
This project has received funding from the European Union's Horizon Programme (HORIZON-CL6-2023-BIODIV-01) under grant agreement No 101135088

European Commission

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## The European Green Deal

Striving to be the first climate-neutral continent


**The first climate-neutral continent**
by 2050

**At least 55% less**
net greenhouse gas emissions by 2030, compared to 1990 levels

**3 billion**
additional trees to be planted in the EU by 2030

## PRIORITIES

- protection of the biodiversity and ecosystems
- reduction of air, water and soil pollution
- movement towards a circular economy
- improved waste management ensuring the sustainability of blue economy and fisheries sectors

**HORIZON-CL6-2023-BIODIV-01-14: Biodiversity friendly practices in agriculture – breeding for Integrated Pest Management (IPM)**

- **EU's biodiversity strategy for 2030** is a comprehensive, ambitious and long-term plan to **preserve nature and reverse the degradation of ecosystems**
- There is a **strong social demand** and expectation for environmental and health protection

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# Why Grapevine?

- Grapevine (*Vitis* spp.) is one of the **major** and most economically important **fruit crops** worldwide
- The vitiviniculture in EU is a **leading sector** of the **agro-industrial economy** with 3.2 million hectares of vines in 2020, 45 % of the world's wine-growing areas (https://agriculture.ec.europa.eu/farming/crop-productions-and-plant-based-products/wine_en)
- Historical connections with the development of human culture and with the **socio-cultural background**
- The ***Vitis* genus** is very rich in genetic variability and includes **80 species** in two sub-genera: Muscadinia and Euvitis.
- The Vitis international variety catalogue identifies **21,045 names of varieties**, of which 12,250 *V. vinifera* varieties, including a considerable number of synonyms and homonyms
- The actual number of vine varieties for the ***V. vinifera*** species in the world is estimated at **6,000**.

***V. vinifera* in EU**

| Country | Vineyard area (ha)* | Number of traditional varieties** |
|---|---|---|
| ITALY | 605,000 | 1,583 |
| FRANCE | 815,000 | 808 |
| GREECE | 51,000 | 622 |
| SPAIN | 884,000 | 537 |

**but….**

* Anderson e Nelgen, 2020
** Maul et al., 2021 (*Vitis International Variety Catalogue*)

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# but…..

- **Viticulture is the sector with the highest use of pesticides,** in particular to **control PM and DM**

  France: 20% of agricultural pesticides are used in vineyards, while vine represents only 3% of the cultivated areas (Eurostat, 2007)

- In the top 15 countries in the world for vineyard area, **less than 10 varieties occupy more than 60% of the vineyards** (OIV 2017)

Image courtesy of A. Schneider

**The limited exploitation of biodiversity in grapevine represent a limitation**

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# Grapevine and climatic changes

**CLIMATE CHANGE**
2016 14.7 °C → 2050 16.0 °C
Increase of average global temperature

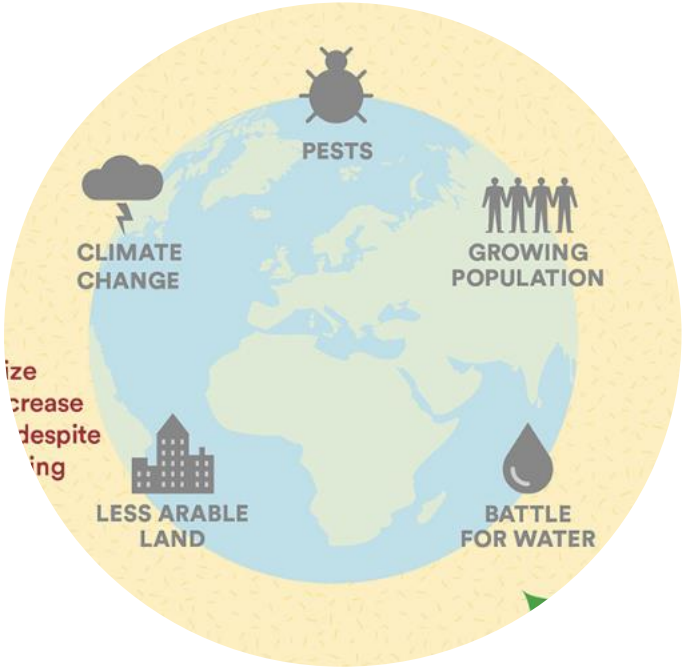
**PESTS**
2016 10-15 % → 2050 20-25 %
Increase in the amount of global crop production lost to pests

**BATTLE FOR WATER**
2016 3,500 km³ → 2050 5,500 km³
Rise of global water demand

**GROWING POPULATION**
2016 7.3 bn → 2050 9.8 bn
Rise of global population

**LESS ARABLE LAND**
2016 0.20 ha → 2050 0.15 ha
Decrease in use per capita

ISF International Seed Federation Seed is Life




PNAS

## Climate change, wine, and conservation

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Edited by Robert E. Dickinson, University of Texas at Austin, Austin, TX, and approved February 19, 2013 (received for review June 21, 2012)

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# Shiled4Grape OVERALL OBJECTIVE

- ✓ **Improvement of resilience of the grapevine agri-food systems** against pest diseases in a context of climatic changes

- ✓ **S4G** will introduce safer and more **sustainable approaches against fungal/oomycete pathogens** in combination with **new grapevine resilient genotypes**.

- ✓ **S4G** will contribute to **safeguard of the territory**, the human health, the farmers, the population living in grape-growing areas and the consumers through a combination of **new knowledge acquired from pathology, genetic and genomics**, along with **innovative IPM** and breeding processes.

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# 3 Targets

***Plasmopara viticola***
**(Downy mildew)**

***Erysiphe necator***
**(Powdery mildew)**

**Grapevine Trunk Diseases**

Resilience of the grapevine agri-food systems against diseases in a context of **CLIMATIC CHANGES**

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# Shield4Grape Consortium

**16** partners from **7** Countries

The consortium is interdisciplinary, multi-actor, cross-border, collaborative and well representative of different EU biogeographical regions and it knows the local requirements.

Start **February 1, 2024**, total funding **5 million €**


Externally supported by the **International Organisation of Vine and Wine (OIV)**

OIV
International Organisation of Vine and Wine
Intergovernmental Organisation

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## Italy

- National Research Council of Italy- Institute for Sustainable Plant Protection (CNR-IPSP) _ **Coordinator, Giorgio Gambino** (giorgio.gambino@cnr.it)
- Council for Agricultural Research and Agricultural Economics Analysis - Research Centre for Viticulture and Enology (CREA-VE), **Walter Chitarra** (walter.chitarra@crea.gov.it)
- Vignaioli Piemontesi
- METEC innovation consulting srl

## Portugal

- Faculdade de Ciencias da Universidade de Lisboa_The grapevine pathogen systems lab (GPS Lab)
- Instituto Nacional de Investigaçao Agraria e Veterinaria (INIAV)
- Associacao de Viticultores do Concelho de Palmela (AVIPE)

## Spain

- Universidad de la Rioja_Laboratory of food quality, sensory analysis and sustainable agricultura
- Instituto Murciano de Investigacion y Desarrollo Agrario y Medioambiental (IMIDA)_Molecular Genetic Breeding team

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## France

- Burgundy School Of Business
- Pôle Bourgogne Vigne et Vin

## Greece

- Aristotle University of Thessaloniki
- Agri-Environmental Originative Solutions P.C. (AGRENAOS)
- Hellenifera P.C.

## Cyprus

- Center for Technology Research and Innovation (CETRI)

## Hungary

- University of Pecs_Research Institute for Viticulture and Oenology

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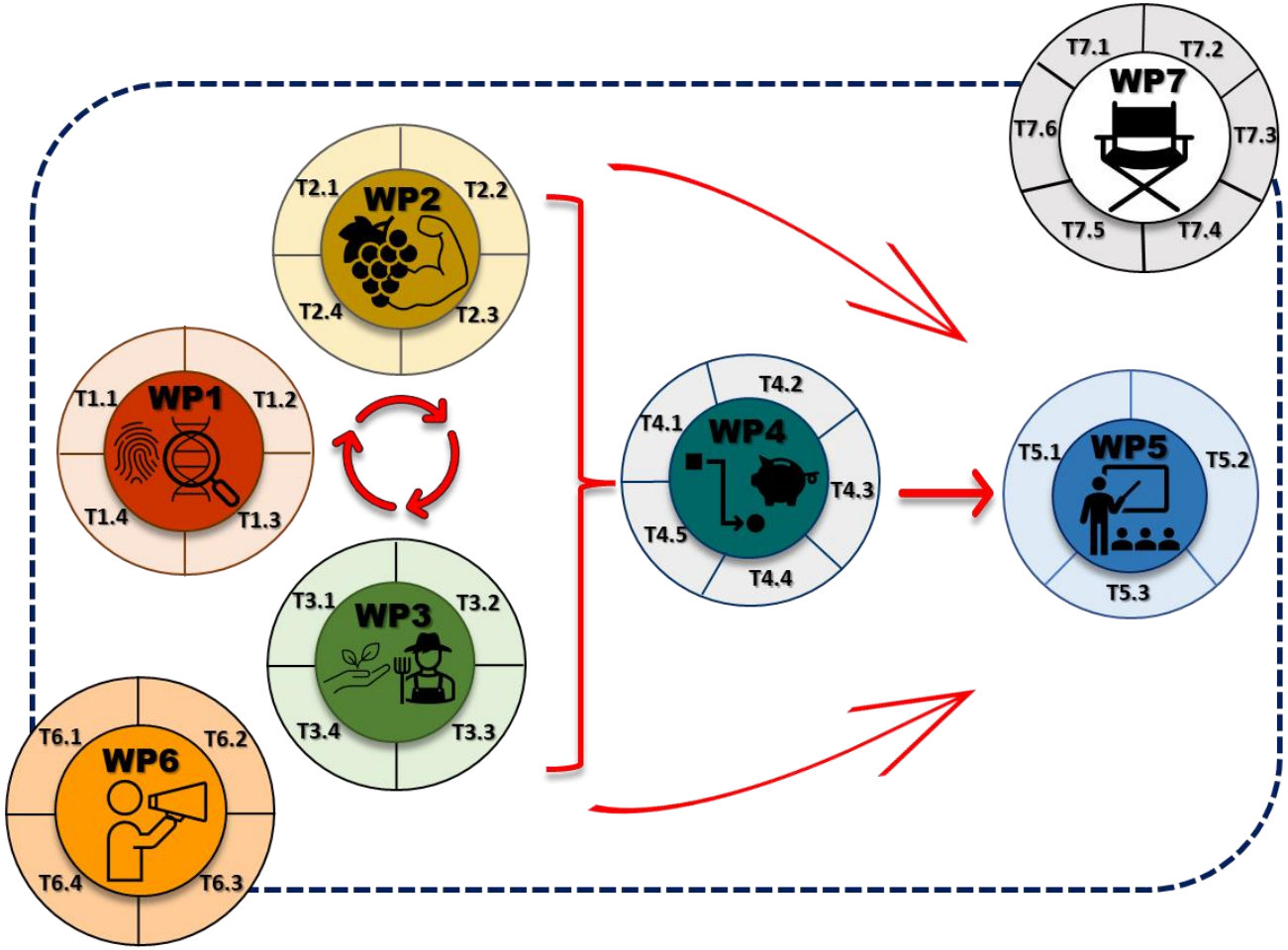
# Shield4Grape Implementation

- ✓ **36 months**
- ✓ **7 Work Packages**
- ✓ **35 Deliverables**

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# Objective #1: Exploitation of grapevine biodiversity

**Grapevine germplasm** (over 5000 accessions) from 6 ex-situ collections (**Italy, Portugal, Spain, Greece, Hungary**) including different Vitis species, V. vinifera subsp. sylvestris, neglected, local, minor and less known V. vinifera varieties.

- ✓ Identification of **grapevine genotypes** able to cope with **biotic stresses** and **adapted to changing environmental** conditions
- ✓ Morphological and molecular **characterization of minor and neglected varieties** showing improved environmental adaptation

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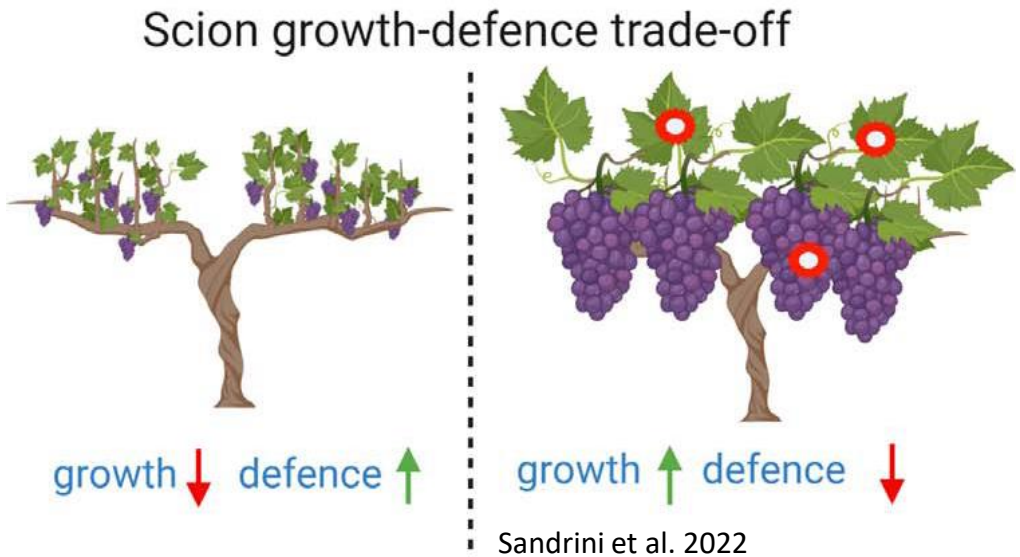
# Objective #2: Identification of new genetic and epigenetic traits for resilience




Sandrini et al. 2022

Identification of **new tolerance traits** that **modify the trade-off** of the plant and **increase the tolerance to biotic stresses overall**, and not only to a specific disease.

- ✓ Identification of **molecular/metabolic signalling networks** underlying the interaction between grapevine and PM/DM/GTD
- ✓ Identification of **genetic/epigenetic traits involved in the response to pathogens** and exploitable for future breeding programs

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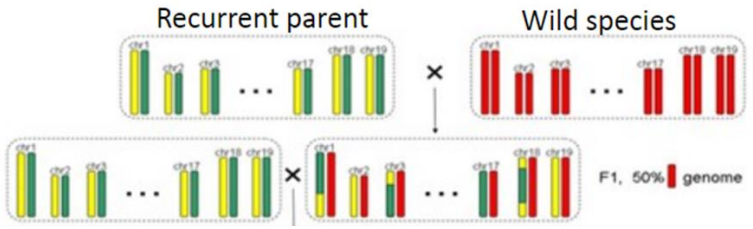
# Objective #3: Breeding activities for new grapevine genotypes resilient to diseases

i. **Marker-assisted breeding** programs already started with local varieties will be implemented to obtain resistant hybrids with **multiple resistant loci to PM and DM**




ii. **New Plant Breeding Techniques**: cisgenesis and genome edited to modify the plant resilience to biotic stresses

iii. **New somaclones resilient** to biotic/abiotic stresses to fully exploit the potential of somatic embryogenesis to increase the intraspecific variability in relevant genotypes

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# Objective #4: Evaluation of IPM strategies applied to tolerant genotypes

Promote the deployment of **tolerant grapevine genotypes** in combination with the range of tools available for **IPM**

**commercial elicitors, resistance inducers, SynComs, green chemistry products and Decision Support Systems**

- ✓ **Agronomic and metabolic responses** associated to the **GxExM interaction**
- ✓ Impact of the selected **IPM strategies on agroecosystem biodiversity**
- ✓ **Life Cycle assessment** of novel **S4G** technologies

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# Objective #4: Evaluation of IPM strategies applied to tolerant genotypes

**12 vineyards** covering all the **most important EU biogeographical** regions interested in **viticulture**


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# Objective #5: Increasing the general awareness of the benefits deriving from the use of tolerant genotypes and IPM practices in viticulture

**S4G** will identify **socioeconomic barriers**, drivers, and behavioural antecedents in the adoption of **tolerant genotypes and IPM** practices in viticulture

- ✓ **Drivers and barriers** to the adoption of **tolerant genotypes and IPM practices**
- ✓ **Impact of policy interventions** on grape growers' engagement IPM practices and adoption of tolerant genotypes
- ✓ **Impact on consumer**: consumer knowledge, acceptance, and perceptions towards reduced pesticides in viticulture and the use of new genotypes

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# Objective #6: Supporting and training farmers and advisors to integrate tolerant genotypes and IPM practices

Implement the **knowledge exchange and networking among EU researchers** and **stakeholders** with the aim to spread new skills among farmers and researchers

- ✓ EU-wide network of participating farmers/stakeholders to get involved into peer-to-peer training and **transfer of knowledge through collaborative on-farm experimentation** and open field info days
- ✓ **S4G will create a community of involved actors** (farmers, extension services, academia, industry, and policy makers) to raise an **immediate and broad application** of the project results

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# Ambition 1. Exploitation and production of new genetic diversity to counteract grapevine diseases

i. **Progress in germplasm characterization**. The resilience of **minor/local/neglected varieties** to biotic factors (in particular PM/DM/GTDs) will be evaluated using leading technology, and the most interesting genotypes will be characterized. The knowledge on **the resilience to the main grapevine diseases will encourage their use by breeders and farmers, thus valuing some minor varieties with a limited diffusion** (TRL6-7).

ii. **Progress in the identification of new traits for resilience**. S4G will identify **new resilience traits** starting **from the high genetic variability available** in the Consortium focusing on traits associated to **general tolerance to multiple diseases** (TRL3-4) integrating **genomics, transcriptomics, smallRNA-seq, methylome, metabolomics and proteomics** approaches. New **epigenome**-wide association study (EWAS) method will be adopted to identify potential epi-alleles/epiQTLs that can be harnessed in future breeding programs (TRL 3-4).

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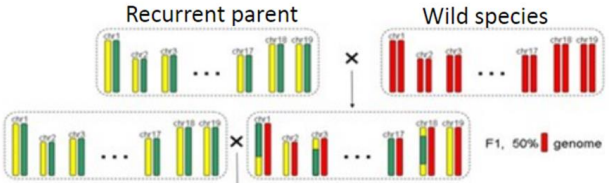
# Ambition 1. Exploitation and production of new genetic diversity to counteract grapevine diseases

iii. **Progress in breeding**. S4G will increase the availability of **new grapevine genotypes** resilient to pest diseases using different approaches **to fully satisfy the needs of all EU territories**, rules and socio-cultural contexts. i) **hybrids from MAB** with multiple insertion of resistance genes against PM and DM will be phenotyped in field (TRL6-7), ii) **NPBT-derived plants resilient to biotic factors** will be phenotyped in greenhouse (TRL4).




iv. **Progress in somatic mutagenesis**. The **new mutants/somaclones** produced from somatic embryogenesis with improved tolerance to biotic/abiotic stresses will be evaluated in vineyards (TRL6-7). **Somaclones will be made immediately available to farmers** as products by conventional mutagenesis and **considered as clonal variants of the traditional varieties** without the limitations of NPBT-derived plants or hybrids resistant to PM/DM .

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# Ambition 2. Reduction of the environmental impact of viticulture

v. **Progress in IPM using biocontrol agents**. S4G will develop **tailored SynComs to prime grapevines against environmental stresses**. Many of the isolates are already characterized in terms of plant growth promoting-PGP-traits and biocontrol potential and these data will be exploited to obtain a **much wider priming of the plant responses in vineyard** (TRL6-7).

vi. **Progress in IPM protocols**. S4G will set up **different IPM strategies**, **specific for the target grapevine genotypes** (local varieties, resistant hybrids, somaclones), and validate protocols in **different EU biogeographical** regions interested in viticulture (TRL6-7).

vii. **Progress in impact evaluation of IPM in the agroecosystem biodiversity**. S4G will evaluate the **preservation and enhancement** of pollinators and **natural enemies of plant pests** (**beneficial endophytes) and the environmental cost (Life Cycle Assessment)** for the adopted strategies (TRL5-6).

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