Modified grape composition under Climate Change conditions requires adaptations in the vineyard

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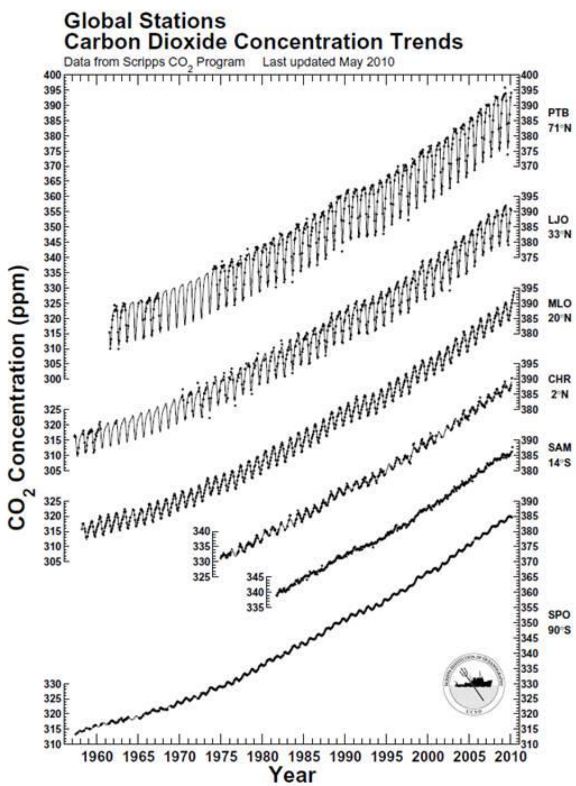
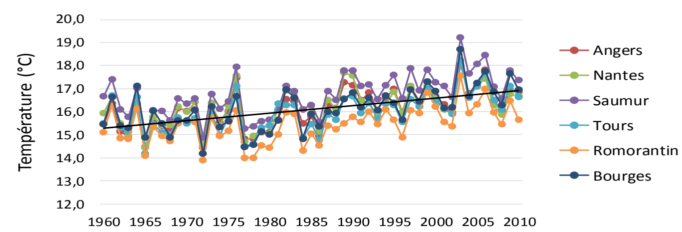
Climate Change results in increased temperatures…

Increase in atmospheric CO_2

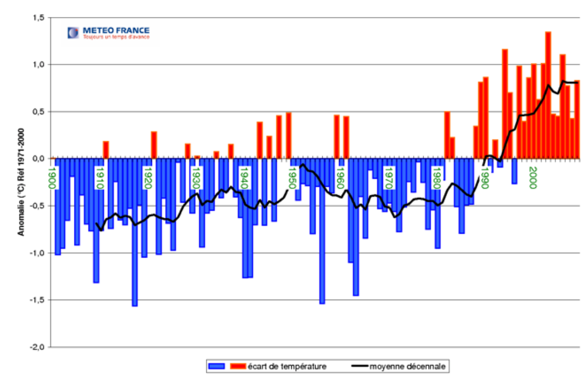


IPCC, 2007

Increase in temperatures



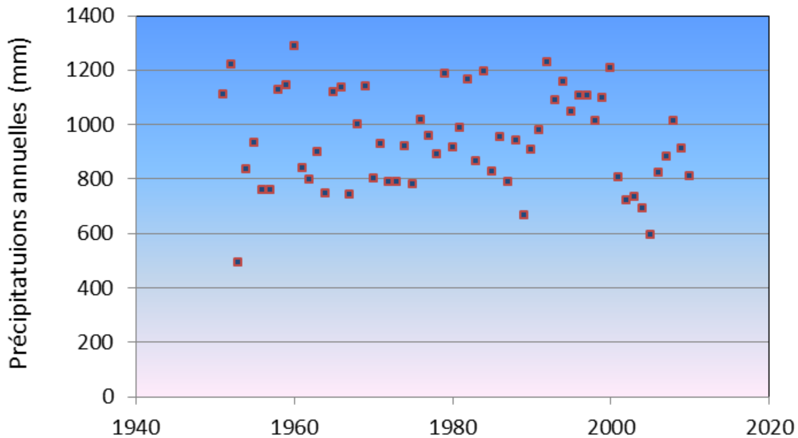
Neethling et al., 2011



Météo France

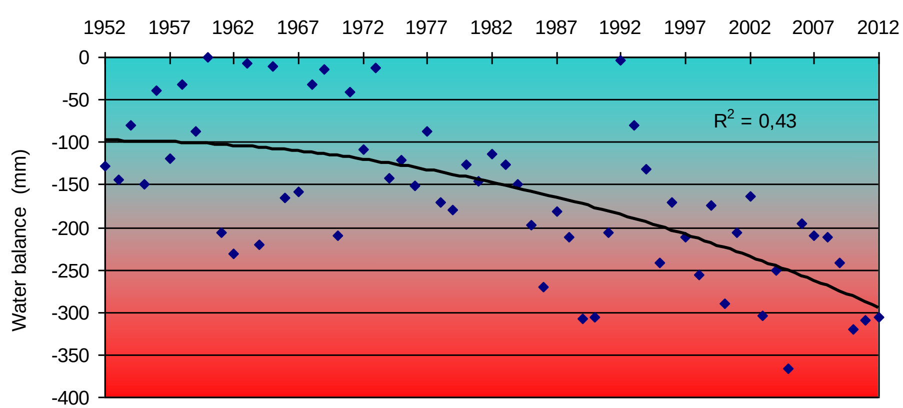
…. and increased water deficits

Rainfall Bordeaux-Mérignac
1951 - 2010



Not necessarily because of reduced rainfall

Water balance Saint-Emilion
1952 - 2012



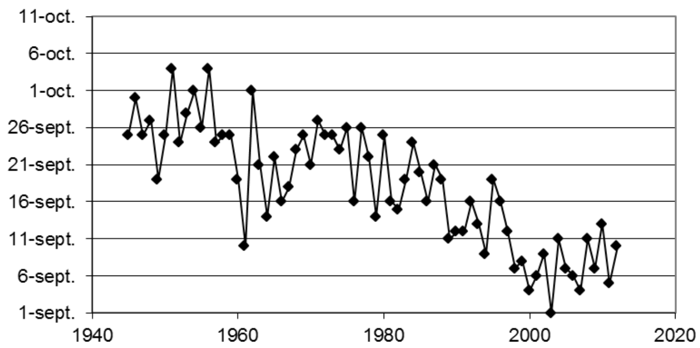
But because of increased ET_0 :

↑ Temp = ↑ ET_0

Consequences of increased temperatures

Start of harvest in Chateauneuf du Pape

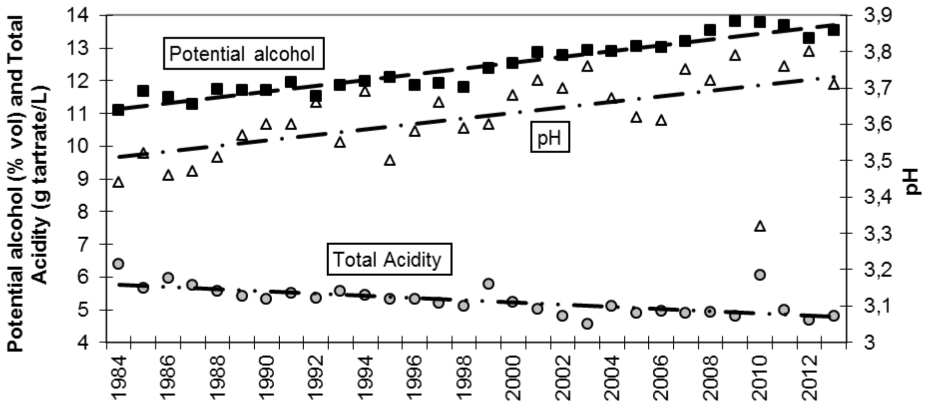
(source: ONERC 2014)



Advanced harvest dates

Grape composition at ripeness in Languedoc

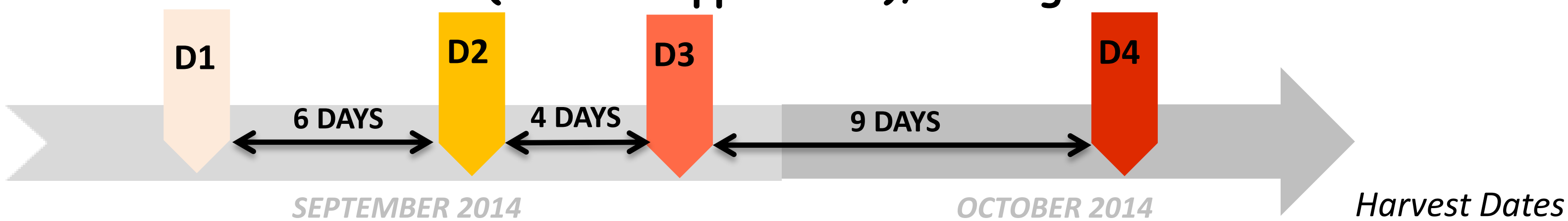
(Source: Dubernet laboratory, Narbonne)



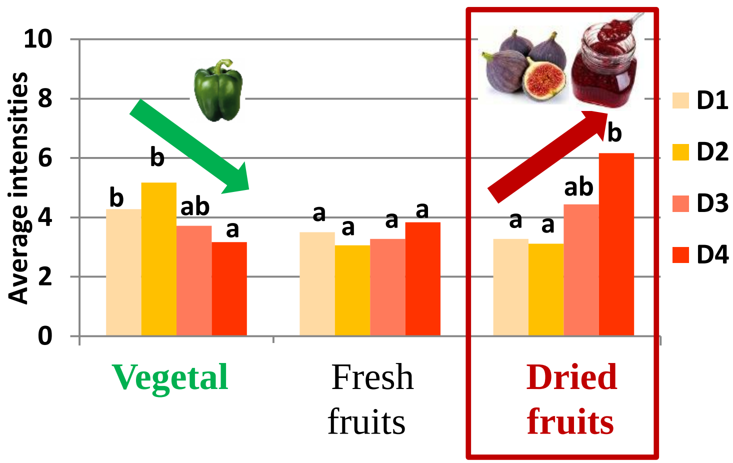
Grapes :
Higher sugar levels
Lower acidity

Effect of the level of ripeness on grape and wine composition

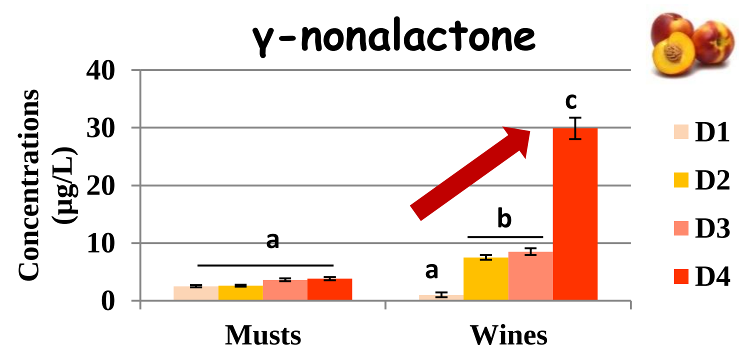
Merlot Plot (Pauillac appellation), Vintage 2014



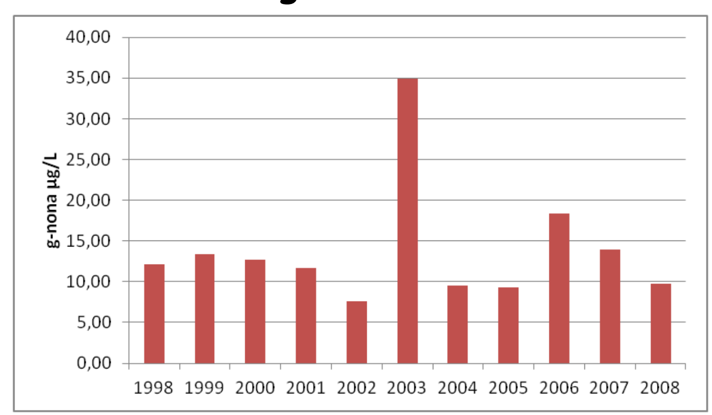
Sensory analyses of wines



Quantitative Analysis (GC-MS)



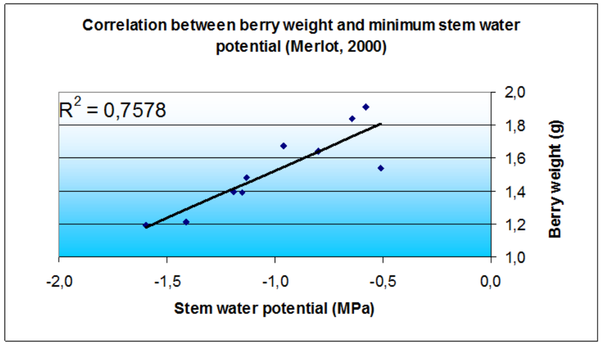
Example of γ-nonalactone distribution in recent vintages from a same estate

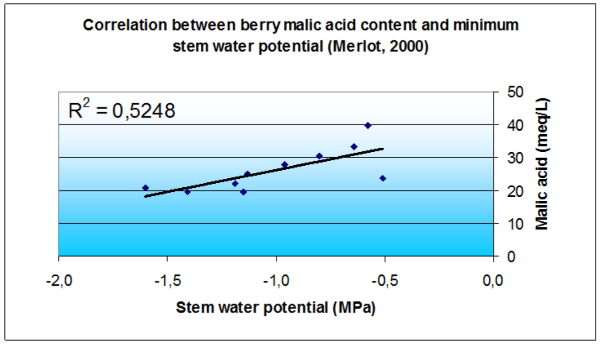


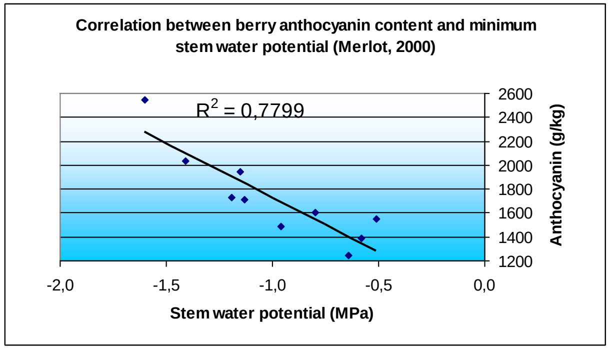
- Dried fruit aromas increased with harvest date and grape maturity
- γ-nonalactone increased with dried fruit aromas and harvest date (oxidation mecanism)

<u>**Poster L. ALLAMY**</u> : **Number**

Consequences of increased water deficit







Smaller berries :
- More concentrated wines
- Lower yields

Lower acidity

Higher skin phenolics

General tendancies
- Better quality (for red wines)
- Lower yields

Conditions for producing high quality « terroir » wines

- Grapes must reach full ripness
- Grapes should not ripen in the hottest part of the season
- → Ideal window for ripeness : between September 10 and October 10
- Risk with climate change : too early ripening

Adaptations to increased temperatures

Delay ripeness

Delay maturity :
1 – training system

- Late pruning
  - Up to one week delayed bud break
- Trunk height
  - Lower maximum temperatures in the fruit zone

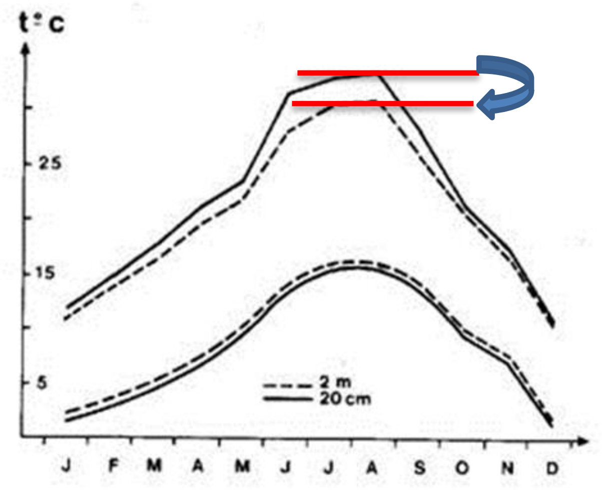
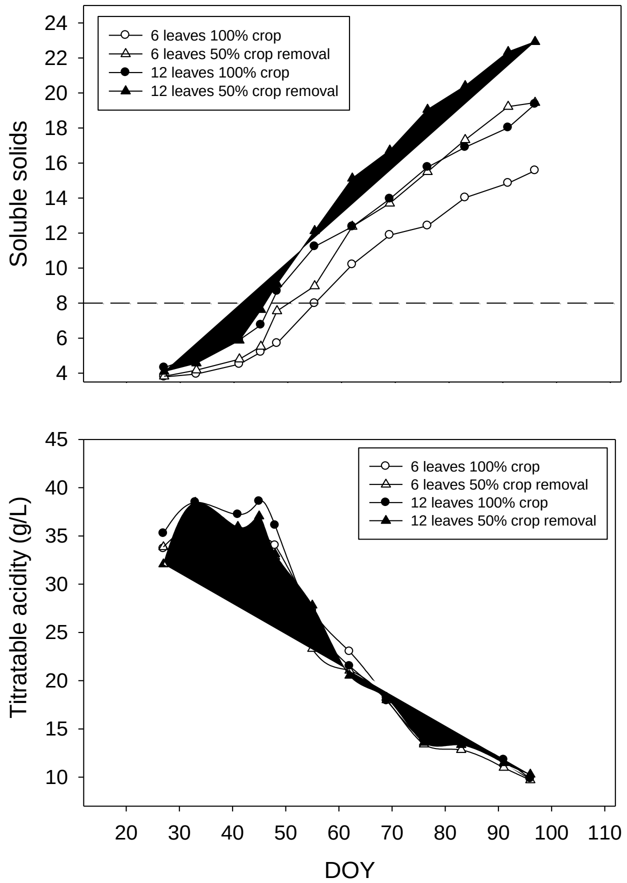


FIGURE 190
Evolution moyenne durant 3 années de la température minima et de la température maxima mesurées sous abri à 20 cm et à 2 m par CHAPTAL à Montpellier, Bel Air.

Champagnol, 1984

Delay maturity :
2 – Canopy management

- Limitation of leaf area / fruit weight ratio
  - Delays veraison
  - Decreases grape sugar (slower accumulation)
  - Little effect on acidity
- Effect on aromas and skin phenolics ?



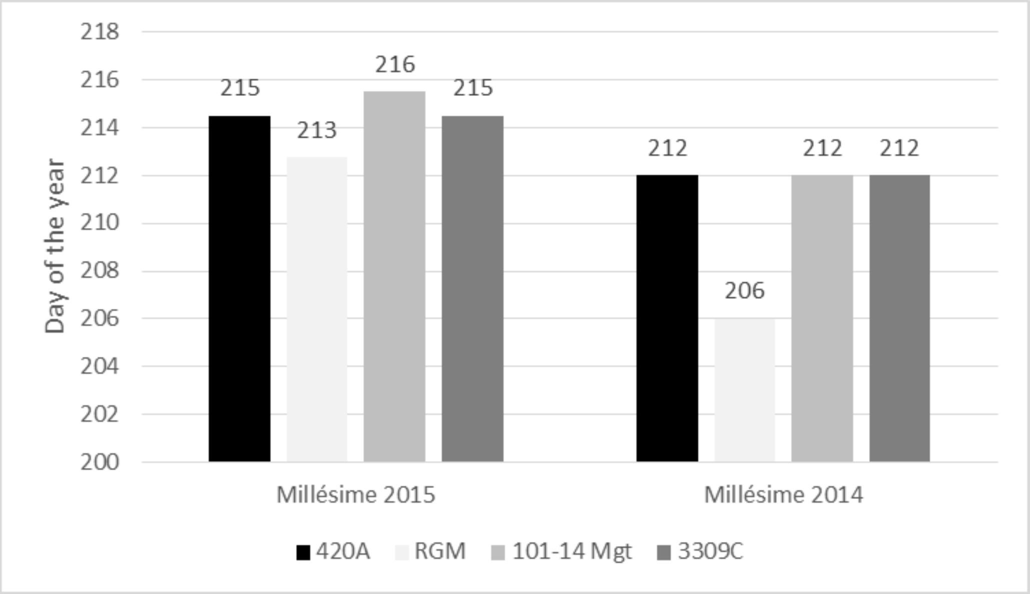
Parker et al., 2014 AJGWR

Parker et al., 2015 AJGWR

Delay maturity : 3a – Plant material (rootstock)

- Up to one week delay in veraison
- Likely even more at ripeness

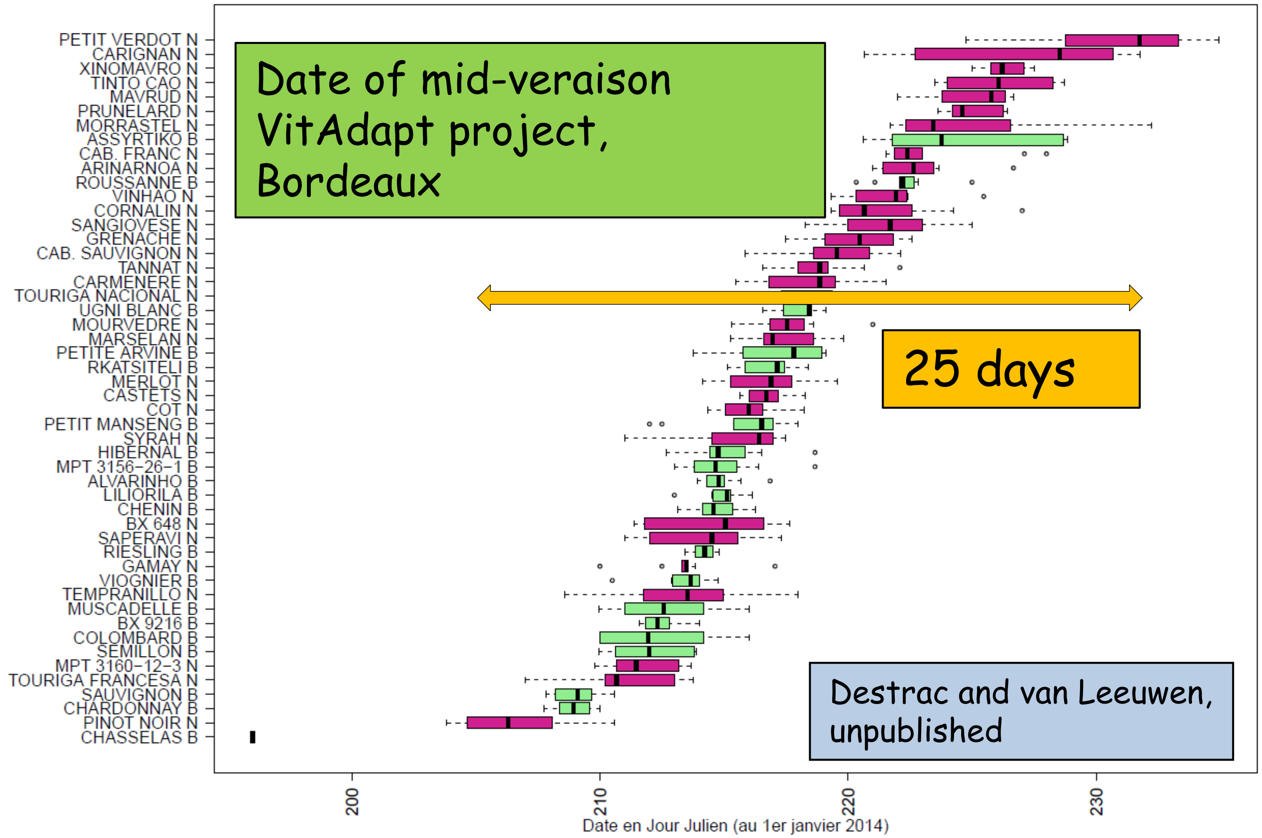
Merlot grafted on 4 different rootstocks in the Saint-Emilion area



Boehler et van Leeuwen, unpublished

Delay maturity:
3b – Plant material (variety)

- Variety choice is the most powerfull tool to delay maturity
- Change variety among existing varieties
  - Merlot -> Cabernet-Sauvignon
- Introduce new varieties



Delay maturity :
3c – Plant material (clone)

- Up to 8 days delay in veraison among clones

Cloanl collection of Cabernet franc, Saint-Emilion

	Clones	Percentage of veraison 03/08/2009	07/08/2009	11/08/2009	Mid veraison
09 05 73	A	58%			02/08/2009
27 37 78	H	52%			03/08/2009
27 44 14	I	46%	72%		04/08/2009
27 23 66	G	46%	84%		04/08/2009
14 47 62	F	43%	85%		04/08/2009
11 34 28	C	45%	70%		04/08/2009
13 32 08	D	28%	65%		05/08/2009
13 55 39	E	38%	85%		05/08/2009
27 44 63	J	36%	76%		05/08/2009
11 28 26	B	17%	63%		05/08/2009
GR 07 30	K	23%	48%	69%	08/08/2009
14 52 45	L	20%	39%	65%	09/08/2009
GR 08 26	M	18%	33%	63%	10/08/2009

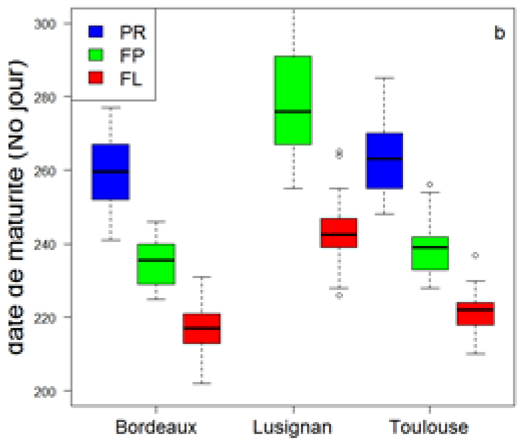
van Leeuwen et al., 2013, JAFC

All these options can be combined and implemented consecutively

- Regional specifications
- For most regions these options will allow maintaining production and typicity at least untill 2050

Action	delay in maturity (days)
Higher truncs	3 - 5
Later pruning	3 - 5
Dereased LA / FW ratio	5 - 12
Rootstock	3 - 6
Clone	3 - 8
Local variety	0 - 14
Non local variety	10 - 25
Total with local varieties	**17 - 50**
Total with non local varieties	**27 - 61**

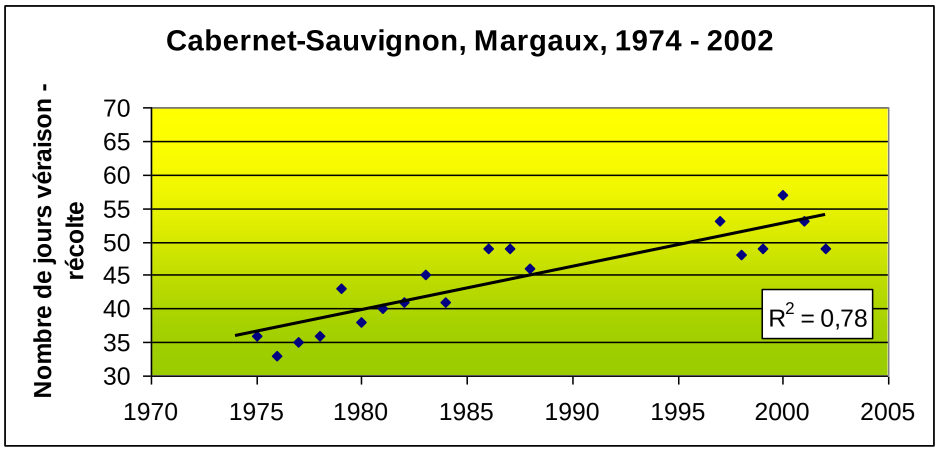
Simulation maturity dates
PR = recent past
FP = 2020 – 2050
FL = 2070 - 2100



Pieri, 2012, Climator

Choice of harvest dates

- Easy to implement adaptation to modify grape composition
- Paradoxe : over the past 30 years tendancy to increased veraison – harvest duration (« hang time »)



Time from veraison to harvest : 35 -> 55 days in 30 years

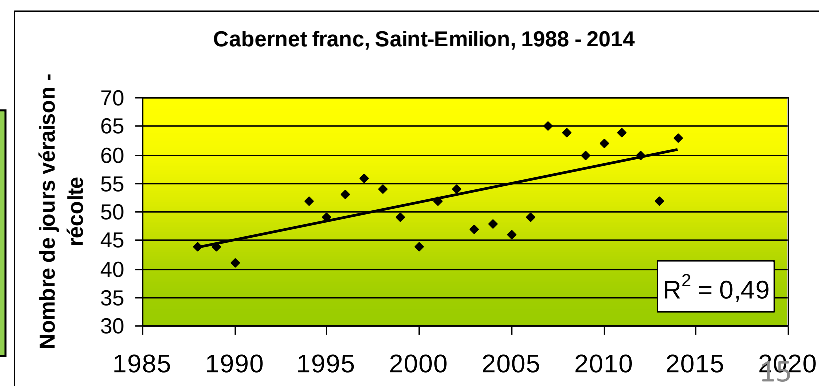
(+ 20 days !)

Guimberteau and Gény (ISVV network)
van Leeuwen and Darriet (2016)

Time from veraison to harvest :

40/45 -> 60/65 days

in 30 years (+ 20 days !)



Adaptations to increased water deficits

Adaptation to increased water deficits : 1a – Plant material: rootstock

- The use of drought resistant rootstocks (110 R) is cost effective and environmental friendly
- New drought resistant rootstocks should be created

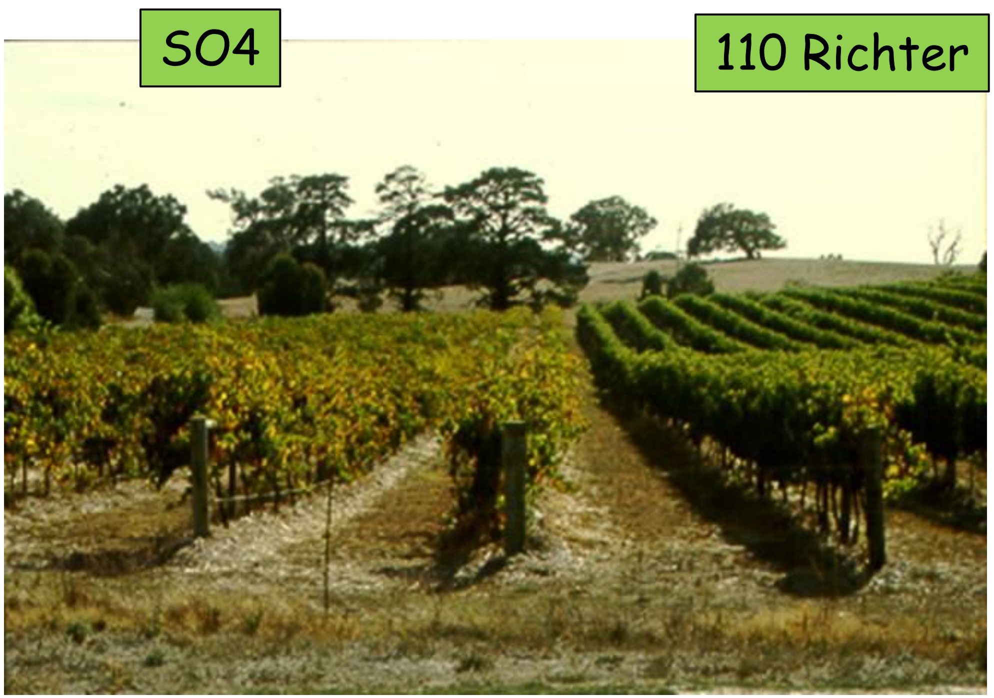
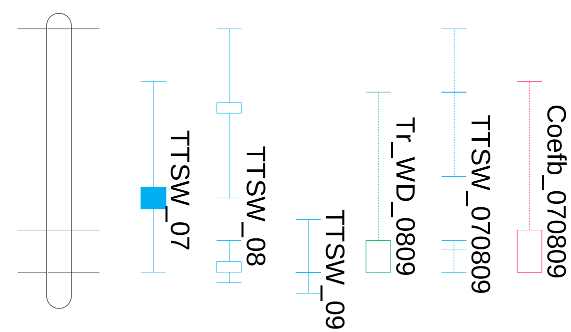


Photo: Pr. H. Schultz

RGM3



Marguerit et al., 2012, New Phytol

Adaptation to increased water deficits : 1b – Plant material : grapevine variety

- Mediterrenean varieties are drought resistant
- Avoid using sensitive varieties in dry climates

Merlot

Grenache

•Appellation: Campo de Borja, Aragon, Spain
•Annual rainfall : 350 mm
•Photos taken on 10 septembre 2006 by Miguel Lorente

Adaptation to increased water deficits : 2 – training system

- Long traditrion to cultivate vines in meditarranean regions : gobelet trained « bushvines »
- Low leaf area and low yield
- High quality wines can be produced with less than 400 mm annual rainfall and without irrigation

Adaptation to increased water deficits : 3 – Soil water holding capacity

- Avoid planting vines on soils with low Soil Water Holding Capacity
- Assess SWHC before plantation

Example: vineyard on hard Urgonien limestone in la Clape

Adaptation to increased water deficits : 4 – Irrigation

- With irrigation economically sustainable yields can be reached in dry areas
- But: water ressources are declining
- Irrigation can induce salinity problems
- Some blocks can never be irrigated

Drought in Californie

Salt stress in irrigated vines

Which priorities for water use?

- Is it reasonable to use 100 to 150 liter of water to produce 1 bottle of wine

=

Long tradition of dry farmed vineyards in mediterranean regions

Marocco

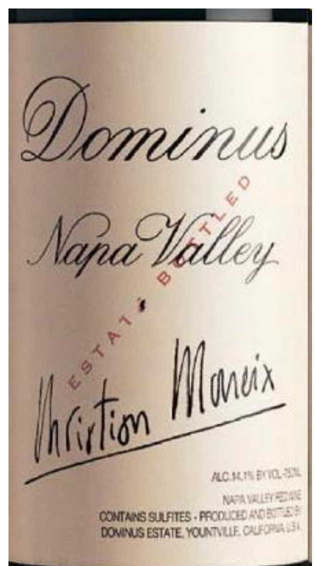
Greece

Spain

Maury (France)

It is possible to produce very high quality wines in dry regions with dry farming

Henschke's Hill of Grace



Economic equation

- With increased drought, yield decreases
- Economic sustainability is threatened
- Two solutions :
  - Increase yields (irrigation)
  - Decrease production cost (... gobelet trained vines)

Developping a mechanical harvester able to harvest gobelet vines should be a priority

Conclusion

- Increased temperatures : advanced phenology and higher temperatures during grape ripening
- Delay maturity
- Plant material is the most promising option
- Increased drought induces reduction in yield
- Three options :
  - Increase yield through irrigation
  - Decrease production costs by mechanization of gobelet vines
  - The use of drought resistant plant material is a cheap and evironmentally friendly option