Julius Kühn-Institut
Bundesforschungsinstitut für Kulturpflanzen
Federal Research Centre for Cultivated Plants

Genebanks in Germany and harnessing of genetic resources

Frank Ordon

Genebanks in Germany

The Federal ex-situ Genebank

Largest Genebank in the EU28

Conservation of Biodiversity

3.168 species,150.000 accessions

Distribution:
since 1946: >1.000.000 samples

Safety Duplicates

LEIBNIZ INSTITUTE OF PLANT GENETICS AND CROP PLANT RESEARCH

The Fruit Genebank Dresden-Pillnitz

- *Ex situ* collections (open field) of different fruit species
- ~1000 wild species accessions of *Malus*, *Prunus*, *Pyrus*, *Fragaria* and *Sorbus*
- ~2000 cultivars of apple, cherry, strawberry, pear, plum, raspberry and wild fruits
- General activities: collection of new material, preservation, evaluation, documentation, utilization (pre-breeding)
- Cryopreservation of *Malus* and *Fragaria*
- Coordinator of the network of the German National Fruit Genebank

http://www.deutsche-genbank-obst.de/

since 2010: Deutsche Genbank Reben
(www.deutsche-genbank-reben.jki.bund.de)

= virtual register for accessions preserved in German grapevine repositories

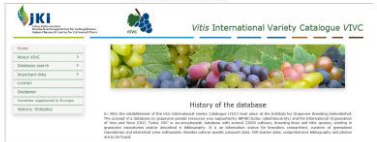
- 7 German grapevine collections maintain 4.327 accessions
- trueness to type assessment is nearly accomplished via funding of the BÖLN-project (2014 - 2016): „Weiterentwicklung von Wissenstransfer- und Informationssystemen zur nachhaltigen Nutzung rebengenetischer Ressourcen"

since 1997: European *Vitis* Database
(www.eu-vitis.de)

= virtual register of accessions preserved in European grapevine repositories

- *Vitis* species, cultivars and breeding lines
- useful for variety identification via photographs, descriptions and microsatellite markers
- uploading of passport and description data and photos is done online by collection curators
- useful for the exchange of material
- 58 European collections maintain 37.694 accessions

since 1984: *Vitis* International Variety Catalogue - VIVC
(www.vivc.de)



= bibliographical register of grapevine cultivars

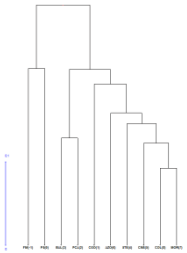
- lexical information source (parentage, origin, breeder, utilization, etc.)
- useful for variety identification via photographs, descriptions and microsatellite markers
- Content: passport data from 24.000 cultivars, Vitis species and breeding lines and genetic profiles from 3355 prime names
- ca. 3700 distinct visits per month are counted

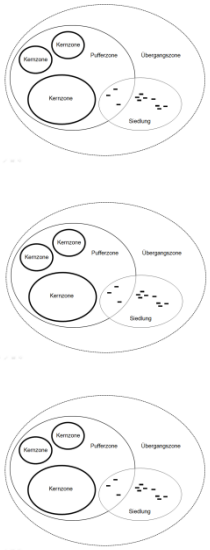
In situ conservation of crop wild relatives

- Implementation of CBD, Art. 8, in situ conservation strategy
- Establishment of genetic reserves as a means to make the strategy operable
- Dynamic conservation of intraspecific variation

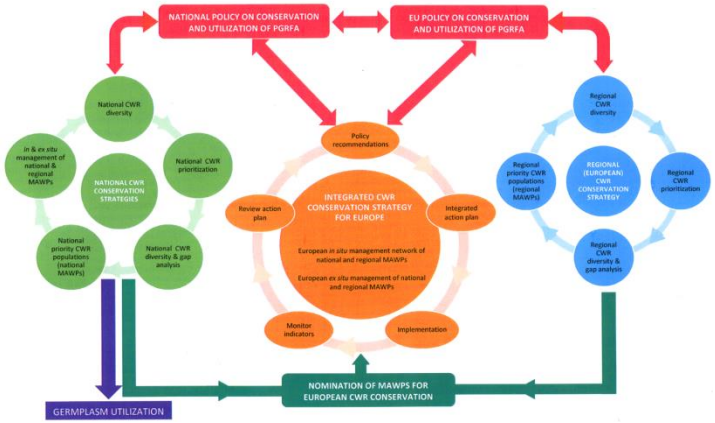
Germany (e.g. *Apium, Helosciadium*)

Spain and Portugal (e.g. *Patellifolia*)





Genetic reserves

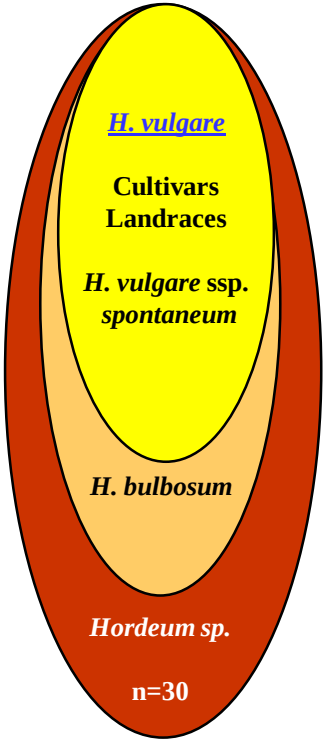


ECPGR Concept for In Situ Conservation of Crop Wild Relatives in Europe (2015). N. Maxted, A. Avagyan, L. Frese, J. Iriondo, J. Magos Brehm, J., A.Singer, A. & S. Kell

- Inventory of species populations
- Assessment of sites and population
- Analysis of spatial patterns of genetic diversity

- Establishment of national networks of genetic reserves
- Integration of national networks into a European network

Harnessing genetic diversity



Development of effective screening methods for resistance

Identification of genetic variation for resistance within the genepool

Genetic analysis of resistance (qualitative/quantitative manner)

Development of molecular markers and marker based introgression into adapted varieties

Gene isolation (map based cloning)

Marker assisted backcrossing
Pyramiding of resistance genes

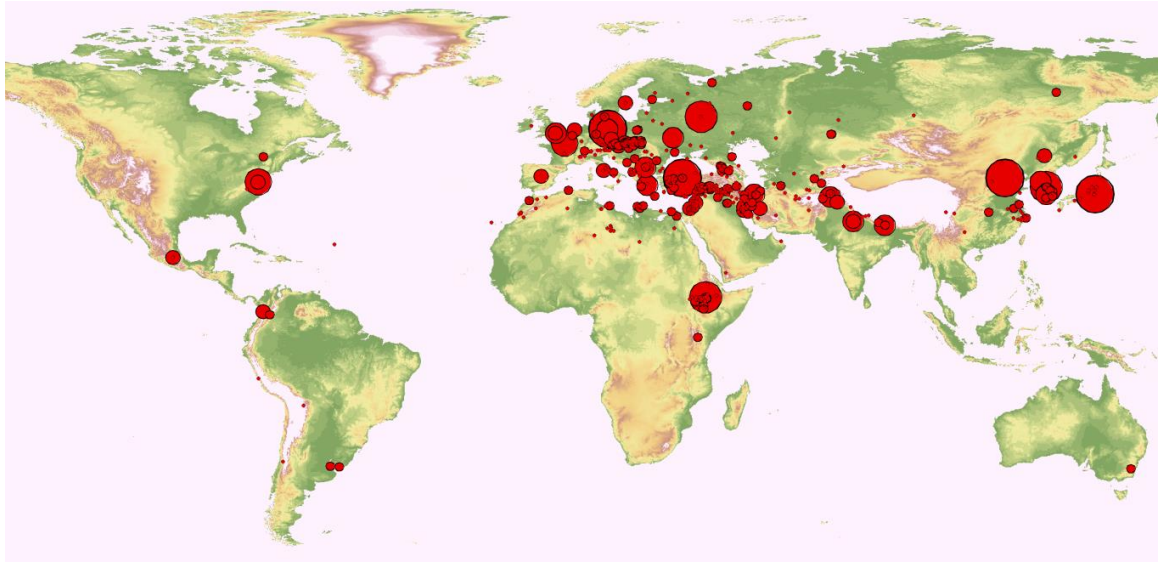
Allele mining

Allele editing

Direct gene transfer to adapted cultivars

Use of genetic resources (examples)

Allele mining: *rym11*



365 Wild barley (*H. spontaneum*)

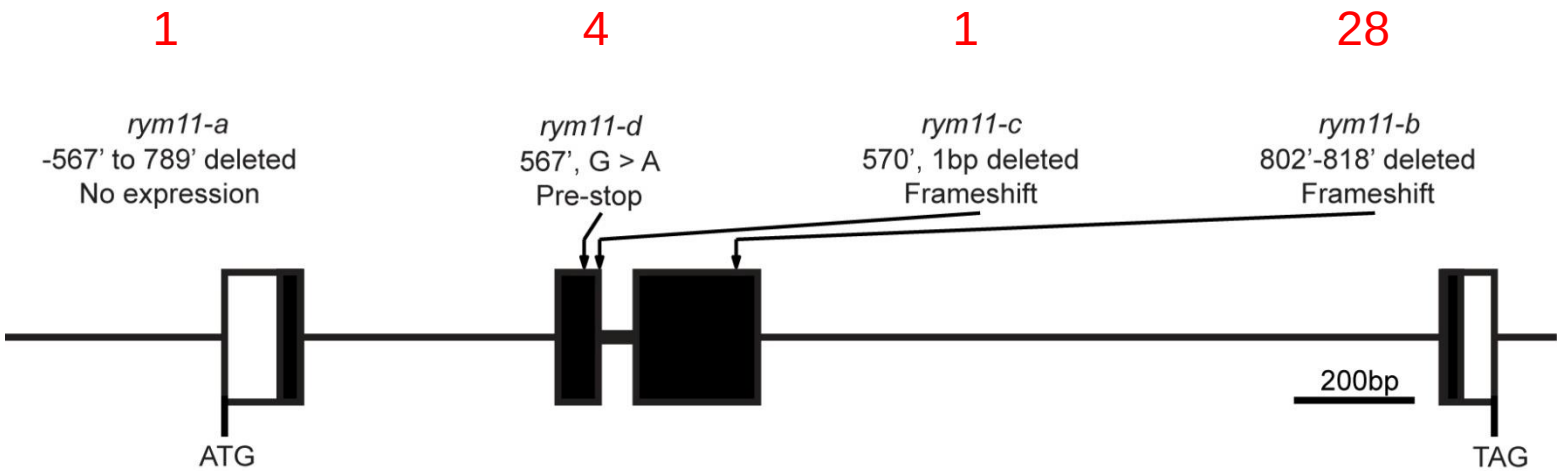
847 Landrace (*H. vulgare*)

559 Cultivar (*H. vulgare*)

5 *H. agriocrithon*

Total = 1,816 accessions

Number of accessions carrying different alleles

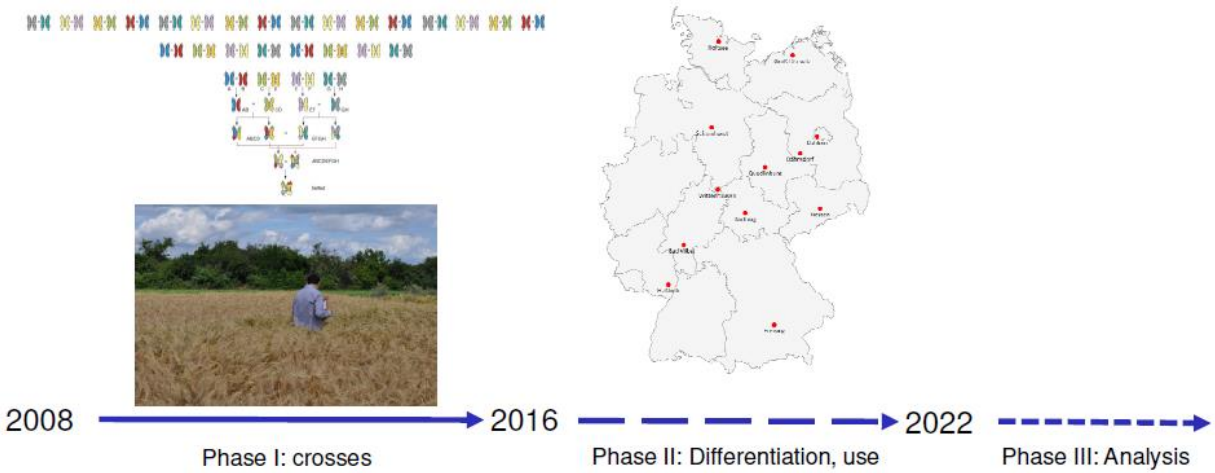


Yang et al. 2014. www.pnas.org/cgi/doi/10.1073/pnas.1320362111

Use of genetic resources (examples)

Adaptation of crops to climate change

•Evolutionary plant breeding as a means to deal with uncertain climate change prognosis



- Establishment of a highly recombinant winter barley population using the MAGIC schema
- Reproduction of the population in Germany at 12 distinct soil-climate-areas until 2022
- Investigation of adaptive processes
- Low cost approach to adapt a crop to climate change
- Dynamic management of plant genetic resources in agricultural ecosystems

Future perspectives

High throughput genotyping and reliable phenotyping also for complex traits followed by e.g. GWAS will facilitate a more directed exploitation and use of genetic resources present in genebanks

Large scale gene isolation followed by allele mining in large genebank collections will transfer the use of genetic resources to the allele level

Conversion of ex-situ genebanks into BioDigital™ resource centres

Challenges

Single genotyping system

Development of standardized phenotyping protocols also for complex traits

Data storage and acessibility of data and seeds

Long term funds covering the above mentioned subjects up to pe-breeding

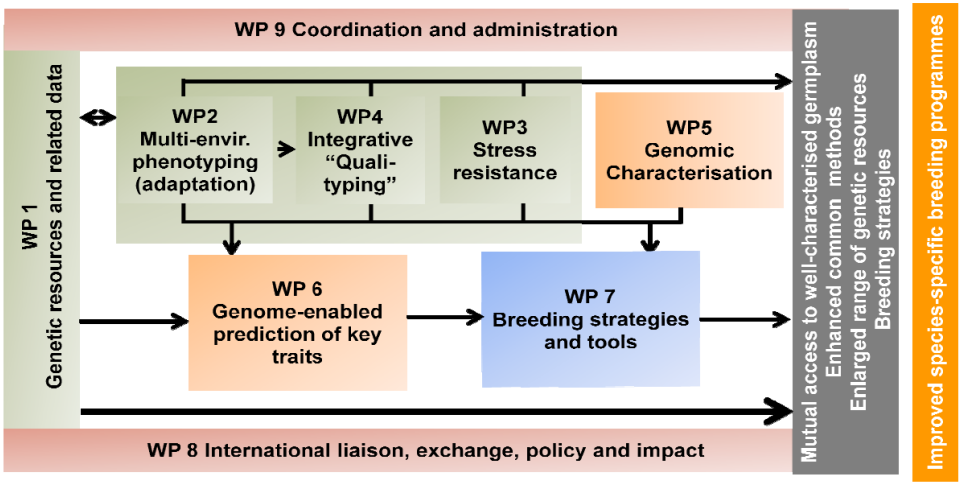
Common proposal

Topic: SFS-44-2016: A joint plant breeding programme to decrease the EU's and China's dependency on protein imports

Proposal number: 727285-2

Proposal acronym: C-ELIA

Chinese-European Legume Improvement Alliance



No.	Participant organisation name	Abrev-iation	Coun try	Type*	Main relevant competences
	European partners				
1.	Julius Kühn Institute	JKI	DE	PSRE	Genetic resources, docu-menttation
2.	Danube Soya	DS	AT	RA	Innovation
3.	University of Helsinki	UH	FI	Uni	Breeding research
4.	Council for Agr. Research and Economics	CREA	IT	PSRE	Breeding research
5.	Processors and Growers Res. Organisation	PGRO	UK	PRO	Phenotyping
6.	Institute of Field and Vegetable Crops	IFVC	RS	PSRE	Breeding research
7.	University of Reading	READ	UK	Uni	Genetics, Phenotyping
8.	Donal Murphy-Bokern	DMB	DE	SME	Impact, Policy
9.	Agritec	AGT	CZ	SME	Breeding
10.	Univ. Nat. Resources and Life Sciences	BOKU	AT	Uni	Quality
11.	Georg-August-University Göttingen	UGOE	DE	Uni	Breeding research
12.	University of Hohenheim	UHOH	DE	Uni	Breeding research
13.	Instituto de Tecnologia Química e Biológica	ITQB	PT	Uni	Genetics, Quality
14.	National Institute of Agr. Research	INRA	FR	PSRE	Genetics
15.	Spanish National Research Council	CSIC	ES	PSRE	Breeding research
16.	University of Perugia	UPG	IT	Uni	Phenotyping
17.	Saatzucht Gleisdorf GmbH	SZG	AT	SME	Breeding
18.	Norddeutsche Pflanzenzucht	NPZ	DE	SME	Breeding
19.	Institute of Plant Genetic Resources	IPGR	BG	PSRE	Phenotyping
20.	John Innes Centre	JIC	UK	PSRE	Genetics, Genebank
21.	National Centre for Scientific Research	CNRS	FR	PSRE	Genetics
22.	Agricultural Research Ltd. Troubsko	ART	CZ	SME	Phenotyping
23.	Marche Polytechnic University	UNIVPM	IT	Uni	Genetics
24.	University of Modena	UMOD	IT	Uni	Data analysis
25.	Poznan Uni. of Life Sciences	PULS	PL	Uni	Breeding, Phenotyping

No.	Participant organisation name	Abrev-iation	Cou ntry	Type*	Main relevant competences
	Chinese partners				
26.	Chinese Academy of Agricultural Sciences – Institute of Crop Sciences	CAAS	CN	PSRE	Genetics, Gene bank
27.	Northeast Agricultural University	NEAU	CN	Uni	Genetics, Breeding
28.	Shandong University	SDU	CN	Uni	Genetics
29.	Nanjing Agricultural University	NJAU	CN	Uni	Genetics, Phenotyping
30.	Lanzhou University	LZU	CN	Uni	Genetics, Phenotyping
31.	South China Agricultural University	SCAU	CN	Uni	Genetic resources
32.	Anhui Agricultural University	AHAU	CN	Uni	Genetics, Phenotyping
33.	Chinese Academy of Sciences - Institute of Genetics and Developmental Biology	CAS	CN	PSRE	Genetics
34.	Heilongjiang Bayi Agricultural University	HLAU	CN	Uni	Phenotyping
35.	Gansu Academy of Agriculture Science-Institute of Crop Sciences	GACS	CN	PSRE	Phenotyping
36.	Beijing University of Agriculture	BUA	CN	Uni	Phenotyping, Breeding
37.	Jilin Academy of Agricultural Sciences	JAAS	CN	PSRE	Phenotyping,
38.	Zhejiang Academy of Agricultural Sciences	ZAAS	CN	PSRE	Phenotyping, Genetics
39.	Chinese Academy of Agricultural Science - Oilcrop Research	OCRI	CN	PSRE	Phenotyping, Genetics
40.	Chinese Academy of Agricultural Science - Livestock Science	CALS	CN	PSRE	Phenotyping, Impact, Policy
41.	Guangxi Academy of Agricultural Science	GAAS	CN	PSRE	Phenotyping
42.	Heilongjiang Academy of Agricultural Sciences-- Heihe Branch Academy	HAHB	CN	PSRE	Phenotyping, Impact, Policy
43.	Heilongjiang Academy of Agricultural Sciences-Institute of Soybean Research	HASR	CN	PSRE	Phenotyping, Impact, Policy
44.	Heilongjiang Academy of Agricultural Sciences- Institute of Crop Breeding	HACB	CN	PSRE	Phenotyping, Impact, Policy
45.	Liaoning Academy of Agricultural Sciences-Institute of Crop Science	LAAS	CN	PSRE	Phenotyping , Breeding
46.	Hubei Academy of Agricultural Sciences-Institute of Food Crops Research	HAFC	CN	PSRE	Phenotyping, Genetics,
47.	Hebei Academy of Agricultural and Forestry Science- Institute of Cereal and Oil Crops	ICOC	CN	PSRE	Phenotyping
48.	Shanxi Academy of Agricultural Sciences, Institute of Industrial Crops	SXAS	CN	PSRE	Phenotyping , Breeding
49.	Shandong Academy of Agricultural Science-Crop Research Institute	SAAS	CN	PSRE	Phenotyping ,
50.	Anhui Academy of Agricultural Sciences-Institute of Crop Sciences	AAAS	CN	PSRE	Phenotyping , Breeding
51.	Henan Academy of Agricultural Sciences-Industrial Crops Research Institute	HAIS	CN	PSRE	phenotyping
52.	Chinese Acadamy of Agricultural Sciences-Biotechnology Research Institute	CABS	CN	PSRE	Genetics
53.	Tonghua Academy of Agricultural Science-Institute of Soybean Research	TASR	CN	PSRE	Breeding
54.	Qujing Academy of Agricultural Sciences	QAAS	CN	PSRE	Breeding