PRO-GRACE

PROMOTING A PLANT GENETIC RESOURCE COMMUNITY FOR EUROPE

CIHEAM - International Centre for Advanced Mediterranean Agronomic Studies

Mediterranean Agronomic Institute of Chania

CAPACITY BUILDING AND OUTREACH ACTIVITIES OF THE FUTURE GRACE RESEARCH INFRASTRUCTURE

Panos Kalaitzis

Dept Horticultural Genetics & Biotechnology, MAICH

PRO-GRACE is implemented by 31 partners from 17 countries

Council of the European Union

Background brief
Brussels, 25 September 2025

Competitiveness Council
Brussels, 29-30 September 2025

PRESS
EN

The European Commission presents the new European Strategy on research infrastructures

Under the call for action on life sciences for the Union's competitiveness

- September 2025 → the new strategy aims to enhance the sustainability, accessibility and effectiveness of these institutions increasing their impact. The strategy will be linked to other flagship initiatives, such as the EU Startup and Scaleup Strategy and to the European strategy for Artificial Intelligence in Science.

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Brussels, 30 September 2025

Council of the European Union

Background brief
Brussels, 25 September 2025

Competitiveness Council
Brussels, 29-30 September 2025

PRESS
EN

The European Commission presents the new European Strategy on research infrastructures

Member States and the Commission are invited to enter a strategic dialogue to establish, maintain, optimize, and interlink research and technology infrastructures, innovation hubs, science parks, and centres of excellence relevant for life sciences.

The strategy responds to long-standing **calls for a more coordinated EU approach** to technology infrastructures, complementing Horizon Europe (2028–2034) and the European Competitiveness Fund. It also supports the "Choose Europe" initiative.

The strategy highlights an estimated **investment need of EUR 13–16 billion** for technology infrastructures by 2030, and outlines potential funding sources from EU, national, regional and private contributions.

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GRACE RI for PGR conservation and use

PLATFORM: Education – Training - Dissemination

Establish a robust framework for Education, Research and Training

cultivate a new generation of PGR professionals

Foster a culture of Appreciation, support for genetic resources

GRACE-RI SERVICES

PGR CONSERVATION PLANNING AND IMPLEMENTATION

- Enhancing all collections to accepted standards
- Ensuring and enhancing access to PGR
- Monitoring and Certification system
- Connection with other RIs to build synergies in certification (e.g. BBMRI)

DATA AND INFORMATION MANAGEMENT

- Leading information system for the storage, management and integration of all
- PGR data
- Trusted long-term repository of project data
- Connection with other RIs to streamline methods and tools (e.g. Elixir, Emphasis, BBMRI)

MULTI-OMICS CHARACTERIZATION AND APPLICATION TO PRE-BREEDING

- Datasets, tools and methods for evaluations and pre-breeding
- Tools and methods for data analysis
- Connection with other RIs for collaborative approaches (e.g. Emphasis)

LEGAL AND PHYTOSANITARY SERVICES FOR PGR (ELSI)

- Strategic guidance
- Legal and policy services
- Phytosanitary services
- Connection with other RIs/orgs to build synergies (e.g. EPPO, EC, BBMRI)

MAINSTREAMING *IN SITU* CONSERVATION

CAPACITY BUILDING AND OUTREACH

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Specific activities and ways to materialize the platform's main pillars:

Partnerships with Universities to enhance curricula of educational programs and establish novel ones

Establish new MASTER OF SCIENCE PROGRAMME(S)

MSc on Plant Genetic Resources Conservation and Exploitation
in collaboration with Universities and/or International Organizations like CIHEAM

PUTATIVE MODULES FOR A MASTER OF SCIENCE COURSE:

Ex situ conservation – In situ conservation – molecular genetics – omics approaches – breeding tools

CIHEAM International Center for Advanced Mediterranean Agronomic Studies

Sharing Knowledge, Feeding the Future

CIHEAM SG


CIHEAM BARI


CIHEAM CHANIA


CIHEAM MONTPELLIER

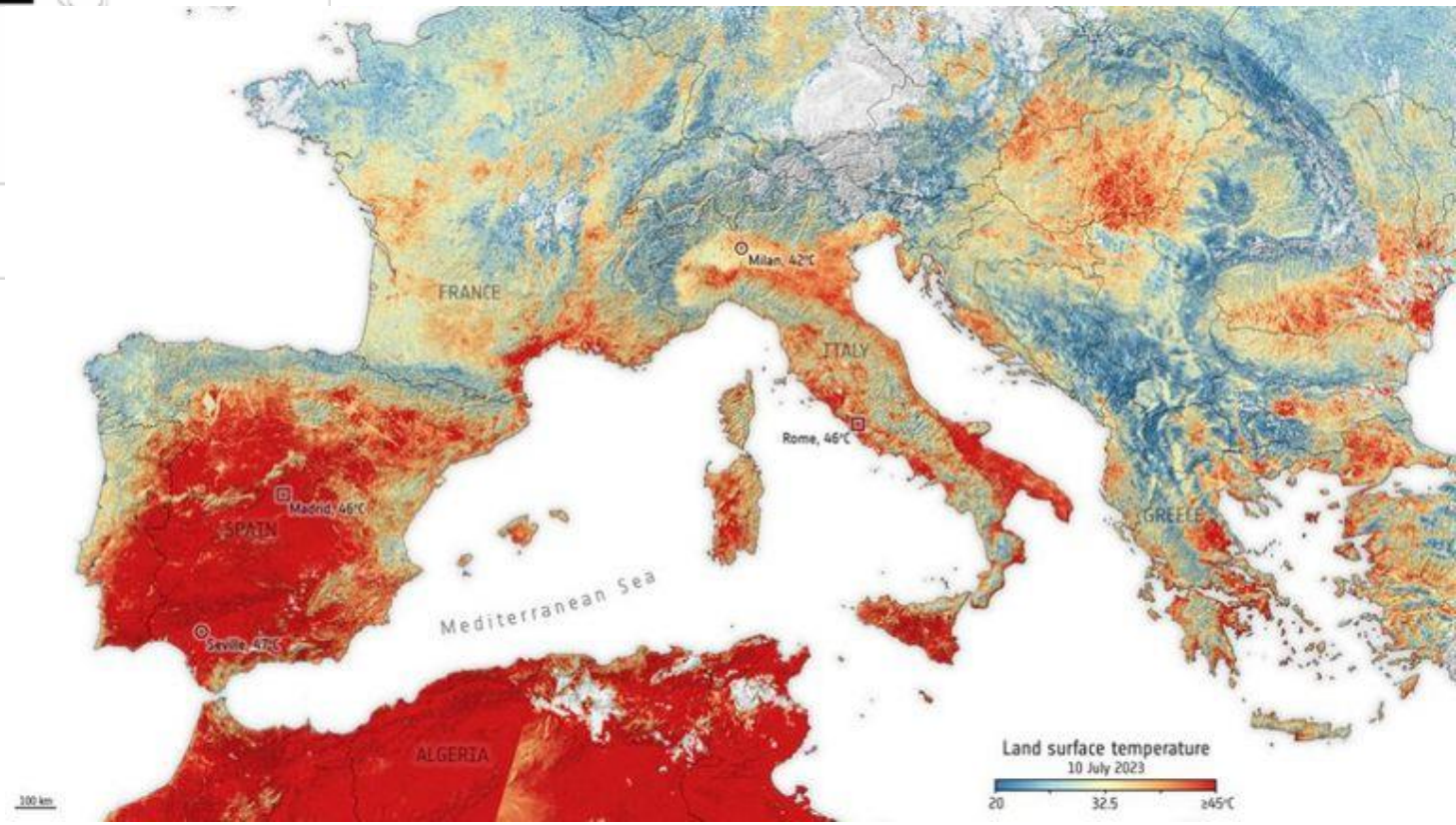

CIHEAM ZARAGOZA

EU Classification: International Organization of European Interest

Approximately 20 Master of Science courses are offered by the 4 CIHEAM Institutes

CIHEAM is comprised of 13 member countries from the Mediterranean region

The Mediterranean region is a hotspot of Climate Change predicting drop in agricultural production



Cerberus Heat WaveSky news, 13 July 2023)

Special Issue

Mediterranean Agriculture under Climate Change

Message from the Guest Editors

Currently, the global concentration of carbon dioxide (the main greenhouse gas) is approximately 50% higher than pre-industrial levels, and the global average temperature has increased by 1.1 °C compared to 1880. This has resulted in extreme phenomena such as heat waves, drought, hail and violent rainfall, as well as soil degradation, the reduction in biodiversity and alterations in ecosystems, significantly compromising the yield of crops. Furthermore, the European Environment Agency predicts that climate change could reduce the value of European agriculture by 16% by 2050 due to increased drought and rainfall, and the agricultural production in Mediterranean areas could fall by 80% by 2100. However, agriculture can also play a fundamental role in climate change mitigation. This Special Issue will highlight the impact of crop management practices (e.g., soil tillage, fertilization, irrigation, crop rotation, etc.), biodiversity and breeding programs on the quality and yield in the field of forage and vegetable crops in the Mediterranean environment. All types of articles, such as original research papers, opinions and reviews, are welcome.

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Saline water

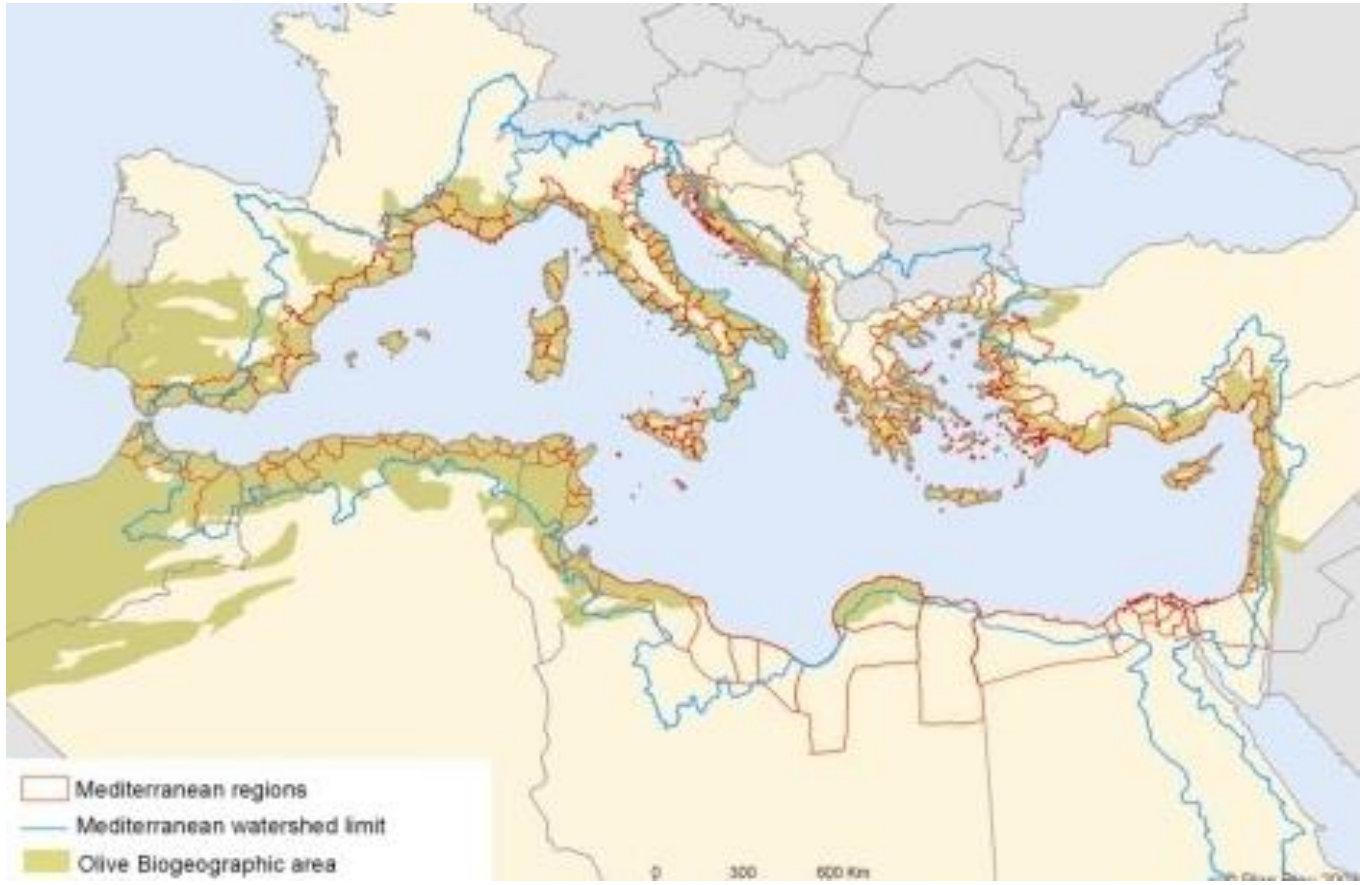

Fig. 1. The Mediterranean countries, their Mediterranean regions and their different limits(Source: Gaussen & De Philippis – FAO)

Alternatively introduce new modules in already existing MASTER OF SCIENCE PROGRAMME(S)

MSc on Horticultural Genetics & Biotechnology – CIHEAM MAICH

PGR conservation & use

HOB520.1	Applied genetics I
HOB521.1	Molecular breeding
HOB522.2	Genetic association studies
HOB546.2	DNA Methods for Authentication and Traceability of Agricultural and Food Products
HOB530.1	Arabidopsis Genetics
HOB531.1	Principles of Arabidopsis genetics
HOB533.1	Arabidopsis transformation and analysis of transgenic plants
HOB532.1	Mutant analysis of Arabidopsis

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Specific activities and ways to materialize the platform's main pillars:

Expand training and capacity building opportunities for PGRs scientists to bridge gaps in knowledge

Organize hands-on SHORT COURSES of at least 5 days:

- **GRACE-RI Central Hub, in PGRs Hubs (Seed Banks),**
- **in National Nodes of GRACE-RI (Universities and Public Institutions)**

- **In countries of interest for European Union such as Southern Mediterranean countries with the support of CIHEAM**

GRACE-RI can identify the gaps

Seed Banks

DISSCO biosamples management

Gap

Omics analysis

EMPHASIS
ELIXIR

Gap

Pre-Breeding & Breeding

GRACE-RI activities can fill the gaps and propose solutions

Identify Synergies & gaps

Identification of Synergies and gaps

Workshops
Interviews
Surveys
Case studies
Focus groups

With the Research community + **Stakeholders**

Researchers involved in RIs

Genotyping
Genomics
Images storage
Phenotyping
Omics
Bioinformatics
Metadata & annotations
Digital libraries

Abiotic, biotic stress
Data bases
Phytosanitary issues
Agrofood characterization
Big data storage
Method standardization
Germplasm, specimen collection
Phenome

cross-disciplinary interactions

Policy makers
(EU, National officials)

Government Organizations

Regional Actors

Beneficiaries at large
Consumers organizations
Local communities
Businesses, SMEs

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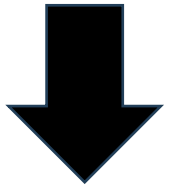
establish, maintain, optimise, and interlink research and technology infrastructures



Examples of interlink between:

GRACE-RI, ELIXIR, EMPHASIS

GRACE-RI, DISSCO, ELIXIR

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COMPREHENSIVE TRAINING PROGRAMS

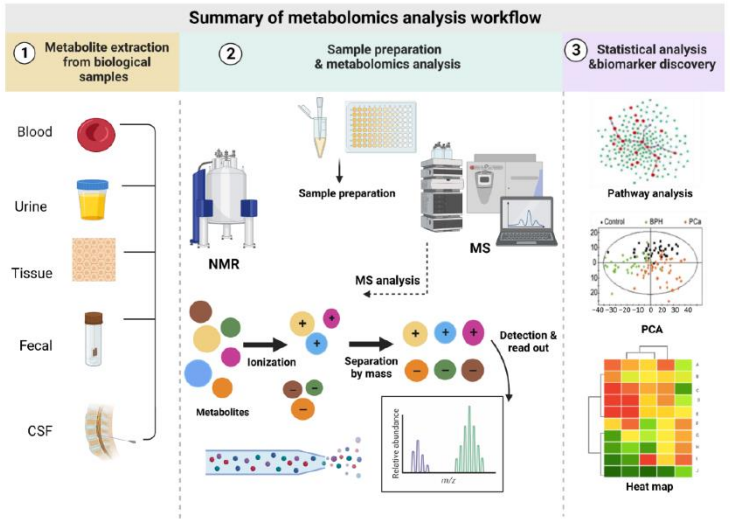
For students, professionals, stakeholders

On PGR conservation and use:

In situ/ex situ conservation methods
Taxonomy,
Conservation planning and management
Applied genetics

Multi-omics Characterization and Application to Pre-breeding:

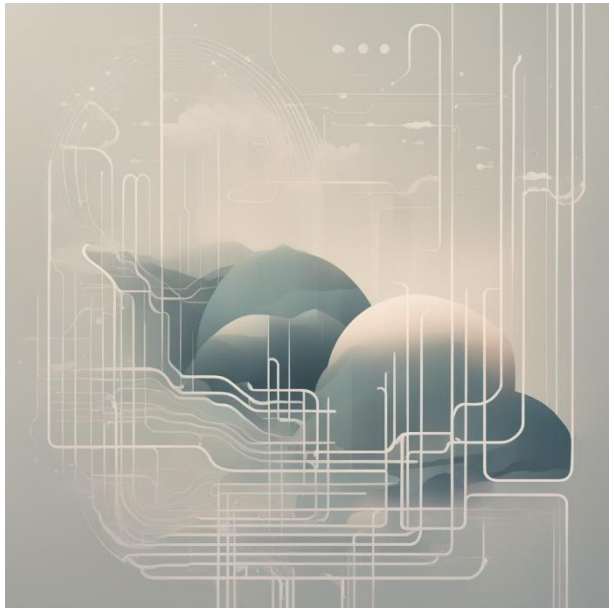
Genotyping
Metabolomics
Phytosanitary issues



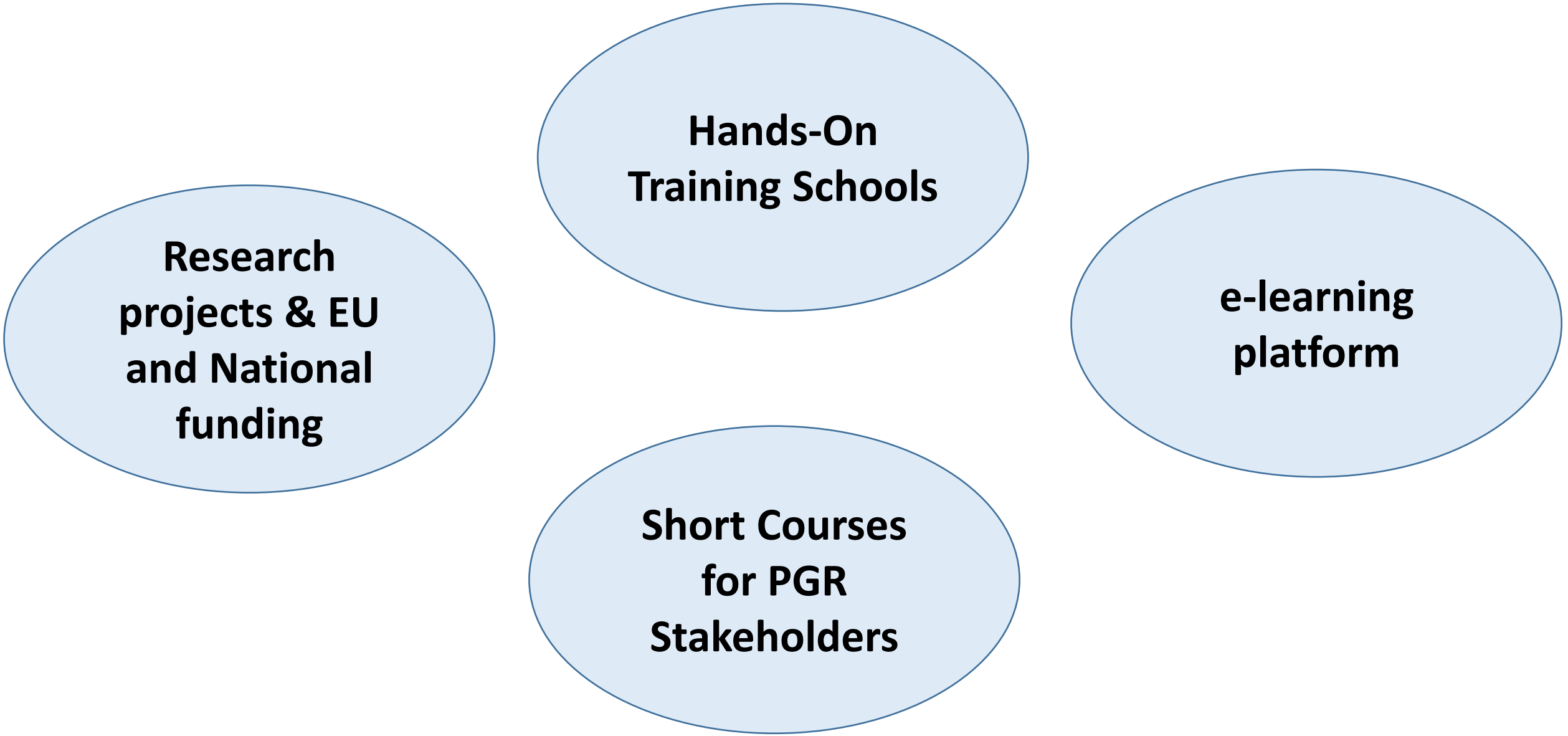
(Al Sulaiti et al., 2023)

Data and Information Management:

Data curation,
Management and analysis
PGR data
FAIR compliance



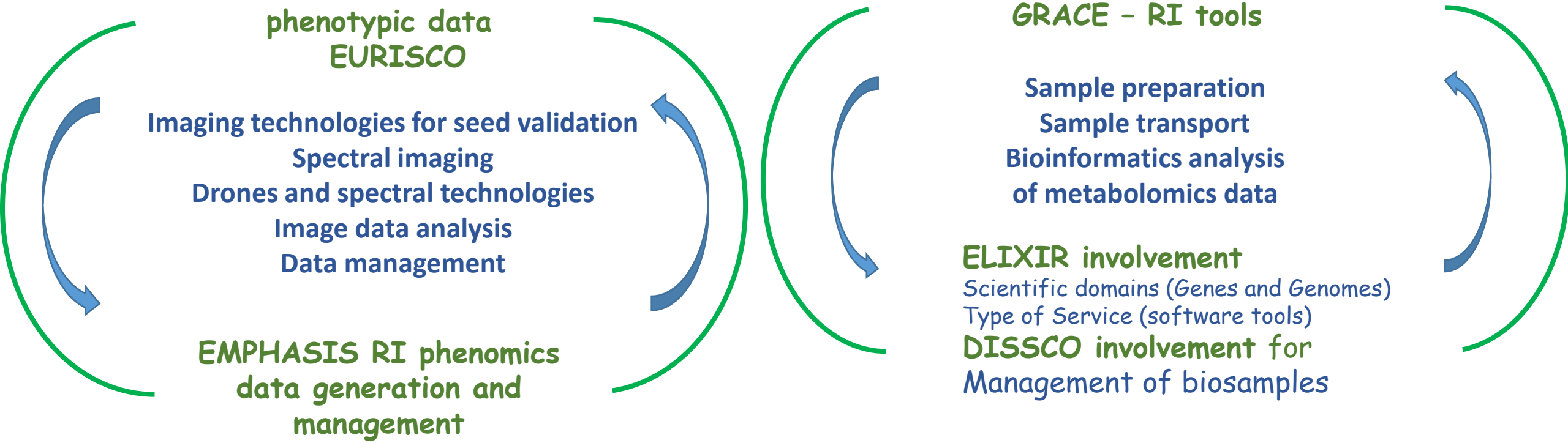
INTERLINKING with RIs, ERICs in Training activities & research



Hands-On Training Schools & Short Courses

Evaluation and Valorization of PGRs
Phenotypic data exploitation courses

PGRs and Metabolomics courses
Genotyping of PGRs & genomics tools courses



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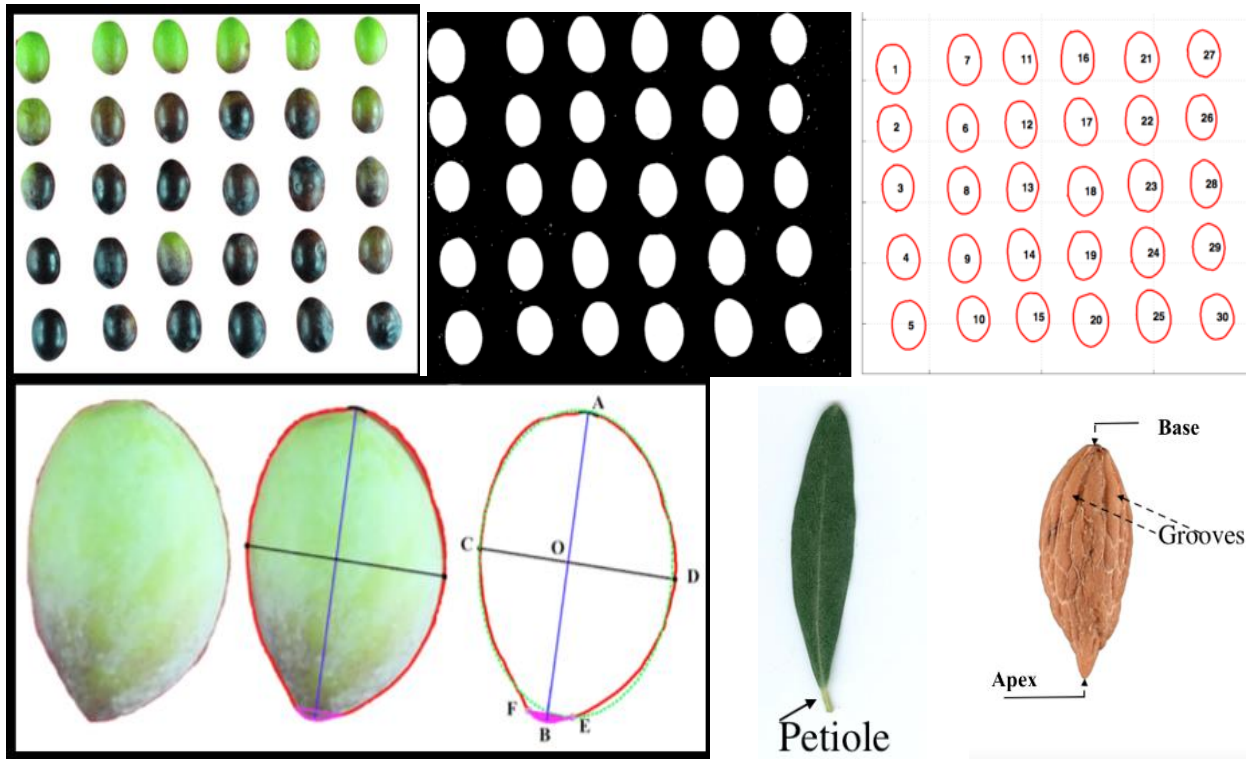
Project for Utilizers of GRACE-RI services with EMPHASIS, ELIXIR and GRACE RIs

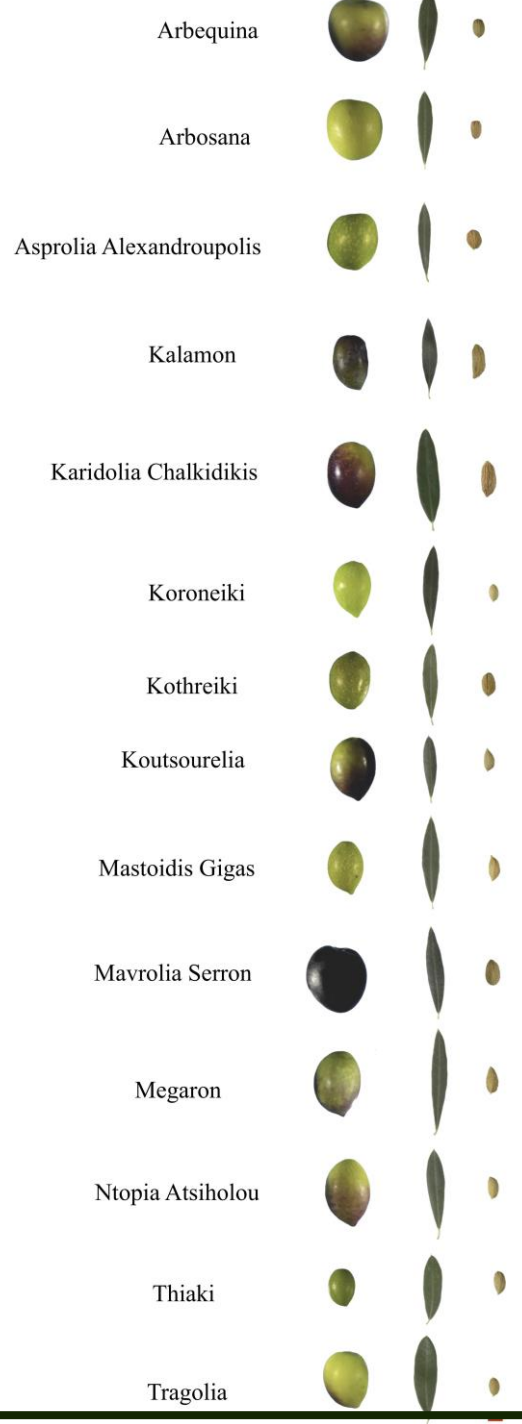
EMPHASIS

Olive fruit, stone image analysis and cultivar classification



(Blazakis et al., Front in Plant Sci 2024)

(Blazakis et al., Plant Methods 2018)



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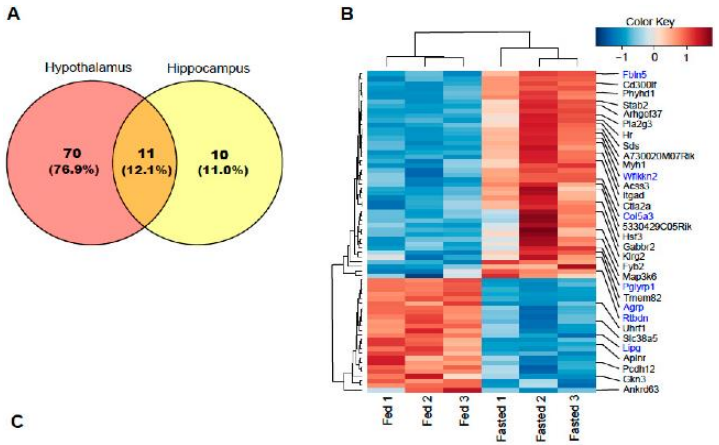
Project for Utilizers of GRACE-RI services with EMPHASIS, ELIXIR and GRACE RIs

GRACE-RI

Olive cultivar genotyping
For validation



Use of olive cultivars genotyping Atlas using SSRs (1500 cultivars)

ELIXIR

Machine learning
Cultivar identification

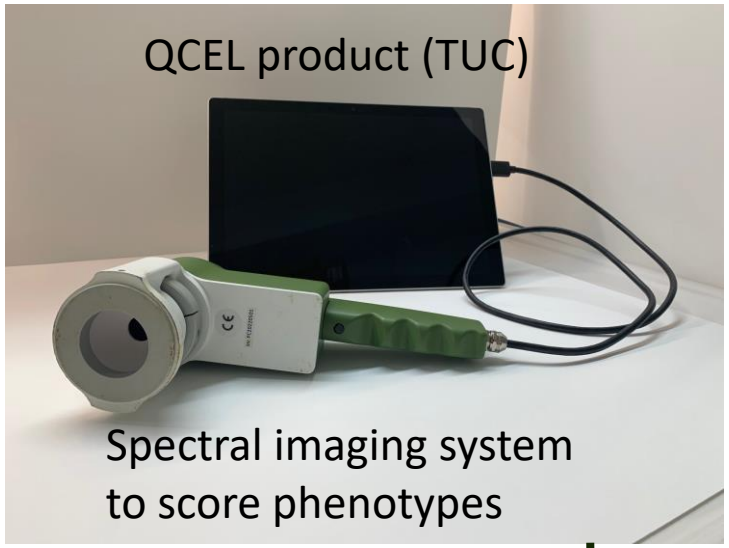
Creation of a smart Phone application to Identify cultivars by taking Picture of a fruit, stone or a leaf using a server

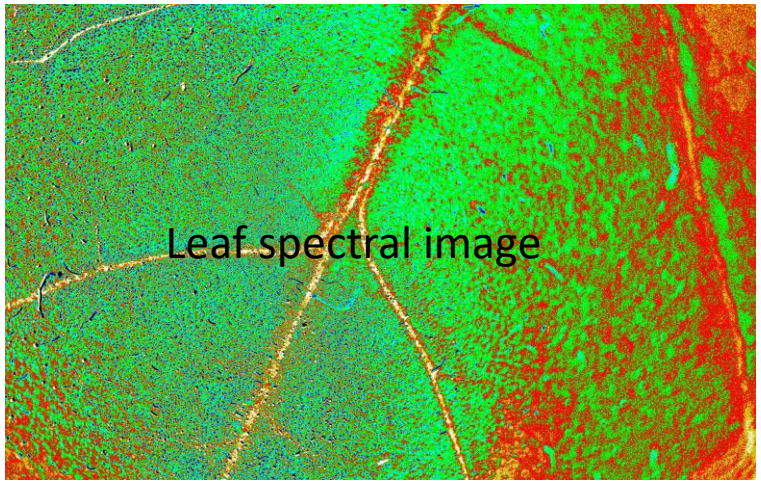
(under preparation)

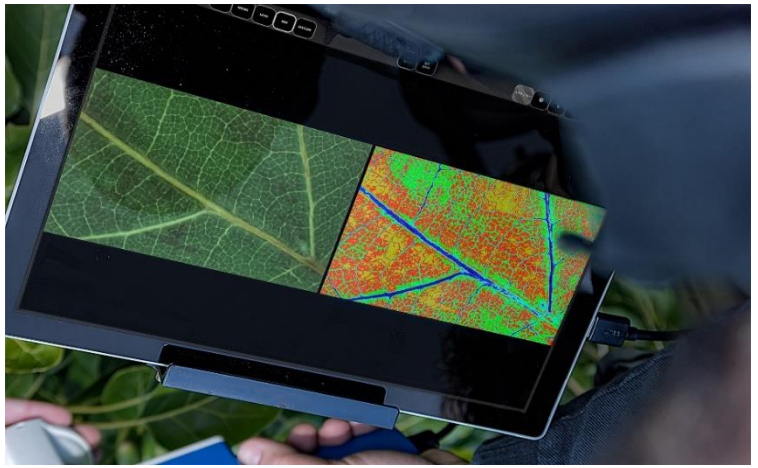
Project
for Utilizers of GRACE-RI services
with EMPHASIS – 1st Approach

A hands-on training workshop with a battery-operated, wearable, macro-imaging system for in-situ monitoring

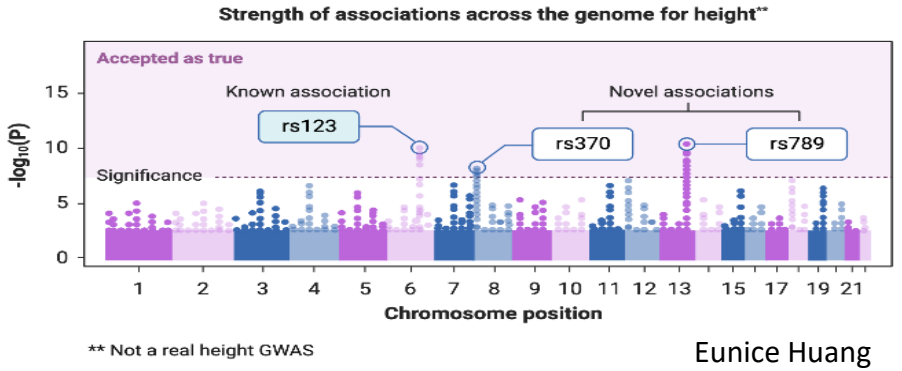
Abiotic and biotic Stress Monitoring







GWAS studies to identify regulatory SNPs related to abiotic stress tolerance



Eunice Huang

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2nd Approach

Provide alleles for agronomical traits which can be introgressed into local cultivars

PANGENOME efforts in eggplant, tomato etc

the plant journal SEB

The Plant Journal (2021) **107**, 579–596 doi: 10.1111/tpj.15313

Improved genome assembly and pan-genome provide key insights into eggplant domestication and breeding

Lorenzo Barchi[1], Mark Timothy Rabanus-Wallace[2], Jaime Prohens[3], Laura Toppino[4], Sudharsan Padmarasu[2], Ezio Portis[1], Giuseppe Leonardo Rotino[4], Nils Stein[2,5], Sergio Lanteri[1] and Giovanni Giuliano[6,*]

nature genetics ARTICLES https://doi.org/10.1038/s41588-019-0410-2

The tomato pan-genome uncovers new genes and a rare allele regulating fruit flavor

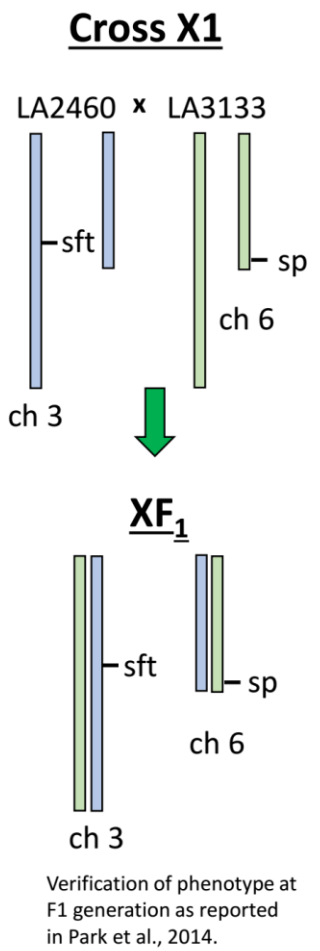
Lei Gao[1,10], Itay Gonda[1,2,10], Honghe Sun[1], Qiyue Ma[1], Kan Bao[1], Denise M. Tieman[3], Elizabeth A. Burzynski-Chang[4], Tara L. Fish[5], Kaitlin A. Stromberg[1], Gavin L. Sacks[4], Theodore W. Thannhauser[5], Majid R. Foolad[6], Maria Jose Diez[7], Jose Blanca[7], Joaquin Canizares[7], Yimin Xu[1], Esther van der Knaap[8], Sanwen Huang[9], Harry J. Klee[3], James J. Giovannoni[1,5*] and Zhangjun Fei[1,5*]

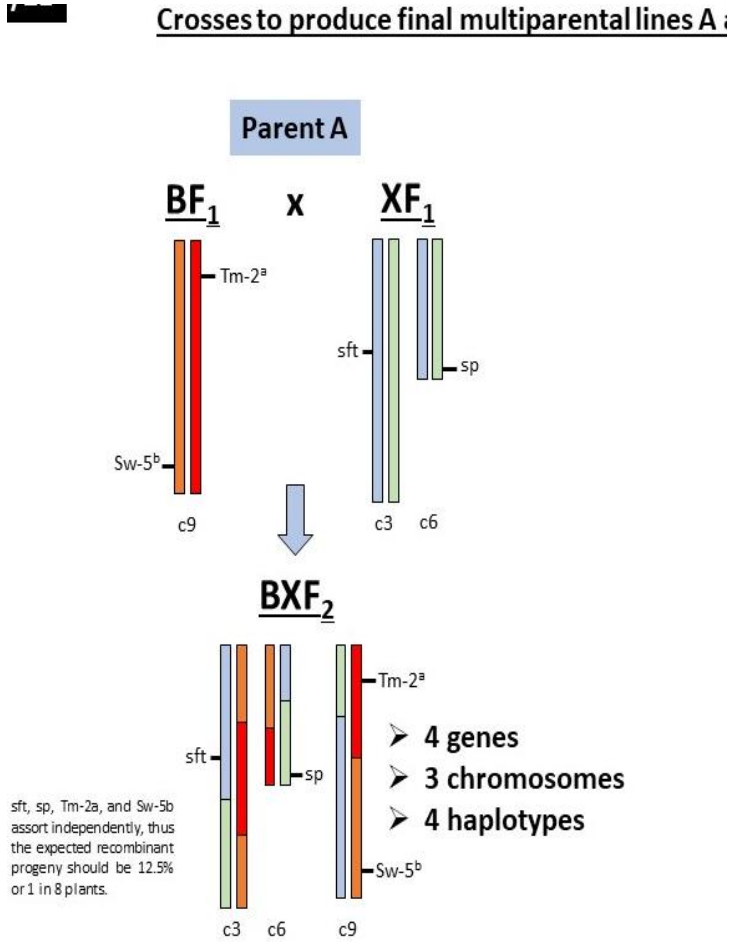
Global range expansion history of pepper (*Capsicum* spp.) revealed by over 10,000 genebank accessions

Pasquale Tripodi, Mark Timothy Rabanus-Wallace, Lorenzo Barchi, +21, and Nils Stein Authors Info & Affiliations

Edited by Elizabeth A. Kellogg, Donald Danforth Plant Science Center, St. Louis, MO, and approved June 21, 2021 (received for review March 5, 2021)

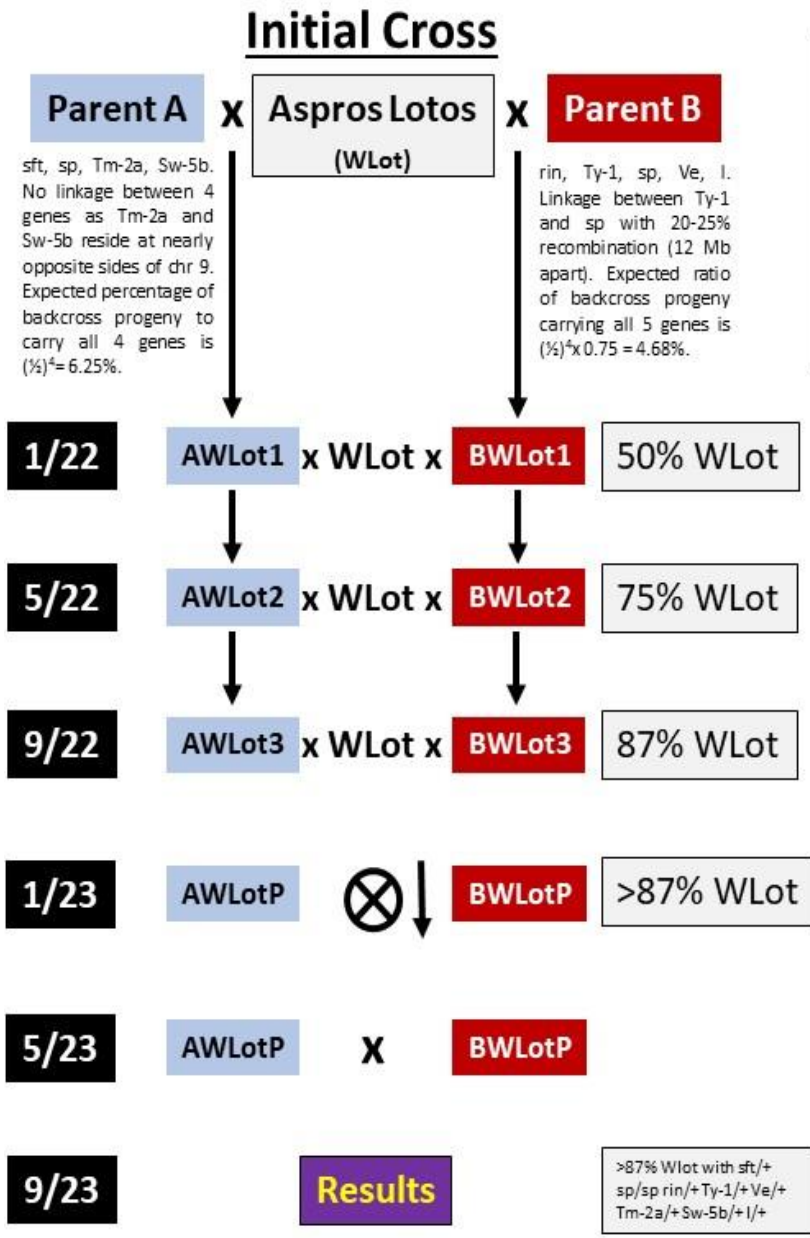
August 16, 2021 118 (34) e2104315118 https://doi.org/10.1073/pnas.2104315118





(tomato introgression scheme- unpublished)

Improvement of local cultivars for UTILIZERs of GRACE-RI services & STAKEHOLDERS



By selecting backcross individuals for the introgressed traits, the chances of selecting other regions for WLot background are higher, since recombination is likely to have happened elsewhere.

Whenever a marker is fixed for WLot haplotype (i.e. homozygous) it will no longer be included in future screens and screening will progress to other markers at other chromosomes.

Screen for traits only. Select most appealing plants to move forward.

Reliable molecular markers

Screen for traits in 200 plants and for markers spanning chromosomes 1-12. Select individuals with most WLot background.

Screen for traits in 200 plants and for markers spanning remaining chromosomes. Select individuals with most WLot background and best phenotype.

Screen for homozygosity in genes of interest in 500+ plants. Maximize WLot background for remaining markers at heterozygous state from previous generation. Eliminate unwanted traits.

Hybrid seed ready for trials and evaluation. Generate as many seeds as possible. Parent A is *sft* homozygous having single flower inflorescences. Test seeds of reciprocal crossing as well.

End of evaluation.

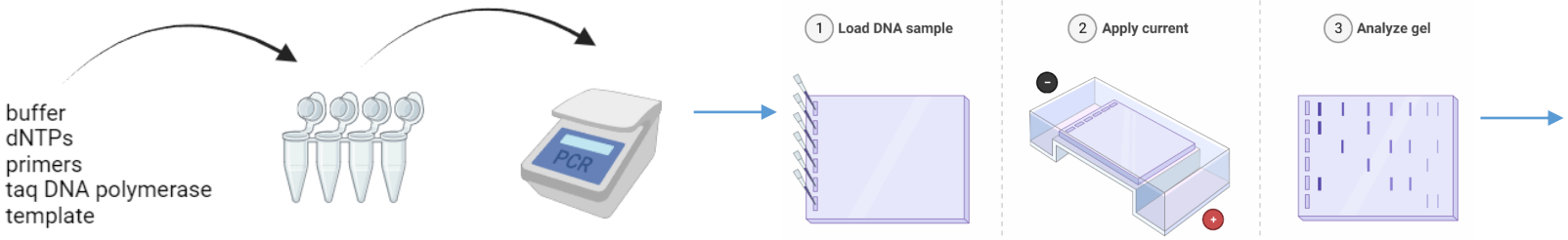
Unpublished

DOUBLE SERVICE:
GRACE-RI Hands-On Training
for Utilizers of GRACE-RI services

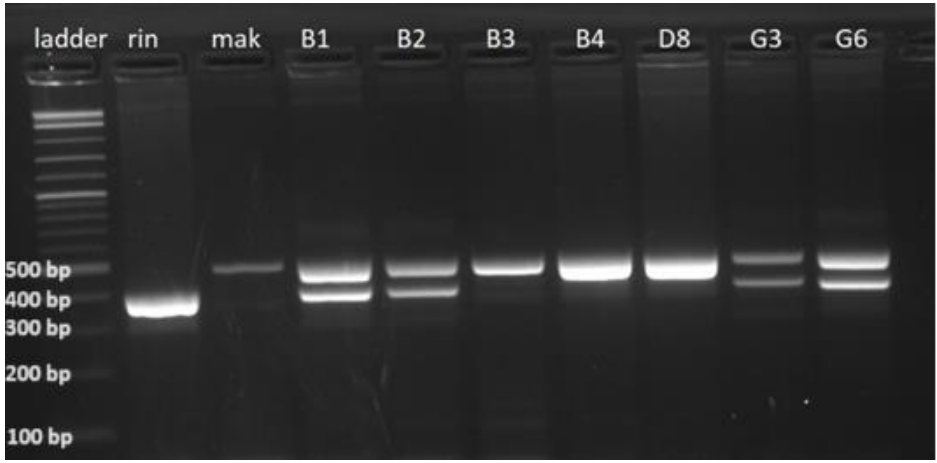
Genotype for breeding

- Marker assisted selection in identifying plants with the desired characteristic

The ripening mutations in tomatoes can be introgressed in local cultivars to increase postharvest life



Created by using biorender



Genotype for breeding tools for limited number of SNPs- Alternative to large scale arrays for genotyping

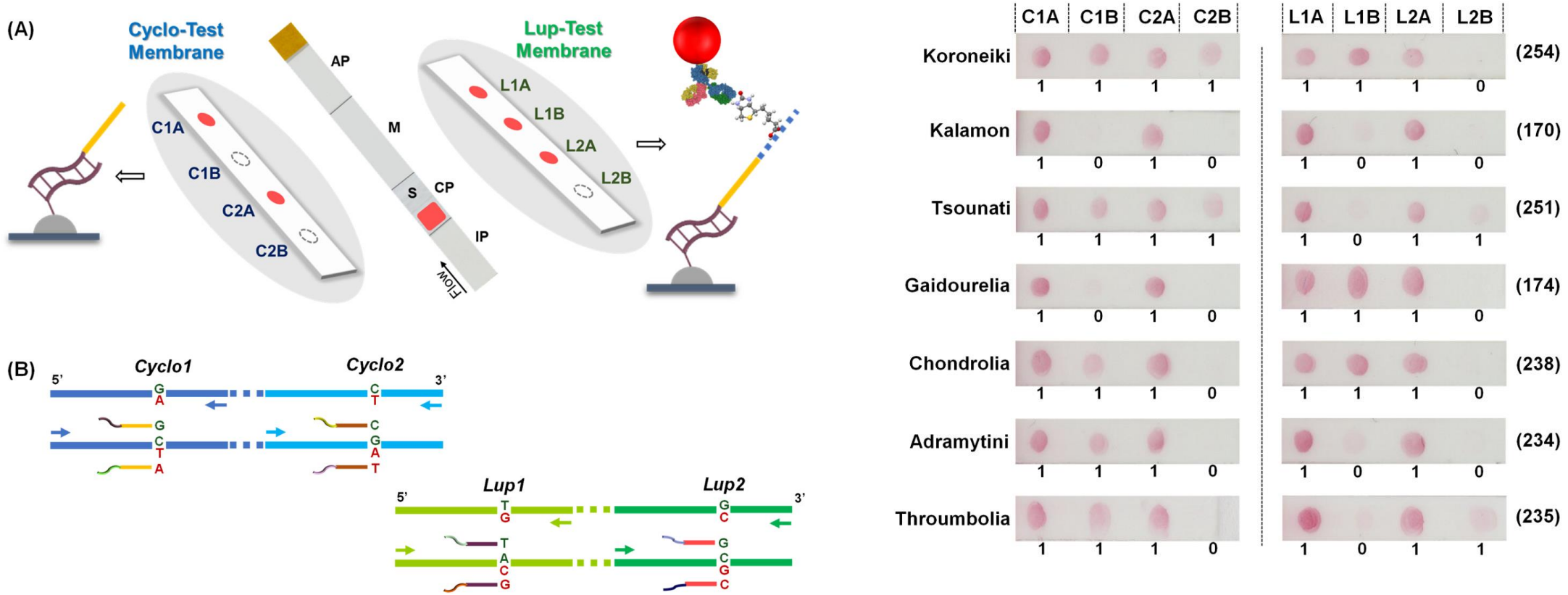


Fig. 1. (A) The architecture and the sensing mechanism of the two devices used for the detection, by naked eye, of 8 alleles. A photo of the main device is shown in the middle of the (A) with the parts explained. The Cyclo-Test is used for the detection of C1A, C1B, C2A and C2B alleles. The Lup-Test is employed for the visualization of L1A, L1B, L2A and L2B alleles. IP = Immersion pad; CP = Conjugate Pad; S = Sample application area; M = Membrane; AP = Absorbing pad. (B) The 4-SNP panel (Cyclo1, Cyclo2, Lup1 and Lup2) along with the relative positions of the primers used for multiplex PCR and multiplex genotyping reaction.

(Natalia-Maria Christopoulou et al., 2024)

PGR training gap: Basic phytosanitary techniques (safe seed transfer among partners)

Hands-On Training Schools

Development of best practices and protocols
Issue of valid certification by GRACE-RI

How to train people to produce a PHYTOSANITARY CERTIFICATE in order to circulate your PGRs (seeds, tissues)

ex situ preservation, storage of clonally propagated PGRs particularly for fruit tree crops

Hands-On Training Schools

Use of Genotyping, phenotyping tools to detect heterogeneous clones
Species-specific, virus free, Clonal propagation protocols
Possibilities for in vitro approaches

Paradigm:

Olive cultivars: Atsixolou, Makris, Kolovi, Agouromanako

50 plant/cultivar were planted in Chania region

The cultivars were selected on the basis of traditionally growing in different regions of the country:
Peloponnesus, Thrace, Lesbos island, Northern Greece

Evaluation of performance
3 years later

Makris and Kolovi performed better showing resilience to enemies (insects) diseases (fungi), drought

Is the germplasm Virus free?
What is the genetic basis of resilience?

Funding of SHORT TERM and VERY SHORT TERM RESEARCH PROJECTS

- **Training through short term projects for conducting research in the GRACE Research Infrastructure network**

A call for proposals will be announced for PIs of PGR community world-wide as well as other interested stakeholders (approx. 2 months duration)

- The proposals will be evaluated by an Evaluation committee established by GRACE RI
- The project will cover the cost for the Host Institution RI and the PI group member to conduct the research
- A specific structure for the proposal application form will be created

A call for proposals for very short term research missions will be announced for PIs interested to develop a collaboration for research project development.

- The proposals will be evaluated by an Evaluation committee established by GRACE RI

THERE IS ALREADY THE EMPHASIS PARADIGM & THE COST ACTION FORMAT

OUTREACH INITIATIVES

Raising awareness of PGRs significance for the GENERAL PUBLIC in relation to CLIMATE CHANGE and FOOD SECURITY as well as PLANET HEALTH

Join forces with other Organizations such as EUFORGEN, ERFP, CROP TRUST, EAT-LANCET, Consumers Associations, NGOs (like PELITI in Greece)

EPSO NETWORK (EUROPEAN PLANT SCIENCE ORGANIZATION -> 200 Research institutions), EUCARPIA (European Association for Research on Plant Breeding -> 59 corporate members and 900 members in 44 countries)

Raising awareness of PGRs significance for policymakers, cooperatives, farmers, regional authorities

epso

EUCARPIA
European Association for Research on Plant Breeding
Europäische Gesellschaft für Züchtungsforschung
Association Européenne pour l'Amélioration des Plantes

CROP TRUST

OVERVIEW

The Planetary Health Diet is a global reference diet based on the best available science. It represents a dietary pattern that supports optimal health outcomes and can be applied globally for different populations and different contexts, while also supporting cultural and regional variation. The PHD is rich in plants: whole grains, fruits, vegetables, nuts, and legumes comprise a large proportion of foods consumed, with only moderate or small amounts of fish, dairy, and meat recommended. The PHD is based entirely on the direct effects of different diets on human health, not on environmental criteria. The diet's name arose from the evidence suggesting that its adoption would reduce the environmental impacts and nutritional deficiencies of most current diets.

A New Way of Eating for People and Planet

The Alternative Community of Peliti

Seed Bank & Collections: Thousands of accessions actively propagated

- **Peliti** (Greek for "oak tree") is a Greek ,volunteer-based, non-profit community, founded in 1995 focused on preserving agricultural biodiversity.
- Peliti collects, cultivates, and distributes traditional / local varieties of seeds.
- Seeds are distributed free of charge (open-pollinated, non-GMO) to amateur and professional growers.
- **Impact**: Over 4,000 varieties distributed, 180,000+ growers reached, 50,000+ free packets annually.
- **Network & Outreach**: Local groups in Greece and abroad; seed catalogue published.

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CONCLUSIONS

The GRACE-RI has to interlink with the other RIs and ERICs namely EMPHASIS, ELIXIR, DISSCO, INSYLVA etc

Interlink on Hands-On Training school and Projects for Utilizers of GRACE-RI increase efficiency and speed for capacity building for PGR professionals and stakeholders

A GRACE-RI might assist towards a higher degree of democratization of PGRs use by interested stakeholders with limited resources (cooperatives, NGOs, farmers clusters)

Outreach activities should identify Organizations with common interests and collaborate to increase the visibility

CASE STUDY-1

BBMRI-ERIC®

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IN SYLVA EUROPE

DiSSCo

LifeWatch ERIC

synergy

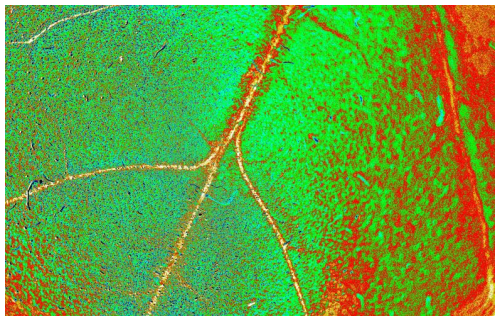
synergy

DATA STORAGE

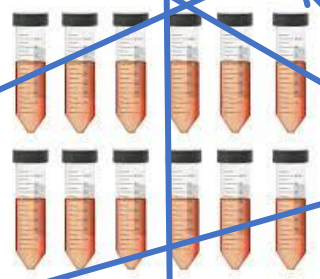
PHENOTYPING

EURISCO

EMPHASIS



Spectral imaging
Drones and spectral technologies



Sample selection & characterization

Metabolomics
Transcriptomics

elixir

Bioinformatics
Analysis
Big Data analysis

synergy

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Project for Utilizers of GRACE-RI services JOINTLY ORGANIZED with ELIXIR and EMPHASIS

EMPHASIS involvement

Phenotypic data To select tissue

Nurseries, Seed Banks, In situ structures

GRACE-RI

Sample preparation

Metabolomics Transcriptomics

ELIXIR involvement

Advanced Bioinformatics analysis

Genetic control of agronomically Interesting metabolite

An eight-point plan

Based on the report's findings, the Commission has drawn up eight solutions aimed at advancing health, environmental and justice goals. These include:

1. Protecting and promoting traditional healthy diets
2. Creating accessible and affordable food environments that increase demand for healthy diets
3. Implementing sustainable production practices that store carbon, create habitat, and improve water quality and availability
4. Halting agricultural conversion of intact ecosystems
5. Reducing food loss and waste
6. Securing decent working conditions across the food system
7. Ensuring meaningful voice and representation for food systems workers
8. Recognising and protecting marginalised groups

"*The report sets out the clearest guidance yet for feeding a growing population without breaching the safe operating space on Earth set by the planetary boundaries,*" commented Johan Rockström, commission co-chair and director of the Potsdam Institute for Climate Impact Research.

Workshops for PGR professionals

Protocols and guidelines for PGR ex situ and in situ management courses