

Agriculture and adaptation to climate change: the experience of a winery in central Italy

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- **The impact of climate change (i.e. Temperature increase and changes of average precipitation) on grape wine harvest date is well known...but there are some shortcomings:**
- **Usually changes of cultivation practices, fertilization, irrigation can effect the harvest date of grape wine....and could interfere with the effect of climate changes**
- **The effects of the changes of other characteristics of precipitation (rainy day, intensity) on harvest date of grape wine, is usually less documented.**

INTRODUCTION

Harvest Data

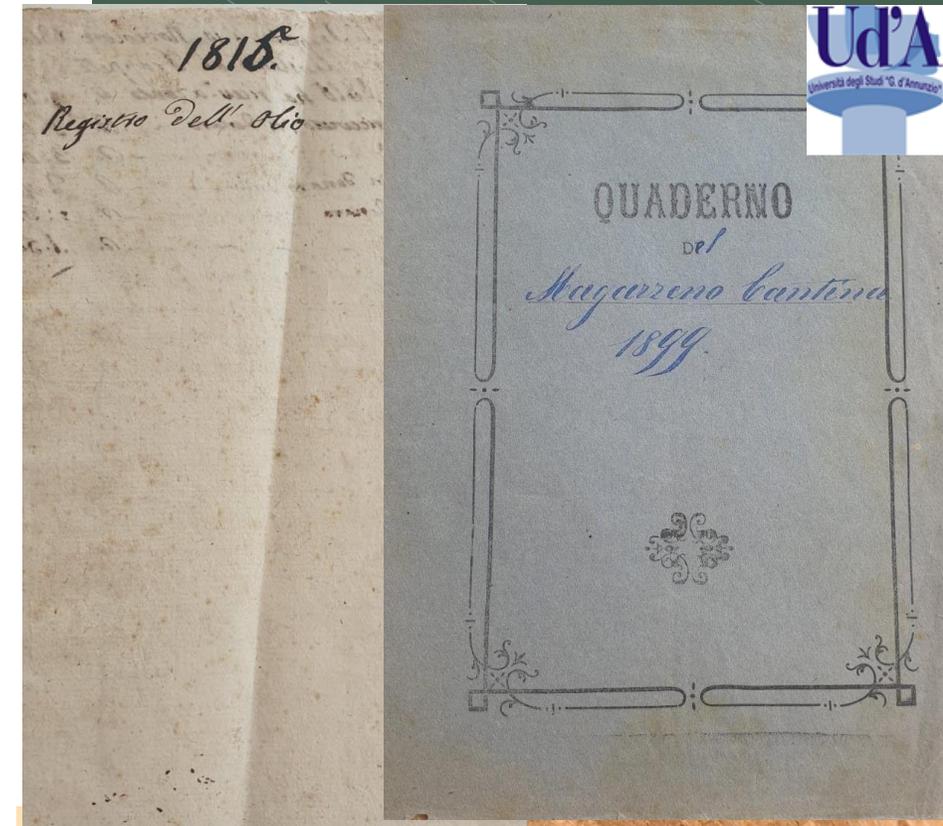
One of the oldest winery in Abruzzo Region (Italy) dating back to 1650: Cantina Valentini di Loreto Aprutino

They started to record the date of the beginning of the harvest of the grape wine since 1817

They have kept the cultivation practices unchanged since then

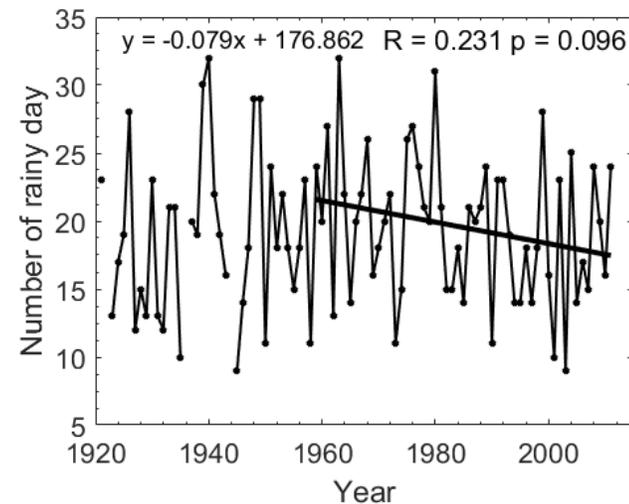
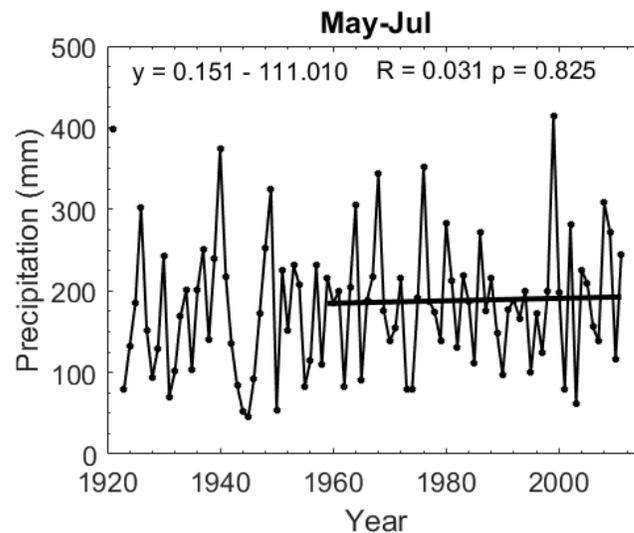
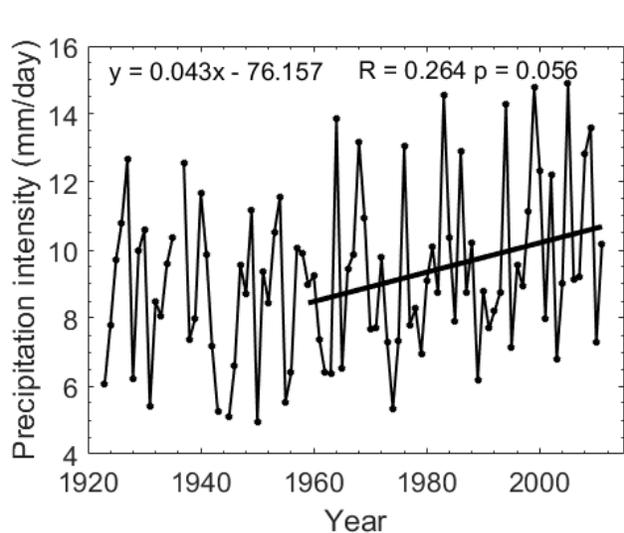
They don't use to irrigate

Date of the start of the harvest is a good proxy of the climate of that period

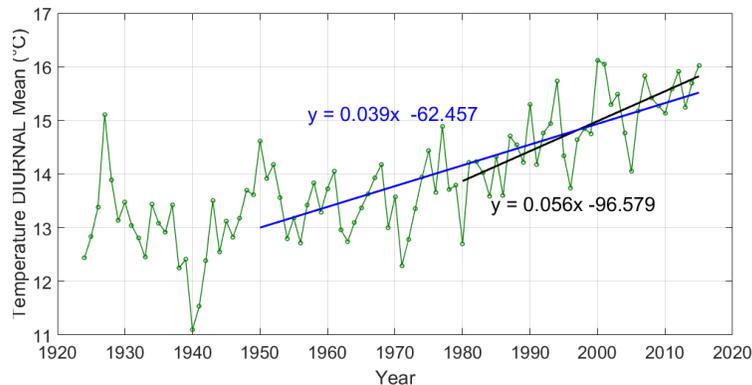
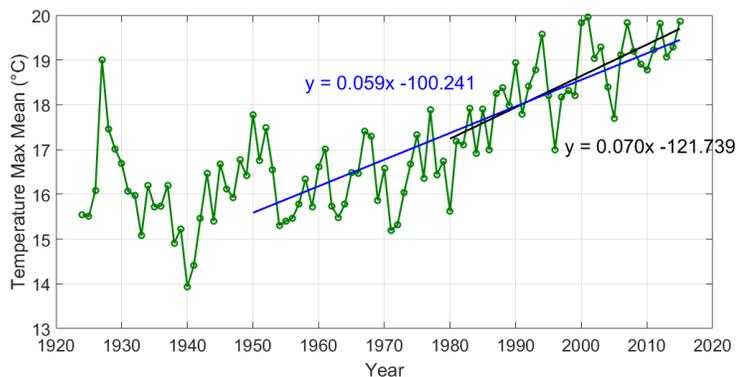


Climate data

local precipitation: intensity, total amount, rainy day



local temperature: max, mean



Homogenization of instrumental time series of air temperature in Central Italy (1930–2015)

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Multivariate regression

- $y = a_1x_1 + a_2x_2 + a_3x_3 + a_4x_4 + \dots a_nx_n$
- Linear combination of predictive variables ($x_1, x_2, x_3 \dots$ meteo data),
- $a_1, a_2, a_3 \dots$, coefficients identified to maximize the correlation coefficient between recorded Harvest date and that estimate by the model (y)

Stepwise regression

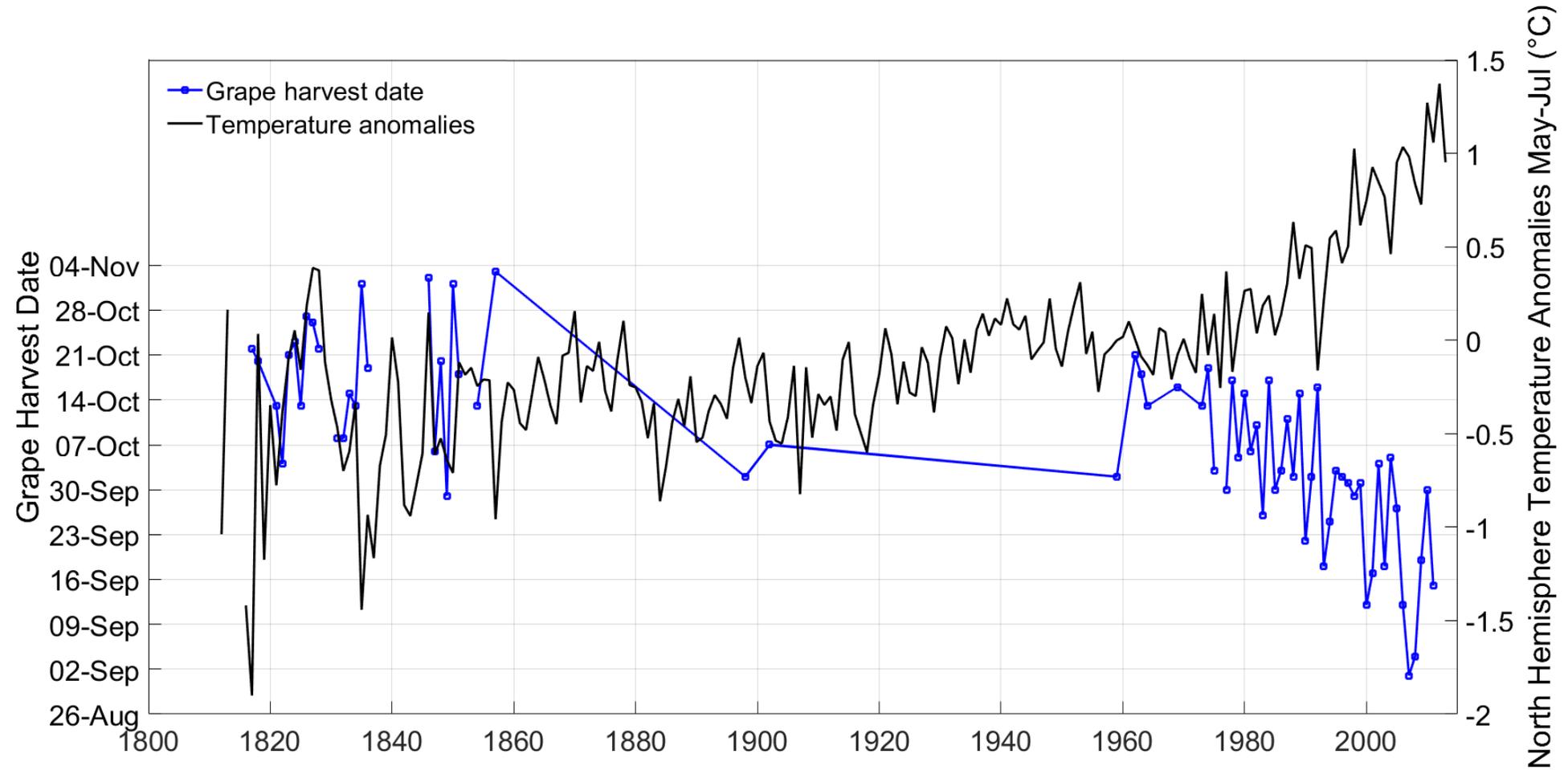
- Same approach of the Multivariate, but starting with a model that includes all the variables, at each step one of them is removed and it is checked to see if the significance has been reduced below the specified tolerance level. If a non-significant variable is found, it is removed from the model.

Models

Predictive variable selected looking at the correlation of the Grape wine Harvest Date with each variables looking for $p < 0.05$

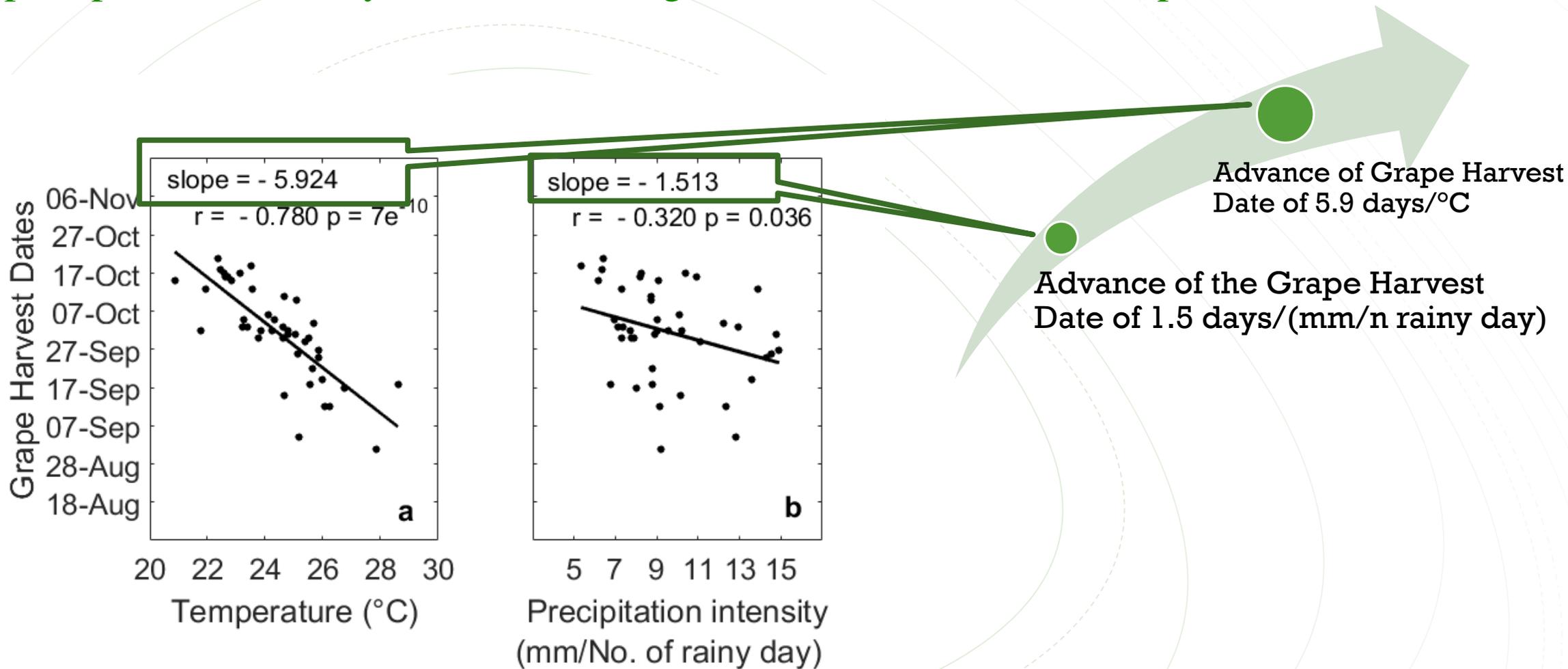
GHD vs	r	p
Local precipitation	-0.074	0.643
Local of rainy day	0.238	0.125
Precipitation Intensity (Local precipitation/ Local No. of rainy day)	-0.320	0.036
Local daily maximum Temperature	-0.780	7.3273e-10
Local daily minimum Temperature	-0.705	1.3327e-07
Local daily averaged Temperature	-0.776	1.0049e-09
PDSI	-0.264	0.087
EAP	-0.387	0.010
PCI	-0.254	0.105
SOI	0.126	0.427
GPH 500mb	-0.623	8.2591e-06
NAO	0.356	0.019
North Hemisphere Temperature Anomalies	-0.678	5.7655e-07

Results: data overview



Results: Grape Harvest Advances

Both models: **Stepwise analysis** and **Multivariate analysis** show that only temperature and precipitation intensity are statistical significant to describe the Grape wine Harvest date changes



Adaptation Strategies: few options

To face the increase of temperature

- Move vineyard to higher altitude to take the advantage of the temperature gradient: $DT/DZ = 0.65^{\circ}\text{C}/100\text{m}$
- For example moving from Loreto Aprutino (~250 m.asl.) to Capestrano (~450 m. asl.) average temperature reduction of $\sim 1.3^{\circ}\text{C}$

To face the increase of precipitation intensity

- Reduce the runoff deep ploughing to accumulate water from precipitation, especially during winter and spring

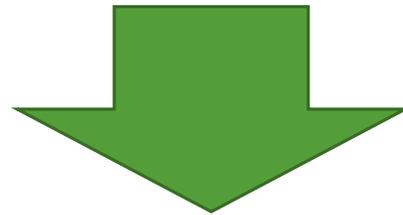
To face both: temperature and precipitation

- Change cultivar, genetic modification

Adaptation Strategies: other options

Move vineyard could be a drastic solution and may have territorial, economical and social implications

Change cultivar including genetic modification of grape wine for well established and with centuries of history winery could be dramatic.



Adaptation keeping the same cultivar and without vineyard migration to higher altitude

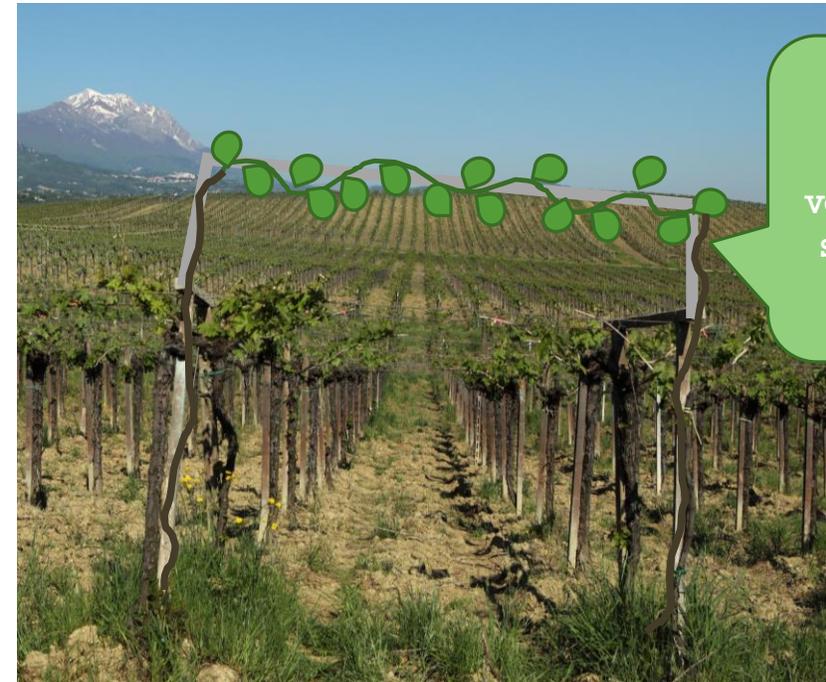
Adaptation Strategies: green solution

So far: Tendone vine-training systems + deep ploughing to accumulate water from precipitation and reduce runoff



Under development

Double-Tendone to protect vines and grapes from high temperatures....shadow with vegetation



Upper Tendone with vegetation to shadow the vine and grape

Summary

Increase of temperature induces early Grape wine Harvest

Increase of precipitation intensity induces also early Grape wine Harvest, whereas the total amount of precipitation usually induces a late Harvest

Temperature may influence other climate variables and can result in an amplification of the effects

Some adaptation strategies are developing to save the traditional cultivar and territories

Thank you for your attention!

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**Thanks to
event**



for supporting my participation to this