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Federal Research Centre for Cultivated Plants



Genetic Resources and Plant Breeding

L. Frese

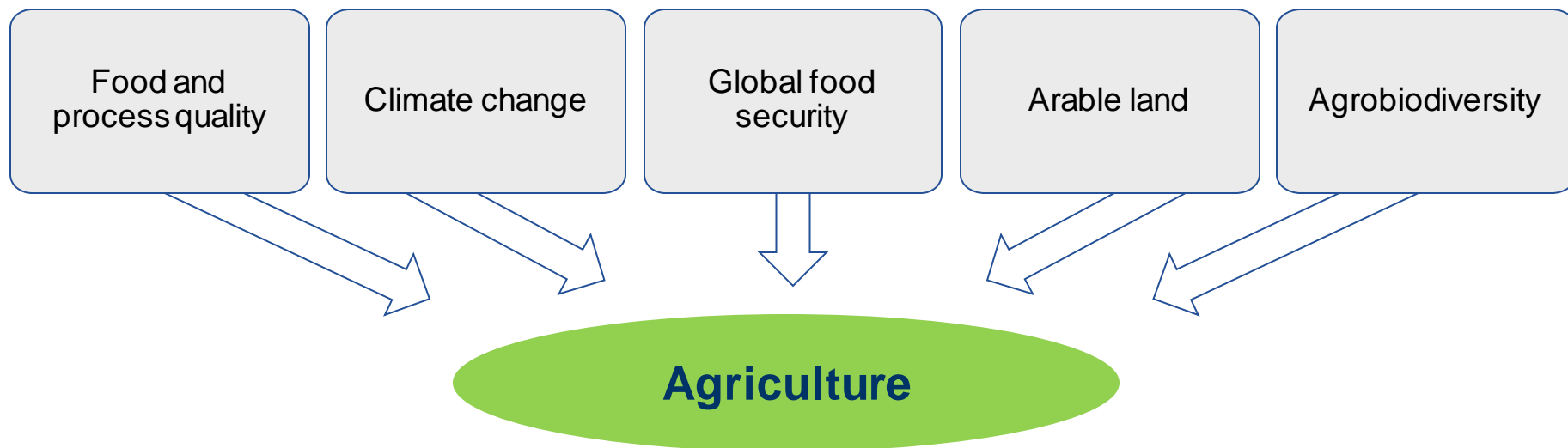
Institute for Breeding Research on Agricultural Crops

Major topics



- 1. Breeding as a complex system**
- 2. Conditions for sustainable plant breeding**
- 3. European Plant Germplasm System**

Challenges



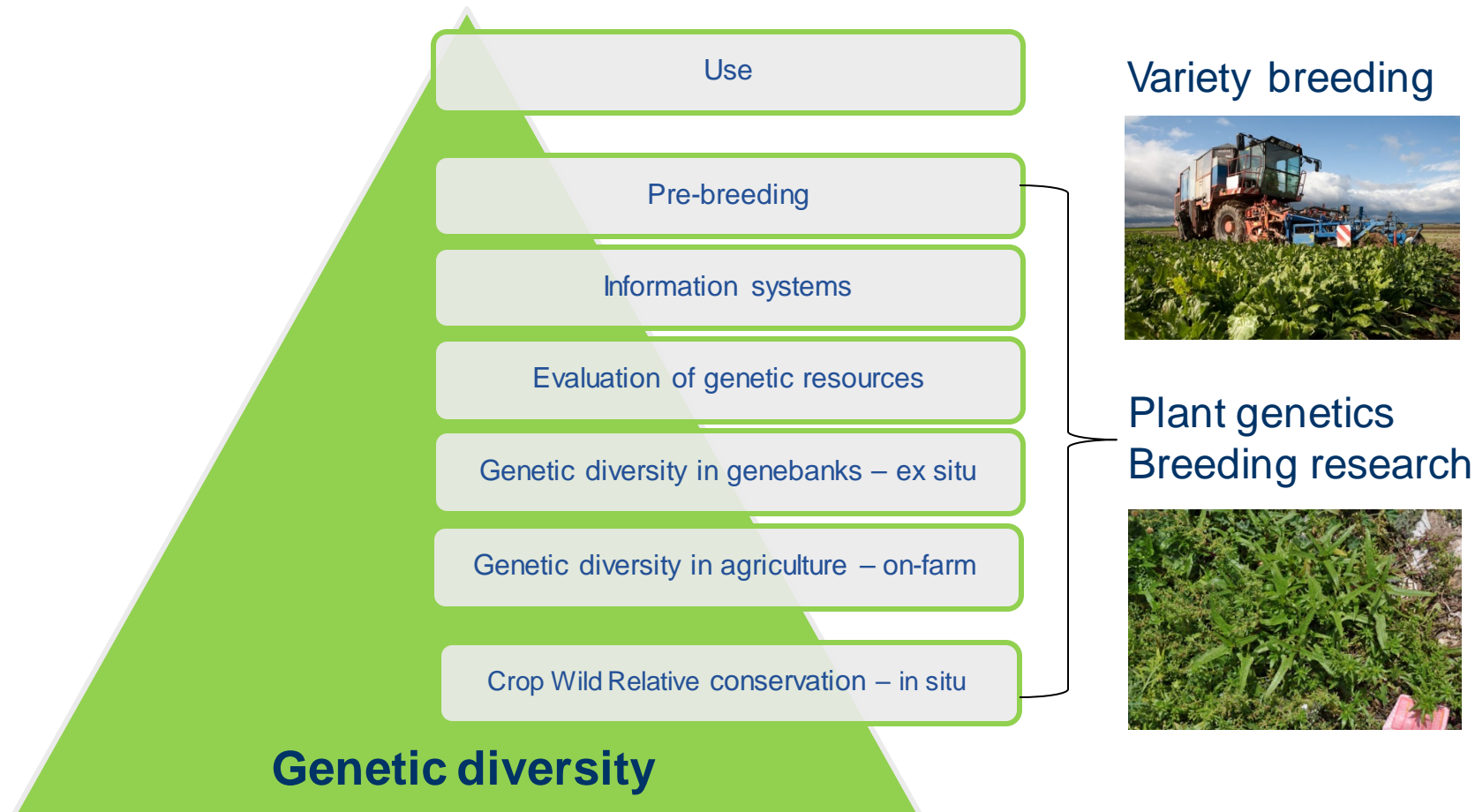
Task of plant breeding:

Adaptation of crops

Indispensable basis:

Plant genetic resources for food and agriculture (PGRFA)

Utilisation of PGRFA



Plant Breeding – a complex system



Environment protection	Breeding Research		Variety sector			Crop production
Plant species protection	PGRFA management	PGRFA utilisation	Variety breeding	National Listing (NL) of varieties	Seed production of varieties	Agricultural practice
Information systems	Information systems	Information systems	Breeding programs	Value test (DUS)	Basic seed	Regional variety tests
Habitat diversity	Ex situ conservation	Evaluation methods	Elite breeding pools	Register test (VCU)	Official seed certification	Seed trade
Species diversity	On-farm management	Phenotyping	Variety applications	Variety protection	Field stand certification	Farming enterprises
Genetic diversity	User service	Inheritance analysis	Pre-basic seed	National Descriptive Variety Lists	Quality inspection	Agricultural goods and markets
In situ management (Genetic reserves)	In situ management (Genetic reserves)	Genetic maps		EU Variety Lists	Certified seed	
		Breeding methods				
		Genetic base broadening				
		Pre-breeding	Pre-breeding			

From environment protection to crop production: a system with connected and interdependent sectors (adapted from Neumann, 2013).

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Is breeding in itself sustainable?



Cowling (2012): “Sustainable plant breeding can be defined as productive and competitive breeding that is achieved without loss of genetic diversity in the elite breeding population during the professional career of the breeder”.

- Sustainable plant breeding
- Does not deplete the used resources, i.e. the breeding genepool
- Operates resources as self-regulatory populations with high adaptiveness
- Breeding and the products of breeding have no negative impacts on other resources (Gregorius, 2010)

Is breeding in itself sustainable?



- Steady breeding progress in winter and spring barley (1970-2003)
- Losses of genetic diversity are compensated by gains (Ordon et al., 2005)

Van der Wouw et al. (2010)

- Gradual narrowing of the genetic base of the varieties released by breeders could not be observed in wheat, barley, corn, oat, pea, rice and soybean

Laidig et al. (2014)

- Yield progress in wheat, barley, corn, rye, canola, sugar beet, perennial ryegrass and Italian ryegrass was mainly caused by genetic enhancement during the past 20 years.

Provided that

- Plant genetic resources are conserved and
- uncomplicated access to genetic resources is possible.

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Outside of Europe

Example: crop wild relative of potato, virus resistance genes, Phytophthora

Climate change will reduce the range size of 108 Solanum species between 38-69% and the patch size by 20-37%. This will inevitably diminish genetic diversity available to potato breeding from now to 2050 (Jarvis et al., 2008)

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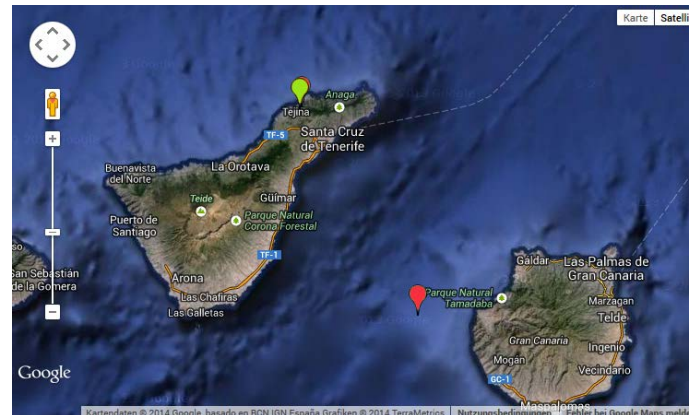
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Within Europe

Today 11.5% of 572 crop wild relative species distributed in Europe were considered as threatened. Amongst them are species of economically important genera such as *Asparagus*, *Avena*, *Beta* or *Brassica* (Bilz et al., 2011)

Is breeding in itself sustainable?



Patellifolia species, crop wild relatives of cultivated beets

Very limited distribution area, ex situ (-), in situ (+)

Is breeding in itself sustainable?

Provided that

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Access means

• Physical

- access to information on germplasm
- availability of accessions held ex situ
- population in situ

• Political

- International regulatory framework facilitating access

International regulatory framework



International Treaty on Plant Genetic Resources for Food and Agriculture (IT- PGRFA)

Multilateral System (MLS) to implement the IT-PGRFA

The MLS serves two purposes:

- to facilitate access to PGRFA and associated information**
- to share the benefits arising from the utilization of PGRFA fairly and equitably.**
- MLS accessions are made available to users after signature of the standard Material Transfer Agreement (sMTA). Under certain conditions mandatory payments into the Treaty's benefit sharing fund are triggered; in addition users are encouraged to make voluntary payments.**

International regulatory framework



As breeding progress in Europe depends to a large extent on access to plant genetic resources existing outside of Europe the functioning of the MLS is of high importance.

To date, a large number of Contracting Parties have failed to make all or part of their PGR available as stipulated by the Treaty (Moeller and Stannard, 2012)

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European countries so far nominated 325,220 accessions which means that approximately 30% of Europe's germplasm holding can potentially contribute to the MLS.

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The Treaty's benefit sharing fund (Stannard et al., 2012, Srinivasan, 2012)

- 2081: annual income 97 Mill. US\$
- 2030: annual income 10 Mill. US\$

International regulatory framework



If the MLS fails

- **to generate the amount of monetary benefits expected by countries**
- **that are located in the centres of diversity**
- **and need financial help for conservation of these genetic resources**
- **then the global plant genetic resources conservation and use system will face an embarrassing problem:**

Constraints will delay the creation of varieties that can cope with the challenges agriculture is facing.

Non-monetary benefit sharing – a way out?



The National Germplasm System (NPGS) of the United States Department of Agriculture (USDA), Agricultural Research Services (ARS)

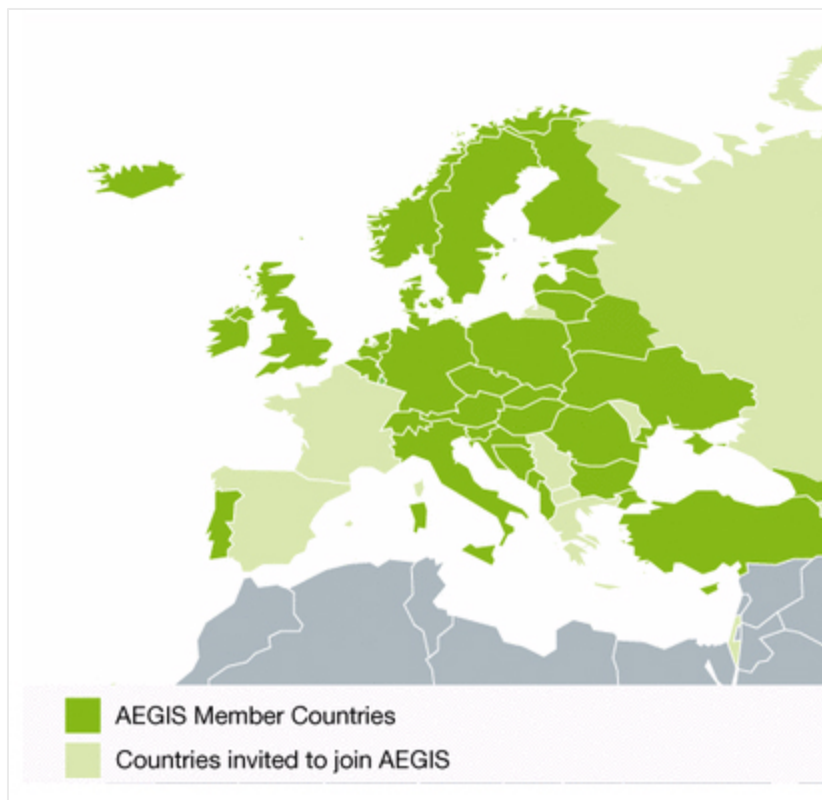
Services to the global plant genetic resources conservation and use community such as:

- **Genetic Resources Information Network (GRIN) it facilitates to germplasm and information 456,000 accessions**
- **Contribution to the global user community**
 - **126,000 accessions distributed each year**
 - **153 nations worldwide**
- **Access to registered germplasm releases = pre-bred material**
- **The value of non-monetary benefit sharing may exceed monetary benefits arising out of the commercial gains**

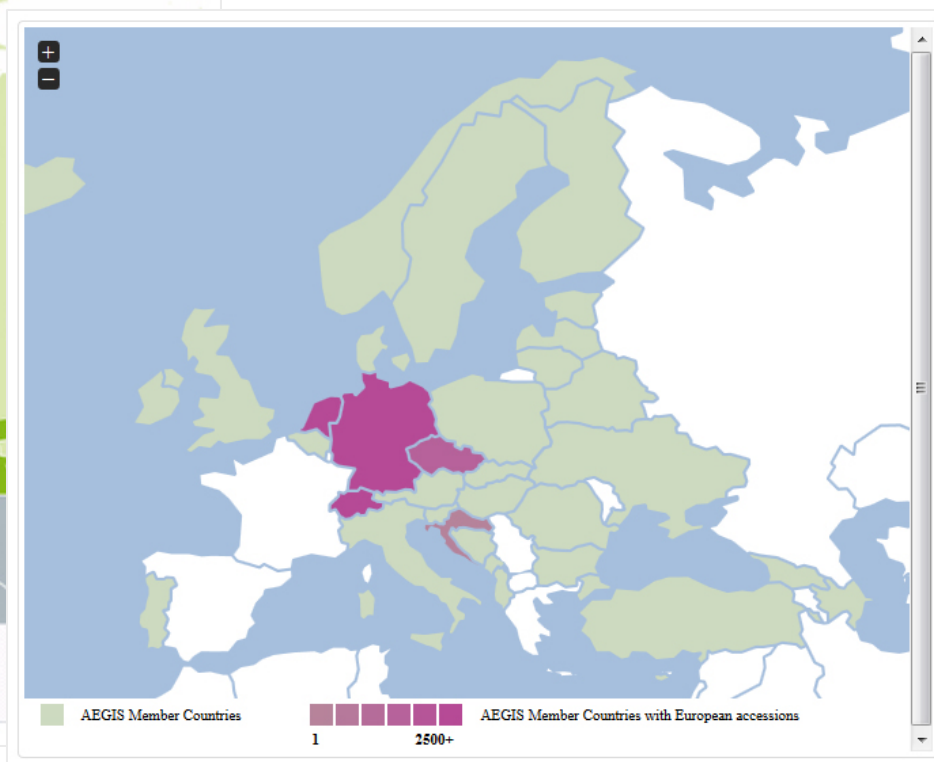
(Williams, 2005)

Non-monetary benefit sharing

European Cooperative Programme on Plant Genetic Resources



1,116,862 accessions
325,220 MLS accessions



**15,133 accessions in the virtual
European genebank (AEGIS)**

Non-monetary benefit sharing



www.pgrsecure.org

On the conservation and sustainable use of plant genetic resources in Europe: a stakeholder analysis

Workshop in Wageningen, November 25–29, 2013

Stakeholders representing the plant genetic resource (PGR) sector were invited to a meeting to discuss the constraints in the conservation and use of PGR in Europe. More than 80 people from 21 countries attended the workshop, representing stakeholders from public research institutes, breeding companies, governments, agro NGOs and gene banks. The goal of the workshop was to assist this community in the development of a joint action plan aiming at the improvement of the PGR conservation and use situation in Europe.



As input to the conference, a report was provided on the current state of PGR conservation and use in Europe. This report is based on interviews of stakeholders from all over Europe, an online questionnaire and subsequent analysis of the institutional strengths, weaknesses, opportunities and threats in the current European PGR system which we observed. Our main findings and recommendations are presented in the report to help structuring and stimulating the workshop discussions. The elaboration of a joint action plan approved by the workshop members is our ultimate goal.

After the workshop the feedback from the participants was integrated into a final report, "On the sustainable use and conservation of plant genetic resources in Europe".



Read more

[PGR Workshop Program](#)
[Venue and travelling](#)
[Workshop documents](#)
[List of participants](#)

[Final report](#)

Opinion forming

120 semi-structured interviews

225 online questionnaires

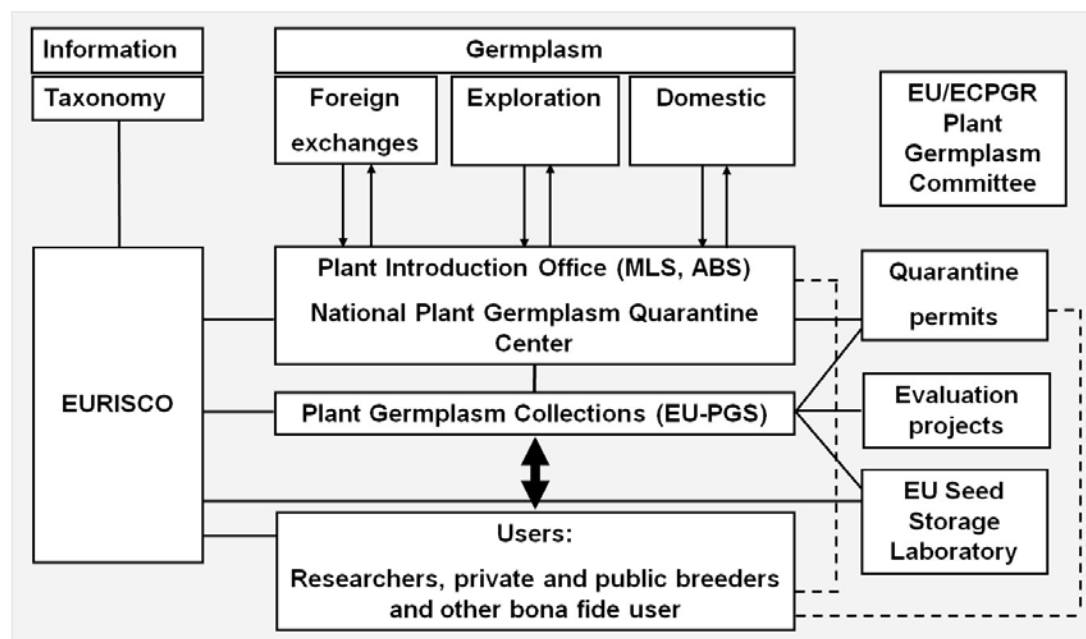
80 experts from 21 countries attended

Non-monetary benefit sharing



A European Plant Germplasm System would be a great contribution to the global user community and ease the access and benefit debate of the Treaty's contracting parties

European institutions have already created elements of a European Plant Germplasm System.



Non-monetary benefit sharing

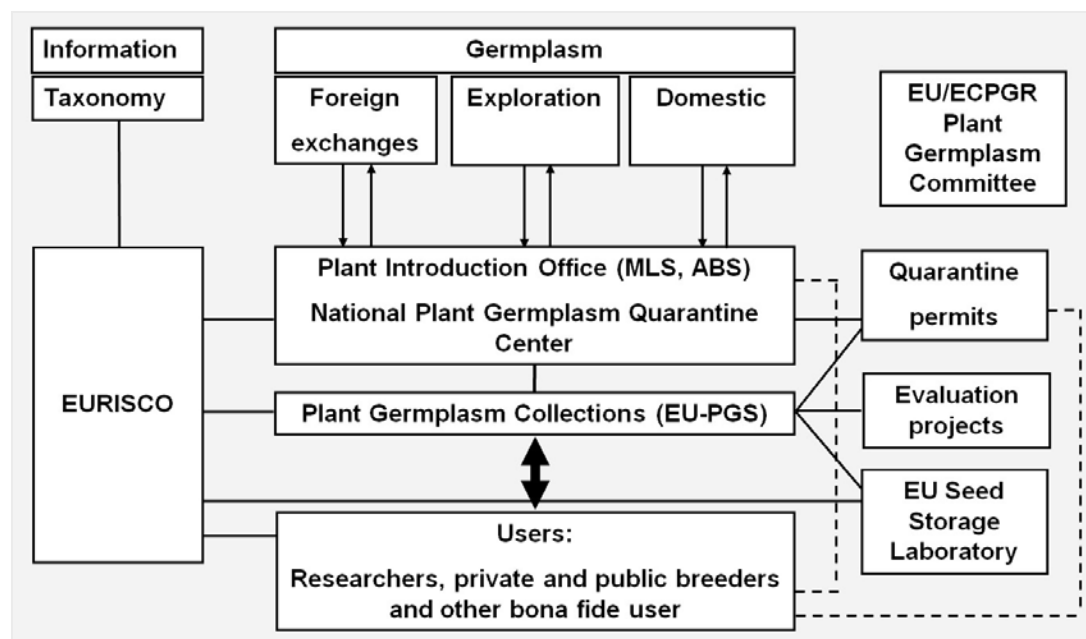


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22 billion €AEM in the period 2007-2013 (EU-27) (Mathews, 2011)

2-3 million € for the European Cooperative Programme on Plant Genetic Resources in the same funding period (ECPGR, 2012)



Summary



- 1. Breeding research and breeding contribute to plant health and yield progress**
- 2. Breeding is sustainable provided that genetic resources are available and accessible**
- 3. Access conditions are ruled by the International Treaty on Plant Genetic Resources**
- 4. Failure of MLS will constrain access to PGRFA**
- 5. Non-monetary benefit sharing systems should be developed**
- 6. European Plant Germplasm System**



Thank you!

PGR Secure is a collaborative project funded under the EU Seventh Framework Programme, THEME KBBE.2010.1.1-03, 'Characterization of biodiversity resources for wild crop relatives to improve crops by breeding', Grant agreement no. 266394. This presentation is partly based on PGR Secure documents.