IMPACT OF GRAPEVINE BREEDING FOR DISEASE RESISTANCE IN WORLD WINE INDUSTRY

Luigi BAVARESCO

[1] *Dept. of Sustainable Crop Production, Pomology and Viticulture Section,*
Research Center on Biodiversity and Ancient DNA
Università Cattolica S.C., 29122 Piacenza, Italy
President Expert Group «Genetic Resources and Vine Selection», OIV, Paris

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BEST BUYS

The World Health Organization's low-cost, high-impact strategies to prevent non-communicable diseases.

Tobacco	• Tax increases • Smoke-free indoor workplaces and public places • Health information and warnings • Bans on tobacco advertising, promotion and sponsorship
Alcohol	• Tax increases • Restricted access to retail alcohol • Bans on advertising
Diet and physical activity	• Reduced salt content in food • Replacement of trans-fats with polyunsaturated fats • Media campaigns on diet and physical activity
Cardiovascular disease and diabetes	• Counselling and medicine for people at high risk of heart attack and stroke
Cancer	• Immunization for hepatitis B to prevent liver cancer • Screening and treatment of precancerous lesions to prevent cervical cancer

(Gostin, *Nature*, 511, 7508, 2014)

WINEinMODERATION.com

Art de Vivre

WINE, A CULTURE OF MODERATION

Understand the wine you drink: knowing where its unique character comes from makes drinking the more pleasurable

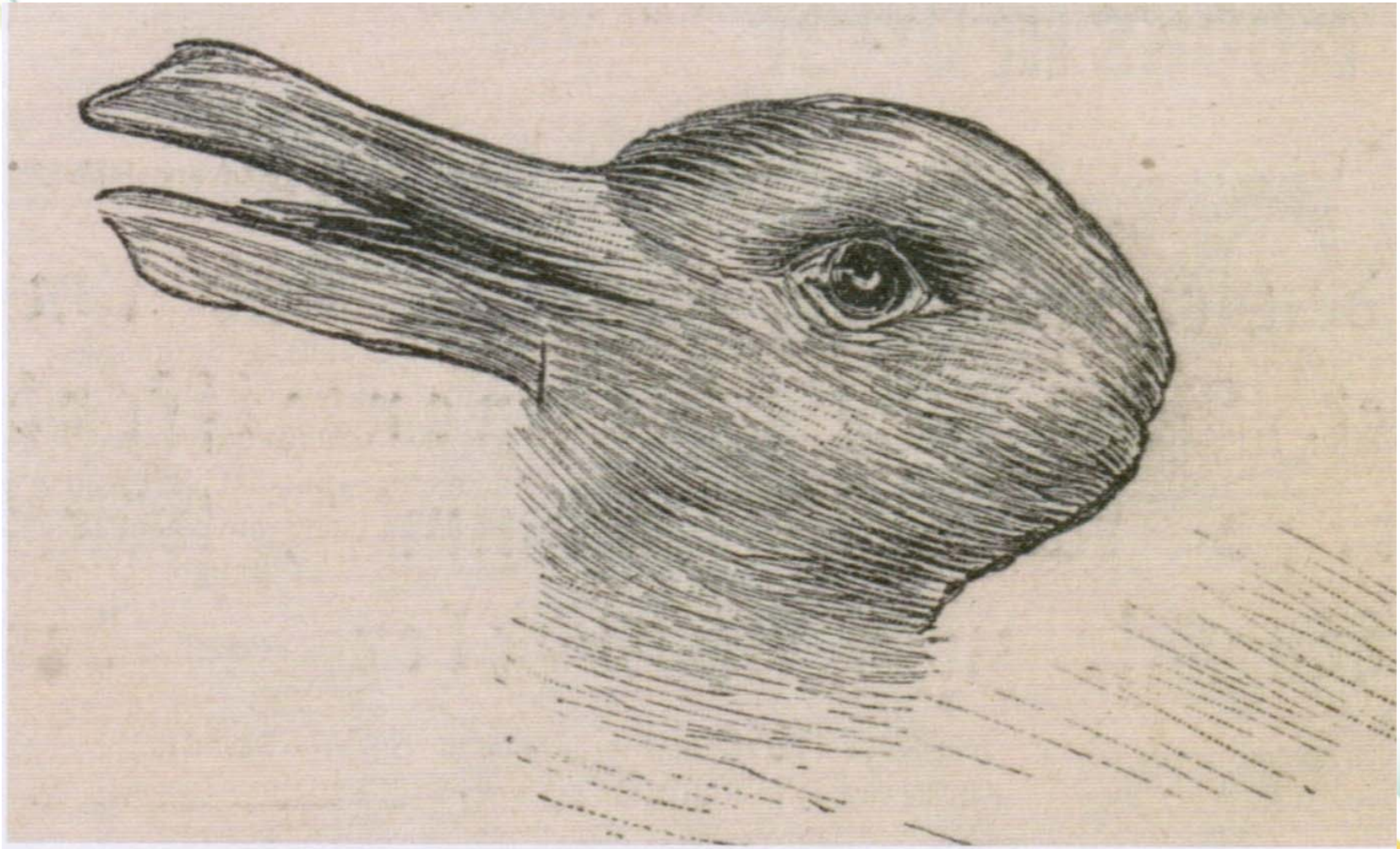
Drink slowly: take the time to savour the wine's distinctive taste

Accompany wine with good food: alongside a glass of water

Appreciate wine with good company,friends and family

Be sensible, avoid excess.

(www.wineinmoderation.eu)



The duck–rabbit figure shows how two pictures can be derived from the same evidence.
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(Kaiser, *Nature*, 484, 7393, 2012)

Wine as a cultural product

Wine as a champion of sustainability

How to reduce pesticide impact in viticulture?
(while controlling pests and diseases)

Biocontrol
Containment sprayers
Epidemiological models
Precision viticulture

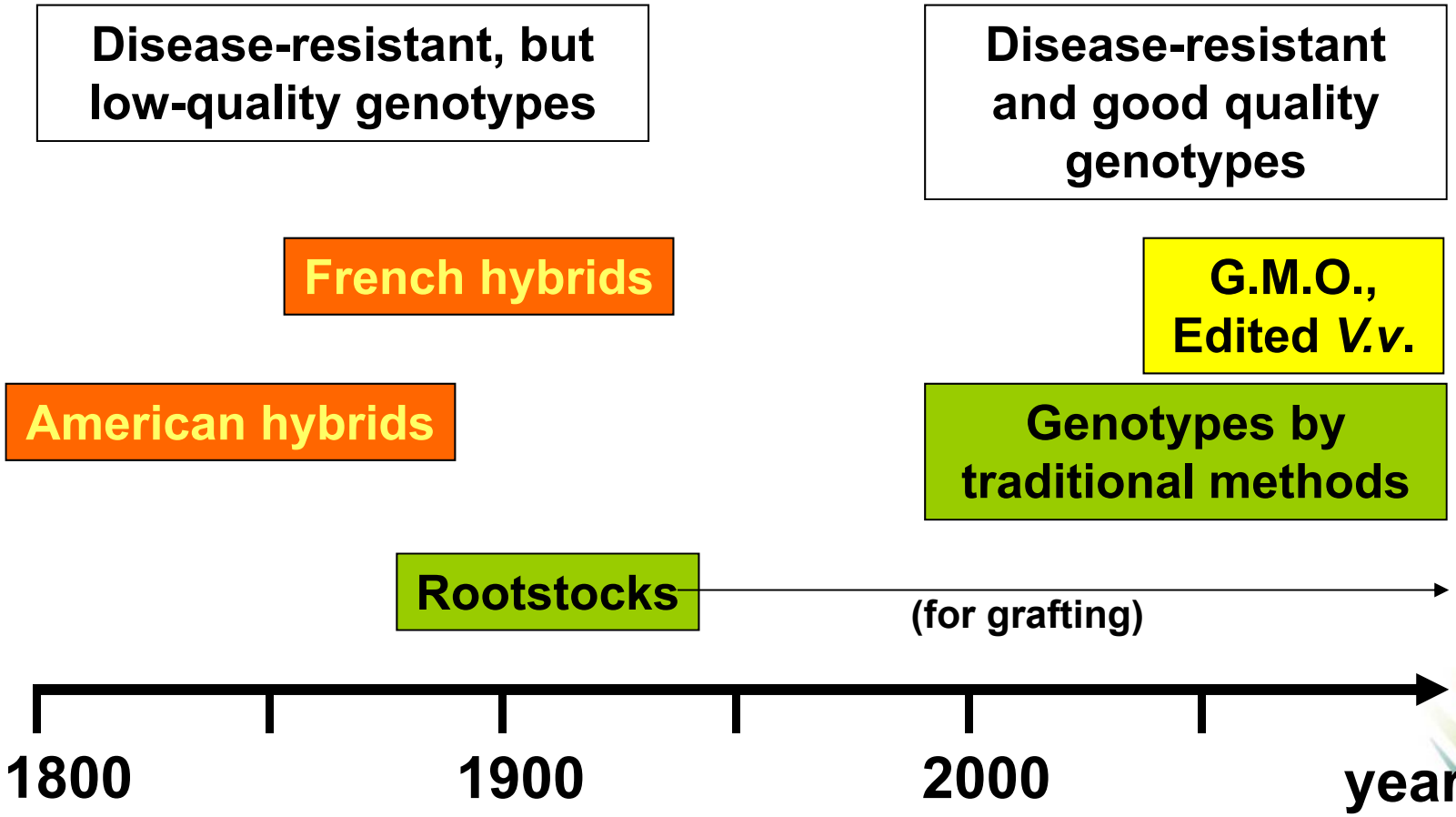
To get vines more resistant toward diseases

1) Breeding : a) clonal selection (poor impact)
b) intra- and inter- specific controlled crosses
c) new breeding techniques (cisgenesis, genome editing)

2) Proper terroirs and cultural practices

3) Enhancement of natural defence mechanisms of *V. vinifera* varieties

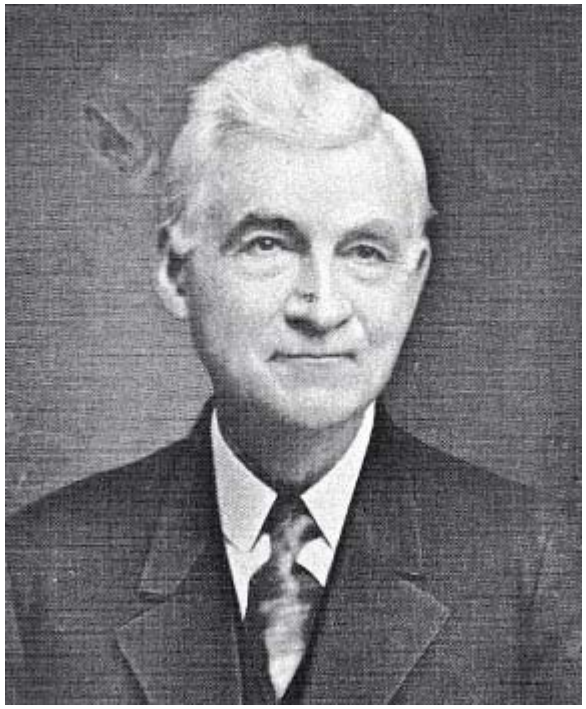
Time-course of grapevine breeding for disease resistance (by interspecific crosses)



(Töpfer and Eibach, 2003, modified)

Personal qualification necessary in the originator

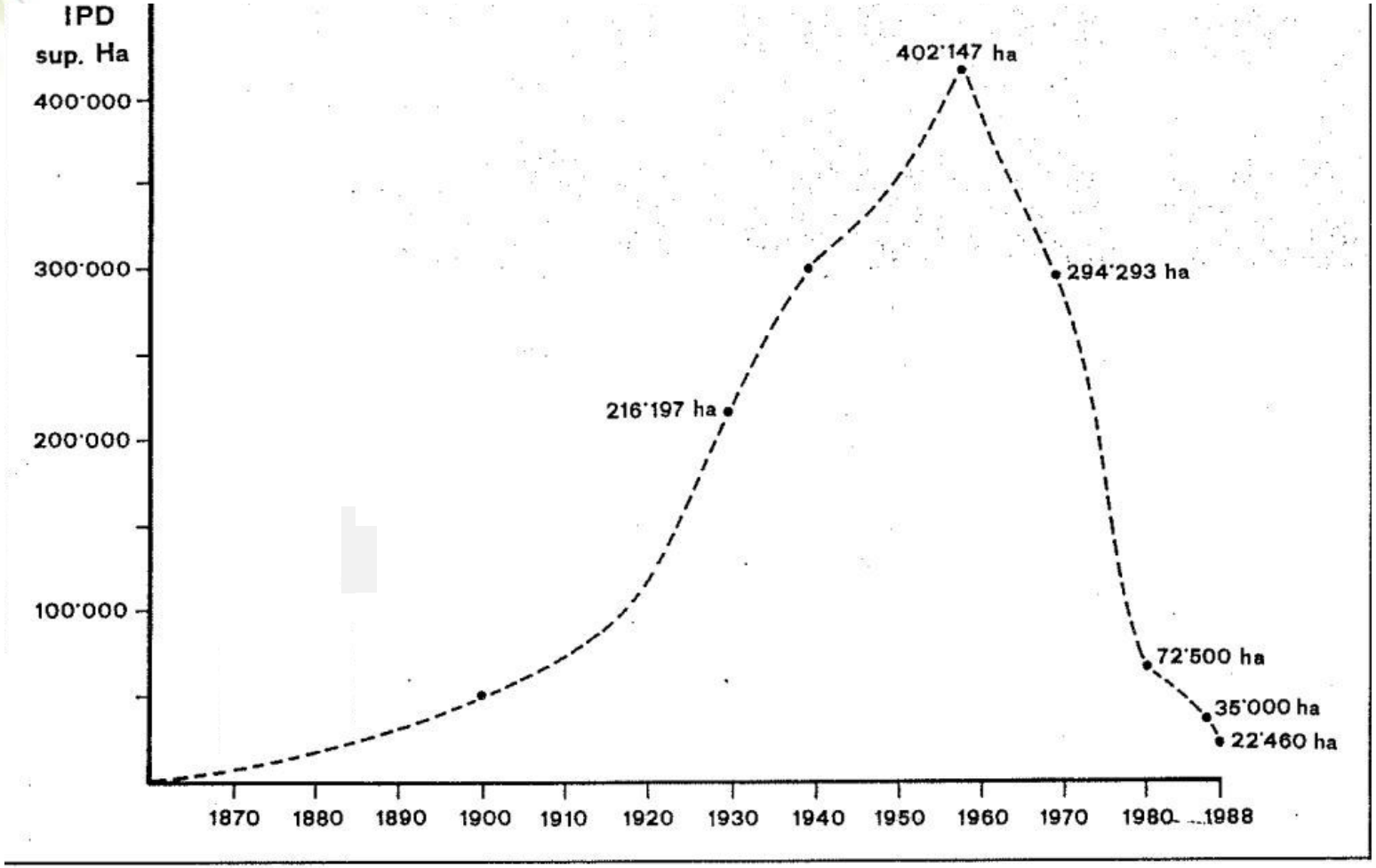
- Theoretical & personal knowledge
- Experience
- Skill
- Inventive faculty
- Patience & perseverance
- No stimulus of money-making
- Enthusiasm
- Ambition
- Intense love of close communion with nature
- Discover the great fundamental truth in ethics
- Love breeds life, hate breeds death



T.V. Munson (1843-1913)

(Munson, *Foundations of American Grape Culture*, 1909)

Evolution of the surface of hybrids in France



(Galet, 1988)

1953: EEC → regulation for use of hybrids in new vineyards;
1976: EEC → prohibition of use of hybrids in new vineyards

Origin of grapes produced worldwide

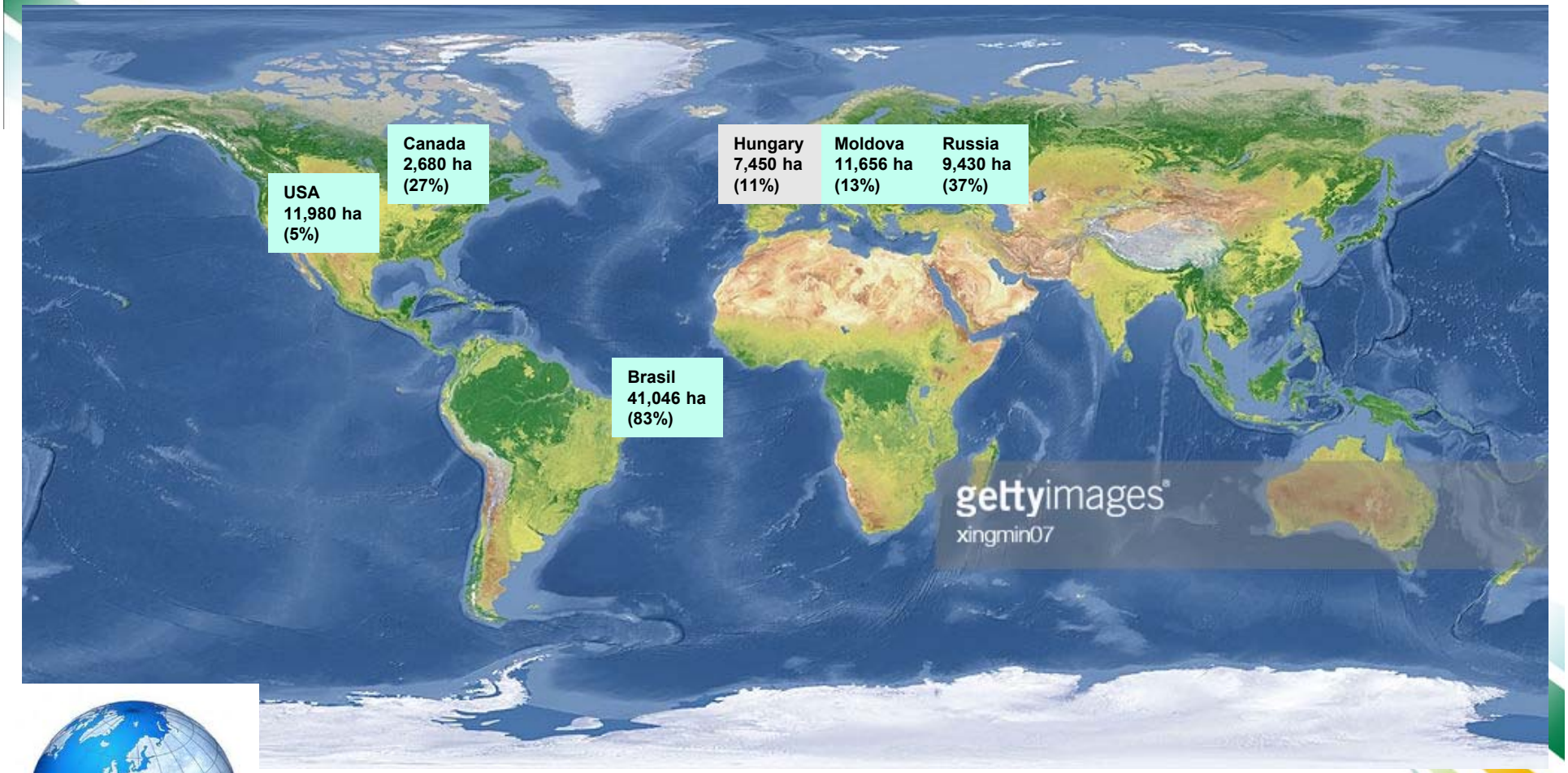
From varieties of	Registered	Estimated surface
Vitis vinifera	about 10,300	93.8%
V. labrusca, *V. rotundifolia*, *V. amurensis*, etc	about 930	0.4%
Hybrids	about 5,900	5.8%

Kyoho (*V. labrusca* x *V. vinifera*), table grapes
World surface 2015: 365,000 ha (www.oiv.int)

(Picture taken at Thaizhou, Zhejiang Province, China)

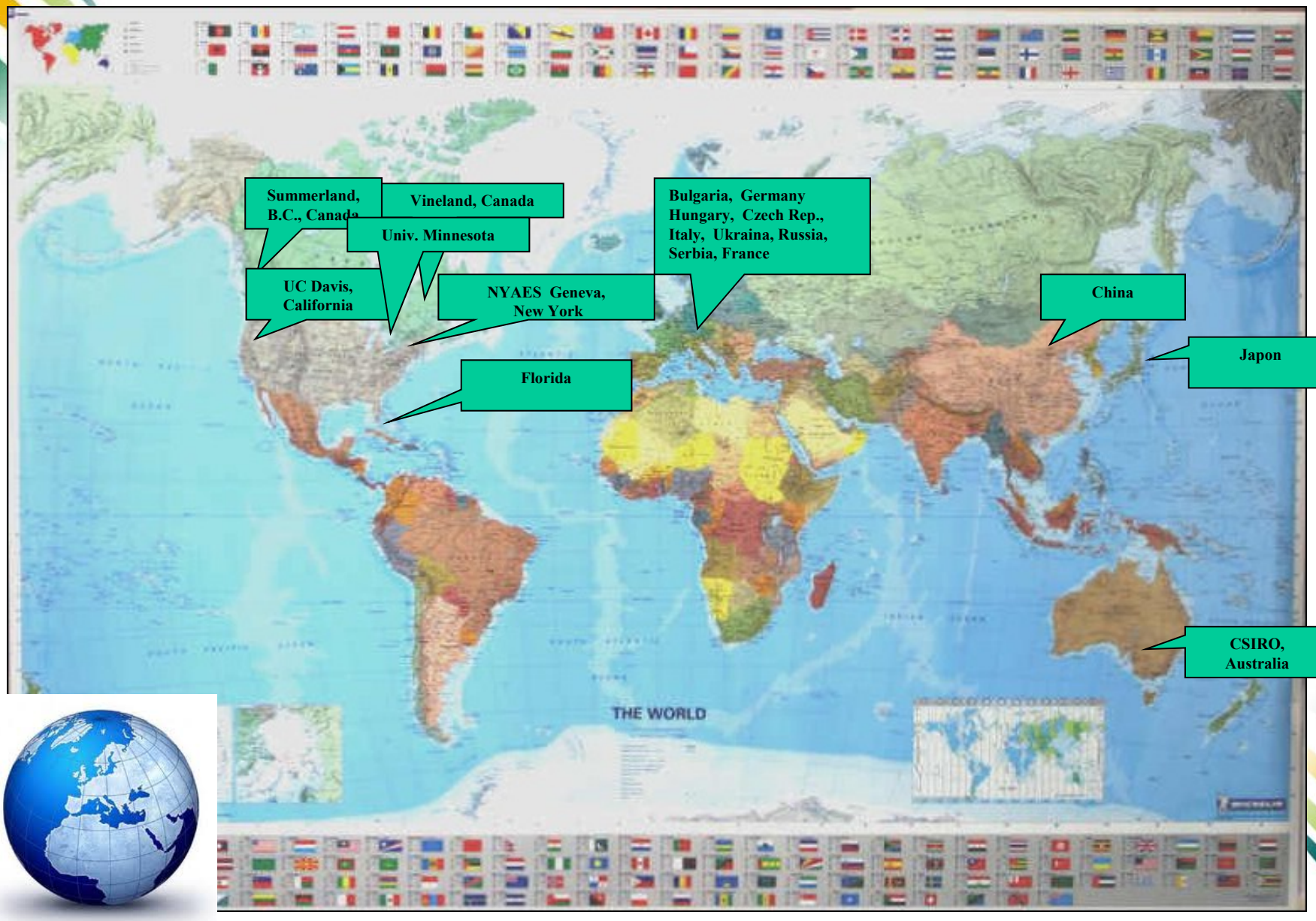
Surface of hybrids/disease resistant wine grape varieties

(absolute value and % on the national wine grape surface, 2010 data)



(Anderson, 2013)

Main countries involved in breeding programs for disease resistance



Disease resistant varieties bred by the University of Udine (Italy)

- FLEURTAI w. (Tocai friulano x 20-3)

- SORELI w. (Tocai fruilano x 20-3)

- SAUVIGNON NEPIS w. (Sauvignon x Bianca)

- SAUVIGNON RYTOS w. (Sauvignon x Bianca)

- SAUVIGNON KRETOS w. (Sauvignon x 20-3)

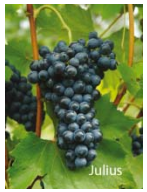
- MERLOT KANTHUS r. (Merlot x 20-3)

- MERLOT KHORUS r. (Merlot x 20-3)

- CABERNET EIDOS r. (Cabernet Sauvignon x Bianca)

- CABERNET VOLOS r.(Cabernet Sauvignon x 20-3)

- JULIUS r. (Regent x 20-3)



ITALIAN PRODUCTION (NURSERIES) OF GRAFTED VINES OF THE NEW DISEASE RESISTANT VARIETIES

Grape varieties	Number of vines (2012)	Number of vines (2015)	Number of vines (2016)	Number of vines (2017)
Sauvignon Kretos b	==	==	141,900	192,999
Cabernet Volos n	==	==	187,350	175,650
Fleurtai b	==	50,050	141,100	163,050
Sorèli b	==	31,200	113,700	153,880
Sauvignon Rytos b	==	==	108,500	155,790
Merlot Khorus n	==	==	80,920	126,315
Sauvignier gris b	==	==	60,400	120,105
Bronner b	17,500	88,500	55,800	117,650
Sauvignon Nepis b	==	==	85,900	98,889
Solaris b	==	==	80,500	96,500
Johanniter b	==	28,100	36,000	90,200
Merlot Khorus n	==	==	80,920	72,497
Cabernet Eidos n	==	==	59,100	69,495
Muscaris b	==	==	==	52,300
Cabernet Cortis n	==	8,060	51,700	36,000
Prior n	==	==	12,800	27,000
Regent n	300,000	2,100	800	1,500
Julius n	==	4,100	3,700	50
TOTAL	*317,500*	*212,110 (0.1%)*	*1,233,670 (0.6%)*	*1,749,870 (0.9%)*

ITALIAN PROGRAMS ON THE PIPELINE

Glera (former Prosecco) x hybrid
by CREA-VE, Conegliano; beginning: 2012
(Bavaresco)

Glera

Raboso Piave x hybrid
by CREA-VE, Conegliano; beginning: 2012
(Bavaresco)

Raboso Piave

Main traits of the new disease resistant wine grape varieties

- ***Organoleptic characteristics of the wine*: vinifera – like, but not the same sensory profile and the agronomical traits as the *vinifera* parent.**
- ***Good agronomical performance***
- ***Disease resistance*: not 100%, but a few spray treatments are needed**
- ***To be grown on the environment where they were obtained***
- ***Some of those are winter hardy***

Legislation (in EU)

- **Regulation EU 1493/1999 , art 19, par. 3: quality wine is allowed only with *V. vinifera* cvs; table wine is allowed with hybrids (except the old ones- Noah, Othello, Clinton, Jaquez, Isabella, Herbemont).**
- **Current EU Reg. 1308/2013: new disease resistant varieties → Table and PGI wines, but not PDO wines (only *V. vinifera*).**
- **Future Regulation: new disease resistant varieties also in PDO wines?**

- **Can the new disease resistant varieties be considered *V. vinifera*?**

Crop improvement schemes

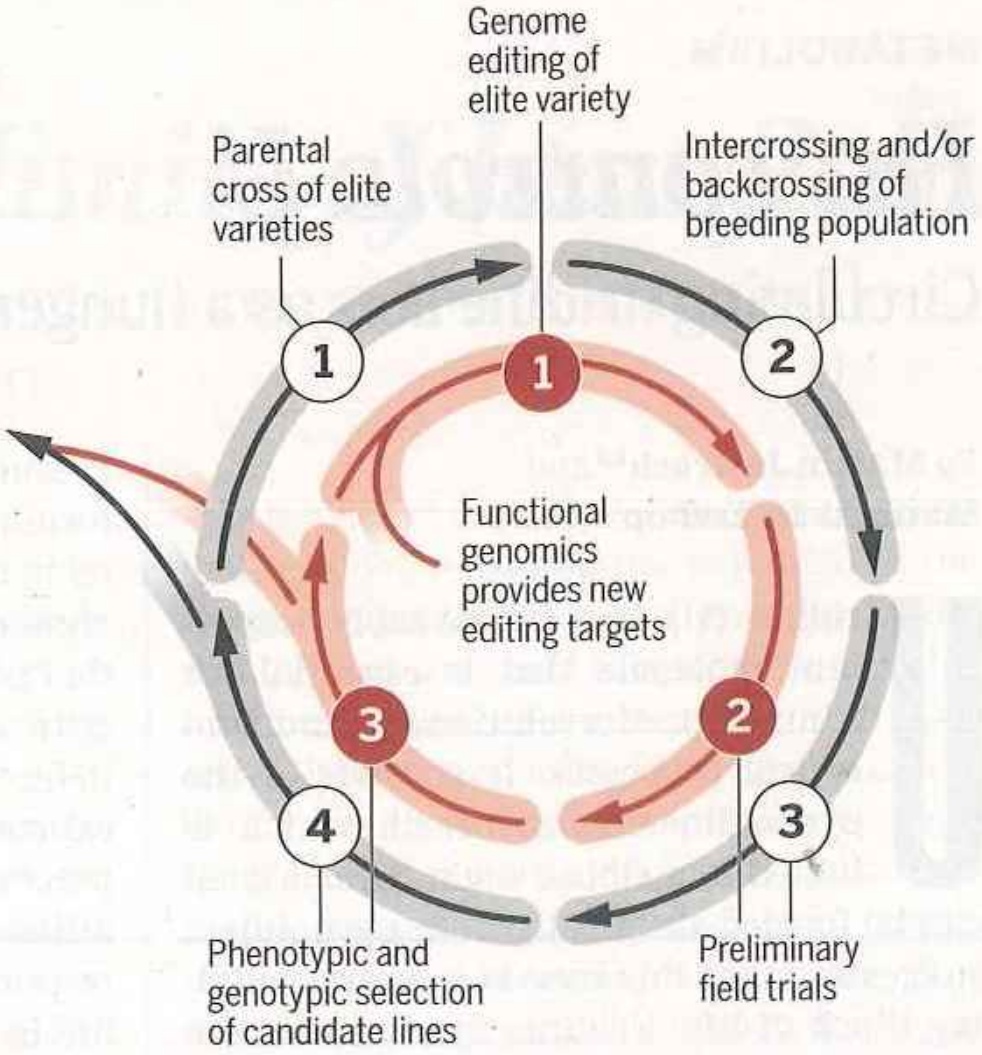
Gene editing tools such as CRISPR/Cas can improve crops more quickly than traditional approaches if the nucleotide sequence and function of the target site are known.

Conventional crop breeding cycle

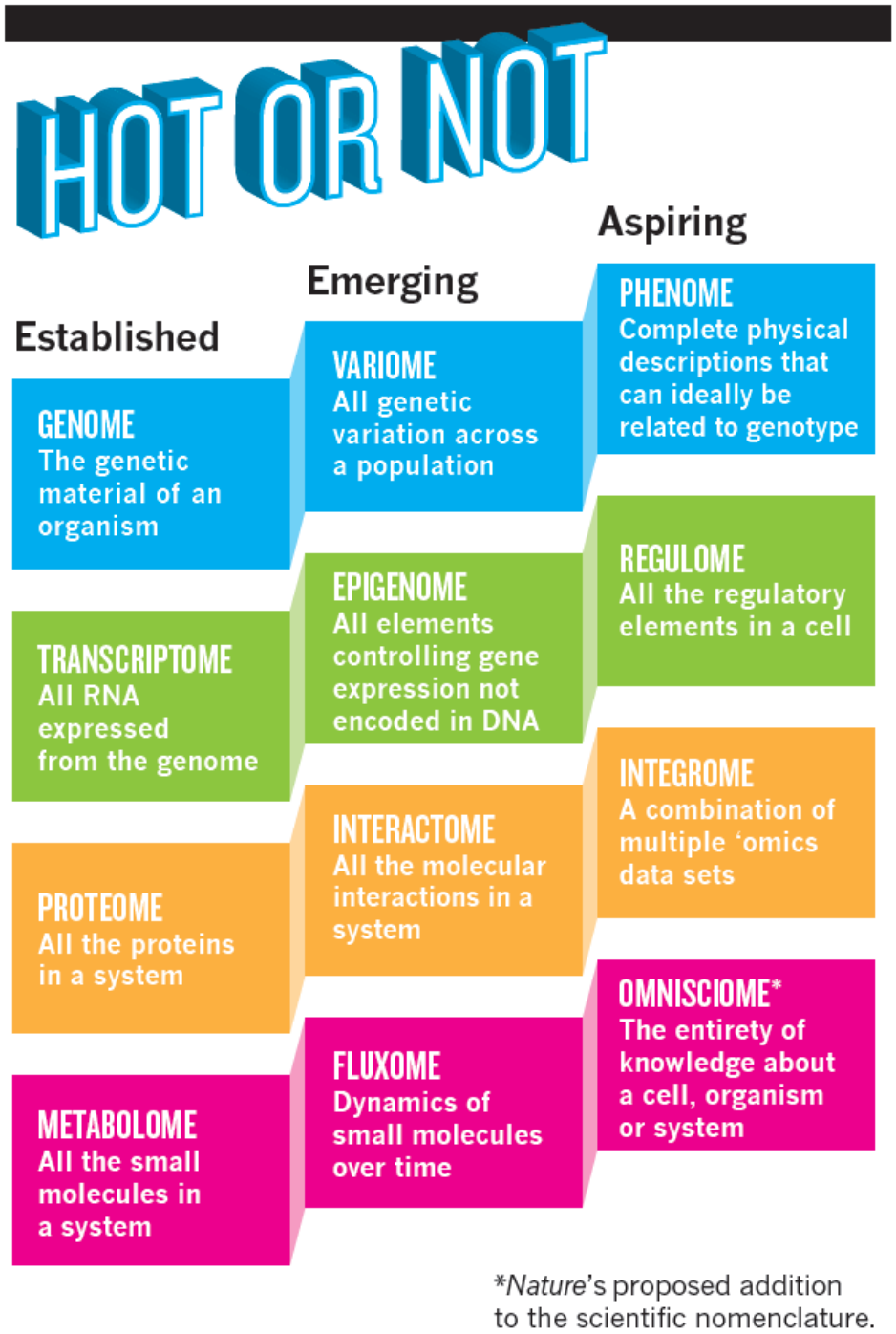
Crop traits are combined via recombination over multiple generations to produce improved varieties.

CRISPR/Cas-assisted crop breeding cycle

Crops with different edits of known targets are produced in a single step, and selected for advanced trials based on phenotypic traits.



(Scheben and Edwards, *Science,* 355, 6330, 2017)



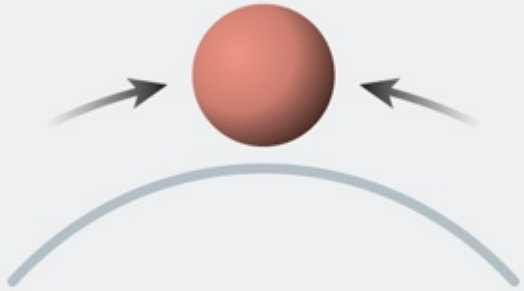
(Baker, *Nature*, 494, 7438, 2013)

SAFETY SECURED

Promoting overall resilience (left) rather than managing many individual risks (right) is the best way to minimize impacts from adverse events.

RESILIENCE

- Concerns whole system
- Aims for long-term security
- Requires indirect management
- Self-regulating
- Makes use of variability
- Seeks dynamic equilibrium



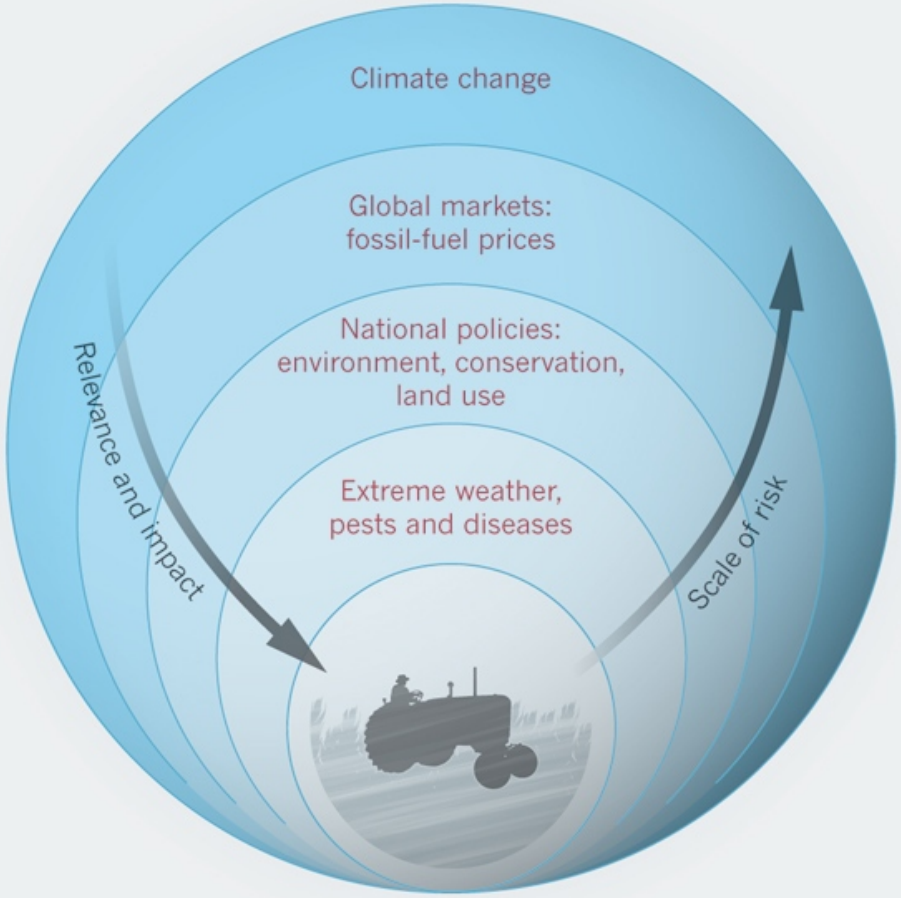
RISK MANAGEMENT

- Focuses on single risks
- Aims for short-term security
- Requires direct intervention
- Needs continuous monitoring
- Eliminates variability
- Seeks static equilibrium

(Erisman et al., *Nature*, 519, 7542, 2015)

NETWORKED THREATS

As well as immediate risks such as droughts and floods, individuals should factor in remote threats such as climate change into their decisions. If risks from the local to the global and connections between them are assessed, people can choose effective actions that build resilience.



(Erisman et al., *Nature*, 519, 7542, 2015)

Conclusions concerning classic breeding for wine grapes

- **Care on wine quality, besides resistance (lesson learned from the past).**
- **Need to develop local breeding programs.**
- **Need to explore all *Vitis* world germplasm, including Near East *V. vinifera* cvs.**
- **Need to address the legislative issue.**
- **Need to coordinate the research efforts.**
- **Need to address more diseases/pests.**
- **Need to preserve previous biodiversity (inter- and intra-varietal variability)⟶ today's standing diversity may include resistance to diseases currently unknown or considered unimportant**

Conclusions concerning new breeding techniques (Nbt) (cisgenesis, genome editing) for wine grapes

- **Science has to take its course, solving current problems (regeneration, side effects) and reaching the target→ new tool to be considered by policymakers.**
- **Choice for utilization of edited grape varieties (when available) → based on political/commercial aspects (best advantage for the national wine chains).**
- **Need to address the legislative issue.**

Ampelographic platform

Traditional breeding

(Vines already on the market)

- Need to be changed

↓

problems with denomination system (where present)

New Breeding Techniques

(Vines not yet on the market)

- No change

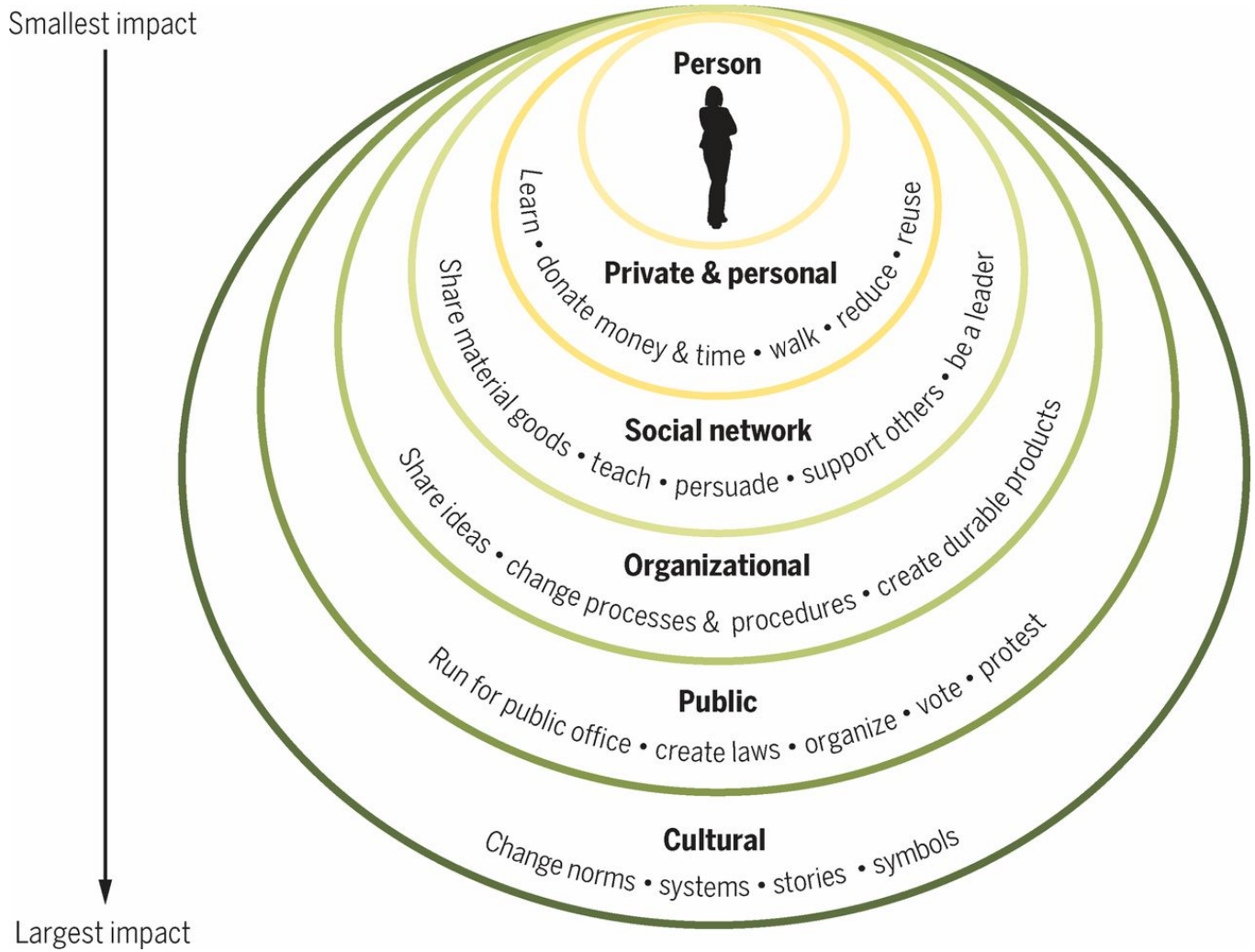
↓

same terroir

Role of scientists

- **Science side: To guarantee the best level of durable resistance together with excellent organoleptic wine traits. To improve resilience of the wine system in a broader way.**
- **Society side: To recognize that this innovation has to be shared with and accepted by the other actors of the wine chain (including the consumers)→ role of education →commitment of resources and time (example ARRIGE)→ policymakers can be flexible in modifying legislation.**
- **Culture side: to emphasize the wine drinking as a cultural fact and a way of life.**

Fig. 1 An individual's spheres of influence.



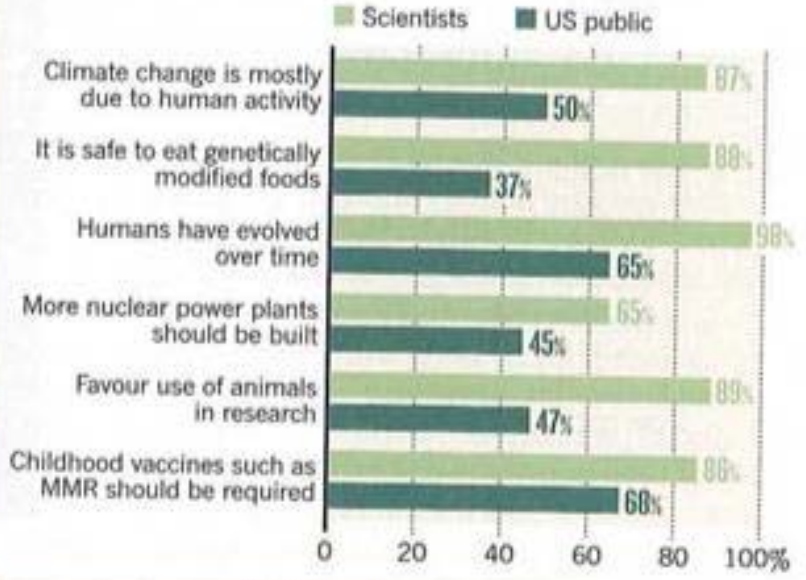
(Elise Amel et al. *Science*, 356, 275-279, 2017)

TREND WATCH

The US public generally supports science, but there seems to be a large gap between it and scientists on some controversial issues. Of about 2,000 adults surveyed, 79% say that science has made life easier for most people, found a poll by the American Association for the Advancement of Science (AAAS) and the Pew Research Center, a think tank in Washington DC. But researchers are left questioning the gulf between them and the public on certain topics. See go.nature.com/jnljfu for more.

OPINION GAP

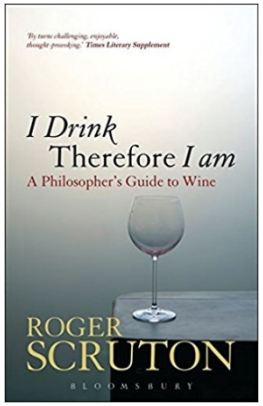
On hotly debated scientific issues, scientists and the public differ greatly, reveals a poll by the AAAS and Pew Research Center.



(***Nature*, 518, 7537, 2015**)

Reading from the book «I Drink, Therefore I am – a Philosopher's Guide to Wine» (Sir Roger V. Scruton, 2009)

- «I have learned from Michelangelo about the pathos of mother love and the divinity of suffering; I have learned from Mozart about the hope that turns the deepest sadness to joy; I have learned from Dostoevskij about forgiveness and how the soul is cleansed by it. And those gifts of understanding were brought to me by art. But what I have learned from wine has welled up from within me: the drink was the catalyst, but not the cause, of what I came to know»



- ***Can a product like this be banned?***

Università Cattolica S.C. at Piacenza, Italy

Many thanks for your attention!