The *Legume Generation* project and adaptation of soybean to European needs

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Legume Generation

Project consortium partners

24 EU-funded partners
33 partners to the consortium agreement

IPK LEIBNIZ INSTITUTE
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Euroseeds Embracing Nature
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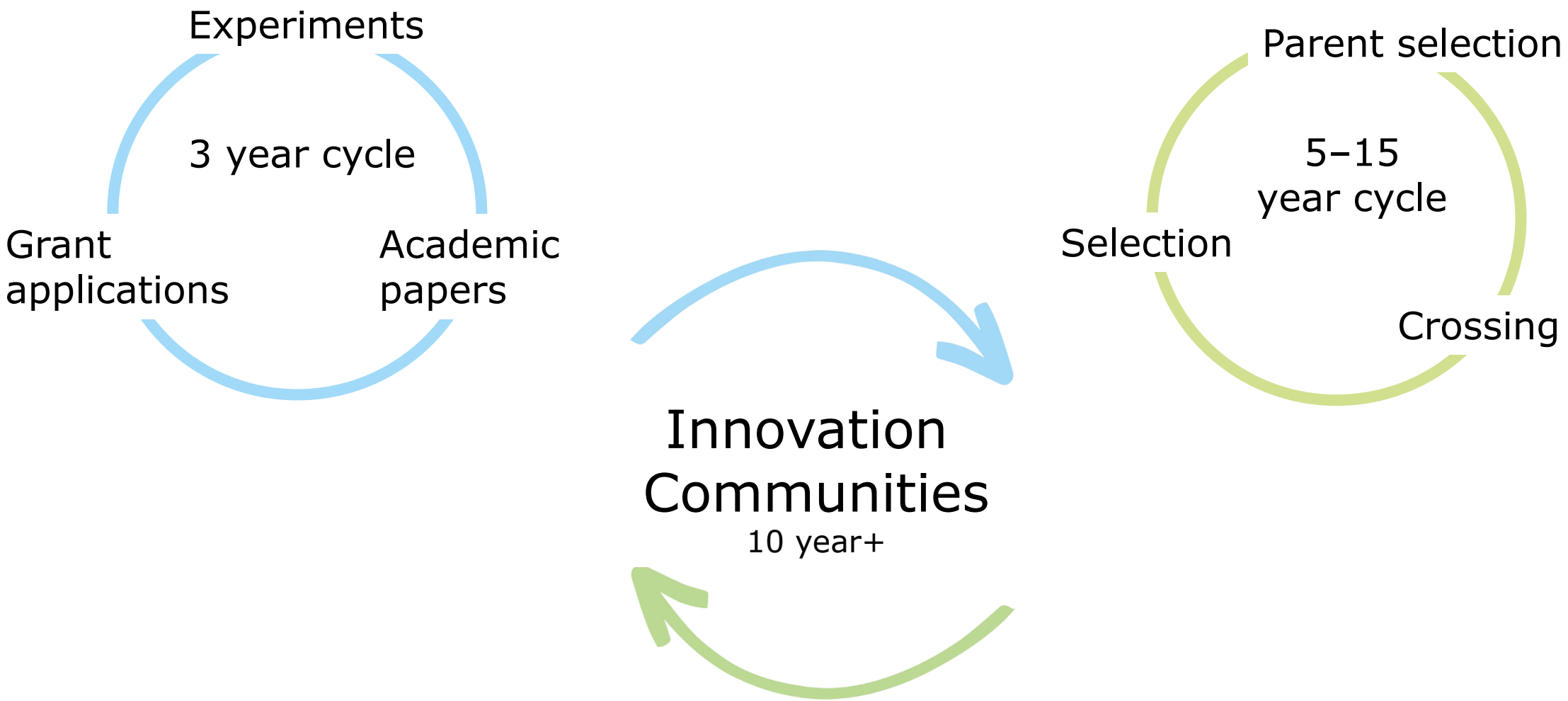
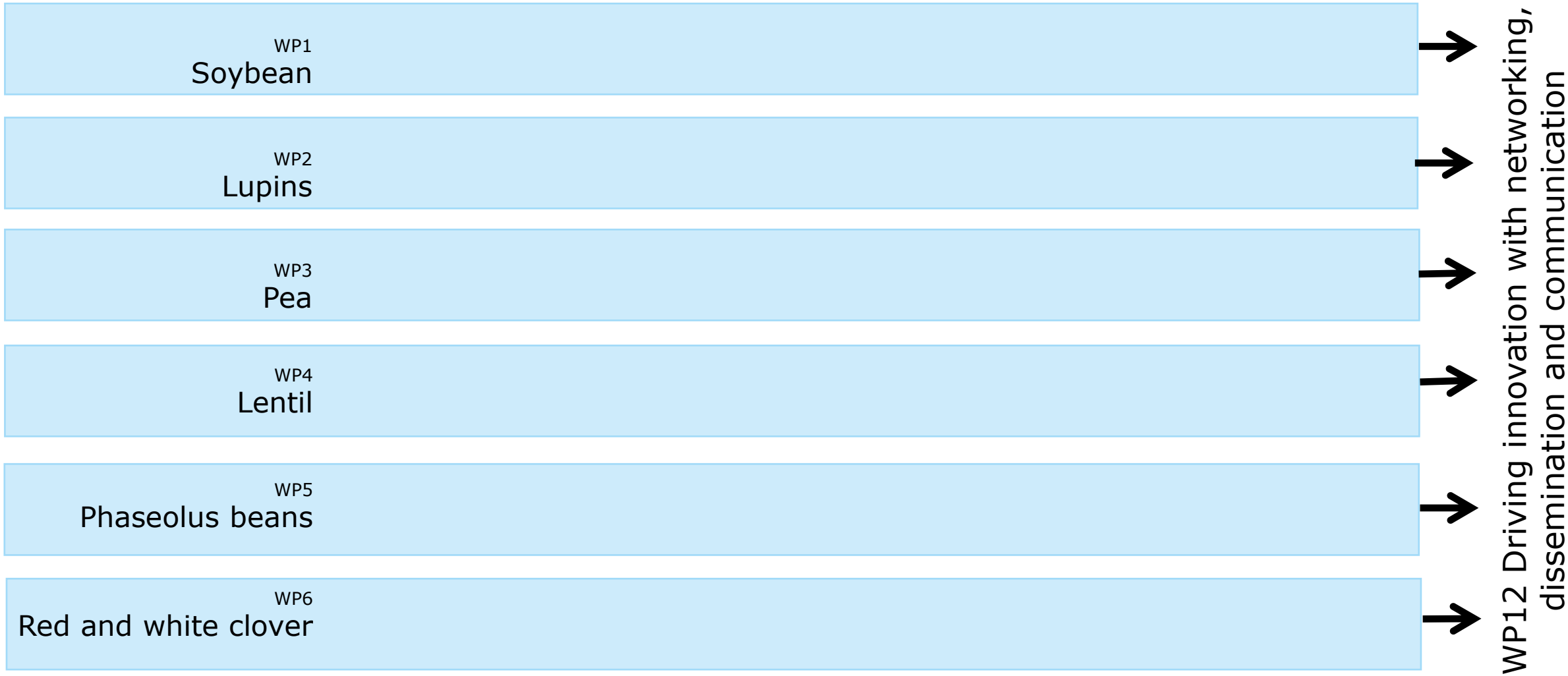
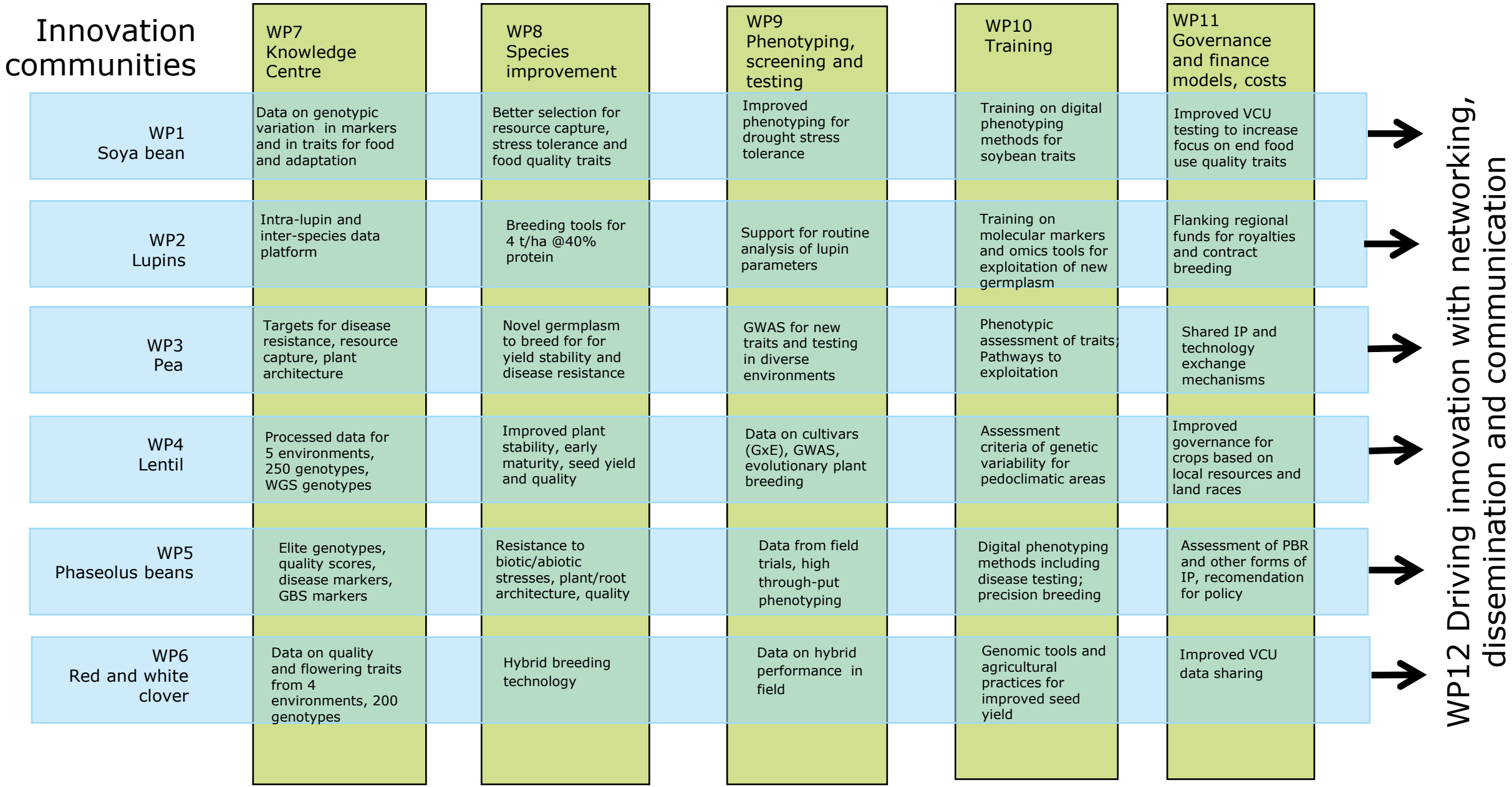
ABI
VAN WAVEREN Saaten GmbH
SZG Saatzucht Gleisdorf
AARHUS UNIVERSITY
Lidea
SaatGut Keyserlingk-Institut
Agroscope
PRIFYSGOL ABERYSTWYTH UNIVERSITY
UNIVERSITÀ DEGLI STUDI DELLA BASILICATA 1982
Ideen um Pflanzen ESKUSA Ideen pflanzen
KWS
UNIVERZITA PALACKÉHO V OLOMOUCI
BOKU UNIVERSITY
LfL Bayerische Landesanstalt für Landwirtschaft
USDA
UNIVERSITY OF OXFORD

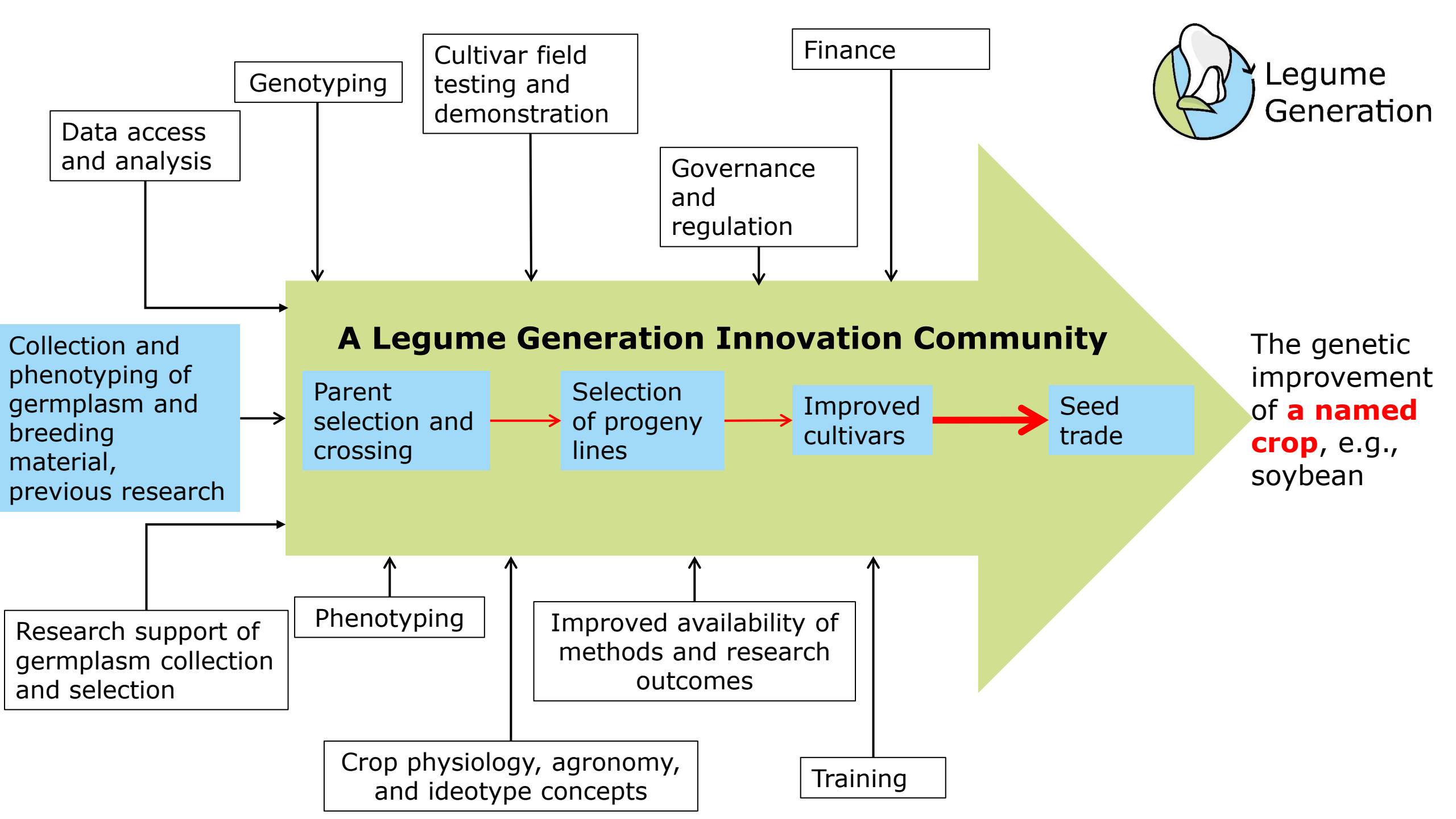
Named crops


Experiments
3 year cycle
Grant applications
Academic papers
Parent selection
5–15 year cycle
Selection
Crossing
Innovation Communities
10 year+

Innovation communities




Innovation communities
WP7 Knowledge Centre
WP8 Species improvement
WP9 Phenotyping, screening and testing
WP10 Training
WP11 Governance and finance models, costs
WP1 Soya bean
Data on genotypic variation in markers and in traits for food and adaptation
Better selection for resource capture, stress tolerance and food quality traits
Improved phenotyping for drought stress tolerance
Training on digital phenotyping methods for soybean traits
Improved VCU testing to increase focus on end food use quality traits
WP2 Lupins
Intra-lupin and inter-species data platform
Breeding tools for 4 t/ha @40% protein
Support for routine analysis of lupin parameters
Training on molecular markers and omics tools for exploitation of new germplasm
Flanking regional funds for royalties and contract breeding
WP3 Pea
Targets for disease resistance, resource capture, plant architecture
Novel germplasm to breed for for yield stability and disease resistance
GWAS for new traits and testing in diverse environments
Phenotypic assessment of traits; Pathways to exploitation
Shared IP and technology exchange mechanisms
WP4 Lentil
Processed data for 5 environments, 250 genotypes, WGS genotypes
Improved plant stability, early maturity, seed yield and quality
Data on cultivars (GxE), GWAS, evolutionary plant breeding
Assessment criteria of genetic variability for pedoclimatic areas
Improved governance for crops based on local resources and land races
WP5 Phaseolus beans
Elite genotypes, quality scores, disease markers, GBS markers
Resistance to biotic/abiotic stresses, plant/root architecture, quality
Data from field trials, high through-put phenotyping
Digital phenotyping methods including disease testing; precision breeding
Assessment of PBR and other forms of IP, recomendation for policy
WP6 Red and white clover
Data on quality and flowering traits from 4 environments, 200 genotypes
Hybrid breeding technology
Data on hybrid performance in field
Genomic tools and agricultural practices for improved seed yield
Improved VCU data sharing
WP12 Driving innovation with networking, dissemination and communication


Legume Generation
Data access and analysis
Genotyping
Cultivar field testing and demonstration
Governance and regulation
Finance
A Legume Generation Innovation Community
Collection and phenotyping of germplasm and breeding material, previous research
Parent selection and crossing
Selection of progeny lines
Improved cultivars
Seed trade
The genetic improvement of a named crop, e.g., soybean
Research support of germplasm collection and selection
Phenotyping
Improved availability of methods and research outcomes
Crop physiology, agronomy, and ideotype concepts
Training

WP1: Boosting the breeding of soybean

Johann Vollmann (BOKU University, Austria)
[on behalf of all Soybean Innovation Community members]

Funded by
the European Union

Legume Generation

Soybean Innovation Community

Johann Vollmann
BOKU

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EUROPE SOYA DONAU SOJA

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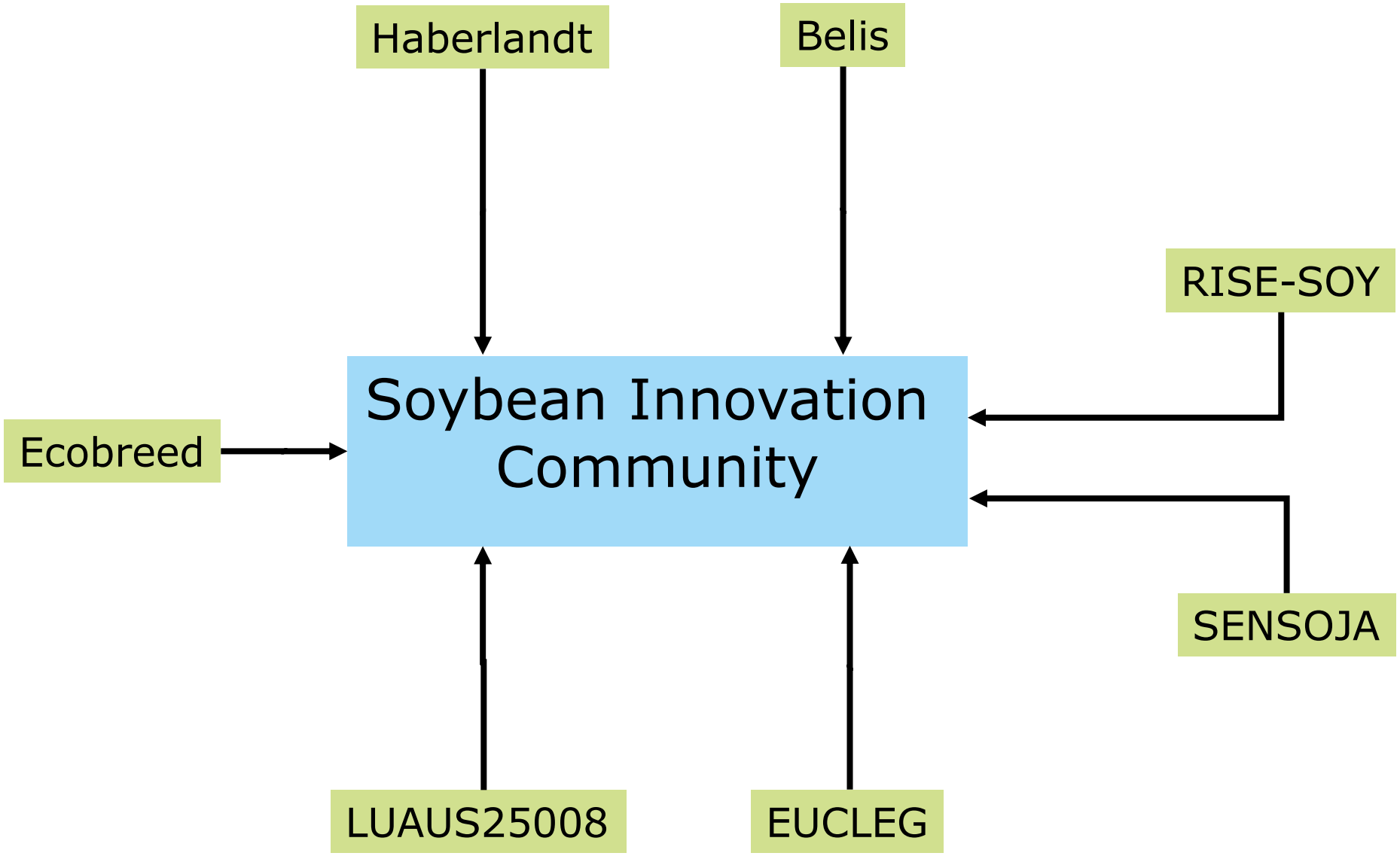
Agroscope



Delivering through four pre-breeding and six breeding programmes

Legume Generation

Legume Generation

soybean innovation community

Work packages

Task 1.1. Networking

Developing, fostering and serving the soybean and other legume innovation communities

other species community agri-food stakeholders

Task 1.2. Breeding for yield and adaptation

Field phenotyping, yield, stress, quality, maturity, resistances, genotyping

Set 1 early
MG 0000-000
60 geno

Set 2 mid early
MG 00
45 geno

Set 3 late
MG 0-I
30 geno

Task 1.3. Breeding for soy-food traits

Food quality traits, maturity, genotyping

Set Food
MG 0000-I
70 geno incl. standards

Team:

Soybean breeders from:

Austria
Bulgaria
Czech Republic
France
Germany
Poland
Switzerland

Task 1.1: Developing and serving the Soybean Innovation Community

Photo credit: Jasmin Karer

Soybean IC meeting,
Tulln, Austria, SEPT 2024

Task 1.2: Breeding for yield and adaptation

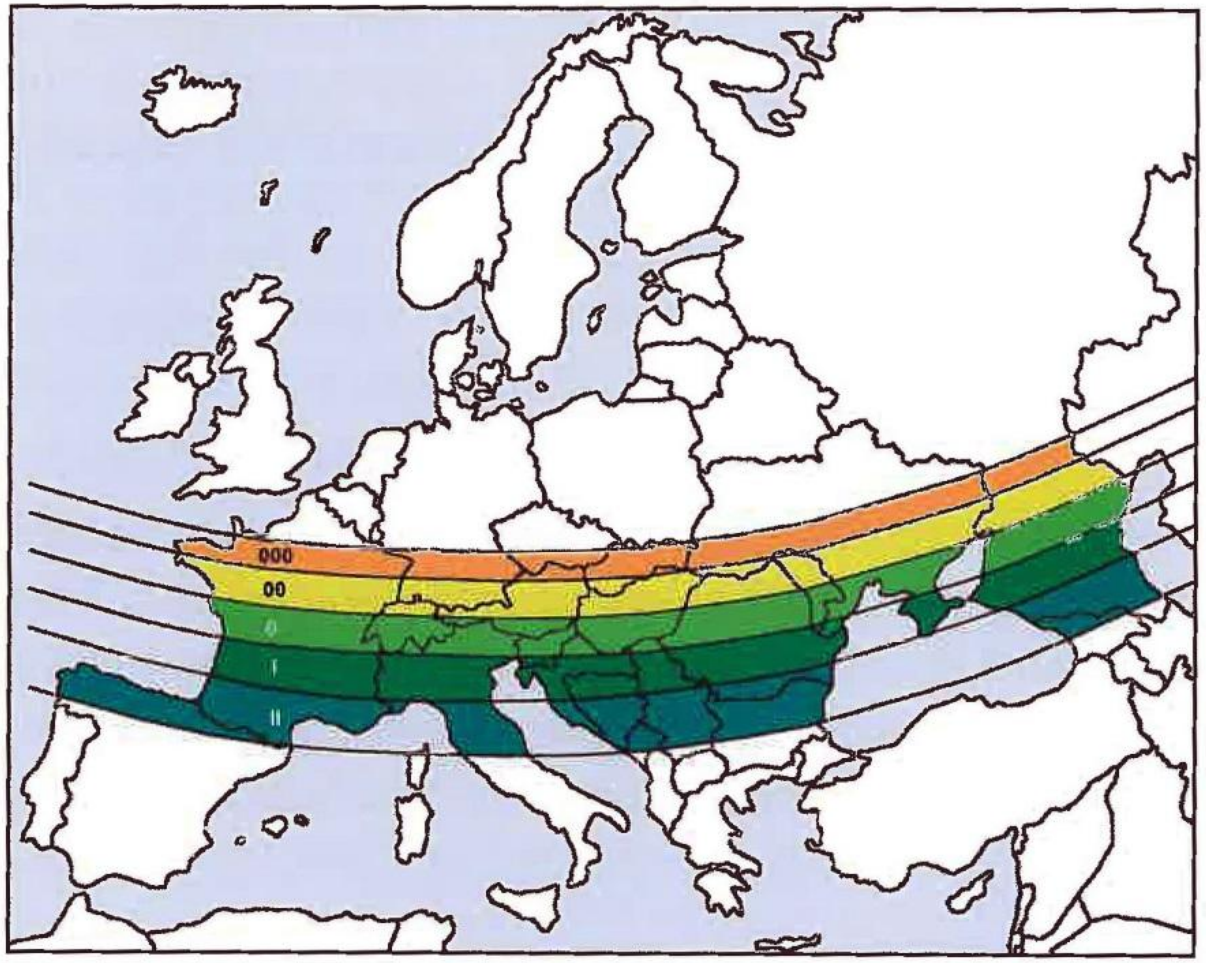
Needs

- Yield performance
- Appropriate flowering / maturity
- Drought tolerance in south and central Europe
- Cold tolerance in north and central Europe

Strategies

Yield trials in different target regions

- MG 000 and 0000: High-latitude long-day environments, northern Europe
- MG 00: Central European conditions
- MG 0-I: Cultivars for low-latitudes, southern Europe



Source: Miladinovic (2011)

Task 1.2: Breeding for yield and adaptation

Yield trials 2024, 2025

Y1 (MG 000/0000): n=60 genotypes

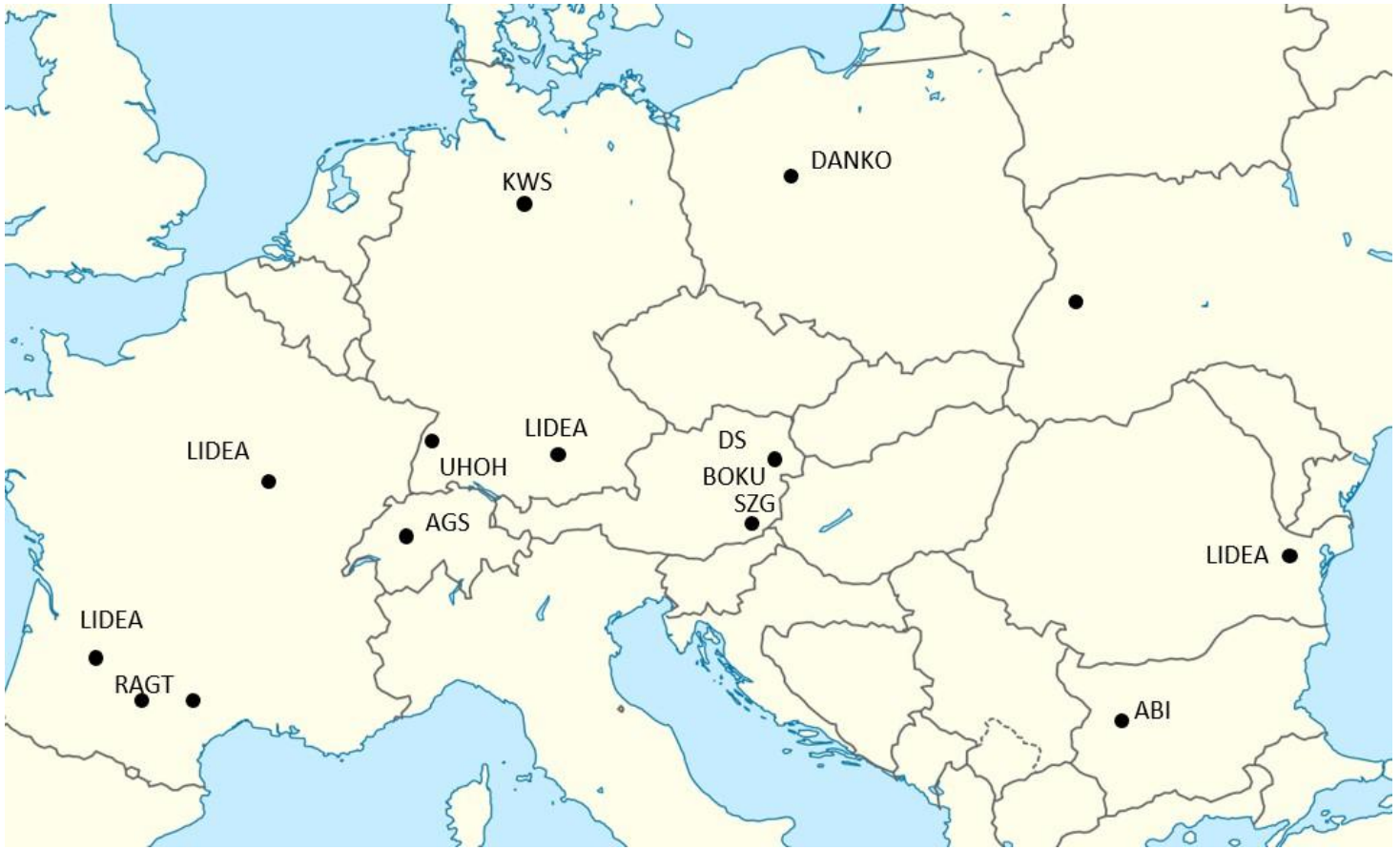
MG 00: n=45 genotypes

MG 0-I: n=30 genotypes

Locations: Covering soybean target regions in different latitudes

Measurements

Agronomic characters, harvest quality, digital phenotyping, physiological traits, genotyping with new marker panel etc.

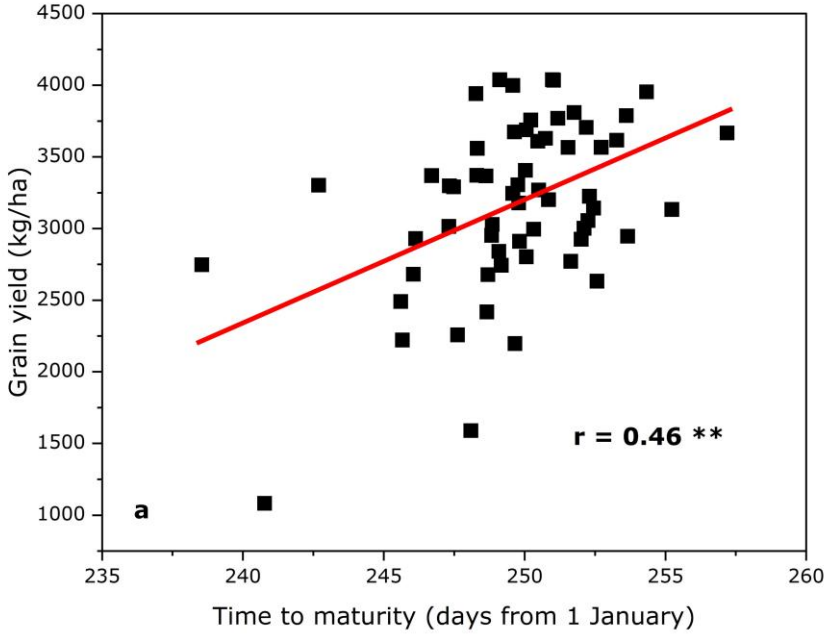


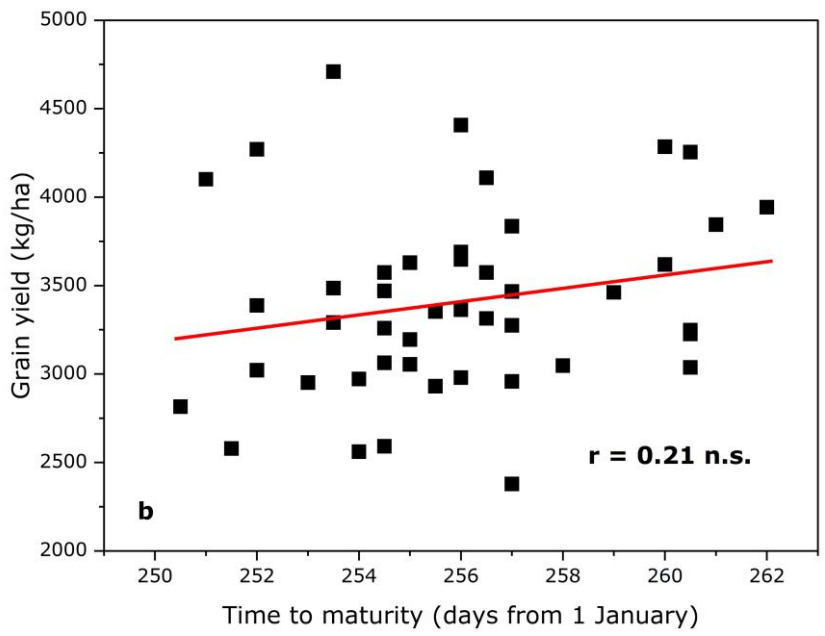
Legume Generation soybean experimental sites

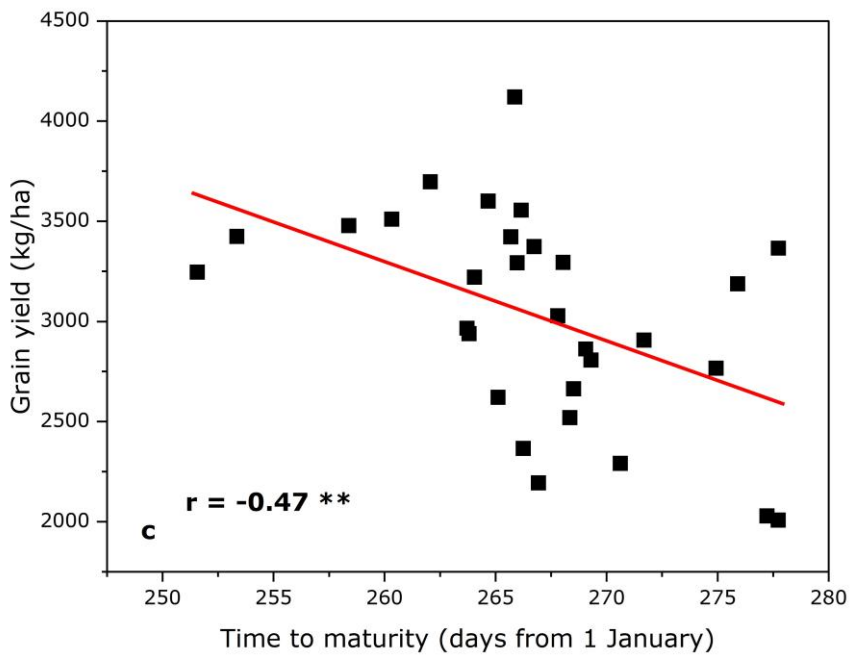
Task 1.2: Breeding for yield and adaptation

Differences in maturity between genotypes and experiments (Tulln, Austria, 2024)

Time to maturity and yield: Adaptation to a given environment

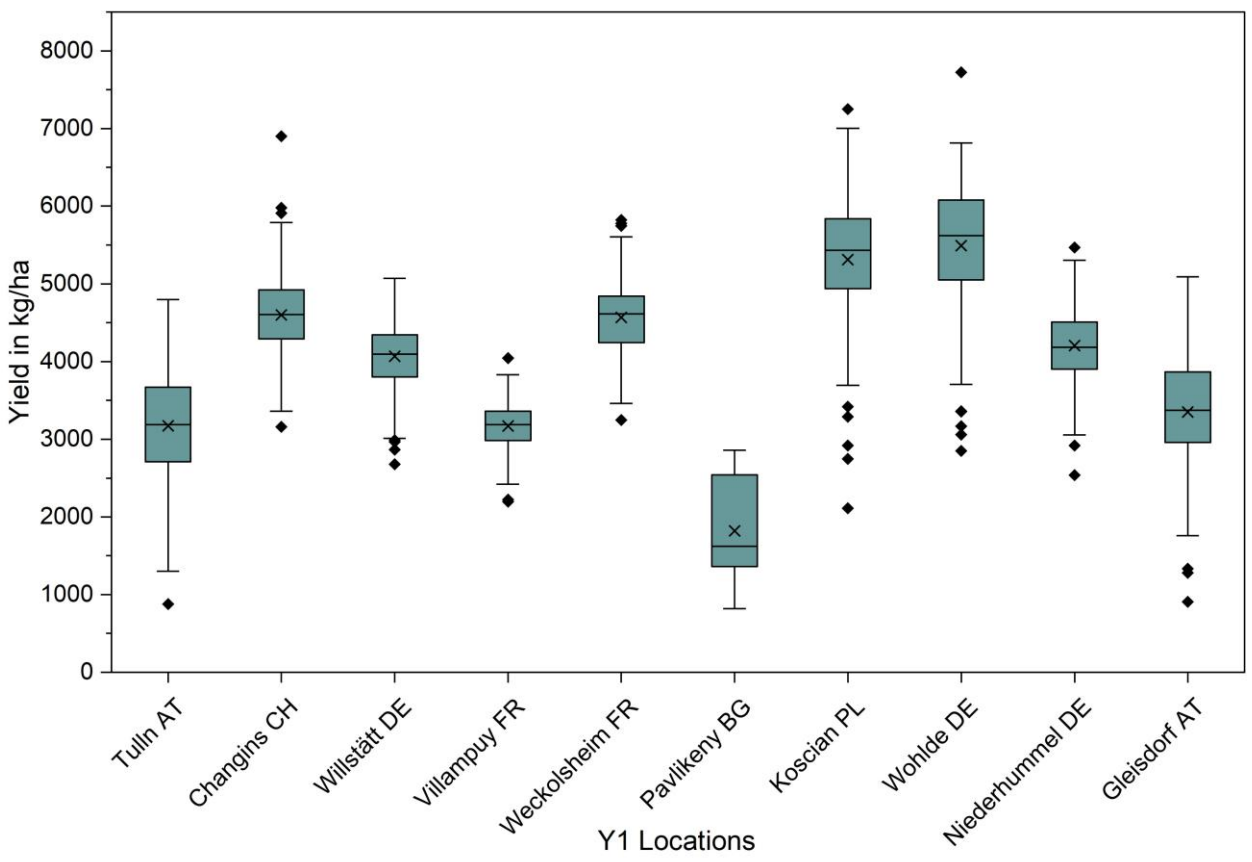


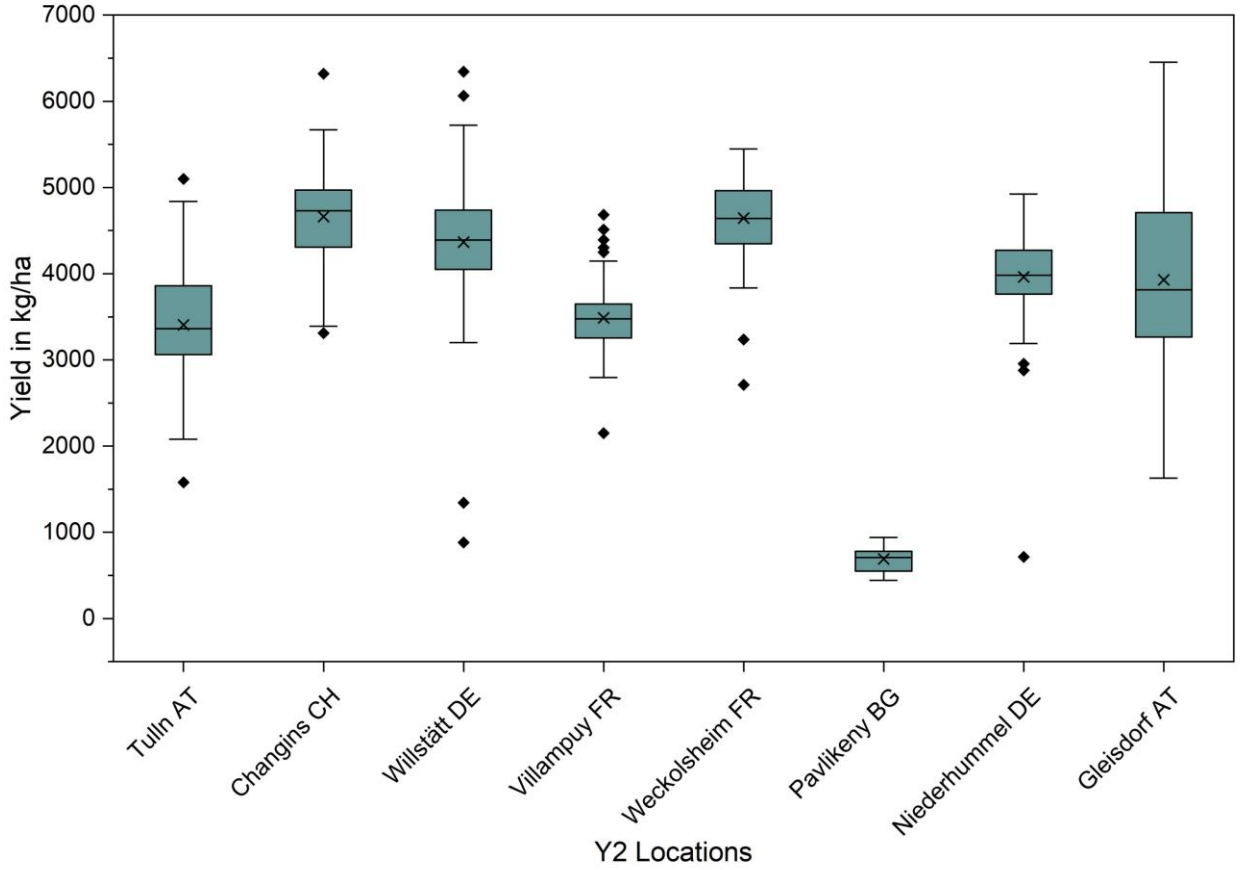




Correlation between time to maturity and grain yield in the early (a), mid early (b) and late (c) sets of genotypes (Tulln, Austria, 2024)

Yield performance at given environments

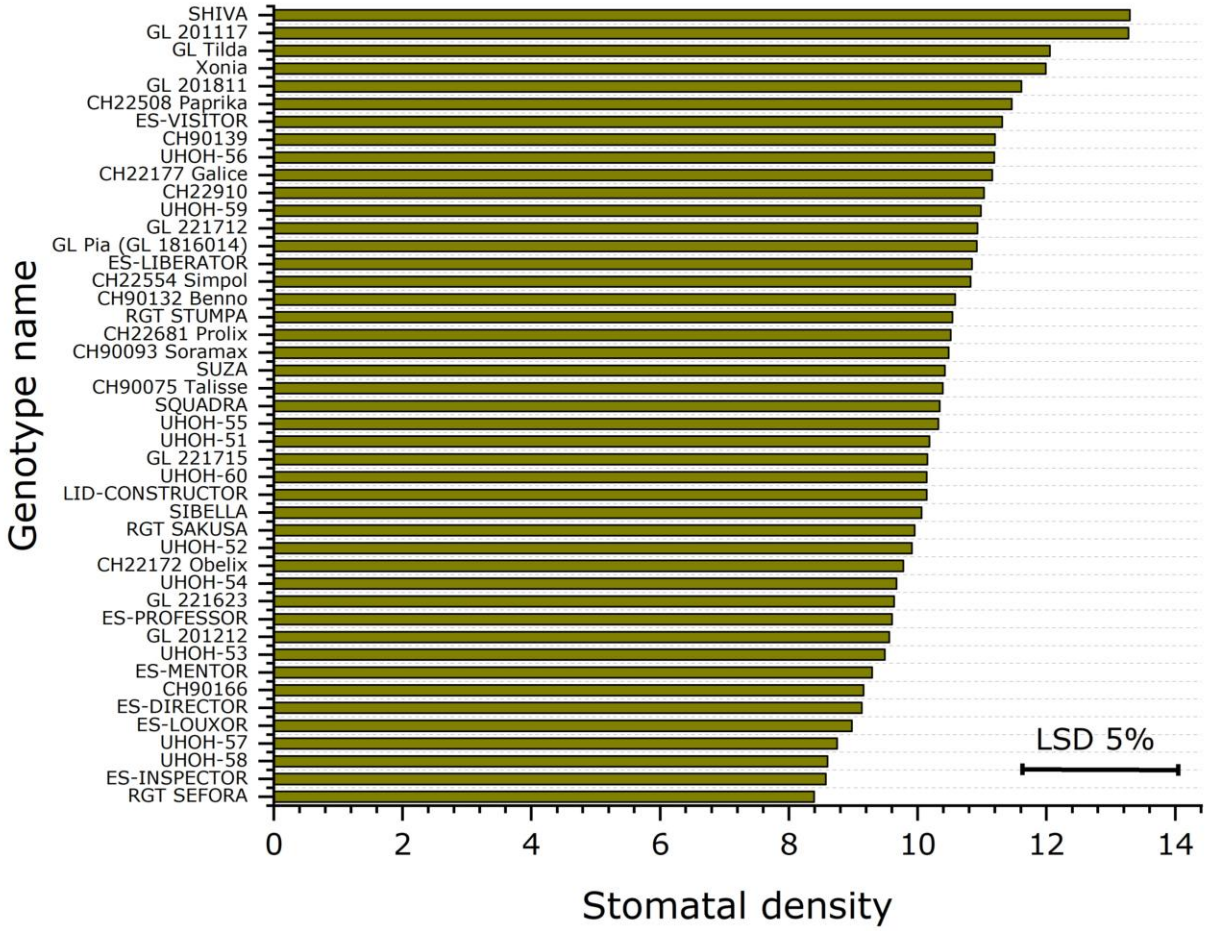




Early and mid early plot yield ranges across test environments in 2024

Drought stress adaptation

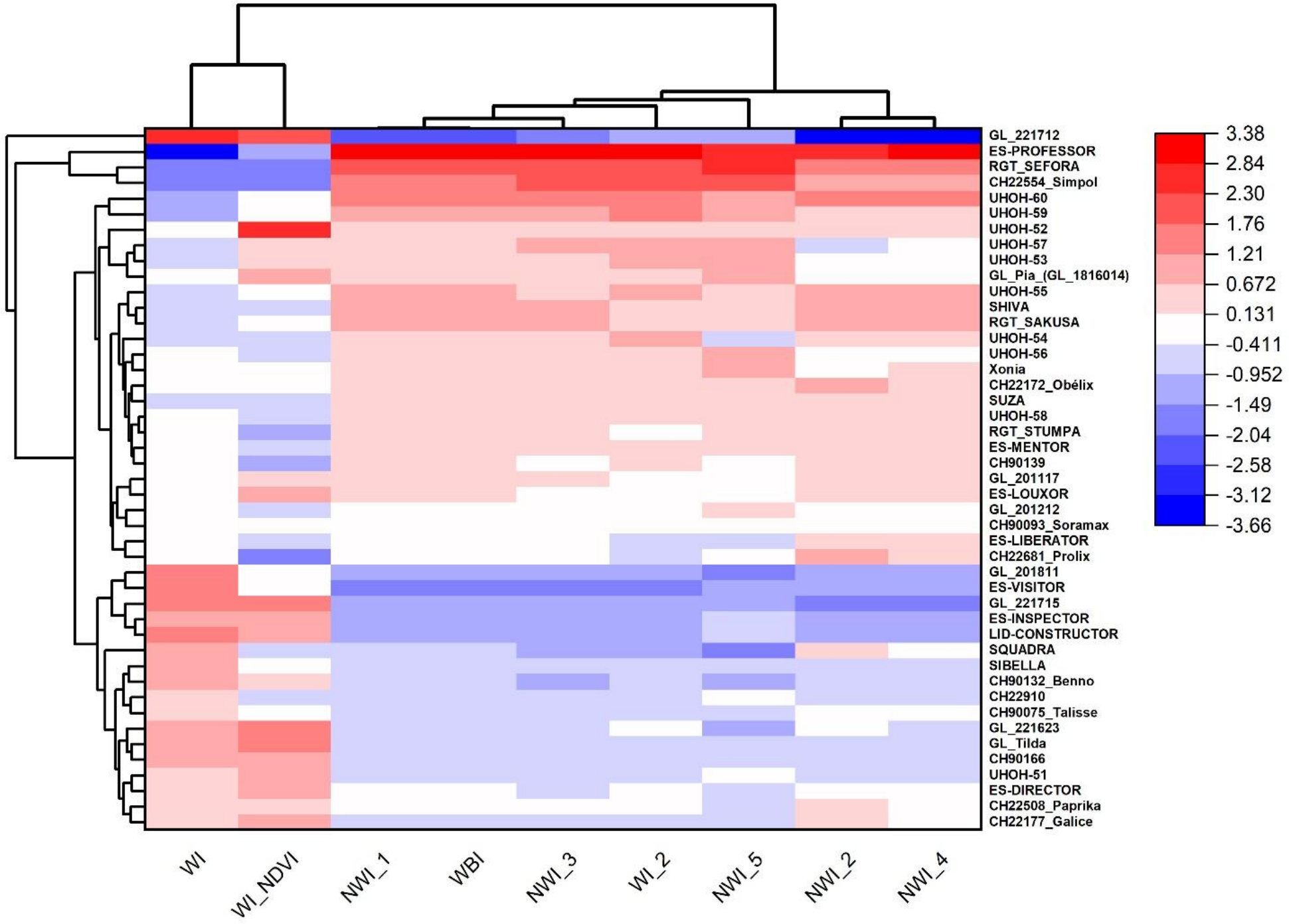
Digital phenotyping: Hyperspectral reflectance is recorded in the field. Over 40 different indices can be calculated from spectral data describing biomass accumulation, water status or nitrogen metabolism (N_2-fixation) etc.



Grouping of genotypes of the Y2 (MG 00) set according to leaf stomatal density (number of stomata per 0.04 mm^2)

Drought stress adaptation

Grouping of genotypes of the Y2 (MG 00) set according to nine **spectral water indices** describing differences in water status of genotypes (Tulln, Austria, 2024)

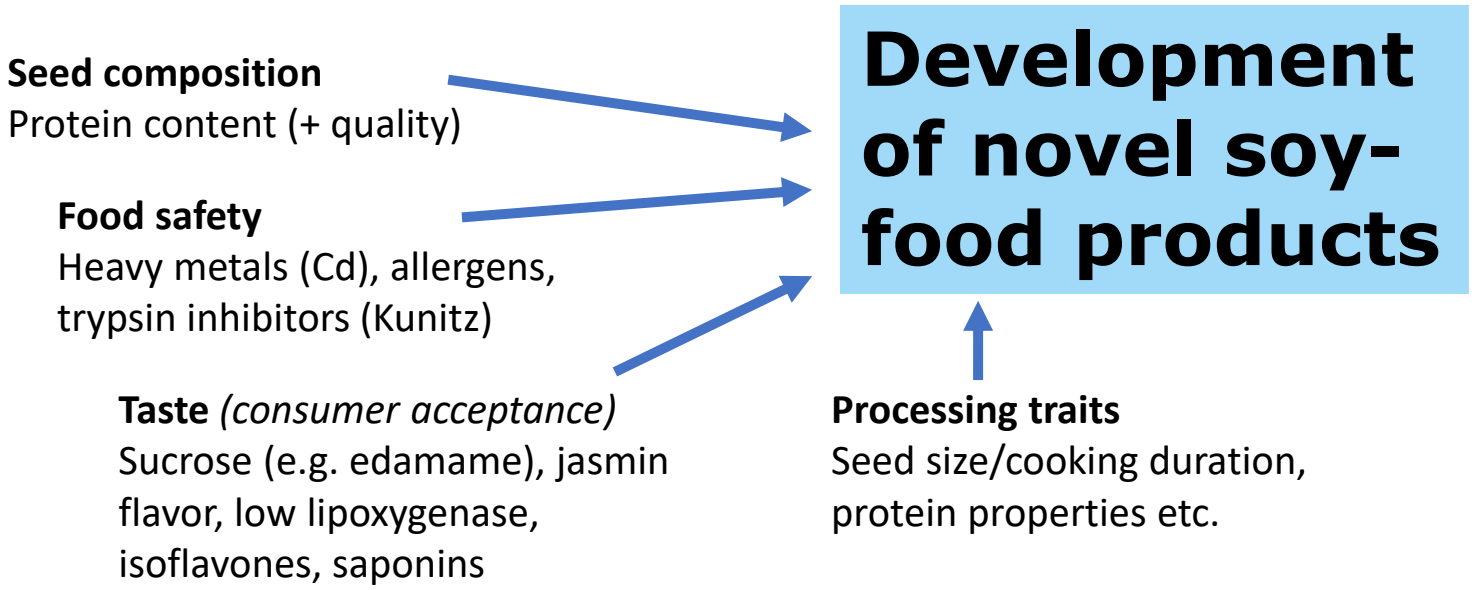


Task 1.3: Breeding for specific food-grade quality traits

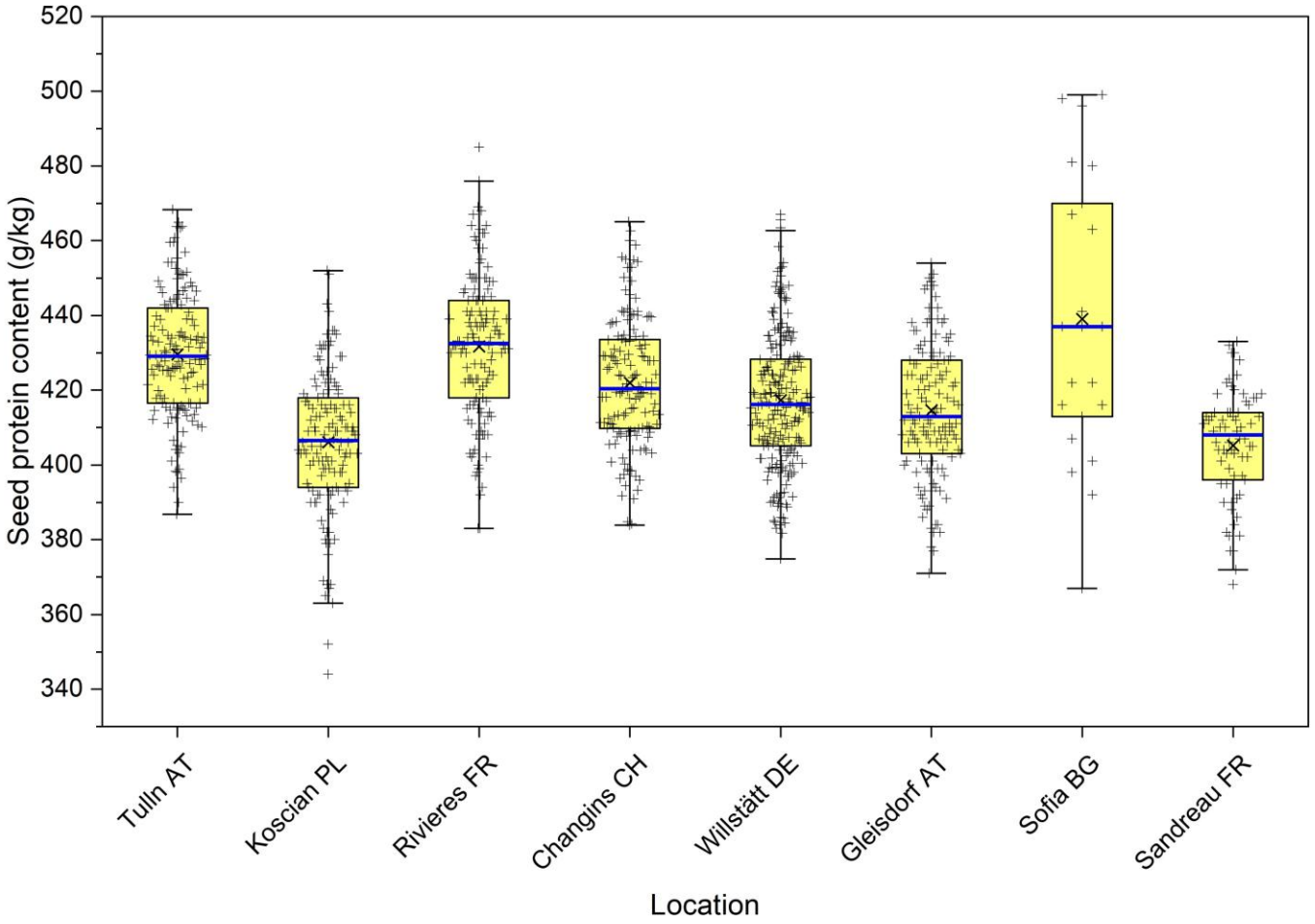
Legume Generation

Germplasm: Existing cultivars, new germplasm/lines with special features

Food-grade breeding goals: **"Generic traits"**

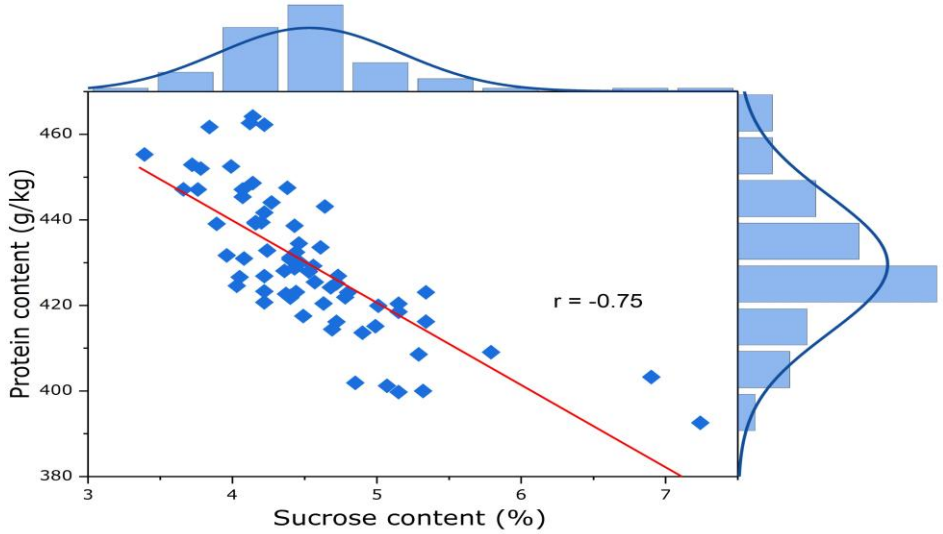


Food-grade soybeans



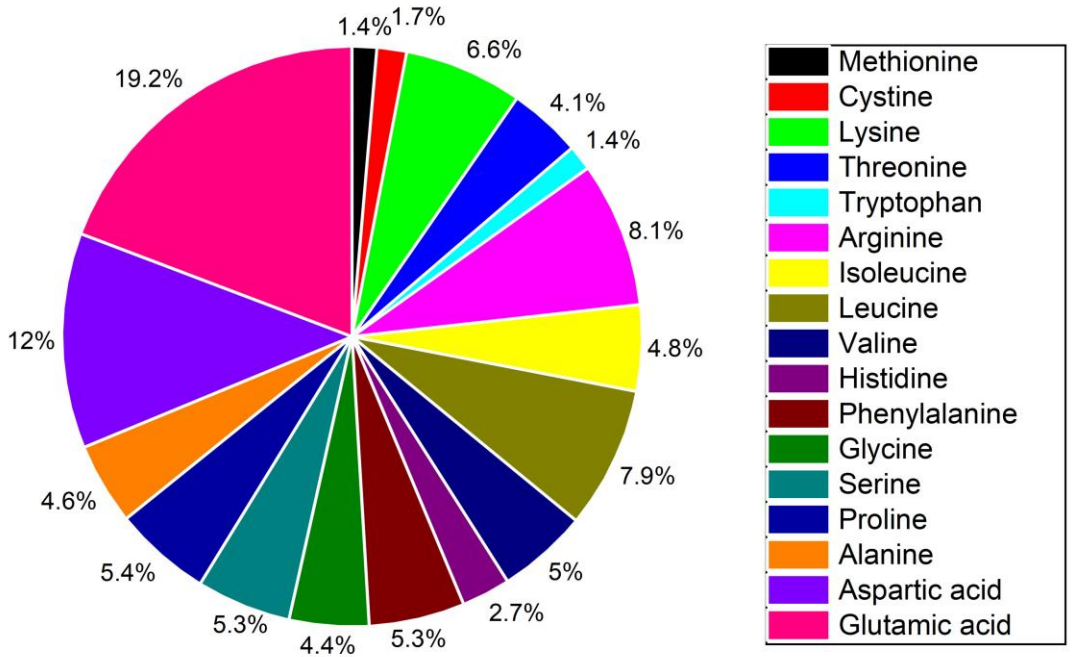
Variation in seed protein content of food-grade soybeans across environments

Phenotypic diversity of food-grade soybeans

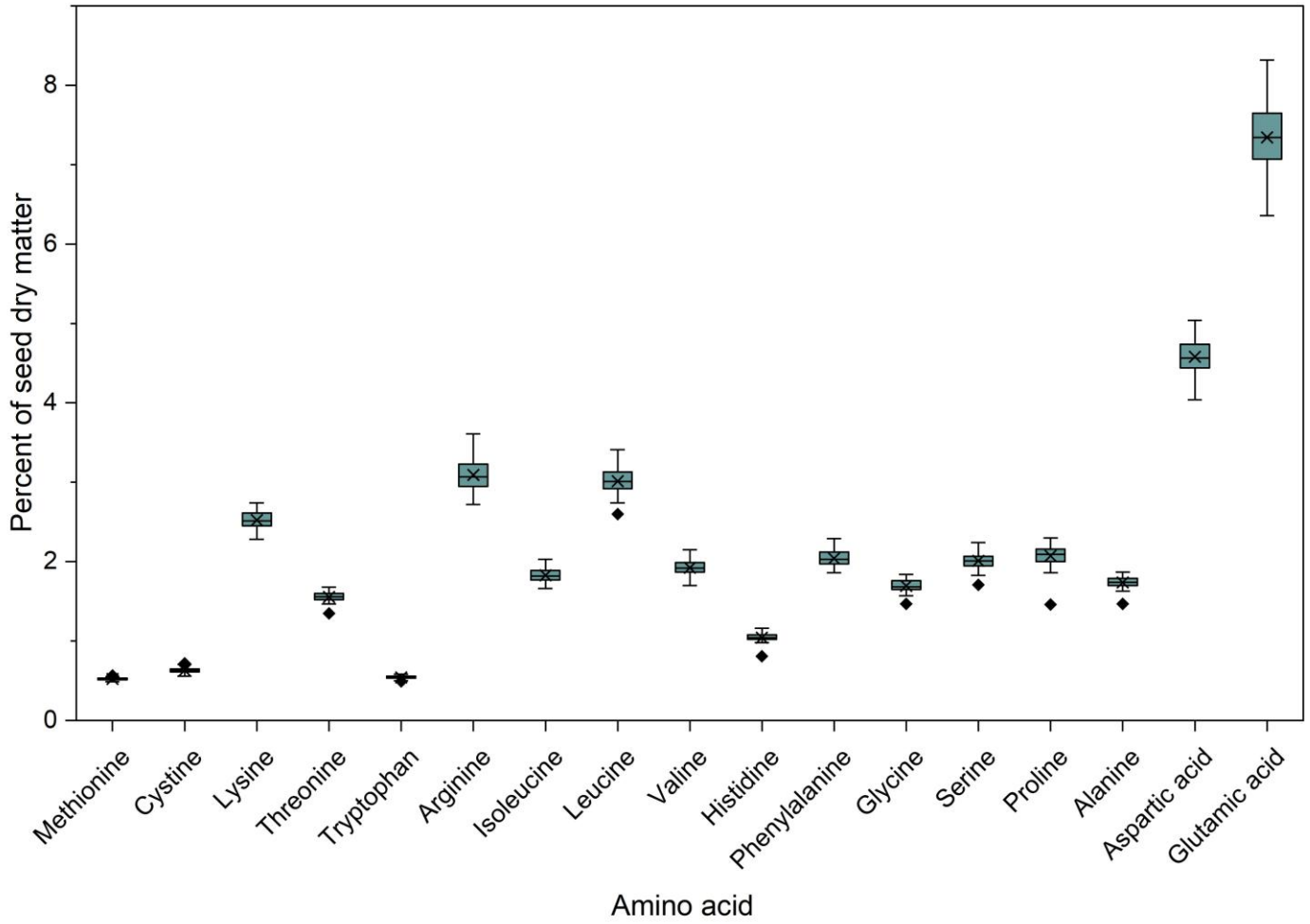


Seed sucrose vs. seed protein content in food-grade soybeans

Food-grade soybeans



Overall amino acid composition in food-grade soybeans



Genetic variation for individual amino acid concentration in a food-grade soybean set

Other achievements and looking ahead:

Genotyping

New marker panel with 5000+ markers optimized for European breeding materials including 355 trait-specific loci (Flex-Seq™ by LGC Biosearch Technologies)

Major steps ahead in 2025

- Completion of genotyping and analysis of genetic data
- Further phenotyping (CID, hyperspectral analysis) and quality analyses (amino acid profiles, saponins etc.)
- Innovation community dialogue with stakeholders (through plant breeding associations, Donau Soja and other platforms)

Thank you for your attention!

Legume Generation (Boosting innovation in breeding for the next generation of legume crops for Europe) has received funding from the European Union through Horizon Europe under grant agreement number 101081329

www.legumegeneration.eu

www.legumehub.eu