Context of Protein Crops Report: improve profitability of European Protein Crops while satisfying feed(food) industries’ requirements and promoting sustainable cropping systems

Recommendations:

- Increase soybean production
- Enhance range of protein crops grown
- Work to overcome financial gap of starch and oilseed-based protein crops in Europe
- Distinguish intensive (feed) and extensive (locally-grown food) production

Other propositions:

- Increase cooperation between actors concerned
- Focus R and D on a few crops
- Step-by-step approach including local value chains in transition
- Trait priorities for different protein crops to be identified

LEGumes for the Agriculture of Tomorrow, (LEGATO), an FP7 KBBE project (2014-2017)

http://legato-fp7.eu/

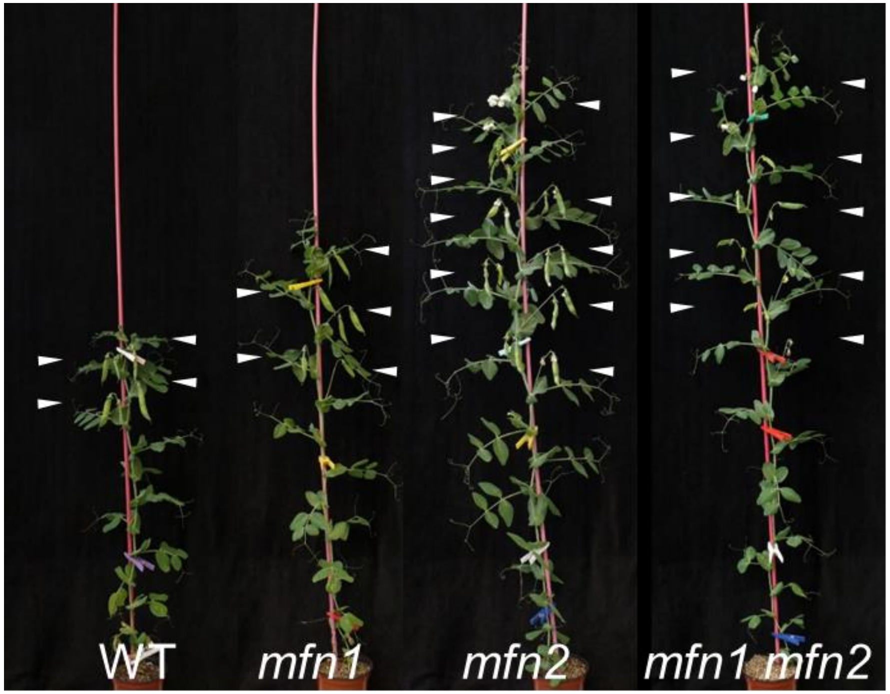
How does LEGATO fit in to the scenario of the EIP-AGRI Protein Crops report?

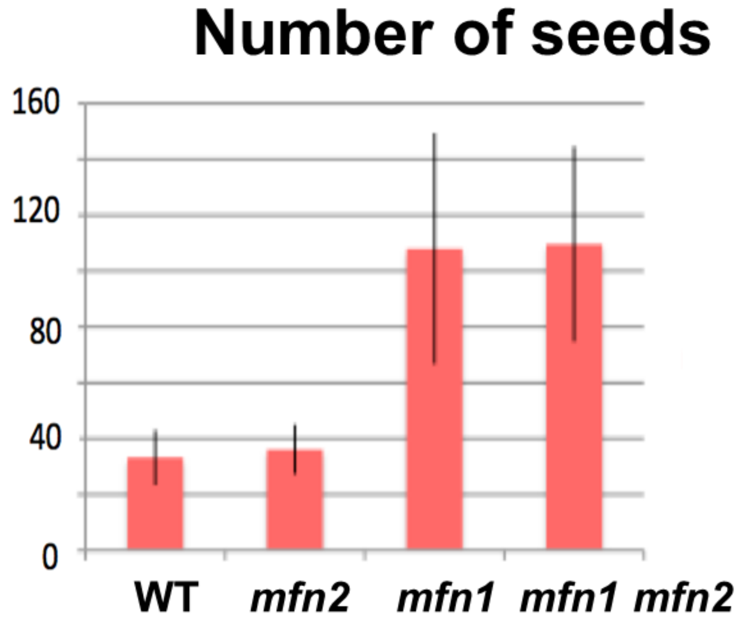
- Project submitted before this report was available, but we have used similar advice from related sources
- The project call oriented most of LEGATO content, eg., to exclude soya
- LEGATO is designed to complement and link pre-existing EU and national projects, not to be a complete response in itself

➢ What's new in LEGATO?

WP1 Genetics: New Breeding tools and material

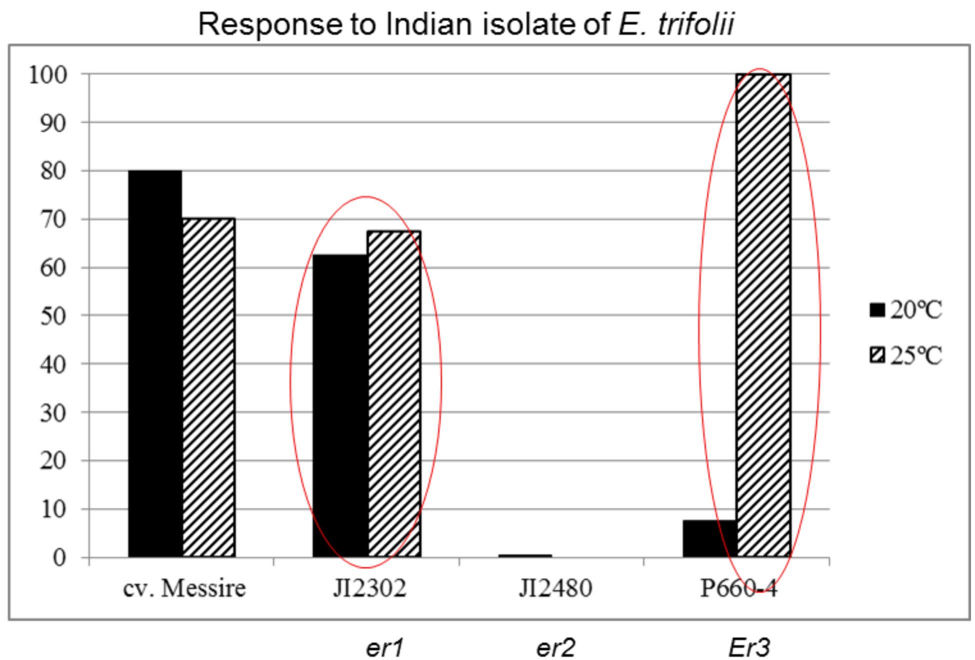
- Exploit NGS: Pea genomic seq. expected by 2017, already RNAseq and partial genomic seq available.
- Develop CSS lines to support genome assembly and introgression of genes from wild ecotypes (fulvum, elatius).
- Test utility of *more flowering node* locus, develop markers for autofertility in faba bean and for several antinutritionals





WP2: Novel sources of resistance to pests and diseases

- Evaluation of resistance to Weevils: bruchid and sitona;
- Novel types of fungal and parasitic weed resistance (pre-penetration, non-host, recessive mlo-type)



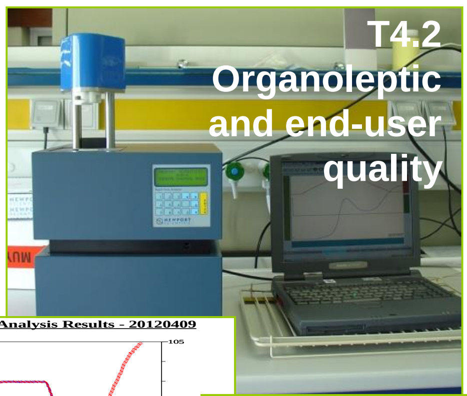
CSIC

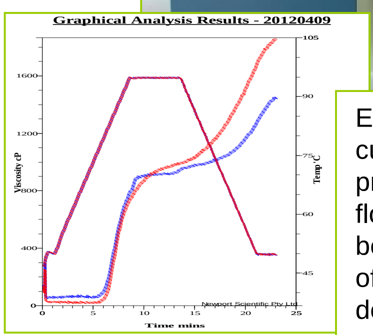
WP3 Optimizing plant adaptation to abiotic stress

- Objective: design ideotypes tolerant to end-of-season drought stress, using state-of-the-art techniques (rhizotube, MRI/PET),
- Non-invasive methods for assessing root and nodule growth and metabolism under stress.
- In parallel, genotypes differing in drought tolerance (from Reforma, Medileg, Arimnet) will be studied using an ecophysiological framework.

WP4 Defining traits adapted to consumers' expectations

- Chemical-physical, organoleptic and rheological/end-user analyses of a collection of the most important culinary grain legumes – most important traits identified on the basis of consumer sensorial analysis of legume-based foods.
- Consumer behavior also assessed using experimental markets (auctions). 2 SMEs producing legume-containing foodstuffs involved.





Ex: Rapid Visco Analyser curves (rheological properties) from legume flours of whole seeds before soaking (blue) and of cotyledons obtained from dehulled seeds after soaking (red) corresponding to different pasting behavior

Ex: Consumer sensorial analysis of innovative legume based food products such as fortified cereal breads

WP5 Grain legume cropping system management

- Using Multi-attribute Assessment of the Sustainability of Cropping systems (MASC) to design CS adapted to local needs (stakeholders involved at all stages).
- Agronomic performance of GL-based CS in 6 locations (intercrops, varietal mixtures and rotations). Effects on disease and pest incidence also evaluated.
- Evaluating rhizobial inoculation requirement, assessing local rhizobial genotypes at 5 sites.

Photo 1. Ascochyta blight (caused by *Mycosphaerella pinodes*).

WP6 Stakeholder interface for target orientation and practical evaluations

- A Europe-wide trial network of the most promising varieties (12 sites);
- Tests of Marker-Assisted Selection in 4 breeding programmes (2 pea, 2 faba bean)

NEW PERSPECTIVES ON GRAIN LEGUME PRODUCTION AND USES FOR HUMAN CONSUMPTION

Swedish University of Agricultural Sciences (SLU), Alnarp, Sweden, 26th of February 2015.

A one-day workshop, co-organized by the EU-KBBE Project ”LEGATO” (http://legato-fp7.eu/), SLU, and the network for research about legumes “LegSA” (www.slu.se/legumes).

There is increasing recognition of the fact that our dietary habits have important consequences for the sustainable development of agriculture and food systems. In this context, the workshop will attempt to answer questions such as: What potential do home-grown legumes have to supply our protein needs? And how can their consumption be promoted?

Session I Levers for boosting grain legume production and quality within the EU

Session II Optimizing grain legumes for human consumption

Session III Examples of commercial innovation involving grain legumes

Speakers: LEGATO project scientists

Representatives of four SMEs involved in GL product development

Members of the LegSA network

+ Pea genome sequencing initiative

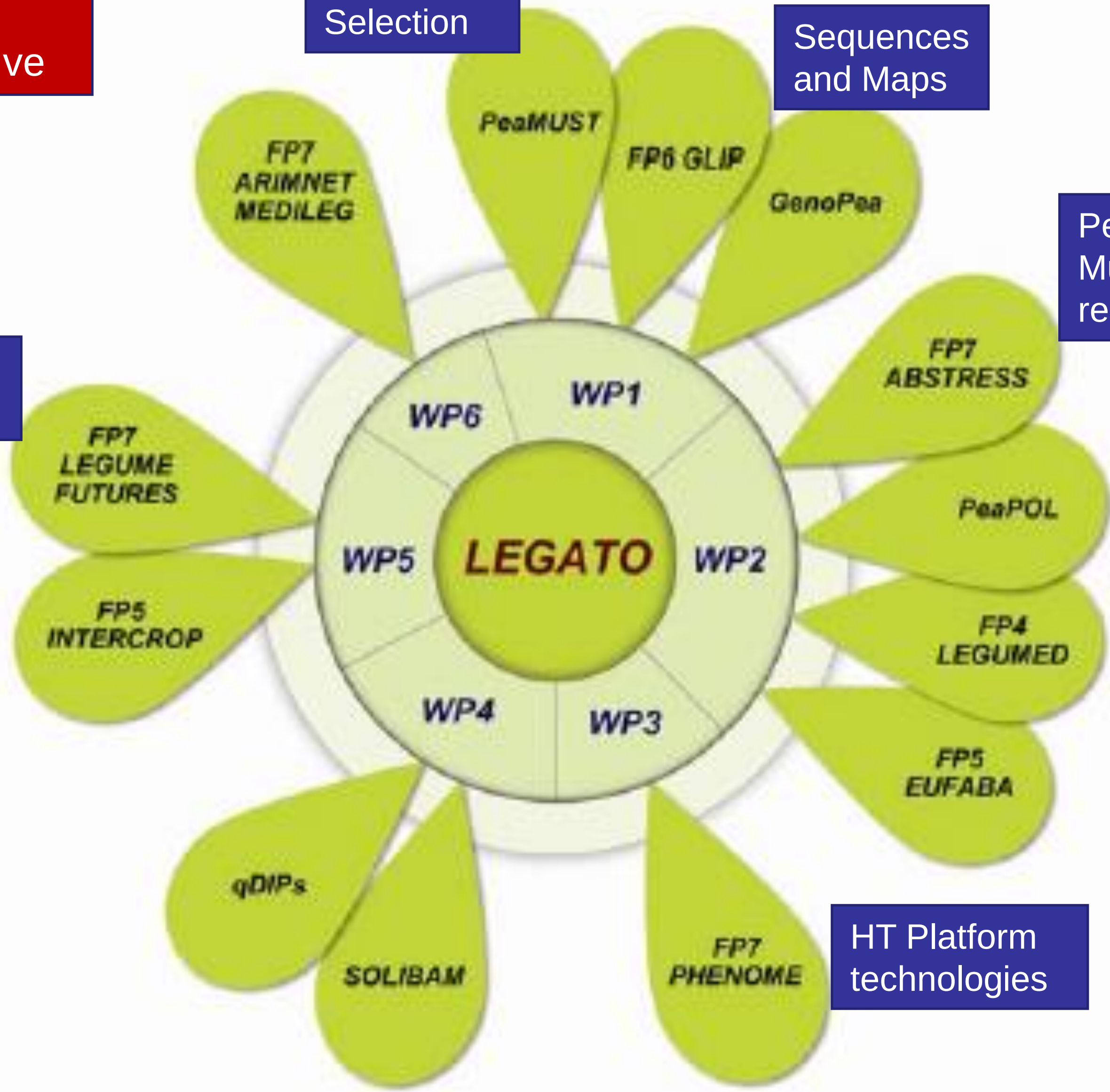
Genomic Selection

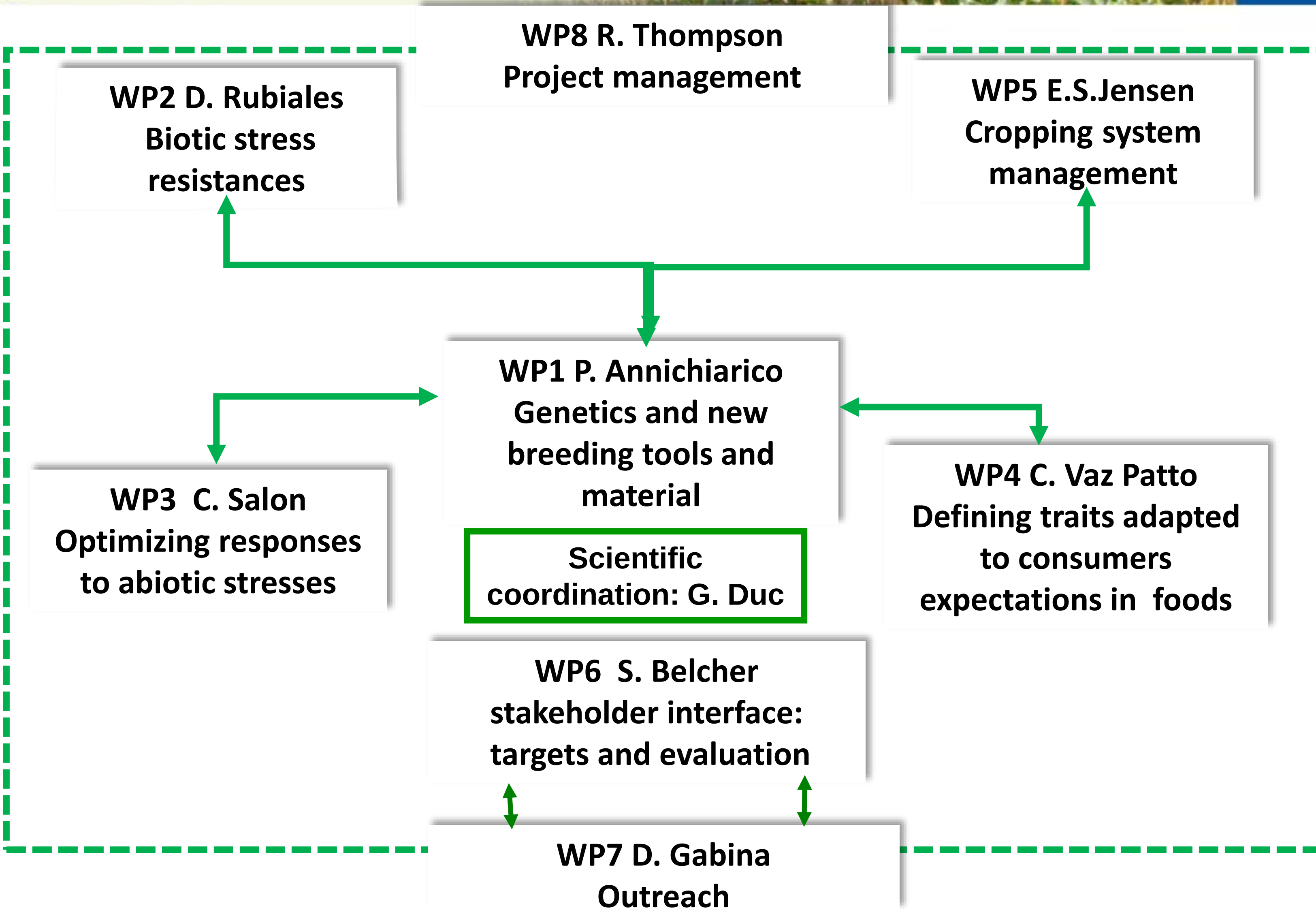
Sequences and Maps

Pea Multistress responses

Ecological Services

HT Platform technologies

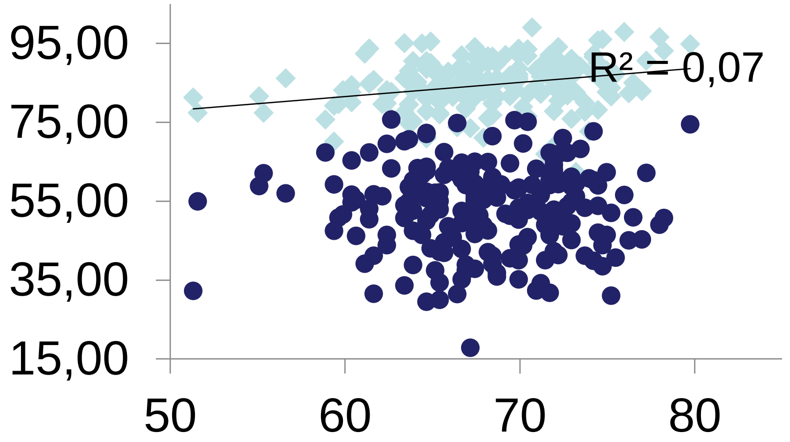



WP8 R. Thompson
Project management
WP2 D. Rubiales
Biotic stress
resistances
WP5 E.S.Jensen
Cropping system
management
WP1 P. Annichiarico
Genetics and new
breeding tools and
material
Scientific
coordination: G. Duc
WP3 C. Salon
Optimizing responses
to abiotic stresses
WP4 C. Vaz Patto
Defining traits adapted
to consumers
expectations in foods
WP6 S. Belcher
stakeholder interface:
targets and evaluation
WP7 D. Gabina
Outreach

What is new in LEGATO?

- Exploit NGS (eg., pea genome sequence data) for marker refinement and test new markers (*mfn*, vicine, autofertility) in breeding programmes (WP1, WP6)
- Focus on previously under-exploited areas (eg., weevil resistance, non-host resistance, gene bank exploitation using new genomic/genetic tools (WP1,2)
- Understand how water stress limits N-fixation in legumes (WP3)
- Explore possibilities for increasing legume uptake in diet including local value chains and considering consumer preferences (WP4)
- Novel GL-based cropping systems including intercropping (WP5)
- Cropping Systems: Relevance for local needs: MASC and Europe-wide trials network (WP6)

Variable yields between sites



Agronomic modelling of pea yield stability

→identify limiting factors

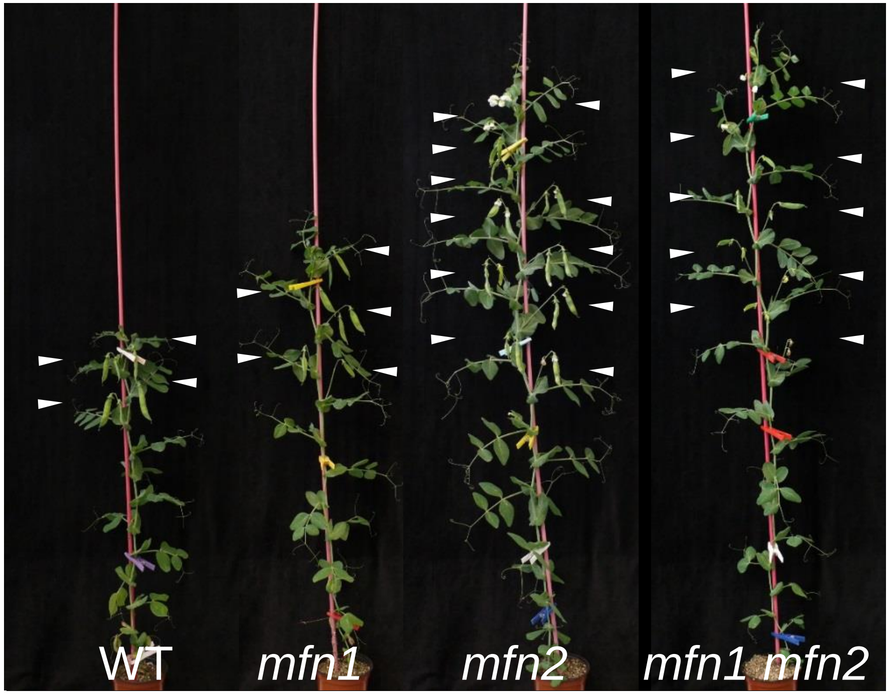
→predict potential yields

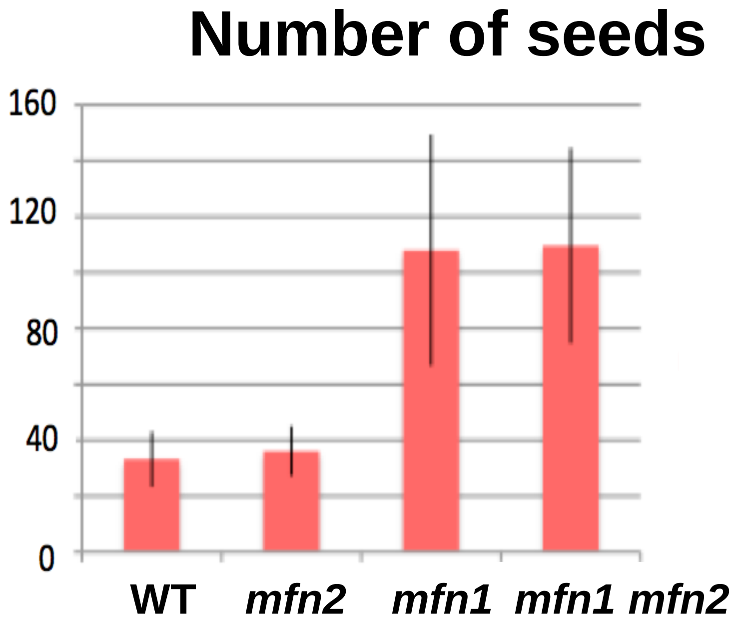
Variety	nr. Trials	Yav	Ymin	Ymax	Y pot	nr limiting factors identified
Isard	**20**	60.41	31.80	87.60	**74.43**	**3**
Cherokee	**18**	58.32	19.10	81.70	**74.90**	**3**
Cartouche	**20**	55.06	33.60	73.00	**85.83**	**6**
886_01	**20**	40.76	15.10	61.10	**59.87**	**4**

(Diagvar programme, courtesy of C. Lecomte)

WP1 Genetics: New Breeding tools and material
-
T1.1 genes potentially regulating yield

Pea *mfn (more flowering node)* mutants control pod and seed number (Madueno et al)





WP1 Genetics: New Breeding tools and Material

T1.2 Marker development and testing

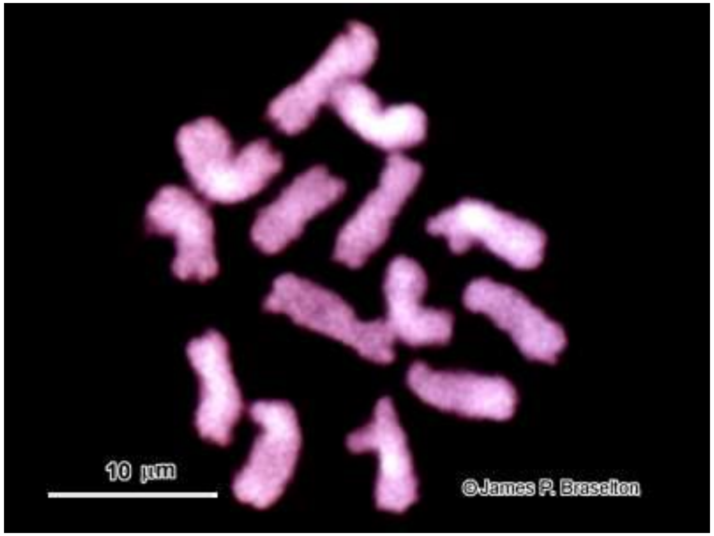
-Development of allele-specific markers
-Assessment of genetic gain from marker-assisted selection in pea

Eg., Grass pea – interest in markers for ODAP concentration

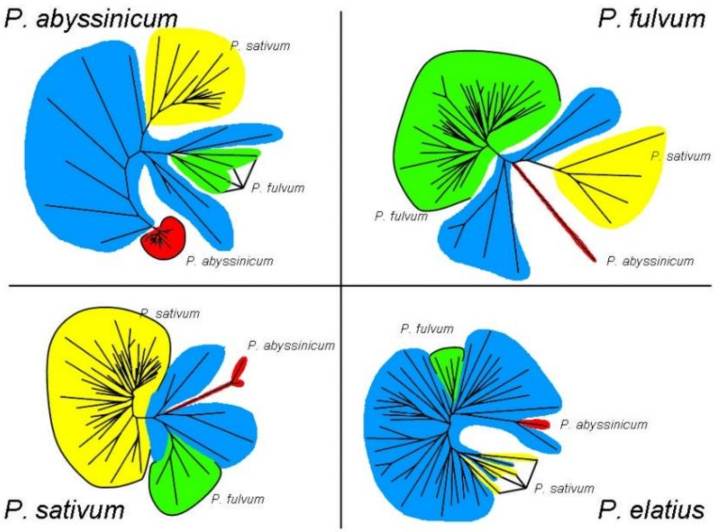
WP1 Genetics: New Breeding tools and material

T1.3 High Density marker collections:

- Chromosome Segment Substitution lines
- high density sequence based genetic map (RAD markers on JI281 x Caméor)



P. sativum karyotype



Phylogenetic relations in JIC Pisum collection

WP2: Novel sources of resistance to pests and diseases

T2.1 Identification of novel sources of resistance

- Components of resistance to broomrape in *Pisum* spp.

	Number of broomrapes per plant
Messire	149
Pf-665	2 ***

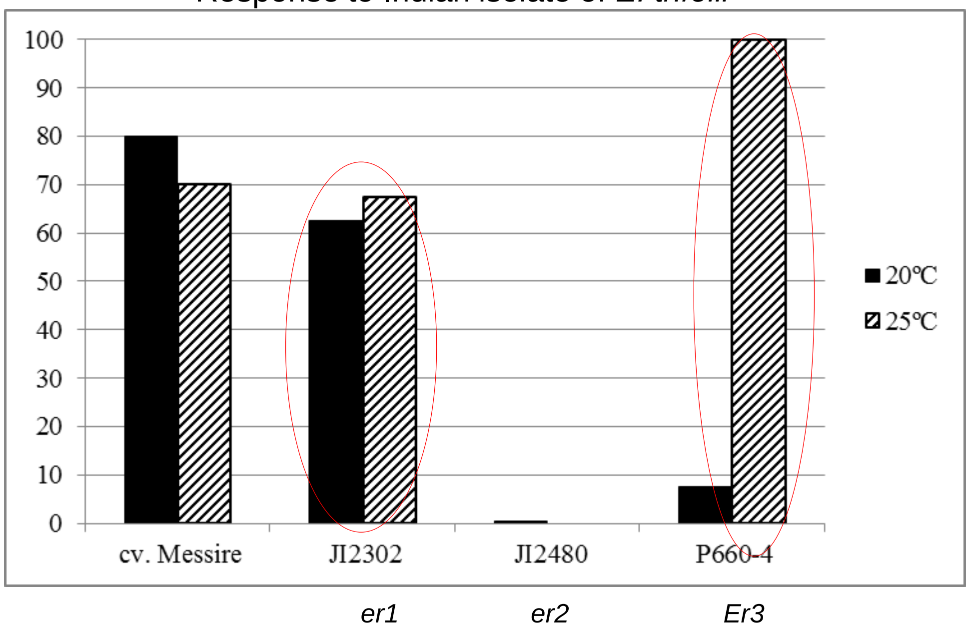
Pea cv with resistance derived from *P. fulvum*

WP2: Novel sources of resistance to pests and diseases:

CSIC

- Genes conferring wide range or Non-host type resistance
  er1 (*mlo* type) provides durable resistance to *E. pisi*

Response to Indian isolate of *E. trifolii*



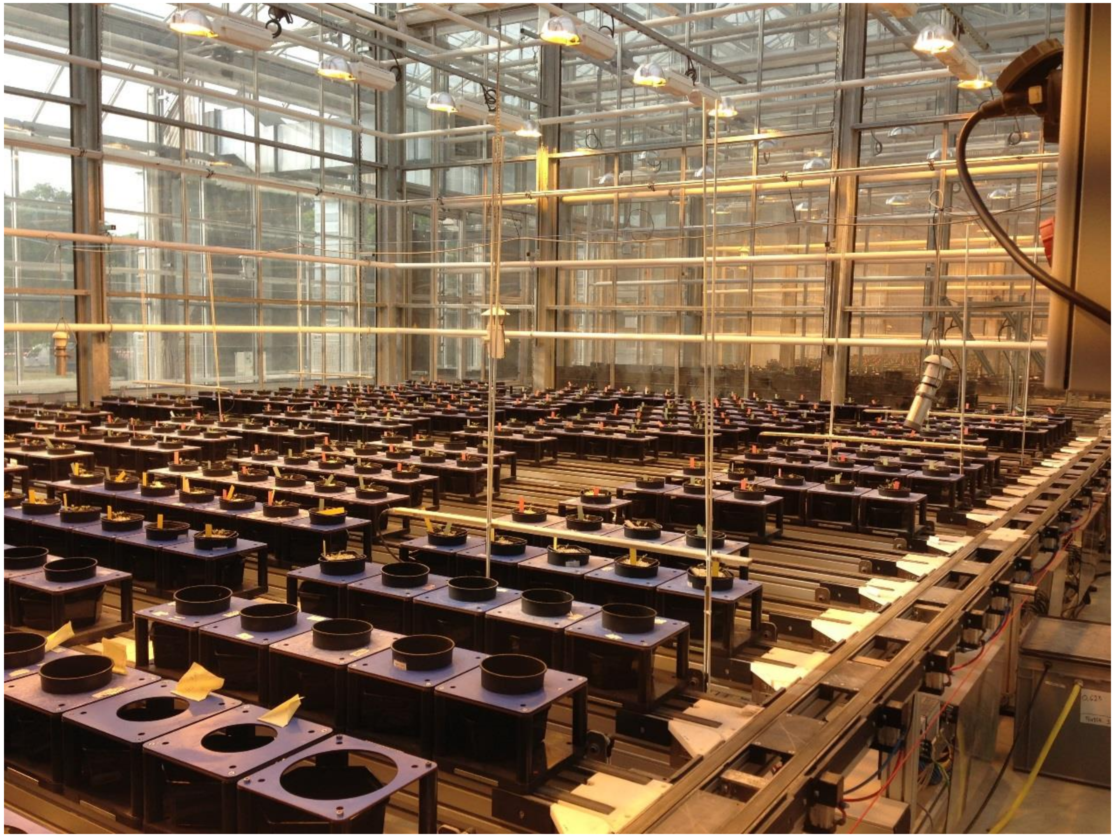
Fondevilla et al., 2013. *Erysiphe trifolii* is able to overcome *er1* and *Er3* resistance genes but not *er2*. **Eur. J Plant Pathol**, 2013.

WP3 Optimizing plant adaptation to abiotic stress

T3.1 phenotyping assay for optimizing roots for N-uptake during drought

T3.2 identifying loci conferring drought tolerance in pea and lupin

T3.3 using automated phenotyping to evaluate heat and drought responses in selected material



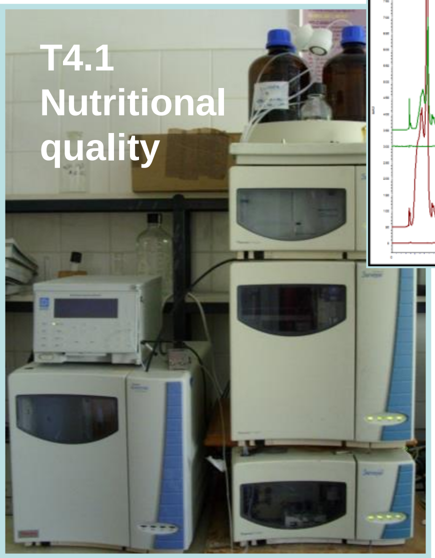
WP3 Optimizing plant adaptation to abiotic stress

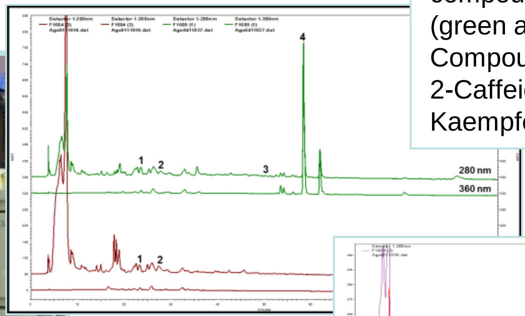
- Non-invasive monitoring of legume development

- Magnetic resonance imaging (MRI)
  - Based on Nuclear Magnetic Resonance (NMR)
  - Detects water in the sample in 3D
  - Custom stationary and portable equipment

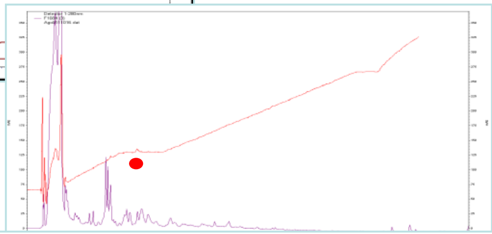
- Positron emission tomography (PET)
  - Detects radiotracers like ^{11}C in 3D
  - Application of radiotracer as $^{11}CO_2$ to individual leaves or whole canopy

WP4 Defining traits adapted to consumers' expectations

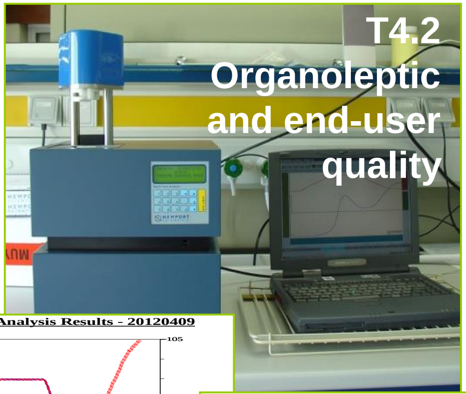


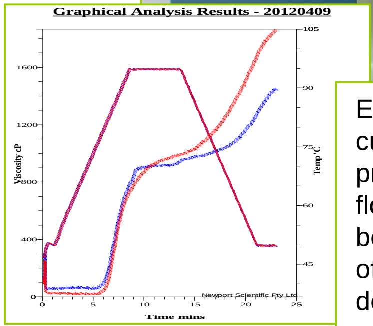


Ex: Chromatographic profiles of phenolic compounds in two legume seed samples (green and red) detected by HPLC-DAD. Compounds detected by LC-MS (1-Catechin; 2-Caffeic Acid; 3-Quercetin-3-O-Rutinoside; 4-Kaempferol-3-O-glucoside)



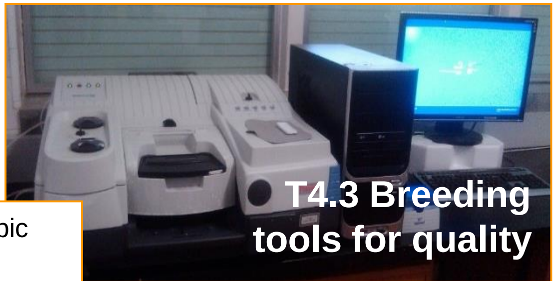
Chromatographic profiles obtained with HPLC-DAD (violet) and HPLC-ED (red) for one legume sample (red dot indicate the compound, Catechin, with ED signal, revealing possible antioxidant activity)





Ex: Rapid Visco Analyser curves (rheological properties) from legume flours of whole seeds before soaking (blue) and of cotyledons obtained from dehulled seeds after soaking (red) corresponding to different pasting behavior

Ex: Consumer sensorial analysis of innovative legume based food products such as fortified cereal breads



Ex: Spectrocopic ATR/FT-IR

WP5 Grain legume cropping system management

T5.1 MASC® (multicriteria sustainability assessment) design of GL-based cropping systems

T5.2 Novel crop rotations involving GL (Intercropping and varietal mixtures)

T5.3 Preventing biotic stress by crop diversification

T5.4 Inoculation requirement of pea and faba bean and selection of strains

WP5 Grain legume cropping system management

- Preventing biotic stress by crop diversification

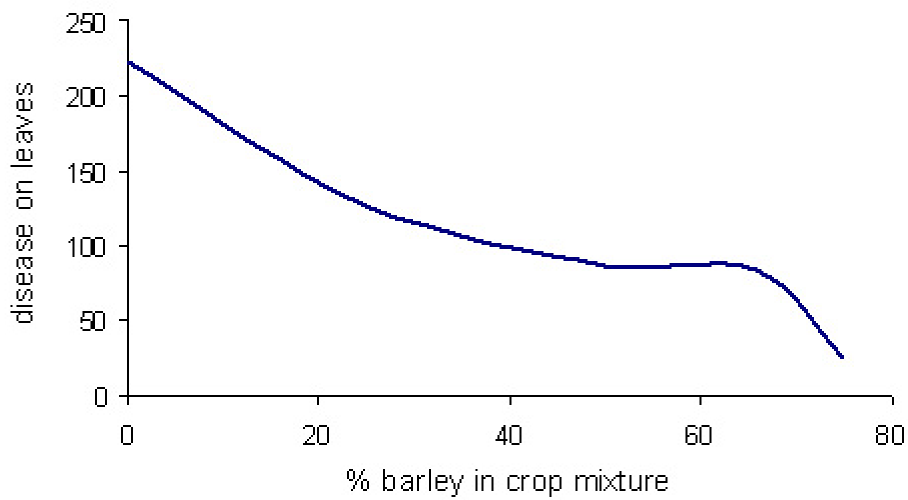
DARCOFenews

Newsletter from Danish Research Centre for Organic Farming

Intercropping pea with barley reduces Ascochyta blight on pea

By **Julia Kinane** and **Michael Lyngkjær**, Biosystems Dept., Risø

Photo 1. Ascochyta blight (caused by *Mycosphaerella pinodes*).



WP5 Grain legume cropping system management

Soybean - + inoculation

- Inoculation requirement of pea and faba bean and selection of regionally adapted strains

WP6 Stakeholder interface for target orientation and practical evaluations

T6.1 - Europe-wide trials of material identified in research WPs
- testing marker-assisted selection in breeding programmes

T6.2 - Economic feasibility evaluation

-approach based on series of stakeholder consultations organized by interprofessional bodies