

## Introduction

The BreedingValue project, supported by the European Union's Horizon 2020 program, focuses on improving breeding strategies for three important berry fruits: blueberry, raspberry and strawberry. These fruits are of global importance and Europe has played a key role in their breeding history. The project addresses challenges and opportunities related to crop specialisation, environmental impacts, domestication effects, genetic and metabolomic diversity, and consumer preferences. Working with 20 partners in eight countries and additional external contributors, the project focuses on characterizing a wide range of plant material, including wild species, historical and modern cultivars, pre-breeding material and model populations. Using techniques such as genotyping, phenotyping, metabolomics and sensory analysis, the project has gained valuable insights into germplasm collections. The aim is to develop robust breeding strategies for these berries in Europe. Stakeholders in the project include research organizations, growers, market players, consumers, the food industry, health authorities and regulators. At the half-way point, the BreedingValue consortium has made significant progress in understanding the diverse structure of European blueberry, raspberry and strawberry germplasm.

## Objectives

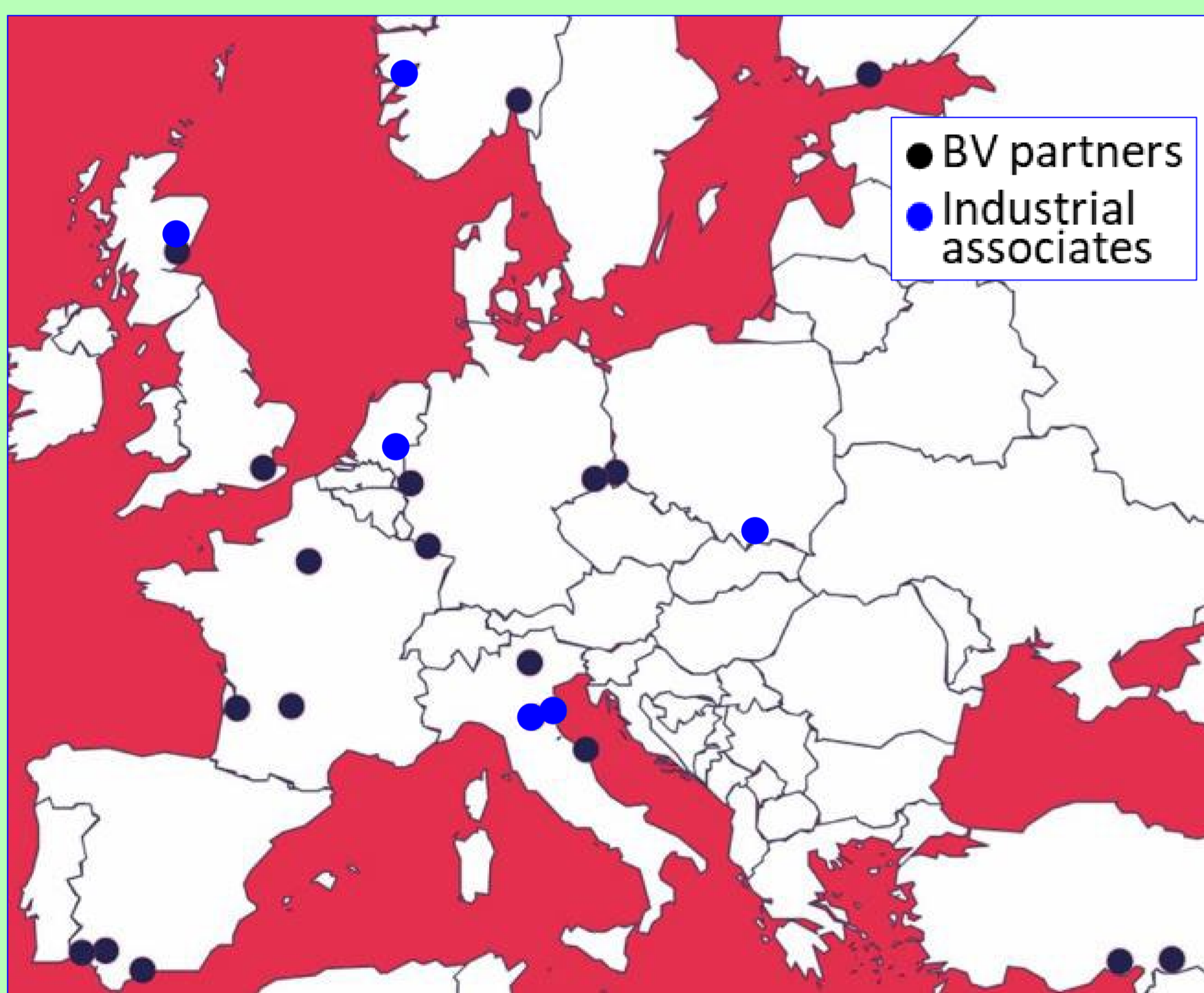
The BreedingValue project, entitled "Pre-breeding strategies for obtaining new resilient and added value berries," aims to provide knowledge and tools for the use of genetic resources and pre-breeding materials in strawberry, raspberry and blueberry crops. The focus is on developing European cultivars that are resilient to climate change and adaptable to different cropping systems, with an emphasis on sustainability and resilience in breeding strategies. The project addresses key issues in small fruit production, including resource input management, fruit quality, consumer preferences, breeding technology and germplasm diversity.

The work package "Genomic tools to enhance the use of genetic resources in pre-breeding" uses single nucleotide polymorphism (SNP) markers to study diversity and improve breeding efficiency in the three berry crops. The study analyses the genetic diversity of the selected small fruit species to assess the suitability of new European cultivars and breeding materials for future challenges. In addition, the project focuses on the development of genomic prediction models for important horticultural and commercial traits.

## Collaborative partners and tasks

### Work packages

- **WP1:** GenRes management, definition and selection of proper plant material, field trials and phenotyping (Hansabred)
- **WP2: Genomic tools for enhancing utilization of genetic resources in pre-breeding (NIBIO)**
- **WP3:** Exploring diverse germplasm collections for plant resilience, fruit quality and postharvest traits (UMA)
- **WP4:** Fruit quality attributes for European berry GenRes emphasized by consumer responses (LUKE)
- **WP5:** Data Analysis and Visualization (FZJ)
- **WP6:** Innovation management and dissemination activities (EURICE)
- **WP7:** Project management and scientific coordination (UPM)



### Project key facts

- Partners No.: **20 (7 SMEs)**
- Countries involved: **8**
- SME subcontractors: **11**
- Start date: **1 January 2021**
- Duration: **48 months**
- Coordinator: Università Politecnica Delle Marche (UPM), Italy
- Grant Agreement ID: 101000747
- Website: [www.breedingvalue.eu](http://www.breedingvalue.eu)
- X/Tweet: **#breedingvalue**



All partners at BreedingValue 2nd Progress Meeting, Dresden, Germany March 15-18, 2023.

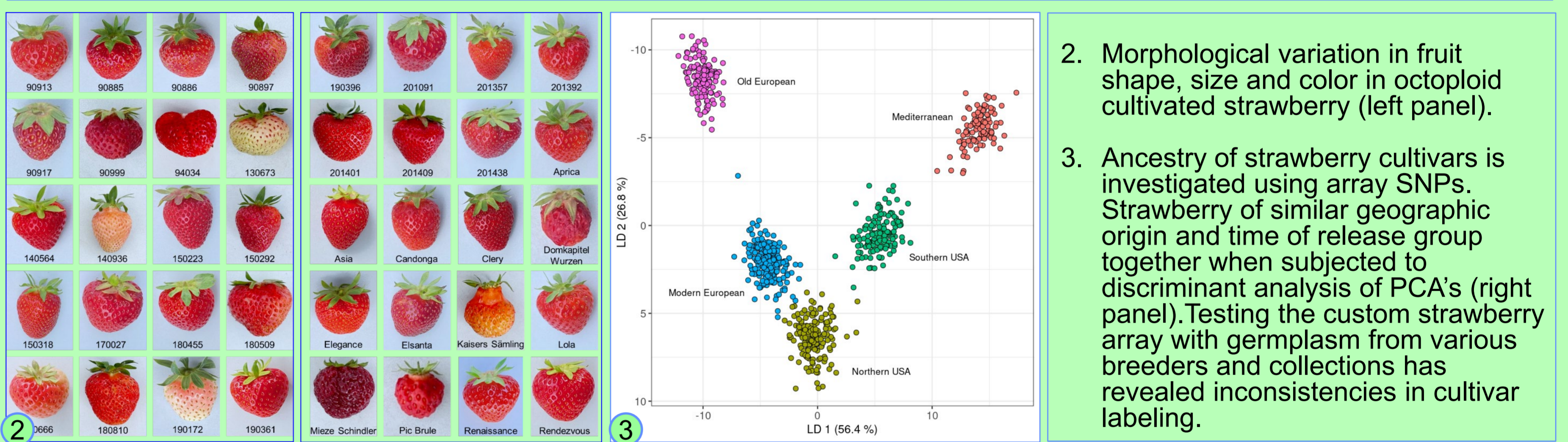
## Genetic and morphological characterization of pre-breeding material

Species	Investigated material
<i>Fragaria</i>	1735 entries and 27 populations
<i>Rubus</i>	409 entries and 4 populations
<i>Vaccinium</i>	79 entries and 2 populations



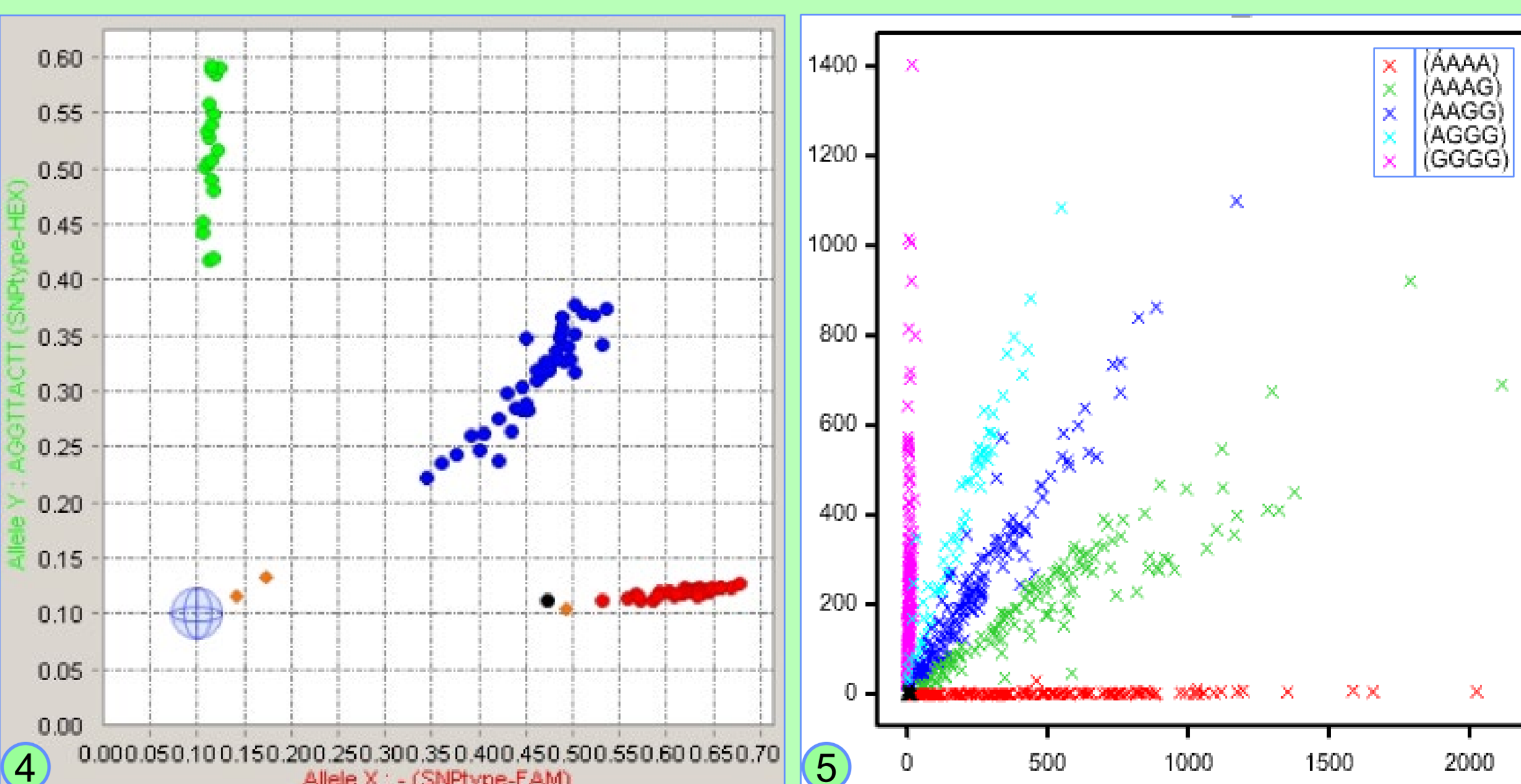
1. The investigated material was selected from 5 different germplasm categories: Category 1, cultivars released up to 1959; Category 2, cultivars released 1960-2004; Category 3, recent cultivars 2005-present; Category 4, pre-breeding material; Category 5, related species. The Plant Journal (2022) 111, 1238-1251, doi: 10.1111/tbj.15876.

Diversity studies, genomic prediction and marker-assisted selection (MAS) in strawberries utilize the Axiom® Strawberry FanaSNP 50K Genotyping Array and a custom-made Fluidigm® array. Raspberry and blueberry markers are based on amplicon sequencing.



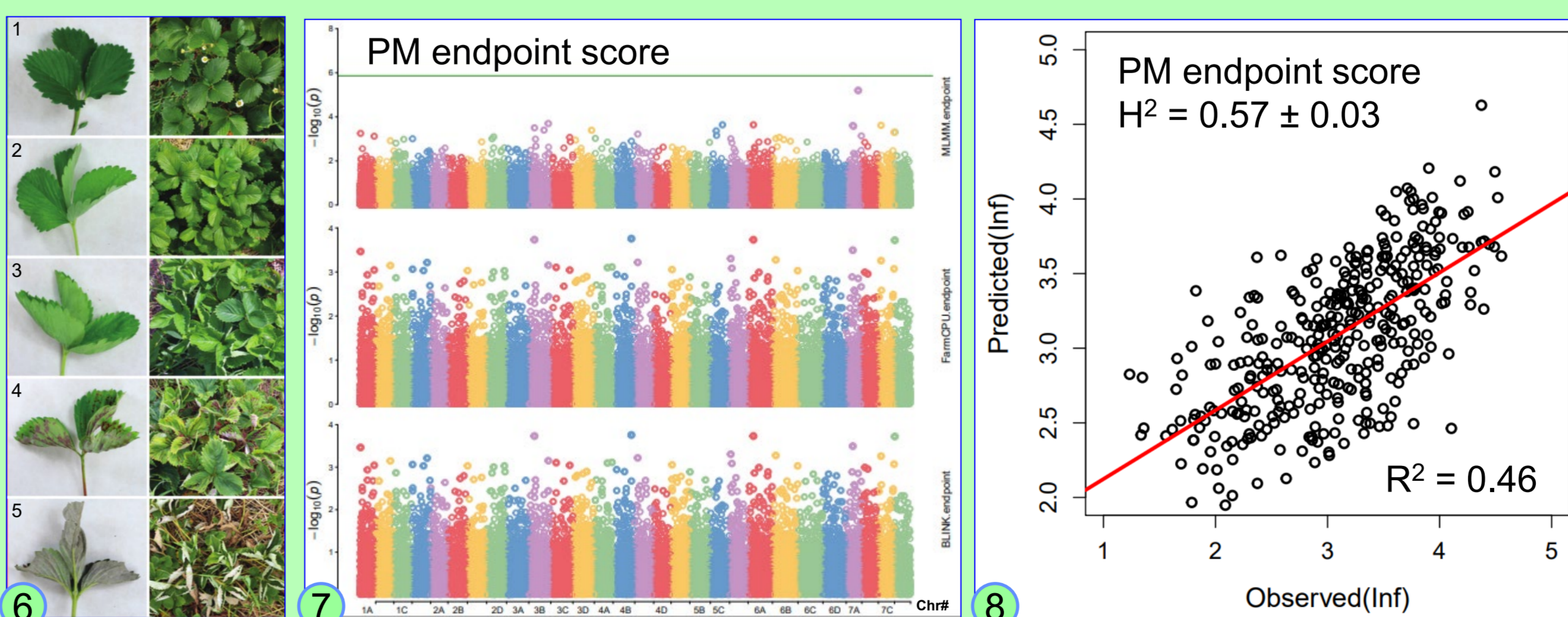
2. Morphological variation in fruit shape, size and color in octoploid cultivated strawberry (left panel).
3. Ancestry of strawberry cultivars is investigated using array SNPs. Strawberry of similar geographic origin and time of release group together when subjected to discriminant analysis of PCA's (right panel). Testing the custom strawberry array with germplasm from various breeders and collections has revealed inconsistencies in cultivar labeling.

## Development of SNP assays for MAS and GWAS



4. A custom-made strawberry Fluidigm® 96.96 JUNO array containing 96 SNP or indel markers for important horticultural traits has been established (left panel). This array is currently tested with germplasm from partners and strawberry breeders. The array is evaluated for MAS and in pedigree and diversity analyses.
5. A blueberry amplicon sequencing genotyping assay has been developed and will be used for MAS and GWAS. The right figure shows a well-behaved bi-allelic SNP-call in the tetraploid blueberry.

## Genomic prediction for disease resistance



6. Powdery mildew (PM) by *Podospheara aphanis* (left panels), is a major threat to strawberry production. Symptoms scored 1 – 5.
7. With the absence of significant QTL (mid panel), we are evaluating the prospects of genomic prediction.
8. Cross-validation is currently being done within and across populations and locations.

## Expected impact

The Horizon 2020 project "BreedingValue" aims to develop genetic resources (GenRes) and guide the selection of plant material for sustainable berry breeding strategies in line with European agricultural, market and regulatory needs. The study of diversity at the molecular and phenotypic level, together with the exploration of marker-assisted selection and genomic prediction, is expected to significantly improve cultivar development in the targeted small fruit species. The results from the project are expected to have a significant impact on the future of berry fruit cultivation and related industries in Europe.