EUCLEG Horizon 2020

Food Security, Sustainable Agriculture and Forestry, Maritime and Inland Water Research and the Bioeconomy

EUCLEG

Breeding forage and grain legumes to increase EU's and China's protein self-sufficiency

- Call: **Sustainable Food Security – Resilient and resource-efficient value chains**
- Topics: **SFS-44-2016: A joint plant breeding programme to decrease the EU's and China's dependency on protein imports**
- Coordinator: **Dr. Bernadette Julier – INRA**
- **EU funding: €5 mio.**

EUCLEG will develop improved breeding strategies for species that are commercially important for highly efficient protein production and provide numerous ecosystem services. The project focuses on two main forage species alfalfa and red clover and three-grain species pea, fababean and soybean.

DLF is involved in the two forage species alfalfa and red clover (main WP3 and WP4) and its main interest is

- to test some of the commercially available varieties in different climate (also China) for productivity, yield stability and protein quality
- to enlarge the available genepool for future breeding initiatives
- develop together with partners genotyping by sequencing (GBS) platforms for forage legumes to analyse the genetic architecture of key breeding traits using association studies based on candidate genes and genome-wide association studies (GWAS)

BREEDING FORAGE AND GRAIN LEGUMES to increase EU's and China's protein self-sufficiency

<u>Objectives</u>

The objective is to

- improve diversification of crops
- crop productivity
- yield stability and
- protein quality of both forage (alfalfa and red clover) and grain (pea, faba bean and soybean) legumes.

EUCLEG will investigate the potential for new uses of forage species for human nutrition. Processed protein extracts have a good nutritive value for human consumption in terms of plant protein intake (amino acid composition close to that of dairy milk). It could be an alternative to meat and milk alleviating negative impacts of agriculture on the environment.

37 partners
INRA is coordinator

N°	Participant organisation name	Country	
1.	Institut National de la Recherche Agronomique – INRA (Coordinator), Res	France	www.inra.fr
2.	Aberystwyth University (IBERS), He, Res	UK	www.aber.ac.uk
3.	Agricultural Research, LTd. (ART), SME	Czech Rep.	www.vupt.cz
4.	Agro Seed Research bvba (Agro Seed Research), SME	Belgium	www.stormseeds.com
5.	Agrovegetal S.A. (Agrovegetal), SME	Spain	www.agrovegetal.com
6.	Boreal Kasvinjalostus Oy (Boreal), SME	Finland	www.boreal.fi
7.	Chinese Academy of Agricultural Science Institute of Grassland Research (CAAS-IGR), Res	China	www.gricaas.net
8.	Crop Tillage and Cultivation Institute, Heilongjiang Academy of Agricultural Sciences (HAAS), Res	China	
9.	DLF SEEDS AS (DLF Seeds), Ind	Denmark	www.dlf.com
10.	Eidgenössisches Departement für Wirtschaft, Bildung und Forschung (WBF), Res	Switzerland	www.wbf.admin.ch
11.	Graminor AS (Graminor), SME	Norway	www.graminor.no
12.	Inner Mongolia Agricultural University (IMAU), He, Res	China	
13.	INRA Transfert S.A. (IT), Other	France	www.inra-transfert.fr
14.	Institut Za Ratarstvo I Povrtarstvo (IFVCNS), Res	Serbia	www.nsseme.com
15.	Institute for forage crops Ltd Kruševac (IKBKS), Res	Serbia	www.ikbks.com
16.	Institute of Animal Science, Chinese Academy of Agricultural Sciences (CAAS-IAS), Res	China	
17.	Instituto Andaluz de Investigaciony Formacion Agraria Pesquera Alimentaria y de la Produccion Ecologica (IFAPA), Res	Spain	www.ifapa.es
18.	International Plant Genetic Resources Institute (IPGRI), Res	Italy	www.fao.org
19.	Jiangsu Academy of Agricultural Sciences (JAAS), He, Re	China	www.jaas.ac.cn
20.	Jouffray Drillaud (JD), SME	France	www.jouffray-drillaud.com
21.	Julius Kühn-Institut Bundesforschungsinstitut für Kulturpflanzen (JKI), Res	Germany	www.julius-kuehn.de
22.	Lantmännen Ekonomisk Forening (Lantmännen), Ind	Sweden	lantmannen.com
23.	Leibniz - Institut für Pflanzengenetik und Kulturpflanzenforschung (IPK), Res	Germany	www.ipk-gatersleben.de
24.	Nanjing Agricultural University (NJAU), He	China	www.njau.edu.cn
25.	Nordiskt Genresurscenter (NordGen), Res	Sweden	
26.	Norges Miljo-og Biovitenskaplige Universitet (NMBU), He	Norway	www.nmbu.no
27.	North-East Agricultural University (NEAU), He	China	www.neau.cn
28.	Northeast Institute of Geography and Agroecology, Chinese Academy of Sciences (CAS-IGA), Res	China	www.nwsuaf.edu.cn
29.	Northwest A&F University (NWAFU), He	China	
30.	Progeno BVBA (Progeno), SME	Belgium	www.progeno.net
31.	Shanxi Agricultural University (SXAU), He	China	www.sxau.edu.cn
32.	Société RAGT 2n SAS (RAGT), Ind	France	www.ragt.fr
33.	Tourneur grandes cultures (Barenbrug), SME	France	www.barenbrug.be
34.	Universiteit Gent (UGENT), He, Res	Belgium	www.ugent.be
35.	VIB (VIB), Res	Belgium	www.irc.ugent.be
36.	Vlaams Gewest (ILVO), Res	Belgium	www.ilvo.vlaanderen.be
37.	Zhejiang Academy Agricultural Sciences (ZAAS), Res	China	www.zaas.ac.cn

Test sites and crops:

Project objectives:

- **DEVELOP MOLECULAR DATA**
  Develop molecular data (reference genome sequence, sequence polymorphism) and tools (high throughput genotyping through genotyping by sequencing (GBS) platforms for forage legumes and faba bean), to increase resource levels sufficiently for molecular breeding. These new markers in addition to single nucleotide polymorphism (SNP) arrays already available for pea and soybean will be used to inform us of genetic diversity and to improve the efficiency of breeding programmes.
- **DEVELOP SEARCHABLE DATABASES**
  Develop searchable databases containing passport data, as well as agronomic and genetic features in order to facilitate exchanges of genetic resources between Europe and China.
- **BROADEN THE GENETIC BASE AND ANALYSE THE GENETIC DIVERSITY OF PROMISING EUROPEAN AND CHINESE LEGUME ACCESSIONS**
  Broaden the genetic base of legume crops and analyse the genetic diversity of promising European and Chinese legume accessions using (1) phenotypic traits that contribute to increase yield, quality, stress tolerance evaluated in multi-site trials and (2) molecular markers.
- **ANALYSE THE GENETIC ARCHITECTURE**
  Analyse the genetic architecture of key breeding traits using association studies based on candidate genes and genome-wide association studies (GWAS). Molecular markers related to phenotypic traits will be identified.
- **INCREASE GENETIC PROGRESS IN EXISTING BREEDING PROGRAMMES**
  Increase genetic progress in existing breeding programmes. Genomic selection (GS) strategies will be developed and assessed for their potential to improve genetic progress. Practical tools for genotyping, data management and calculation will be

provided to breeders to implement marker-assisted selection including genomic selection leading to the creation of new varieties in the long-term.

Legume advantages:

Legumes are the most widespread fodder crops on arable land, and they are also the best intercrops in agriculture. Legumes are very important in forage production, and they also have many positive environmental effects, primarily:

- nitrogen fixation, approximately 120-220 kg of nitrogen per hectare are fixed through the symbiosis with Rhizobium bacteria on the roots of legumes,
- effective carbon sequestration,
- improvement of physio-chemical soil properties,
- positive phytosanitary effect,
- deep root system penetrating compacted soils that improves soil resistance and protects it against erosion.

FORAGE LEGUMES ADVANTAGES

Forage legumes:

- provide high quality animal feed in the form of green mass, silage, concentrates, pellets and hay,
- are an essential part of legume-grass mixtures on meadows and pastures,
- provide a nectar source for pollinators, and are a food source for wild animals.

GRAIN LEGUMES ADVANTAGES

Grain legumes:

- are essential sources of minerals, vitamins, lecithin, fibre, and other healthy elements,
- can be effectively used in intercropping systems with cereals,
- seeds produce high protein food sources for human and animal nutrition,
- green pods and seeds are used as vegetables.

Alfalfa

Alfalfa (or lucerne in British English), Medicago sativa, is a perennial herbaceous forage legume, grown in pure stands or in mixtures with perennial grasses (tall fescue, cocks-foot). It is grown worldwide except the tropical areas. This species produces the highest protein yield per hectare under temperate climates.

Besides the protein content and forage production, it has other advantages for ruminant nutrition (mineral content, fiber content against acidosis…), agronomy (soil structure and nitrogen content), and environment (water quality, energy saving, reduced phytosanitary inputs).

It is mainly harvested as hay, bales or dehydrated, but grazing is also possible. As an outcrossing species pollinated by insects and polyploidy species (2n = 4x = 32), alfalfa varieties are synthetic populations.

Red clover

Red clover, Trifolium pratense L., is a perennial herbaceous forage legume, predominantly grown as roughage in ruminant based livestock systems.

It is highly valued thanks to its high nutritive value and its ability to fix atmospheric nitrogen.

Red clover is a bee-pollinated, outcrossing and diploid (2n = 2x = 14) species with a gametophytic self-incompatibility system. Grass-red clover leys play an important role in crop rotation and the species is also found in permanent pastures and meadows of temperate regions.