



**BRESOV**

Breeding for Resilient, Efficient and Sustainable Organic Vegetable production

# SAG members: synergies, cooperation, observations and recommendations

## ECOBREED 2<sup>nd</sup> Annual Online Meeting

- Ferdinando Branca (Coordinator)
- P1-UNICT
- 16 June 2020



UNIVERSITÀ  
degli STUDI  
di CATANIA



# Contents

- **Context and overall objectives**
- **Progress and successes during the 1<sup>st</sup> reporting period**
- **Progress towards achieving impact**
- **Future steps in cooperation/synergies**



# BRESOV

## Breeding for Resilient, Efficient and Sustainable Organic Vegetable Production

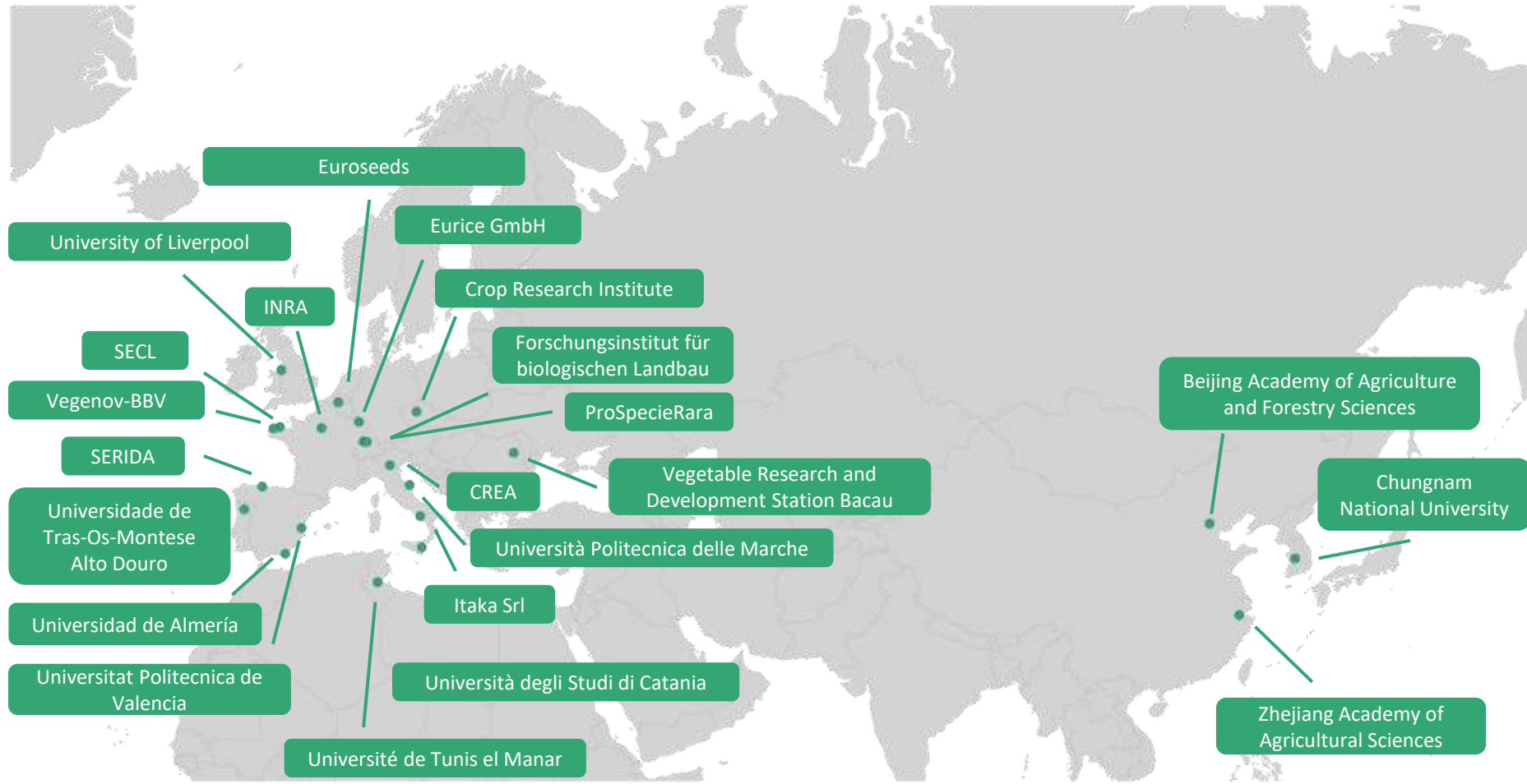
# Overview

Exploitation of **genetic resources**, in terms of formulating **climate-resilient** cultivars addressed to **vegetable organic production** systems under current and future scenarios of climate change

## Three crops: broccoli, snap bean and tomato

- 🌱 **4** years (*1 May 2018 - 30 April 2022*)
- 🌱 **22** partners
- 🌱 **9** EU28 countries (*IT, BE, ES, PT, CZ, FR, UK, RO, GER*)
- 🌱 **2** Associated countries (*Switzerland, Tunisia*)
- 🌱 **2** Third countries (*China, South Korea*)

# BRESOV Partners at a Glance



## Consortium

- BRESOV follows a **multi-actor approach** involving academia, industry and farmers



- BRESOV is supported by **external stakeholders** (i.e. seed and breeding companies, growers) through strategic advice and field testing

# BRESOV: Main Objectives

The **overall aim** of BRESOV is to improve the **competitiveness** of the three crops (broccoli, snap bean, tomato) when grown in an **organic production system**:

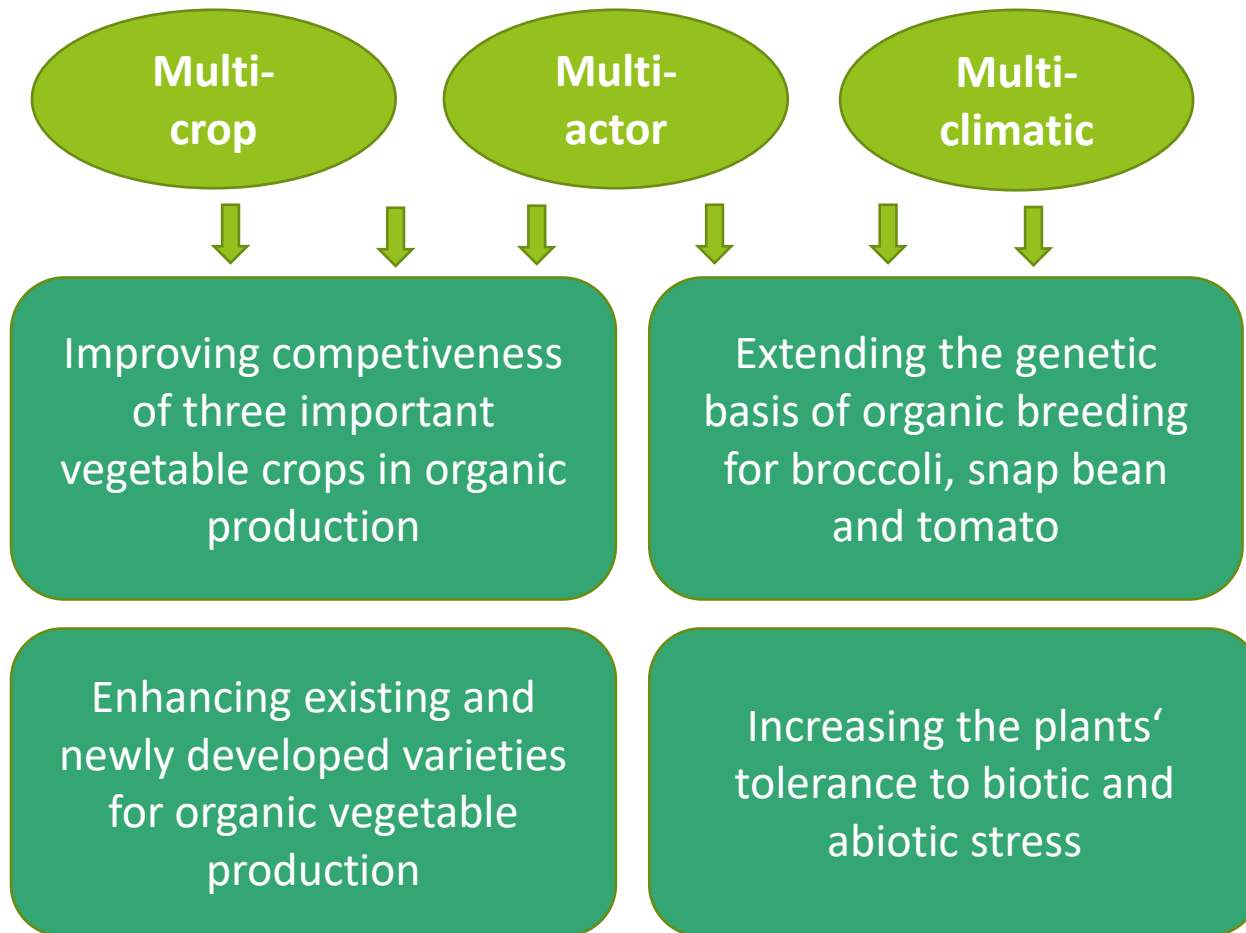
- a) Establishing **core collections** of non-redundant genotypes for each species.
- b) Exploring the **genetic basis of main traits for organic cultivation** and **develop molecular markers** for assisted breeding of new cultivars (OP cultivars, inbred lines and hybrids) adapted to organic farming agro-systems for **biotic and abiotic stresses** on several organic vegetable farming systems in different European and non-European locations.

# BRESOV: Main Objectives

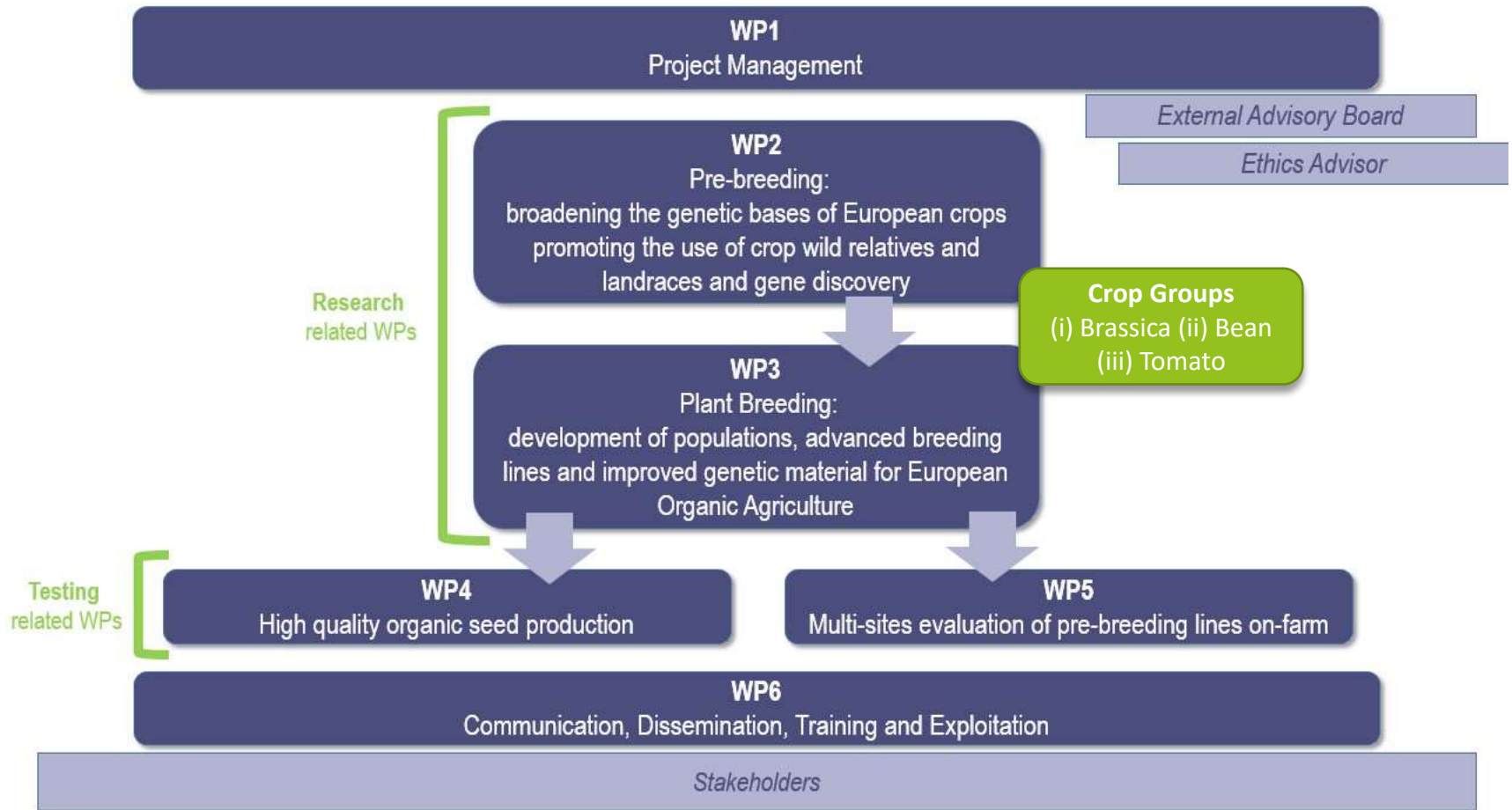
- c) Increasing **quality** and **quantity** of **organic vegetable seed** for the growers of **different European geographic/climatic conditions** by developing methodologies that ensure the availability of organic seed of high quality.
- d) Improving the **adaptability** of the target crops in organic vegetable farming systems and the **interaction between the new cultivars and the soil microbiome**.
- e) Demonstration/testing/training activities to **disseminate the outcomes of the project** in view to innovate vegetable organic farming to the BRESOV stakeholders: one of our primary goals is to make **organic agriculture accessible** to more growers.



# Approach and Anticipated Outputs



# Work Packages



# Methodologies

## **Bio-morphological, genetic, biochemical, organoleptic, post-harvest characterization**

- BRESOV, ECPGR and UPOV descriptors
- HPLC, GC?, LCMS? (GC-MS, LC-MS), sugars, N, C
- GBS, dd-RadSeq, WGS
- GWAS, Linkage analyses, population genomics
- Shovelomics, *GrowScreen-PaGe* (root traits), image analysis
- Trained jury for sensory analysis (in tomato), semi-trained jury for sensory analysis (Broccoli and bean)
- Marketable quality checklist of varieties according to the Swiss quality regulations for vegetables-Swisscofel (Qualiservice; CH for broccoli and bean)
- Practice abstracts, workshops, newsletter.....
- Gas exchange measurements, ELISA test, Thermography

## **Database**

- SMTAs (FAO)
- Consolidated genetic and phenotypic database (1 per crop)
- Genetic fingerprinting database (molecular marker data) for genetic purity control (1 per crop)

# Methodologies

## Breeding

- Crop wild relatives, Landraces, DH lines, F1 hybrids, improved lines
- Interspecific hybrid rootstocks (tomato)
- Molecular markers (Genotyping by sequencing/SNPs/SSRs for genetic diversity analysis, gene/QTL mapping, Marker-Assisted Selection)
- Resistance/tolerance to pests and diseases evaluation
- Tilling analysis
- Mapping\_by\_sequencing

## High quality organic seeds

- real time PCR
- PCR / molecular markers for pathogen detection
- Molecular markers for purity control (SSRs mainly)
- Physical seed treatments, seed germination and grow-out tests (e.g. ISTA)

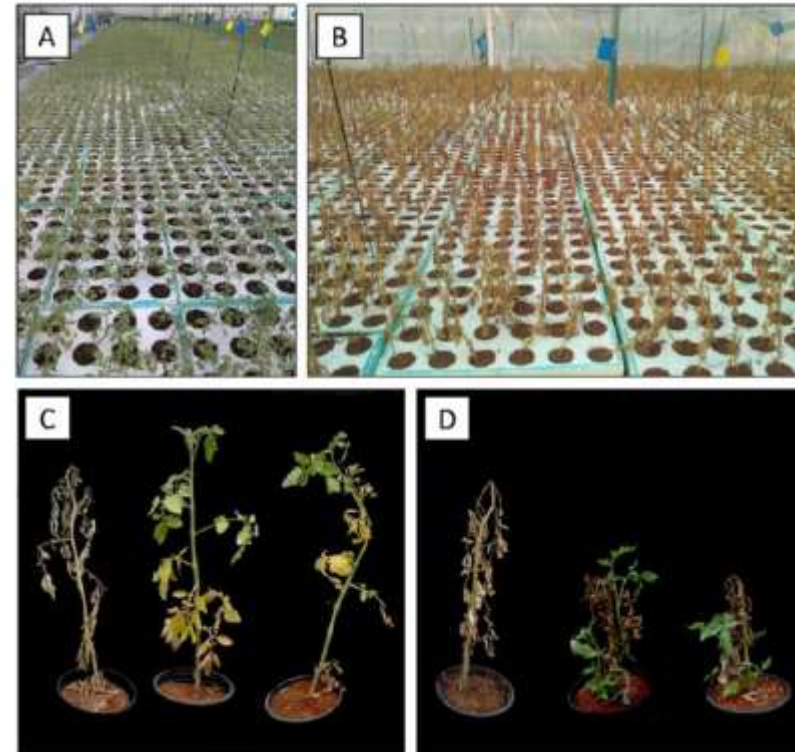
# Achievements



## Explore the genetic basis of **main traits** for organic

### *Solanum lycopersicum*

- ✓ plant bio-morphology and agronomic (P10-UPV, P12-CREA)
- ✓ carotenoids (P12CREA)
- ✓ nitrogen use efficiency (P10-UPV)
- ✓ high temperature and water stress (P3-UAL)
- ✓ *Phytophthora infestans* (P8-VEG)
- ✓ fruit firmness and *Fusarium oxysporum* f. sp. *radicis lycopersici*



Temperature and drought stress screening

# Achievements

## ✓ Establish **core collections** for each Species



The sets of materials have been designed to maximise the genetic and phenotypic diversity to exploit genetic diversity not included in elite germplasm and to identify sources of useful traits and map traits of interest for organic farming agriculture

- ✓ For *B. oleracea* 837 accessions
- ✓ For *S. lycopersicum* 496 accessions
- ✓ For *P. vulgaris* 675 accessions



Sample of diversity of tomato materials in the CC



# Achievements



## Explore the genetic basis of **main traits** for organic

### *Brassica oleracea*

- ✓ water stress (P1-UNICT),
- ✓ plant bio-morphology (P1-UNICT, P15-UTM),
- ✓ waterlogging and dark induced senescence (P9-UNILIV),
- ✓ *Xanthomonas campestris* pv. *campestris* (Xcc1, Xcc4) (P1-UNICT and P20-UNICHU),
- ✓ *Hyaloperonospora parasitica* - downy mildew (P5-VURV),
- ✓ broccoli hollow stem (P14-ZAAS, P1-UNICT)
- ✓ bud purple (P14-ZAAS, P1-UNICT)
- ✓ *Alternaria brassicicola* (P14-ZAAS, P1-UNICT)
- ✓ glucosinolates (GLS) amounts and profiles (P4-UTAD, P1-UNICT and P15UTM))
- ✓ GLSs products of degradation, polyphenols and antioxidant capacity (P12-CREA),
- ✓ size and shape of inflorescence (P1-UNICT and P15-UTM)



Water stress trial

# Achievements



## Explore the genetic basis of **main traits** for organic

### *Phaseolus vulgaris*

- ✓ plant bio-morphology and agronomic (P16-SERIDA, P7-UNIVPM, P11-VRDS)
- ✓ *Sclerotinia sclerotiorum*-white mold
- ✓ *Pythium* and *Erysiphe polygoni*-powdery mildew (P16-SERIDA)
- ✓ anthracnose (P19-INRA)
- ✓ protein content, antioxidant activity and sugar content (P12-CREA)
- ✓ *Uromyces appendiculatus* – bean rust (P14-ZAAS)
- ✓ analysis of sugars (sucrose, glucose and fructose) and the polyalcohol myo-inositol (P16-SERIDA)



Pod investigation, sample preparation and lyophilisation for shipment



# Achievements



## Develop **molecular markers for assisted breeding of new cultivars** adapted to organic farming agro-systems

### *B. oleracea*

- ✓ size and shape of curd inflorescence (P1-UNICT, P15-UTM)
- ✓ Pr1 and SOD markers for detecting *Xanthomonas campestris* Xcc resistance (P20-UNICHU)
- ✓ broccoli hollow stem and purple bud, and *Alternaria brassicicola* (P14- ZAAS, P1-UNICT)



2028-4

### *S. lycopersicum*

- ✓ Tm22 allele marker for resistance to ToMV (P10-UPV)



2016-2

### *P. vulgaris*

- ✓ white mold, *Pythium*, powdery and TUM antracnose RIL populations

(P16-SERIDA)

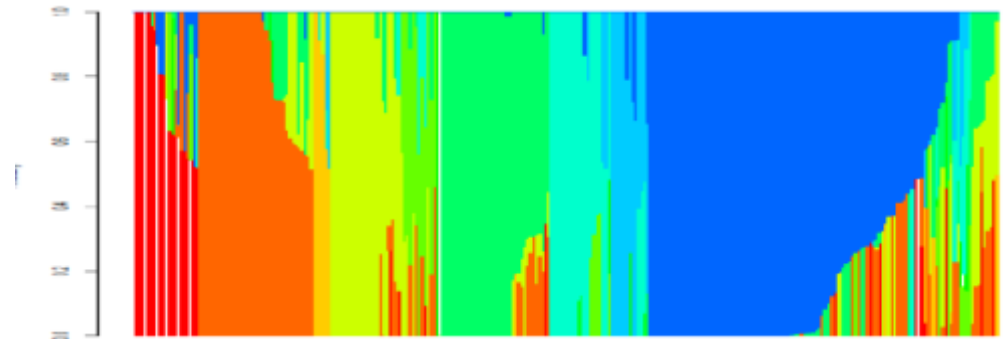
Two pure lines selected for the development of DH population

# Achievements



- **develop **molecular markers for assisted breeding** of new cultivars adapted to organic farming agro-systems**

**GBS** genotyping activities for detecting the diversity of the BRESOV core collection (CC) and of the Breeding Set (BS) have been performed and will allow the acquisition of genotyping data of interest, which combined with different levels of phenotyping data, will allow detecting QTLs, major genes, and associated markers



Number of subpopulations (evidenced by different bar colours) detected by admixture analysis

# Achievements



## ✔ Increase **quality and quantity of organic vegetable seed** available for the growers of different European geographic/climatic conditions

- ✔ Review of the knowledge related to the biocontrol agents (BCAs) and natural compounds (NCs) for controlling seedborne diseases has been performed (D4.1)
- ✔ trialling plan **on going** is taking in consideration three key seed diseases for:

B. oleracea	Xanthomonas campestris pv. campestris (Xcc), Alternaria spp., Phoma lingam (Leptosphaeria maculans)
P. vulgaris	Colletotrichum lindemuthianum, Pseudomonas savastanoi pv. Phaseolicola, Fusarium solani f.sp phaseoli
S. lycopersicum	Clavibacter michiganensis subsp. michiganensis (Cmm), Pseudomonas syringae pv. tomato, Xanthomonas spp pathogenic to tomato, ToMV, Fusarium oxysporum f.sp. radicis lycopersici

# Achievements



- Increase **quality and quantity of organic vegetable seed** available for the growers of different European geographic/climatic conditions

Seed quality will be determined by seed germination tests performed by each partner on the harvested seeds. First results for tomato indicate an **effect of different plant densities on seed yield but not on the one thousand seed weight.**

**plant density, nutrition level, and harvesting time were the investigated treatments**

# Achievements



## 🌱 **Improve the adaptability** in organic vegetable farming

several genotypes were identified for:

- ✓ ***B. oleracea*** one broccoli line of Ramoso Calabrese Precoce of the resistant to water logging , two accessions of kale and one of broccoli resistant to Xcc1 and Xcc4
- ✓ ***S. lycopersicum*** 7 genotypes belonging to EMS M2 mutants have been found to be resistant to heat and drought conditions, due to mutations in genes SICL1D (n. 2), HSP100 (n.3), CAX1 (n.2), 2 long shelf life tomato genotypes have shown high nitrogen use efficiency, 3 breeding lines and 8 LRs have been found to be resistant to *Fusarium oxysporum* f. sp. *Lycopersici*, 2 accessions of the LR 'De Penjar' have proved tolerant to TSWV, and five new combination lines resistant with good adaptation and resistance
- ✓ ***P. vulgaris*** the TUM RIL population has been screened for anthracnose resistance and six SBP and nine HCC lines have been found to be resistant to powdery mildew

# Achievements



## ✔ **Demonstration/testing/training activities to disseminate the outcomes of the project in view to innovate vegetable organic farming**

A list of about **20 registered stakeholders** (seed companies, organic farmers, NGOs, etc) has been traced by the Consortium

- ✔ A number of dissemination activities in connection with stakeholders (seminars, conferences, regional events collecting further link with the rural and urban communities in each Eu and extra-EU countries, etc) already took place (D6.1-D6.9)
- ✔ Proper training activities in a format of workshop/demonstration are ongoing to be organised in cooperation with BRESOV sister's project LIVESEED and ECOBREED

## Dissemination Highlights

### **Dissemination towards general public/scientific community:**

- ✓ BRESOV website, audio-visual material, dissemination toolkit
- ✓ First (peer-reviewed) journal publications
- ✓ Press releases in various participating countries
- ✓ Presentation at many scientific events
- ✓ Presentation at many public events
- ✓ Regular interaction with stakeholders, related initiatives, and other target groups (LIVESEED, ECOBREED)

# Dissemination Highlights: some events



**BIOFACH 2019 Nuremberg, Germany**  
**BRESOV poster presented (in cooperation with ECOBREED and LIVESEED)**

**ECO-INT NATURAL TASTE - BACAU, International fair for Ecological Agriculture Business affairs and exhibition Center Bacău**



**Summer School at UPV 2019**  
**UNILIV at V&A Museum**



# Progress towards Achieving Impact

- Activities will contribute to increase knowledge on relevant **genetic traits** for organic crop production

## ***Brassica oleracea***

- ✓ water stress (P1-UNICT), plant bio-morphology (P1-UNICT, P15-UTM), waterlogging and dark induced senescence (P9-UNILIV), *Xanthomonas campestris* pv. *campestris* (Xcc1, Xcc4) (P1-UNICT and P20-UNICHU), *Hyaloperonospora parasitica* - downy mildew (P5-VURV), broccoli hollow stem (P14-ZAAS, P1-UNICT), bud purple (P14-ZAAS, P1-UNICT) *Alternaria brassicicola* (P14-ZAAS, P1-UNICT), glucosinolates (GLS) amounts and profiles (P4-UTAD, P1-UNICT and P15UTM), GLSs products of degradation, polyphenols and antioxidant capacity (P12-CREA), size and shape of inflorescence (P1-UNICT and P15-UTM)

## ***Solanum lycopersicum***

- ✓ plant bio-morphology and agronomic (P10-UPV, P12-CREA), carotenoids (P12CREA), nitrogen use efficiency (P10-UPV), high temperature and water stress (P3-UAL), *Phytophthora infestans* (P8-VEG), fruit firmness and *Fusarium oxysporum* f. sp. *radicis lycopersici*

## ***Phaseolus vulgaris***

- ✓ plant bio-morphology and agronomic (P16-SERIDA, P7-UNIVPM, P11-VRDS), *Sclerotinia sclerotiorum*-white mold, *Pythium* and *Erysiphe polygoni*-powdery mildew (P16-SERIDA), anthracnose (P19-INRA), protein content, antioxidant activity and sugar content (P12-CREA), *Uromyces appendiculatus* – bean rust (P14-ZAAS), analysis of sugars (sucrose, glucose and fructose) and the polyalcohol myo-inositol (P16-SERIDA)

# Progress towards Achieving Impact

- Activities will contribute to improve access to a wider pool of **high-quality seeds**, varieties and cultivars for the organic farming Sector

	Brassica	Tomato	Snap Bean
P1-UNICT	nutrition factor	nutrition factor	nutrition factor
OBS	density factor		density factor
P6-FiBL		harvesting time factor	
P18-ITAKA	density factor	density factor	density factor
P21-SECL		density factor	

# Progress towards Achieving Impact

- Activities will contribute to the availability of **tools and resources for pre-breeding and breeding** (including improved genotyping and/or phenotyping capabilities)

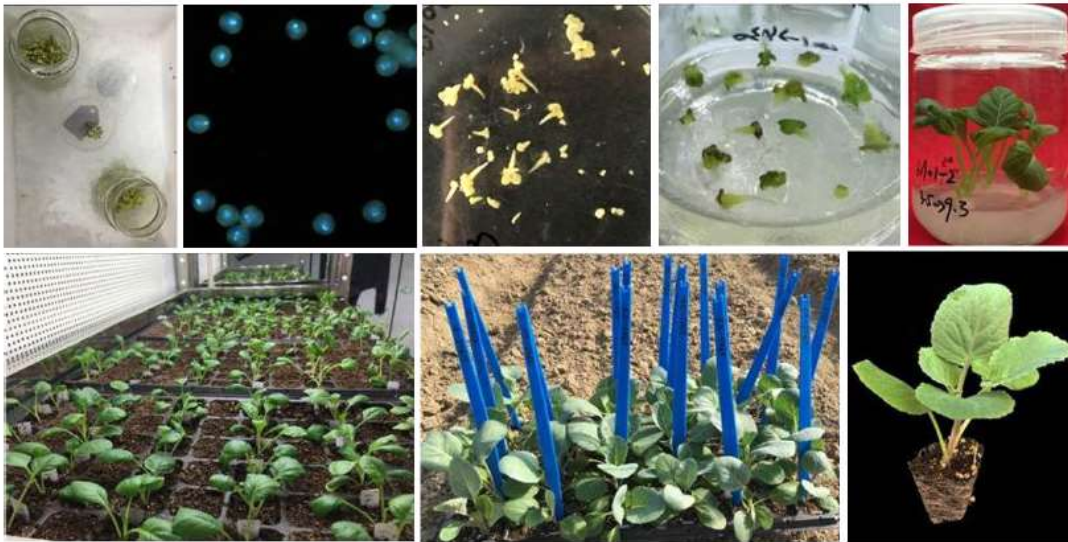


Figure 2.19. Optimized and high-efficient microspore culture technology

# Progress towards Achieving Impact

11 tomato, 9 broccoli and 35 bean varieties were scouted for traits interesting in organic farming such as:

Tomato	Bean	Broccoli
<b>Selected in low-input conditions</b>	Heirloom variety	Open pollinated
<b>Tolerance to drought</b>	Intense flavour	Branching
<b>Tolerance to reduced nutrient supply</b>	Robustness	Homogeneity
<b>Resistance against pathogens</b>	Ease/speed of harvest	Shape
<b>Field resistance against <i>Phytophthora infestans</i></b>	Yield	Resistance to pathogens and pests

- All of tomato and broccoli and 10 of the bean varieties are grown and evaluated in France, Sicily or Switzerland
- A selection will be grown on-farm in multiple locations

# Progress towards Achieving Impact

- EU and extra-EU scientific collaboration in view to render organic vegetable production much more appreciated if suitable germplasm resources increase yield and quality of vegetable crops.



In April, BRESOV partner Terre d'Essais started a tomato trial on its site in Brittany (above). FiBL started the same trial on-farm in Therwil (below). The trial is performed as part of BRESOV's WP5 work to evaluate the effect of formulations of microorganisms and local compost on crop performance of tomato.

## Progress towards Deliverables

- ✓ The activities planned for the 1<sup>st</sup> period (Month 18) have been accomplished
- ✓ All due Deliverables (17) have been submitted on time

## Future Steps in Implementation

- ✓ **elite genotypes** of great interest for organic vegetable farming systems will be regenerated for sharing with the WP4 and WP5 partners for comparing their adaptability in multi-climate conditions around EU and Extra-EU countries in their second year trials.
- ✓ specific experimental trials will test their interaction with the **soil microbiome**, their **organoleptic and nutraceutical** traits, and the **seed quality and yield**
- ✓ The GWAS ongoing activities will be integrated with the BRESOV phenotyping activities for their data association allowing the acquisition of **genetic information relevant to the control and breeding of traits** for organic crop production.

## Future Steps cooperation/synergies

- ✓ 8th-10th of March 2021 → EUCARPIA section Organic and Low-Input Agriculture, Cesis (LATVIA)
- ✓ 14<sup>th</sup>-17<sup>th</sup> December 2021 → OrgHort2020 ISHS Symposium in Catania (Italy) and training course on “Organic Breeding and Seed Production” addressed to the BRESOV, LIVEEEDS and ECOBREED partners and the related stakeholders
- ✓ March 2020 → Workshop “BIOCONTROL AGENTS AND NATURAL COMPOUNDS: IMPORTANT TOOLS FOR ORGANIC VEGETABLE FOOD SUPPLY CHAIN”, Catania (Italy) → **postponed to September 2020 (webinar mode)**



# Thank you for your attention!



## BRESOV

**Breeding for Resilient, Efficient and Sustainable  
Organic Vegetable Production**