LEGATO

LEGumes for the Agriculture of TOmorrow

Collaborative project
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SEVENTH FRAMEWORK PROGRAMME

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Stakeholder topic meeting report n°1

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Workpackage concerned: 6

Concerned workpackage leader: PGRO
Concerned task leader: UNIP (CETIOM)

Dissemination level: PU (public)

Content

1. Focus

The LEGATO stakeholder topic meetings are related to the task 6.2 - sharing expertise to orientate and evaluate possible levers of improvement offered by the project results.
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. In this context, the stakeholder meeting attempted to answer questions such as: What potential do European-produced legumes for food have to supply our protein needs? And how can their consumption be promoted? The meeting was targeted to legume stakeholders: agricultural, food and feed industries, environmentalists, technicians, administration officers, scientists, etc….
The meeting attracted 79 participants including 52% academic researchers, 24% students, 9 % industry, 8% SMEs and 5% interprofessional bodies, coming from Europe (See figure 1 below).

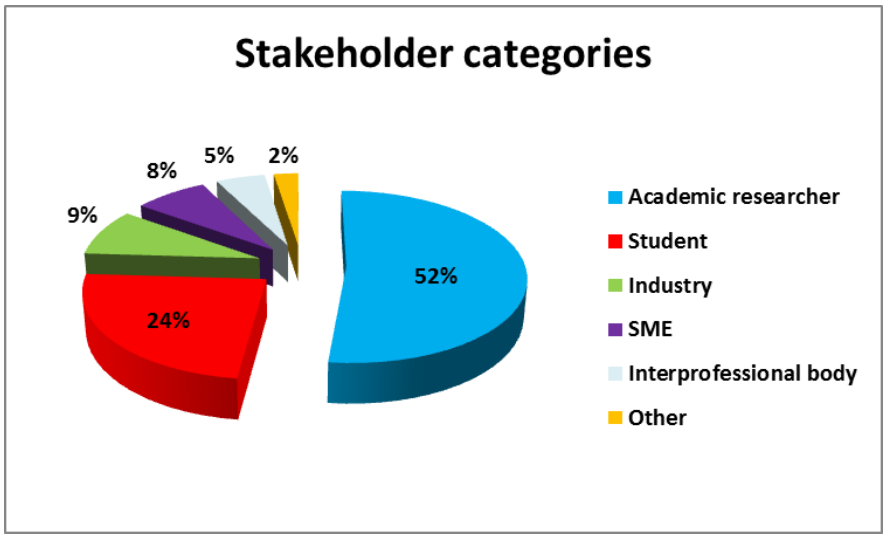

Figure 1: Stakeholder categories

2. Objectives

The content of the stakeholder meetings was defined in the DOW. Three topic meetings of stakeholders was initially planned: 1 for science, techniques and economy of production; 1 for science, techniques and economy of uses; 1 for interfacing production x uses and analysing the limits.
One final general meeting in year 4: on the basis of the input of results from the different WPs and of the agro-economic context, definition of adapted ideotypes (genotypes x cropping management systems) for different European regions, with seed product quality fitting user requirements, and estimation of their potential development in areas and volumes.
The content for meeting at Alnarp has deviated a little from the format originally planned, having been organized jointly with LegSA and topics aligned accordingly. It corresponds to the analysis of breaks end levers to production in interaction with current economic policies, and reflections on how to optimize GL traits for human consumption.

3. Short summaries of the presentations

- **Introduction**

The meeting was introduced by Richard Thompson - LEGATO coordinator. He presented the LEGATO structure and the objectives of the project. He focused on what is new in LEGATO and then presented the agenda of the meeting (see Annex 1):

After a rapid presentation of the SLU and LegSA by Georg Carlsson, the meeting was structured in two main sessions:

- Session 1 “Levers for boosting EU Grain Legume (GL) production and quality”, with two conferences on “Improving key quality traits in GL” and “Brakes and levers on GL production for food and feed”.

- Session 2 “Optimizing GL for human consumption” dealt with “Defining traits adapted to consumers’ expectations”, and “Which traits for human consumption? – Consumer perception”, followed by presentations on “SME experience and feedback”.

- **LegSA presentation by Georg Carlsson,**

LegSA is a network which aims to promote and visualize research on legumes and legume-based production systems. This network started during autumn 2010 on the initiative taken by SLU scientists. A first workshop was held in January 2011, where important new research questions with a joint interest were discussed, and strategies to highlight SLU legume research and improve the communication between legume researchers were proposed. During the second annual meeting in 2012, it was decided to develop LegSA as an international network open to anyone, scientists as well as persons outside academia, interested in research about legumes.
The core network activity is the organization of annual meetings, where ongoing projects and results from research about legumes are presented and discussed. One open form: www.slu.se/legumes allows to exchange information on GL.

- **Session 1 “Levers for boosting EU Grain Legume (GL) production and quality”**

- **Improving key quality traits in GL** (G. Duc, INRA France, and A. Torres, IFAPA Spain)

This presentation focused on the example of faba bean. A quite complete description of the composition of the seeds has been made and the possibility to use molecular studies and to find markers for traits of interest is now available. The objective is to exploit collinearity with Medicago to identify syntenic regions and genes in order to select positional and functional candidate genes controlling quality traits such as color of the flower or vicine content.

The seeds of faba bean have, like soyabean seeds, high levels of protein content: from 28 % to 32 % of the dry matter. Faba bean production in France is currently essentially exported to Egypt for human consumption for which prices are more attractive (+ 50 €/t).

The evolution of yield for different species from 1982 to 2012 shows the stagnation of yield and the great instability for GL such as pea or faba bean. The lack of competitivity of faba bean taking into account the product yields x prices was underlined, especially for some years with poor yields. In this context, farmers should consider the global performance and beneficial effects of legume crops on the whole cropping system.

The question of which levers to focus on was asked (national or export, feed, food or non-food, …) and it was suggested to ask breeders which genetic variability (yield, seed quality in particular) is available to develop some markets and also which alternatives do exists between breeding and industrial processes.

The variation in protein content of a given variety according to years (from 2004 to 2012) is about 2 points (27.5 % to 29.5 % of the dry matter). A large genetic variability exists for protein content: from 25 to 38 % of dry matter. A strong negative correlation starch-protein exists but there is no strong negative genetic correlation with yield, thus, it appears possible for breeders to increase yield without degrading protein content. Visual aspects of seeds are also important: the percentage of split seeds or with bruchids or spots must be low. The large genetic variability in seed size and colours allows access to various markets. The proportion of the seed coat is also highly variable and this is important for seed dehulling. Tannins (polyphenolics) which are concentrated in seed hulls, can be eliminated using 2 genes, zt1 and zt2, also responsible for the co-expression of the white flower trait. By this means, 10 points of digestibility for monogastric animals (poultry, pig) are gained. The other

alternative is seed dehulling. Further antinutritionnal factors are vicine and convicine (Glucopyranosides in cotyledons of fresh and dry seeds).
A low vicine-convicine progenitor was discovered in a genetic resources survey. The vc- gene responsible reduces by 10 to 20 the vicine and convicine content. It is possible to combine low tannin and low vicine contents. The double low variety types are called « FEVITA ». In humans carrying a particular G6PD mutation, vicine and convicine cause favism. The problem of favism could be solved for susceptible humans by the consumption of low vicine-convicine beans.

Some further seed components for which genetic diversity exists, such as total phenolics, stachyose or verbascose, may play useful dietary roles. Several markets can be accessed (feed, food, non-food) depending on the final seed composition. Consequently, priority perspectives for breeding in faba bean are: high protein and low vicine content, good visual aspects (resistance to bruchus), good protein solubility and digestibility, avoiding factors generating unwanted flavours in food industry, and perhaps to have low phytates. The question is to whether to aim for specific or ubiquitous products.

The LEGATO project aims to develop efficient markers for selection for low-vicine because chemical detection of vicine is costly and there is a continuous variation in faba bean collections. The gene which determines low vicine content is linked to the white hilum color. It is a recessive gene with maternal inheritance, so genotypes are expressed one generation later than expected. That leads to a delay in the breeding process. RAPD markers linked to low vicine content exist. Absence of tannin in the seed coat is controlled by two recessive genes (zt-1 and zt-2) associated to white flower color. Two SCAR markers have been developed for zt-1 (SCC5 95% efficiency). The simultaneous use of CAP markers predicts zt-2 genotypes with 89% accuracy. zt1 and zt2 are respectively found on chromosome II and chromosome III. The gene controlling low vicine content is located on chromosome I.

The objective is to exploit collinearity with Medicago and linkage analysis to identify syntenic regions and narrow down the search for genes, and then selecting positional and functional candidate genes controlling these traits. Markers for zero tannin content have been identified in Medicago allowing saturation of the target region. Numerous candidate genes have also been identified in the vicinity. A diagnostic marker will be developed for selecting white flowered, zero tannins (zt-1) plants. Similar approaches are being applied for low vicine-convicine content.
The presentation showed with these examples the current potential for genetic improvement of seed quality based on high resolution markers and exploitation of seedbank diversity.

- **Brakes & Levers on GL Production for Feed & Food - A UK Perspective** (Stephen Belcher, Processors and Growers Research Organisation, UK)

In UK, winter bean acreages decreased over the last 5 years and is now about 30 000 ha, while spring beans acreages varied from 60 000 ha to 100 000 ha for the 2005-2014 period. Spring pea acreages are around 30-40 000 ha. The total UK bean production reaches 400 000 t. Yields vary from 3 to 5 t/ha. Many limiting factors may occur and impact the yield stability. Grower's attention is concentrated on these factors, which are diseases (leaf and pod spot, rust, downy mildew, chocolate spot, sclerotinia, foot and root rots), and pests (black bean aphid, P&B Weevil, Bean seed beetle, Pea aphid and stem nematode).

A UK report by commissioned the NFU, the AIC and the CPA, looked at the economic impact of plant protection products (PPPs) on UK agriculture and the wider economy. This report assessed that 40 active substances are deemed likely to be lost or restricted in their use, including: 10 insecticides, 12 fungicides, 16 herbicides and two molluscicides. This represents a drop of 20 per cent on the five-year average from 2009-2013 and drop by £1.73 billion in monetary terms for the UK farming profit (Total Income From Farming).

For many reasons, the UK pulse crop could be expanded between 25% and 50% over the next five years and over a million tonnes could be gained: CAP reform and the Three Crop Rule, CAP reform and Ecological Focus Areas, low values for oilseed rape forecast, increased problem with black grass (Alopecurus myosuroides), a wider rotation and a move away from wheat/rape rotations. Furthermore, consumption of vegetable proteins will increase as premiums for, and competitiveness of, wheat will be reduced. The demand for food will be seen in Norway, Southern Europe and North Africa. The

gross margin is quite interesting for GL in UK, (spring and winter beans, blue peas and marrowfat), and could be improved next years.

Fundamental research will have long-term benefits while near-market research gives shorter term benefits. New Policy CAP 2014-2020 reform and Greening could change the situation. Markets (feed or food) need sustained product and grower commitment. Growers need stable markets and prices and indications of policy direction. The objective is to increase production through increasing area but also productivity (yield per unit area). This target can be achieved with research at both short and long-term levels.

- **Brakes and levers on GL production for feed and food** (Frédéric Muel, CETIOM)

The analysis of Grain Legumes production in the EU shows that pea production has decreased from 1998 to 2013 by a factor of 5. The acreage of pea has also decreased in France from 730 000 ha to 130 000 ha while acreage of faba bean, mainly located in UK and France, varied 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 UE: the impact of CAP changes on protein crop acreage in the EU (QMG in 1986, first CAP reform in 1992, Agenda 2000, SMG since 2003,…) and the decrease of pea yield in UE (from 45 q/ha to 25 q/ha from 1983 to 2012). The same trend is observed in France: yield decrease can be due on one hand to relocation of production (from deep soils (Picardie, Normandie,…) to superficial soils of the Center, (perhaps with a negative impact on nitrogen fixation efficiency), and on the other hand to diseases (root rot diseases, especially Aphanomyces, and ascochyta blight) that cause greatly reduced yields in some years with climatic conditions favorable to these diseases. The protein content of pea in France has also decreased from 25 % of DM to 22 % of DM, due to change of variety but perhaps also to the relocation of production, while the protein content in faba bean is more stable (between 28 to 29.5 % of DM). All these factors have contributed to the loss of competitiveness of GL in the cropping systems.

For end-uses of pea and faba bean, from 1990 to 1998, GL production reached 2 MT to 2.5 MT used in France for feed and 1 MT exported within the UE for feed. The pea market in France was essentially dedicated to feed uses (France and export) while the faba bean market in France is mainly for export to Egypt for human consumption. Since 2002, a new market has appeared, from time to time, for food uses exported outside the EU (India), and recently the development of pea fractionation industry for isolated protein and starch.

In France, quality is an important criterion. An annual survey of quality production is organized, in order to provide information on the quality of each harvest. Each year, maps showing the distribution of samples and protein content per region are established. The percentages of split grains for pea seeds or bruchid damages in fababean seeds are assessed. For variety registration, the main objective is to maintain and increase protein content, to have no (or low) antinutritionnal factors (Trypsin inhibitors in pea, vicine/convicine in fababean), lower seed size (for seed production) 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. Generally, when it is good for monogastric animals, it is good for human food. No processing is needed in feed compared to food. We can ask if trypsin inhibitors are a problem for food or if we should define a European standard for fababean with a low vicine/convicine content.

Some hope for 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 a national policy can help protein crops. That has 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 is time to include some objectives for quality improvement and end-users needs. Technical support and training will be

enhanced: use of new varieties, input reduction, new cropping systems, quality, new markets, and maintenance of the breeding programs.

- **Strengthen governance devoted to the interprofesionnal institute on GL** (UNIP) to express synergies in the production (cropping systems) and development of products, strengthen the role of UNIP in the economic field, streamline activities within UNIP: promotion, advertising, communication, 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, bring greater transparency in pricing negotiations.

- **Session 2 "Optimizing GL for human consumption"**

- **Defining traits adapted to consumers' expectations** (Maria Carlota Vaz Patto, ITQB)

An overview on the different tasks planned in the WP4 of the LEGATO project, which aims to define traits adapted to consumers' expectations in foods, was presented.
The main objective of this workpackage is to define grain legume quality characteristics that can be translated into consumers demand and develop the necessary tools to exploit these in breeding. It includes 4 tasks:

T4.1: Studies on grain legume nutritional quality
T4.2: Studies on organoleptic and end-user quality
T4.3: Breeding tools for quality traits valuable for consumers
T4.4: Consumers Perception of sustainable indicators related to novel legume food uses

The approach is based on three main steps: grain legume diverse germplasm quality characterization (breeders, geneticists), definition of quality breeding objectives turned by consumer preferences and development of selection tools and orienting marketing approaches for sustainable labelling.

- **Which traits for human consumption? – Consumer perception** (JB Traversac – INRA Paris, Carla Moita Brites – INIAV)

The increasing world population leads to a huge increased demand for proteins and interrogations arise about how to satisfy population needs while limiting the environmental footprint. The limiting of meat consumption is recommended to stay in good health. A free-meat day could be established. Another way could be to use traditional plant proteins or to develop alternative products (Novel Protein Food) or insect-based products.

Legume consumption from 1992 to 2010 decreased and no new products have been developed. There is a negative relationship between the level of earning and the consumption of plant protein. High earning levels lead to a high animal product consumption. Legumes are the protein of the poor. Although processed protein food based on soyabean and meat protein has a high cost with higher environmental impacts (factor 4.4 to more than 100) than for plant protein, there is still a preference for meat (taste, odour, importance of the meat status in a social context).

The price of GLs is quite variable due to grain size, insect damage, color and seasonality). The Genetic Modification of Plant protein is quite acceptable in some countries: Norway (oil), China (rice), Japan (soyabean), with different status (discount or premium). According to a survey made in Germany, mostly positive terms are associated to pulses. Flatulence does not block legume consumption but the time to prepare them is too constraining for 9% of the respondents. Nethertheless, meat is preferred. This result can be related to the important marketing funds and subsidies used to sustain the meat supply chains.

A change in consumer behavior could occur for different reasons: health (reducing meat), food safety crises which have altered confidence in the meat food chain and the huge ecological impact of animal production which is underestimated by the consumers. A SWOT analysis shows the different components of consumer perception for GL. One solution for promoting GL is to develop new products by different technical methods (dehulling, milling, pre-cooking and canning, germination, vacuum pressure cooking, extrusion, extraction of ingredients for food applications). The communication on

factors such as sustainability or health benefits will restore interest in GL. A sensory analysis will be conducted on 100 randomly chosen consumers to know their opinions.

- **SME experience and feedback**

Two SMEs made presentations on their activities: Patrimus and Go Green.

- **Patrimus** is a Portuguese company which belongs to a bakery chain. They produce different types of breads where 5% to 10 % of flour of legumes is introduced.

- **Go Green** is a Swedish company which proposes different products made with grain legumes (soups, purées …), packaged in cartons. The company belongs to a group of farmers. Then, it is possible to have good traceability of the products, from the fields where GL have been grown to the consumers. They aim to expand their market position in Scandinavia. Legumes currently consumed in Sweden are mainly imported from China. This example could inspire others initiatives elsewhere in the world.

The conclusion of this session was that it is very important to promote products made with GL.

4. Main conclusions and eventual actions to be taken

For the first question, what potential do European-produced legumes for food have to supply our protein needs, the conclusions drawn are 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 spiraling soybean prices and the increased restriction on phytochemical inputs have recently led to a more positive political which promote legume crops, reflected in the CAP which is somewhat "greener", and in 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.

For the second question, and how can their consumption be promoted, the meeting participants provided several innovative examples of how grain legume consumption can be promoted for human consumption 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 start-ups or their equivalent, show there is a great potential.

Annex 1: First Stakeholder meeting program

Thursday 26th February 2015

"GRAIN LEGUME PRODUCTION AND USES FOR HUMAN CONSUMPTION"

Background: There is increasing recognition that legumes such as peas, beans and lentils are tasty, healthy and environmentally sound food sources, and increasing the proportion of legumes in our diets will have positive 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 European produced legumes for food have to supply our protein needs? And how can their consumption be promoted?

Place: The Crafoord hall (Sundsvägen 14), Swedish University of Agricultural Sciences (SLU), Alnarp, Sweden

Agenda:

08:45 Introduction: LEGATO structure and objectives
Richard Thompson – INRA - LEGATO coordinator

08:50 Short presentation of LegSA
Georg Carlsson - SLU; LegSA contact person

09.00 – 10.00 Session I: Levers for boosting EU Grain legume (GL) production and quality

09:00 Improving key quality traits in GL; Gérard Duc (INRA)/Ana Torres (IFAPA)

09:25 Brakes and levers on GL production for feed and food; Steve Belcher (PGRO) + Frédéric Muel (UNIP/CETIOM representative)

09:50 Discussion

10:00 Coffee break

10:20-11:45 Session II : Optimizing GL for human consumption

10:20 Overview of LEGATO WP4: "Defining traits adapted to consumers' expectations"; Carlota Vaz Patto (ITQB)

10:35 Which traits for human consumption? – Consumer perception; Carla Brites (INIAV)/ Jean-Baptiste Traversac (INRA)

10:50 SME experience and feedback; Patrimus + Moulin Decollogne + GoGreen. Including a round-table discussion

11:45 Conclusion and perspectives, closing the LEGATO stakeholder meeting

12:00 Lunch

Annex 2: List of participants

Name	Organisation	Category
Adnane Bargaz	SLU	academic researcher
Elinor Hallström	Lund University	academic researcher
Frederick Stoddard	University of Helsinki	academic researcher
Gert Poulsen	University of Copenhagen	academic researcher
Kerstin Huss-Danell	SLU	academic researcher
Lotta Nordmark	SLU	academic researcher
Otto Toldi	Szent István University	academic researcher
Viktoria Olsson	Kristianstad University	academic researcher
William English	SLU	academic researcher
Kristina Hammerö	Lantmännen Cerealia	industry
Roland Fransson	Magnihill	industry
Rolf Stegmark	Findus Sverige AB	industry
Wiveca Almgren	Magnihill	industry
Josiah Meldrum	Hodmedods	industry/innovation
Silvia Sponza	Danube Soya	interprofessional body
Anna Palme	NordGen	interprofessional body (gene bank)
Morten Rasmussen	NordGen	interprofessional body (gene bank)
Gunnar Backman	OpenEye AB	interprofessional body (innovation company)
Kasper Vaessen		other
Marcus Nordgren		other
Rita Diana Farkas	AMBIS Ltd.	SME
Anna Hermansson	SLU	student
Anton Lindesson	SLU	student
Björn Larsson	SLU	student
Blenda Agell	SLU	student
Camilo Ardila	SLU	student
Emma Tozer	SLU	student
Heather Tribe	SLU	student
Hilde Vaessen	SLU	student
Ida Widin	SLU	student
Itzhak Bakal	SLU	student
Joerg John	SLU	student
Jonas Jonsson	SLU	student
Md.	SLU	student

Raseduzzaman		
Miquel Saludas	SLU	student
Pamela Konfor	SLU	student
Sbatie Lama	SLU	student
Swathi Chaganty	SLU	student
Taylor Older	SLU	student
Thomas Andersson	SLU	student
Thompson	INRA	academic researcher
Le Gall	INRA	academic researcher
Bourlet	INRA	academic researcher
Duc	INRA	academic researcher
Oonen	INRA	academic researcher
Lepetit	INRA	academic researcher
Traversac	INRA	academic researcher
Salon	INRA	academic researcher
Martel	Agrovegetal	SME
Annicchiarico	CRA	academic researcher
Pecetti	CRA	academic researcher
Rubiales	CSIC	academic researcher
Madueño	CSIC	academic researcher
Ferrandiz	CSIC	academic researcher
Torres	IFAPA	academic researcher
Brites	INIAV	academic researcher
Vaz Patto	ITQB	academic researcher
Bronze	ITQB	academic researcher
Gabiña	IAMZ-CIHEAM	academic researcher
Wolter	NPZ	academic researcher
Sass	NPZ	academic researcher
Seelt	Patrimvs	SME
Belcher	PGRO-RL	SME
Johnson	PGRO-RL	SME
Winkler	SZG	academic researcher
Adam	SZG	academic researcher
Jensen	SLU	academic researcher
Carlsson	SLU	academic researcher
Bargaz	SLU	academic researcher
Muel	CETIOM	SME
Lopez-Bellido	UCO	academic researcher

Polanco	ULE	academic researcher
Evidente	UNINA	academic researcher
Cimmino	UNINA	academic researcher
Kiss	AMBIS	SME
Pillinger	LIMAGRAIN	Industry
Smith	WHERRYANDSONS	Industry
Lichtenzveig	Curtin University	academic researcher
Rees	SRUC	academic researcher

Annex 3: The panel at the end of the stakeholder workshop

Judith Lichtenzveig (Curtin University, Australia), Gunnar Backman (OpenEye AB, Sweden) and Fred Stoddard (Helsinki University, Finland)