



LEGumes for the Agriculture of TOmorrow

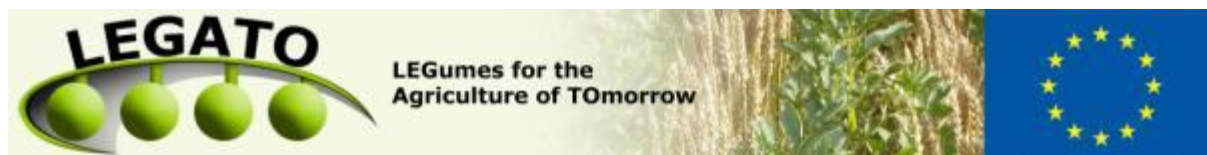
Newsletter

**A biannual bulletin of the EU KBBE project LEGATO,
aimed at increasing grain legume cultivation in Europe**

No 2 2015

Table of contents

Title	page
Introduction	2
Field trials with grain legumes	2
Preparing a boost for Protein Crops in Europe Horizon 2020	3
Brakes and levers on grain legumes production for feed and food	3
UK point of view	3
French point of view	4
Screening pea and faba bean gene banks for processing quality traits	5
Improving key quality traits in grain legumes	6
Design and ex ante assessment of cropping systems with legumes in four European countries	7
Report on LEGATO first stakeholder event	8
LEGATO project Outreach	8
Events	9
Key papers published by LEGATO members in periodical scientific journals	10
Forthcoming events	11
LEGATO partners	11
Publisher	11



<http://www.legato-fp7.eu/>

Introduction

February 2015 saw the LEGATO consortium reunited on the shores of the Baltic Sea at Alnarp, near Malmö in Sweden. The occasion was the first annual project meeting, hosted by the Swedish Agricultural University, and followed by a stakeholder meeting on the subject of "brakes and levers on grain legume production for feed and food". The latter event was organized jointly with LegSA (Legumes for Sustainable Agriculture), the Scandinavian Legume Interest group, who held their annual meeting during the same day. This enabled both participating groups to profit from an exciting programme of invited speakers.

In this newsletter we report on some of the highlights of the stakeholder meeting (page 2 onwards). Besides numerous participants from SLU and members of the LegSA network, we were accompanied by two members of the LEGATO Advisory Board, Professors Judith Lichtenzweig (Curtin University, Australia) and Robert Rees, (Scottish Agricultural College, UK). Their report is now available on the project-internal platform. Many thanks to Georg Carlsson and Erik Steen Jensen, our hosts at SLU, for all their efforts, and to Partnership Alnarp, for generously supporting this event! And a special mention to the SLU restaurant chefs for their excellent gourmet legume menus!!

Field trials with grain legumes

One of the goals in the LEGATO project is to evaluate the performance of new genotypes and of management regimes in a Europe-wide network of trials. The trial network is established in three climate zones:

Mediterranean zone (Greece, Italy, Spain, Portugal)

Maritime zone (France, Germany, UK)

Continental zone (Serbia, Austria)

The network of trials includes both winter and spring sown legumes. The trials include new genotypes of winter and spring pea, winter and spring faba bean, chickpea, grass pea, white lupin and yellow lupin. This research should provide information of agronomic performances, as well as quality parameters of grain legumes in various climatic conditions all around Europe.



Trials in France (LIMAGRAIN), Italy (APSOVSENTI) and Austria (SZG)

Preparing a boost for Protein Crops in Europe Horizon 2020

The European Innovation Partnership for Agricultural productivity and Sustainability (EIP-AGRI) was launched in 2012 to contribute to the European Union's strategy 'Europe 2020' for smart, sustainable and inclusive growth. EIP-AGRI has a major input into H2020 project call development. The working group on Protein crops¹ produced its final report in May 2014², which makes wide-ranging recommendations for boosting European protein crop production. LEGATO was among the projects consulted during its presentation, in a workshop entitled 'How to make protein crops profitable in the EU?' held on 26-27 November 2014³. More details on the following links:

1 <https://ec.europa.eu/eip/agriculture/en/content/protein-crops>

2 https://ec.europa.eu/eip/agriculture/sites/agrieip/files/fg2_protein_crops_final_report_2014_en.pdf

3 <https://ec.europa.eu/eip/agriculture/en/node/199>

Brakes and levers on grain legume production for feed and food

At the first Legato stakeholder meeting in Alnarp, Frédéric Muel (CETIOM) and Steve Belcher (PGRO-RL) gave presentations on the above topic, Steve from a UK perspective and Frederic from a more EU wide view, but with specific examples from France. The two independent presentations arrived at broadly similar conclusions.

A UK viewpoint

It is a very wide ranging and complex topic and set against recent falling production there appears to have been more brakes than levers, with Frédéric citing CAP reform as a contributing factor. There are many factors to consider including abiotic and biotic stresses, and I am sure there are others that could be added to the list below.

Economics.....

Policy.....

Markets....

Uses.....

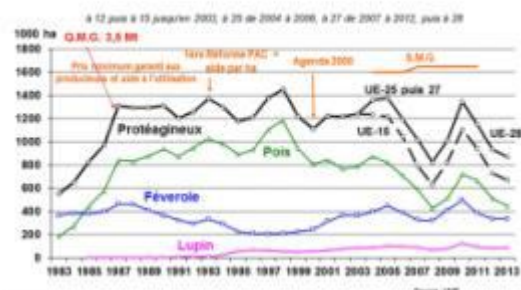
Sustainability.....

Agronomics....

GHG Emissions.....

But to bring some focus, a topical subject currently is policy in the form of CAP reform. The current CAP 2014-2020 offers some hope for increasing Grain Legume (GL) production. It is a little greener compared with the previous one and offers some opportunities for the use of protein crops (minimum 3% of Ecological Focus Area (EFA)), crop rotation encouragement to increase diversification (environmentally friendly). Importantly for the UK, peas and beans (and other legumes) can fulfill the role of crop diversification and

Impact of CAP changes on protein crops acreage in the EU



also satisfy the requirements of the EFA (in whole or part).

The British Edible Pulse Association (BEPA) has forecast that the UK pulse crop could expand over the next 5 years by 25 – 50%. This in

response to CAP reform measures, low values for oilseed rape, increasing problems with black grass control and the move away from wheat / rape rotations. However, it must be remembered the UK pulse area fell by 25% during the last 5 years.

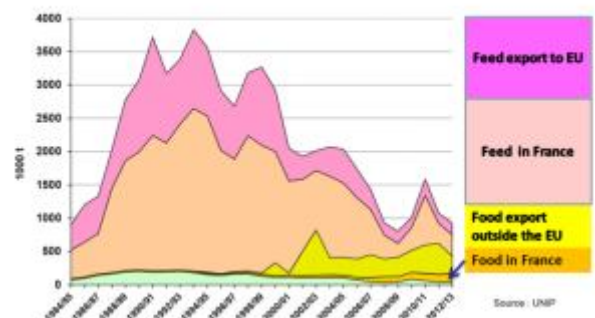
Of course policy can change and indeed the CAP post-2020 may have a different focus to the current one. In light of this, both growers and users (markets) of GL need to have indications of policy direction. Active lobbying will be needed to keep GL and their benefits (including environmental and human health) at the forefront of policy makers' minds.

Increasing production by increasing area grown is only part of the story, but just as important is increasing production per unit area. This is particularly important in the UK, where there is limited land available and limited scope for increased pulse area. This is

perhaps where research and projects such as Legato plays a role (both in the short and long term). Legato includes an element of optimizing GL for human consumption and the health benefits of GL could play an increasing role in the future.

Steve Belcher, PGRO-RL

Pea and fababean market in France



A French viewpoint

The analysis of the grain legumes production in the EU shows that pea production has decreased from 1998 to 2013 by five-fold. The analysis of the acreage of pea in the EU shows also a great decrease in France from 730 000 ha to 130 000 ha while acreage of faba bean, mainly located in UK and France, varies from 100 000 ha to 180 000 ha in UK and is around 70 000 ha in France since 2002. Two main reasons can explain the decrease of the acreage of pea in the UE:

(i) the impact of CAP changes on protein crops acreage in the EU (QMG in 1986, first CAP reform in 1992, Agenda 2000, SMG since 2003,...)

(ii) the decrease of pea yield in the EU, from 45 q/ha in 1983 to 25 q/ha in 2012. The same trend is observed in France: yield decrease can be due on one hand to relocation of production from deep soils to superficial soils (perhaps with a negative impact on nitrogen fixation efficiency) and on the other hand to disease (root rot disease called *Aphanomyces*) that has strongly affected yields in the years with climatic

conditions favorable to disease development. In the same period of time, the protein content of pea in France has also decreased from 25 % of DM to 22 % of DM, while the protein content in faba bean is more stable (between 28 to 29.5 % of DM). All these factors have contributed to reduce the competitiveness of GL in the cropping systems. The Pea market in France was essentially dedicated to feed uses. In the nineties, pea production reached 3.5 MT with 2.5 MT used in France for feed and 1 MT exported within the UE for feed as well. Since 2002, a new market has appeared, from time to time, for food uses exported outside of the EU (India), and recently the development of pea fractionation industry that produces isolated protein and starch. The faba bean market in France is mainly for export to Egypt for human consumption (between 0.1 to 0.3 MT each year). In France, quality remains an important point. An annual survey of quality production is organized, in order to provide information on the quality of each harvest. For variety registration, the main objective is to maintain and increase protein content, to have no (or low) anti-nutritional factors (Trypsin inhibitors in pea, vicine/convicine in

fababean), and to keep the same quality for spring and winter types without affecting the yield potential. It is important to verify that quality criteria for food and feed are not antagonistic.

Some hope in the future appears in the CAP 2014-2020 which is a little greener compared with the previous one and offers some opportunities for protein crops (minimum 3% of ecological interest area, crop rotation encouragement to increase diversification (environmentally friendly), and National policy is allowed to support protein crops.

That led to the French initiative launched in December 2014 ("Plan Protéines Végétales pour la France 2014-2020") which includes 3 main axes:

- **Direct support to the farmers** for the development of protein production (pea, fababean, lupin, soybean and alfalfa)
- **Continuing research efforts and training:** definition of a research program for the next 10 years, starting probably by the end of 2015,

gathering public and private research. It will include some objectives for quality improvement and feed and food uses needs. Technical support and training will be enhanced: use of new varieties, input reduction, new cropping systems, quality, new markets.

- Strengthen governance devoted to the GL interprofessional institute

To express synergies in the production (cropping systems) and development of products, strengthen the investment in the economic field; streamline activities like promotion, advertising, communication. Develop contracting approach between farmers, co-operatives and end users. Improve the production offer to anticipate end-users needs, give a better visibility on the opportunities offered to production, seek complementarities opportunities between human food and animal feed, and bring greater transparency in pricing negotiations.

Frédéric Muel, CETIOM

Screening pea and faba bean gene banks for processing quality traits

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Grain legumes are primary sources of dietary protein and high-value nutrients, and also function as substitutes for common allergenic food ingredients (e.g. gluten) in cereal based products. Significant drivers to improve production and consumption of grain legumes are addressed by FP7 LEGATO project which includes germplasm evaluation of food quality traits. The grain and flour characteristics of 88 different *Vicia faba* (faba bean-FB) and 105 different *Pisum sativum* (pea-P) accessions were evaluated.

Faba bean accessions revealed great variability in seed size and weight, being peas more homogeneous. FB with higher grain weight had greater protein content and hydration capacity. Great variability was detected in protein content. FB and P accessions with higher protein levels showed great hydration capacity. Whole FB flours from 87 accessions reveal similar pasting behavior: peak viscosity >2500cP, breakdown < 500cP, final viscosity >3000cP. However, BG-1085 accession showed a different pasting behavior. Wrinkled pea seeds showed higher protein content and hydration capacity and revealed difficulty of gelatinization leading to lower peaks of viscosity (< 500cP) and no breakdown during the holding period at 95°C. The relationships between chemical composition and cooking ability are being investigated to take the optimum nutritional benefits of the incorporation of grain legumes in the diet.

Improving key quality traits in grain legumes

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Some bioactive or non-nutritional compounds decrease the biological value of faba bean in feed or food. The most important are **tannins**, which bind to proteins in the digestive tract, and **vicine** and **convicine** (v-c) that cause favism in humans, carrying an enzyme deficiency. In animals, the effects of v-c are important in laying hens resulting in a decrease in weight, size and fertility of their eggs. In pigs they have been related to a reduced reproductive performance. No problems have been described for ruminants.

In the case of tannins, there are two independent recessive genes, *zt1* and *zt2*, producing a white colour of the flower and absence of tannins. Vicine and convicine, and their degradation products appear to have no direct effect on nutrient digestion and metabolism. The levels of vicine and convicine vary considerably between varieties of faba beans and selecting against v-c content is complicated as the chemical detection of v-c is costly and difficult. The discovery of a spontaneous mutant allele named *vc-* that induces a 10-20 fold reduction of v-c content is facilitating the process (Duc et al. 1989). Molecular markers closely linked to these traits have been identified (Gutierrez et al. 2006, 2007, 2008) to track the introgression of the desired alleles in the development of new cultivars with improved nutritional value. However, no candidate genes controlling low tannin and v-c content have been reported to date.

In order to perform an early and efficient selection of low tannin and low v-c faba bean genotypes, within LEGATO we aim at: i) identifying the gene underlying the these traits, ii) detecting the specific, single nucleotide DNA change responsible for the genetic variation with the purpose of iii) developing fully reliable and cost effective markers for MAS (Marker Assisted Selection). We are using a combination of genetic linkage, association studies and functional and comparative genomic approaches to select positional and functional candidate genes controlling both traits.

In case of tannins, key structural and regulatory genes involved in the flavonoid pathway were studied. Once the sequences of these genes were available and mapped the objective was to associate the different mutations with the target phenotype. As a result, we now know that one transcription factor (TTG1) regulates the white flower and the absence of tannins (gene *zt1*) in faba bean (Fig. 1; Gutierrez et al., in preparation). In case of v-c, although the gene has been confined in the distal part of the long chromosome 1, no candidates have been identified so far. Next activities will comprise the genotyping of new candidate genes involved in the pyrimidine pathway and the characterization of the v-c content in a RIL population in order to refine the target region. The identification of genes and mutations responsible for low tannin and v-c content phenotypes will facilitate the application of gene pyramiding approaches for the generation of value-added faba bean cultivars free of anti-nutritional compounds.

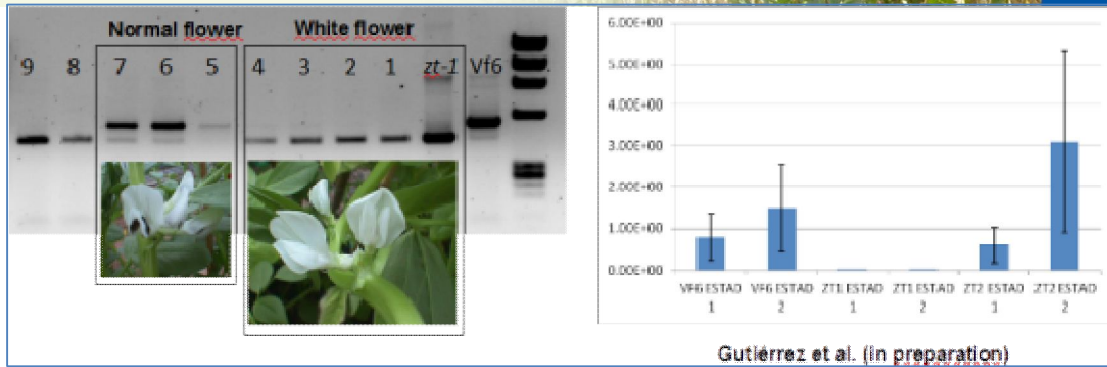


Figure 1. Left: Identification of a candidate SNP in the TTG1 gene showing significant association with zt1, one of the genes controlling white flower and low tannin content in faba bean. Right: Differential expression profiles of TTG1 in flowers at two different stages of growth. The figure shows down regulation of the gene in line zt1 (white flower) when compared to lines Vf6 (normal flower) or zt2 (white flower).

Design and ex ante assessment of cropping systems with legumes in four European countries

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Cropping systems (CSs) with grain legumes show many agronomical and environmental benefits. However, the area dedicated to these crops has largely decreased in Europe since the 90ies and currently represents no more than 1.8% of the arable land. The aim of this study was to design, together with local experts, grain legumes based-CSs in 4 countries, and to assess their sustainability, accounting for the diversity of stakeholders' points of view. This work was performed in Sweden (Scania), Spain (Andalously), Czech Republic (Olomouc region) and France (Parisian basin). It was included in the European project LEGATO (LEGumes for the Agriculture of Tomorrow).

In a first step, current CSs of each case study region were described and assessed with the MASC[®] tool (Multi -criteria Assessment of the Sustainability of CSs). In a second step, innovative CSs were collectively designed with researchers from each country, according to a defined set of objectives and constraints. Designed innovative CSs contained at least two grain legume species, as sole crop or intercropped with cereals. They had longer crop rotations than current CSs. The management plans for each crop were designed in order to decrease their environmental impacts linked with the use of mineral fertilizers and pesticides. As the characterization of sustainability can highly differ according to different stakeholders, the sustainability assessment of these CSs has to account for this diversity. Thus, in a third step, meetings with stakeholders will be organized in each country to catch their points of view on sustainability and use them to assess the sustainability of the designed CSs. Current and innovative performance will then be compared within each country. This meeting with stakeholders will also allow us to discuss the feasibility of innovative CSs and to identify the innovative CSs accepted by most (or even all) stakeholders.

Report on LEGATO first stakeholder event

The first stakeholder meeting took place in the morning of 26th February 2015 at the Swedish University of Agricultural Sciences (SLU) in Alnarp, Sweden, jointly with the network LegSA (Legumes for Sustainable Agriculture) and synchronized with the LEGATO first annual meeting. The stakeholder topic meeting was based on the growing recognition that legumes such as peas, beans and lentils are tasty, healthy and environmentally sound food sources, and that increasing the proportion of legumes in our diets will have positive consequences for the sustainable development of agriculture and food systems. **However, what potential do European-produced legumes for food have to supply our protein needs?** The session concluded that on the macro-economic scale, European agriculture has the potential to supply a significant proportion of our protein needs as pulses. Whether this will occur depends on many factors; competition with cheap soybean imports and more profitable crops, disease and abiotic stress problems which have resulted in diminishing legume crop areas for the past 20 years. The spiralling soybean prices and the increased restriction on phytochemical inputs have recently led to a more positive political will to promote legume crops, reflected in the CAP which is somewhat "greener", and in various national policies such as the French protein plan. The first positive indications on production and consumption are also detectable. Research projects such as LEGATO can help to fuel this positive impetus by providing innovative genetic material better adapted for food and feed, and for low-input agriculture, as well as locally-adapted cropping systems built around grain legumes that optimize their ecological

services. However, the final arbiter will be the consumer - **how can legume consumption be promoted?**

The meeting participants provided several innovative examples of how grain legume consumption can be stimulated through both the development of novel products and marketing strategies, focusing on the merits of local sourcing and the use of traditional varieties and/or recipes. This theme was continued with further examples in the LegSA meeting, which took place the same afternoon. Although it is early days, the examples presented, from regionally delimited crops, presented by start-ups or their equivalent in more established companies, show there is a great potential.

LEGATO project Outreach

Identification of key institutions /organizations /individuals of each one of the levels of audiences of project dissemination was done in order to assemble a database of contacts in each partner state at all levels of project dissemination.

The LEGATO website has been active since January 2014: www.legato-fp7.eu, with full information about the project, the activities carried out, the public deliverables and published publications and also on other events. A section has been created to provide information on industrial, environmental and societal applications. A section of other EU funded projects on legumes has also been created, with information on Eurolegume, Legume Futures, Legume Plus and Leguval. The website has received more than 7,400 visits since January 2014.



First project meeting at SLU, Alnarp, 25-26 February 2015.

Events

During the spring 2015, LEGATO partner AGROVEGETAL has received two visits at the LEGATO trials in Escacena del Campo (Huelva), in Spain. On 17th April, AGROVEGETAL received a group of 30 students of Plant Breeding of ETSIAM (University of Cordoba) with Professor Teresa Millan. The visitors came from at least 5 different countries (Spain, Italy, Mexico, Argentina, Syria, etc.) and they made a lot of interesting questions about the objectives and work packages of the LEGATO project. A few weeks later, the Presidents of 20 Andalusian agricultural cooperatives visited the AGROVEGETAL trials in Escacena del Campo and AGROVEGETAL dedicated twenty minutes to explain the interest of the LEGATO project to improve knowledge about legumes in European Union.



Field visit at AGROVEGETAL

During spring of 2015, LEGATO partner MOULIN DECOLLOGNE has organized a visit at the LEGATO trials in Aiserey, France (2nd June 2015). The objectives of the project and trials have been presented to a group of 40 farmers and 10 industrials/plant breeders.



Field visit at MOULIN DECOLLOGNE, Aiserey, F

Key papers published by LEGATO members in periodical scientific journals

- ✓ Sulfate transporters in the plant's response to drought and salinity: regulation and possible functions. Review. Gallardo K; Courty PE; Le Signor C; Wipf D; Vernoud V. Front Plant Sci. 2014, Art. 580, 1-7. Doi: 10.3389/fpls.2014.00580.
- ✓ Control of aphids in legumes: confusions on the way to Integrated Plant Management. SEIDENGLANZ, M., HUNADY, I. Úroda. 2015, Vol. 63, No. 05, 78-84. ISSN 0139-6013 (in Czech).
- ✓ Models, developments, and perspectives of mutual legume intercropping. Aleksandar Mikic et al. Advances in Agronomy. 2015. Doi: 10.1016/bs.agron.2014.10.004.
- ✓ DASH transcription factor impacts Medicago truncatula seed size by its action on embryo morphogenesis and auxin homeostasis. Noguero, M., Le Signor, C., et al. The Plant Journal. 2015, Vol 81, pages 453-466. Doi: 10.1111/tpj.12742.
- ✓ Quantitative trait loci associated to drought adaptation in pea (Pisum sativum L.). Iglesias-García R, et al. Plant Molecular Biology Reporter. 2015. DOI 10.1007/s11105-015-0872-z.

Forthcoming events

LEGATO 2nd annual meeting and 2nd stakeholder workshop will be held on Tuesday 1st & Wednesday 2nd December 2015 in Cordoba, Spain at the University of Cordoba (at "past Veterinary faculty").



LEGATO partners



Publisher

Edited by Vuk Đorđević, Dunixi Gabiña, Aleksandar Mikić, Caroline Sautot and Richard Thompson. *LEGATO Newsletter* is a deliverable of the LEGATO project funded from the European Community's Seventh Framework Programme (FP7/ 2007-2013) under the grant agreement n°FP7-613551.

UNIVERSITY of York