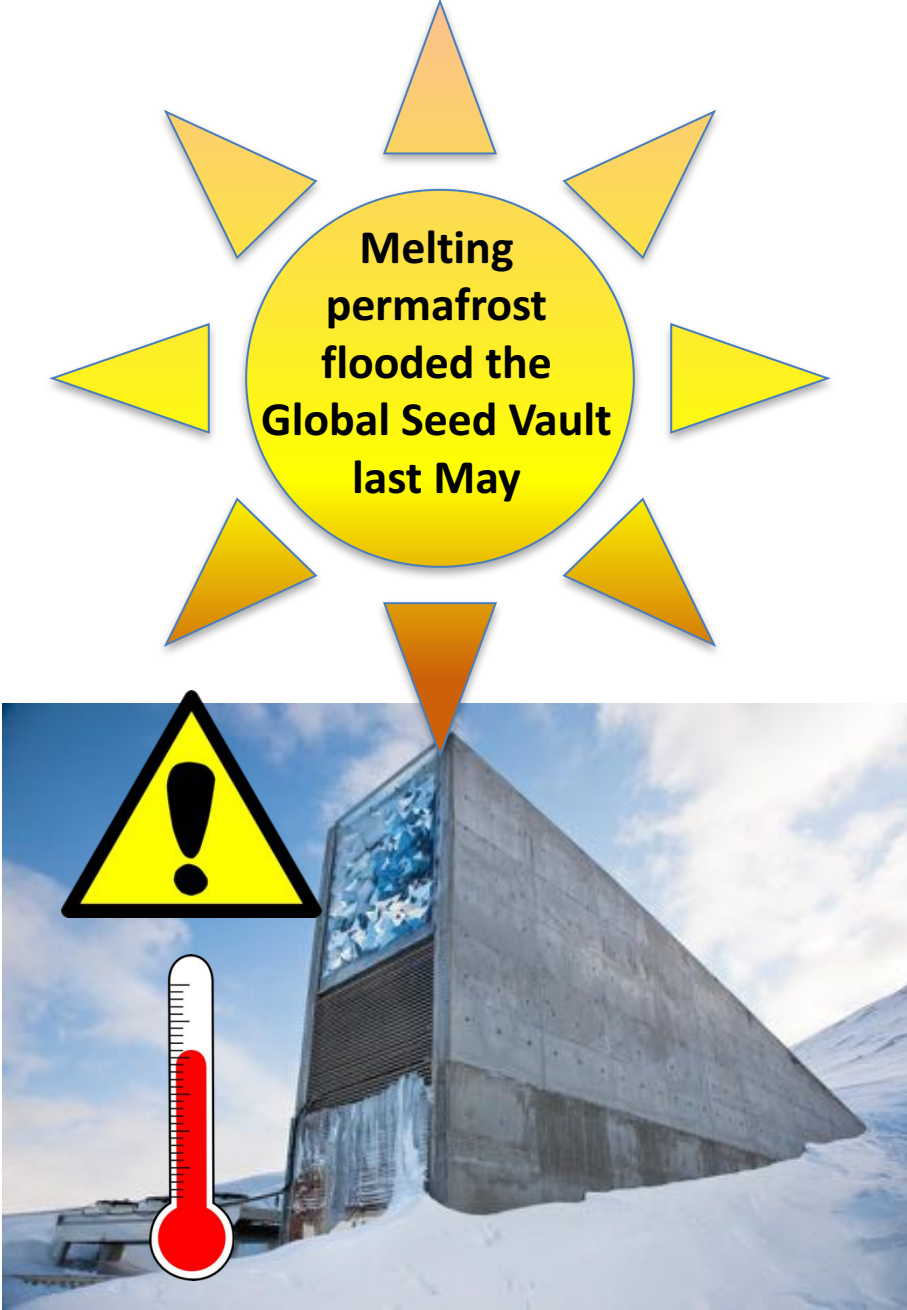
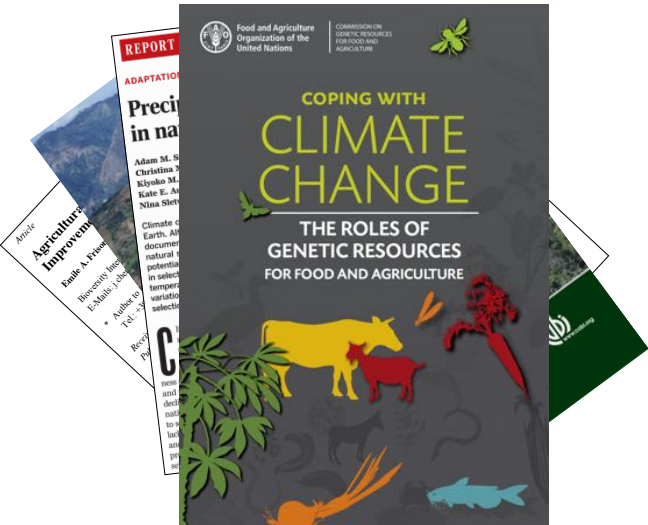
*Partner Institutions
PABC, NUI Galway
Rete Semi Rurali, Italy*



Biodiversity and Food Security in a Changing Climate



Bocci, 2017



Evolutionary Breeding, Biodiversity and Specific Adaptation



Harry Harlan - 1929

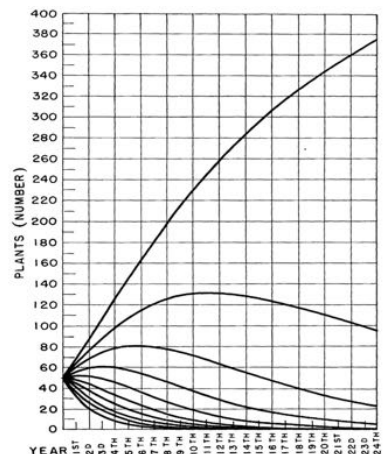


FIGURE 1.—Theoretical curves of natural selection based on an equal mixture of 10 varieties differing by 2 kernels each in their productivity per plant, the poorest plant producing 45 seeds.



2010 -2014



2015 -2018



Coit Suneson - 1956

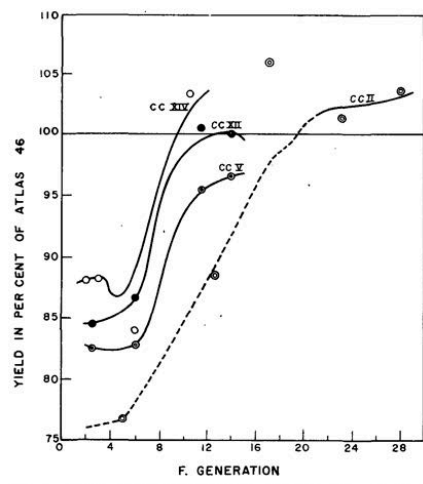


Fig. 1.—Yields of 4 composite crosses compared with each other and Atlas 46 in successive generations.

Participatory Approaches in Evolutionary Breeding



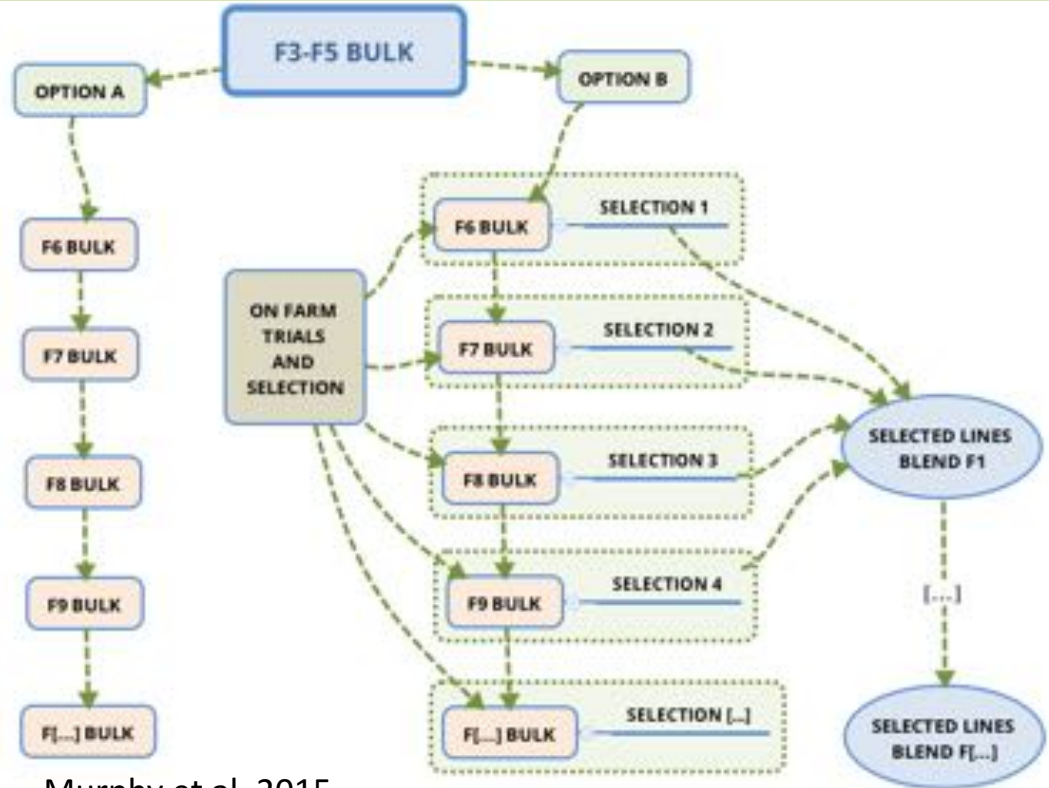
Plant breeding and farmer participation



Plant breeding with farmers

A technical manual

Salvatore Ceccarelli

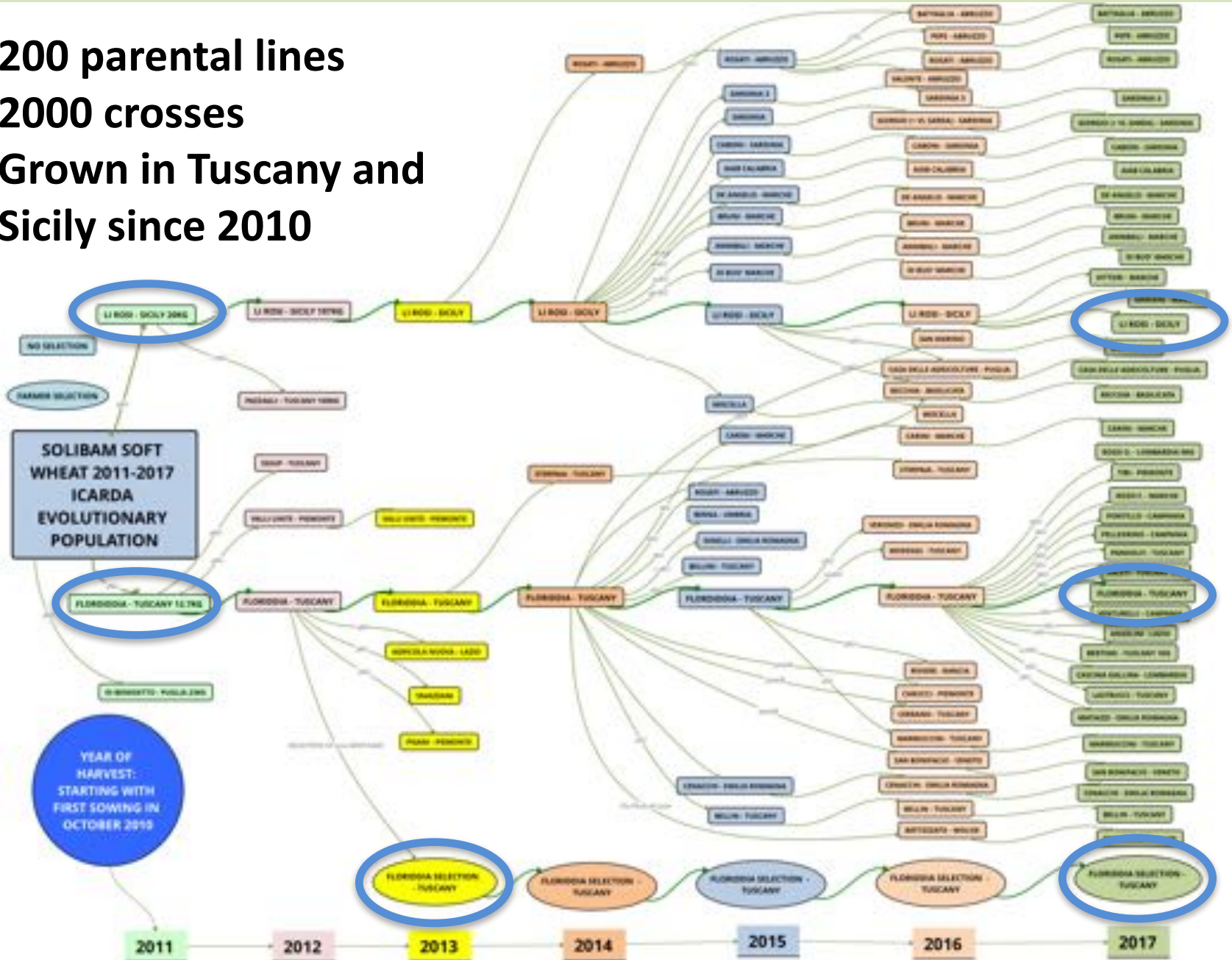


Murphy et al. 2015



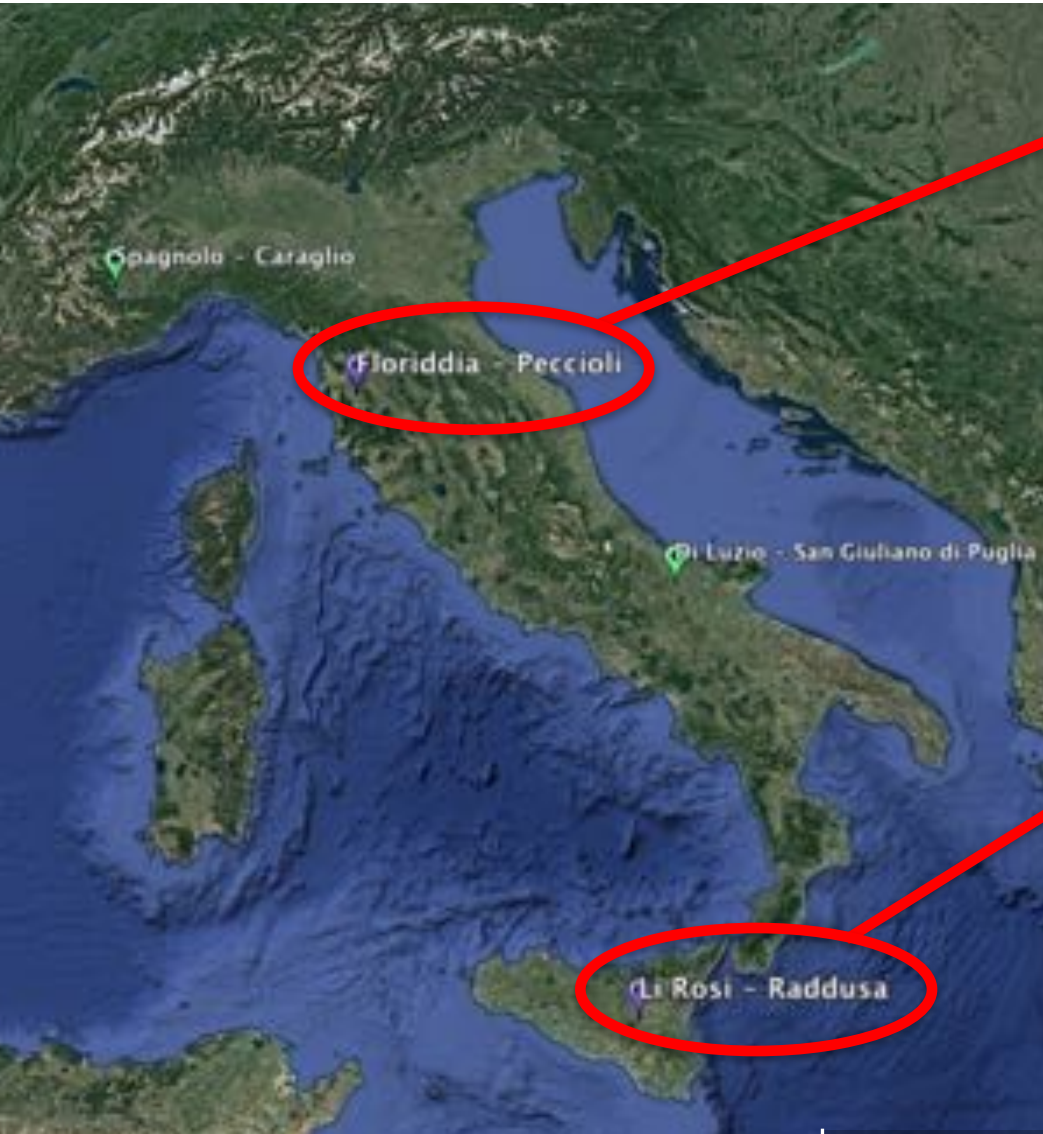
SOLIBAM Soft Wheat Evolutionary Population

- 200 parental lines
- 2000 crosses
- Grown in Tuscany and Sicily since 2010



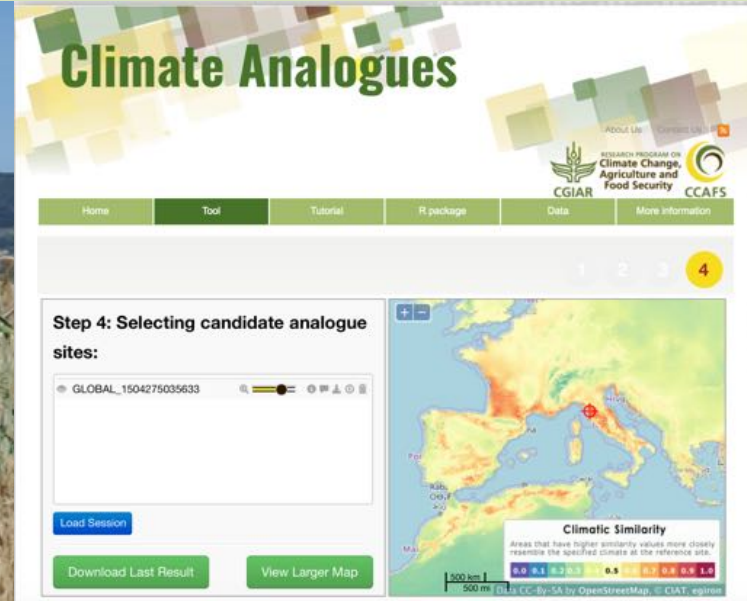
Research Goal

Assessing adaptation of same Evolutionary Population (EP)
to two different regions



Materials and Methods

- 14 entries
- 4 locations
- 3 years



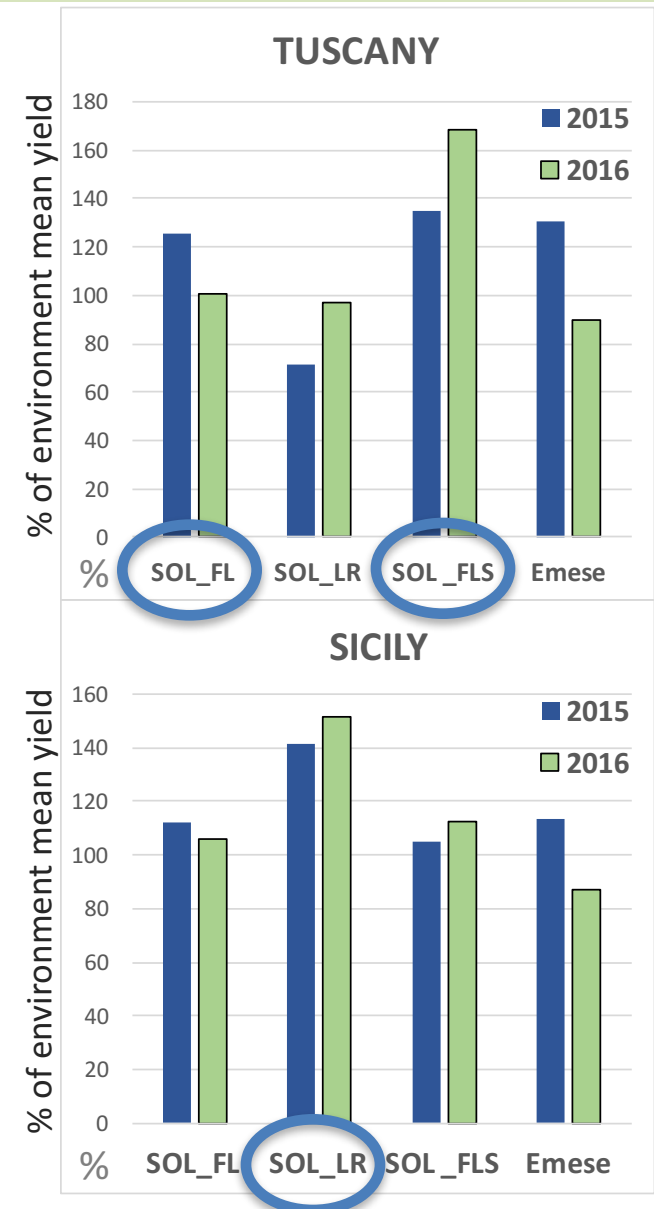


Results



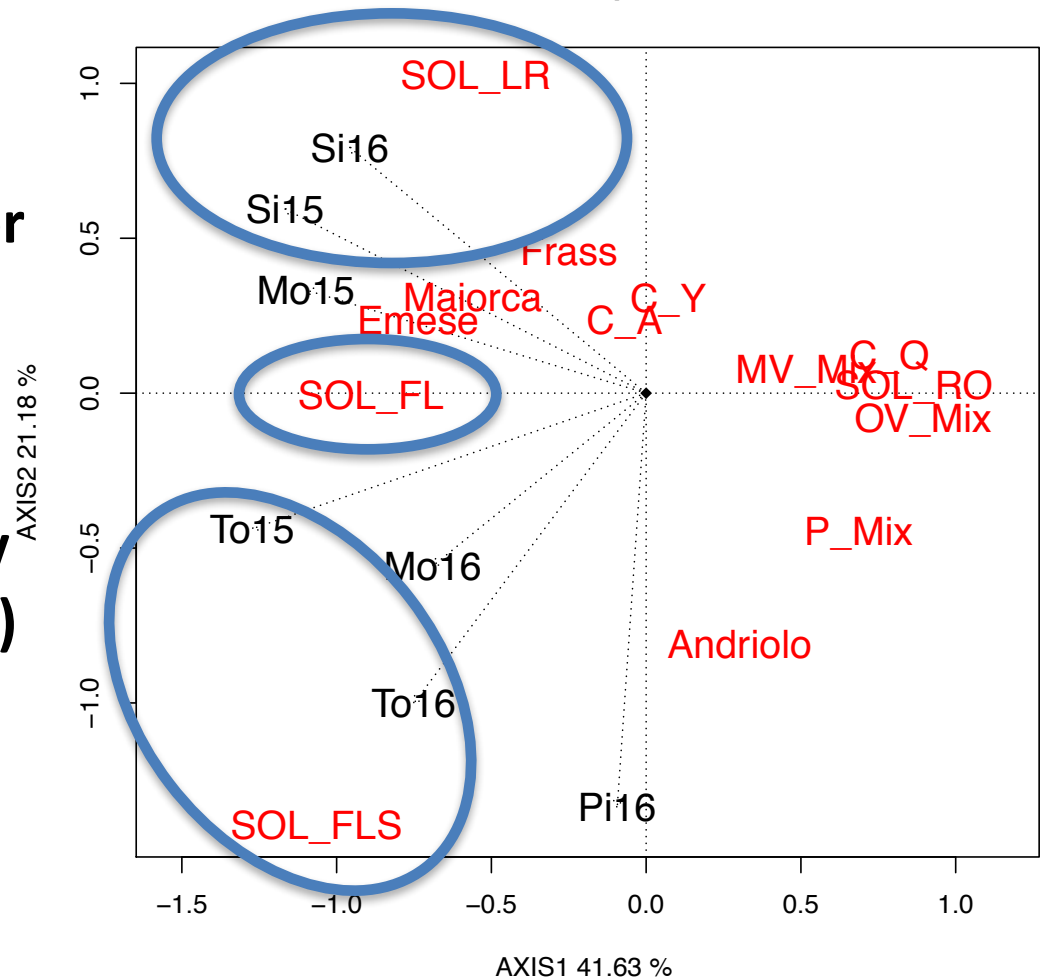
Relative Yield of SOLIBAM EPs

- Tuscan EP out-yielding Sicilian EP in Tuscany (SOL_FL) and showing comparable performance to modern variety control (Emese)
- Farmer selection of Tuscan EP best yielding entry in Tuscany in both years (SOL_FLS)
- Sicilian EP best yielding entry in Sicily in both years (SOL_LR)



Genotype by Environment Interactions

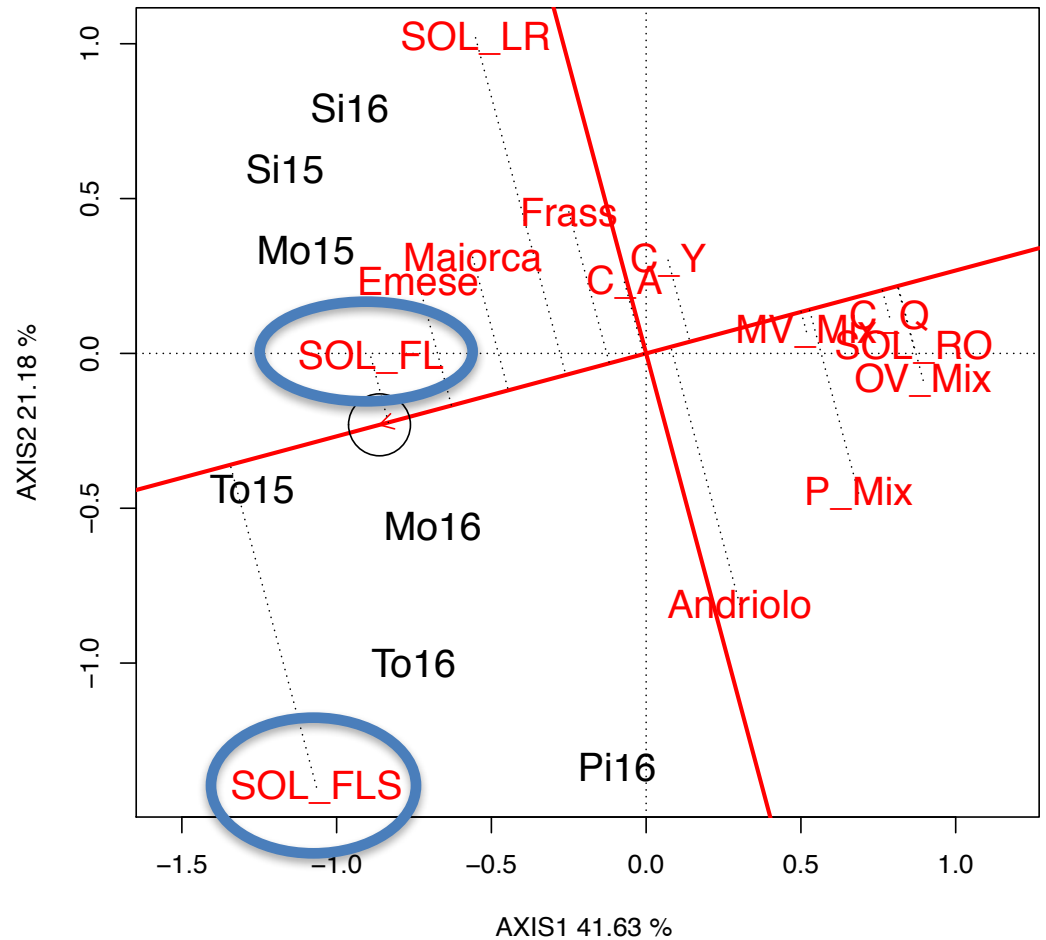
- Sicilian EP strongly associated with Sicily for both years (SOL_LR)
- Farmer selection of Tuscan EP strongly associated with Tuscany for both years (SOL_FLS)
- Tuscan EP (SOL_FL) positively correlated to all tested environments



GGE Biplot

Mean Yield and Stability

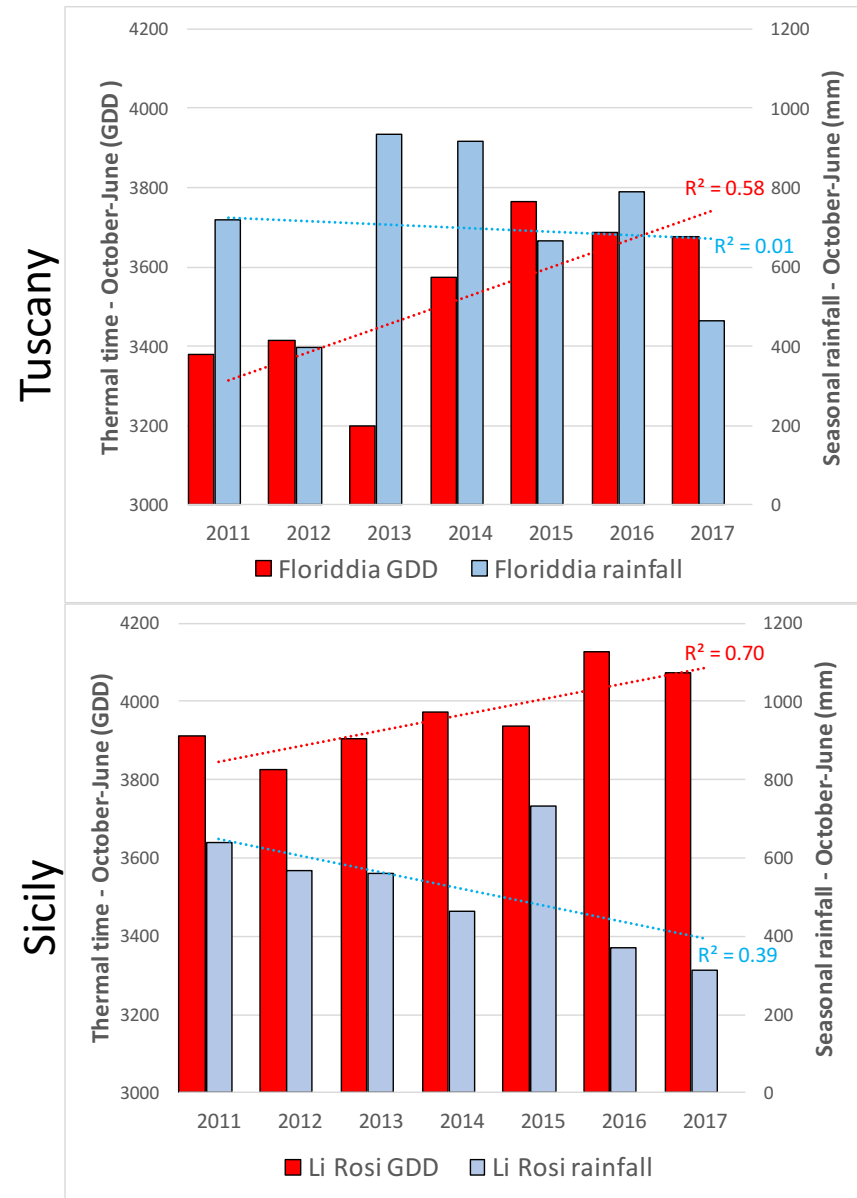
- Farmer selection of Tuscan EP (SOL_FLS) highest mean yield over all tested environments
- Tuscan EP (SOL_FL) highest stability amongst entries yielding above overall mean (all location x year)



GGE Biplot

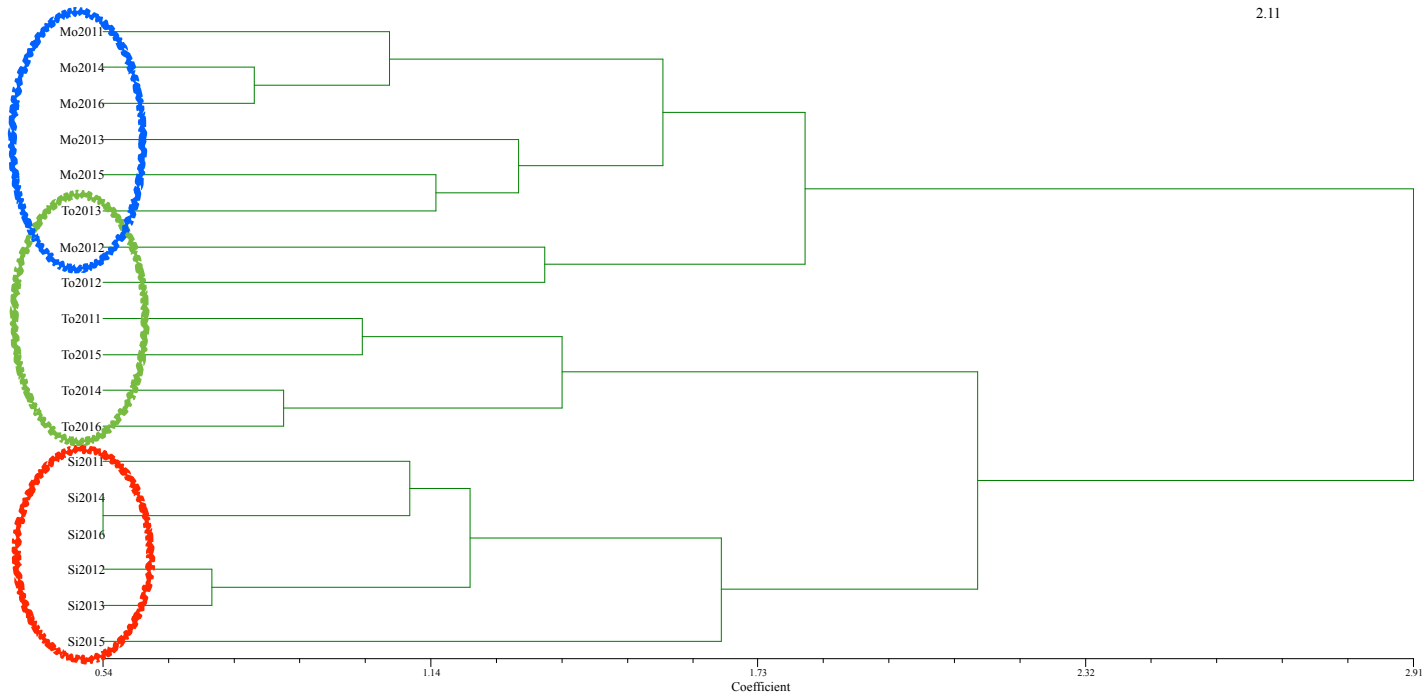
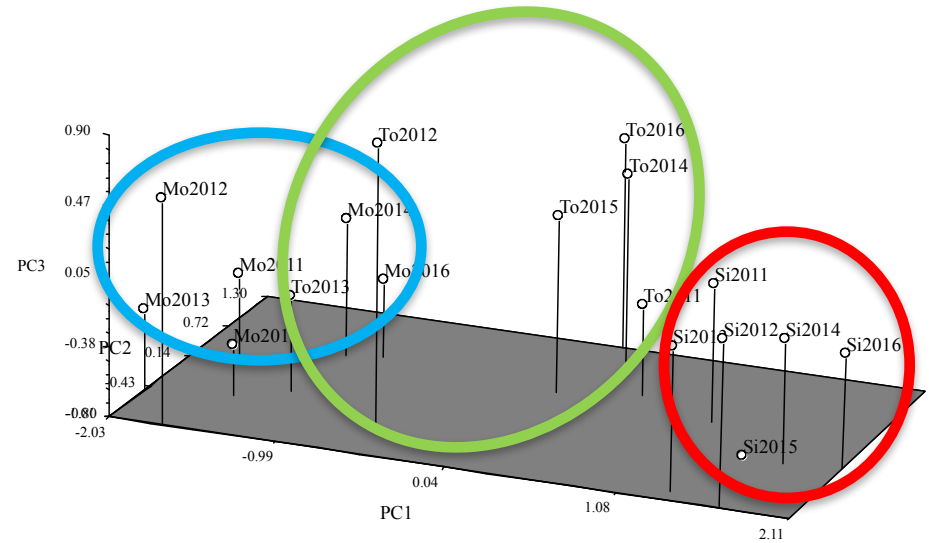
Meteorological Data Indicate Differences in Climatic Patterns (1)

- Thermal sum increased in both evolution sites
- Inter-annual rainfall variability observed in Tuscany
- Sicily's seasonal rainfall decreased steadily



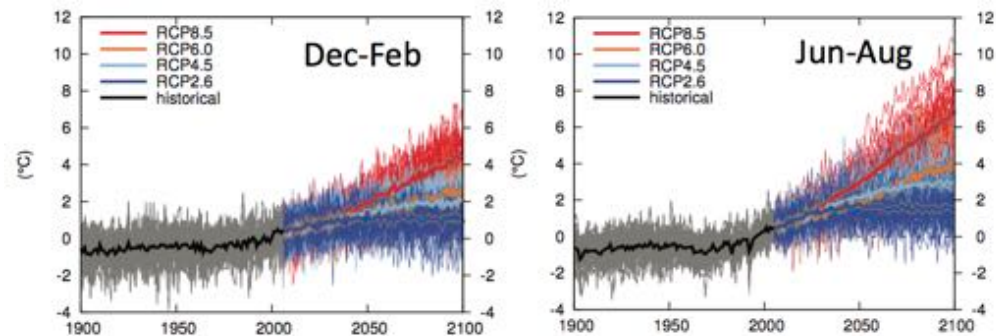
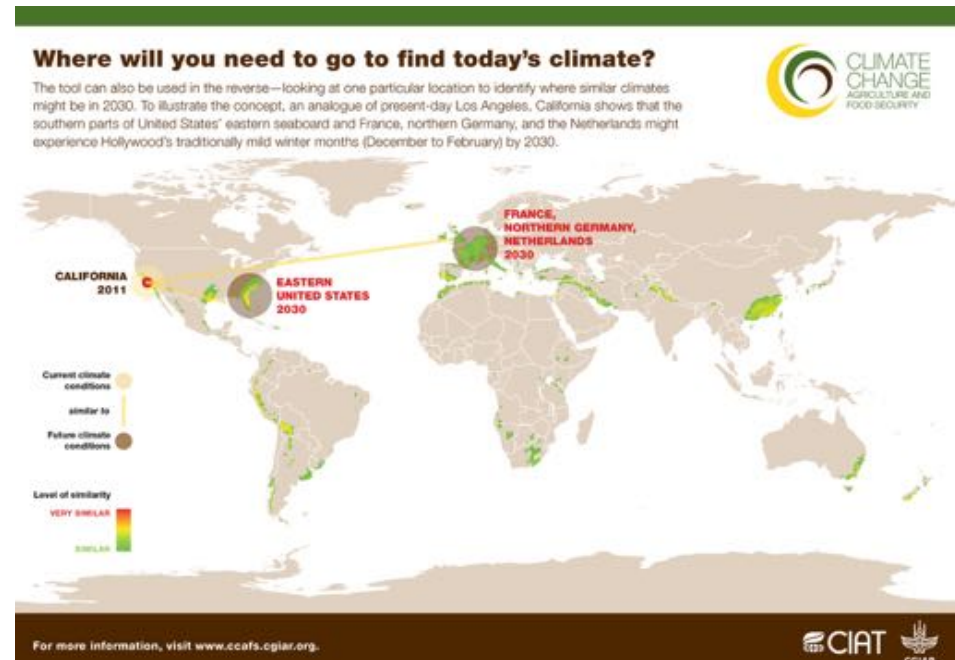
Meteorological Data Indicate Differences in Climatic Patterns (2)

- Multivariate PCA confirmed clear distinction between Tuscan and Sicilian climate

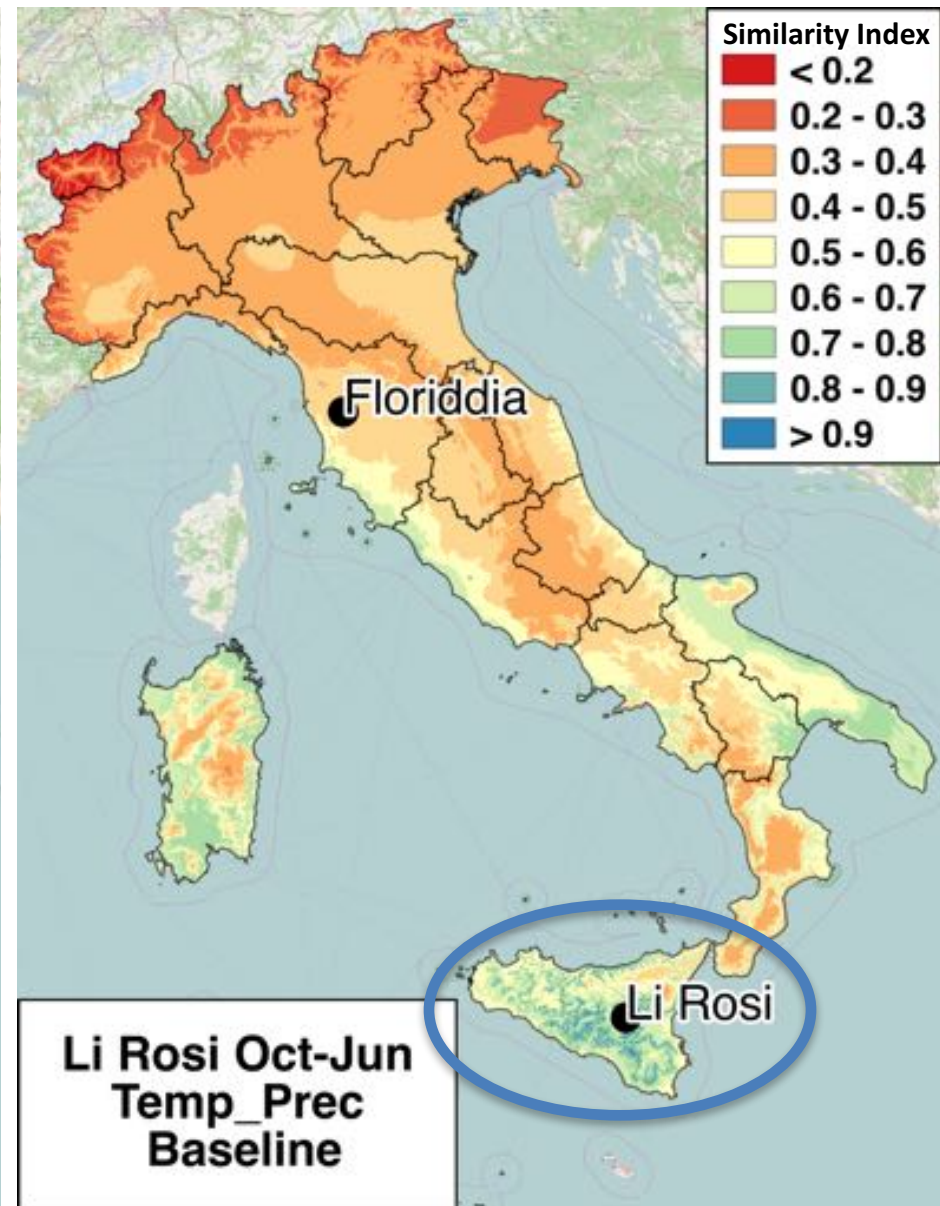
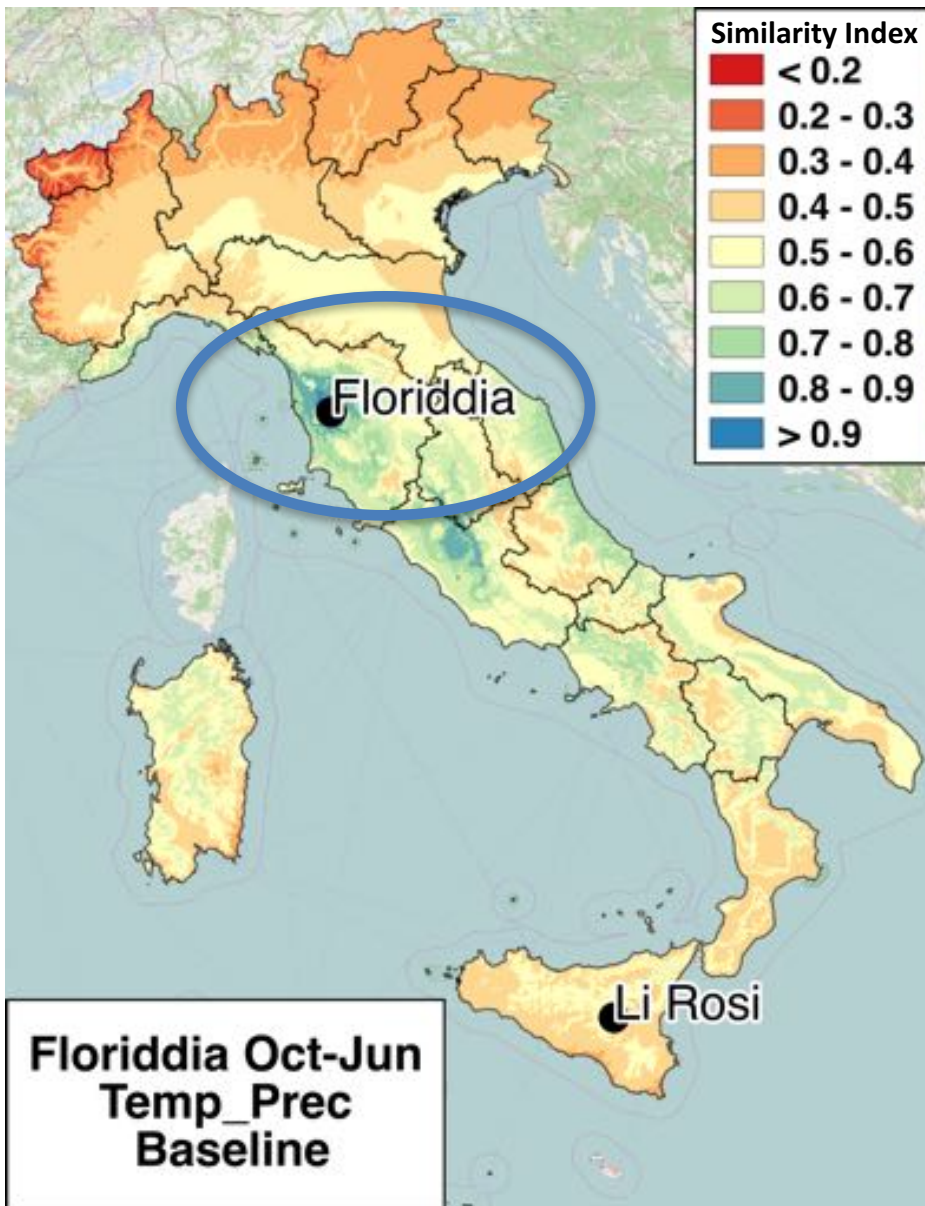


The Climate Analogues Approach

- Compares climates across different spatial and time scales (Brown & Katz 1995; Hallegatte 2007; Ramirez et al. 2011)
- Analogues Tool developed by CCAFS to anticipate climate changes and adapt agricultural systems accordingly
- Baseline:
 - WorldClim 1950-2000
- RCP 8.5 Scenario:
 - Models' Ensemble 2020-2050

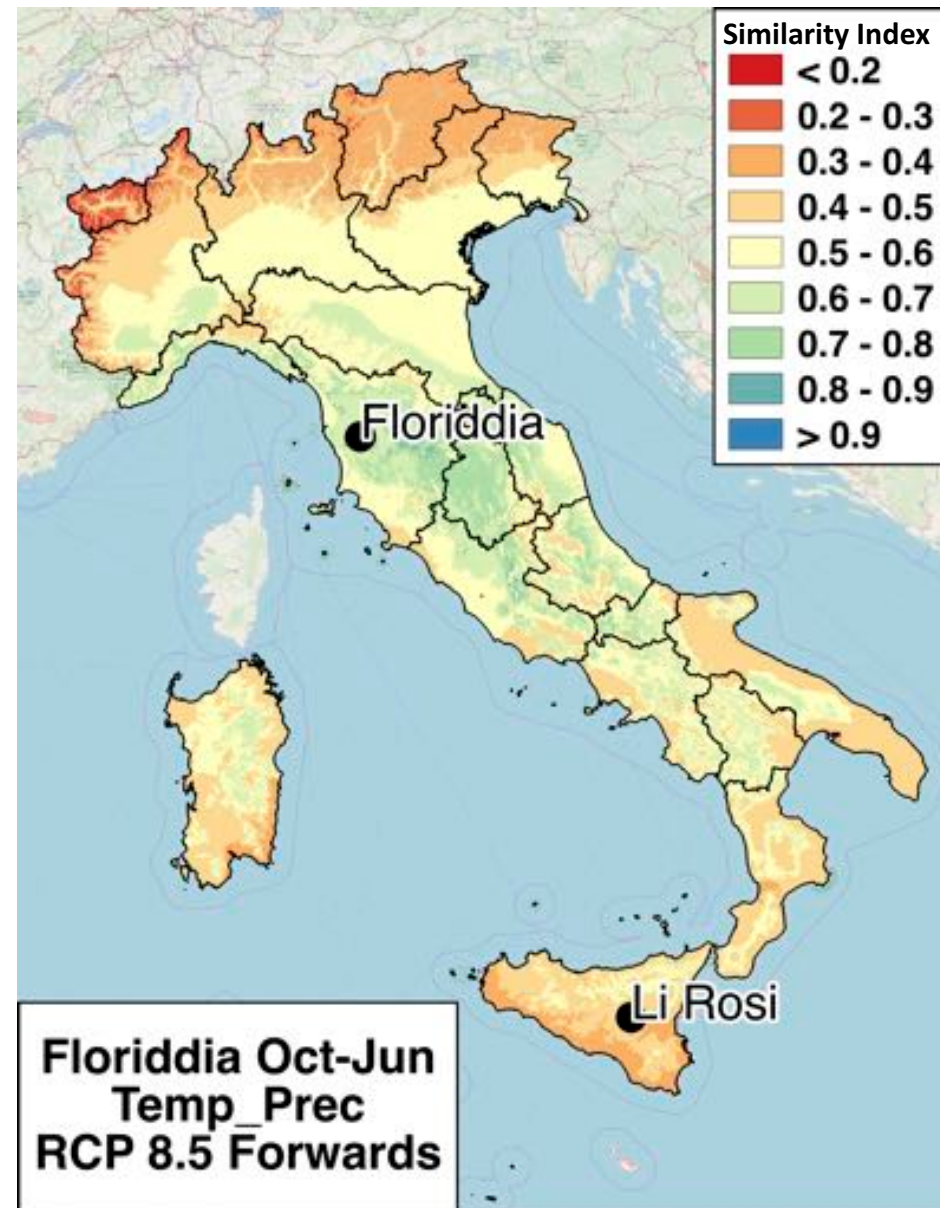


Current Climatic Similarities



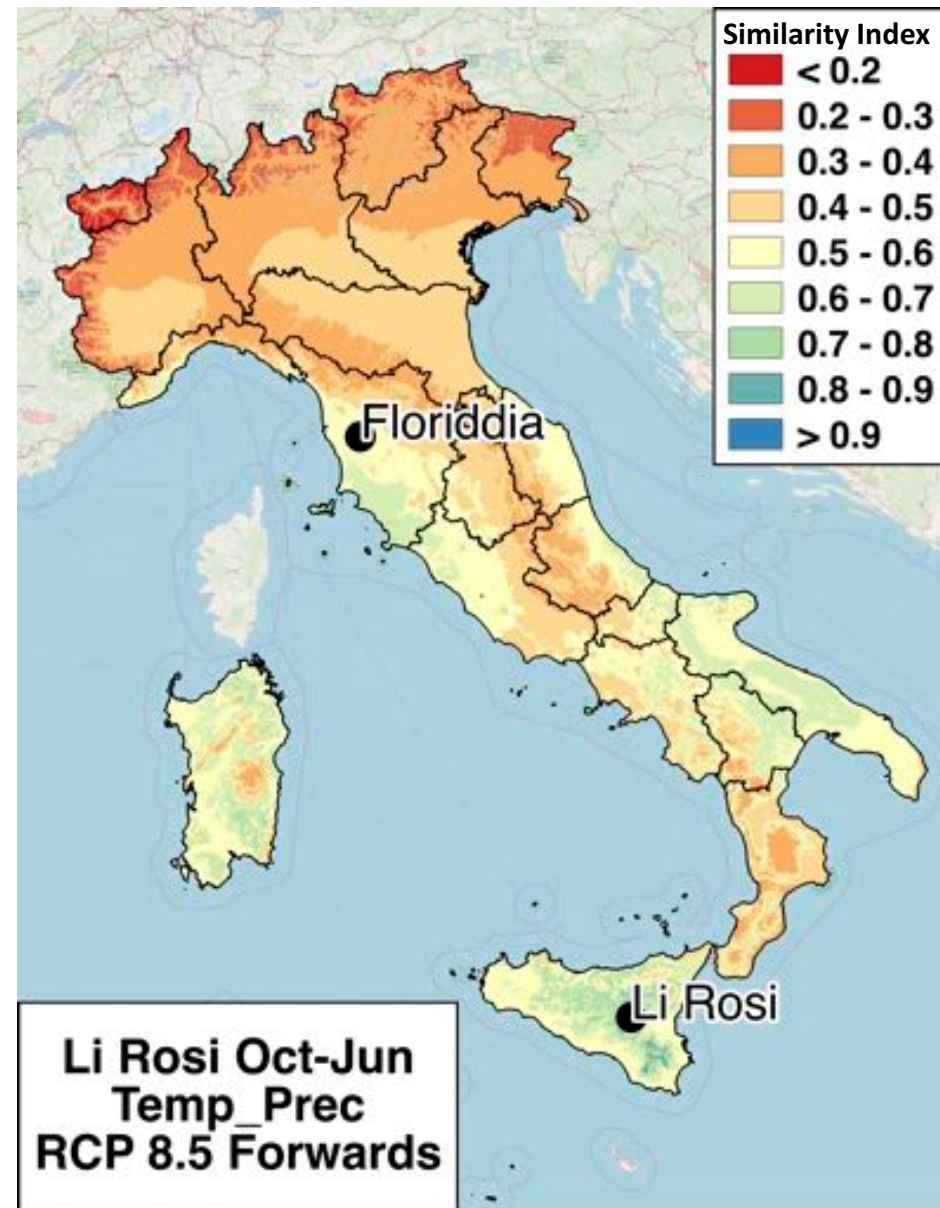
Forward Scenarios (1)

- Compares Floriddia's (Tuscany) current climate with projected climates for the rest of Italy under RCP 8.5 emission scenario (2030s)
- Map shows large areas with climate similarity index > 70%



Forward Scenarios (2)

- Compares Li Rosi's (Sicily) current climate with projected climates for the rest of Italy under RCP 8.5 emission scenario (2030s)
- Map shows climate similarity similar to baseline (Sicily and south-east of Italy)



Conclusions (1)

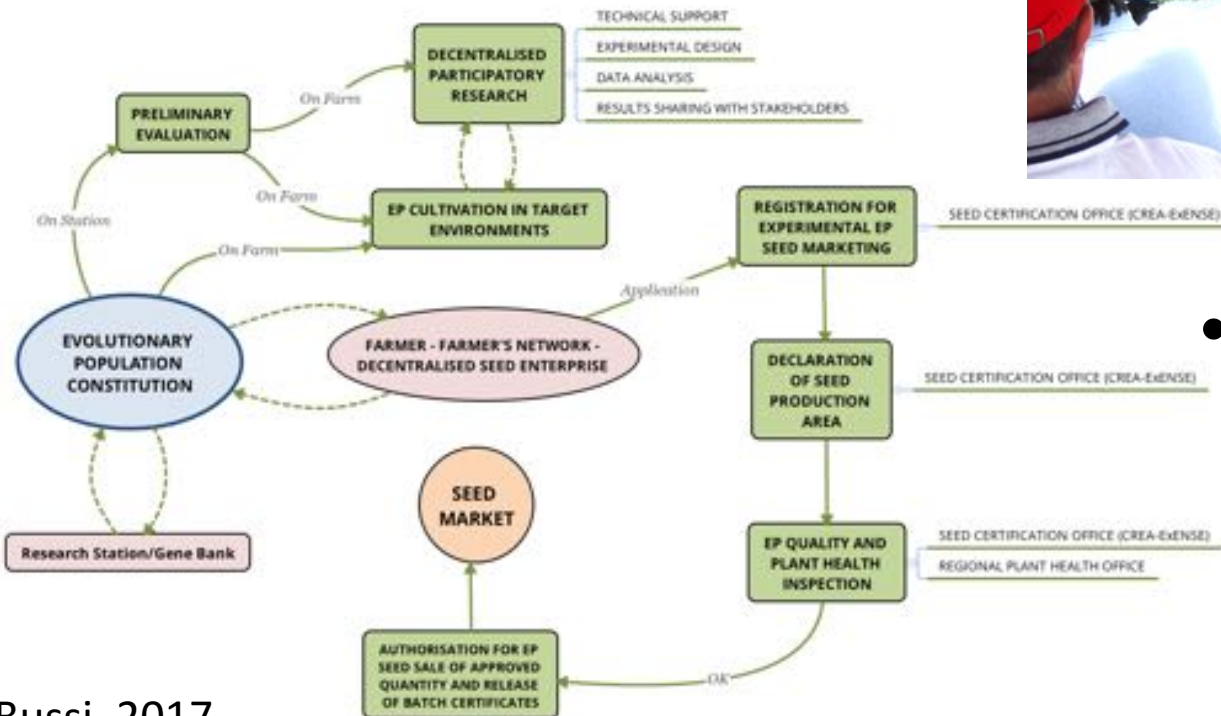
- **Evolutionary Populations respond to both natural and farmers' selection generating locally adapted sub-population**
- **The selective environment of Sicily created a highly adapted sub-population, which consistently out-yielded every other tested entry**
- **The variable climate of Tuscany created a less adapted sub-population, which showed good stability across a range of different environments**

Conclusions (2)

- **Evolutionary Breeding is a low cost and effective tool to create locally adapted “modern landraces” for marginal areas, low-input or organic management**
- **Farmers’ participation allows to include their knowledge in the selection process and ensures high adoption rates**
- **Climate Analogues simulations indicate that the two Tuscan and Sicilian sub-populations will continue to be suitable for cultivation in their area of evolution and beyond, for the near-term future (2030s)**

Impact Pathway of my MScCCAFS Research Thesis Work

- Inform EU policy on EPB for low-input and organic agriculture



- Climate change proofing of decentralised seed systems

Acknowledgements

NUI Galway Supervisors

Prof Charles Spillane

Dr Peter McKeown



Partner institution supervisors

Riccardo Bocci

Dr Bettina Bussi

Dr Salvatore Ceccarelli

External examiner

Dr Andy Jarvis



Funding: SUSI, DIVERSIFOOD

