European Cooperative Programme for Plant Genetic Resources
ECP/GR

PRO-GRACE
PROMOTING A PLANT GENETIC RESOURCE COMMUNITY FOR EUROPE

EVA NETWORKS:
PUBLIC–PRIVATE PARTNERSHIPS TO EVALUATE GENEBANK MATERIAL FOR BREEDING

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Scientific Officer ECPGR

Pro-Grace training school,
5 October 2023, Chania, Greece

Topics

- Genetic resources for breeding
- Connecting conservation and use of PGR
- Public private partnerships
- The example of EVA (ECPGR European Evaluation Network)
  - Establishment
  - Method of operation
  - Benefits

Variety available in our markets are the result of breeding activities

Breeding adapts crops to:

- Grow in different climates
- Resist different pathogens
- Improve yield and resilience
- Increase shelf-life and reduce food waste
- Improve quality and nutritional content
- Appeal to different tastes
- Produce different ingredients for industry

Where can breeders find genetic diversity to develop new varieties?

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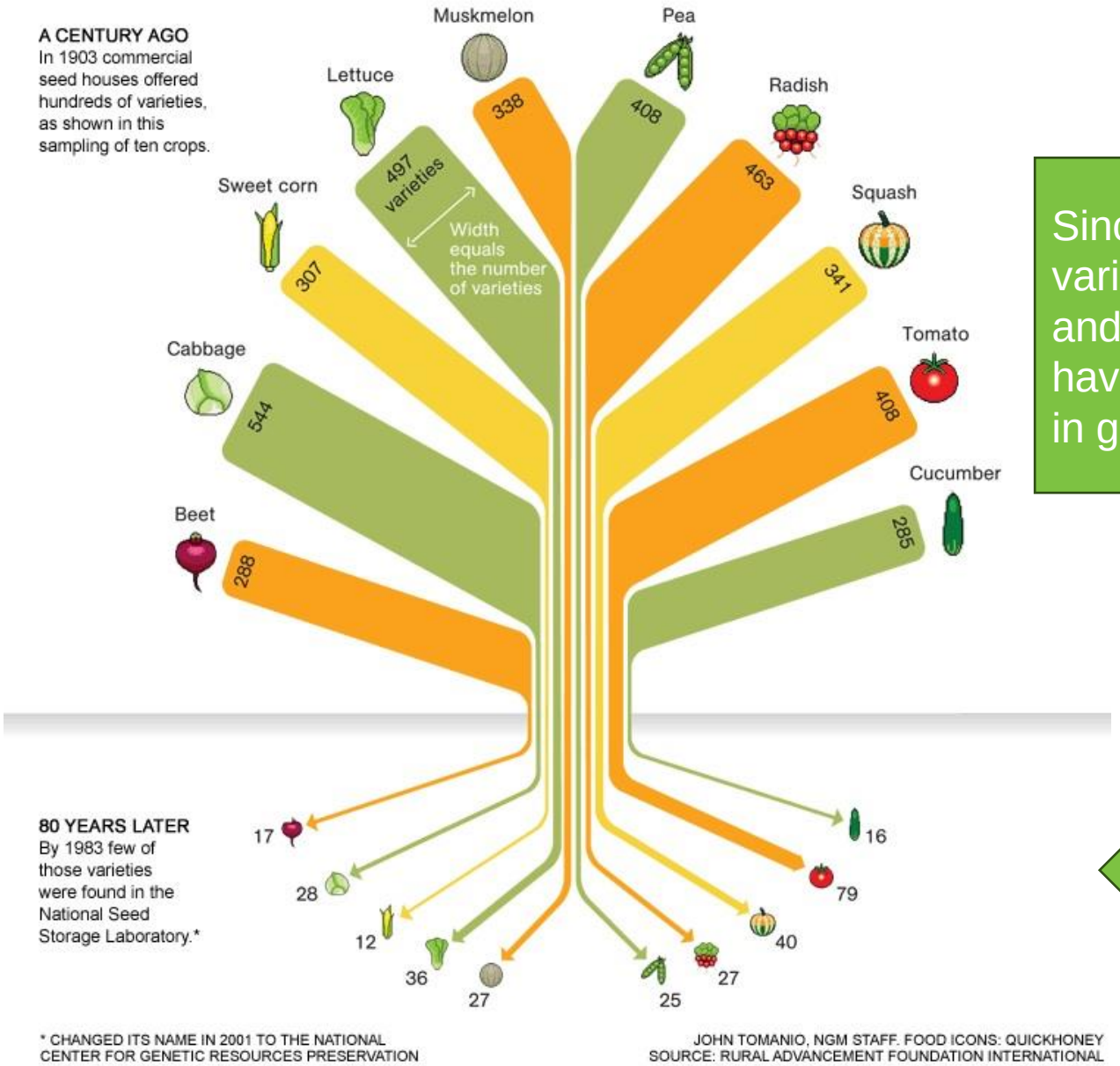

Since ~1920, varieties, landraces and wild relatives have been collected in genebanks

Maize conserved at the Portuguese genebank. Credit: L. Maggioni

Loss of crop varieties in active use by farmers over the past century – genetic erosion

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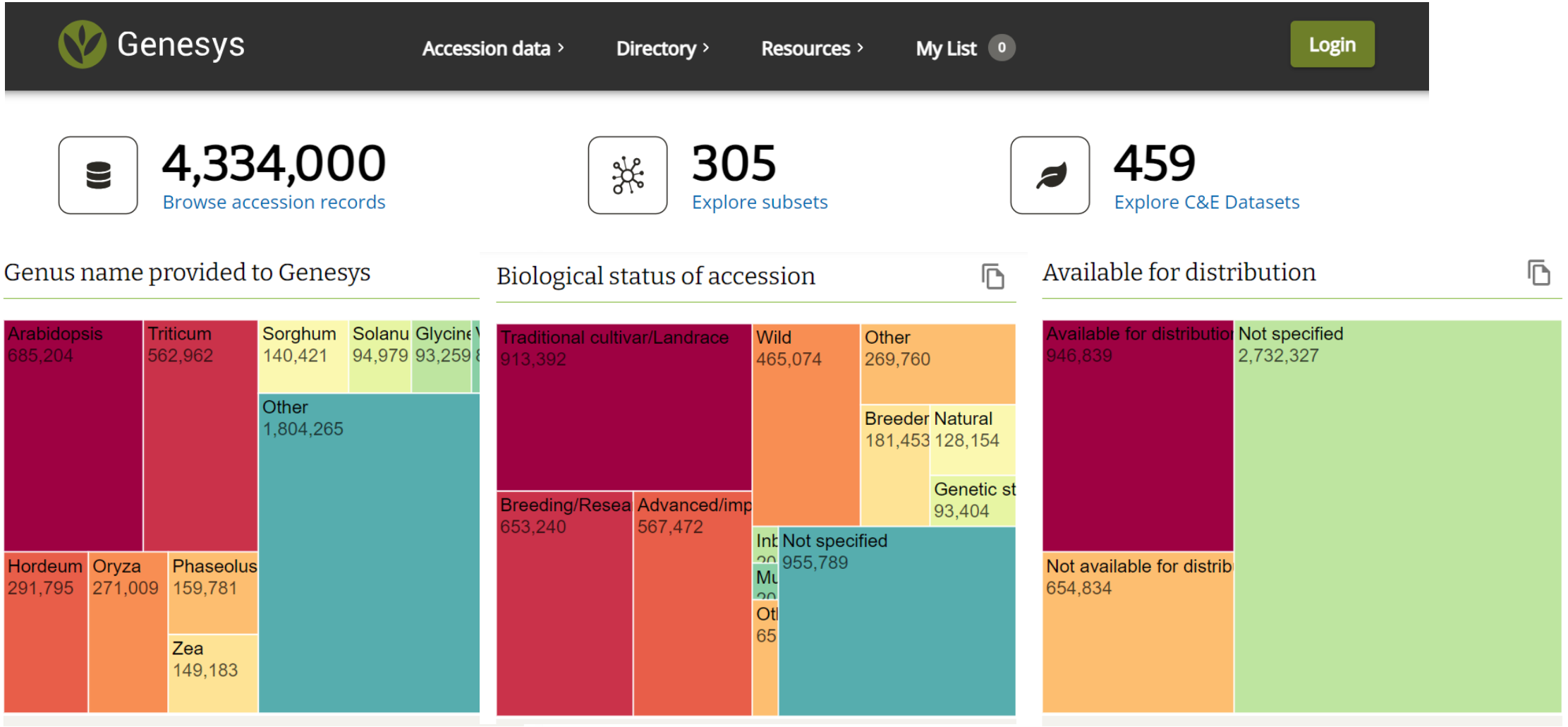
Global PGR genebank collections

https://www.genesys-pgr.org/



PGRFA diversity in European genebanks

2.088.705	accessions
43	national inventories
411	holding institutes
6.731	different genera
45.115	species
430.317	MLS accessions
70.427	AEGIS accessions
230.759	DOIs

eurisco
Finding seeds for the future

http://eurisco.ecpgr.org

Aegis

- Decentralized **European Collection** of unique germplasm
- Availability through **SMTA**, including non-Annex I material
- **Quality System**: agreed standards, peer review and capacity building

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Connecting conservation and use of PGR

- Crop landraces and wild relatives collected over past century may have characteristics useful for today's agriculture
  - Disease resistances
  - Local adaptation
  - Resilience to abiotic stresses
  - Taste and nutritional value

Need to make genebank accessions available to users (farmers and breeders)!

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Connecting conservation and use of PGR

- Documentation on PGR conserved in genebanks is not consistently complete
  - Collecting location and habitat
  - Morphological descriptors
  - Species identification (taxonomy)
- Characterization data collected during regenerations are not fully digitized and available, especially for old records

How do you know which genebank accessions may be interesting for your breeding project?

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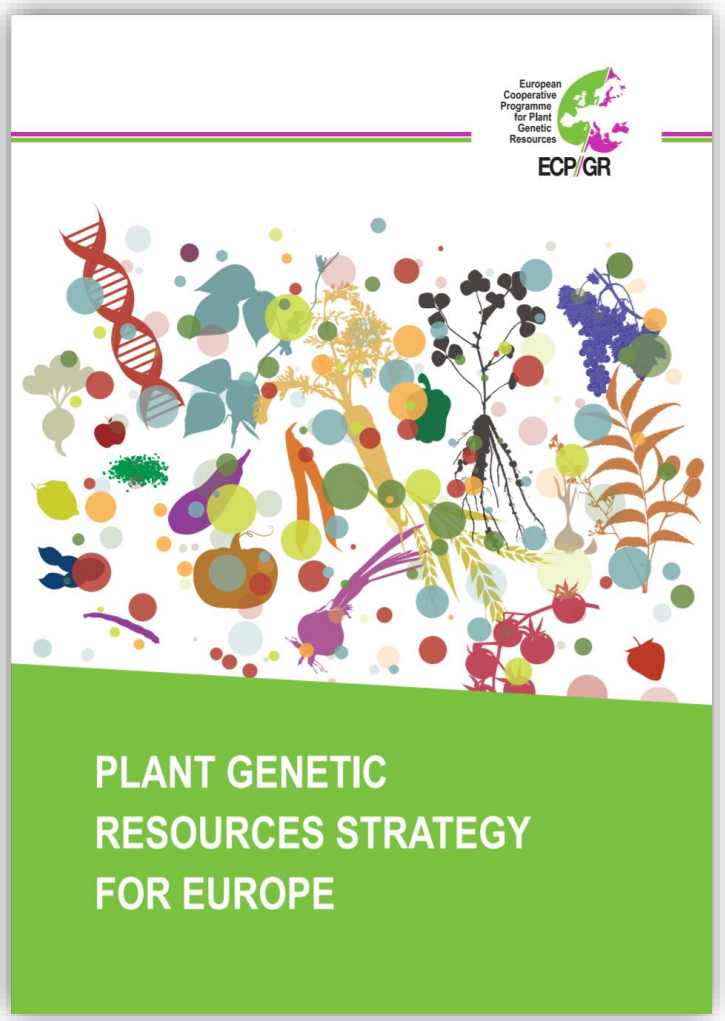
Strategic goals to promote sustainable use of PGR

The potential value of PGR European diversity to face agricultural challenges is underexploited!

By 2030

- Access to well-documented genetic diversity
- Dynamic crop portals for European crops
- Wide phenotypic and genotypic PGR characterization
- Systematic use of CWR in research and crop improvement
- Farmers and civil society participation to breeding
- More diversified European production systems



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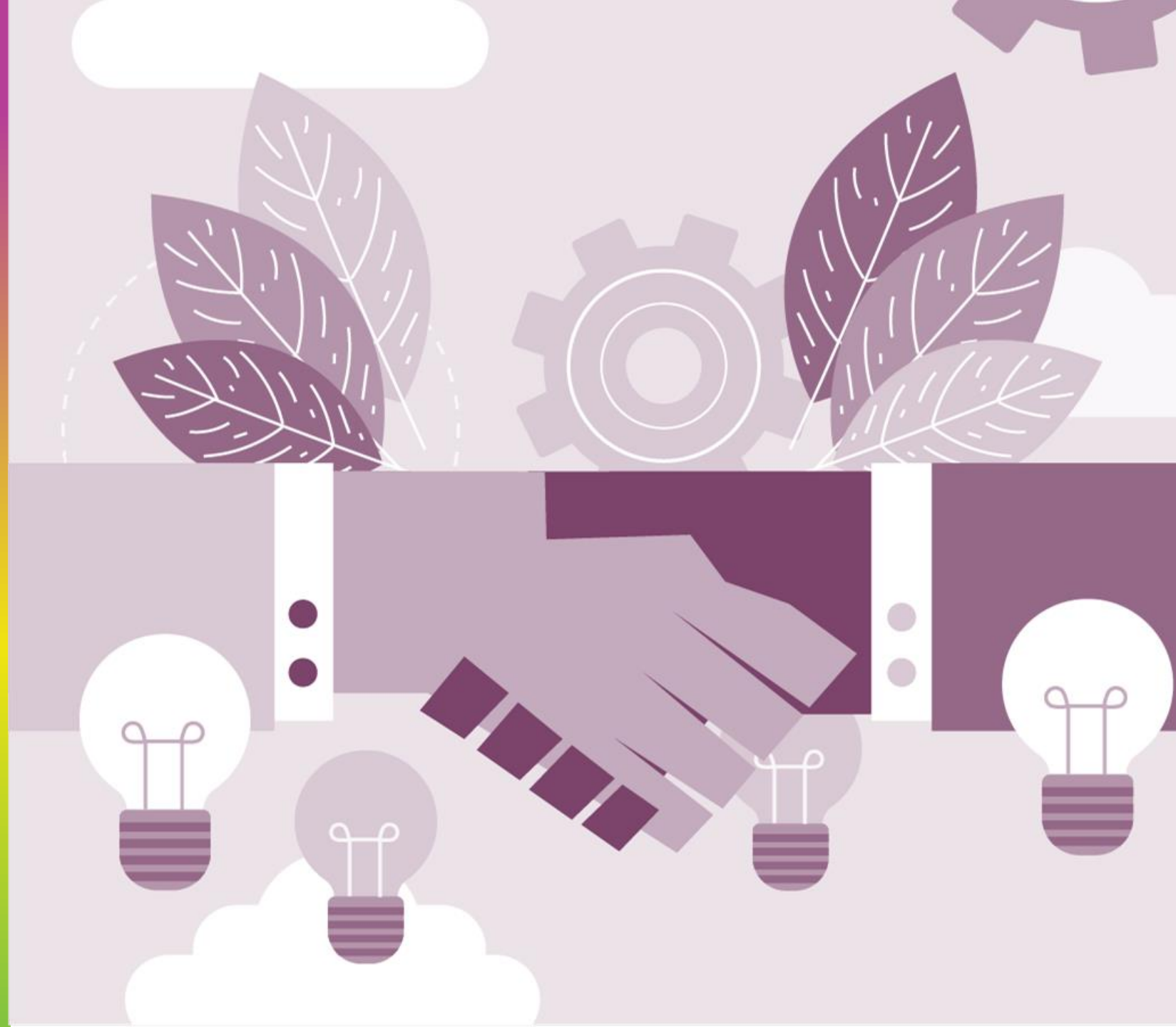
Public–private partnerships



European Cooperative Programme for Plant Genetic Resources
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Federal Ministry of Food and Agriculture

PUBLIC–PRIVATE PARTNERSHIPS

Increasing ECPGR knowledge and opportunities on public–private partnerships for the use of plant genetic resources for food and agriculture.

What are Public–Private Partnerships (PPP)?

A Public–Private Partnership (PPP) is a long-term collaboration between a government/public sector actors and private sector institutions towards delivering a project or service traditionally provided by the government, solving specific problems in applied and strategic research and technology development.

- Both sides share resources and co-invest (money, personnel, facilities, information) to reach a specific objective.
- PPP is the legal framework for pooling of resources and gathering a critical mass to achieve results at scale.
- Partners share risks, rewards and responsibility

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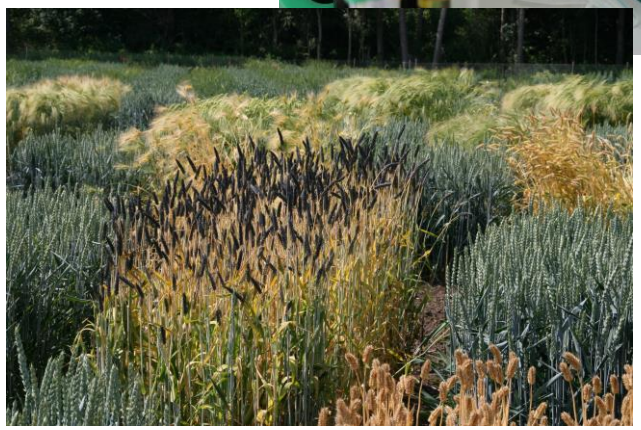
Public–private partnerships in PGR evaluation bring specific expertise and goals

- Public genebanks
  - Knowledge of collections and their potential
  - Often lack of capacity/funding to document and evaluate
  - Long-term outlook for conservation
- Public sector breeders and researchers:
  - Data, results and expertise from previous projects
  - Technological capacity
  - Project funding needs publications
- Private sector breeders:
  - R&D knowledge and capacity for evaluations
  - Short-term investments in projects
  - Commercial interest → return on investment



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ECPGR PPP Knowledge base

~ 50 National and international projects on PGRFA

Apply PPP concept to European PGRFA collections for systematic evaluation for breeding purposes

EVA

European Evaluation Network

Private Public Partnerships Knowledge base

This knowledge base provides information about Private Public Partnership (PPP) examples in Europe with a focus on use of Plant Genetic Resources for Food and Agriculture (PGRFA).
Search below for a PPP by selecting from the drop down lists or simply start typing in the field and select from the list that will be generated automatically while you type.
Alternatively browse through the PPPs listed underneath the search interface. Click on +More to view details about a specific PPP.
We will be glad to receive and include additional PPP examples. You can download the PPP form here (28,5 KB), write down the requested information about your PPP and email the form to the ECPGR Secretariat.

https://www.ecpgr.cgiar.org/resources/private-public-partnerships-ppp/ppp-knowledge-base

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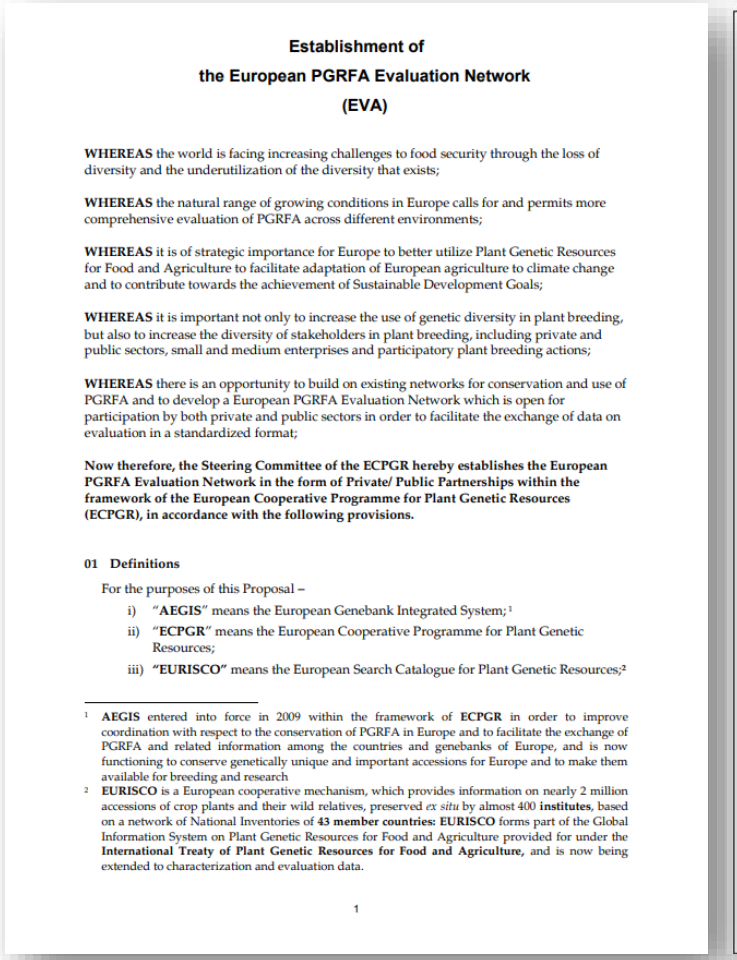
ECPGR-EVA networks for evaluation of PGR

EVA

European Evaluation Network

Establishment of ECPGR European Evaluation Network EVA - 2018

European Evaluation Network (EVA) approved by the ECPGR Steering Committee



Establishment of
the European PGRFA Evaluation Network
(EVA)

WHEREAS the world is facing increasing challenges to food security through the loss of diversity and the underutilization of the diversity that exists;

WHEREAS the natural range of growing conditions in Europe calls for and permits more comprehensive evaluation of PGRFA across different environments;

WHEREAS it is of strategic importance for Europe to better utilize Plant Genetic Resources for Food and Agriculture to facilitate adaptation of European agriculture to climate change and to contribute towards the achievement of Sustainable Development Goals;

WHEREAS it is important not only to increase the use of genetic diversity in plant breeding, but also to increase the diversity of stakeholders in plant breeding, including private and public sectors, small and medium enterprises and participatory plant breeding actions;

WHEREAS there is an opportunity to build on existing networks for conservation and use of PGRFA and to develop a European PGRFA Evaluation Network which is open for participation by both private and public sectors in order to facilitate the exchange of data on evaluation in a standardized format;

Now therefore, the Steering Committee of the ECPGR hereby establishes the European PGRFA Evaluation Network in the form of Private/ Public Partnerships within the framework of the European Cooperative Programme for Plant Genetic Resources (ECPGR), in accordance with the following provisions.

01 Definitions

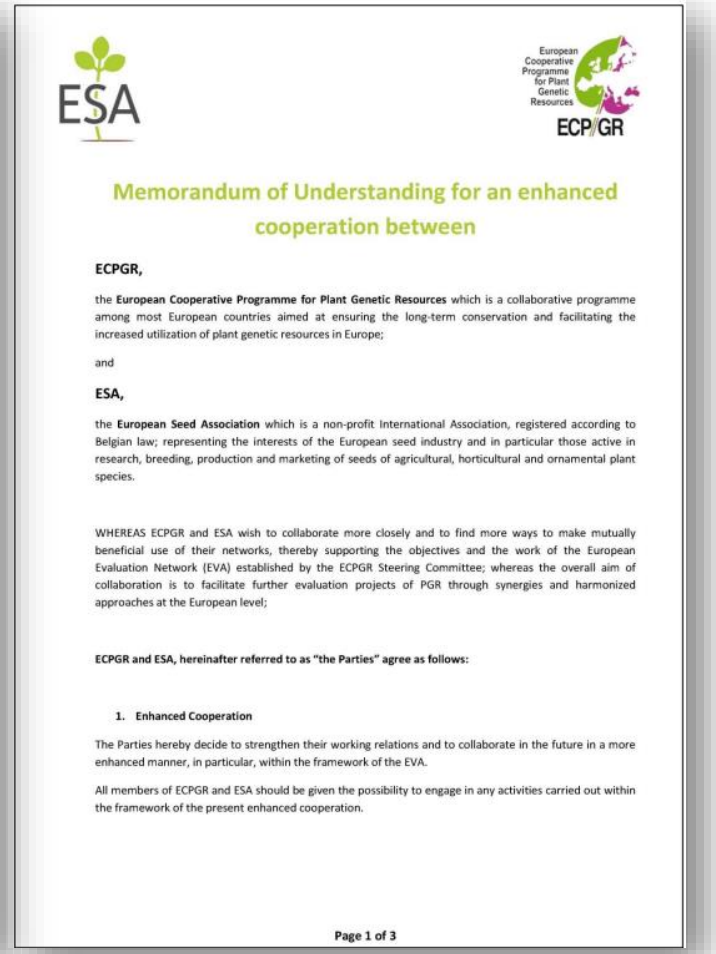
For the purposes of this Proposal –

i) "**AEGIS**" means the European Genebank Integrated System;[1]
ii) "**ECPGR**" means the European Cooperative Programme for Plant Genetic Resources;
iii) **"EURISCO"** means the European Search Catalogue for Plant Genetic Resources;[2]

[1] **AEGIS** entered into force in 2009 within the framework of **ECPGR** in order to improve coordination with respect to the conservation of PGRFA in Europe and to facilitate the exchange of PGRFA and related information among the countries and genebanks of Europe, and is now functioning to conserve genetically unique and important accessions for Europe and to make them available for breeding and research

[2] **EURISCO** is a European cooperative mechanism, which provides information on nearly 2 million accessions of crop plants and their wild relatives, preserved *ex situ* by almost 400 **institutes**, based on a network of National Inventories of **43 member countries: EURISCO** forms part of the Global Information System on Plant Genetic Resources for Food and Agriculture provided for under the **International Treaty of Plant Genetic Resources for Food and Agriculture,** and is now being extended to characterization and evaluation data.

1



ESA

European Cooperative Programme for Plant Genetic Resources
ECP/GR

Memorandum of Understanding for an enhanced cooperation between

ECPGR,

the **European Cooperative Programme for Plant Genetic Resources** which is a collaborative programme among most European countries aimed at ensuring the long-term conservation and facilitating the increased utilization of plant genetic resources in Europe;

and

ESA,

the **European Seed Association** which is a non-profit International Association, registered according to Belgian law; representing the interests of the European seed industry and in particular those active in research, breeding, production and marketing of seeds of agricultural, horticultural and ornamental plant species.

WHEREAS ECPGR and ESA wish to collaborate more closely and to find more ways to make mutually beneficial use of their networks, thereby supporting the objectives and the work of the European Evaluation Network (EVA) established by the ECPGR Steering Committee; whereas the overall aim of collaboration is to facilitate further evaluation projects of PGR through synergies and harmonized approaches at the European level;

ECPGR and ESA, hereinafter referred to as "the Parties" agree as follows:

1. Enhanced Cooperation

The Parties hereby decide to strengthen their working relations and to collaborate in the future in a more enhanced manner, in particular, within the framework of the EVA.

All members of ECPGR and ESA should be given the possibility to engage in any activities carried out within the framework of the present enhanced cooperation.

Page 1 of 3

Euroseeds
Embracing Nature

ECP/GR

EVA Timeline

Federal Ministry of Food and Agriculture

2017 - 2019

- Preparatory phase: PPP knowledge base, workshops to develop framework
- **ECPGR Steering Committee approves EVA framework**
- Germany (BMEL) grants project to implement EVA

2020 - 2022

- EVA project starts with 5 networks in July 2019: **Wheat and Barley, Carrot, Lettuce, Maize** and **Pepper**
- Project extension with funds until 2024 to compensate for COVID-19 delays
- H2020 project **AGENT** extends activities of EVA Wheat and Barley to 2025
- EVA networks phenotype and genotype >5000 accessions
- First in person project meetings of all EVA networks in 2022
- EVA crop networks present first results in international conferences

2023-2024

- Focus on final evaluations and data analysis, exploitation and dissemination
- Networks develop workplans for next phase
- **ForEVA** project develops **EVA Grain Legumes Network,** projected to start in 2024

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EVA initiative aims to:

EVA
European Evaluation Network

- **Increase knowledge** on germplasm held in European genebanks
- Improve passport information and add C&E data in **EURISCO**
- Promote the **use of genebank germplasm** in research, breeding and cultivation
- Identify **climate-resilient** breeding material
- Foster cooperation between public and private sector through **MoU with Euroseeds** signed in 2018
- Widen the stakeholders involved in using PGRFA through creation of **public-private partnerships**
- Create **self-sustaining networks** that evaluate available PGRFA in continuous evaluation cycles

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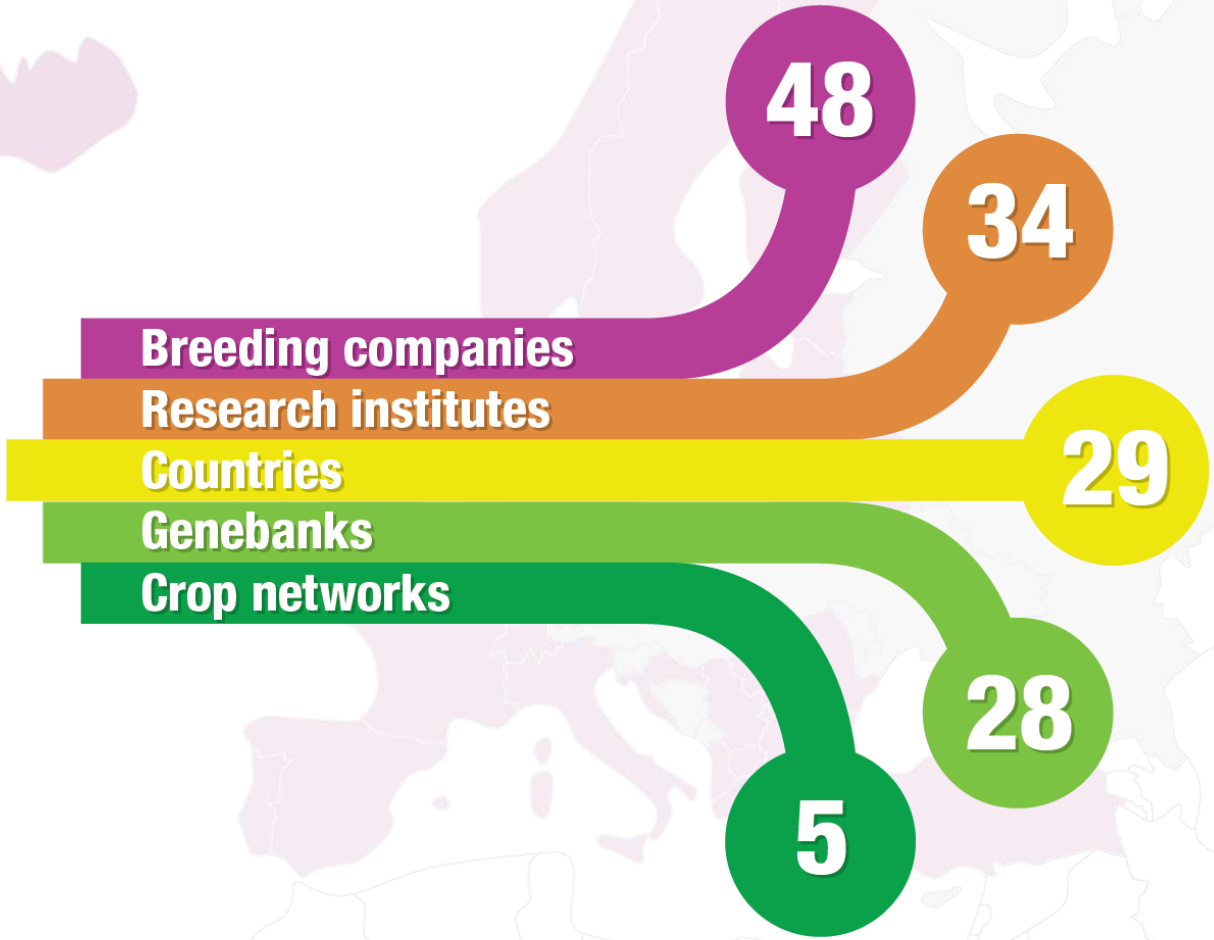
EVA

European Evaluation Network

More than 90 EVA partners

- **Public partners**
  - Genebanks
  - Universities and research institutes
- **Private partners**
  - Multinational breeding companies
  - SME breeding companies
  - Organic breeding companies
  - Breeding and farming cooperatives



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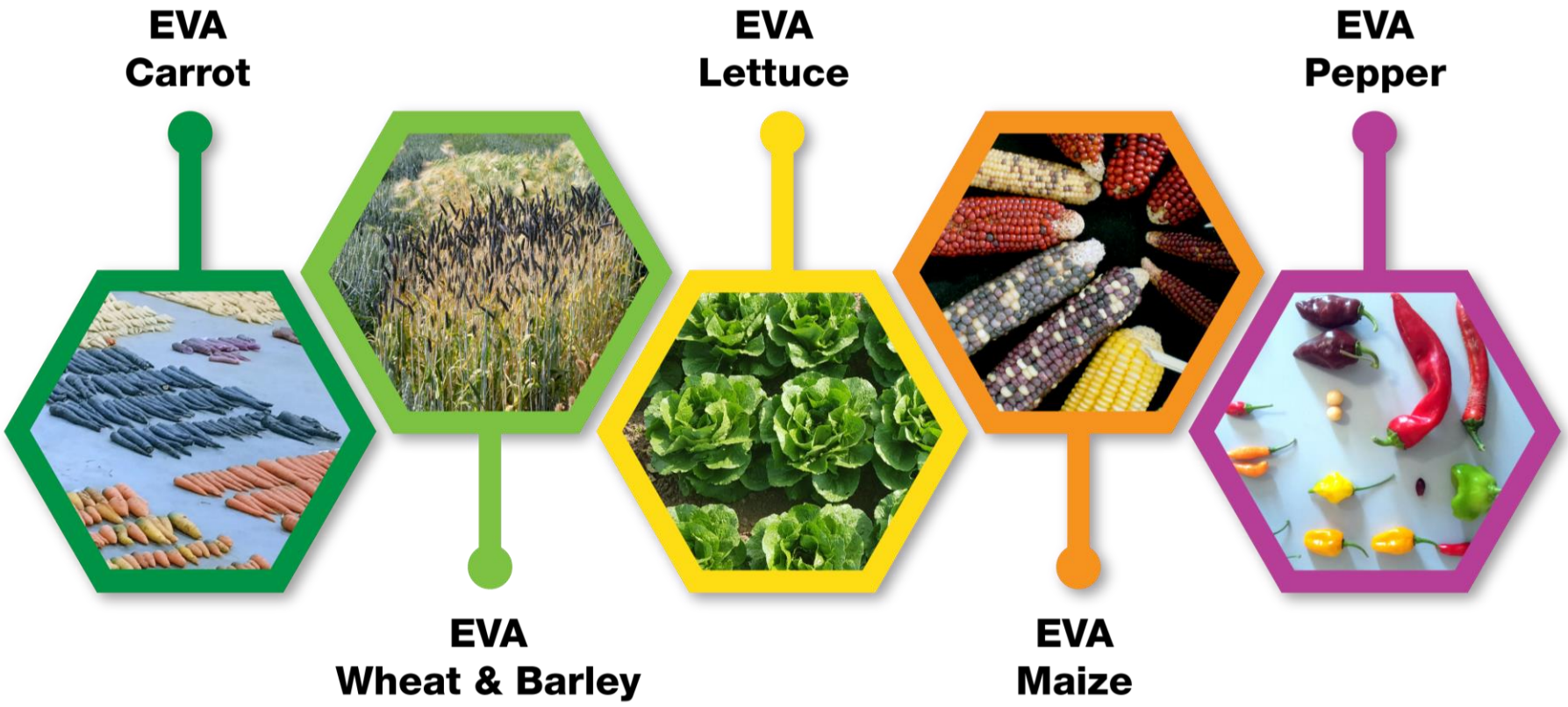
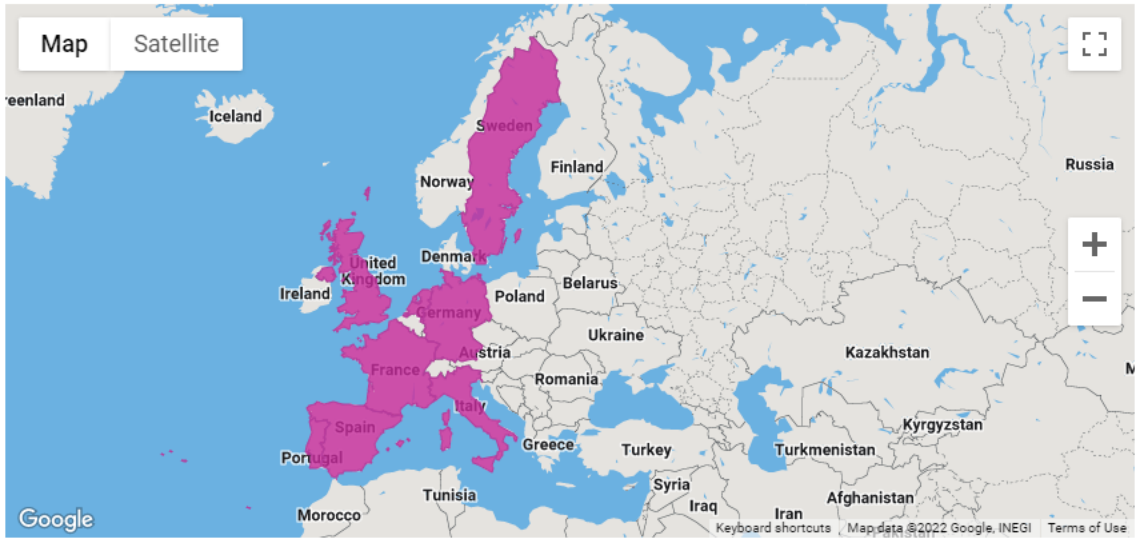
Five crop-specific EVA networks



EVA Legumes is in preparation through Grain Legumes WG activity **ForEVA**

EVA Carrot Network

Countries involved

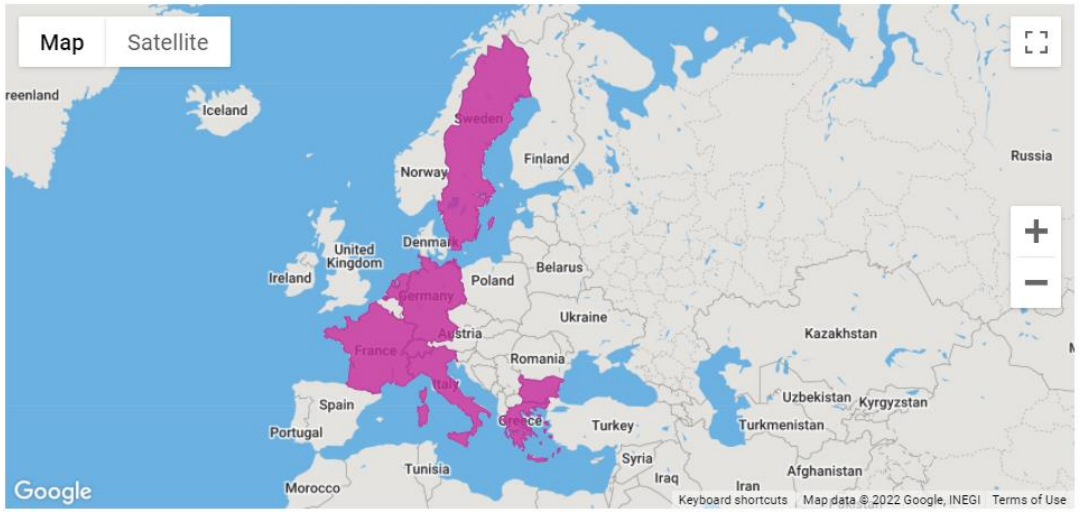


14 partners from
8 countries

- 6 genebanks and/or research institutes
- 8 breeding companies

EVA Lettuce Network

Countries involved



- 11 partners from 8 countries
  - 6 genebanks and/or research institutes
  - 5 breeding companies

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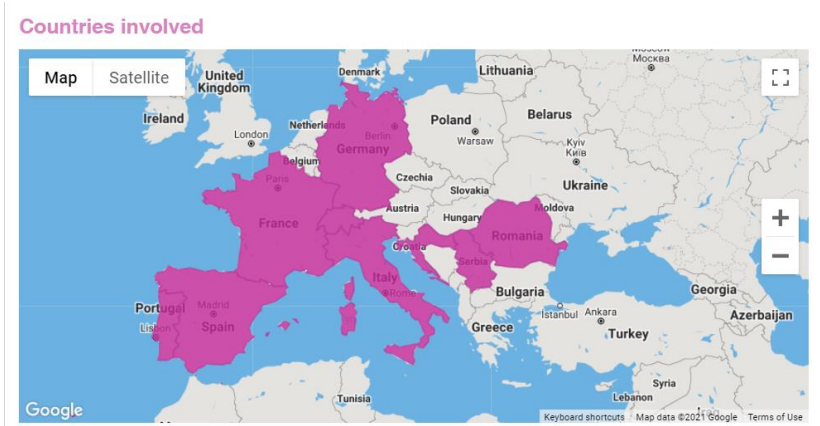
EVA Maize Network



- 18 partners from 9 countries
  - 10 genebanks and/or research institutes
  - 8 breeding companies

Politécnico de Coimbra

BAYER

CSIC

INRAE

mas seeds UNITED TO GROW

DSP

Limagrain from earth to life

Lidea

MAIZE RESEARCH INSTITUTE ZEMUN POLJE
Belgrade - Zemun

iniav Instituto Nacional de Investigação Agrária e Veterinária, I.P.

R·A·G·T SEMENCES

IPK GATERSLEBEN

AGRONOMSKI FAKULTET ZAGREB MCMXIX

BRGV Suceava

crea Consiglio per la ricerca in agricoltura e l'analisi dell'economia agraria

Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

KWS

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EVA Pepper network

Countries involved

15 partners from 10 countries

- 6 genebanks and/or research institutes
- 6 breeding companies (Italy and Spain)

ELGO - DEMETER
HELLENIC AGRICULTURAL ORGANIZATION- DEMETER

ISI

TERA SEEDS
world professional seeds

crea
Consiglio per la ricerca in agricoltura e l'analisi dell'economia agraria

ibbr

Sativa
SEEDS & SERVICES

1951
UBT

Institute of Genetics and Cytology
of the National Academy of Sciences of Belarus

האוניברסיטה העברית בירושלים
THE HEBREW UNIVERSITY OF JERUSALEM

fito

WAGENINGEN
UNIVERSITY & RESEARCH

La Semiorto Sementi

ESASEM
IL SEME DELLA RICERCA

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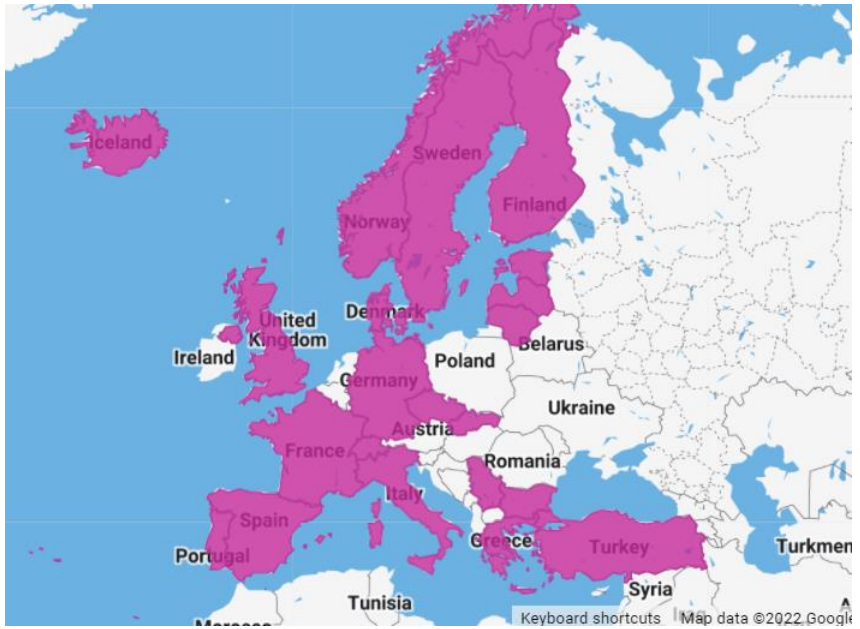
EVA Wheat and Barley Network



47 partners from 21 countries

- 23 genebanks and/or research institutes
- 24 breeding companies

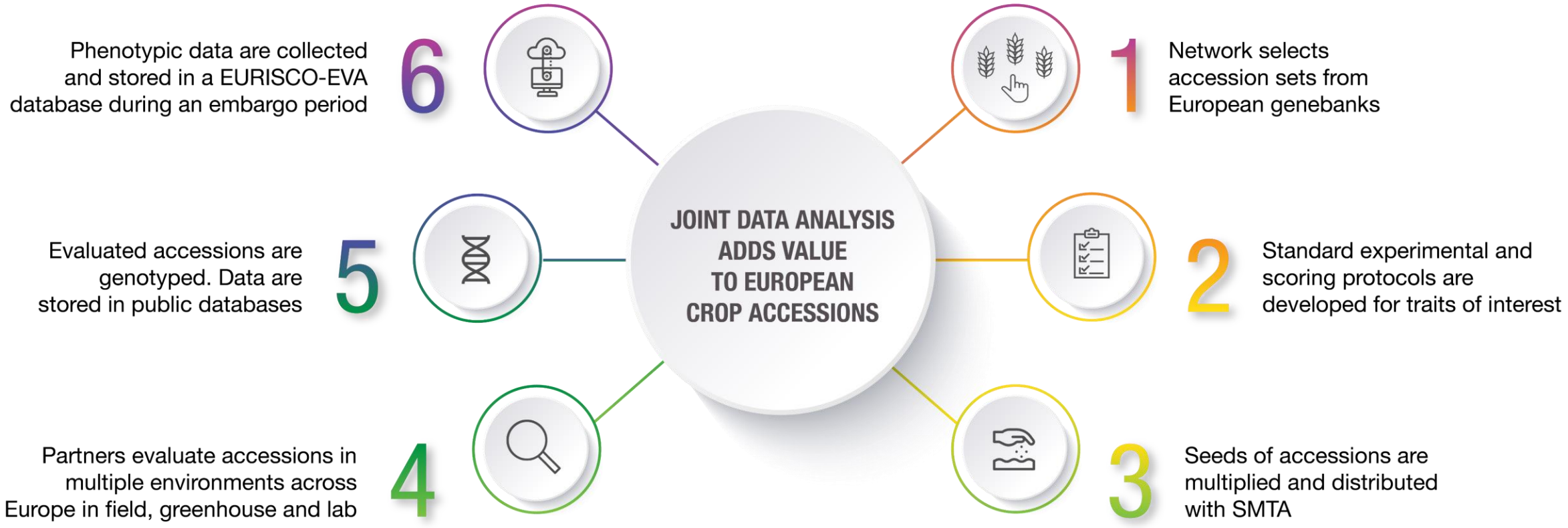
EVA Wheat and Barley network

How EVA networks operate

EVA

European Evaluation Network

HOW THE EVA CROP NETWORKS OPERATE

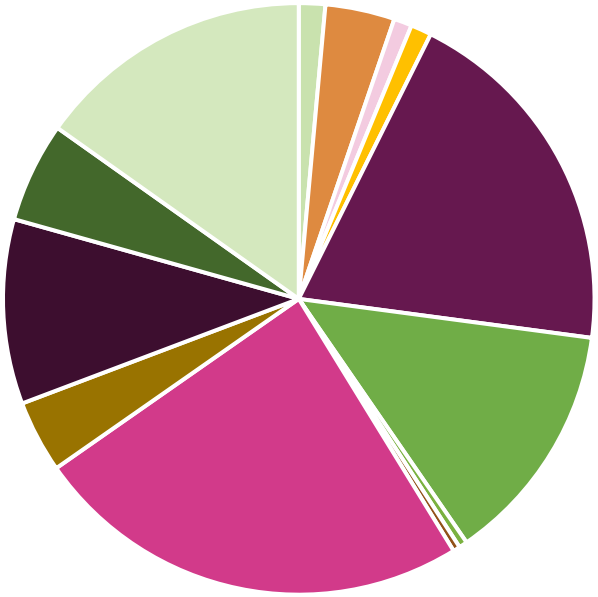


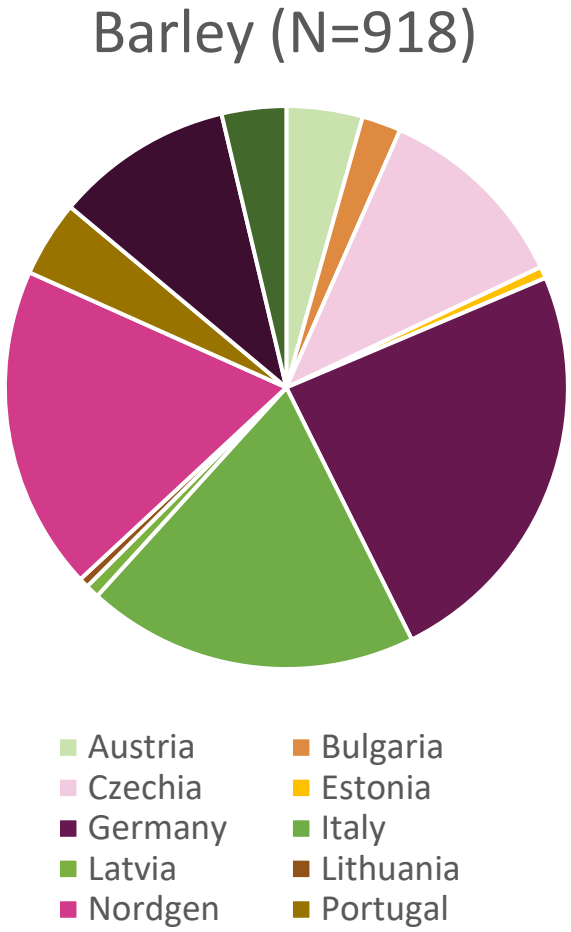
Cooperation agreement ensures privileged access to data, while material is exchanged through SMTA and can be used for further development and eventual commercial use

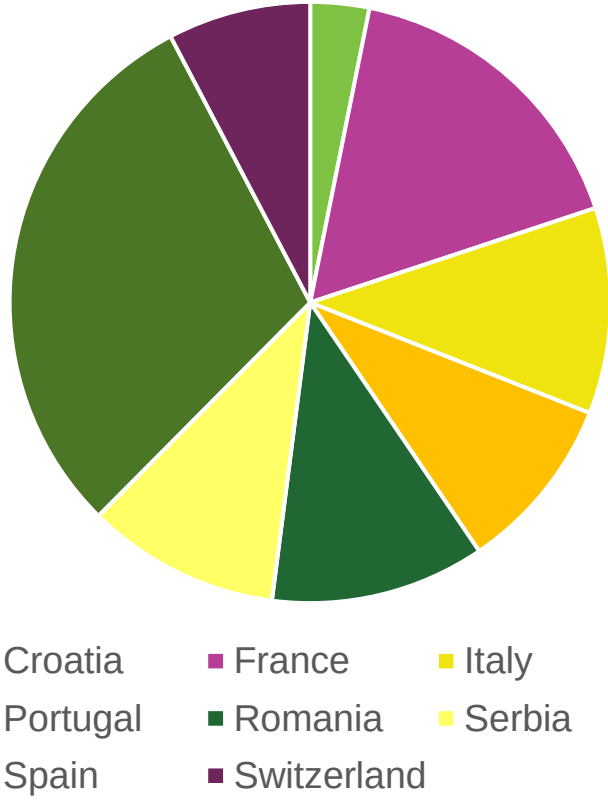
ECP/GR

1 Network selects accession sets from European genebanks

EVA Accessions field crops





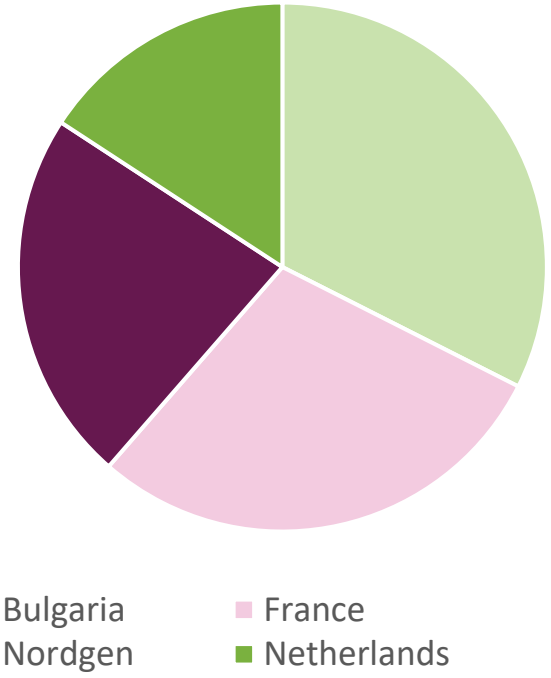


ECP/GR

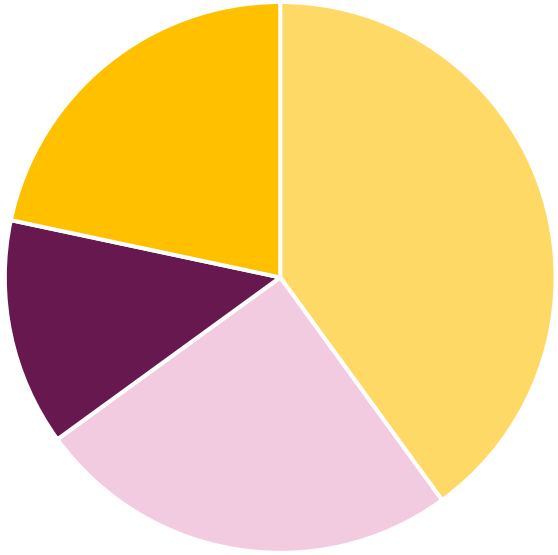
1 Network selects accession sets from European genebanks

EVA Accessions vegetables

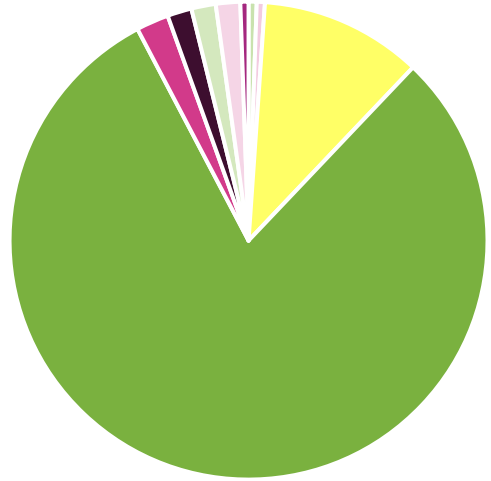
Lettuce (N=228)



Carrot (N=60)



Pepper (N = 182)



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2 Standard experimental and scoring protocols are developed for traits of interest

Traits of interest

- Morphological traits
  - Shape, color, height,
- Agronomical traits
  - Vigor, yield, development time
- Quality traits
  - Biochemical, processing, storage
- Biotic stress traits
  - Fungal, bacterial or viral diseases
- Abiotic stress traits
  - Drought, heat, cold stresses

Bread Wheat (Triticum aestivum) Illustration by Lizzie Harper

ECP/GR

2 Standard experimental and scoring protocols are developed for traits of interest

Standard scoring methods

Standard protocols combine:

- IPGRI descriptors
- Published protocols
- Partners' expertise

Powdery mildew_SW

Powdery mildew of wheat -*Blumeria graminis* f. sp. *tritici*

spring wheat

Design of tests: micro plots

The screening for resistance is achieved by field experiments in micro plots or hill plots without replications. For common fungal diseases, check varieties are included. Inoculation, rating methods and data processing are carried out as described below.

Natural infection in field trials:

Spring wheat can be infected in spring at growth stage BBCH 21 to BBCH 25

Inoculation:

Artificial inoculation in field trials is possible using the method of Bousset et al. (2001) by planting pots with infected plants into the middle of plots twicely at growth stages from BBCH 15 to BBCH30. Pots in greenhouse can be inoculated by brushing of powdery mildew conidia or by spraying a conidia/ water suspension onto leaves of susceptible seedlings.

Growth stage of inoculation: BBCH 15 to BBCH 30

Rating

Date of rating: At heading (BBCH 35) Repeated estimations of infested leaf area are carried out weekly over the complete disease period. Three estimations at weekly intervals might be the minimum.

Parameter to assess: Average of percentage of infected leaves per plot

Alternatives: Symptom expression as score (1 to 9)

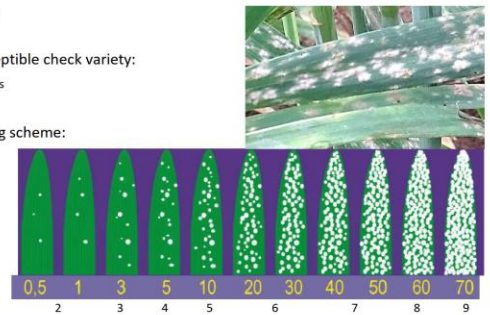
Resistant check variety: Typical symptoms (susceptible variety)

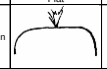
Servus

Susceptible check variety:

Quintus

Rating scheme:



9 7.4.16 Root shoulder shape	Notation	1	2	3	4	5	99
	Modality	Flat	Flat to rounded	Rounded	Rounded to conical	Conical	Other
	Illustration						
10 7.4.17 Colour of skin on shoulder (Modified)	Notation	0	3	5			
	Modality	No difference	Green	Violet			
	Illustration						
11 7.4.21 Root tip/end shape	Notation	1	2	3			
	Modality	Blunt	Rounded	Pointed			
	Illustration						
12 7.4.22 Root skin pigmentation colour	Notation	1	2	3	4	5	99
	Modality	White	Yellow	Orange	Red	Purple	Other
	Illustration						
13 7.5.5 Outer core pigmentation/colour (Observation at maximum diameter)	Notation	1	2	3	4	5	99
	Modality	White	Yellow	Orange	Red	Purple	Other
	Illustration						
14 7.5.7 Inner core pigmentation/colour (Observation at maximum diameter)	Notation	1	2	3	4	5	99
	Modality	White	Yellow	Orange	Red	Purple	Other
	Illustration						

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3 Seeds of accessions are multiplied and distributed with SMTA

Multiplication and distribution

Preparation of SSD in greenhouse

Harvest of SSD in greenhouse

Multiplication in the field

Preparation of seed distribution

www.julius-kuehn.de

ECP/GR

3 Seeds of accessions are multiplied and distributed with SMTA

EVA uses SMTA

The ITPGRFA Standard Material Transfer Agreement (SMTA)

- Provisions that govern the exchange of material under the Multilateral System
- Used for every transfer of material
- Significantly lower transaction costs compared with bilateral approach
- Ensures benefit sharing multilaterally among Contracting Parties

ECPGR promotes use of SMTA:

- ECPGR recommends use of SMTA for all exchange of PGRFA, even if not Annex 1
- Use of SMTA with the terms and conditions of the MLS of ITPGRFA has proven to be the best available option to involve private breeders into partnerships with genebanks and the public sector in EVA

ECP/GR

Multilocation trials

Partners evaluate accessions in multiple environments across Europe in field, greenhouse and lab **4**

>100 Trial locations across Europe

Behavior of crops in different environments allows identification of locally adapted accessions

Evaluations in field, lab and greenhouse

Partners evaluate accessions in multiple environments across Europe in field, greenhouse and lab

4

EVA wheat trial 2021, BASF (V. Spamer)

EVA carrot trial 2021 Institut Agro Angers (E. Geoffriau)

EVA pepper trial 2021, Semillas Fito (M. Fernandez)

EVA maize trial 2021, CREA-CI (C. Balconi)

EVA pepper lab trial 2021, CREA-OF (L. Sigillo)

EVA lettuce trial 2022 *Sativa* Rheinau (C. Aichholz)

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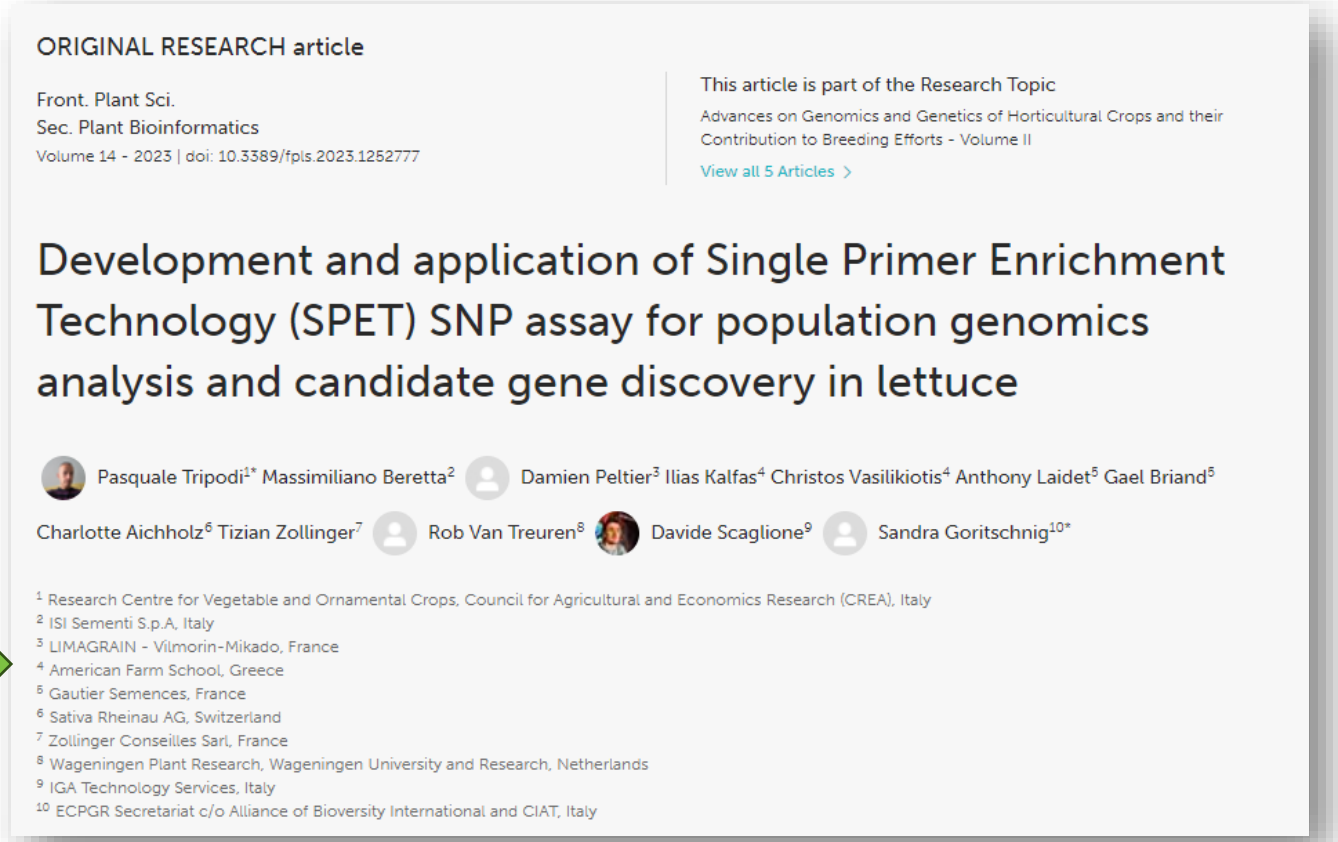
Evaluated accessions are genotyped. Data are stored in public databases

5

Genotyping

- SNP arrays
- WGS
- Marker genotyping
- SPET

EVA Lettuce developed new genotyping assay for lettuce



ORIGINAL RESEARCH article

Front. Plant Sci.
Sec. Plant Bioinformatics
Volume 14 - 2023 | doi: 10.3389/fpls.2023.1252777

This article is part of the Research Topic
Advances on Genomics and Genetics of Horticultural Crops and their Contribution to Breeding Efforts - Volume II
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Development and application of Single Primer Enrichment Technology (SPET) SNP assay for population genomics analysis and candidate gene discovery in lettuce

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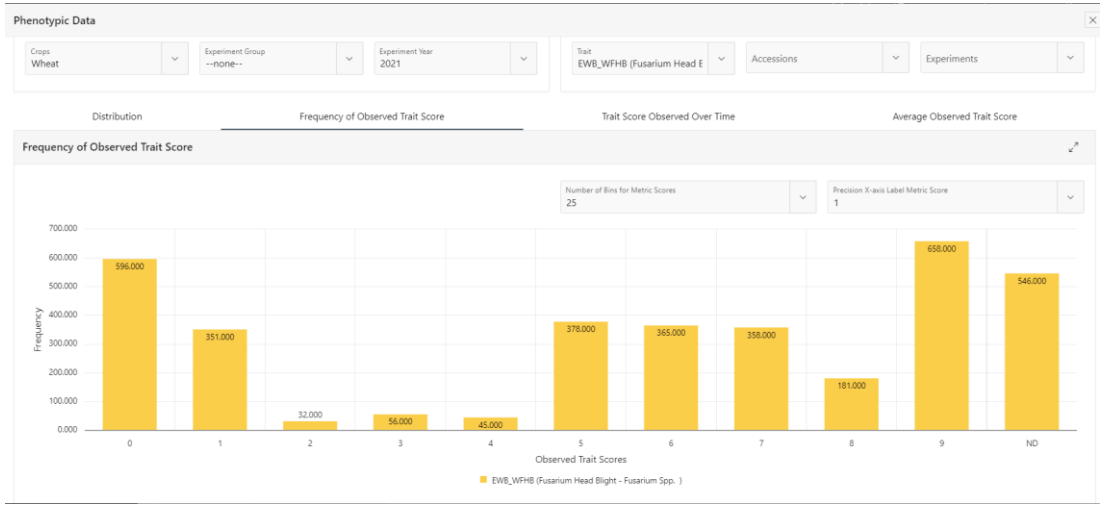
Evaluated accessions are genotyped. Data are stored in public databases

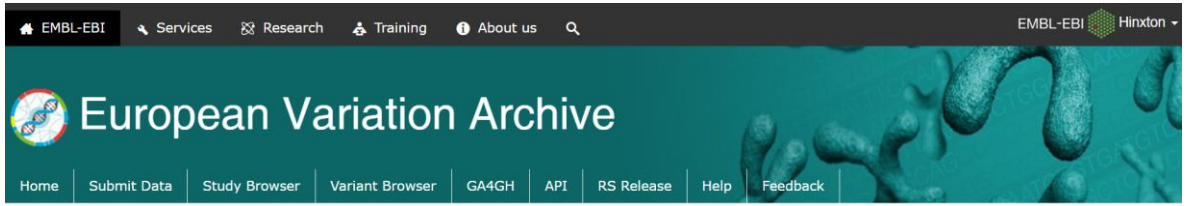
5

Data management

- Phenotyping data → **EURISCO-EVA** intranet compatible with EURISCO



- Genotyping data → public repository **Elixir/EMBL EVA**



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Evaluated accessions are genotyped. Data are stored in public databases

5

Open access and FAIR data management

Ensure open access to EVA project data according to **FAIR** principles:

Findability – indexed metadata allows easy search

Accessibility – open access databases and common identifiers

Interoperability – standardized data is usable across platforms

Reuse – clear and accessible licensing

Accessions in EURISCO with direct link to C&E data and genotyping data

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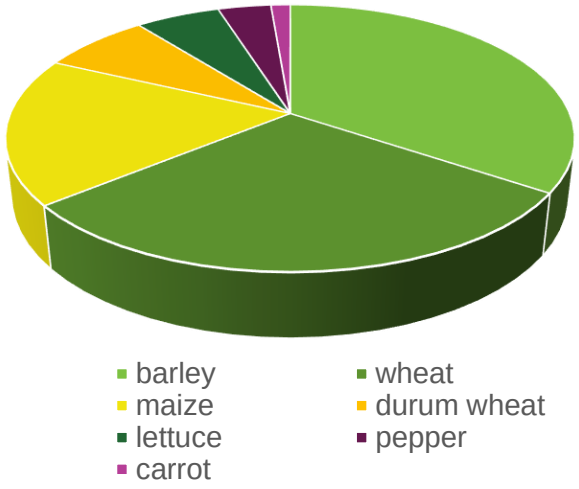
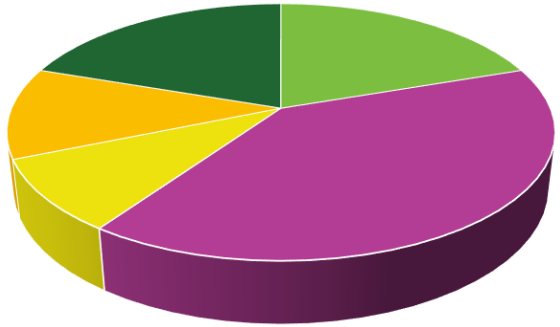
Output of EVA networks (2020-2023)

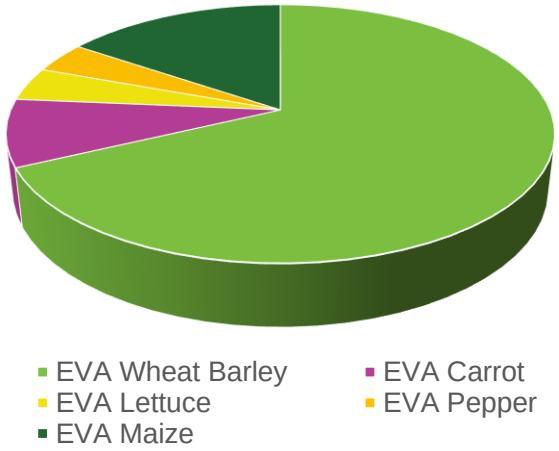
>5000 accessions



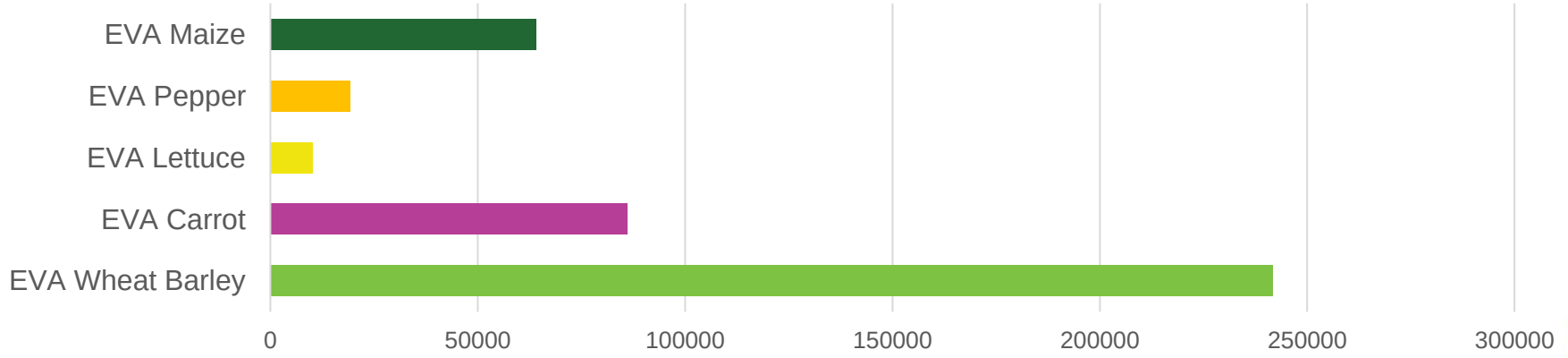
> 230 Traits evaluated



309 EVA trials



> 420.000 evaluation data points



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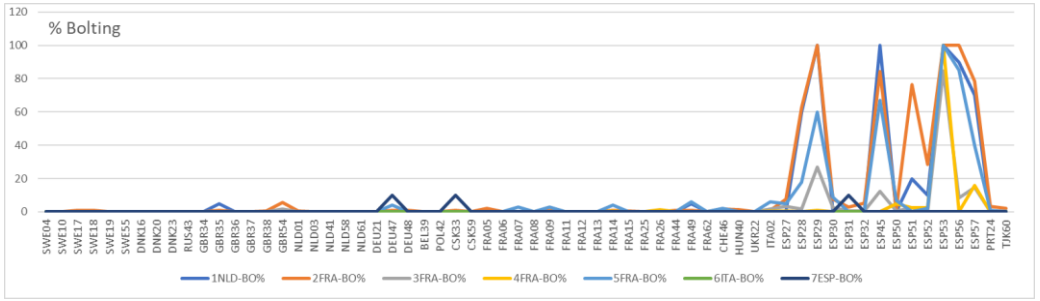
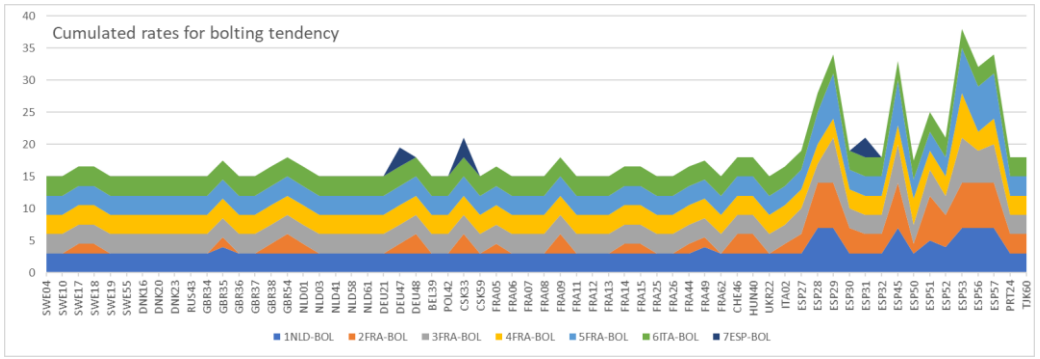
JOINT DATA ANALYSIS ADDS VALUE TO EUROPEAN CROP ACCESSIONS

Data analysis – phenotypic data

- Diversity in phenotypes and bolting sensitivity of 60 accessions evaluated in **EVA Carrot**

Photos: E. Geoffriau, Institut Agro Rennes-Angers, France





Data from seven trials in 2020, 115 days after sowing, rates cumulated from Northern to Southern trials, accessions sorted by latitude of country of origin)
E. Geoffriau (Institut Agro)

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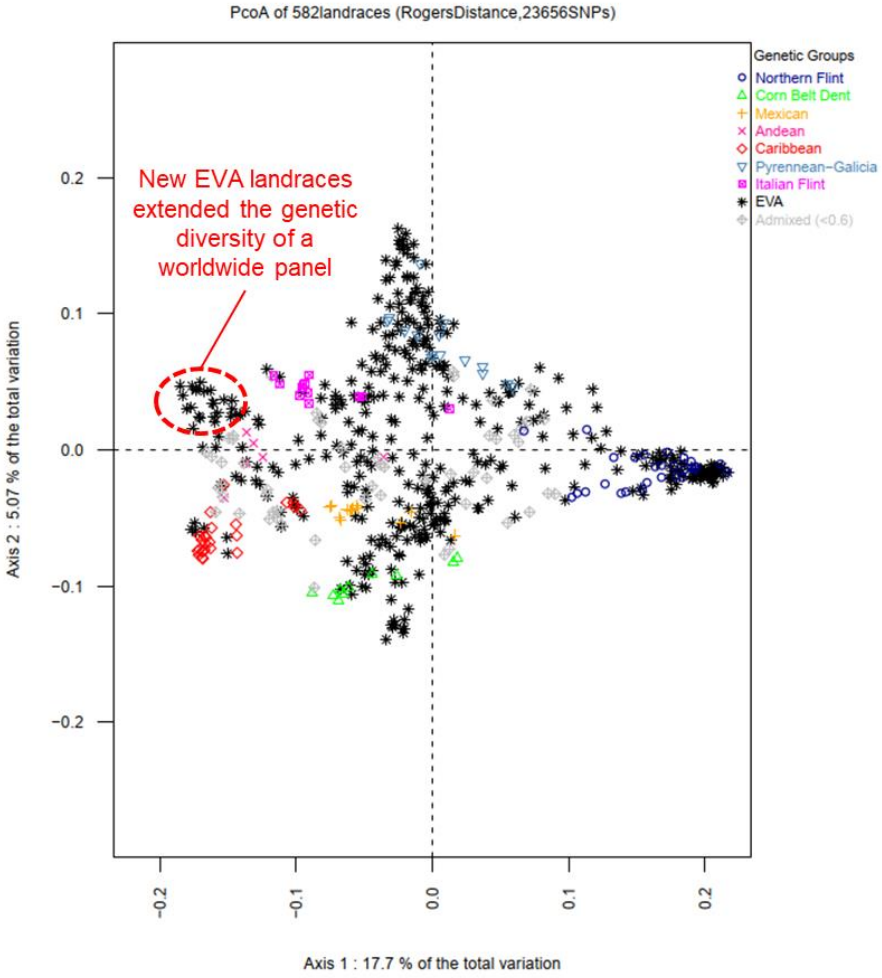
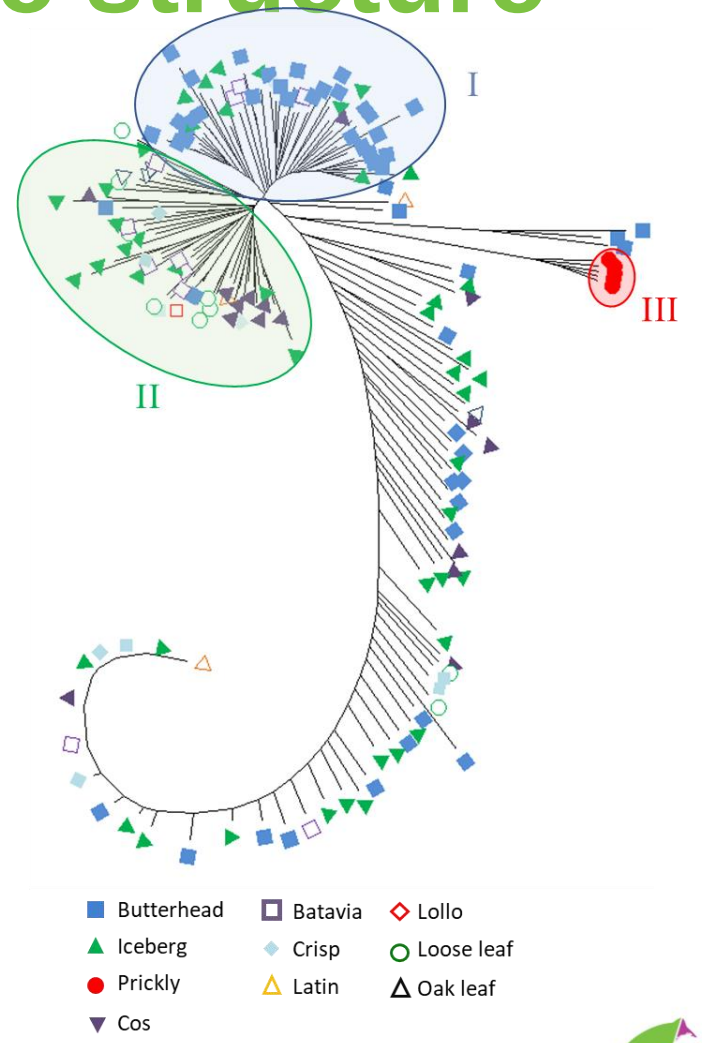
JOINT DATA ANALYSIS ADDS VALUE TO EUROPEAN CROP ACCESSIONS

Data analysis – genetic structure

Genetic diversity of **EVA maize** (left) and **EVA Lettuce** (right) landraces



D. Madur, INRAE, France



P. Tripodi, CREA, Italy

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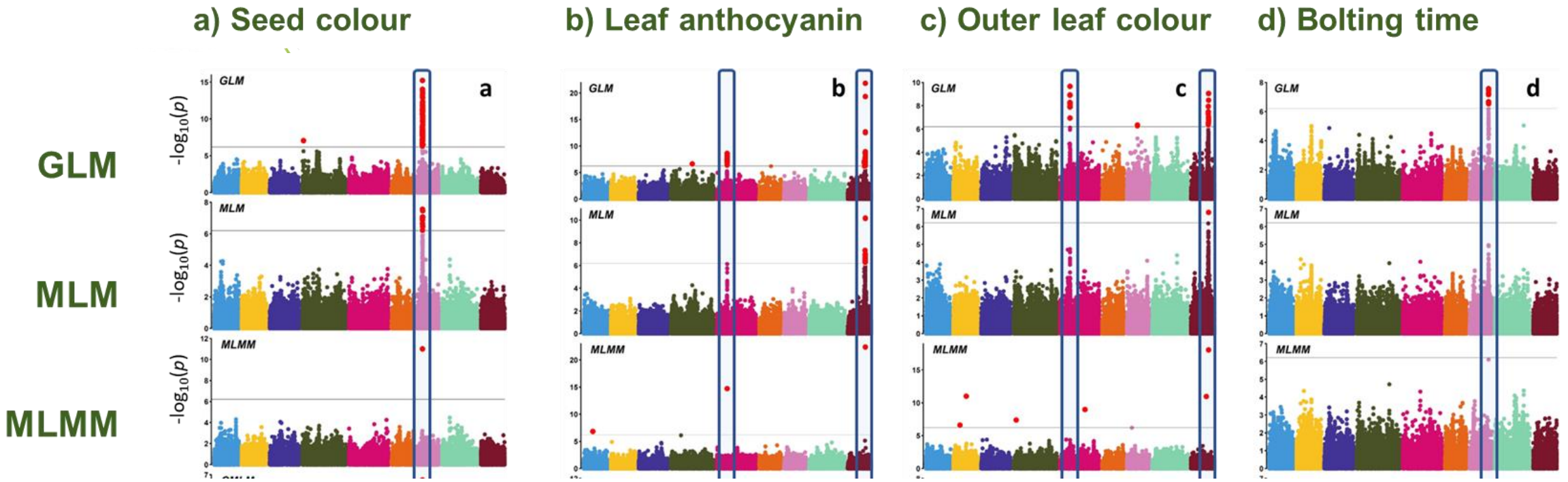
JOINT DATA ANALYSIS ADDS VALUE TO EUROPEAN CROP ACCESSIONS

Genome-wide association in Lettuce



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Benefits of participating in EVA

EVA

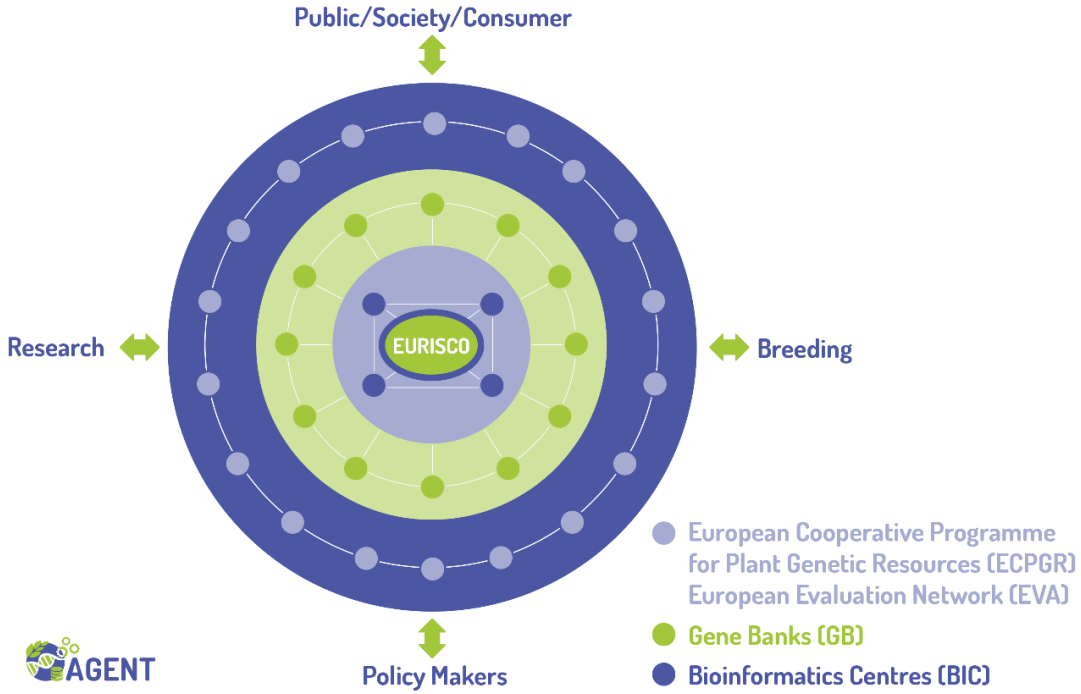
European Evaluation Network

Benefits of EVA networks

Joint work on pre-competitive level provides benefits to all partners:

- Access to unique international research and breeding network
- Access to genebank collections and unique materials
- Shared expertise and knowledge
- Joint work based on expertise and capacity
- Large phenotypic datasets from multilocation trials
- Genotyping data for evaluated accessions
- Joint analysis and dissemination of results
- Data embargo as incentive to contribute in-kind
- Results and materials will be publicly available (through EURISCO and SMTA)

EVA as part of an activated genebank network



- 10 Genebanks created precision collections of wheat and barley
  - 6600 Wheat accessions
  - 3900 Barley accessions
- Genotyping with GBS and DartSeq
- EVA network evaluates ~750 each in 2023 and 2024
- Evaluation by EVA partners including organic farmers' network

The AGENT project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 862613.

Dissemination and exploitation

IHC 2022
31ST INTERNATIONAL HORTICULTURAL CONGRESS

INTERNATIONAL CARROT & OTHER APIACEAE SYMPOSIUM 2-5 OCT 2023

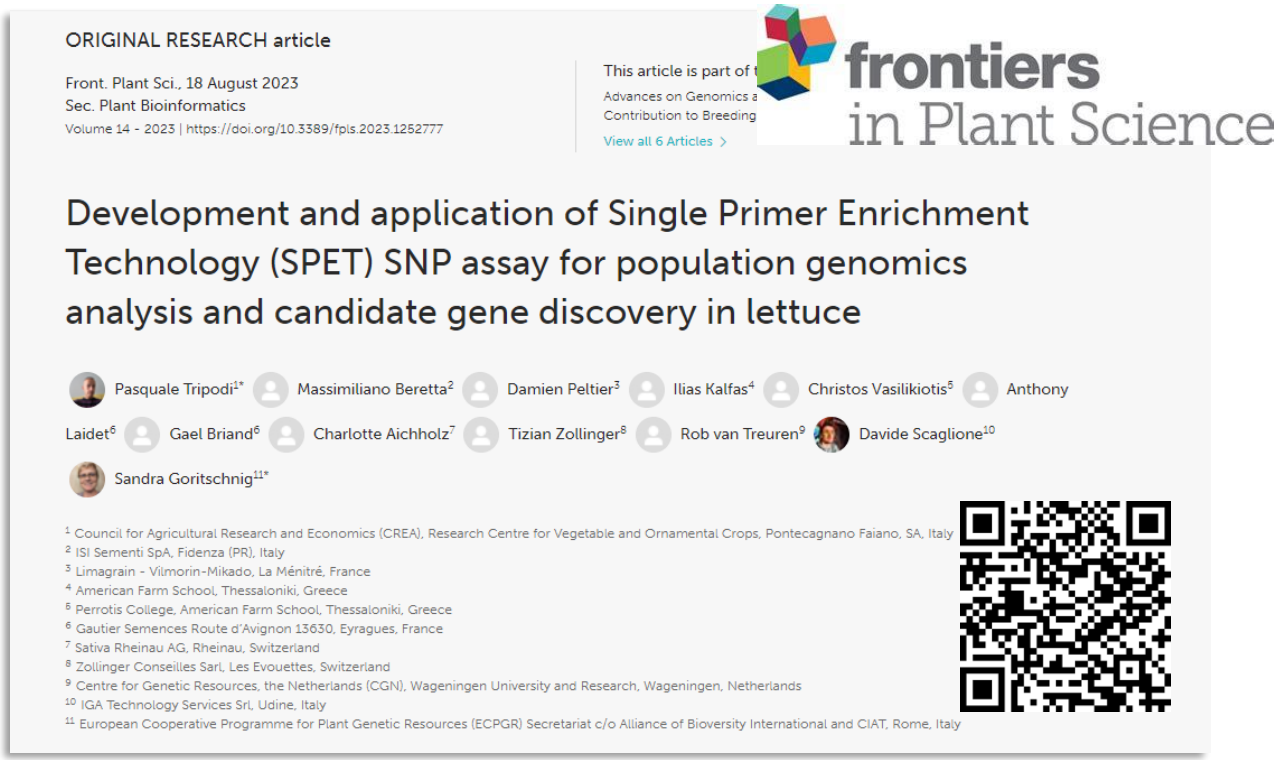
PBE PLANT BIOLOGY EUROPE 2023

25th EMS conference

66th ANNUAL CONGRESS ITALIAN SOCIETY OF AGRICULTURAL GENETICS

Bari, 5-8 September 2023

ISHS



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Financial sustainability for EVA

Federal Ministry of Food and Agriculture

ECPGR support for EVA

- Coordination of networks
- Budget management
- Permanent database infrastructure (EURISCO)
- Meetings organization

Funding for specific network activities:

- Genotyping
- Public partners' activities
- Specific experiments (requiring lab space, special equipment)
- Data analysis
- Project meetings

In-kind contributions by private and public partners

- Phenotypic evaluations (field trials)
- Regenerations/multiplications
- Data analysis

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Long term outlook

- ECPGR support for EVA
  - Coordination of networks
  - Permanent database infrastructure (EURISCO)
- Networks continue work
  - New accessions sets
  - In kind contributions from private sector
  - Collaboration with projects for specific activities
- Establishment of new EVA crop networks (e.g. EVA Legumes)
- EVA can use GRACE-RI for their work

SusCrop ERA-NET FACCEJPI

FACCEJPI

AGENT

for EVA

PRO-GRACE
PROMOTING A PLANT GENETIC RESOURCE COMMUNITY FOR EUROPE

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Acknowledgements

EVA network partners:

Euroseeds
Embracing Nature

Project funding:

Federal Ministry of Food and Agriculture

AGENT

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For more info:

https://www.ecpgr.cgiar.org/eva

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THANK YOU