



EVA Boost Perennials workshop

13-14 March 2025, Ancona, Italy



Pre-breeding strategies for obtaining new resilient and added value berries

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Highly Cited
Researcher
2019



Highly Cited
Researcher
2020



Highly Cited
Researcher
2021



Funded by
the European Union



Project Key Facts

Partners N.: **20 (7 SMEs)**

Countries involved: **8**

4 open calls include another 10 companies

Start date: **1 January 2021**

Duration: **54 months**

Coordinator: Università Politecnica Delle Marche (UPM), Italy

Website: www.breedingvalue.eu

Twitter: [#breedingvalue](https://twitter.com/breedingvalue)



PRE-BREEDING STRATEGIES FOR OBTAINING NEW RESILIENT AND ADDED VALUE BERRIES



Duration
48 Months



Budget
6.98 Mio €



20 Partner
8 Countries



Raspberry



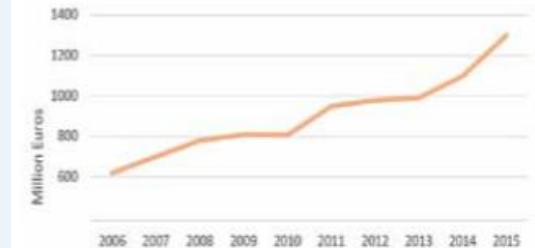
Blueberry



Strawberry

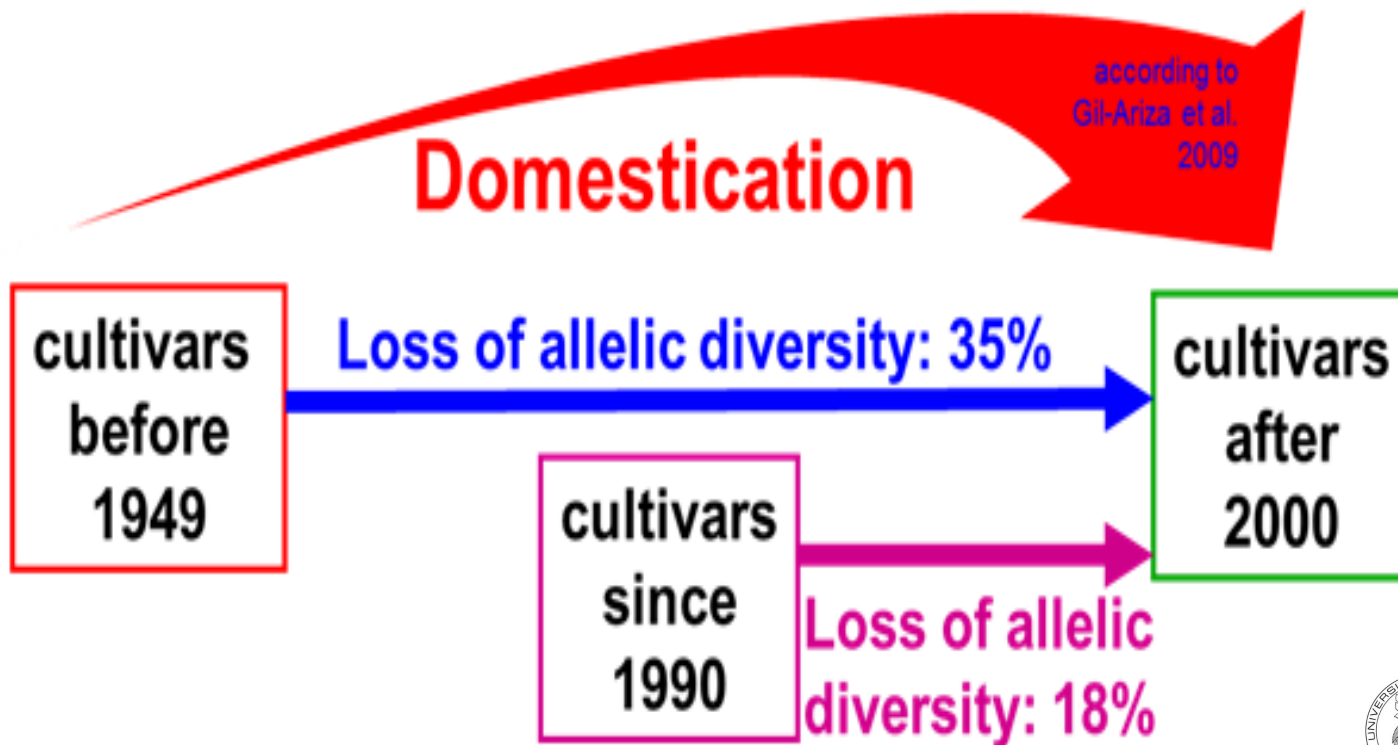
Minimum +3-4% :
annual rate

Growth in world berry consumption



WHY IS THE BREEDING VALUE PROJECT IMPORTANT:

Loss of allelic diversity in a study for strawberry by Gil-Ariza et al., 2009.



Aim of BreedingValue:

- Investigation of the domestication effect by determination of allelic diversity and answering the question: How resilient is our breeding base for future breeding?

- Definition of plant categories (for the 3 crops) and identifying the relevant GenRes available.

Plant category 1

Plant category 2

Plant category 3

Plant category 4

Plant category 5

Plant category 6

Old cv.
(until 1960)

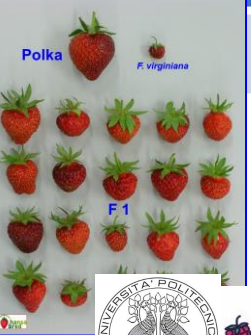
Modern cv.
(1960-2005)

Newest
(released) cv.
(2005 till now)

Pre-breeding
(advanced
selections or
selections in new
breeding
directions)

Species

Populations



Increasing Value of EU Berry Genetic Resources

Project Management

Genetic Resources

- Selected accessions
- Breeding material and populations
- Replicated trials in field, tunnel and greenhouse

Genotyping

- Marker-assisted selection
- Genomic selection
- Marker-Trait associations

Phenotyping

- Fruit quality and resilience
- Plant architecture
- Image analysis
- Metabolomics
- Panel sensory tests

Consumer science

- Survey and focus groups
- Definition of sensory profiles
- Consumer tests

Data Management and Analysis

Sharing Technologies

IP Management

User-friendly Communication

Berry Pre-Breeding Material for EU-Companies and Consumers



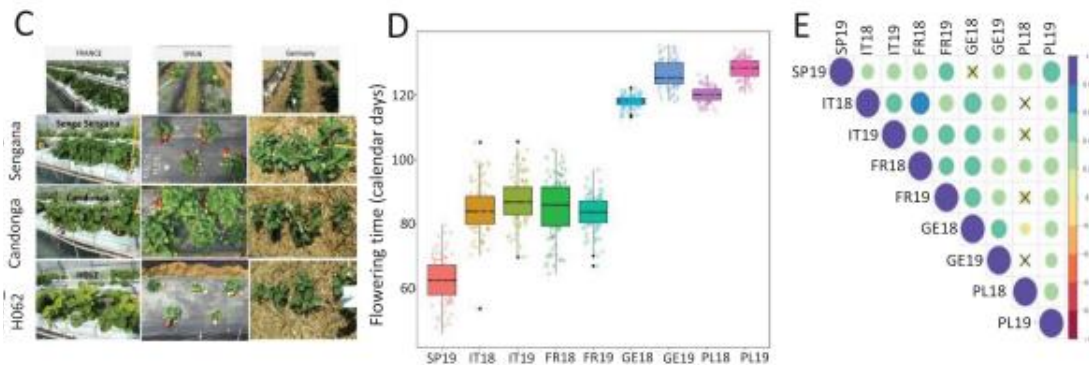
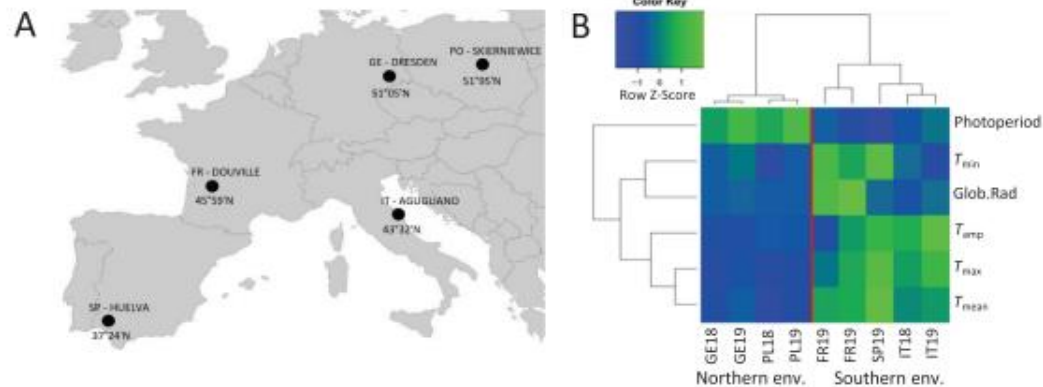
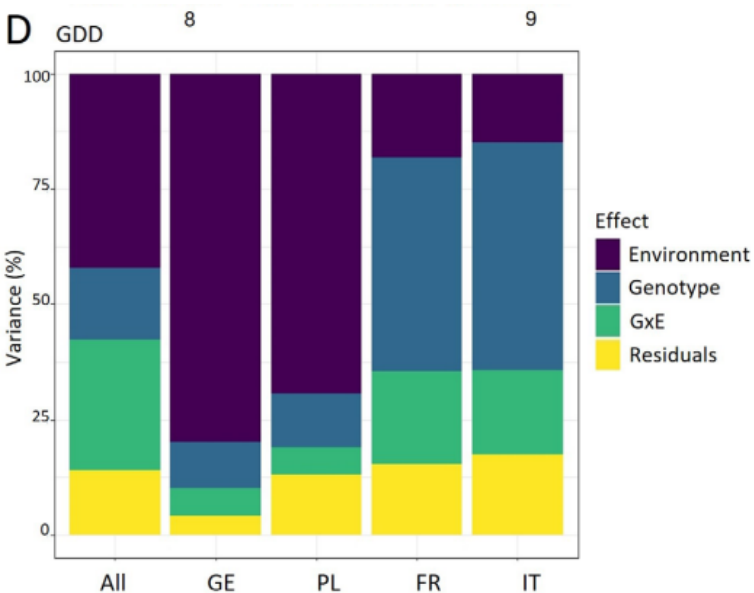
Strawberry, raspberry and blueberry genetic resources

Germplasm included in the first project period per germplasm category and genus – Klaus Olbricht - Hansabread

Germplasm category	Number of included genotypes		
	Fragaria sp.	Rubus sp.	Vaccinium sp.
1: Old cultivars (until 1959)	188	12	14
2: Modern cultivars (1960 - 2004)	312	20	35
3: Newest cultivars (2005 - now)	144	15	8
4: Pre-breeding material	1019	354	20
5: Related species	72	8	2
Total (Cat. 1 - Cat. 5)	1735	409	79
6: Number of Populations*	27	4	2
* each population represented by varying numbers of genotypes			



RESEARCH PAPER

Strawberry phenotypic plasticity in flowering time is driven by the interaction between genetic loci and temperatureAlexandre Prohaska^{1,2}, Aurélie Petit², Silke Leseemann³, Pol Rey-Serra¹, Luca Mazzoni⁴, Agnieszka Masny⁵, José F. Sánchez-Sevilla^{6,7}, Aline Potier¹, Amélia Gaston¹, Krzysztof Klamkowski⁸, Christophe Rothan⁹, Bruno Mezzetti¹⁰, Iraida Amaya¹², Klaus Oibrich¹⁰, and Béatrice Denoyes¹¹

Examination (Affymetrix SNP array), using different phenological models, of the response of FT to photoperiod, temperature, and global radiation indicated that temperature is the main driver of FT in strawberry. 25 FT QTLs summarized as 10 unique QTLs. The design and validation of a genetic marker for the 6D_M QTL offers great potential for breeding programs, for example selecting early-flowering strawberry varieties well adapted to different environmental conditions.

Life Cycle Assessment (LCA) to test sustainability of new berry cultivars

- In eight countries for Raspberry, Strawberry
- Breeding material: 61 + standard cultivars
- Cultivation systems: tunnel, open field, soilless, glass greenhouse.
- Trials: **different soil type, heights of bed, different fertigation solutions, primocanes and floricanes raspberry.**



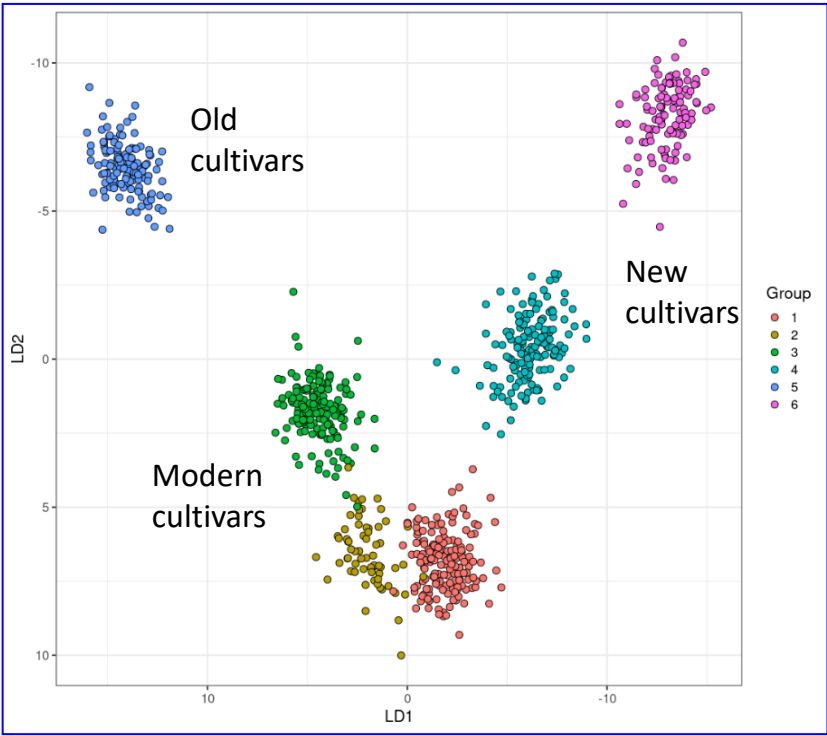
WP 2: Genomic tools for enhancing utilization of genetic resources in pre-breeding

P8: Norwegian Institute of Bioeconomy Research (NIBIO)/ Jahn Davik



1. Characterize pre-breeding material of strawberry, raspberry, and blueberry (2.1).
2. Investigate the applicability of known molecular markers in breeding (2.2).
3. Explore the usefulness of genomic selection/mating in early-stage small fruit breeding (2.3).
4. Three targeted calls on strawberry and raspberry (2.4-2.6).
5. A final seminar on MAS, GWAS, and GS (2.7).

Fruit Evaluation, Genetic and Metabolomic Diversity Studies



Genetic Diversity study using strawberry cultivars defined by WP 1 and performed by WP 2: preliminary results show clear clustering of different groups

RASPBERRY GENETIC DIVERSITY

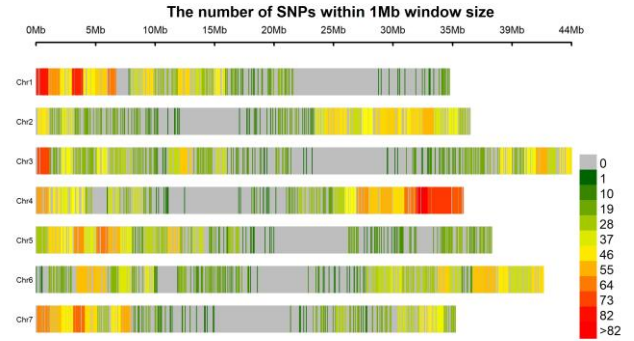
RESULTS FROM THE GENOMIC STUDIES

Published papers from Work package 2: 4
Papers in process: 7

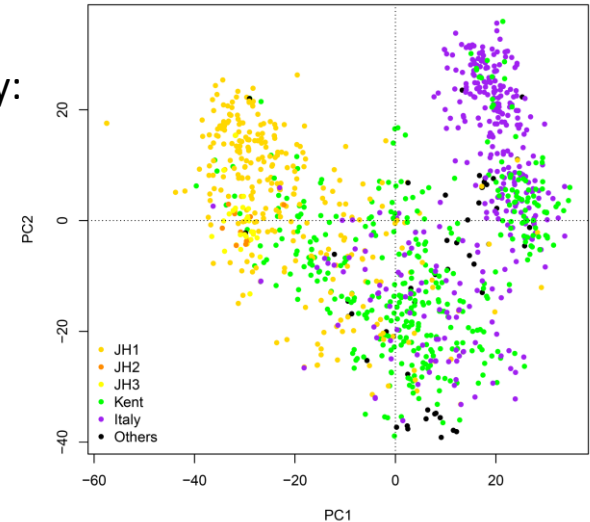
WP2-presentations at PAG 32: 2
Attiq ur Rehman (LUKE) at the 'Strawberry Genomics' workshc
Jakob Junkers (NIBIO) at the 'Fruits and Nuts' workshop.

Targeted calls – an instrument for technology transfer to the industry:

- Development of MAS in strawberry breeding using a new low-density SNP array.
 - 3 industry partners
- MAS and GWAS in raspberry
 - 2 industry partners
- Genomic prediction in early-stage strawberry breeding.
 - 2 industry partners



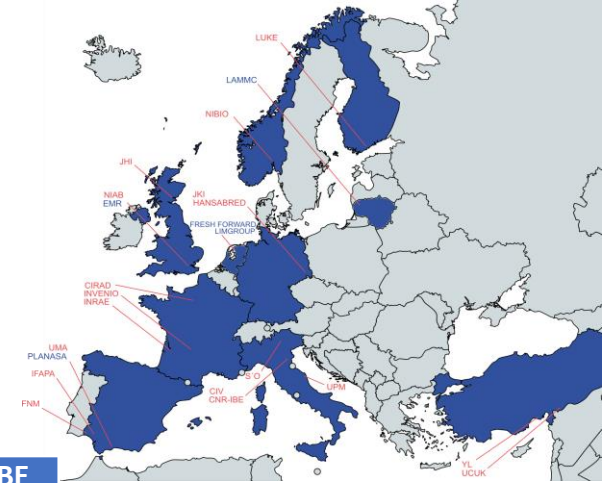
Marker distribution in raspberry



Structure in populations of raspberry.

Metabolite Diversity Study (fruit)

Sonia Osorio – UMA SP



Allelic and Metabolite diversity analyses
GxE interaction interaction study

Methabolites analysed by different partners

Countries of origin of partners participating in the allelic and metabolite diversity study.



Chemical Analysis	P1-UPM	P3-UMA	P6-IFAPA	P11-CNR-IBE
Primary metabolites (sugars, acids, phenolics and amino acids)		strawberry raspberry blueberry		
Secondary metabolites (phenylpropanoids, flavonoids, anthocyanins and proanthocyanins)		strawberry raspberry blueberry		
Volatiles (aldehydes, cetones, esters, lactones, etc)		strawberry		raspberry blueberry
Vitamin C			strawberry	
Folic acid	strawberry			
Dry weight		strawberry		raspberry blueberry



Study of metabolite diversity in strawberry and raspberry

- Study the metabolite structure with regard to the breeding history and metabolite diversity
- Include newest releases and advanced selections to draw a picture of domestication effects and the status of current and perspectives of future strawberry breeding in Europe
- Partners involved: UMA, JKI, Hansabred, SO', FZJ
- Time frame: summer/autumn 2023, 2024



Strawberry
ca. 260 genotypes



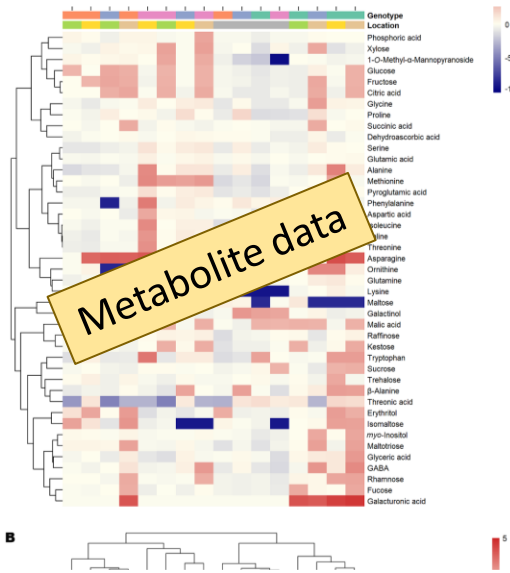
Raspberry
134 genotypes

Source: Absalom
Shank

Metabolic variation vs. Sensory variation

■ Linking metabolic data with fruit quality: taste & flavour

- Taste evaluation for a different parameters by a professional panel / Consumer panel



Professional panel test

attributes

- Mouth coating
- Fruity aftertaste
- Bitter aftertaste
- Caramel or burnt flavor
- Floral aroma
- Clarity
- Fermented or vinegary flavor
- ...

Increase fruit vitamin C content for consumer health

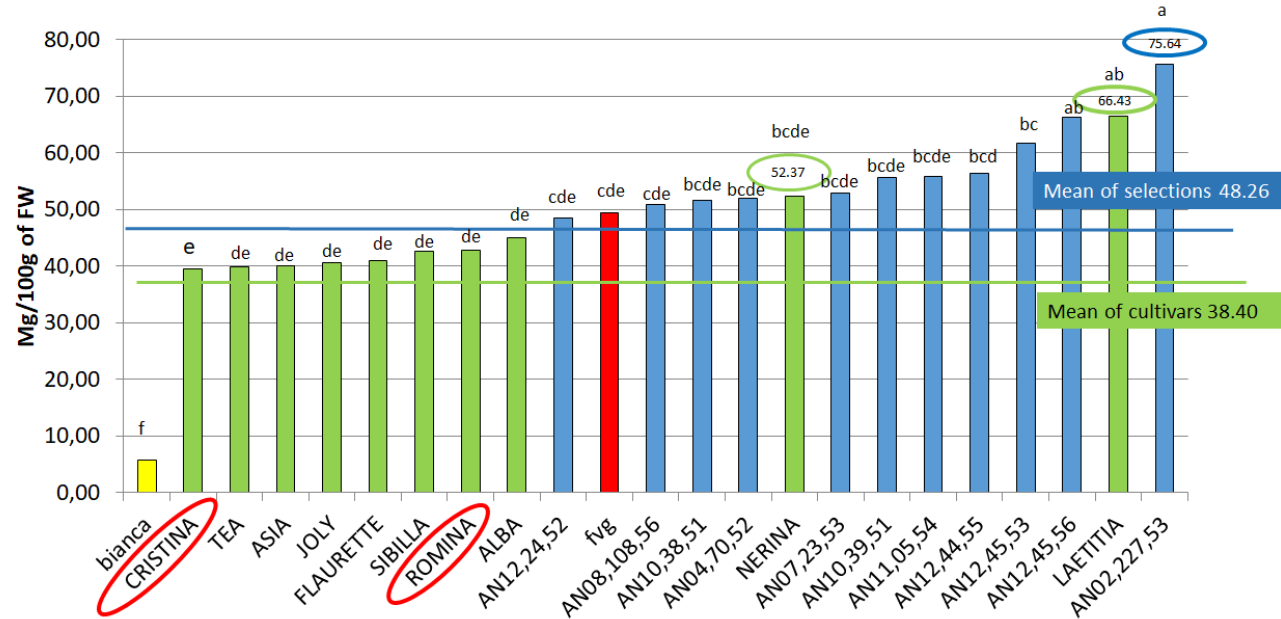
VITAMIN C

Important biological functions for humans:

- Electron transportation
- Antioxidant function
- Metabolism of metal ions
- Enzymatic co-substrate

Vit. C in 100 g of fresh fruit	
Kiwifruit	85 mg
Strawberry	54 mg
Orange	50 mg
Banana	16 mg
Apricot	13 mg
Sweet cherry	11 mg
Apple	5 mg
Peach	4 mg

Our best 22 genotypes in the field (+ white strawberry «bianca»)



New nondestructive phenotyping methods

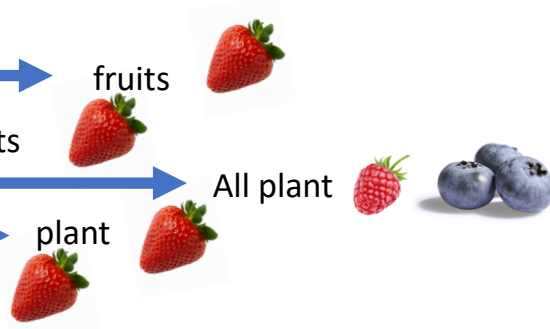
- Near-infrared spectroscopy (NIR), hyperspectral, 3D imaging and architecture phenotyping

**Non-invasive
phenotyping**

aim

to link image/spectral signatures to **biotic and abiotic stresses, resilient** and **fruit quality** traits as well as **fruit yield** that can be used in breeding programmes for climate resilient traits

- Near-infrared spectroscopy (NIR) → fruits
- 3D imaging → fruits
- Hyperspectral imaging → All plant
- Plant architecture → plant
- Root architecture → root



Fruit quality attributes for European berry GenRes emphasized by consumer responses

P4: Natural Resources Institute Finland (Luke)/ Saira Karhu (WP leader), Terhi Latvala
P11: CNR Institute for BioEconomy/ Stefano Predieri (WP Vice Leader)

Main objectives

1. To harmonize the assessment of fruit sensory quality of European berry GenRes.
2. To create visualized sensory profiles to the selected berry varieties.
3. To define consumers' preferences of berry quality in different regions of Europe.
4. To transfer the selected sensory methodologies to the use of European breeders



Data Analyses and visualization (Interrelation with all WPs activities) Bjorn Usadel FZ-Juelich GE

- Data harmonization and clean up.
- Integration of BreedingValue data with public and project specific data
- Data Mining of deep integrative data
- Data management plan

Data visualization and Germinate warehouse for berry data

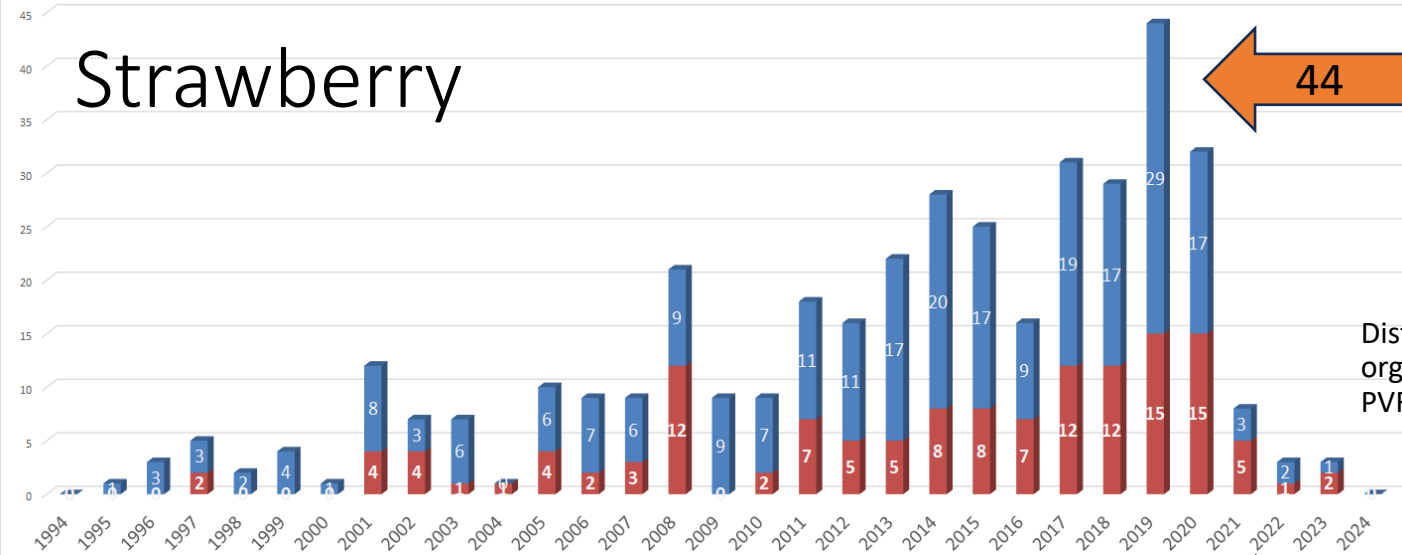
The screenshot displays the Germinate web application interface. At the top left is the 'Germinate' logo. A search bar is located at the top right. Below the header is a navigation sidebar on the left with the following items: Home, Projects (0), Data, Publications (0), Groups (27), Images (254), Search, and About. The main content area features four colored cards: an orange card for '6.2K Germplasm' with a plant icon, a green card for '54K Markers' with a DNA helix icon, a teal card for '661 Traits' with a tag icon, and a purple card for '72 Locations' with a location pin icon. Below these cards is a large banner with a blue background, featuring a DNA double helix intertwined with various berries (raspberry, blueberry, strawberry, cherry) and the text 'Breeding Value' in a large, bold, blue font. In the bottom right corner, there are two logos: the circular seal of 'UNIVERSITA' POLITECNICA DELLE MARCHE' and the 'Breeding Value' logo.

What is the trend of the cultivars registered in Europe for the different berries?

Data from CPVO database on new berry cultivars granted (last 30 years) and applications (last 7 years).



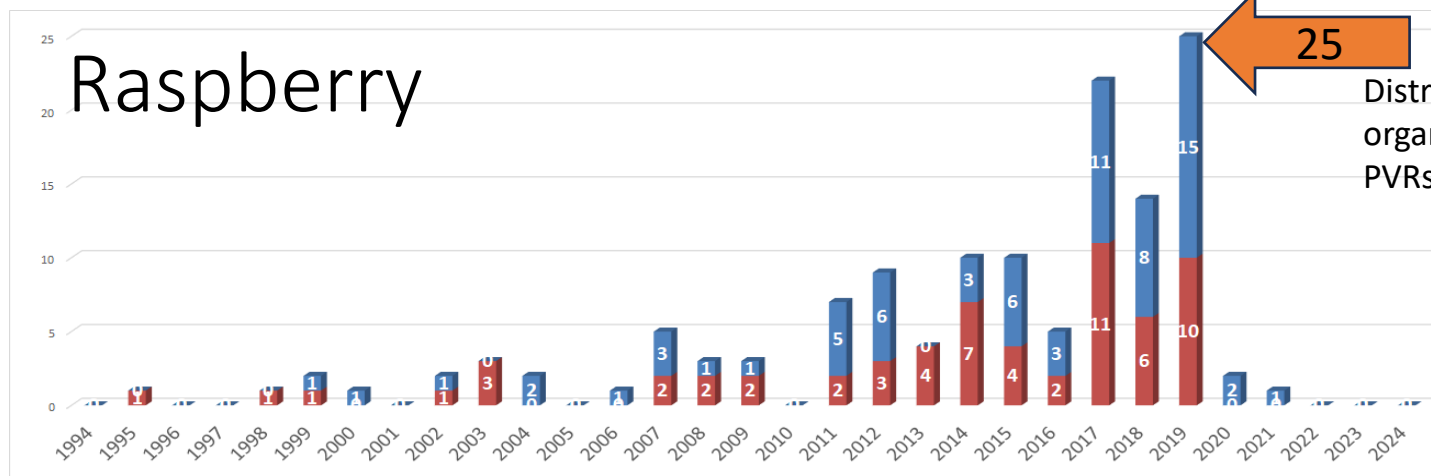
Strawberry



44

Distribution between EU and non-EU organisations for **granted** strawberry PVRs.

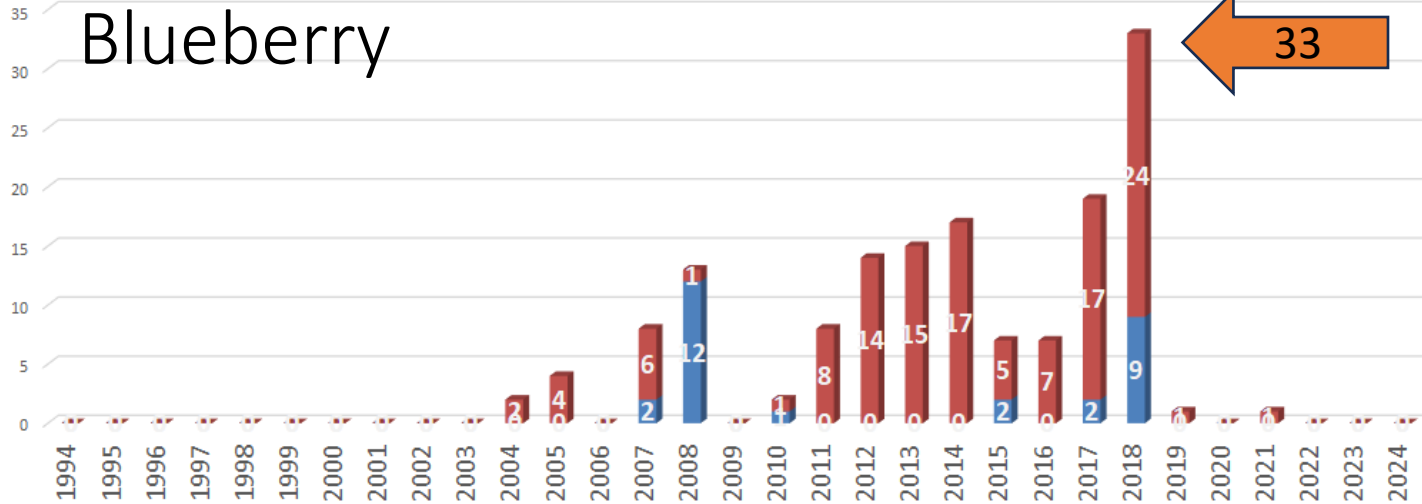
Raspberry



25

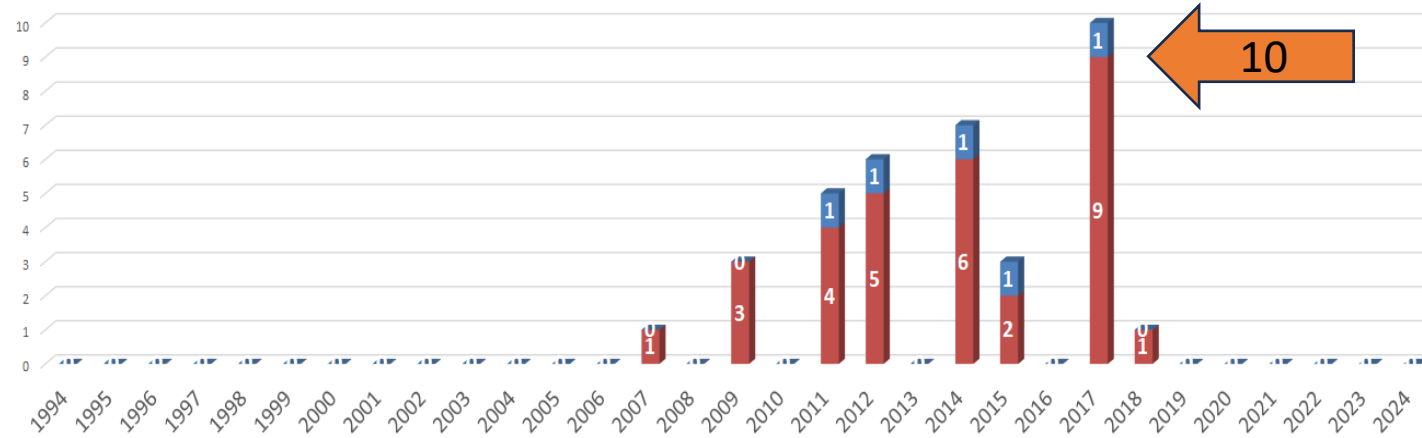
Distribution between EU and non-EU organisations for **granted** raspberry PVRs.

Blueberry



■ Non EU
■ EU

Distribution between EU and non-EU organisations for granted blueberry PVRs.



■ EU
■ Non EU

Distribution between European and non-European organisations for granted blackberry PVR

Expected contribution of Breeding Value to EU GenRes

To berries GenRes:

- **Improve the information status of berry GenRes:** tools to display user-friendly information on accessions and their characteristics and also to the visualization of this information
- **Speed up the introduction of useful characteristics from GenRes into berry breeding** and delivery of new cultivars which are fit for purpose with respect to changing environmental/climatic conditions and consumer demands

To EU GenRes

- **Align berries GenRes to EU GenRes**
- **Contribute to the development of genotyping and phenotyping tools** for GenRes characterization.
- **Bring together public and private actors** for partnerships created by internationally renowned scientists, GenRes managers and SMEs.
- **Intellectual Properties (IP) and exploitation management** in respect of GenRes related protocols
- **Increase consumers awareness on the benefits** deriving from plant GenRes in creating new commercial cultivars

Don't miss the Final Workshop "Advancing Berry Breeding: From Phenotyping to Genomic Innovation", Ancona (IT) and on line April 2nd and 3rd, 2025



第10届世界草莓大会（中国·盐城）

10th International Strawberry Symposium (Yancheng·China)

Countdown **3 2 4** Days

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THE 10TH INTERNATIONAL STRAWBERRY SYMPOSIUM

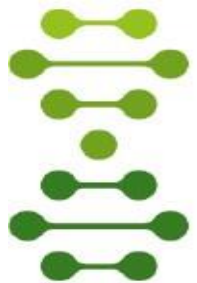
Quality & Germplasm & Brand & Innovation

YANCHENG·CHINA

March 16 - March 21, 2025

Strawberry from coast to plateau





INTERNATIONAL SYMPOSIUM on **BIOTECHNOLOGICAL Tools in HORTICULTURE**

5-9 MAY 2025

<https://symposiumbiotechinhort.com>



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RICCI



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RIMINI EXPO CENTER 5-9 MAY 2025

MACFRUT 2025

For more information on the project: <https://breedingvalue.eu/>



Breeding Value @BreedingValue



I thank all the partners,
collaborators and all of
you for your attention.

the plant journal




















The Plant Journal (2022)

doi: 10.1111/tpj.15876

PERSPECTIVES

Towards smart and sustainable development of modern berry cultivars in Europe

Elisa Senger^{1,*} , Sonia Osorio² , Klaus Olbricht³ , Paul Shaw⁴ , Béatrice Denoyes⁵ , Jahn Davik⁶ , Stefano Predieri⁷ , Saira Karhu⁸ , Sebastian Raubach⁴ , Nico Lippi⁷ , Monika Höfer⁹ , Helen Cockerton¹⁰ , Christophe Pradal^{11,12} , Ebru Kafkas¹³ , Suzanne Litthauer¹⁰ , Iraidia Amaya^{14,15} , Björn Usadel^{1,16}  and Bruno Mezzetti¹⁷ 