FONDAZIONE EDMUND MACH

L’innovazione digitale e genetica: Il futuro dell’agricoltura

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Fondazione AGRION
Manta, 6 Ottobre 2022

Una Nuova Agricoltura :
un sogno, un incubo o una possibilità?

The new agriculture paradigm

- Increased yield
- Pressure to improve resource efficiency and sustainability
- Changing consumer needs and expectations

The ongoing digitization of agriculture

- Increasing customer proximity
- Greater transparency into input value
- An enhanced customer experience

Industry consolidation and value chain shifts

- Increasing price pressure and competitiveness
- A stronger set of integrated competitors
- A blurring of boundaries between agricultural-supply sectors

Source: BCG analysis.

Agriculture plays a critical role in limiting the impact of climate change

The agriculture sector accounts for a **large, growing, and impactful** share of global greenhouse gas (GHG) emissions.

Agriculture is ...

... larger than you think

Agriculture is one of the highest-emitting sectors.

Total GHG emissions by sector, % (20-year AR5 GWP values)

[1] Including forestry, land use, fertilizer production, and electricity used in agriculture.

Cattle and dairy alone emit enough GHGs to put them on par with the highest-emitting nations.

2016 GHG emissions by country (top three GHGs), $GtCO_2e$[2] (20-year AR5 GWP values)

[2] Gigatonnes of equivalent carbon dioxide.

Major contributors to agriculture emissions include:

Enteric fermentation | Manure | Rice cultivation | Fertilizer release and runoff | On-farm energy use | Nitrogen fertilizer production | Deforestation

... growing faster than you realize

Demand for agricultural production over the next 30 years will likely be shaped by two primary factors:

Population reaching

~10 billion

Per capita food consumption growth of

8–12%

As a result, agriculture emissions are likely to increase

15–20% by 2050[3]

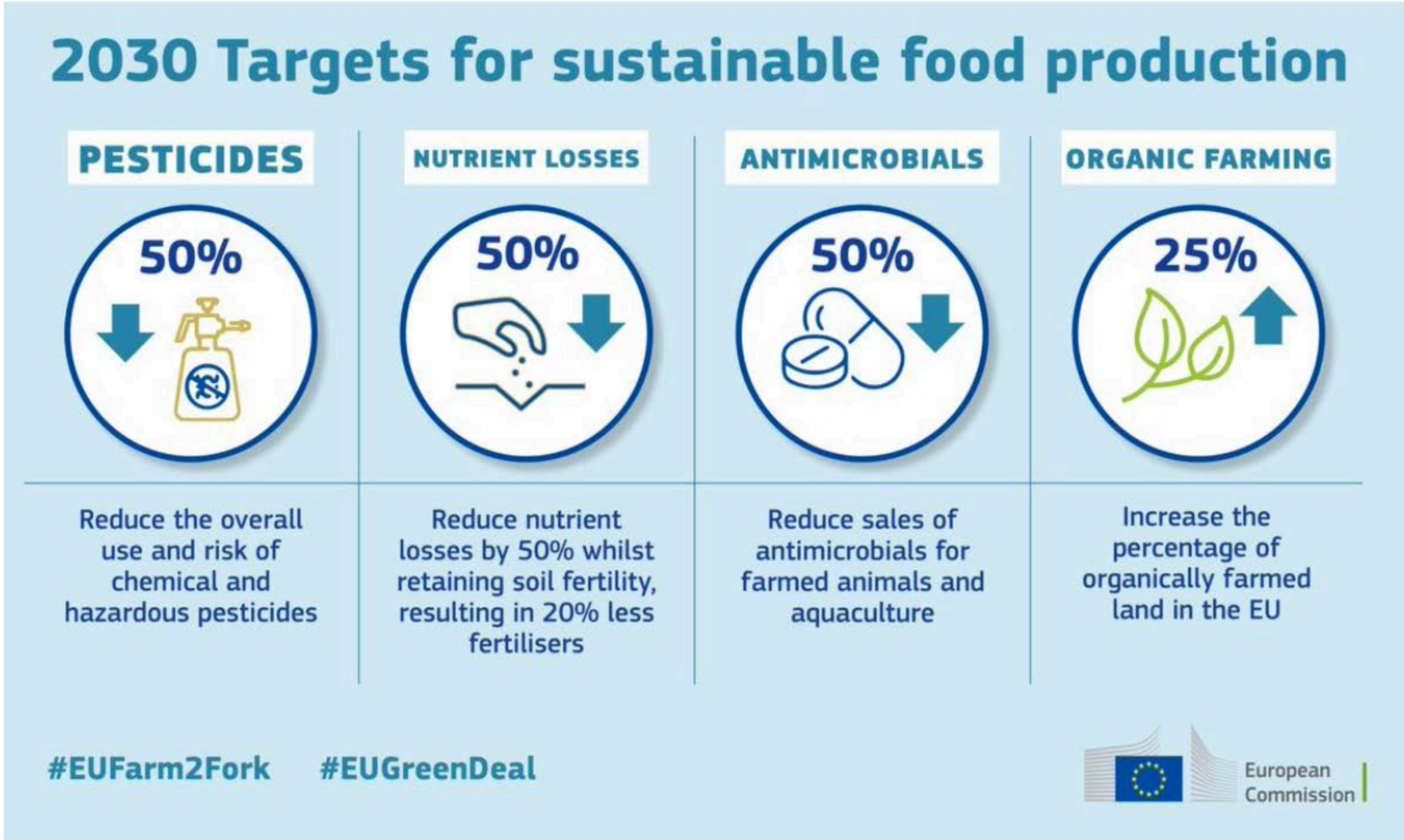
[3] Assuming current levels of production efficiency.

Agriculture

27% GHG

McKinsey & Company

Agricoltura Sostenibile!!!!!

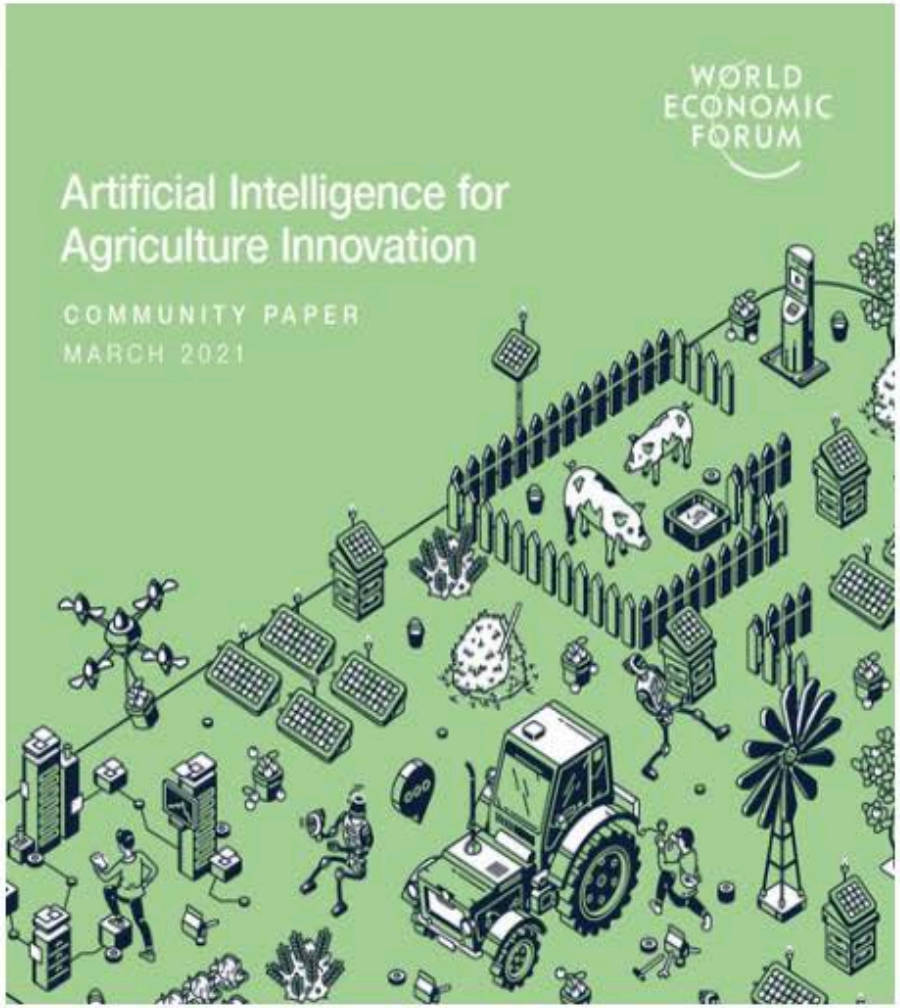


Tecnologie Emergenti in Agricoltura

Tecnologie Emergenti in Agricoltura

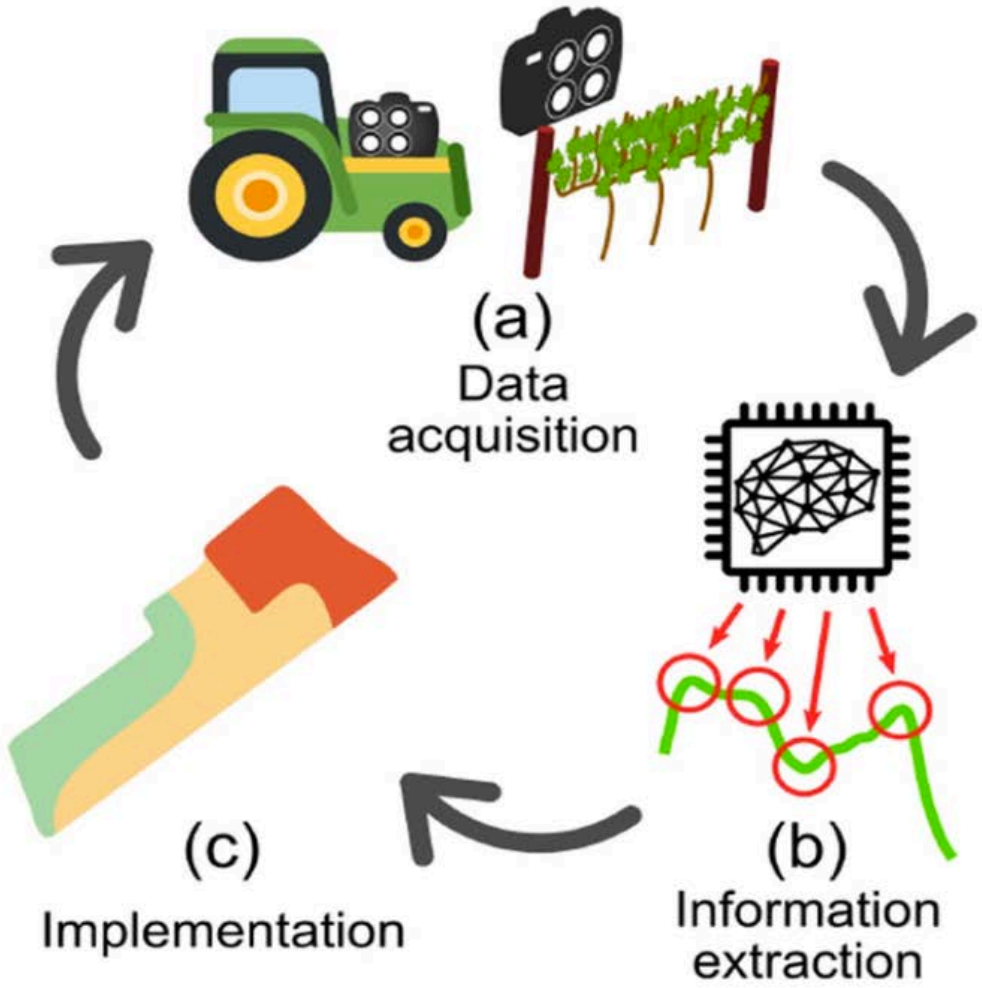
Source: PwC

Intelligenza artificiale e innovazione in agricoltura

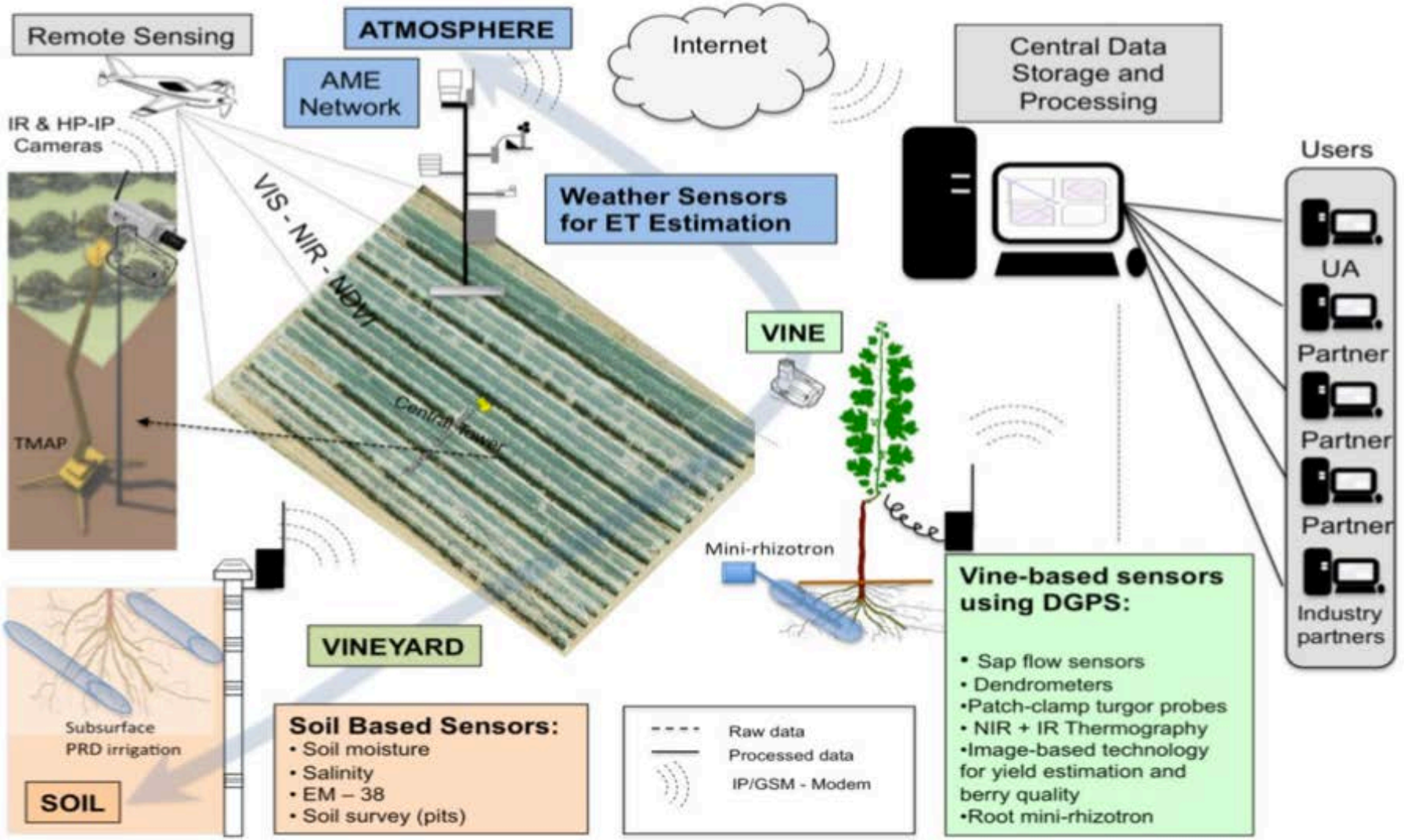


Emerging technologies from drones to digitalization have the potential to transform farming productivity, reduce environmental impact and boost farmers' incomes.

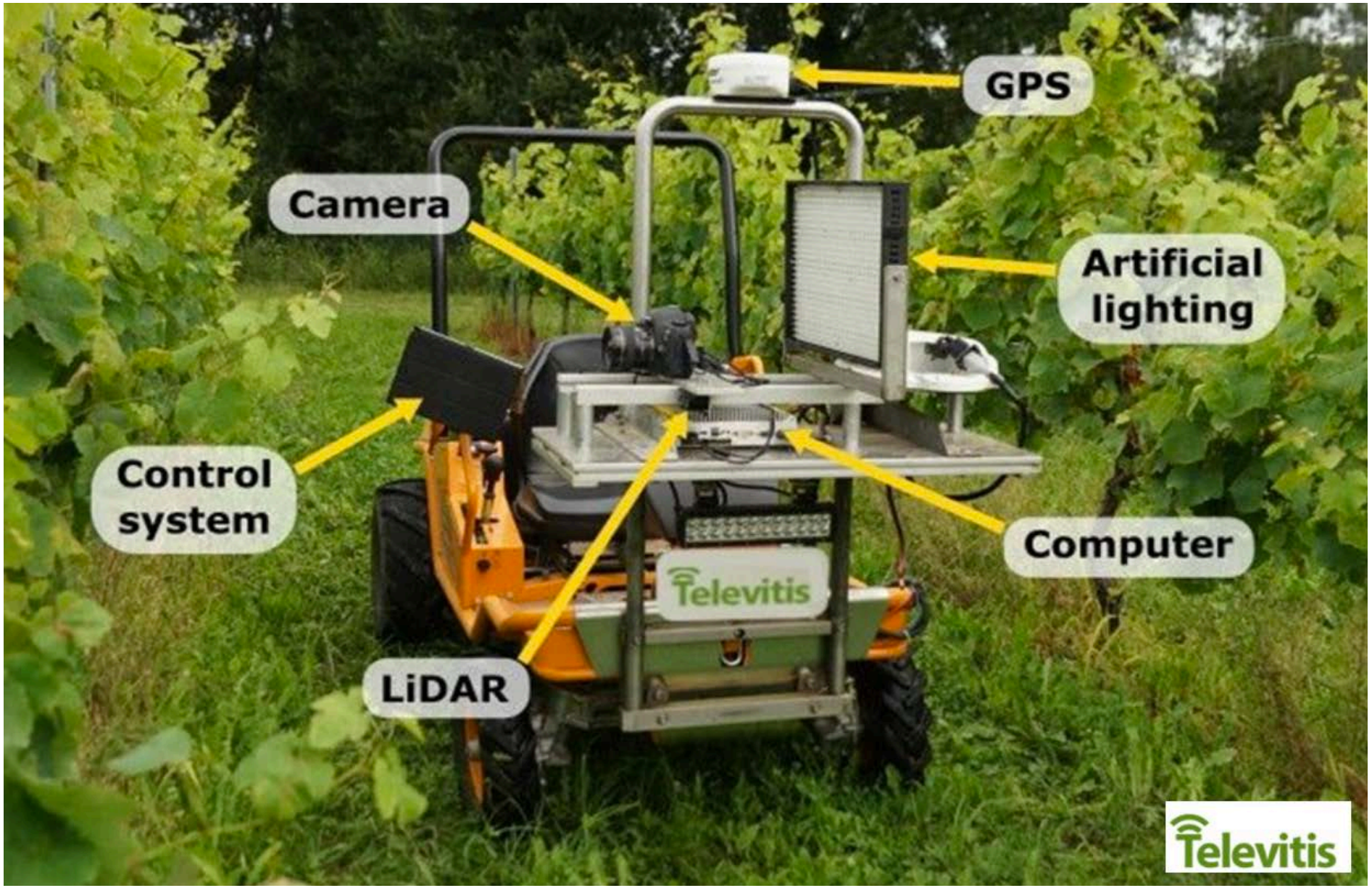
Viticoltura digitale: viticoltura data-driven



Viticoltura del futuro



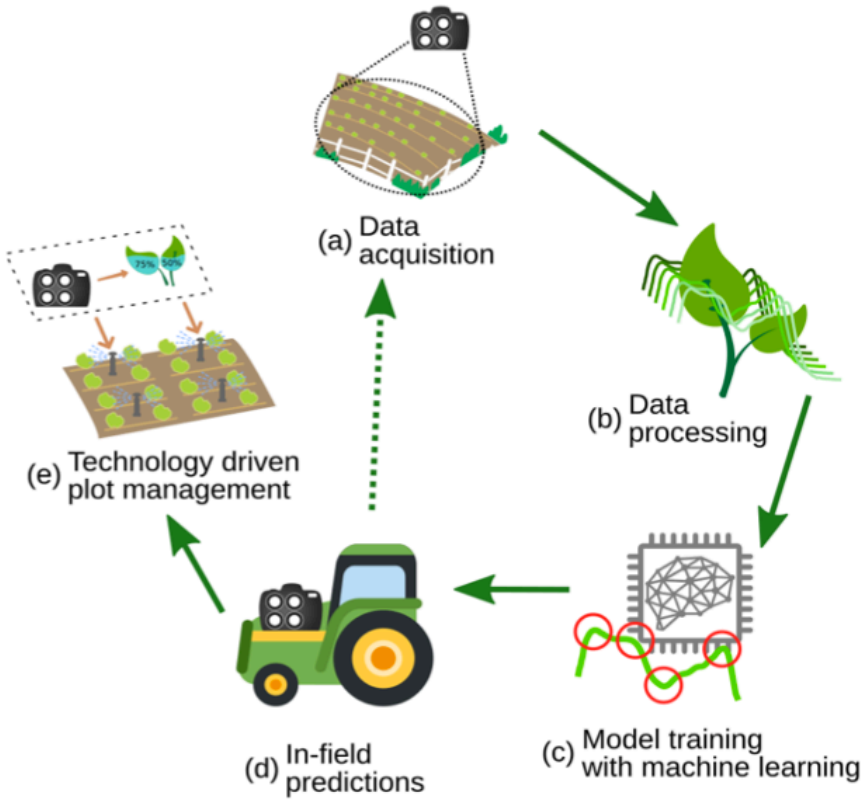
Piattaforma mobile-sensing



Robots in viticoltura

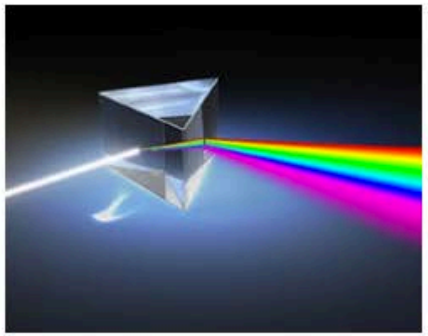
Robots in viticoltura

Data-driven viticoltura smart

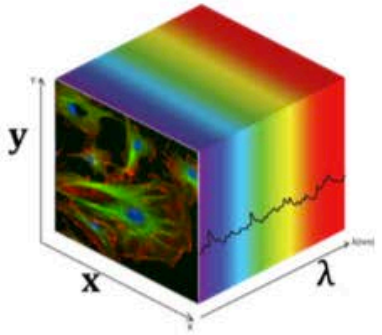


TARDAGUILA, J., STOLL, M., GUTIERREZ, S., PROFFITT, T., DIAGO, M. P. (2021) Smart applications and digital technologies in viticulture: A review. Smart Agricultural Technology

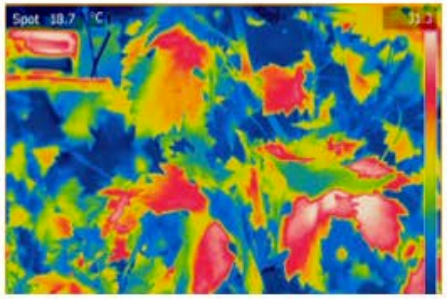
Nuove ed emergenti tecnologie non-invasive



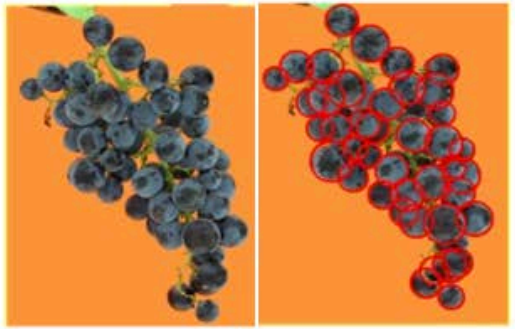
Spectroscopy



Hyperspectral imaging



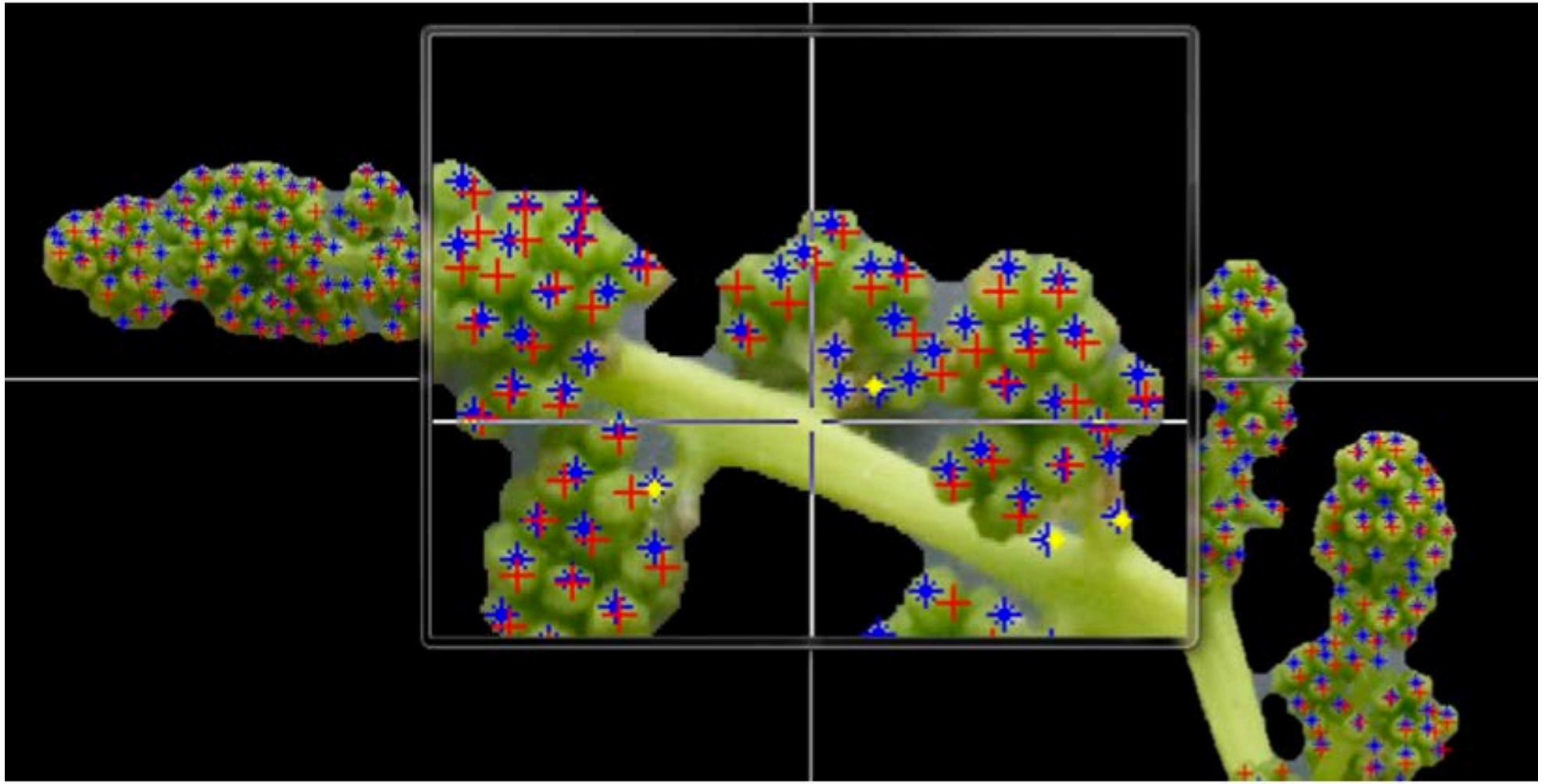
Thermal imaging



Machine vision

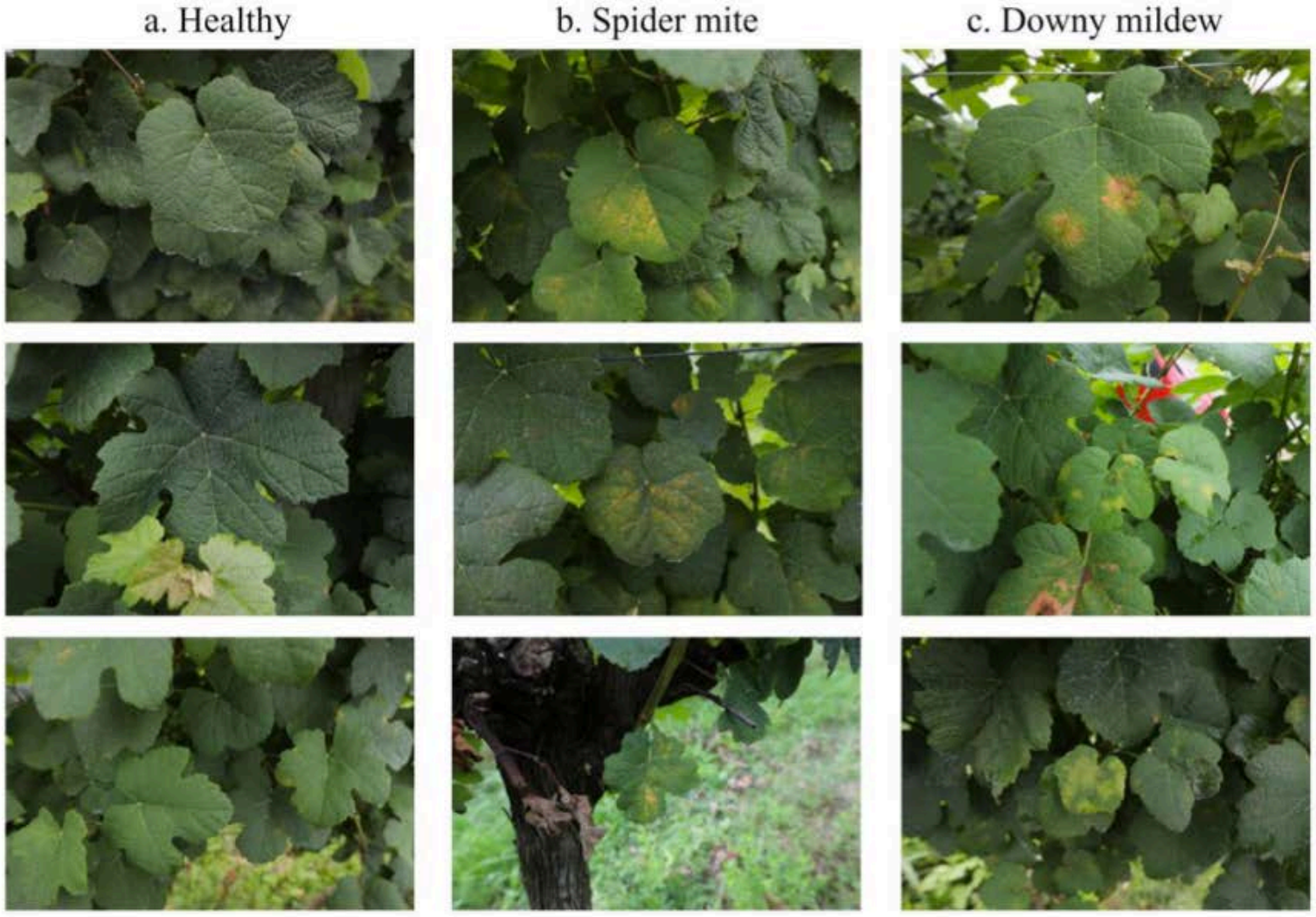
Applicazione in pieno campo

Immagine iperspettrale dal campo

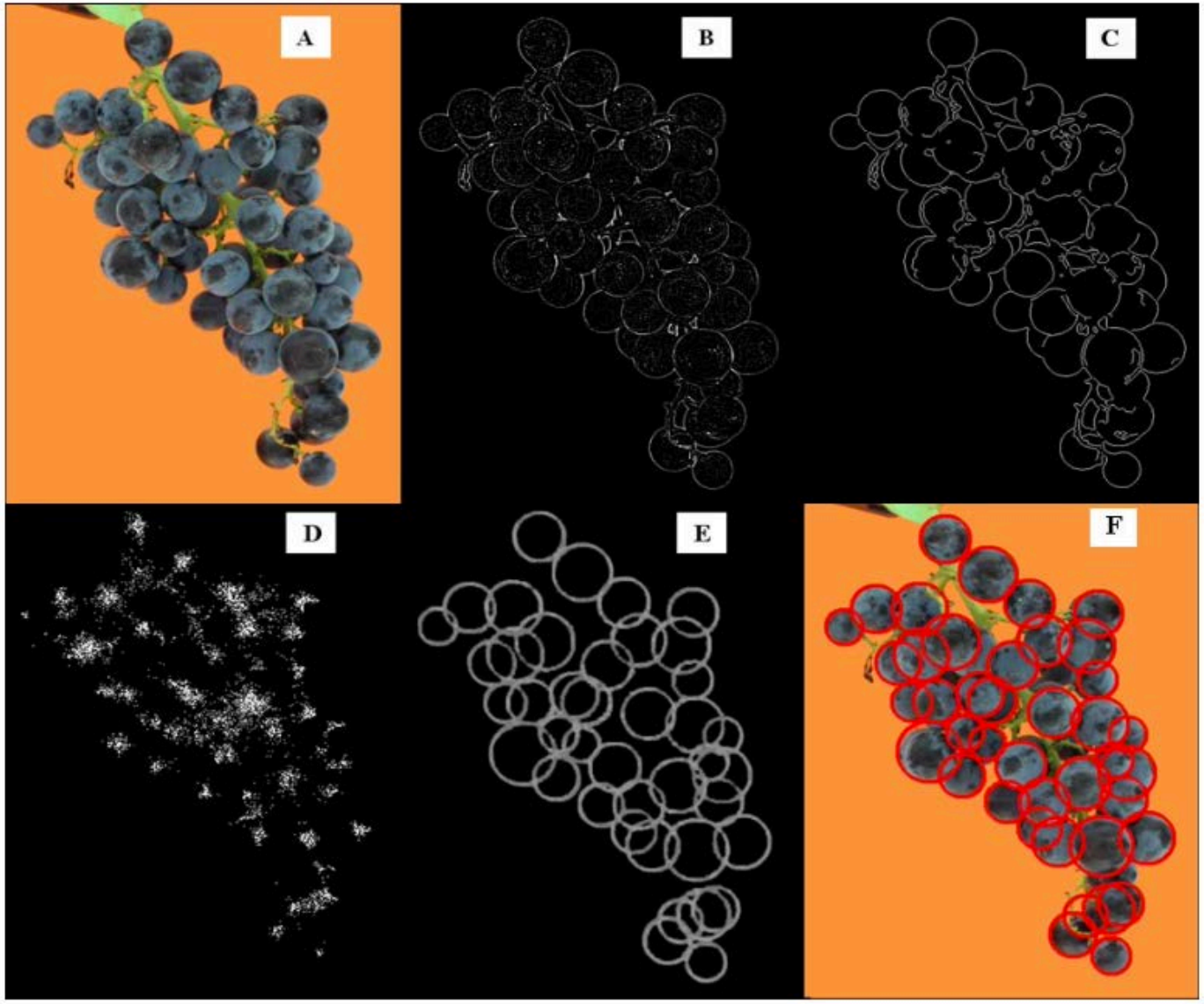


Predizione della resa attraverso la visione computerizzata e AI

Deep learning e computer vision per il rilevamento e la valutazione del danno



Numero di acini per grappolo



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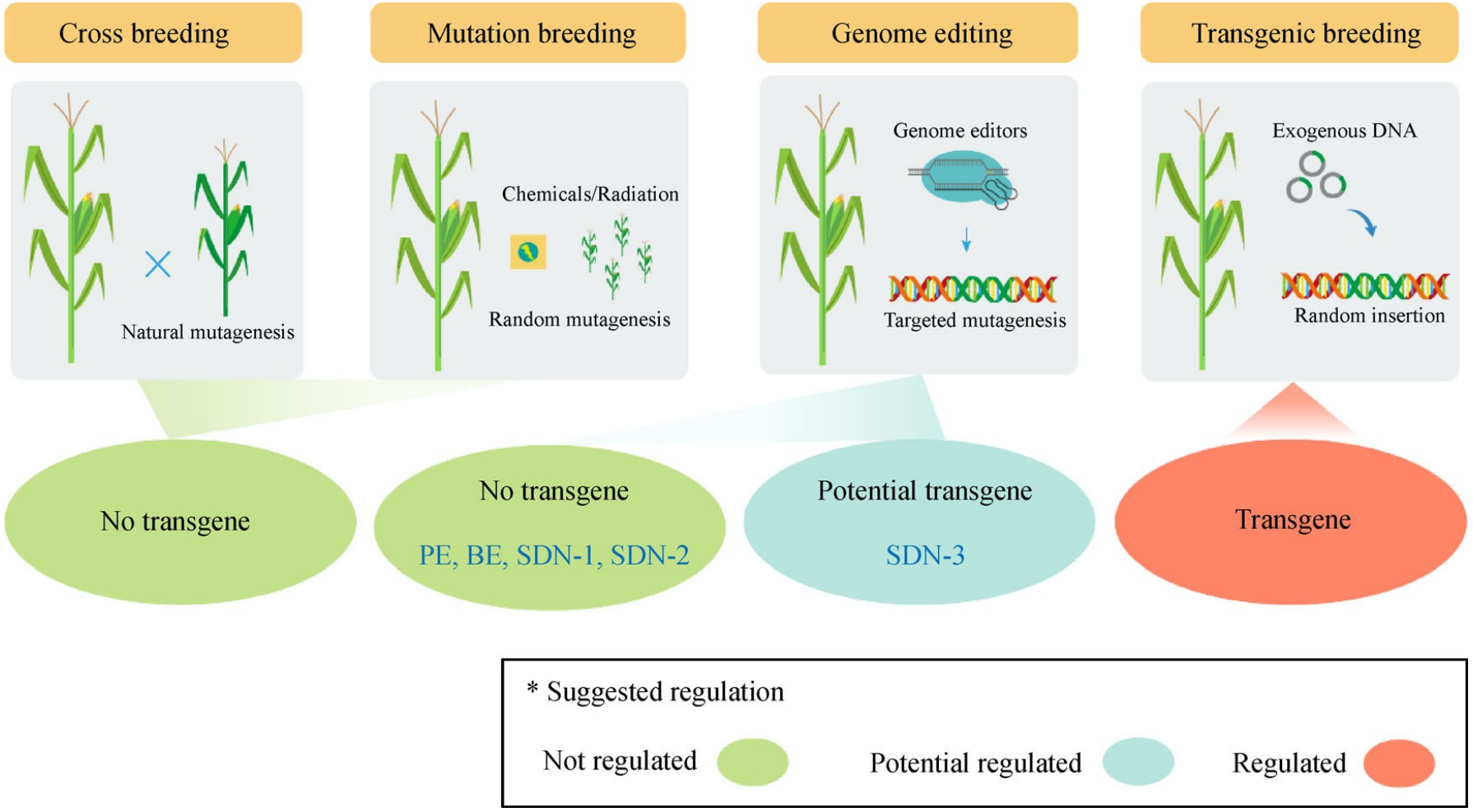
Gli strumenti della genetica



Gao 2021

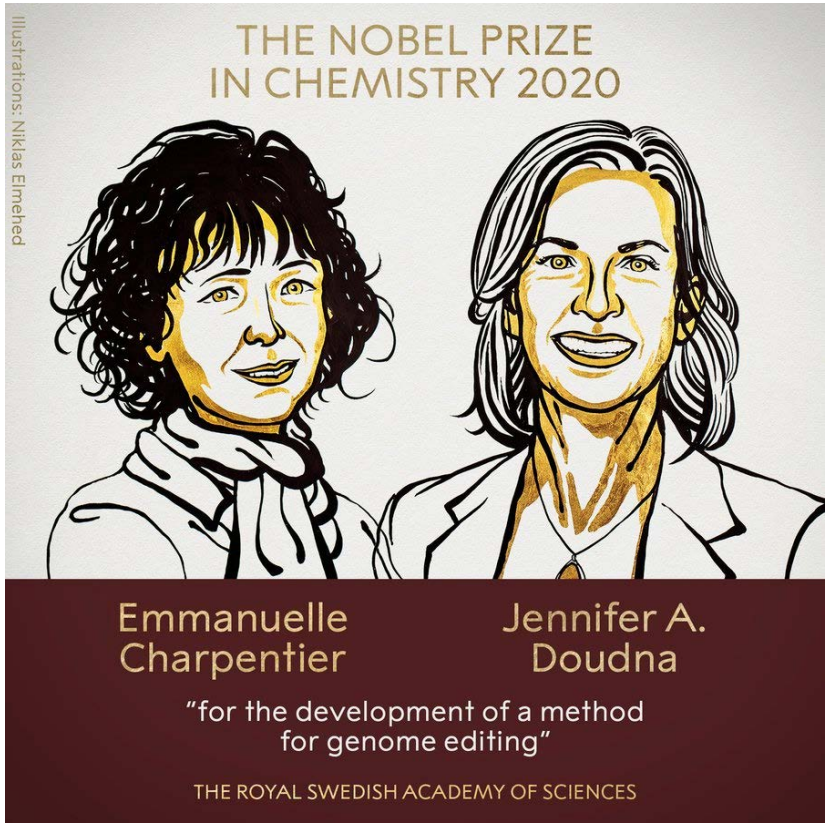
Innovazione: TEA

TEA= Tecnologie di Evoluzione Assistita

Tecnologie che consentono modificazioni precise e dirette del DNA delle piante coltivate

Riproducono gli effetti dell'evoluzione biologica: mutazioni del DNA e scambio di geni fra individui che possono incrociarsi.

EDITING GENETICO



EDITING GENETICO

FONDAZIONE EDMUND MACH

Editing genetico

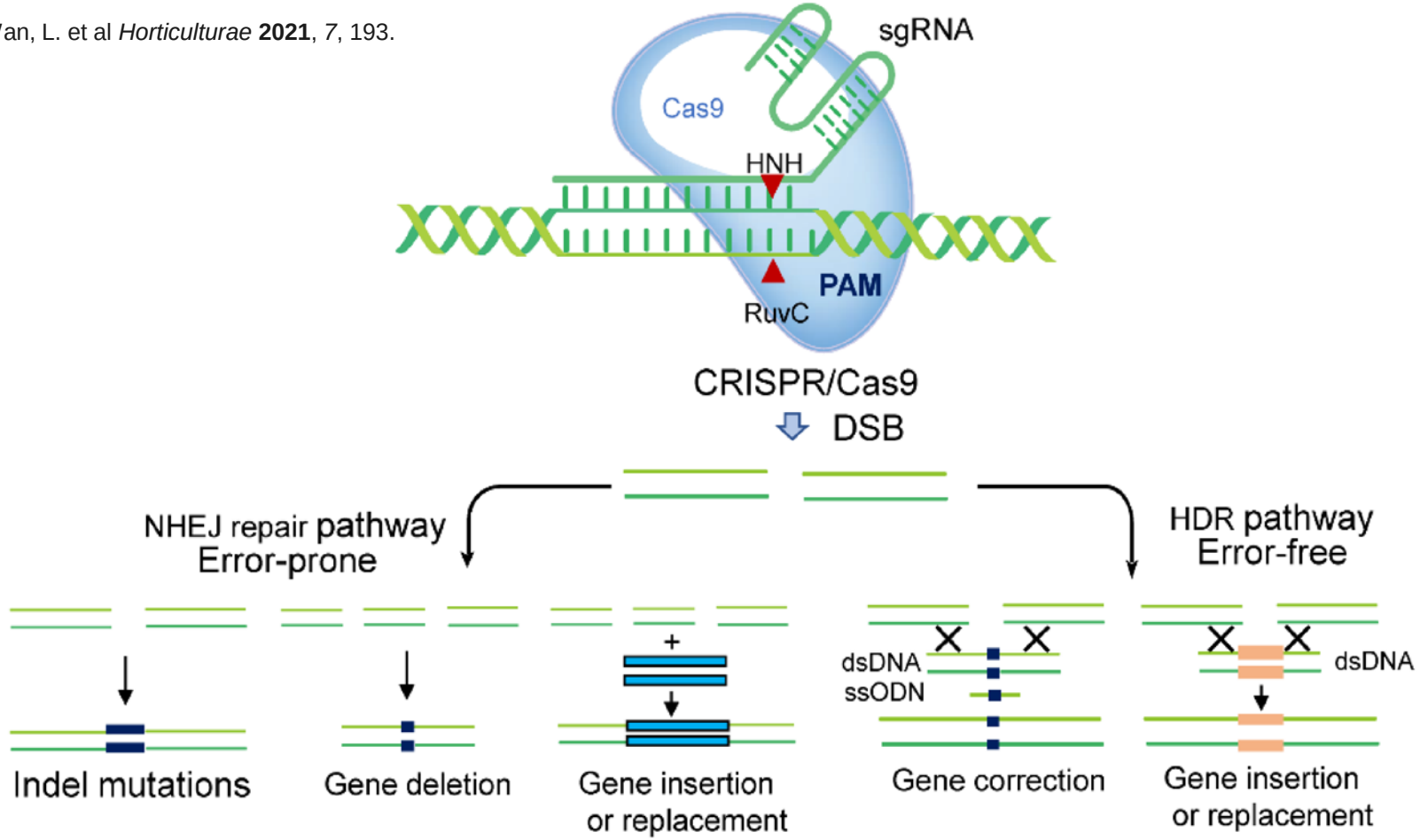
Correzione puntuale del DNA

MUTAGENESI MIRATA
E
SPECIFICA DI UN GENE

PRODOTTI CHE POTREBBERO ESSERE OTTENUTI TRAMITE BREEDING CLASSICO
O MUTAZIONE NATURALE

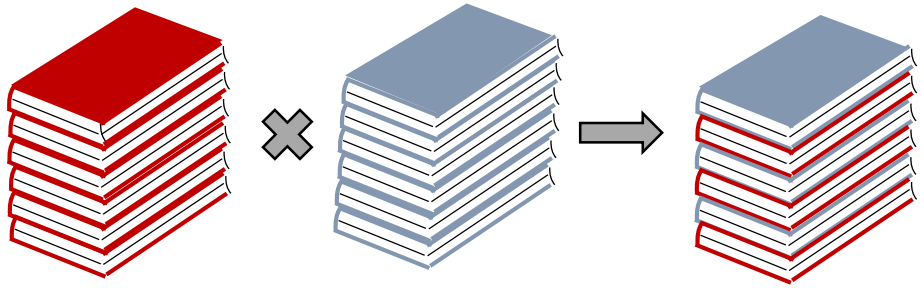
EDITING GENETICO: diversi prodotti possibili

da: Wan, L. et al *Horticulturae* **2021**, *7*, 193.

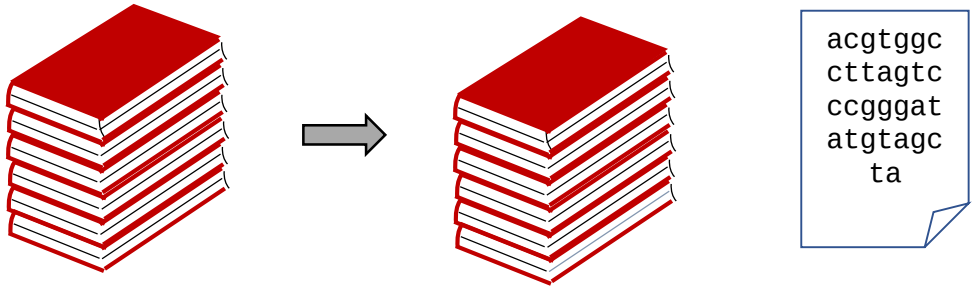


1. Inattivazione del gene – 2. Correzione del gene – 3. Inserimento di un nuovo gene

EDITING GENETICO:
I vantaggi



Miglioramento genetico
per incrocio



Miglioramento genetico
con editing genetico

- Il genotipo e il fenotipo della pianta editata sono del tutto simili a quelli originali, se non per un carattere > **ottengo un nuovo clone nel caso delle piante arboree**
- La **modifica** del DNA è **molto contenuta** (anche singolo nucleotide) e **precisa** (sito-specifica)
- La **rapidità**: si evitano i reincroci che richiedono parecchi anni in particolare in piante arboree

L'EDITING GENETICO: come si fa in pratica

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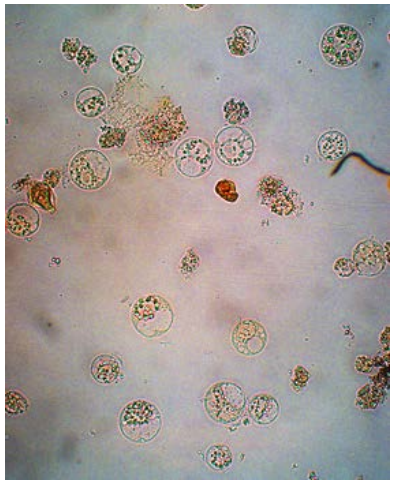
Embryogenic callus



Protoplasts

Mature Embryo

Germinating somatic embryo

Plantlet

In-vitro plant

Plant

CENTRO RICERCA e INNOVAZIONE
Fondazione Edmund Mach

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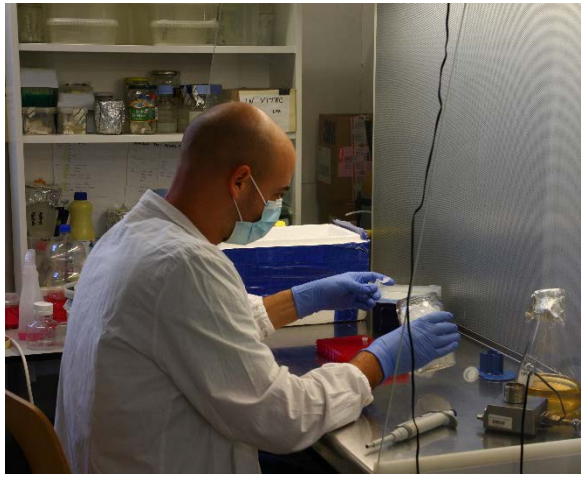
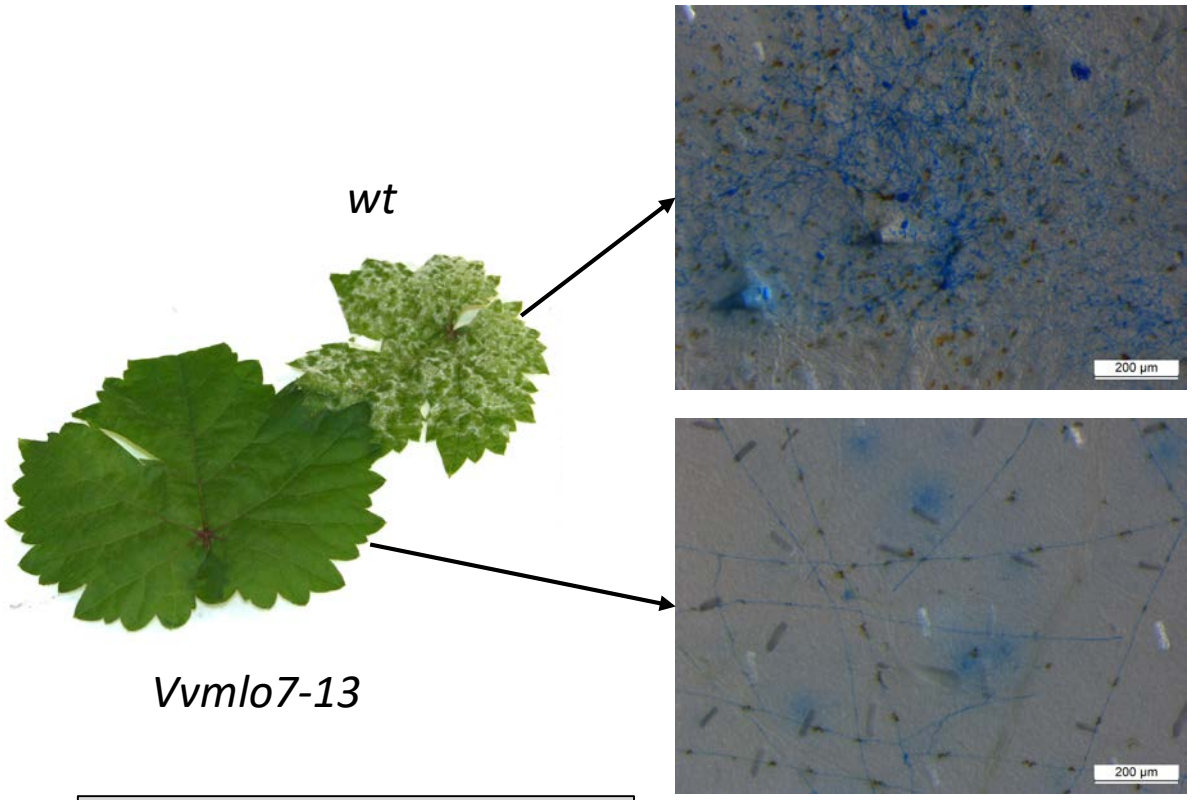
CAMPI SPERIMENTALI – SERRE – LABORATORI – 250 RICERCATORI



EDITING GENETICO:
Esempio di vite

INATTIVAZIONE DI GENI DI SUSCETTIBILITA' A PATOGENI

Infezione con oidio

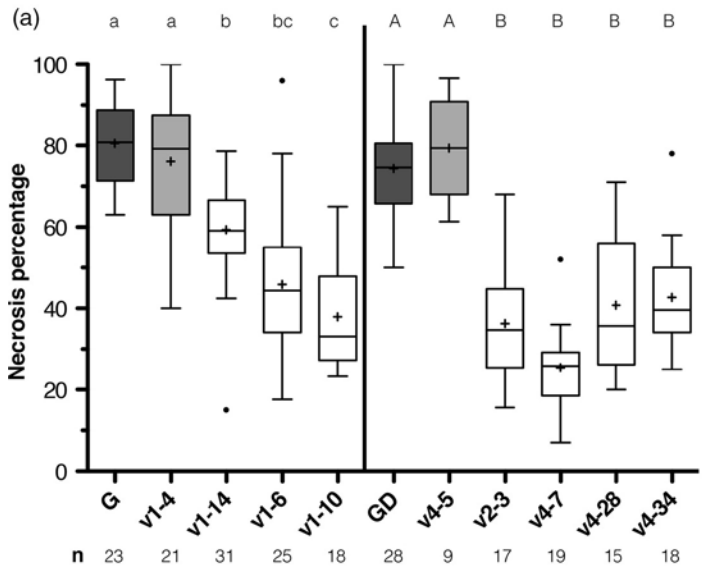


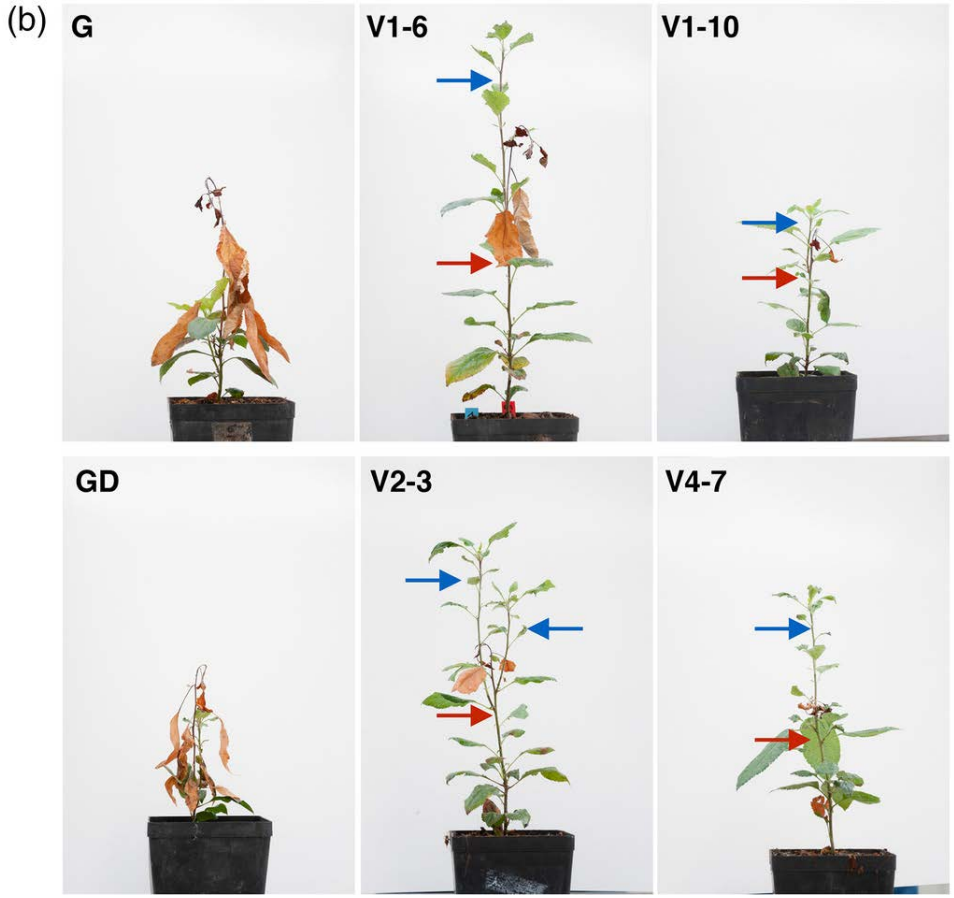
Riduzione uso fitofarmaci

mario.pezzotti@fmach.it

EDITING GENETICO:
Esempio di melo

Colpo di fuoco batterico



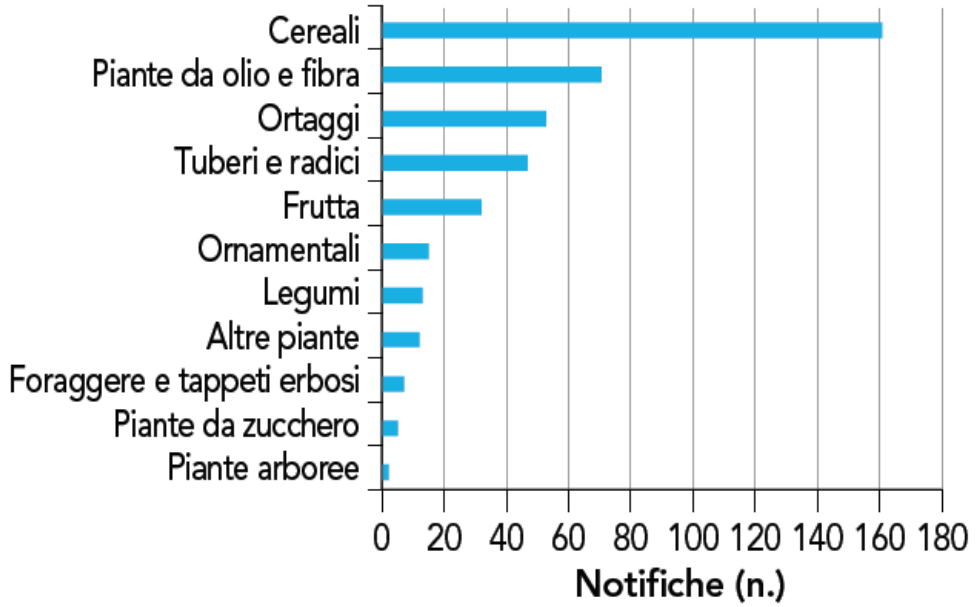


Riduzione uso fitofarmaci

Pompili et al. 2019 Plant Biotechnology Journal
https://doi.org/10.1111/pbi.13253

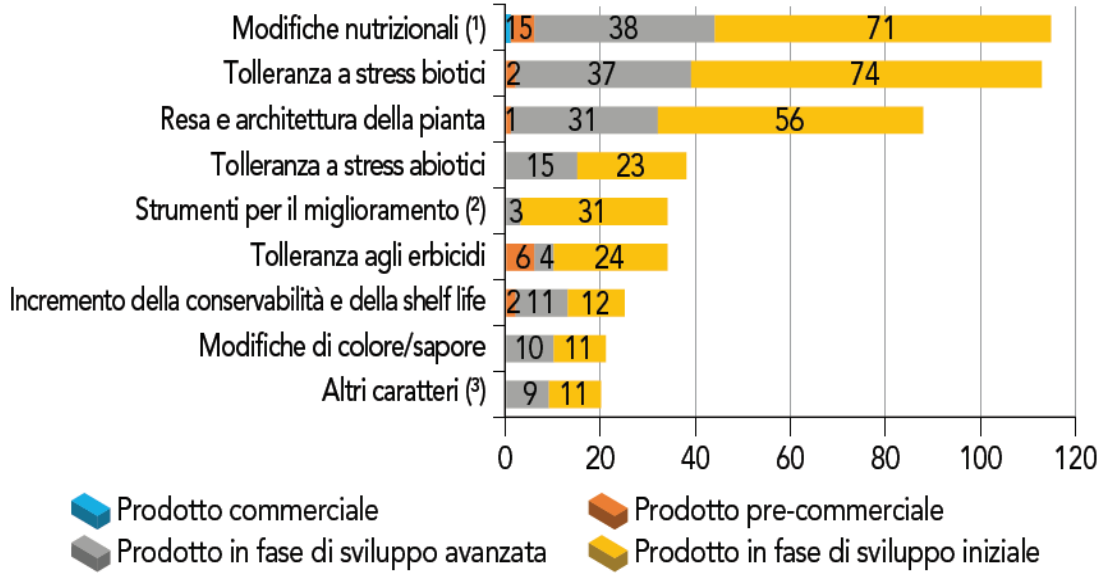
EDITING GENETICO: a che punto siamo in Europa

GRAFICO 1 - Notifiche di piante TEA depositate al giugno 2021



Su un totale di 444, 260 provengono da enti pubblici e 184 da enti privati.
Fonte: https://datam.jrc.ec.europa.eu/datam/mashup/NEW_GENOMIC_TECHNIQUES/index.html

GRAFICO 2 - Caratteri e fase di sviluppo delle notifiche di piante TEA



(1) Comprende le modifiche del contenuto di amido, oli, proteine, vitamine, fibre, sostanze tossiche e allergeni, incluso il glutine. (2) Comprende caratteristiche riproduttive come la maschiosterilità, l'autoincompatibilità e l'induzione di aploidi. (3) Comprende la produzione di molecole di interesse industriale, la modifica del periodo di fioritura e l'efficienza d'uso dell'azoto.
Fonte: adattato da https://datam.jrc.ec.europa.eu/datam/mashup/NEW_GENOMIC_TECHNIQUES/index.html

Prodotti già sul mercato:

- soia con profilo di ac. grassi modificato,
- patata che non imbrunisce e resistente alla ruggine

https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/13119-Legislation-for-plants-produced-by-certain-new-genomic-techniques/F_en

Legislation for plants produced by certain new genomic techniques

PAGE CONTENTS

About this consultation

Target audience

Why we are consulting

Responding to the questionnaire

Consultation outcome

Related links

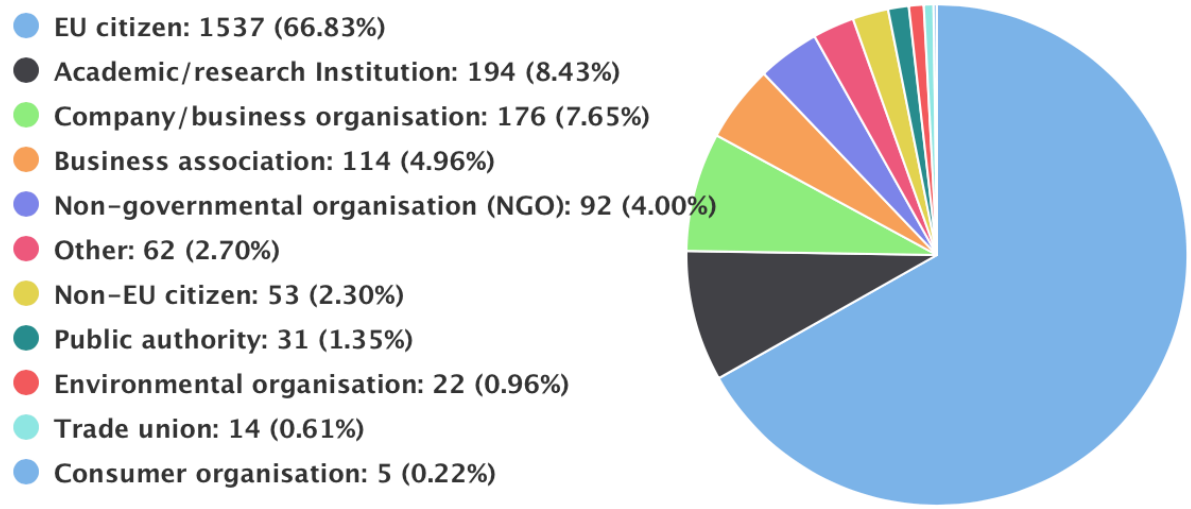
About this consultation

Consultation period	29 April 2022 - 22 July 2022 (midnight Brussels time)
Topic	Food safety

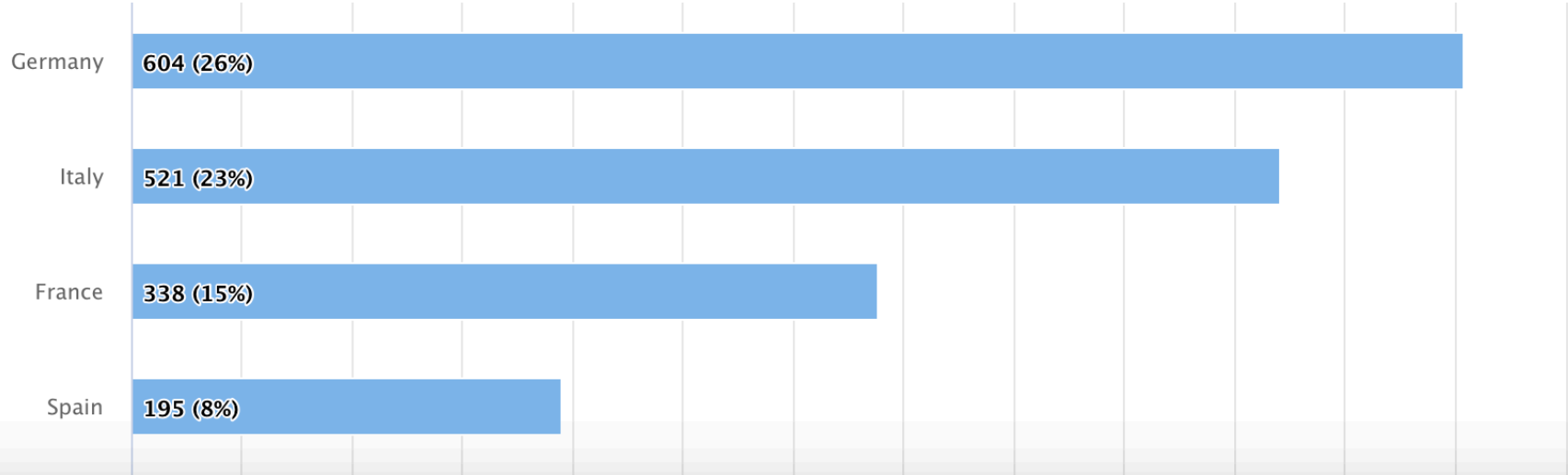
Target audience

The initiative on plants produced by certain new genomic techniques concerns citizens and stakeholders (e.g. EU and national public authorities, breeders, farmers and other economic

By category of respondent



By country

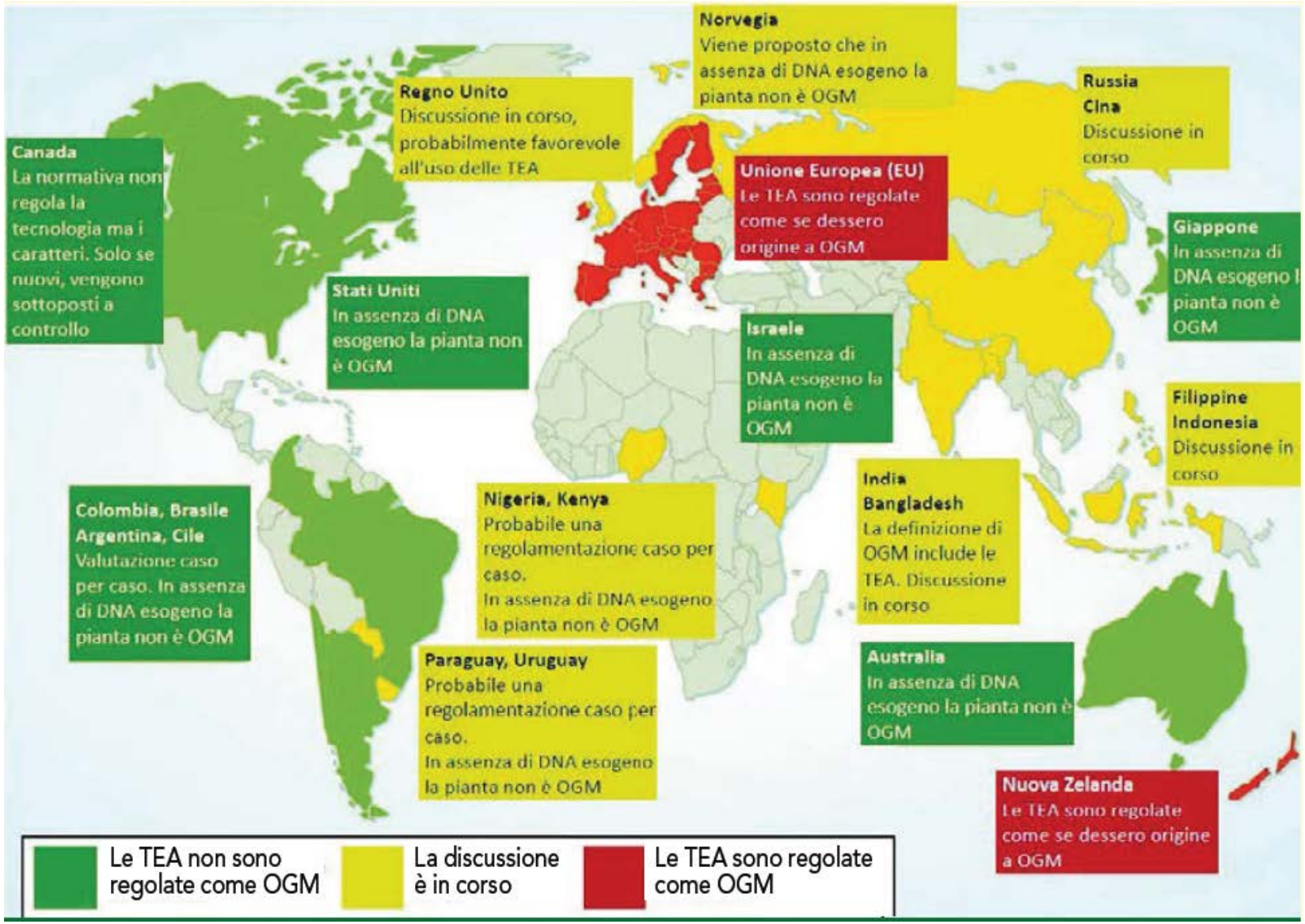


Adequacy of existing framework:

Overall, four out of five (1732; 79%) participants in the consultation found that the **existing provisions of the GMO legislation are not adequate for plants obtained by targeted mutagenesis or cisgenesis**. This view was expressed by the large majority[1] of EU and non-EU citizens, academia/research institutions, business associations, companies/business organisations, and public authorities, as well as the majority[2] of trade unions. Among the economic sectors, this view was expressed by the large majority of operators from biotechnology and bio-based industry, farming, feed, ornamental plants, plant breeding and plant protection and fertilisers, and by the majority of operators from trade and food processing/manufacture.

17% (375) of the total consultation respondents found the **current GMO provisions adequate for plants produced by targeted mutagenesis or cisgenesis**; this view was expressed by a large majority of environmental organisations, and by the majority of NGOs and consumer organisations. Among the economic sectors, this view was expressed by a large majority of operators in food retail/service, organic, GM-free and forestry.

Regolamentazione: si possono coltivare?



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INGREDIENTI NECESSARI PER INTRODURRE INNOVAZIONI TECNOLOGICHE IN AGRICULTURA
(cioè come passare dal laboratorio alla tavola)

1. Ricerca di eccellenza
2. Un ecosistema dell'innovazione
3. **Un *corpus* normativo adeguato**
4. **Accettazione da parte del consumatore**

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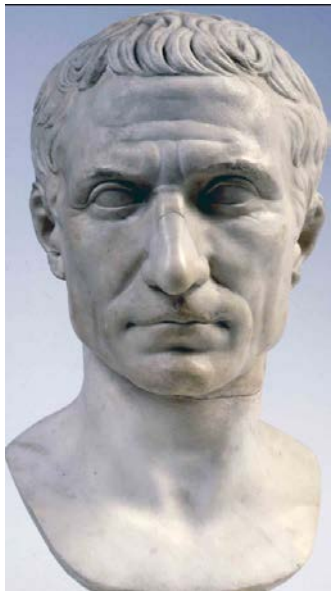
COME CAMBIARE LA PERCEZIONE DELL'INNOVAZIONE IN AGRICOLTURA

- Abbiamo bisogno di una nuova narrativa ed una nuova visione
- TEA e agricoltura di precisione al centro di una rivoluzione in agricoltura
- Combinare produttività e sostenibilità
- Innovazione per preservare le tradizioni
- Innovazione per preservare la diversificazione agricola ed alimentare
- Ruolo chiave della viticoltura

«La natura ci ha dato due strade per giungere alla conoscenza delle cose agrarie e cioè l'esperienza e l'imitazione. Gli antichi agricoltori appresero la gran parte delle cose tramite l'esperienza mentre i loro discendenti appresero soprattutto tramite l'imitazione.
Noi dovremmo oggi fare ambedue le cose, e cioè da un lato imitare gli altri e dall'altro saggiare le cose tramite esperimenti svolti non tanto seguendo il caso quanto adottando un metodo razionale»



Marco Terenzio Varrone
116-27 a.C.

GRAZIE DELL’ ATTENZIONE!