PRO-GRACE
PROMOTING A PLANT GENETIC RESOURCE COMMUNITY FOR EUROPE

Funded by the European Union

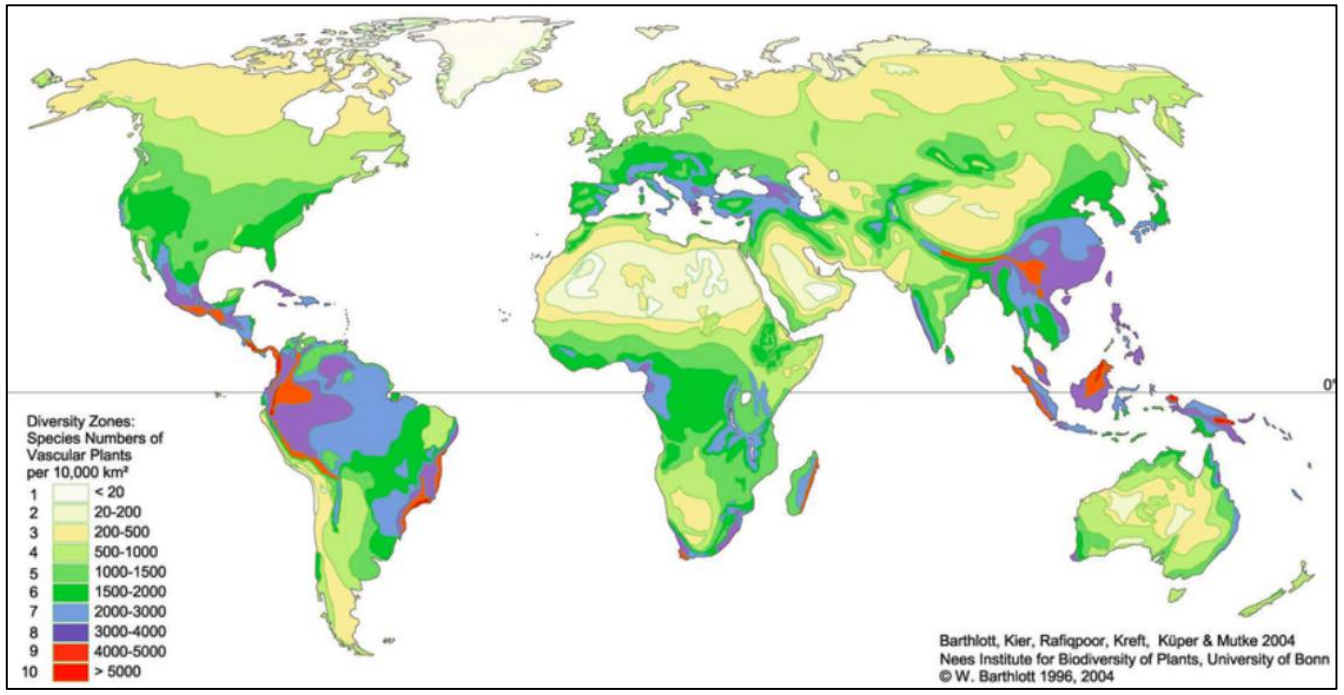
The GRACE-RI proposed role and services

Giovanni Giuliano – Former PRO-GRACE Coordinator

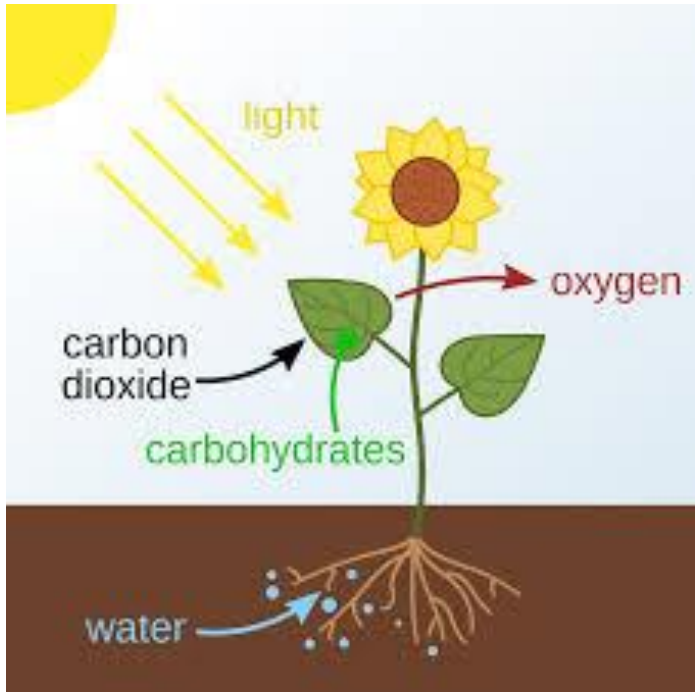
Chania, 09/10/25

Plants are essential for life on earth

- About 400,000 known species of terrestrial plants populate Earth. **We use about 8,000 of them as food, medicines, or raw materials for industry (timber, textile fibres, ….)**.
- Plants, through photosynthesis, **fix CO_2** from the atmosphere and produce the **O_2 we breathe** and all the **organic matter** that we ultimately **use as food**.

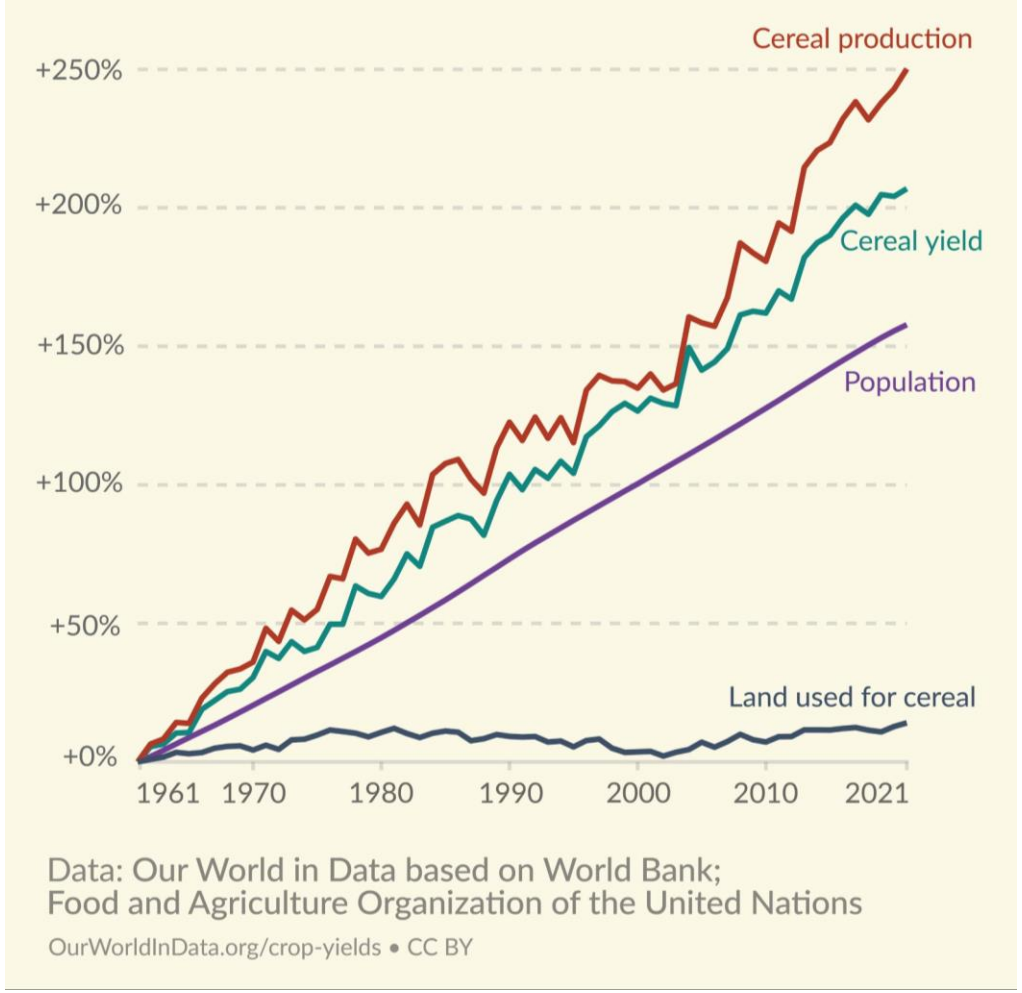


Worldwide distribution of plant biodiversity (Barthlott et al, 1996)

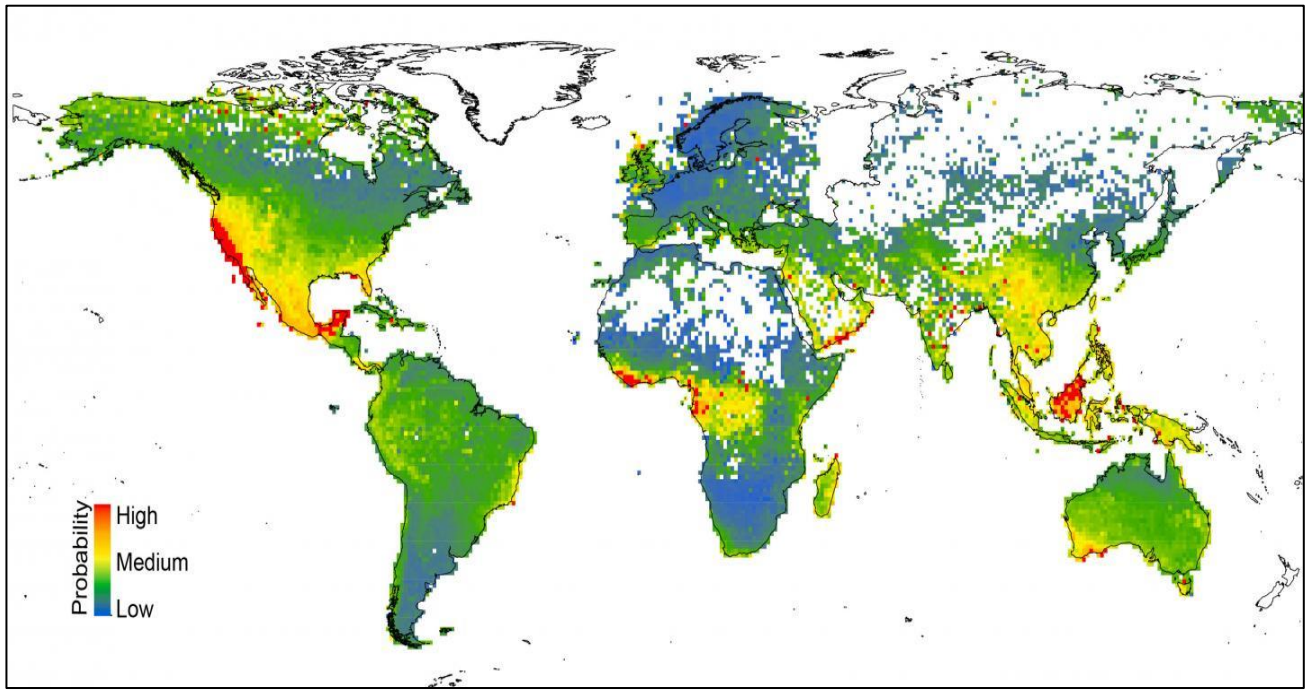


The photosynthetic cycle

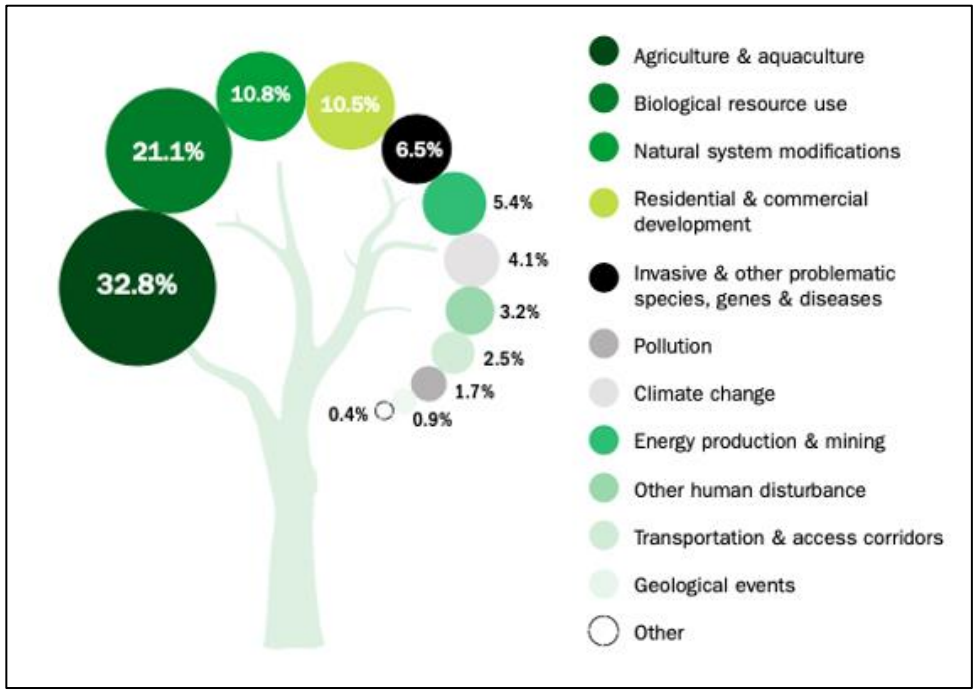
Plant breeding has prevented widespread famine in the past decades



We live at the beginning of the 6th mass extinction



Worldwide distribution of plant species at risk of extinction

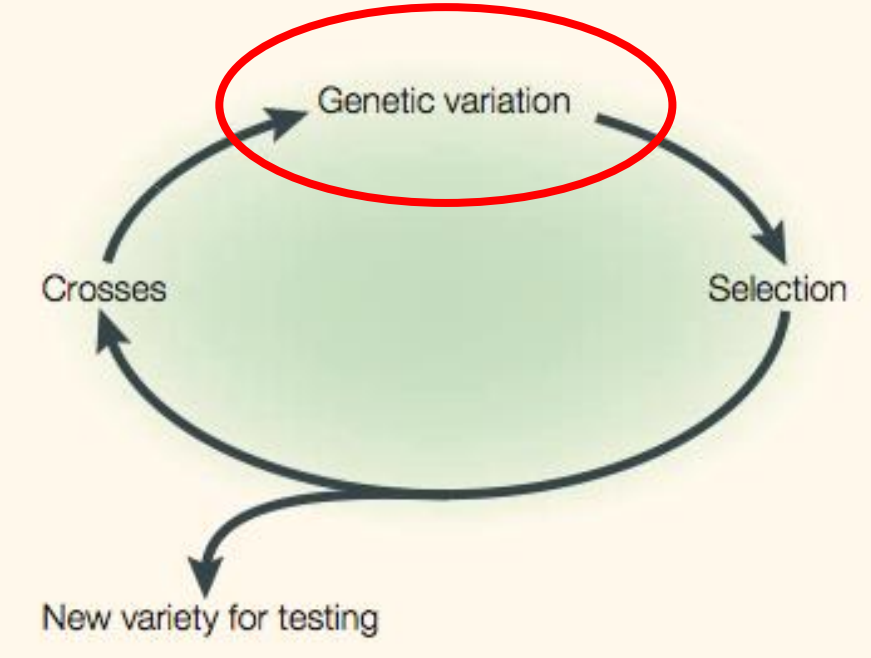


Main causes of plant extinction (1)

- **Around 40% of plant species are at risk of extinction globally.**
- **This figure fluctuates between 10%-45% for crop wild relatives, and reaches 60% for some groups (cycads, epiphytes, orchids)**

(1) Kew Gardens «State of the World's Plants and Fungi»

Crop wild relatives and landraces are reservoirs of pathogen resistance genes



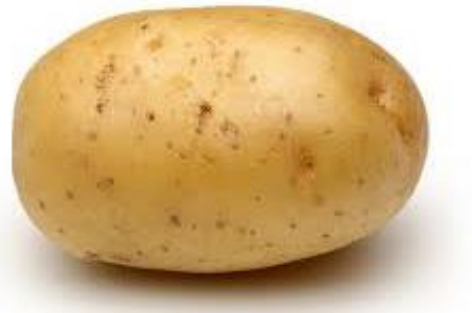
The plant breeding paradigm

(Zamir, 2021)

S. demissum

(potato wild relative)

R gene



Phytophthora-resistant potato

A. sharonensis

(wheat wild relative)

R gene

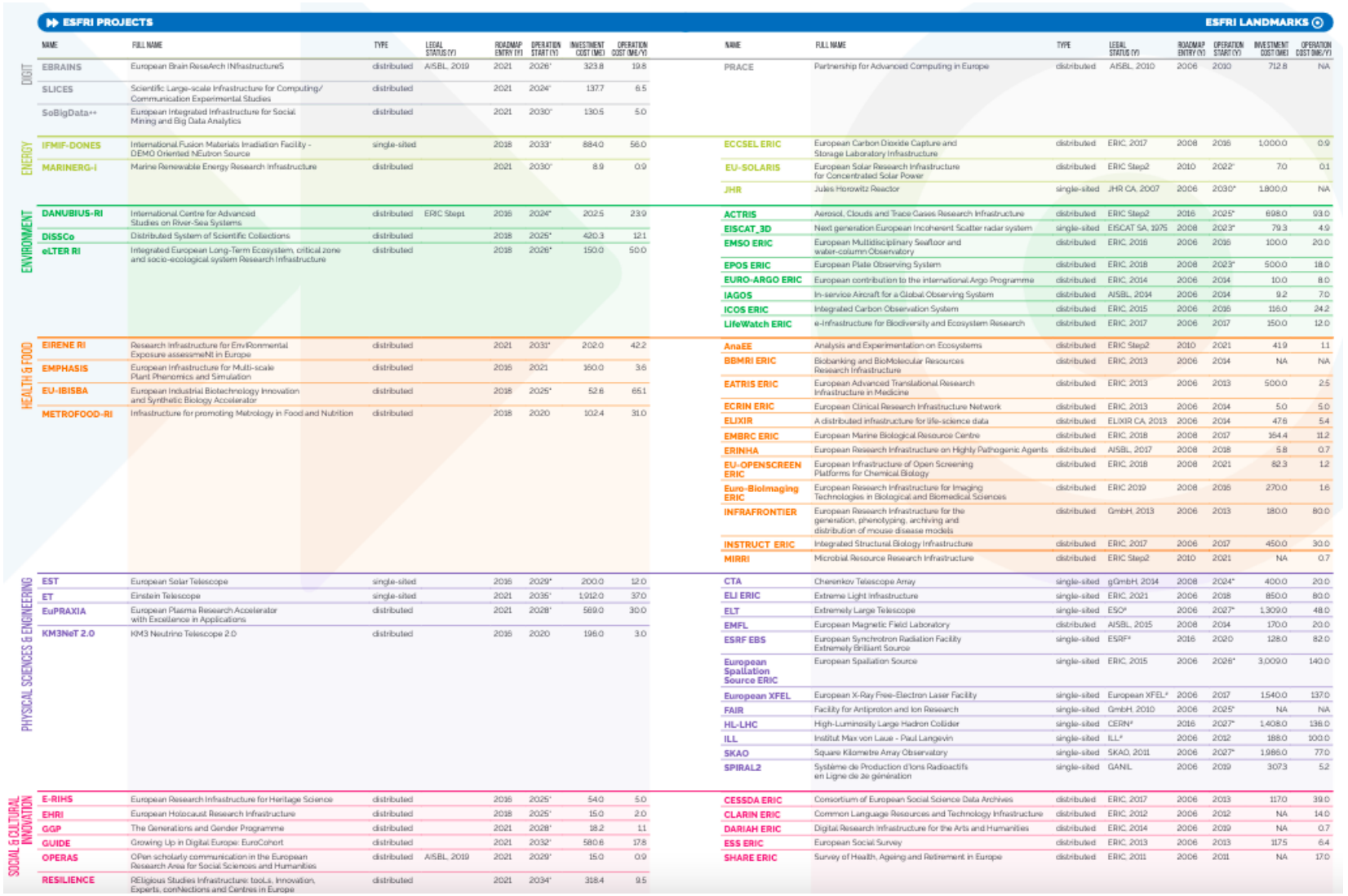
UG99-resistant wheat

R gene

PI 374670

(low yielding wheat landrace)

European governments fund a series of Research Infrastructures…but none of them is dedicated to PGR conservation and their use in breeding



ESFRI PROJECTS

	NAME	FULL NAME	TYPE	LEGAL STATUS (Y)	ROADMAP ENTRY (Y)	OPERATION START (Y)	INVESTMENT COST (M€)	OPERATION COST (M€/Y)
DIGIT	EBRAINS	European Brain ReseArch INfrastructureS	distributed	AISBL, 2019	2021	2026*	323.8	19.8
	SLICES	Scientific Large-scale Infrastructure for Computing/Communication Experimental Studies	distributed		2021	2024*	137.7	6.5
	SoBigData++	European Integrated Infrastructure for Social Mining and Big Data Analytics	distributed		2021	2030*	130.5	5.0
ENERGY	IFMIF-DONES	International Fusion Materials Irradiation Facility - DEMO Oriented NEutron Source	single-sited		2018	2033*	884.0	56.0
	MARINERG-I	Marine Renewable Energy Research Infrastructure	distributed		2021	2030*	8.9	0.9
ENVIRONMENT	DANUBIUS-RI	International Centre for Advanced Studies on River-Sea Systems	distributed	ERIC Step1	2016	2024*	202.5	23.9
	DISSCo	Distributed System of Scientific Collections	distributed		2018	2025*	420.3	12.1
	eLTER RI	Integrated European Long-Term Ecosystem, critical zone and socio-ecological system Research Infrastructure	distributed		2018	2026*	150.0	50.0
HEALTH & FOOD	EIRENE RI	Research Infrastructure for EnvIRonmental Exposure assessmeNt in Europe	distributed		2021	2031*	202.0	42.2
	EMPHASIS	European Infrastructure for Multi-scale Plant Phenomics and Simulation	distributed		2016	2021	160.0	3.6
	EU-IBISBA	European Industrial Biotechnology Innovation and Synthetic Biology Accelerator	distributed		2018	2025*	52.6	65.1
	METROFOOD-RI	Infrastructure for promoting Metrology in Food and Nutrition	distributed		2018	2020	102.4	31.0
PHYSICAL SCIENCES & ENGINEERING	EST	European Solar Telescope	single-sited		2016	2029*	200.0	12.0
	ET	Einstein Telescope	single-sited		2021	2035*	1,912.0	37.0
	EuPRAXIA	European Plasma Research Accelerator with Excellence in Applications	distributed		2021	2028*	569.0	30.0
	KM3NeT 2.0	KM3 Neutrino Telescope 2.0	distributed		2016	2020	196.0	3.0
SOCIAL & CULTURAL INNOVATION	E-RIHS	European Research Infrastructure for Heritage Science	distributed		2016	2025*	54.0	5.0
	EHRI	European Holocaust Research Infrastructure	distributed		2018	2025*	15.0	2.0
	GGP	The Generations and Gender Programme	distributed		2021	2028*	18.2	1.1
	GUIDE	Growing Up in Digital Europe: EuroCohort	distributed		2021	2032*	580.6	17.8
	OPERAS	OPen scholarly communication in the European Research Area for Social Sciences and Humanities	distributed	AISBL, 2019	2021	2029*	15.0	0.9
	RESILIENCE	REligious Studies Infrastructure: tooLs, innovation, Experts, conNections and Centres in Europe	distributed		2021	2034*	318.4	9.5

ESFRI LANDMARKS

NAME	FULL NAME	TYPE	LEGAL STATUS (Y)	ROADMAP ENTRY (Y)	OPERATION START (Y)	INVESTMENT COST (M€)	OPERATION COST (M€/Y)
PRACE	Partnership for Advanced Computing in Europe	distributed	AISBL, 2010	2006	2010	712.8	NA
ECCSEL ERIC	European Carbon Dioxide Capture and Storage Laboratory Infrastructure	distributed	ERIC, 2017	2008	2016	1,000.0	0.9
EU-SOLARIS	European Solar Research Infrastructure for Concentrated Solar Power	distributed	ERIC Step2	2010	2022*	7.0	0.1
JHR	Jules Horowitz Reactor	single-sited	JHR CA, 2007	2006	2030*	1,800.0	NA
ACTRIS	Aerosol, Clouds and Trace Gases Research Infrastructure	distributed	ERIC Step2	2016	2025*	698.0	93.0
EISCAT_3D	Next generation European Incoherent Scatter radar system	single-sited	EISCAT SA, 1975	2008	2023*	79.3	4.9
EMSO ERIC	European Multidisciplinary Seafloor and water-column Observatory	distributed	ERIC, 2018	2006	2016	100.0	20.0
EPOS ERIC	European Plate Observing System	distributed	ERIC, 2018	2008	2023*	500.0	18.0
EURO-ARGO ERIC	European contribution to the international Argo Programme	distributed	ERIC, 2014	2006	2014	10.0	8.0
IAGOS	In-service Aircraft for a Global Observing System	distributed	AISBL, 2014	2006	2014	9.2	7.0
ICOS ERIC	Integrated Carbon Observation System	distributed	ERIC, 2015	2006	2016	116.0	24.2
LifeWatch ERIC	e-Infrastructure for Biodiversity and Ecosystem Research	distributed	ERIC, 2017	2006	2017	150.0	12.0
AnaEE	Analysis and Experimentation on Ecosystems	distributed	ERIC Step2	2010	2021	41.9	1.1
BBMRI ERIC	Biobanking and BioMolecular Resources Research Infrastructure	distributed	ERIC, 2013	2006	2014	NA	NA
EATRIS ERIC	European Advanced Translational Research Infrastructure in Medicine	distributed	ERIC, 2013	2006	2013	500.0	2.5
ECRIN ERIC	European Clinical Research Infrastructure Network	distributed	ERIC, 2013	2006	2014	5.0	5.0
ELIXIR	A distributed infrastructure for life-science data	distributed	ELIXIR CA, 2013	2006	2014	47.6	5.4
EMBRC ERIC	European Marine Biological Resource Centre	distributed	ERIC, 2018	2008	2017	164.4	11.2
ERINHA	European Research Infrastructure on Highly Pathogenic Agents	distributed	AISBL, 2017	2008	2018	5.8	0.7
EU-OPENSCREEN ERIC	European Infrastructure of Open Screening Platforms for Chemical Biology	distributed	ERIC, 2018	2008	2021	82.3	1.2
Euro-BioImaging ERIC	European Research Infrastructure for Imaging Technologies in Biological and Biomedical Sciences	distributed	ERIC 2019	2008	2016	270.0	1.6
INFRAFRONTIER	European Research Infrastructure for the generation, phenotyping, archiving and distribution of mouse disease models	distributed	GmbH, 2013	2006	2013	180.0	80.0
INSTRUCT ERIC	Integrated Structural Biology Infrastructure	distributed	ERIC, 2017	2006	2017	450.0	30.0
MIRRI	Microbial Resource Research Infrastructure	distributed	ERIC Step2	2010	2021	NA	0.7
CTA	Cherenkov Telescope Array	single-sited	gGmbH, 2014	2008	2024*	400.0	20.0
ELI ERIC	Extreme Light Infrastructure	single-sited	ERIC, 2021	2006	2018	850.0	80.0
ELT	Extremely Large Telescope	single-sited	ESO#	2006	2027*	1,309.0	48.0
EMFL	European Magnetic Field Laboratory	distributed	AISBL, 2015	2008	2014	170.0	20.0
ESRF EBS	European Synchrotron Radiation Facility Extremely Brilliant Source	single-sited	ESRF#	2016	2020	128.0	82.0
European Spallation Source ERIC	European Spallation Source	single-sited	ERIC, 2015	2006	2026*	3,009.0	140.0
European XFEL	European X-Ray Free-Electron Laser Facility	single-sited	European XFEL#	2006	2017	1,540.0	137.0
FAIR	Facility for Antiproton and Ion Research	single-sited	GmbH, 2010	2006	2025*	NA	NA
HL-LHC	High-Luminosity Large Hadron Collider	single-sited	CERN#	2016	2027*	1,408.0	136.0
ILL	Institut Max von Laue - Paul Langevin	single-sited	ILL#	2006	2012	188.0	100.0
SKAO	Square Kilometre Array Observatory	single-sited	SKAO, 2011	2006	2027*	1,986.0	77.0
SPIRAL2	Système de Production d'Ions Radioactifs en Ligne de 2e génération	single-sited	GANIL	2006	2019	307.3	5.2
CESSDA ERIC	Consortium of European Social Science Data Archives	distributed	ERIC, 2017	2006	2013	117.0	39.0
CLARIN ERIC	Common Language Resources and Technology Infrastructure	distributed	ERIC, 2012	2006	2012	NA	14.0
DARIAH ERIC	Digital Research Infrastructure for the Arts and Humanities	distributed	ERIC, 2014	2006	2019	NA	0.7
ESS ERIC	European Social Survey	distributed	ERIC, 2013	2006	2013	117.5	6.4
SHARE ERIC	Survey of Health, Ageing and Retirement in Europe	distributed	ERIC, 2011	2006	2011	NA	17.0

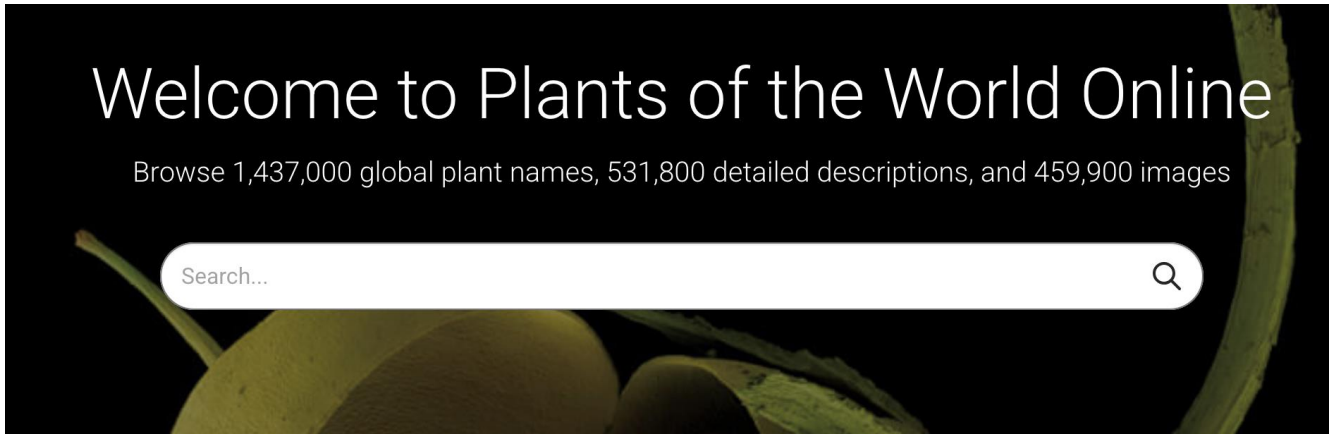
www.esfri.eu

We’re not starting from scratch

European Cooperative Programme for Plant Genetic Resources
ECP/GR

eurisco
Finding seeds for the future

EUFGIS
ESTABLISHMENT OF A EUROPEAN INFORMATION SYSTEM ON FOREST GENETIC RESOURCES



Information systems of PGRFA (EURISCO), forest genetic resources and botanic species are in place, but are largely not communicating

>**90 EU-funded projects** have generated novel genetic resources and associated knowledge and methods on important crop plant taxa. The phenotypic data generated require a long-term repository.

AGENT

FORGENIUS

INCREASE

G2P-SOL

Breeding Value

Farmer’s Pride

TRADITOM

HARNESSTOM

GEN4OLIVE

The GRACE (Plant Genetic Resources Community for Europe) Research Infrastructure

The GRACE main stakeholders

- ~ 400 institutes holding «ex situ» PGR collections
- ~ 900 botanical gardens/arboreta
- Hundreds of European plant research institutes
- Hundreds of natural reserves/Natura 2000 sites
- International organizations: ECPGR, European forest genetic resources programme (EUFORGEN), European Plant Science Organization (EPSO), European and Mediterranean Plant Protection Organization (EPPO)
- Seed exchange NGOs, farmers' organizations
- Private seed companies

Research community

Agricultural sector

PGR conservation community

GRACE RI

UN sustainable development goals

Plant breeding community

Plant-based bioproducts

1st PROBLEM: LIMITED ACCESS TO *EX SITU* CONSERVED ACCESSIONS

Availability	Subgroup	# Accs	Notes
Available		38	Material was either received (33 accessions), the request was terminated (2 accessions) or material was lost in the mail (3 accessions)
Possibly available	Request terminated	2	Material may be obtainable if special permission is requested and granted (Availability for research only; MTA)
	Wrong accession was received	1	
Not available	Genebank confirmed non-availability	18	Material not available at genebank
	Process took longer than 5 months	1	Delivery is uncertain
	Genebank did not respond	40	Material could not be requested due to no response
Total		100	

Table 1: availability status of requested material. Accessions have been grouped according to availability status, in which availability was defined as the ability to receive material within a 5 month period.

From Theo van Hintum's Pillar 1 presentation

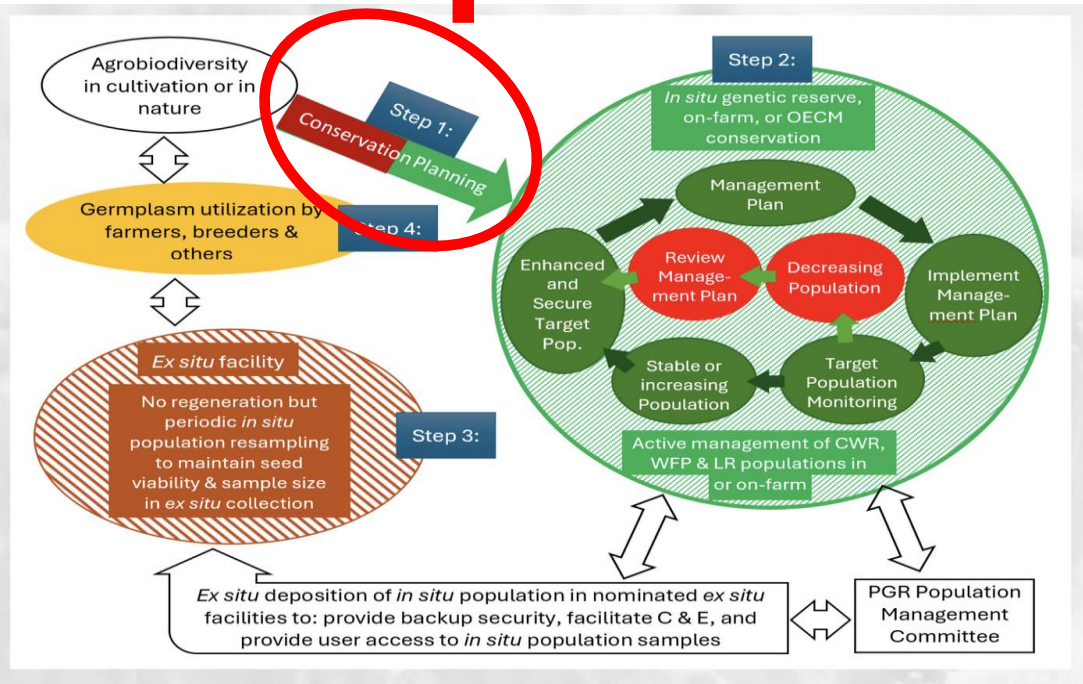
Only 38% of accessions listed on Eurisco are available in practice.

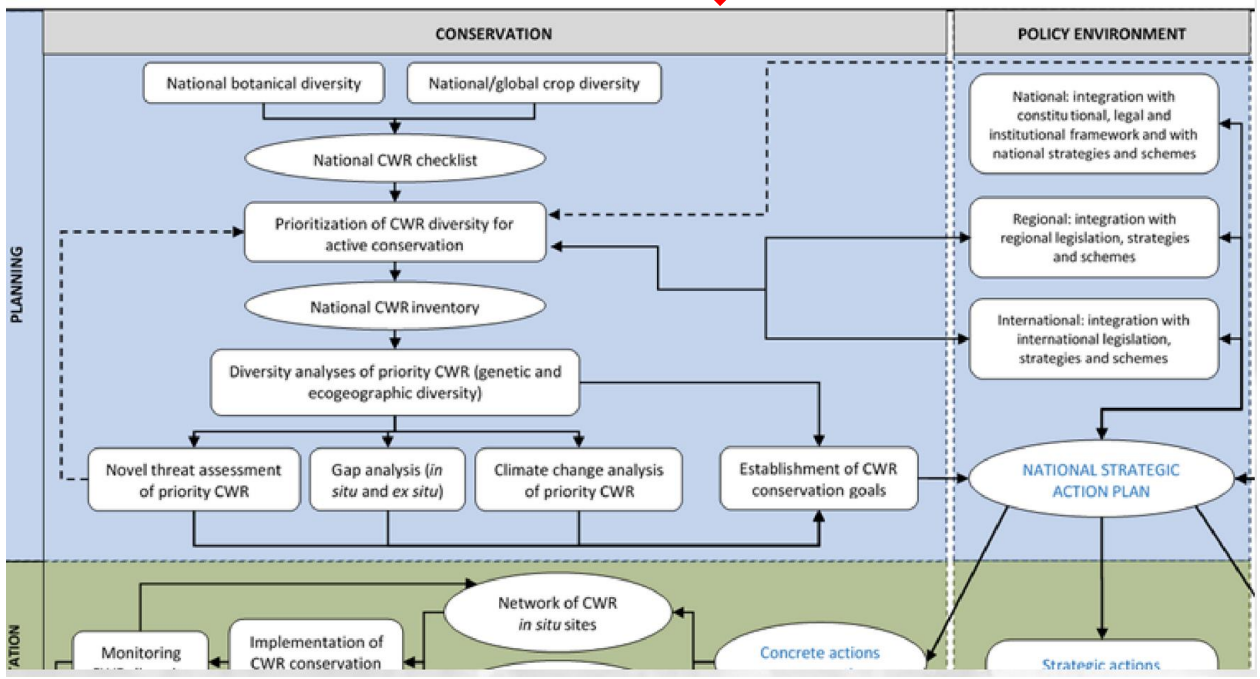
Different reasons: Understaffing, under-funding, improper conservation, insufficient personnel to carry out phytosanitary/legal procedures for distribution, non-streamlined request system..

The role of GRACE-RI:

- To determine **a minimum common standard of services** to be provided.
- To provide **technical, scientific and certification services** to support quality conservation, phytosanitary and legal procedures (thus alleviating undestaffing and underfunding, especially on small genebanks).

2nd PROBLEM: THE COMPLEXITY OF *IN SITU* CONSERVATION





From Nigel Maxted's Pillar 2 presentation

Different players: ECPGR, national authorities, natural reserves genebanks and, in the future, GRACE-RI

The role of GRACE-RI: t

- To provide **technical and scientific services** to support decision making, conservation and access (but **not** to be the decision making body)

The GRACE-RI proposed scientific services

GRACE-RI SERVICES

I. SERVICES FOR *EX SITU* CONSERVATION

- Quality management system
- State-of-the-art conservation protocols
- Routine use of (cyto) genomics and phenomics in PGR management
- Well-characterized core collections
- Safety duplication of collections

II. SERVICES FOR *IN SITU* CONSERVATION

- *In situ* PGR inventories and conservation strategies for natural populations
- On-farm/ in-garden conservation of landraces
- Genomic-phenomic monitoring of *in situ* populations
- Safety e*x situ* duplication of threatened populations/ landraces

III. DATA AND INFORMATION MANAGEMENT

- Enhanced EURISCO
- Standardized data formats
- Integrated solutions for PGR project data management
- Integrated systems for *in situ* and *ex situ* data
- AI-powered data curation
- Predictive Modeling

IV. CHARACTERIZATION AND (PRE)BREEDING SERVICES

- Genotyping/ sequencing/ eDNA barcoding
- Cytogenomic, metabolomic, phenomic, introgressiomic services
- Data analysis

V. SERVICES FOR PGR ACCESS

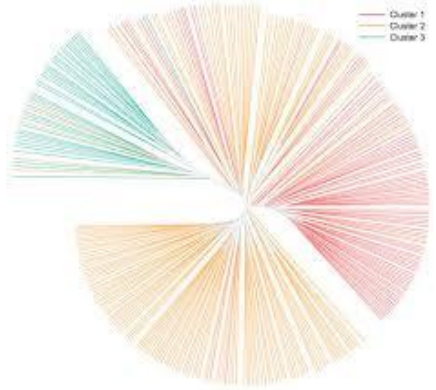
- Regulatory support services for PGR users
- Phytosanitary infrastructure
- Scientific expertise for policymakers
- Regulatory support for conservation strategies

CAPACITY BUILDING AND OUTREACH

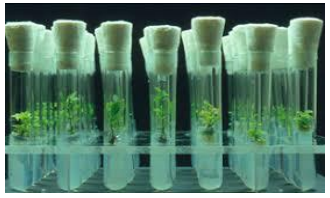
Pillar 1: SERVICES FOR *EX SITU* CONSERVATION

A quality management system for Genetic Resource Centers, including monitoring, auditing and certification

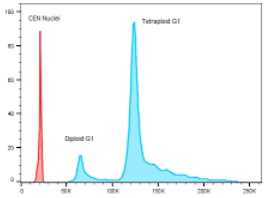
Core collections for priority taxa



State-of-the-art protocols for *ex situ* conservation, regeneration



Routine application of (cyto)genomics and phenomics to *ex situ* PGR management

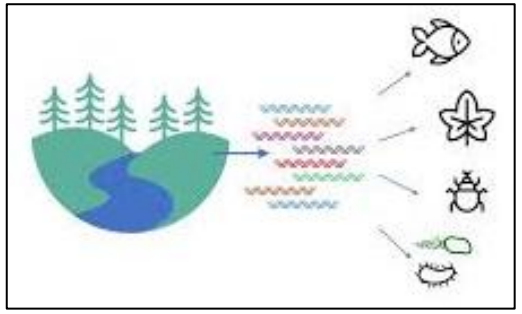


Safety duplication of accessions

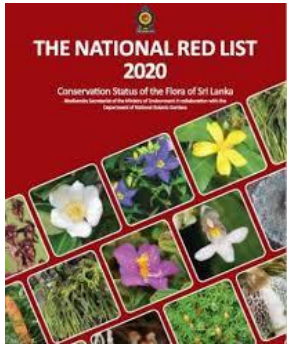
Pillar 2: SERVICES FOR *IN SITU* CONSERVATION

In situ PGR inventories and conservation strategies for natural populations

Genomic-phenomic monitoring of in situ populations



Safety ex situ duplication of threatened populations/ landraces



On-farm/ in-garden conservation of landraces

Pillar 3: DATA AND INFORMATION MANAGEMENT

Enhanced EURISCO

In situ data

Phenotype databases

Integrated systems for *in situ* and *ex situ* data

Generation of standardized (meta)data formats

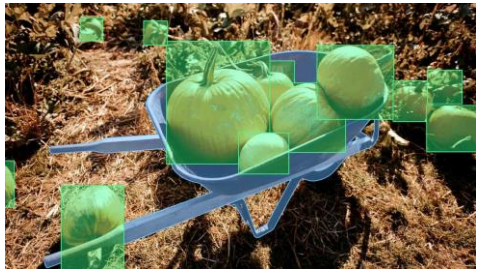
- *Collaboration with EUFGIS, PLANTSEARCH, ELIXIR, EMPHASIS, DiSSCO and GBIF*

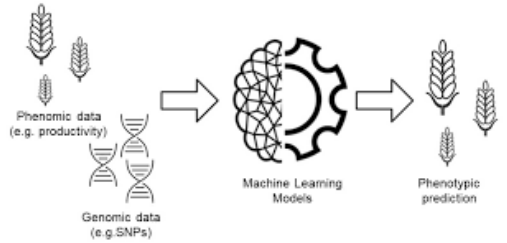
AI-powered data curation

Integrated solutions for PGR project data management

- *Data management guidelines*
- *Advice and support for (meta)data curation*
- *Streamlining to recommended repositories.*
- *Assignments of DOIs*
- *Linking with passport data in EURISCO.*

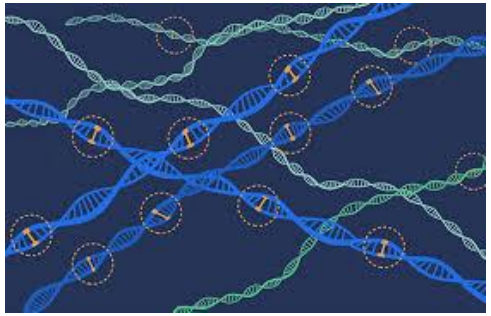
Predictive Modeling



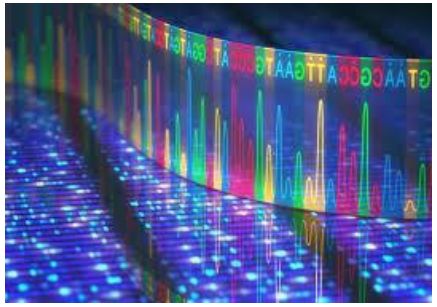


Pillar 4: CHARACTERIZATION AND (PRE) BREEDING SERVICES

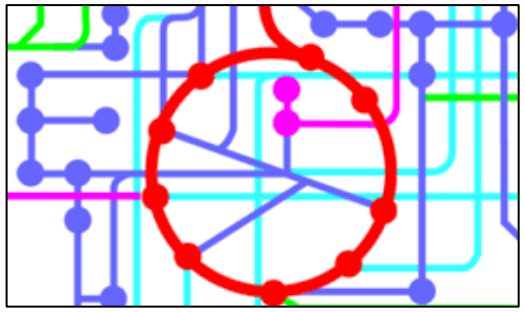
Genotyping



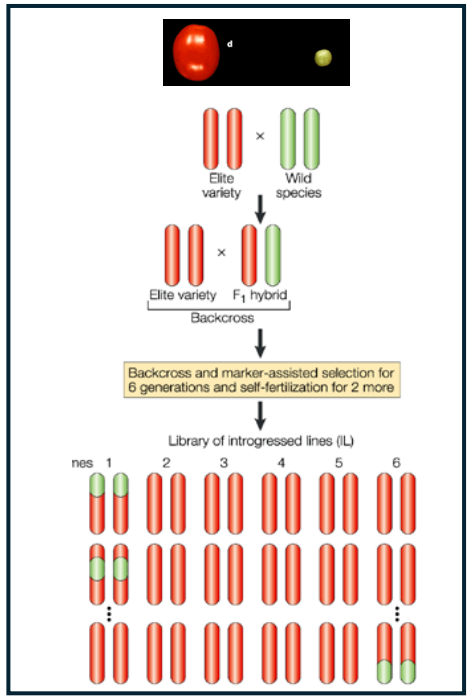
Sequencing



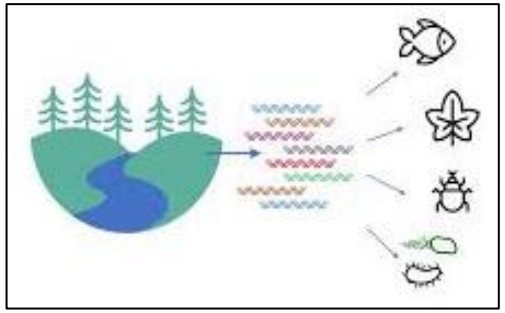
Metabolomics



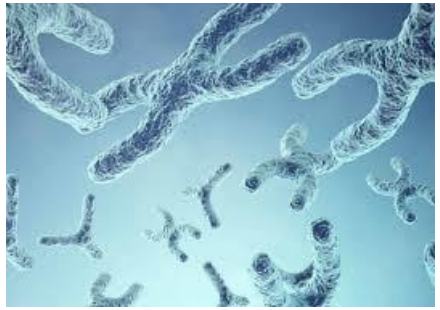
Introgressiomics



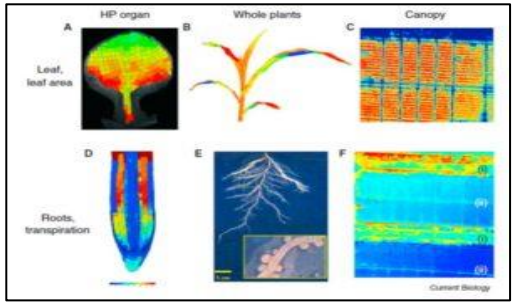
eDNA



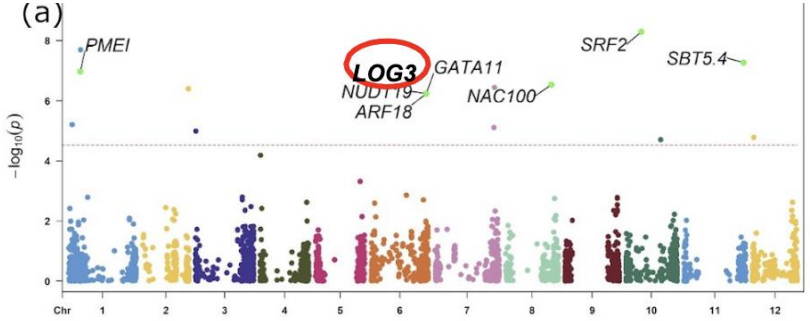
Cytogenomics



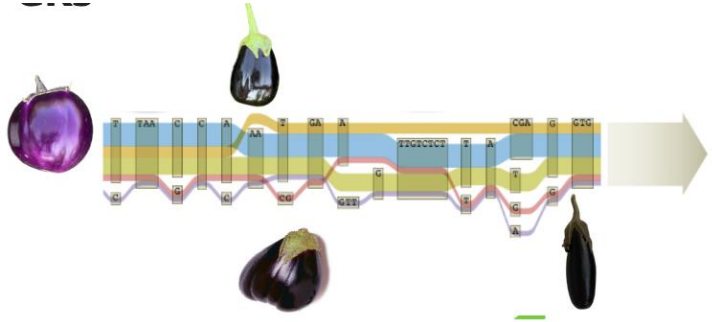
Phenomics



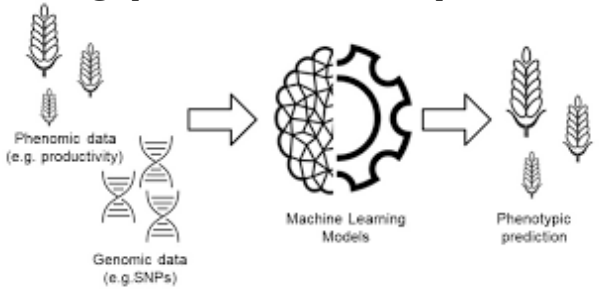
Genome-wide association



Pangenomes & pan-phenomes



Breeding performance prediction



Pillar 5: SERVICES FOR PGR ACCESS

Regulatory and legal support for PGR users

International Treaty on Plant Genetic Resources for Food and Agriculture

Nagoya Protocol

Phytosanitary support for GRCs and users

PLANT QUARANTINE SERVICE
D.A.
BUREAU OF PLANT INDUSTRY

Scientific advice to policymakers

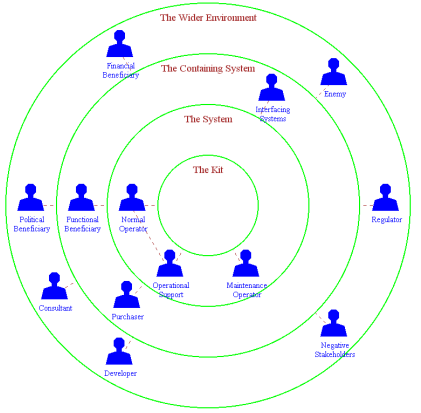
Technical support for national and EU conservation strategies

CAPACITY BUILDING AND OUTREACH

Educational modules

Communication and Awareness campaigns

Support networks for stakeholders



Comprehensive training programs

Training for data curation and management

Outreach and citizen science

COORDINATION IN THE EUROPEAN LANDSCAPE

From J Prohens
Pillar 1 presentation

Key roles:

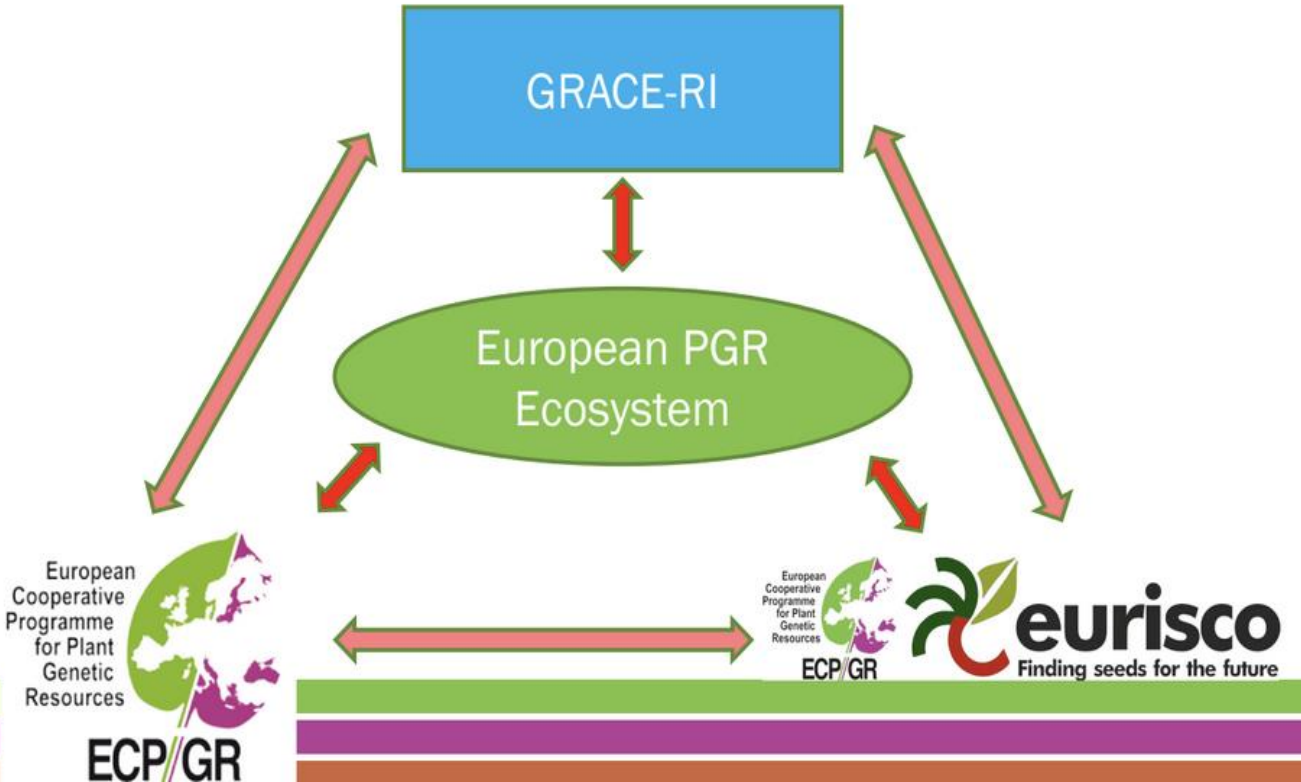
- EURISCO → European catalogue of accessions (accession data backbone).
- ECPGR → Policy & coordination network (countries, crop groups, AEGIS, EVA).
- GRACE-RI → Service provider (advanced scientific, technical, legal, training support).

Integration:

- EURISCO remains the data hub
- ECPGR remains the governance & coordination platform
- GRACE-RI provides infrastructure services to strengthen both

GRACE-RI Support:

- Complementarity
- Robust European system for *ex situ* conservation and use of PGR



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SYNERGIES WITH OTHER RIs

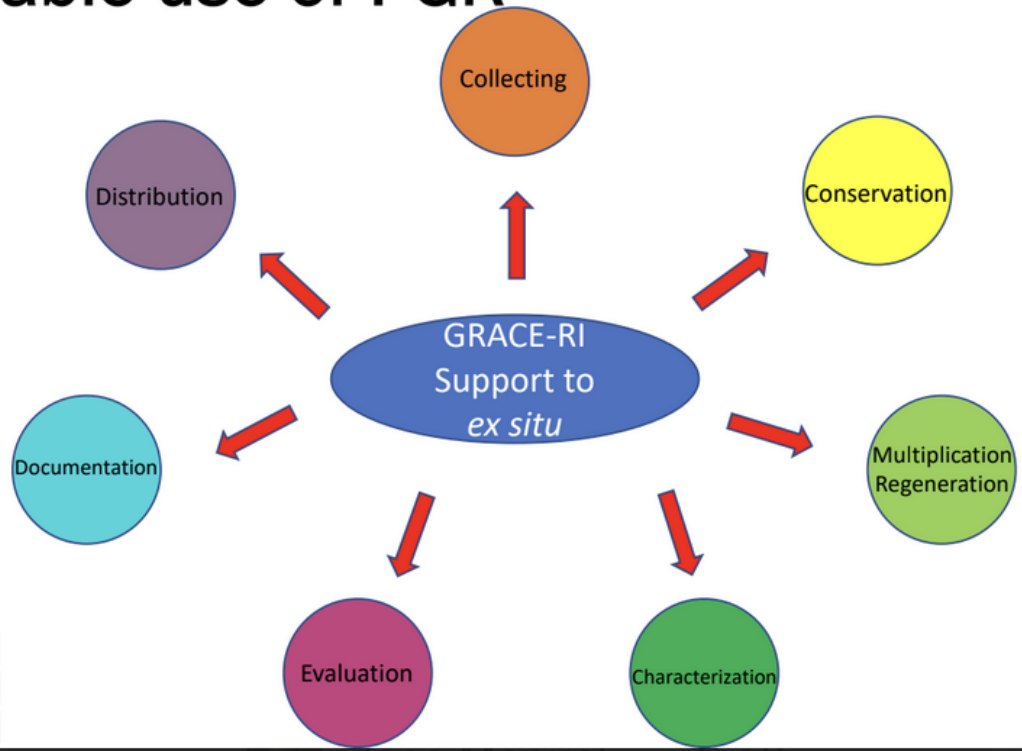
From J Prohens
Pillar 1 presentation

Potential synergies:

- EMPHASIS → Plant phenotyping
- ELIXIR → Life Science data and bioinformatics
- LifeWatch ERIC → Biodiversity and ecosystem data integration
- DiSSCo → Distributed system of scientific collections
- In-Sylva ERIC → Forest and tree genetic resources, linking *in situ* and *ex situ* networks
- BBMRI – ERIC → Biobanking and biomolecular resources
- METROFOOD → Metrology for Food & Nutrition

Conclusion:

GRACE-RI will support the *ex situ* conservation community with services that secure, connect, and enable use of PGR



Thank you for your attention!

PRO-GRACE
PROMOTING A PLANT GENETIC RESOURCE COMMUNITY FOR EUROPE

Funded by the European Union

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