Legumes Translated Report 1

Actor group's knowledge and insights into constraints and opportunities

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Legumes Translated

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About this report

The purpose of this report is to document the contributions of the 15 actor groups in the Legumes Translated project, particularly the work done to fulfil contract deliverable 3.1 (Compendium of actor group knowledge).

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Introduction

This report provides an overview of the knowledge management concepts in Legumes Translated and provides a compendium of assessments of the knowledge resources that the actor groups represented in the project have.

The overall aim of Legume Translations is to increase the production and use of grain legume crops in Europe as part of an overall change in how protein is sourced and used in Europe (a European Protein Transition).[1] Although grain legumes such as faba bean, pea and soybean account for about 14% of the global arable cropping area and are essential to global plant protein supplies and many sustainable plant-based foods, they account for only a few percent of arable cropping in the EU.[2] The European Union's agricultural system as a whole is 71% self-sufficient in all tradable plant protein[3] but 86% of the high-protein plant product imported to meet the 29% deficit is soya (the equivalent of about 36 million tonnes per annum. This protein deficit is a fundamental challenge to the resilience, acceptance and performance of our agri-food systems. Legumes Translated supports innovation in all major grain legume-supported cropping systems and related agricultural activities by linking sources and users of quality-assured knowledge. It is the first EU Framework Programme thematic network in this area and is also unusual in strongly featuring the development of soybean production.

Our consortium comprises an existing innovation community of actor groups that draws on its own research-based knowledge, other knowledge, and on its own value-chain actors' knowledge. Thanks to the project, the involved actors have the benefit of extended inter-group exchange and rigorous knowledge synthesis and compilation at two levels. The first is at the level of specific actor group farming systems and related value chain activities. The second is exchange, compilation and synthesis of knowledge from different but related actor groups within seven networked technical areas of agricultural sector and value-chain transition (sub-networks called transition networks). A co-learning framework will test, validate and add to emerging knowledge. From this, we will produce an extensive range of outputs, including (a) practice notes that focus on specific questions or decisions; (b) practice abstracts for the European Innovation Partnership for Agricultural Productivity and Sustainability (EIP-Agri) based on practice notes; (c) practice guides that provide the knowledge and understanding background; and (d) videos mainly for practitioners. All our outputs will be brought together on an internet-based knowledge internet platform (The Legume Hub) for upscaling and out-scaling of farming system and value-chain development activities.

Translating research into practice is more than collecting and 'transferring' existing knowledge. Legumes Translated uses a co-learning framework to supporting empowering knowledge acquisition with two stages: the exchange, compilation, validation and publication of knowledge and insights in 14 actor groups and the same within seven transition networks. Partners DMB, HEL, SRUC, TEAG, TI and ZALF have

[1] www.murphy-bokern.com/images/The_Protein_Transition_DS_DMB.pdf
[2] Watson, C.A., Reckling, M., Preissel, S., Bachinger, J., Bergkvist, G., Kuhlman, T., Lindström, K., Nemecek, T., Topp, Cairistona, F.E., Vanhatola, A., Zander, P., Murphy-Bokern, D., Stoddard, F. (2017). Grain legume production and use in European agricultural systems. Advances in Agronomy 144, 235-303.
[3] Murphy-Bokern, D., Peeters, A. and Westhoek, H. (2017). The role of legumes in bringing protein to the table. In: Murphy-Bokern, D., Stoddard, F., and Watson, C. (Eds.). Legumes in cropping systems. CABI.

recently reviewed the development of legume cropping in Europe.[4,5,6] Despite the large amount of existing agronomic and other technical research in the EU, inter-disciplinary thinking and outputs that integrate knowledge in the context of value chains are rare. This project integrates the contributions of all relevant actors and support key decision makers. The project is about enabling active and empowering knowledge exchange and acquisition rather than just 'knowledge transfer'.

Our 'multi-actor' knowledge exchange, compilation and co-learning concept

Four co-learning cycles (Figure 1) support exchange, compilation, practical testing and validation of knowledge. Each actor group includes or works with research-based partners to validate and compile knowledge in co-learning cycle 1. Building on this, the seven themed transition networks of these actor groups (sub-networks) develop knowledge outputs relevant to sectors and value chains within co-learning cycle 2. Co-learning cycles 3 and 4 arises from the interaction between the actor groups and the policy community in relation to private and public benefits respectively.

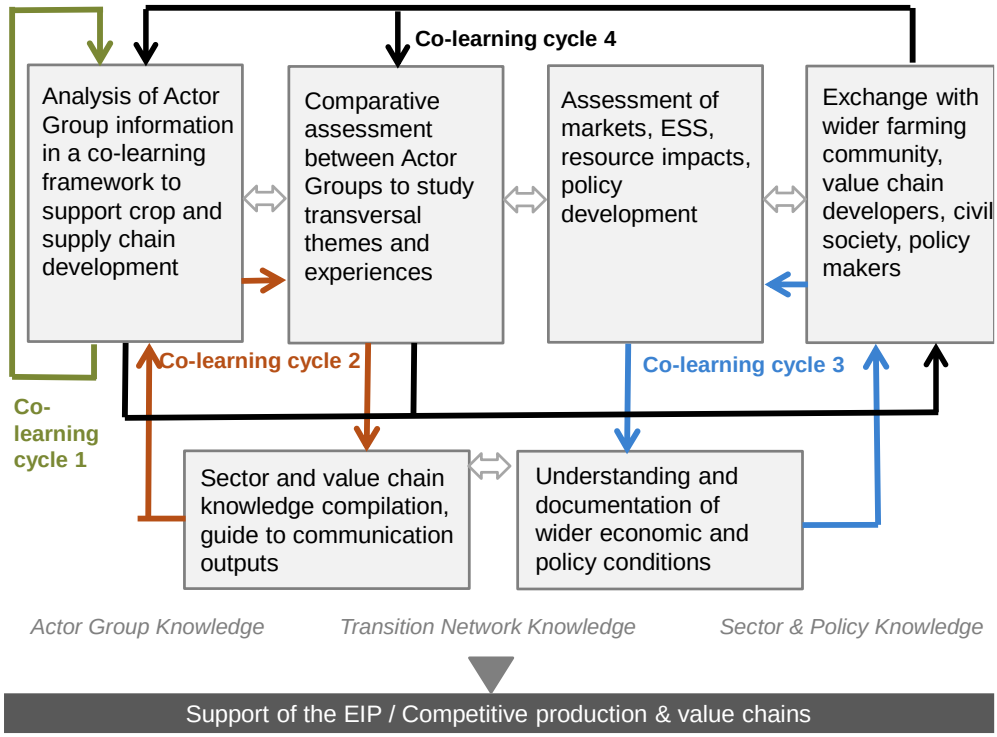

Figure 1. Overview of the analysis and cycles of co-learning in Legumes Translated

Our actor groups: Each actor group is unique and has its own locally-funded role and management. The actor groups themselves are not part of the project. Through the representing partner in the consortium, each has a facilitator within Legumes Translated who supports the knowledge exchange and interactions within each actor group within the project (co-learning cycle 1) and the exchange/interactions between actor groups

[4] Zander et al. (2016). The decline and potential recovery of grain legume cultivation in Europe: A review. Journal of Agronomy for Sustainable Development

[5] Murphy-Bokern et al. (2017). The role of legumes in bringing protein to the table. In: Murphy-Bokern, D., Stoddard, F., and Watson, C. (Eds.). Legumes in cropping systems. CABI

[6] Watson, C.A., Reckling, M., Preissel, S., Bachinger, J., Bergkvist, G., Kuhlman, T., Lindström, K., Nemecek, T., Topp, Cairistona, F.E., Vanhatola, A., Zander, P., Murphy-Bokern, D., Stoddard, F. (2017). Grain legume production and use in European agricultural systems. Advances in Agronomy. In press.

(co-learning cycle 2) in transition networks. Actor groups provide information on current systems and potential legume and other crops. They will discuss priorities/aims they have for re-designing their systems (market demand, climate change, diversification, policy...) with other experts in the consortium. From this, we identify cropping system innovations, evaluate these and the current practice. As the project progresses, actor groups are expected and encouraged to develop their role and outputs flexibly beyond that foreseen as networking reveals technical and commercial opportunities.

Our actor groups activities range from improving agronomy and rotations, integrating farm-grown and processed legumes into local and regional feeding systems (including aquaculture), improving large-scale soy production in eastern Europe and developing large-scale east-to-west flows of soy; and improving the linkage between producers and processors in locally-produced pulses. Each actor group includes existing interactions between research-based experts. These connections are summarised in Table 1.

Table 1. The actor groups and how they support knowledge interaction

1. Bulgarian Legumes Network, Bulgaria
Responsible participating organisation: Agrobioinstitute (ABI) **Associated research-based organisations**: Dobrudzha Agricultural Institute (DAI-General Toshevo), Experimental Station of Soy-bean (ESS-Pavlikeni), Institute of Forage Crops (IFC-Pleven) Research Institute for Mountain Stockbreeding and Agriculture (RIMSA-Troian)
The Bulgarian Legumes Network comprises legumes researchers, breeders, farmers and small private feed and food producers. It was established in 1995 by the Flanders Government Programme "*Cooperation of Flanders with the country from Central and Eastern Europe*" 1995-2005 and continued under the Agricultural Academy. Activities include breeding and development of agro-technologies for varieties adapted to particular environments and establishment of production programmes for the farmers and growers. Research units in the Bulgarian Legumes Network provide knowledge for grain and forage cultivation.
2. German Soybean Association (Deutscher Sojaförderring), Germany
Responsible participating organisation: Centre for Agricultural Technology, Augustenberg (LTZ) **Associated research-based organisations**: LTZ Augustenberg, LZSE Freiburg, University of Hohenheim.
The German Soybean Association (GSA) has more 100 members (mainly farmers, companies involved in soybean business, advisors, scientists). It supports knowledge exchange to optimize soybean cultivation, transformation and use in Germany, including from the German Federal Soy Demonstration Network. A website (www.sojafoerderring.de), audio-visual material, manuals (e.g. in cooperation with FiBL/Donau Soja), field days and lectures for farmers, training for farmers and responses to direct enquiries are provided.
3. Soy Network Switzerland
Responsible participating organisation: Research Institute of Organic Agriculture (FIBL) **Associated research-based organisations**: FIBL, Agroscope
Aiming to support organic soy production within Switzerland especially for human consumption, this actor group involves the Coop supermarket and all relevant stakeholders to coordinate efforts relating to breeding, cultivation research, extension, processing, product development, retailing, and promotion. Group meetings identify market- and sector development opportunities and constraints, and share research results. FiBL provides technical leaflets, writes newsletter news and articles for the Swiss organic knowledge platform www.bioaktuell.ch, and farmer magazines. Additionally, field days are organized and courses are offered (www.FiBL.org/fileadmin/documents/de/FiBL-kurskalender.pdf). Information and research findings are also exchanged with organisations from other countries such as in Germany, France and Austria.
4. Schwaebisch Hall Producers, Germany
Responsible participating organisation: Schwäbisch Hall Producers Community (BESH) **Associated research-based organisations**: Internal education and training unit
The BESH Network is based on the BESH Farmer Producers' Association, a farmer-owned development organisation. BESH owns a meat processing enterprise that goes through to finished products, marketing and retailing. Sustainable animal production schemes are mandatory. The actor group brings together BESH farmer members, feed suppliers, education organisations and farm advisors implementing new scientific knowledge to secure a reliable supply of regionally-produced plant protein. BESH is also a member of the EIP-Operational Group for animal welfare and nutrition.
5. Soybean cultivation group in south-eastern Europe

Responsible participating organisation: Institute for Field and Vegetable Crops (IFVC), Serbia (RS)
Associated research-based organisations: The institute is a research organization with very close ties to farming through its seed-producing subsidiary NSEME.

This actor group assembles knowledge about soybean cultivation in Serbia where soya is a particularly important crop. Serbia is the only European country which does not have a protein deficit. The aim of the group is to improve the profitability and sustainability of soybean production through the optimization agronomy practice and knowledge interaction with farmers. Information from farmers will be combined with research-based expertise and shared to promote best practice. Specific activities include data collection on farm level bases, as well as production of multimedia material for soybean agronomy practice optimization.

6. Donau Soja value chain development group

Responsible participating organisation: Donau Soja Organisation (DS), AT, DE, HU, Serbia (RS)
Associated research-based organisations:

This actor group assembles the knowledge from actors (especially farmers) across east and south-east Europe who have so far successfully expanded soy production in Europe. The overall aim of the group is to further develop soya production over this large region and link it to new value chains for livestock production, supported with certification and corporate social responsibility. This includes development of improved practices supported by Development Guides and Practice Abstracts with related knowledge exchange. The Actor Group includes research-based experts and has direct access to research in the Horizon 2020 Internet of Things project.

7. The German Lupin Network, Germany

Responsible participating organisation: Leibniz-Centre for Agricultural Landscape Research (ZALF)
Associated research-based organisations: State Research Centre of Agriculture and Fishery Mecklenburg-Western Pomerania, JKI GroßLüsewitz, University of Rostock, Bavarian State Research Centre for Agriculture, LTZ, University of Applied Science Weihenstephan-Triesdorf, Fraunhofer IVV, ZALF, DAFA (German Agricultural Research Alliance)

The German Lupin Network supports the increase of lupin cultivation and use by networking all relevant value chain actors. Representing the network in Legume Translations, ZALF is developing its crop rotation planning and assessment tool ROTOR further to optimize lupin-supported rotations concerning N-balances, weed pressures and phytosanitary issues. Assessment results of current and optimized rotations including lupins of network farmers are presented and discussed at regional farmer's workshops. The network's internet platform informs farmers about new research results from related projects, experiences of network partner farmers. Regional field days, and conferences and workshops are used.

8. The German Bean and Pea Network, Germany

Responsible participating organisation: Hessen State Centre for Agriculture (LLH)
Associated research-based organisations: See Actor Group description in Section 4

This actor group is analogous to the German Lupin Network, supporting innovation in the production and use of pea and faba bean. The partners are state institutions, universities, associations and a private institute and are involved in activities including extension services, farmer field trials, market development, quality control. This Network was established in 2016.

9. Swiss Lupin Network

Responsible participating organisation: Research Institute of Organic Agriculture (FIBL)
Associated research-based organisations: FIBL, Louis Bolk Institute (NL), LfL in Bavaria, Centro di Ricerca per le Produzioni Foraggere e Lattiero-Casearie (CREA-FLC) in Italy, and Semillas Baer in Chile.

This network started in 2015 in the Horizon2020 project DIVERSIFOOD (Embedding crop diversity and networking for local high quality food systems) in collaboration with Edwin Nuijten (Louis Bolk Institute, NL) and supported by the Swiss wholesaler Bio-Partner. It comprises partners from the entire (organic) lupin production chain including plant breeders (Getreidezüchtung Peter Kunz), farmers' organisations (Progana, Bio Suisse), feed mills (Mühle Rytz, Mühle Lehmann), tofu producers (Fredag), Swiss retailers (Coop Switzerland) and wholesalers (BioPartner). The objective is to establish sweet lupin as a valuable domestic food and feed crop, complementing Swiss soybean.

10. Brandenburg Farmers' Networks

Responsible participating organisation: ZALF - Leibniz Centre for Agricultural Landscape Research
Associated research-based organisations: ZALF

Two networks (conventional and organic) focus on improving the efficiency and sustainability of their cropping systems. The integration of legumes and the improvement of techniques including grain legumes (lupin, pea, soy bean) and perennial forage crops (legume-grass and alfalfa) is or will be one of the main focus of the networks. ZALF is conducting on-farm trials and develop cropping measures to optimize the legume production within a participatory approach. For optimizing legume-supported crop rotations, we use the crop rotation planning and assessment tool ROTOR. There are periodical field days and workshops to transfer knowledge.

11. Irish Grain Legumes Group, Ireland

Responsible participating organisation: Teagasc, Arvum
Associated research-based organisations: Teagasc

Ireland imported over 1 million tonnes of high-protein oilseed meals while producing less than 20,000 tonnes of this material in 2014. This group brings together representatives of industry, research, technology transfer and farming to examine the barriers to the development of protein crops, the research required to make them viable in Ireland, knowledge transfer from research to farms and the initiatives/incentives required at government level to promote "green" protein. Teagasc runs a field-based research programme on faba bean production, seed companies provide knowledge derived from variety trials, industry reps. provide knowledge on end use and markets, policy makers offer their views on legislation; and in a structured way this group combines all this available knowledge to create a strategy that will develop and sustain an Irish "green" protein industry. Through conferences, meetings with government policy makers, open days on research and demonstration farms, the compiled knowledge is transferred to the people who have the power to effect change in the value chain.

12. SAC Dairy Protein Group, UK

Responsible participating organisation: Scotland's Rural College, (SRUC), UK
Associated research-based organisations: SRUC

This is a grouping of consultants and researchers that support commercial farms aiming to optimise their use of protein and replace purchased protein feeds by home-grown sources - with particular emphasis on white clover and faba beans. There is specific interest in Scotland in reducing purchased protein supplements and replacing them with home-grown protein crops. All consultants have farmer clients who are optimising their use of protein within a wide range of dairy farming systems and the consulting team also includes specialists in feed evaluation and diet formulation. The group brings together expertise from SRUC researchers and consultants, milk purchasers, feed supply companies, plant breeding and veterinary surgeons. The group is assembling practical experience about agronomy, feed evaluation, diet formulation and milk production responses to grain and forage legumes from commercial farms and evaluating this alongside results from previous and current research trials conducted at the SRUC Dairy Research and Innovation Centre.

13. LegumesForFish, Greece

Responsible participating organisation: NIREUS
Associated research-based organisations: University of Thessaly.

The use legumes in fish feeds as substitutes of fish meal is steadily increasing. However, soybean is not suited to the arid parts of the Mediterranean. *LegumesForFish* aims to develop a prototype legume-based supply chain based on Greek varieties of other legumes that are well- adapted to the local conditions for use in farming of Mediterranean fish species. This Actor Group consists of a dynamic agricultural cooperative of young farmers (THESGI) that cultivate 2,800 hectares in total in the region of Thessaly, the biggest plain in Greece; the biggest Mediterranean fish producer (NIREUS) that operates two fish feed factories of 75,000 tonnes annual production; and the University of Thessaly (UTH) that uses innovative methods for the qualitative control and benchmarking of legumes as fish feed ingredients. *LegumesForFish* conducts trials and develops protocols for the production of local legume varieties adapted to the pedo-climatic conditions of southern Europe, best management practices for cultivating small pieces of land and provides support services to farmers. *LegumesForFish* runs seminars and knowledge transfer to the farmers using agricultural engineers as knowledge transfer fellows. Comparative farming protocols are presented in manuals and brochures and feedback is collected. Conferences, meetings, regional development workshops, are the main vehicles for the dissemination of knowledge to other professionals and policy-makers.

14. Ground for Growth, Finland

Responsible participating organisation: University of Helsinki, HEL
Associated research-based organisations: UH, Finnish Natural Research Institute LUKE

Farmers, consumers and their organisations, NGO representatives, as well as food and circular-economy enterprises work together with scientists to co-create directions for the transition to increased legume production and consumption in Finnish society. The Group is driven by a desire to increase sustainability in food production. All actors will be organized around Interactive Meeting Points (IMP), which combine face-to-face meetings, workshops and seminars with a virtual platform, including the use of social media, to provide a means for trans-disciplinary, value- and experience-based co-creation of knowledge. The AG supports closer ties with farmers through events organized by the rural advisory ProAgria's member organisations. Consumers gain knowledge about cooking pulses from workshops organized by the Martha association.

Figure 2. Location of each of the 14 actor groups.

Actor group knowledge resources

The work reported here is mostly support function. This support takes the form of continuously observing and assessing actor groups' knowledge resources and 'soft' interactive activites as well as more structured events and interactions. This then supports the production of knowledge ouputs, especially the practice notes. This report is complemented in particular by the development of transition networks' publication plans.

The early discussions with and between actor groups in the seven transition networks revealed the wealth of information and experience in actor groups. Some of this information comes from other projects and this route represents and important way for the consortium to access the results of related projects.

The work started with a workshop of the actor groups in the first consortium meeting. Together with workshops for each of the transition networks, this resulted in an overview of the actor groups and their interests. It was agreed at the workshop that each actor group should report further on its expectations and ambitions for the project as part of the multi-actor approach using a questionaire designed for this propose. This was completed in March 2019.

At the start of the second year of the project, it was decided that a special effort to link the consortium's knowledge base in actor groups and the project's publication activities was required. This resulted the drafting of six publication plans which were the subject of a special consortium meeting on 4 and 5 March 2020.

Because of the concurrent work on publication plans, it was decided to focus the synthesis of knowledge so as to directly support publication planning. Discussions at consortium meetings indicated that actor groups have a great deal of knowledge but they often have difficulty recognising the knowledge they have in ways that can be used in publication planning. All actor group representatives were asked to report on:

Relevant strategic insights
Relevant formal knowledge and understanding
Relevant informal (tacit) knowledge and understanding
Information on associated projects
Relevant publications

The results are presented for each actor group.

Actor group descriptions

Bulgarian Legumes Network

1. Bulgarian Legumes Network	
Responsible participant organisation: AgroBioInstitute **Status:** Public Sector Research Establishment (PSRE) **Contact person:** Anelia Iantcheva **Email:** aneliaiancheva@abi.bg **Telephone:** 00359 (2) 963 54 13 **Web:** www.abi.bg **Country:** Bulgaria	

Context

The main grain and forage legumes grown in Bulgaria are common bean, soybean, lentil, pea, alfalfa, trefoil, winter and spring forage pea and clover. Of these, soybean, alfalfa and pea are mostly grown using informally imported foreign varieties: only 3% of the soy crop, for example, consists of Bulgarian varieties. Most of these foreign varieties are not well adapted to Bulgarian conditions and drought is a major cause of low yields where irrigation is not used. Droughts and lack of irrigation facilities, alongside the use of inappropriate varieties, are the main factors limiting yield and quality of grain and forage legumes in Bulgaria.

In Bulgaria, research, breeding and development of appropriate agro-technologies for legume production, together with extension and advisory services, are the responsibility of research institutes, which are the core of Bulgarian Legumes Network. Their responsibilities are to promote newly created varieties and technologies appropriate to Bulgarian climate conditions and to translate new knowledge and innovations in crops development to farmers and growers.

Group description

The Bulgarian Legumes Network (BGLN) is a flexible network of researchers, breeders and growers. It was established in 1995 by the Flanders Government Programme "*Cooperation of Flanders with Central and Eastern Europe*" 1995-2005 and continued within the structure of Agricultural Academy. BGLN activities include breeding and growing programmes for the development of legume varieties adapted to Bulgaria-specific environmental conditions. The connected research units are:

Dobrudzha Agricultural Institute (DAI) -General Toshevo has long term experience in the breeding and selection of grain legumes and the appropriate agro-techniques for their cultivation. DAI produces basic and pre-basic seeds and provides agro-techniques for common beans, peas and lentils, which are widely accepted by Bulgarian farmers.

Experimental Station for Soybean (ESS) - Pavlikeni has both a scientific research and a seed production department. ESS breeds all Bulgarian soybean varieties (non-GMO), focusing on increased grain yield, grain yield stability and resistance to stress factors including economically important diseases. Work is underway on variety maintenance,

breeding and seed production for certified soy-bean varieties. The annual production is about 60 tonnes of elite soybean seeds.

Institute of Forage Crops (IFC) – Pleven is an unit involved in breeding and seed production of forage crops, technology and ecology of forage crops, forage preservation, quality evaluation and utilization. In the network IFC is presented by their legumes forage unit and particularly alfalfa due to its role in development of sustainable and ecologically friendly agriculture.

Research Institute for Mountain Stockbreeding and Agriculture (RIMSA) –Troyan is unique institute established for agriculture in mountain and semi mountain regions in Bulgaria. In RIMSA is located all breeding programs for forage crops, conveyable for mountain conditions. Locally created varieties of red clover and white clover are one of the most important forage legume species in meadows and pastures located in mountain and semi mountain region of Bulgaria and for forage production for stockbreeding in the mountain conditions.

AgroBioInstitute (ABI) - Sofia is the leading scientific, research and advisory organisation, and coordinator of the BGL network. It aims to improve the methods and systems for evaluation of economically important Bulgarian legume varieties, their value chain for food and feed production and ecological impact – by using modern agricultural methods, molecular biology and genomics and metabolomics approaches.

Aims and work

The aim of the BGL Network is to increase legumes production by supporting their development through the testing, demonstration and dissemination of innovative agronomic techniques and by providing data related to their desirable attributes (quantitative and qualitative) for agricultural farmers, growers and food and feet processors. Such spreading of knowledge related to local legumes varieties, assessment of their nutritional qualities and their regular inclusion in crop rotations can be considered as a base for support sustainable legume transition in Bulgarian agriculture. Other specific outputs are:

- soil analyses, performed during field trails;
- nitrogen fixation ability, assessed by a number of different methods;
- transcriptomic analyses, related to growth and nitrogen fixation ability;
- multidisciplinary analyses, for assessment of the quality of seeds and forages with respect to human diet and health, and animal feed

Work on research and development needs, e.g. surveys

The data from research collected on local legumes cultivars, agro-technology for their cultivation and evaluation of their food and feed profiles are related to specific agro-climatic conditions across Bulgaria. This innovative knowledge is then transferred to farmers cultivating legumes through talks and discussions at events like field open days, seminars, workshops, conferences, courses and summer schools.

Members of BGLN use the annual special event "Agra" – organized by Agricultural Academy – which gathers together breeders, agronomists, researches, growers, farmers, grower group representatives, food and feed processors, agricultural trade representatives, funding bodies and agricultural ministry officials, to promote Bulgarian legumes crop varieties and agro-technologies, raise debate, and highlight and prioritise

the production issues which are most important to growers.

Identified barriers and challenges to developing legume-supported farming systems

The main barrier at the national level to increasing the area occupied by legumes is the dependence on non-locally adapted varieties in the absence of irrigation facilities. The limited number of early varieties, high risk of decrease in yield and low purchase price of legume-derived products are also factors that act to deter the process of legume transition. A lack of knowledge and experience to grow legumes at farm level for animal feeding is a further constraint. The challenge facing BGLN is to promote early local Bulgarian varieties with good yield potential and confirmed nutrient profile (i.e. protein content, amino acid composition) for food and feed production to farmers; to convince them that these early Bulgarian cultivars are better and have higher plasticity than the currently dominant cultivars. For many of these varieties, there is a further barrier posed by the current deficiency in seeds to supply farmers that express interest. Our ambitions are to affirm well-adapted legumes that respond well in mixtures/intercropping. BGLN also aims to promote additional advantages of forage legumes, many of which currently have almost unknown nutritional benefits and environmental value. Our efforts are focused to assess the value of legumes' protein in the food and feed sectors of agricultural production.

Plans for innovation

For the proposed project, knowledge interaction using farm-based field demonstration in Task 2.3 is planned. The proposed development theme for local grain and forage varieties aims to explore the impact of major agronomic factors, on the quantity and quality of production of local common varieties. A two-year multifactor field demonstration will be performed for local farmers and growers and the following indicators examined: phenological observations; biometric measurements; overcoming weed competition; nodule evaluation; crop rotation; disease and pest observations; harvest index; seed weight; grain yield and technological qualities of the seeds - taste and chemical composition (protein and amino acids) for example.

Translation of knowledge will be focused on the role of legumes for human and animal benefit and wellbeing. The agronomic, technical and environmental performance will be evaluated by multidisciplinary assessment. The impact of the production and use of legumes on the environment will be assessed in different agro-ecological locations in Bulgaria. Soil analyses related to macro- and micronutrients and soil structure will be collected and analysed before, during and after field trials of the selected varieties of legumes mentioned above. Assessment of nitrogen fixation ability, together with the number structure of nodules and assessment of their efficiency will be conducted for legumes growing on the fields. Nutritional value of grain legumes for human consumption and of forage legumes as a feed for animals will be evaluated by different analysis and approaches NIRs, transcriptomics, proteomics and metabolomics.

Field performance of different case studies for mentioned above grain legumes with new Bulgarian varieties and growing parameters will be compared with standard European varieties. The innovation objective is to promote new Bulgarian grain and forage varieties to achieve a sustainable, legumes-based transition in agriculture. The planned multidisciplinary analyses will enable preparation of nutritional profiles (protein and fat

content and amino acid composition) for Bulgarian grain and forage legumes to confirm their value for inclusion in human and animal diets. They will identify the strains that respond well in mixtures/intercropping systems, and also provide assessment of positive environmental impacts and ensure development of a sustainable agro-ecosystem. By identifying early on local Bulgarian varieties with good yield potential and confirmed nutrient profiles, along with additional environmental advantages associated with their growth, it is hoped that it will become possible to increase inclusion of legumes within the Bulgarian farming system. The exchange of knowledge on agro-techniques, varieties and innovative research methods through newly established connections with other Actor Groups will facilitate improvement of legume-based farming systems and agri-feed and food chains in Bulgaria. The close work with other Actor Groups and wide dissemination of results will benefit the successful implementation of this innovative working plan.

Expectations and ambitions for Legumes Translated

Our expectations from the project are firstly to develop a complete agronomical and nutritional profile of new Bulgarian grain and forage legumes, which will benefit local farmers and growers involved in crop production. We expect the research on promoted varieties will help farmers and large cereal agro-producers of the benefit of use of legumes in crop rotation for positive environmental impact and maintenance of sustainable agro-ecosystems. We aim to affirm the nutritional role and values of grain and forage legumes for human diet and health and animal welfare. BGLN will exchange the knowledge collected during the project with other Actor Groups and intends to support a dissemination strategy enable rebalancing of European farming systems based on legumes.

Contribution to the project

Establishment of agronomical and nutritional profiles and assessment of environmental impacts of locally grown grain and forage legumes will benefit the consortium through provision of results specific for climatic conditions of Bulgaria. The results will be used to establish an innovation strategy and vision for future work in the field and to assess legume food and feed value and environmental impacts. Together in close collaboration with other actor groups in the project, these outputs will enable successful rebalancing of European agriculture. Specifically, BGLN will provide:

- exchange of data on agro-techniques and local legumes varieties used;
- exchange of data and innovative methods and approaches for the establishment of a nutritional profile of cultivated local grain and forage legumes and the evaluation of positive environmental impacts from legume-based agro-ecosystems;
- results collected from the case studies of BGLN will be compiled with the results from other actor groups through participation in annual meetings and workshops. These will be used for the innovative analysis of alternative transition pathways to legume-based agriculture in Europe.

Data/knowledge availability

This AG will provide to the project a wide range of agronomic data and cropping experiences South-Eastern Europe, which is a large part of European arable land. Data to be made available will include agronomic data, such as: local grain and forage varieties and their characteristics, crop management strategies, fertilisers used, crop rotations and

crop yields. These data are currently available in electronic format, but to be easily accessed they have to be brought together. These data sets are incomplete and represent certain periods of times. For the consortium participants, these data are not commercially sensitive.

2. German Soybean Association

Responsible participant organisation: LTZ

Status: Registered Association (e.V.)

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Country: Germany

Context

Soybean is not a traditional crop in Germany, but has been identified as having significant potential to change German cropping systems. As there was not much choice in cultivars or experience in cultivation, a group of breeders, farmers, advisors, agronomists and consumers founded the German Soybean Association in 1980 to support soybean cultivation by networking interested actors and providing useful information for breeding, cultivation, processing and consumption as food or feed.

Group description

The aim of the group is the improvement of cultivation and processing of soybeans in Germany. Since its beginnings in Baden-Württemberg (Southwest Germany) in 1980, the group has expanded to cover 11 federal states with work focused primarily on Bavaria and Baden-Württemberg. From the start, the association has organised excursions and annual meetings to share information and has published a guide for soybean cultivation with annually updates about cultivars and products for plant protection. It also proposes tests of new cultivars and connects the state institutes in charge of cultivar testing with specialised advisors. All information collected is public (by internet in recent years complementing articles in farming press). The group has more than 100 members: farmers (conventional and organic), advisors, agronomists, breeders and private individuals as well as companies (breeding, transformation into feed and food, cooperatives, machinery etc.). It operates on the basis of information exchange drawing on long-term personal contacts.

Aims and work

The association aims to implement soybean production to complement grain legume such as peas, beans and lupins in Germany by making cultivation reliable and economically viable. This is achieved by laying the technical base for added-value chains in the conventional and organic food and feed sectors by providing technical and economic information as well as connecting the different parts of the value chains. Specific activities include:

- website www.sojafoerderring.de;
- helpdesk for all partners in the value chain and for journalists interested in soybeans;
- publication of an annual cultivation guide and articles in farmer press; and
- support for experimenters, students and scientists working on soybeans

Work on research and development needs, e.g. surveys
Discussion about research needs have been on-going in the group since its founding.
Identified barriers and challenges to developing legume-supported farming systems
• Breeding for better yields and quality in combination with early maturation. • Identification of reliable cultivars for different agro-climatic situations in Germany. • Optimisation of production systems including soybeans (and other legumes) in different situations (farm types, soil and climatic conditions) e.g. reducing soil erosion; reducing harvesting losses). • Integration of different legumes in (organic) rotations. • Safe systems to avoid GMO-contamination. • Development of reliable price-information systems for different product categories. • Quality and availability of seed. • Weed control. • Approval of new herbicides for the middle EU zone in plant protection. • Inadequate access to collection points (merchants) handling soy. • Processing capacities. • Processing quality (monitoring, certification).
Plans for innovation
Quick and cheap tests for soybean quality (after processing).
Expectations and ambitions for Legumes Translated
We expect that Legumes Translated will help develop solutions on how to produce more protein/ha by improving profitability of grain legume production and optimizing production systems through combining different legumes, subject to natural conditions as well as by optimizing value-adding chains in feed and food-production (e.g. smart combinations with other protein sources for an ideal composition for different uses, maybe all on a regional basis for strengthening existing labels or create new ones.
Contribution to the project
Specifically we will: • exchange information and best practices; • contribute data from value chains; • produce extension material to be adapted and translated for other contexts; and • support joint development of new extension material (e.g. short videos).
Data/knowledge availability
The AG will contribute to the project its wide resources of knowledge in cropping soybeans in Germany and insights in developing soy-based food and feed value chains. • Data about value chains, including data that may be commercially sensitive. • Data (yield, protein) from German soybean cultivar-trials 2011-15 and hopefully onwards. • More data (for surveys; opinions for validation of propositions) might surge during the project and may be submitted to the members.

3. Soy Network Switzerland

Responsible participant organisation: FIBL

Status: Private research organisation (PVRO)

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Country: Switzerland

Context

This network is based on a long-standing partnership between FiBL and Agroscope that promotes organic soy production within Switzerland (more than 30 years breeding soy together) – together with other partners from the entire (organic) soy production chain, especially seed producers (DSP), organic farmer organisation (Bio Suisse), mills (Mühle Rytz). It aims to establish and promote organic soy production for human consumption as well as feed soy. As the market for domestic organic food soy is growing slowly, there is a much bigger potential for feed soy.

Group description

From 2016 to 2018, the network gained strength in promoting organic soy production for human consumption within Switzerland with various projects, the involvement of Coop supermarket (an funding by COOP sustainability fund). Activities are market-oriented (starting from breeding activities aiming to develop suitable varieties). The network involves the following actors:

- FiBL, with a huge network of farmers and experience in on-farm research, conducting practical and participative research, trials and extension in arable crops over many years;
- Agroscope, the Swiss State Agricultural Research Institute, breeding soy for temperate climates for 30 years;
- Delley Samen and Pflanzen AG, a seed producer closely linked to Agroscope and the Swiss Seed Producers Association (SWISSSEM), also involved in breeding activities;
- Progana, Bio Ackerbauring Ostschweiz, organic producers' associations or non associated organic producers;
- Bio Suisse, the Swiss organic farmers association; 95% of organic farmers are members. It is involved in practical research, market development, and policy development;
- Mühle Rytz has been involved in organic products for many years and plays an important role in the development of organic arable crops. They contract farmers, buy the harvest, set up infrastructure for collection, produce feed, trade with seeds and has long experience with organic soy. The business is a big player in organic soy in Switzerland;
- COOP, Supermarket Chain in Switzerland

These network partners are all involved with their capacities and expertise in this and other projects aiming to establish and promote organic soy for feed and food from Switzerland. FiBL facilitates stakeholder meetings and the development of yearly workplans towards this objective.

Aims and work

Driven by the shared interest to establish and promote organic soy production for human consumption for feed in the future in Switzerland, the actor network functions as an "innovation platform". FiBL facilitates this platform such that stakeholder interactions lead towards this objective. Following activities were prioritised:

- fostering of stakeholder networking to improve and promote organic soy production in Switzerland;
- development and testing of well-adapted soy varieties for human consumption (i.e. tofu, "milk" and "yoghurt", other products);
- optimisation of organic soy cultivation by conducting on-farm trials (focus on weed management) and cost efficient cultivation to decrease cost.
- development of sound marketing structures and services that promote and assure a stable business environment for all stakeholders;
- development of specialised organic soy extension structures (peer-to-peer, organic soy organisation) and extension materials, plus organisation of field days etc.;
- evaluation of varieties and breeding material for their suitability for organic cultivation and processing;
- support of product development and diversification in cooperation with the COOP supermarket, processing companies and food researchers;
- enhancement of the quality of soy by optimising the cleaning process in the mill; and
- expansion of this network by involving new stakeholders within Switzerland and cooperation with similar networks outside Switzerland.
- Since 2017 participatory breeding approach on 4 farms. Goal is to develop a soy population and to produce interesting breeding material for selection.

The Network is facilitated by FiBL experts who lead working groups to foster the exchange of ideas and interests, and the development of activities that innovate the organic soy sector in Switzerland..

Work on research and development needs

The Actor Group involves yearly roundtable meetings to plan, share and assess activities. To further boost learning and social capital development among involved actors, these meetings are linked to field days or special visits (seed production, variety trials, soy processing infrastructure etc.). Since involved actors play different roles within the sector, research and development needs are prioritised along the whole soy value chain. The strength of the Group is that all discussions and needs are very much market-oriented, which is a precondition for the development of successful innovations. Most urgent need to develop feed soy is the development of cropping systems to increase gross margin of the crop and motivate farmers to get in.

Identified barriers and challenges to developing legume-supported farming systems

Identified barriers and challenges are:

- successful involvement of mills to cooperate and to buy and process mixed cropped

harvests (e.g. peas and cereals);

- legumes fatigue in soils and need to further improve crop rotations or to develop resistant varieties.
- need for improved soy varieties for Swiss organic conditions (i.e. improved cold tolerance, suitable nutrient composition, weed suppression) responding well to the Swiss context and to organic production techniques (e.g. mechanical weed control). Especially interesting are early varieties with good yield potential and high protein content;
- need for testing of existing and new varieties for anti-nutritive compounds, nutrient contents, interaction with cultivation parameters;
- quality oriented production to increase share of domestic legumes in feed mixtures or for human consumption.
- need for quality oriented payment scheme and successful involvement of new organic producers;
- need for better agronomy to increase gross margin for farmers (i.e. better mechanical weed control, improved post-harvest infrastructure and technology); and
- need for more on-farm trials to adapt technologies to specific production contexts

far more extension, dissemination, demonstration.

Plans for innovation
Innovation plans include: • development and access to new soy breeding material; • development of new soy-based consumer products and new soy processing technology; • enhancement of new production techniques (i.e. intercropping) and best practices (i.e. mechanical weed control); • processing of intercropped harvests (i.e. soy/beans with cereals); • expansion of network to implement more on-farm trials and regional workshops on legume cultivation and processing in general; and • participative breeding
Expectations and ambitions for Legumes Translated
Expectations and ambitions are: • to interact with actors from other countries who are dealing with similar challenges; • to joint-reflect on the network's innovation in a bigger range of actors with foreign experts; • to be able share best practices with a wide range of actors and contribute to the development of organic soy within Europe; and • improving Swiss organic cropping systems with information from project
Contribution to the project
Our contribution will be: • sharing of insight into how to facilitate such a market-oriented innovation platform, involving all actors of a value chain; • sharing of innovations (e.g. invitation to field days and special learning events); • exchange of challenges and opportunities relating to legume-based cropping systems;

and
- important input to develop joint technical publications / extension material

Data/knowledge availability

Data relating to the farm level will be shared, i.e. crop management practices, input use, harvesting practices. Available extension material on organic soy production would be shared (potentially translated).

With the project funding, the actor group will collect production cost data on the involved farms for further economic assessment (i.e. scenario analysis), which would be shared with the project through networking activities,

The AG will provide its experiences in knowledge management and maximise the success of participatory learning in this project. The AG can access a wide range of experiences also for methodological questions referring to on-farm trials, variety evaluations, extension methods used etc. Potentially, market-near actors will be ready to share knowledge, information and data relating to processing and product development in the context of special "field visits". Nevertheless, certain information in this area is confidential and this has to be respected.

4. Schwaebisch Hall Producers

Responsible participant organisation: Bäuerliche Erzeugergemeinschaft Schwäbisch Hall (BESH)

Status: Small to Medium-sized Enterprise (SME)

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Country: Germany

Context

The BESH actor group is based on the BESH Farmer Producers' Association. It is a farmer self-help organisation, owned by the farmers and running for almost 30 years. Today, BESH owns a slaughterhouse and a meat processing enterprise. BESH markets to retailers, restaurants and consumers. Mandatory for membership and use of BESH sales channels are sustainable animal production schemes that prohibit the use of GM feed and oblige animal welfare protection. Especially in the supply of protein for pigs, this is a big challenge. A wide set of essential acids is necessary and usually only soybean meal is able to meet this demand. Therefore, the use of local alternatives seems to be the only sustainable way to provide a feed supply for the pigs that meets the meat consumers' demand.

Group description

The actor group is formed from independent livestock farmers organised in the association Bäuerliche Erzeugergemeinschaft Schwäbisch Hall w.V (BESH). BESH works as an independent company, comparable to a cooperative. The BESH Council defines the required animal production schemes for the different types of animals. BESH also works together with partners like "Kraichgau Raiffeisenzentrum eG" or "RKW Kehl" to organise a suitable feed supply for its members. Distinctively, BESH owns a slaughterhouse, meat processing facility, cool chain logistics, advertising and PR agency and shops. Therefore BESH group has direct access almost all the way "from farm to fork". The BESH actor group also contains international partners in Romania and Serbia that supply non-GM soy. All Stakeholders along the feed supply chain need to work together, to develop reasonable priced alternatives that meet the requirements of the animals, farmers and meat consumers. The Landwirtschaftliche Beratungsdienst Schwäbisch Hall e.V. (BDSH), a specialised farmers' advisory service, has been the link between farmers, feed suppliers, the slaughterhouse, and certification bodies for more than two decades. The introduction of mobile mills is a recent innovation.

Aims and work

BESH markets the meat using its own brand and is in charge of the whole value chain: from the farm to the consumer. Therefore, a sustainable production system is very important for it.

- The group considers it very important to have a trustable supply chain for non-GM

feed. The aim of BESH is that all members will be able to feed 100% regional feed in the next 10-20 years. Until then, however, feed from crops grown in Europe should replace overseas imports as soon as possible.

- BESH also works to empower farmers. The group supports activities to bring consumers to farms to discuss matters of animal breeding, keeping and feeding, whilst for farmers in foreign countries, it provides assistance to organise the production and marketing of sustainably grown crops.
- Cool-season legumes are an important alternative or supplement to soy. Therefore, farm evaluation about alternatives and knowledge transfer about how to grow and/or use the legumes is essential. Furthermore, the use of legumes needs to be assessed and an integration into quality control implemented to ensure appropriate usage of them at BESH member farms.
- BESH has a lot of experience in conducting projects. Examples include: Leading Pilot chains 5 and 7 in the EU Project "Q-Pork-Chains" (sustainable pig production and marketing of regional specialty meat); Partner in the EU Horizon 2020 Project "Treasure" (use of traditional pig breeds); PPP Project in the Region Krasnodar (supply of non-GM soy), supported by DEG; PPP Project in Ukraine (supply of organic soy), supported by DEG; Cooperation with Landwirtschaftlicher Beratungsdienst Schwäbisch Hall e.V. (supporting farmers in feeding non-GM, supply and own cultivation of soy); The EU funded marketing campaign "Den Geschmack der Region Hohenlohe erleben – Schwäbisch Hällisches Qualitätsschweinefleisch" (www.haellisch.de); Use of "Heimatfutter", in cooperation with Raiffeisen Kraichgau eG; and involvement in "Deutscher Sojaring" (helping farmers to grow soy on their own fields in the region Hohenlohe); member of the EIP Agri Operational Group: *Animal welfare – through an innovative feeding concept for pigs – Cultivation and exploitation of domestic grain legumes and fibre animal feed.*

Work on research and development needs

BESH, as a grass-roots organisation, uses its Board and Workgroups to develop and decide about its own guidelines that members are obliged to conform to. These discussions support on-going appraisal of challenges and research needs.

Identified barriers and challenges to developing legume-supported farming systems

Identified barriers and challenges:

- transition from bean to crushed or extracted soybean meal of high quality;
- local roasting and processing of soy;
- legume seeds and breeds suitable for the climate in Hohenlohe;
- risks and the development of suitable action plans: e.g. if weather leads to bad harvest and not enough regional legumes are available;
- infrastructure to handle regional flows from non-GM products, especially soy, peas and beans;
- high quality livestock need a high quality feeding system – there is a necessity to develop something that uses different regional legumes; and
- protein crops grown in Hohenlohe do not currently meet the demand of regional livestock production.

Plans for innovation

Through the work of the actor group's farmers and stakeholders, the value chain should be

facilitated to use sustainably grown protein crops produced as locally possible for livestock production. Several steps are necessary and much innovation is needed. One step is to evaluate the possibilities on different farms to grow or source regional legumes for protein. Through the actor group, knowledge transfer about cultivars, planting technology and processing of legumes will be organised. Furthermore, feeding management needs improvement and feeding concepts for different livestock production methods for a sustainable use without quality losses will be demonstrated on farm in Legumes Translated. These farm evaluations will help to cluster farms and farming techniques in order to develop information materials for farmers to show them new options. Farmer counselling organisations are important partners and consultants will be educated about the outcomes to enable them to help farmers in the adoption of suited concepts. Actors such as farmers, consultants, feed processors, feed traders and certification bodies will be brought together in regional groups to work jointly for more sustainable protein crops use. These regional networks will be important groups for dissemination of results and knowledge transfer.

Within the value chain approach, quality management will also be assessed and improved. This will help to solve occurring issues as soon as possible and also ensure that consumers and journalists can have proof of the proper implementation of sustainable feeding regimes. Infrastructure for processing and growth of legumes will also need to be improved as part of the actor group's work.

The planned approach for Legumes Translated is laid out below. The first, highly important, step will be to execute an on-farm demonstration of the possibilities to integrate sustainably grown local legumes for livestock production. Specific activities will comprise farm visits and a survey about the status quo, to:

- evaluate of the possible uses of locally grown legumes considering climate, animal breed/legume species, processing (e.g. soybean toasting), feed processing;
- calculate feed ratios and develop feeding concepts which meet the demand of livestock and integrate sustainable grown legumes;
- evaluate the potential for growing legumes on farms; and
- evaluate the possible supplies of legumes from local partners.

The actor group will be developed to extended to actors along the value chain. This will involve:

- research to identify the necessary actors to improve sustainable use of legumes; (farms, feed mills, mobile mills, seed suppliers, processing partners, farm counselling services (Beratungsdienste), certification bodies, haulage contractors, …); Transition pathways knowledge transfer about use & cultivation of legumes;
- group meetings for famers; presentation at farmers events (Mitgliederversammlungen etc.) (2 meetings/year for 3 years = 6 meetings/presentations, Individual meetings with stakeholders (mills, feed suppliers etc.) to discuss possibilities of legume use; 8 meetings/year for 3 years = 24 meetings;
- cross-actor group meetings (for example, joint meetings with farmers and feed suppliers) to develop concepts 4 meetings/year for 3 years = 12 Meetings
- development of a quality management concept to be implemented throughout the value chain;
- evaluation of critical success points in the value chain regarding use of legumes; and

- analysis of GM contamination in legumes/feed to prove success (50 tests/year for 3 years =150 tests);
- establishment of a concept for the use of sustainable legumes for high quality livestock production; and
- quality management to prove that the value chain acted as promised.

Expectations and ambitions for Legumes Translated

The group includes experts in cultivars, crop production, processing, certification, national and international trade and science. The BESH Network expects to be the major facilitator of a Transition Pathway, providing knowledge transfer to farmers and the value chain in practice. We also aim to conduct farm evaluation in WP2 (Task 2.3) together with the Waitrose farming partnership and SRUC. Evaluations of the BESH Actor Group will give deep insights for specialists and transfer knowledge about the most important and most difficult fields of operation. Additionally, the possibility to visit farms, mills and slaughterhouses could be good source of first-hand information. BESH ambition is to improve the quality management and food supply chain towards a regional sourcing of protein feed. For products with a strong connection to a region, like the P.G.I. pork from BESH, it is important to close such gaps to maintain consumers trust.

Contribution to the project

The BESH Actor Group will provide:

- a network of farmers (BESH Members) who can use legumes for feed or grow legumes on the farm;
- access to a value chain from farm to fork to analyse outcomes as well as consumer preferences;
- research on the growth and processing of legumes in partner projects in Serbia and Romania;
- experts from BESH and the landwirtschaftliche Beratungsdienst Schwäbisch Hall (BDSH);
- meat quality data from pigs (outcomes from different feed strategies could be tested); and
- reports about on farm and value chain evaluation.

Data/knowledge availability

The BESH actor group can draw on a wider range of knowledge resources in the field of livestock production including domestic legumes including technical, farm economic and marketing aspects as well as experiences how to design knowledge transfer processes. Since BESH operates on multiple levels of value chains the AG is able provide experiences on developing whole farming systems. In addition, the following data will be made available for analysis:

On-farm evaluation

- analysis of livestock farms (n=40 farms);
- farm categorisation;
- SWOT analysis for each category (Potential use of legumes, obstacles, opportunities…)
- report with analysis;
- spreadsheet with farm data on production systems, region, size, land use, animal

production, feeding technology, feed category etc.; and
- categorisation by possible improvements for each individual farm

Within the pigmeat and poultry transition networks

- report about the necessary actors to improve the sustainable use of sustainable legumes in the value chain;
- development and dissemination of Transition Pathways in 42 meetings;
- report about critical success factors for implementation of the quality management concept from farm to through to slaughterhouse or point of sale;
- assembled outcomes and analysis of these;
- calculation of the costs of implementation and use of "new" legumes in the value chain and the feasibility of implementation; and
- publication of a report about marketing ad communication of "new" legumes, a list of critical points and a handbook for use in marketing.

5. Soybean Cultivation Group in South-Eastern Europe

Responsible participant organisation: IFVC

Status: Public Sector Research Establishment

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Country: Serbia

Context

Soybean farmers in SEE face several challenges regarding sustainability on financial and environmental level due to climate changes and input/output price fluctuation. Main problem for those farms are agronomy practice optimization on farm level, sustainable management with special emphasis on economical and environmental impact of different agronomy practices. Optimizing agronomy practice could improve overall impact on environment and finical benefit to farmers. Soybean cultivation group in South-Eastern Europe consists of small and large well-equipped farmers, state research institutes, extension services and breeders.

Group description

The Institute for Field and Vegetable Crops has, through its commercial arm (NSSEME), direct access to Serbia leading producers of grain legume crops, especially soy. This Actor Group systematically draws on this knowledge resource and integrates it into the project through the participation in soy, pigs and poultry transition networks.

Aims and work

The aim of the group is to improve the profitability and sustainability of soybean production through the optimization agronomy practice and knowledge transfer to farmers. Providing information from the latest scientific research and optimizing within the context of individual farming systems. Information from farmers will be shared to promote best practice. Specific activities include data collection at farm level, as well as production of Practice Abstracts and video material for soybean agronomy practice optimization.

Work on research and development needs

The group identifies individual farmer gaps in soybean agronomy practice and links these to research requirements and available resources. Individual farmer needs are identified and management practices are developed based on research.

Identified barriers and challenges to developing legume-supported farming system

Main barriers and challenges to developing legume-supported systems are:

- variability in soybean yield between years;
- commodity price fluctuation and decision on agronomy management practice;
- impossibility of application recommended practice.

Plans for innovation

Support of innovation through the knowledge exchange and supporting communication materials, within the on-going NSSEME innovation support programme.

Expectations and ambitions for Legumes Translated

Legumes Translated can help actor group by providing the following:

- information from a range of soybean farming systems across Europe;
- economic analyses from European regions with similar problems;
- access to new technology in agronomy practice and possibility of application in our conditions.

Contribution to the project

The actor group can offer data from the following studies:

- data from soybean farm about agronomy management and its relation to yield;
- production of multimedia material related to particular agronomy management;
- production of leaflets describing best practices; and
- harmonization and equalization of the level of knowledge and experience of farmers in terms of the best agricultural practices in soybean production in the SEE region.

Data/knowledge availability

Information and knowledge will be made available from:

- IFVC research data;
- large plot soybean historical yield;

Collected and optimized data will be accessible in electronic format and through multimedia material.The data will concern yield, crop quality and crop management.

6. Europe Soya Value Chain Development Group

Responsible participant organisation: Donau Soja

Status: SME

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Country: Central Europe (Danube Region)

Context

Soya production is increasing steadily in eastern Europe, especially in Romania and Ukraine. A significant body of practical experience has developed and the actors involved are now placed to develop new animal feed value chains that replace the traditional value chains based on imported soya that is processed centrally in oil mills.

Parallel to this development, Donau Soja has established expertise in developing new and quality demanding feeding system. In the Austrian egg sector, the retailers and their supply-chains responded to consumer demands for regionally produced GMO-free food products (plant and animal-based). The egg farms replaced imported soy with European soy and began to use the Donau Soja Quality Standard and Label ("Donau Soja") which guarantees the production origin of soybeans (Danube basin), the compliance with GMO-free requirements and additional sustainability criteria (e.g. ban of desiccation of soybean fields). This experience with eggs offers a model for achieving analogous change in other livestock species and value chains. Such new value chains require more efficient and precise decentralised heat treatment and the optimisation of the processing of relatively small batches.

Group description

This actor group consists mainly of farmers (crop and livestock producers) and feed & food processors (SMEs) located in central and eastern Europe (AT, IT, DE, CH, RO, HU and Ukraine). Researchers and technology providers are also indirectly linked via the activities of the DS R&D team to this group. The majority of them are members of Donau Soja or are linked by the quality assurance system implemented in accordance to the quality standard 'Donau Soja'.

Aims and work

The overall aim of the group is to further develop soya production over this large region and link it to new value chains for livestock production. This actor group also seeks to collaborate with the AGs focused on soybean cultivation (AGs 2, 3 and 5).

Farmers and SMEs within this group are already collaborating in the area of soy production and use to achieve a higher competitiveness of their products. This group, facilitated by Donau Soja, provides a platform for knowledge exchange and the implementation a quality standard for traceable and transparent food products and by PR activities aiming at consumers. The R&D team of DS facilitates research-based knowledge exchange at the European level to support innovation in the group's businesses. The feed processors have as buyers of soybean and sellers of feed products a central role. They are certified according to the 'Donau Soja Quality Standard' and are supplying certified feed for livestock-producers located today mainly in Austria, Switzerland, South-Germany and Serbia.

Work on research and development needs

This actor group represents the main actor members of Donau Soja that are involved in the production of soya in central and eastern Europe. The agricultural expert team of DS maintains a close and good relationship to independent researchers, technology and input providers and producers to identify development needs. In this work, the DS R&D team receives strong support of the independent Scientific Advisory Board of Donau Soja (see also DS Partner description).

Identified barriers and challenges to developing legume-supported farming system

Experiences of the actor group have shown that the main challenges are:

- availability of grain legumes for value chains (quantity and price);
- stability in the delivered quality of grain legumes for feeding livestock;
- integrating domestically grown grain legumes into feeding systems; and
- consumer awareness about the importance of regional feed

Plans for innovation

Complementing AG 2,3 and 5, this AG concentrates on value chain development at various scales. The plans for innovation include:

Development of techniques to optimise these alternative feed supply chains. This includes for example the use of processing technology supported by the use of sensor technology (e.g. NIRS).

Development of improved practices supported by Development Guides and Practice Abstracts with related knowledge exchange. A best practice guide which describes the success factors for producer-processor groups (key data for processing technology and infrastructure; required production capacities)

Out-scaling of a decision-support system for farmers based on sensor data and on soil and weather information to optimise variety selection. This includes tools for traceability and a web-based platform for all actors along a value-chain to exchange experiences. This is being developed in another project (IOF2020 project).

Developing feed rations based on the quality of regionally sourced soybeans.

Expectations and ambitions for Legumes Translated

The group hopes that Legumes Translated will support the exchange of best practises in sourcing and processing regional protein crops (e.g. feed rations or soybean production guides (practice abstracts). Further it is expected that international expert meetings will support network building and knowledge exchange. Soybean and livestock producers will benefit from best practises demonstrated in multimedia-materials. Legumes Translated should in particular solutions to meet challenges related to climate change (e.g. extreme droughts in summers).

As part of the "Strategic Development Partnership with the Austrian Development Agency", DS runs a development programme in Moldova and Ukraine where it aims to establish regional soy-based value-chains. Experiences from best practices found in groups in Austria for producing-processing and feeding regional soy could be effectively assembled by Legumes Translated for end-users in Ukraine and Moldova.

Contribution to the project

The group will contribute its existing knowledge and experience in value chain development, especially based on the development of the egg-based value chain. The group as a whole unparalleled experience of growing soya at various scales. It has a deep understanding on the role of and implementation of certification.

The group includes an international network consisting of DS offices and representation in Austria, Germany, Italy, Hungary, Serbia, Poland, Romania, Moldova and Ukraine. This network can be used to reach end-users with project results (best practises). Regularly organised events such as field days, B2B meetings and farmer trainings will offer valuable outlets. This includes the Donau Soja organised European congress that is held every two years which is a meeting for CEOs and researchers working with soy. DS is interested to link this congress with annual project meetings or with expert workshops.

Data/knowledge availability

The following data will be made available:

- The actor group has access to statistics in parts of the European feed sector (market reports provide basic information; detailed information requires data mining)
- Descriptions of employed technology and key figures about the best-practise processing facilities.

7. The German Lupin Network

Responsible participant organisation: ZALF

Status: Public sector research establishment (PSRE)

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Country: Germany

Context

The German Lupin Network is one of several networks initiated by the German Federal Ministry of Agriculture, Forestry, Environment and Water Management within the framework of the national protein crops strategy. The aim of the strategy, and thus this Network, is to support legume production in Germany and to expand the area under cultivation. Lupins are particularly relevant in Germany because of large areas characterised by sandy acid soils in northern and eastern Germany to which lupins are well adapted.

Group description

The German Lupin Network (full title: Demonstration network for cultivation and utilisation of lupin) brings together nationwide best-practise farmers with long term experience in growing lupins, state research centres, advisory agencies, breeders, processors and trading companies. The main objectives of the network are to support the increase of lupin cultivation, the development of relevant value chains and the transfer of knowledge between research institutions, extension services, breeders, processors and farmers. The German Lupin Network is funded by the Federal Ministry of Agriculture in Germany and was started in 2015. The different partners are:

1. *Partners that focus on network activities.* These include national (ZALF) and federal state research and extension centres from the federal states of Mecklenburg-Vorpommern, Brandenburg, Saxony-Anhalt, Lower Saxony and North Rhine-Westphalia. These are focused on the cooperation with regional partners and **knowledge transfer**.

2. *Partners involved in specific technical activities.* These comprise processing, trading and advisory companies along **the value chain**: Saatzucht Steinach GmbH & CO KG (lupin breeder), Prolupin GmbH (lupin food processing), Börde-KRAFTKORN-SERVICE GmbH (trading company) Baywa AG (trading company) and Biopark e.V. (farmers' association).

3. *Farmers.* A number of demonstration farms/data acquisition farms (DF, DAF) exist, with 21 DF involved in the demonstration of best practice **cultivation and feed use of**

lupines and 31 DAF in providing farm production data concerning the cultivation and feed use of lupins.

4. *Cooperating partners (CTC)*. These will provide their knowledge and experiences along **the value chain** of lupins (breeding, cultivation, processing and trading). Partners are: JKI Groß Lüsewitz, University of Rostock (AUF), Society for the Promotion of Lupine e. V., Stiftung Ökologie & Landbau, Bavarian State Research Centre for Agriculture, Agricultural Technology Centre Augustenberg, Seed Production Triesdorf, University of Applied Science Weihenstephan-Triesdorf, Fraunhofer IVV (Fraunhofer Institute for Process Engineering and Packaging), ZALF e.V. (Leibniz-Centre of Agricultural Landscape Research), UFOP (Union for Promoting Oil and Protein Plants), DAFA (German Agricultural Research Alliance), JKI Groß Lüsewitz (national breeding research centre), feed & grain trading companies (FUGEMA, Bio Eichenmühle GmbH & Co. KG, HaGe Nord/ HaGe Hauptgenossenschaft AG, Biopark Markt GmbH) and DSV Saaten (Breeding company).

The network is directed by the State Research Centre of Agriculture and Fishery Mecklenburg-Western Pomerania. This is also where the agronomic and economic data of the partner farms is collected, analysed and provided for the network partners.

Aims and work

The goal of the Lupin Network as part of the German Protein Crop Strategy is to support the expansion of lupin cultivation and utilisation. By building a nationwide network, knowledge transfer on the cultivation and utilisation of lupin crops along relevant value chains is facilitated.

The Lupin Network's work extends from cultivar selection to cultivation, processing and utilisation of lupin in conventional and organic livestock breeding (dairy cows, laying hens, pig), as well as in the advanced processing for human food products. Exemplary selected value chains for lupin, based on scientific findings as well as on sound practical experience and guidelines from farming policy, will be described. Information about economic viability, preceding crop effect and the ecosystem services of lupin cultivation is provided. A core element of the Lupin Network as a communication platform for knowledge acquisition and knowledge transfer between research, consultancy and practice. Knowledge and newly gained insight about lupin cultivation and utilisation are disseminated through field days, seminars, lectures, newsletters and symposia. Guidelines for the entire value chain will be developed.

Work on research and development needs

The network as a national project is well connected with a number of different scientific and breeding partners, stakeholder associations and federal extension departments, as listed above. Several national research projects concerning lupins have been established and closely interlinked with the Network. These projects cover diverse areas, including food, feed (ruminants, monogastrics and aquaculture), breeding, soil improvement and phytopathological aspects. Through the involvement of different stakeholders and scientific partners, further research and development demands are identified and prioritised using field days, workshops, project meetings and the communication platform.

Identified barriers and challenges to developing legume-supported farming system
Barriers: Current barriers are low yield level, high spatial and seasonal yield variations, insufficient pest and weed control both in conventional and organic farming systems and insufficient seed availability. Lack of practical knowledge about the best implementation of lupins into cropping systems and animal diets is also an issue. **Challenges:** The main challenge in lupin cultivation and marketing is the maintenance of sufficient quantity and quality concerning the protein and alkaloid content, through shifts to improved cultivars and cropping techniques.
Plans for innovation
To foster the lupin production through knowledge transfer and improved interlinkage of scientific partners and all actors within the whole value chain. By conducting and then communicating research on areas such as the role of lupins in food and feed, lupin breeding, soil improvement and the agronomic and phytopathological aspects of cultivation, it will be possible to ensure that all stakeholders along the supply and value chain are mobilised to increase their production of lupins as part of a sustainable agricultural system.
Expectations and ambitions for Legumes Translated
The Lupin Network is particularly seeking innovation in cultivation (tillage, fertilisation, weed control, cultivars) – especially for heterogenic sandy soils – and in the processing and trading of lupins. Legumes Translated can aid this, providing: • collaboration between European networks for exchange experiences and common innovation activities; • innovative transregional and national trade cooperation; and • decision support for farm and regional specific planning and implementing of legume based cropping and farming systems.
Contribution to the project
The network will analyse the motivation for cultivating lupins and the problems in cultivation, utilisation and processing. The Network will provide information about economic viability, preceding crop effects and the ecosystem services provided by lupine cultivation. The information will cover conventional and organic farming systems and differing farm types, sizes and site qualities from West to North-Eastern Germany. We will analyse the value of feed quality and ingredients (e. g. proteins, amino acids). We will also develop and test a cropping system planning tool (ROTOR) to optimise the implementation of lupin into organic cropping systems and assess the ecosystem services provided.
Data/knowledge availability
The group has extensive knowledge resources on cropping a cool-climate grain legume and developing a value chain and a network from the ground up available. Nearly 50 farms provide field-related data on lupine and other comparable or following crops. The data will concern yield, crop quality and crop management (input, tillage, seed date, weed control, crop sequences or rotations) and the database will cover conventional and organic farming systems. At present, this data is only available for use within the German Lupine Network. Data will need to be handled as commercially sensitive data and anonymised.

8. German Pea and Bean Network

Responsible participant organisation: LLH

Status: Public extension and information service

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Country: Germany

Context

The aim of the Federal Government's Protein Crops Strategy is to enhance legume cultivation in Germany to reduce the dependency on imported protein crops. This will require an increase in both supply and demand of regional conventional and organic legumes. For such increases to be achieved, the economic competitiveness of pulses compared to other crop options has to be increased, research gaps filled, the positive, practical impacts and ecosystem effects of legume cultivation established and presented, and strategic marketing structures developed. Recently, because of the CAP reform and environmental programmes, the area cultivated with legumes has steadily increased. Problems in cultivation (weed competition, diseases, pests and lack of breeds), appropriate feeding, lack of marketing structures and inadequate prices are the main restrictions to cultivation.

Group description

The actor group "Exemplary demonstration network for expanding and improving cultivation and utilisation of peas and beans" – in short, the "pea and bean network" – covers 11 of the 16 federal states of Germany with 16 partner institutions. The partners are state institutions, universities, associations and a private institute and are involved in activities including extension services, farmer field trials, market development, quality control and knowledge transfer. The group was officially established and assembled in January. It will work on the project until December 2018 and will cooperate with research projects dealing with issues regarding pea and bean cultivation.

The main work of the group is done in cooperation with a network of 75 demonstration farms, who demonstrate best practice in growing, feeding or processing peas and beans. The cultivation itself and knowledge gained from demonstration plots is presented at farmer field days, workshops and seminars, alongside good examples for feeding, processing and marketing legumes. Some initiatives also follow the use of legumes for human consumption. The individual actors form a specific project group and network focused on the projects' specified aims. The project coordinator is Ulrich Quendt, Landesbetrieb Landwirtschaft Hessen and more details of the project can be found at: http://orgprints.org/29873/. The registered partners in the network project are:

- Landesbetrieb Landwirtschaft Hessen (Coordination)

- Ulrich Quendt (Coordinator), Kölnische Str. 48-50, 34117 Kassel
- Forschungsinstitut für biologischen Landbau (FiBL), Frankfurt am Main
- Fachhochschule Südwestfalen, Iserlohn
- Universität Hamburg
- Bioland Beratung GmbH
- Öko-BeratungsGesellschaft mbH
- Landesvereinigung für den ökologischen Landbau in Bayern e.V.
- Thüringer Landesanstalt für Landwirtschaft
- Landwirtschaftskammer Nordrhein-Westfalen
- Sächsisches Landesamt für Umwelt, Landwirtschaft und Geologie
- Bayerische Landesanstalt für Landwirtschaft
- Landesanstalt für Landwirtschaft, Forsten und Gartenbau Sachsen-Anhalt
- Landesforschungsanstalt für Landwirtschaft und Fischerei Mecklenburg Vorpommern
- Kompetenzzentrum Ökolandbau Niedersachsen GmbH
- Landwirtschaftliches Technologiezentrum Augustenberg
- Dienstleistungszentrum ländlicher Raum Rheinhessen-Nahe-Hunsrück.

Aims and work

The pea and bean project group aims to:

- demonstrate and improve legume cultivation on German fields;
- demonstrate and improve the use of legumes in livestock feed, especially for cows, pigs and poultry;
- establish marketing structures for legumes (feed and food);
- show the ecosystem benefits resulting from the cultivation of legumes;
- show the economic returns possible from a crop rotation that includes legumes.

The aims are being realised through the following activities:

- provision of extension services, especially for the demonstration farms mentioned above;
- organisation of farmer field days covering topics including the growth, processing and marketing of legumes
- demonstration trials on 75 farms across Germany, covering topics including breeding, planting and weed management and plant protection
- research on the nutritional aspects of feeding legumes, analysis of different species, evaluation of feeding and processing requirements and lectures and publication of best practices;
- economic analyses of legume inclusion in crop rotations;
- conduction of environmental assessments;
- organisation of seminars for farmers, teachers and students on diverse aspects of legume cultivation and use;
- provision of material for farmers, teachers and students regarding legume cultivation and use;
- establishment of marketing structures through relationships with companies and communication of value added marketing schemes;
- a public website http://www.demoneterbo.agrarpraxisforschung.de/;
- publication of a newsletter, articles and cultivation guides.

Work on research and development needs
The aim of the pea and bean project is to work closely with existing and upcoming research projects in order to realise further knowledge transfer and to communicate practical research questions to the scientists. There are several interfaces within the Actor Group to identify and address the research and development needs and priorities of the different actors. These include working groups, an advisory board bringing in external expertise, field days and interdisciplinary seminars. The project itself concentrates on the demonstration of pea and bean cultivation, processing and market chain development.
Identified barriers and challenges to developing legume-supported farming system
Successful legume cultivation needs skilful farmers. Knowledge transfer regarding all the relevant aspects of legume cultivation, marketing and use in feed is currently lacking, with the consequence that insufficient farmer expertise is limiting legume expansion. The high perceived risk of legume cultivation, combined with current low market prices, is presenting a barrier to legume uptake. Higher consumer prices for products like meat, milk and eggs when produced with regional fodder is also a barrier. Further challenge exists in the communication of the additional environmental values associated with legume cultivation to farmers, and the farmers' appreciation of the advantages of these.
Plans for innovation
Through the establishment of a broad network focused on peas and beans, many good and missing aspects of cultivation and use can be identified and made transparent. The national group of experts is providing a profound platform for concerted activities. The network will bring together supply and demand with quality aspects, product innovation and new marketing structures regarding feed and food.
Expectations and ambitions for Legumes Translated
The pea and bean project expects Legumes Translated to give it the opportunity to share knowledge and information with other groups with common concerns linked to the development of legumes in Europe. The idea is to profit from the other experiences in Europe in similar or different contexts. How do they create high value food chain? How do they increase profitability of legume production at farm and market-chain levels? How do they process produced legumes? How do they valorise these sources of protein? It is also an opportunity to integrate with a network dedicated to such questions and to share experiences with different trials and partners. Such a network could then support suggestions to EU for the development of evidence-based policies at the European and national levels.
Contribution to the project
The pea and bean project can contribute German experiences, results and findings to an international network. Specifically we will: • exchange data and best practices from a broad network across Germany; • share marketing structures and new developments • produce extension material to be adapted and translated for other contexts; and

- participate in the joint development of new extension material (e.g. internet platforms, short videos).

Data/knowledge availability

The group has extensive data on our value chains and demonstration trials that it can contribute to the project. Much of this is, however, considered confidential and work is ongoing regarding data protection and security of systems to identify the exact scope of existing data that can be provided.

9. Swiss Lupin Network

Responsible participant organisation: FiBL

Status: Private research organisation (PVRO)

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Country: Switzerland

Context

Up to 2014, lupins were hardly known or grown in Switzerland. There were some attempts by farmers and feed mills to grow lupins in Switzerland about 10 years ago, but with little success. At present, only about 100hectares of blue lupin *(L. angustifolius*) are grown. But with growing awareness for the need to produce protein crops domestically, FiBL started to re-evaluate lupins, especially the intercropping of lupins with cereals to overcome weed problems, a system that has become well-established for peas and faba beans over the past eight years within organic farming. The real breakthrough for this intercropping was when organic feed mills agreed to accept the harvest from intercropped legumes. They invested in devices to separate the harvest to support domestic legume cultivation. FiBL is working at present to establish a Swiss soybean network for human consumption. Learning from this experience, it also started to establish a Swiss Lupin Network in parallel to the Soy Network.

Group description

This Network started in 2015 under the Horizon2020 project DIVERSIFOOD (Embedding crop diversity and networking for local high quality food systems) in collaboration with Edwin Nuijten (Louis Bolk Institute, NL) and supported by the Swiss wholesaler Bio-Partner. The Network is led by FiBL and comprises partners from the entire (organic) lupin production chain, including: plant breeders (Getreidezüchtung Peter Kunz), farmers' organisations (Progana, Bio Suisse), feed mills (Mühle Rytz, Mühle Lehmann), tofu producers (Fredag), Swiss retailers (Coop Switzerland) and wholesalers (BioPartner). The objective is to establish sweet lupin alongside Swiss soybeans as a valuable domestic food and feed crop in the protein-demanding Swiss market. This needs effort and communication between all stakeholders along the value chain. The lupin network involves many actors of the Swiss soybean network. In addition, there is close collaboration with the Louis Bolk Institute (LBI) in the Netherlands (Horizon2020 DIVERSIFOOD project), as well as contacts to LfL in Bavaria, Centro di Ricerca per le Produzioni Foraggere e Lattiero-Casearie (CREA-FLC) in Italy, Semillas Baer in Chile and the International Lupin Society. International contacts are essential, as lupin breeding requires collaborative efforts across countries.

Aims and work

The aim of this Actor Group is to introduce another high value legume crop besides soybean and pea into Switzerland/Europe, with the intention to diversify the crop rotation

and increase the percentage of legume crops in order to lower overall protein imports. The network promotes the cultivation of white and blue lupin (*Lupinus albus and L. angustifolius*) as an economically viable production options for the present, especially in the context of mixed cropping. In collaboration with farmers, the network monitors the genetic tolerance of lupins against biotic and abiotic stress. Good yield stability is an important aim of the activities, with lupins are regarded as a crop of high potential once the anthracnose problem is under control. The network has its own breeding activities for white lupin linked to on-farm research in Switzerland and the research focus here is on obtaining a better anthracnose tolerance – anthracnose being a devastating disease and the main reason for farmers to refrain from lupin production. Yet, at a much wider level, the network aims to serve as an "innovation platform" to establish lupin production as a viable economic crop within Switzerland. The specific activities involve:

- promoting interaction among (organic) lupin stakeholders in Switzerland and other countries;
- collecting and screening of white lupin genetic resources for anthracnose resistance,
- developing genetically broad pre-breeding material of white lupin;
- developing selection tools to select sweet lupins for human consumption (tofu, milk, other products);
- optimising the cultivation of blue and white lupin under organic conditions by conducting on-farm trials. These consider shortcomings (e.g. disease resistance and weed management) that are be evaluated and prioritised in a participative process;
- evaluating varieties and breeding material for their suitability for organic cultivation and processing;
- fostering domestic organic lupin production through on-farm pilot cultivations;
- raising public awareness about lupins through field days, newspaper articles and online information;
- supporting product development and diversification in cooperation with retailers, processors and experts; and
- enhancing the quality of lupins by optimising the mill separation and cleaning process.

Work on research and development needs

The Swiss Lupin Network is flexible and well connected with FIBL's Extension Department and the Soybean Network. Research and development needs are defined through stakeholder meetings relating to field days, workshops and special events. Farmers have been involved in the network from the beginning. At the present stage of development, most research and development needs are identified through direct contact between actors, taking place at events like field days, trade fairs, workshops, conferences and courses on a national, European and international level. Open-house days and publications in agricultural newspapers, as well as videos, are used to create awareness among farmers, processors, feeding mills in addition to consumers looking for healthy diets..

Identified barriers and challenges to developing legume-supported farming system

Barriers and challenges identified include:

- higher risk for producers who cultivate legumes (lower yield stability than cereals, special equipment needed, practical experience with the crops is missing, undeveloped market);
- cooperation with mills necessary to buy and process intercropped harvests (e.g. lupin/oat);
- need for adapted varieties (anthracnose tolerance, pH tolerance, weed suppression, lodging resistance, suitable nutrient composition, no anti-nutritive compounds, early

ripening, no pod shedding);
- monitoring needed in existing and new varieties for anti-nutritive compounds (bitter lupins) and nutrient content and their interaction with cultivation parameters;
- optimising production techniques to increase gross margin for farmers (relating to weeds, diseases, nutrient management);
- breeding of suitable varieties for organic production (anthracnose tolerance, low alkaloid content, weed tolerance pH tolerance etc.); and
- access to early varieties with good yield and protein content.

Plans for innovation

The approach to innovation includes:

- supporting international connections with other actor groups to present and discuss our innovative cultivation approaches and to promote the breeding results in lupin;
- developing access to new breeding material;
- funding for more on-farm trials and regional workshops on legume cultivation and processing in general;
- learning about innovative products and marketing ideas from abroad; and
- technology exchange.

Expectations and ambitions for Legumes Translated

Legumes Translated will emphasise the importance of Swiss-grown legumes to all stakeholders as well as to the public. It will add a broad European dimension to communications providing the network with direct access to experience across Europe.

Contribution to the project

The actor group will contribute to the project by:

- organising field days with stakeholder contributions, and subsequent reporting of these in newspapers, Swiss journals and social media;
- publishing and discussing results of field trials with farmers; and
- partnering up with other actors from Europe to update the existing FIBL technical guide on lupins.

Data/knowledge availability

The AG has specific knowledge how to connect breeding ambitions and the needs of consumers/ users of grain legumes. These insights will be contributed to the project with benefits for the development of food and feed value chains of other grain legumes. Available data include:

- field performance data from on-farm trials are available from 2013 on. Data are publicly available on www.bioaktuell.ch and have partly been published in a German-speaking organic stakeholders' journal (Dierauer et al, 2015), a scientific Swiss bi-lingual journal (Clerc et al., 2015), in newspapers and at seminars;
- field performance data from an on-farm field trial, consisting of cultivar testing and intercropping partner testing for Blue (*Lupinus angustifolius*) and White lupin (*Lupinus albus*), will be available online after being published in a scientific journal;
- economic data collection (e.g. cross margins at farm level) will be one of the aims of

the network but has not taken place to date, since lupin is only just starting to be grown and processed in Switzerland;
- data from sensory testing with untrained panels and collect data on consumer acceptance.

Data will be made available across sites and years in form of excel sheets at the end of the project. Data or methods on lupin processing for human or animal consumption may contain confidential data of the respective stakeholders involved.

References:

Clerc, Maurice; Klaiss, Matthias; Messmer, Monika; Arncken, Christine; Dierauer, Hansueli; Hegglin, Django und Daniel Böhler (2015): Amélioration de l'approvisionnement en protéines indigènes avec des cultures associées. Recherche Agronomique Suisse 6 (11-12): 508-515.

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Dierauer, H., Clerc, M., Böhler, D. und C. Arncken (2015): Die Erbse kommt zurück. Ökologie und Landbau 176 (43. Jg. (4)), 34-35.

10. Brandenburg Farmers' Network

Responsible participant organisation: ZALF

Status: Public Sector Research Establishment (PSRE)

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Context

Under the site conditions of the German Federal State of Brandenburg, with its highly variable sandy soils and low precipitation, building soil fertility is a critical task to improve the sustainability of current cropping systems. Legume-supported cropping systems are particularly well-suited to this purpose. Site-adapted improved cropping measures and systems are needed to overcome the current, often insufficient, yield performance of grain legumes.

Group description

The Brandenburg Farmers' Network consists of two groups of farmers, one conventional and one organic, with strong regional, thematic and member overlaps. The farms are mainly mixed farms (beef and dairy production and arable food, feed and forage crops). Both groups are scientist-farmer networks arising out of the long term transdisciplinary research approach at ZALF. All the farms are regionally representative large farms of 500 ha to 4,000 ha per farm. The organic farms are less intensive but have a higher crop diversity including legumes.

The network of conventional farmers is located in two districts in the east of the federal state of Brandenburg and comprises around 10 large conventional farms with a size of 1,000-4,000 ha per farm. The network has existed for more than 15 years, is led by an advisor (former senior scientist at ZALF) and is supported with scientific and technical resources from ZALF. The activities include monthly meetings to discuss issues such as pest control, crop rotation planning, nutrient and carbon management, cover crops and field visits are included at every meeting (meetings take place on-farm, with location changing every month).

The network of organic farmers is located in the eastern areas of the federal state of Brandenburg and comprises of 9 large organic farms with a size of 500-2,400 ha per farm. The network was established in a previous national project on climate change adaption in Brandenburg called INKA-BB, which was led by ZALF and stopped 2014, and has been continued in the EU project Climate-CAFE til Jan. 2018, but will be continued together with the Eberswalde University for Sustainable Development within an ELER project called 'Network of organic crop production'.

Aims and work

Both networks are focusing on improving the efficiency and sustainability of their cropping systems. The integration of legumes into their cropping systems and the improvement of the legume cropping measures, including of grain legumes (lupin, pea, soy bean) and perennial forage crops (legume-grass and alfalfa including new harvest techniques for high protein feed), is or will be one of the main aims of the networks.

Work on research and development needs
The identification of research and development needs is the subject of on-going informal discussions which will be reinforced in Legumes Translated.

Identified barriers and challenges to developing legume-supported farming system
Identified current barriers to grain legumes are: • insufficient pest and weed control both in conventional and organic farming systems and the strong temporal and spatial yield variability; and • lack of practical knowledge for implementation of legumes into cropping systems, the assessment of their agronomic benefits at cropping system level and use as feed stuff.

Plans for innovation
The current plans for innovation are: • development and demonstration of promising, new, site-specific lupin and soy bean cropping measures in cultivation (tillage, fertilisation, weed control, cultivars), particularly for heterogenic sandy soils, and crop sequences (for improving yield stability and water use efficiency); • optimisation of farm internal feed use; and • development and testing of innovative high cutting techniques for forage fractionation of alfalfa to produce high protein feed.

Expectations and ambitions for Legumes Translated
We expect Legumes Translated to enable networking between European networks of legume-transition actor groups for exchange of experiences and knowledge transfer. Specifically, we want to develop decision support for farms and regionally specific planning and implementation of legume-based cropping and farming systems in the project.

Contribution to the project
We can contribute: • on-farm data about economic viability, preceding crop effects and ecosystem service provision of legumes; • data and knowledge about legume-based cropping systems at large farms; • knowledge of legume cropping under water limited conditions;

- knowledge of farm internal feed use of legumes; and
- development of a cropping system planning tool (ROTOR) to optimise the implementation of grain and forage legumes into organic cropping systems and assess the ecosystem services they provide.

Data/knowledge availability

The Brandenburg Farmers' Networks will provide multi-year farm- and site-specific data on different grain legumes and some relevant main crops. The data will concern yield, crop quality and crop management (input, tillage, seed date, weed control, crop sequences or rotations) and the database will cover conventional and organic farming systems. Beyond this, analogue data from several on-farm trials optimising grain legume cultivation will be provided. Observations of weed, pest and disease infestations will be included. Data will need to be handled as commercially sensitive data and anonymised

11. The Irish Grain Legumes Group

Responsible participant organisation: Teagasc

Status: Public Sector Research Establishment (PSRE)

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Country: Ireland

Context

The Irish arable cropping sector is mostly devoted to the production of cereals, such as barley and wheat that are used as feedstuffs to the livestock sector and feedstock to industries like malting, milling, breakfast cereal and distilling. Irish cereals yields are amongst the highest in the world but have lower protein content and need to be supplemented with other vegetable protein sources for the livestock sector. Although grain legumes, such as peas and faba beans, are grown in Ireland, they currently only represent a small fraction of the arable sector. The main source of plant protein for the feed market is soybean imported mainly from the USA. Currently, Ireland imports over 1.3 million tonnes of protein feeds annually (with more than 50% derived from GMO) while producing less than 20,000 tonnes (2014 data).

In 2010 the Irish Department of Agriculture produced the FoodHarvest 2020 report, which laid out a roadmap for Irish agriculture and in 2012, Teagasc published the Tillage Sector Development Plan with the purpose to identify profitable opportunities for increased markets that exist for the arable sector. From a number of political and market perspectives, Ireland is under pressure to reduce its reliance on imported soybean as a protein source. The use of native feed grains would sustain a more stable feed supply and actively support the FH2020 targets and would allow traceability to national quality schemes. Sustainable sourcing aligns with the Bord Bia's Origin Green Ireland programme.

Group description

This actor group involves the Seedtech seed business specialists and the seed growers, and Teagasc specialists and linked farmers. The group liaises with other relevant agents of the seed sector, agricultural suppliers, farming community, research, technology transfer and food and feed industries to promote knowledge transfer and identify opportunities and/or weakness in the sector.

Aims and work

The aim of The Irish Grain Legumes Group is to support the development of a national self-sufficient protein supply to the feed sector, based on grain legumes crops. Work is mainly focused on bringing together representatives of all the relevant agencies to discuss the details of grain legumes production in Ireland aiming to: identify the barriers to the development of grain legumes to provide the protein requirements of the feed sector within Ireland but also to compete with high-value international and national markets; identify the research requirements to make grain legumes viable options to Irish farmers; improve knowledge transfer from research to farms and the initiatives/incentives required at government level to promote national vegetable protein sources.

Work on research and development needs

The Seedtech (AST) and Teagasc partners are well established among the grain growers, industry, academia and governmental bodies. Research and development needs were established in earlier work. The research and development needs are continuously ascertained through stakeholder engagement in open days, field days, trade fairs, workshops, surveys and other specific events.

Identified barriers and challenges to developing legume-supported farming system

Main barriers and challenges to develop national legume-based protein feed for livestock:

- lack of knowledge of legume cropping: little knowledge of optimum production methods, lack of information of the beneficial effects of a legume crop to the crop rotation and lack of knowledge among farmers and feed processors as to nutritive values, digestibility and maximum inclusion rates in ruminant diets have all been identified as factors impairing the growth of legumes;
- perception of increased variability in yield and hence profit when compared to conventional cereals;
- lack of economic data;
- fear of change;
- lack of knowledge of disease incidence and control;
- lack of incentives; and
- deficit in information as to the best end use of grain legumes.

With the new CAP "greening" rules of 2015 requiring at least two crops on farms between 10 and 30 ha and three crops on farms above 30 ha, and the introduction of a coupled protein support payment by the Irish government, faba bean production is already increasing. Record yields with a nationwide average of 7t/ha and reports of individual yields of 10 t/ha have fuelled increased interest in the crop. The major challenge is to develop the required agronomic knowledge (seed rates/establishment method/crop husbandry requirements), as well as knowledge in processing and end use so as to make the most of this opportunity to develop and sustain an Irish plant protein non-GM protein industry.

Plans for innovation

The group plans to development and diversify the grain legumes production in Ireland for use in the food and/or feed sectors by filling the gap of knowledge in bean agronomy under Irish climate and soil diversity and further transfer that knowledge to breeders and growers.

Expectations and ambitions for Legumes Translated

A number of the barriers to growth as discussed above can hopefully be addressed through collaboration in the Legumes Translated project. Specifically, the sharing of knowledge and data on new breeding programmes, state of the art production systems and processing and end use of grain legumes grown in temperate climates and would be most useful. Economic assessments as to the profitability of legumes within a rotation, as well as

economic analyses of different protein sources in animal feeds would also be of benefit to farmers and industry alike and such relevant data could be shared among all members. As Ireland is a very small market for the licensing of disease control products and the area of beans in Ireland is relatively small, there is a lack of suitable chemistry for weed and disease control in beans. Joint initiatives for research into these options, as well as the possibility of licensing across a climatic region, could be of vital importance to Irish farmers and could hopefully be explored through this project.

Contribution to the project
Teagasc holds an Alternative Crops Research Programme currently directed to fundamental agronomic research on faba bean under Irish conditions. The research being conducted would be shared with members of the consortium. This includes primary field research into topics such as: plant physiology; seed rates; sowing dates; N fertilisation; P fertilisation; the use of plant growth regulators; disease control trials; weed control trials; cultivar comparisons. A survey is also being conducted at a national level to cover all main areas where beans are sowed to identify the adopted agronomic practices and to evaluate the presence of weeds, pests and diseases. The Seedtech seed business (AST) is the leading wholesaler of faba beans in Ireland. Seedtech represent the major faba bean breeding companies, such as NPZ and Limagrain, in Ireland. Seedtech conducts private faba bean variety and agronomy trials and contracts out the production of seed faba beans to elite growers in Ireland. Therefore, knowledge of the crop performance, field history and other relevant data over time is readily accessible. This information would contribute to reveal the very high performance of grain legumes in Ireland.
Data/knowledge availability
Comprehensive crop management data including cultivation system, establishment, fertiliser input, weed, pest and disease control, yield and varietal comparisons from research and commercial trials. Production input, financial performance, resource and environmental data are also available. The data will be easily accessible in electronic format from a single location. Some data on PGRs, disease and weed control and varietal comparisons will be commercially sensitive.

SRUC Dairy Protein Group

12. SRUC Dairy Protein Group	
Responsible participant organisation: SRUC **Status:** University **Contact person:** Richard Dewhurst **Email:** richard.dewhurst@sruc.ac.uk **Telephone:** +44 1387 263961 **Web:** www.sruc.ac.uk **Country:** UK (Scotland)	

Context

There is a need in Scotland to help sustain the dairy industry in the face of increasing price volatility. The SRUC Dairy Protein Group was established to bring together the latest information from research and commercial practice and to disseminate this to Scottish dairy farmers via the SRUC Consulting Network of local and national advisers. There is a focus within the group on the sustainable use of home-grown protein and farmer clients include both organic and conventional producers. The group aims to improve the financial sustainability and reduce the environmental impact of dairy farming taking into account individual farm circumstances.

Group description

This is a grouping of SRUC consultants and researchers in SRUC who act as the conduit for information from commercial farms who are aiming to optimise their use of protein and replace purchased protein feeds by home-grown sources with particular emphasis on white clover. The group will also bring in expertise from the following sectors: SRUC researchers, milk purchasers, feed supply companies, forage and plant breeding companies and veterinary surgeons.

Aims and work

The aim of the group is to improve the profitability and sustainability of dairy farming systems on client farms. This is undertaken by providing information from appropriate research projects and setting this within the context of individual farming systems. Rationing programmes are used to ensure that animal performance, health and fertility are maintained with different protein rations. Information from farmer clients within the group is shared to promote best practice. Specific activities include farmer open days, discussion group meetings, and information provided on websites and through social media. The Group has considerable experience in dairy systems research and will link in with the Defra funded project AC0122: Increasing Efficiency of Dietary Nitrogen Use in Dairy Systems.

Work on research and development needs

The group identifies individual farmer needs and links this with milk buyer requirements and available resources. Individual farmer needs are identified by one to one meetings

with farmers to discuss their overall management strategies, target milk yields, rationing and cropping plan. These individual meetings are complemented by group discussions to challenge the individual farmer management strategies. Relevant information is then sourced from published literature (referred papers, conferences, commercial publications, farming press) with the flow of information co-ordinated by the group facilitator to ensure all members of the group receive the information. Examples of stakeholder analyses are reported in the following publications:

Romer D.A.M., Roberts D.J., Mardell P. (2009). The influence of management decisions and external factors on the dairy farmers environmentally friendly farming objectives: the Green dairy experience. International Journal of Agricultural Sustainability 7, 164-175.

Roberts D.J., Leach K.A. and Goldie J (2007) Assessment and improvements of the efficiency of nitrogen use on commercial dairy farms. International Journal of Agricultural Sustainability 5: 295 – 305

Leach K.A. and Roberts D.J. (2002) Assessment and improvement of the efficiency of nitrogen use in clover based and fertilizer based dairy systems. 1. Benchmarking using farm gate balances. Biological Agriculture and Horticulture 20 : 143 – 155.

Identified barriers and challenges to developing legume-supported farming system

Main barriers and challenges to developing legume-supported systems are:

- variability in legume crop yield within and between years;
- lack of confidence in agronomy and feeding of legumes; and
- relative cost of home-grown protein crops versus purchased protein supplements.

Plans for innovation

Dairy farm management strategies need to be dynamic to take into account changes in the milk market, genetic capability of animals, new crops and varieties within crops as well as changes in climate. The Group plans to develop and access new crop varieties and management techniques, test them under local conditions and then promote the most promising to leading dairy farmers. Data from these farmers will then be fed back to the group to inform part of the information and guidelines for other farmers in the region.

Expectations and ambitions for Legumes Translated

Legumes Translated can help Scottish Actor Group by providing the following:

- relative costings information from a range of farming systems across Europe;
- agronomy information on legumes which are not usually grown in Scotland e.g. lucerne, soy;
- data on home-grown protein feeding levels and subsequent milk production and quality;
- animal health related challenges with differing protein sources in rations; and
- published information which is not easily accessible in English language.

Contribution to the project
The actor group can offer data from the following studies: • farm systems demonstration information from feeding of lower protein levels in dairy cow rations. Defra funded project AC0122: Increasing Efficiency of Dietary Nitrogen Use in Dairy Systems. Direct information from demonstration work in Scotland in 2016/17 and from associated research work at Reading and Aberystwyth Universities; • farm systems data from systems research into dairy systems with all feed grown on the farm (protein sources – clover and field beans). Data available from Phase I 2010–2016 and Phase II 2016–2021; and • commercial farm data on a range of dairy systems including organic farming, which can be linked to detailed information from farmers on technical and economic challenges associated with their systems.
Data/knowledge availability
Information and knowledge will be made available from: • SRUC dairy farming systems research; • national variety testing evaluation; and • farm scale demonstration plots. These data and information will include crop yields, crop management, crop gross margins, whole systems financial margins, fertiliser inputs and soils characteristics. The data will be available electronically and can be shared via open (web based) or closed (Sharepoint) sites. The research data is comprehensive, with systems study data from 2010-2016. The data is all relatively easily accessible, although there will be a need to develop a framework to gather the data from commercial farms. Individual farmers will be asked to provide comprehensive data, but some may not wish to provide financially sensitive data. Some data on PGRs, disease and weed control and varietal comparisons will be commercially sensitive.

13. LegumesForFish

Responsible participant organisation: NIREUS

Status: Large enterprise

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Country: Greece

Context

The quest of legume sources with low environmental footprints for use in fish feeds led to the formation of this Actor Group three years ago. *LegumesForFish* promotes the inclusion of legumes in sustainable cropping systems for use in the production of fish feeds. It is based around three members – THESGI, NIREUS and University of Thessaly – who lead in the legume production, processing, and quality control incorporation in the fish feed , respectively. Previous efforts from local fish feed manufacturers to secure legume supply from regional producers were unsuccessful due to lack of legume farming experience and organisational support. The reluctance of individual farmers to engage in a transition to legumes is to be overcome with the organisational support THESGI offers to its members.

Group description

LegumesForFish is a relatively young Actor Group based around three members which form the main part of the legume production, processing, and quality control incorporation in the NIREUS fish feeds-fish production value chain. In Legumes Translated, the group will develop a prototype value chain and aspires to develop a transition path to overcome specific constraints and dependency of European fish farming on imported soy of varying availability, quality and price. The three members are an agricultural cooperative and legume producer (THESGI), a group of fish feed and fish farming companies (NIREUS) and the University of Thessaly. THESGI is a dynamic agricultural cooperative of young farmers that cultivate and aggregate the production of 3,300 hectares in the region of Thessaly, which is the biggest plain in Greece. THESGI members experiment with local legume cultivars meant for human and/or animal consumption. These cultivars are the product of a local breeding programme run by the Greek National Agricultural Research Foundation to perform optimally at local conditions and function in rotation farming systems as the second (cool season) crop within the cropping year.

The Nireus Group is the biggest Mediterranean fish producer with an annual fish production of 30,000 tonnes. The Nireus Group operate two fish feed factories, the production of which is 75,000 tonnes of fish feed annually, which are based exclusively on imported soya – mainly from non-EU countries. The use of plant-based proteins in fish feed as a substitute of fish meal is steadily increasing, to the extent that legumes have become essential in fish feed formulations.

The Department of Biochemistry & Biotechnology, University of Thessaly (UTH), supports the qualitative control of legumes to be used in fish feeds. OptiFeed Services is a unique set of tests that defines the bioavailability of dietary proteins of raw materials and fish feed formulations as well as the content of antinutritional factors accumulated in legume seeds and impair the digestive process.

Aims and work

The overall aim of this Actor Group is to bring together the technical, economical and organizational requirements for a successful production of legumes as protein sources in fish feeds. LegumesforFish is a self-sustained Actor Group that it works to validate legume crop characteristics, ecological footprint, methods of processing and ultimate performance in the field and in fish feed in order to produce evidence for a novel structured value chain.

LegumesForFish aims to establish a self-learning cycle based on data generated from large scale operations in real-world conditions. The products of these operations will be subjected to qualitative analysis that will become the benchmarking tool for present and future reference. Current activities include:

- feasibillity studies of the production and processing of legumes and carry-over effects on production cost of rotation systems that are completed within a year;
- studies of the application of integrated legume production to optimise economic performance and support the operation of the agricultural cooperative with a code of conduct and good production practices;
- establishment of quality control protocols for using legumes in fish feeds; benchmarking of fish-relevant properties;
- studies on the effects of soy meal substitution in fish feeds; cost of alternative diets, ecological footprint and production performance indicators. For example, if the final price of the legume flour is <10€/protein unit then, based on current market prices, the cost of feed can be reduced by 5%. The soil enrichment, lower pressure on water resources, cultivation of non-GMO plants and reduction in use of raw materials related to human food production contribute to a lower ecological footprint.
- pilots of alternative legume production systems in southern Europe and their capacity to support the growth of EU fish farming. Legume production is combined with cereal and vegetable crops within a single year rotation. The legume production enriches the nitrogen elements of the soil, resulting in lower need for fertiliser use in cereal crops. This reflects beneficially on farmers income and environment; and
- micro-financing tools (e.g. contractual farming) to enhance long term cooperation.

Work on research and development needs

LegumesForFish has identified gaps in knowledge, organisation, resources and logistics services that should be addressed before a designed value chain can be functional. Relevant research projects were analysed and researchers active in selective breeding of local legume varieties were invited to provide input to the logic of intervention planned by *LegumesForFish*. This revealed the benefits of establishing farming protocols for legume crops with low irrigation demands, suitable for the southern EU territories, and rotation systems that take advantage of the southern European climatic conditions. Furthermore, it became evident that the cost analysis of legume crops should also consider in a quantitative manner the benefits of ecosystem services offered by those crops, as well as the carry-over benefit for the crops succeeding legumes in the field, since locally produced legume crops are not competitive with imported soy. Important additional parameters that should be considered in the cost analysis are the protein content and amino acid profile as well as the content of antinutritional factors that directly affect the performance of legumes in fish feeds as they are linked to fish digestion and growth processes and the overall welfare. Ultimately, a new specifications system is required to consider all parameters

contributing to the final cost.

Identified barriers and challenges to developing legume-supported farming system

Despite the global volatility in the availability and prices of soy meal, it remains the main leguminous ingredient in fish feeds. The requirements of soy cultivation can be a limiting factor for the development of the crop in many areas in EU, particularly the arid southern-European areas. In addition, the small farms and site variability and the lack of access to processing, storage and supply to the end user are key barriers to be overcome by the transition path designed by *LegumesForFish*.

Legumes other than soy are not widely used today by the fish feed industry. As a consequence, there is a lack of knowledge on the presence of antinutritional factors related to the fish species intended to be fed, and on the appropriate quality control tests. Moreover, the dependency on imports of proteineous plant ingredients for the production of fish feeds is a limiting factor for the development of fish farming in EU. Given that aquaculture is the sector of primary production with the highest growth rate globally and the target for EU aquaculture is to double in size by 2030, it is apparent that novel mechanisms to connect the legume and aquaculture production in EU are a prerequisite to the sustainable growth of the sector.

LegumesForFish is to determine a transition path that considers the subjective barriers and challenges and sets out to demonstrate novel strategies and practices at the organisational, production, ecosystem, biological resources, processing, and product quality levels with expected socioeconomic, environmental and technological impacts.

Plans for innovation

In Legumes Translated, *LegumesForFish* will work on the knowledge synthesis to create value at local scale reducing the currently high ecological footprint of fish feeds. A prototype supply chain will be developed on the basis of the production of sufficient quantities of legumes for the formulation of growing-on feeds for gilthead sea bream (*Sparus* aurata) and European sea bass (*Dicentrarchus labrax*), processing, quality certification, transportation, feed formulation, live fish feeding and evaluation of fish production performance. This will involve some testing. The mode of operation of the agricultural cooperative THESGI will be used as a case study of collective management of small-size fields to achieve economies of scale, implement the reformed CAP and amplify the spread and adoption of good practices. Examinations of the delivery of ecosystem services will be used for the development of the prototype supply chain. Based on the data already available, the strategy for setting up the prototype supply chain and generate knowledge to be shared within the context of Legumes Translated is to:

- cultivate up to four different pulse legumes (legumes other that soy, e.g. lentils (Lens culinaris), common bean (Phaseolus vulgaris), chickpeas (Cicer arietinum), faba beans, (Vicia faba)) in rotating systems. This will provide the data to infer realistic costs of crop production, to identify integrated management issues, to assess ecosystem services and financial estimates of the benefits on successive crops;
- compare two different processing methods on the basis of protein yield and elimination of antinutritional factors according to fish nutritional requirements. The cost and the qualitative and quantitative yield of each method will add to the feasibility study that will be developed for each crop species;

- measure fish-relevant qualitative characteristics to develop an important targeted estimate, the cost per unit of fish bioavailable protein. This will be used as the benchmark number for comparisons across legumes and processing methods; and
- validate novel fish feed formulations based on the legumes produced in fish feeding trials. This is expected to identify the cumulative effects of the inherent crop properties, farming practices, processing methods, fish feed formulation. The calculation of the Feed Conversion Rate will allow the overall assessment of technological, economic and environmental impacts of the prototype value chain designed.

The upscaling and out-scaling of the prototype supply chain will be supported by the introduction of innovative tools for benchmarking of legumes for use in aquaculture. The establishment of a reliable, rapid and low cost quality control scheme is expected to be an innovative step for legume producers that will support their supply agreements with fish feed companies. This quality control system will be also used to explore and introduce innovative legume processing methods that will help lead to the inactivation or removal of antinutritional factors that inhibit digestion process in the focal fish species, tailoring the legumes for targeted use.

It is envisaged that the development of this prototype supply chain will offer tangible outputs to support wider transition in the Mediterranean region that provides important ecosystem services and exploits genetic adaptation in legumes to local conditions. This includes exploiting conditions that allow two-three crops in a single year, sustainable water use, development of marine-based production of high quality dietary protein (fish) in systems. Through other members of the aquaculture Transition Network (notably PGRO), the results will be available for developing other aquaculture systems, particularly in the Atlantic region.

Expectations and ambitions for Legumes Translated

The EU is considered a pioneer in aquaculture globally in terms of innovation and knowledge generation. Sea bream and sea bass are by volume the third (36.4%) and fourth (28.15%) most farmed fish species in the EU, whereas their collective value (1.04 M€) surpasses that of salmon (0.78 M€), trout (0.55 M€) or mussel (0.49 M€). Legumes Translated is the suitable vehicle to give *LegumesForFish* the visibility at EU scale. However, fish farming is only one of the several sectors relying on legumes and Legumes Translated brings all these sectors together to exchange best practices and manage the conflict for use in a balanced fashion. With access to high quality economic, social, environmental and policy analysis, Legumes Translated is expected to offer *LegumeforFish* the support required for developing the prototype value chain and support the technological development of the benchmarking system of legumes for use in fish feeds. Furthermore, it is expected that the exchange of good practices within the consortium and the experience aggregated between its members, will be in the benefit of the members of *LegumesForFish* seeking alternative, efficient modes of operation.

New knowledge about fish dietary requirements, agriculture products processing and protocols for raw materials assessment expected to be obtained. Local agriculture production is expected to adjust accordingly to meet the expectations of local aquaculture production. This interaction is expected to grow to a positive feedback loop that will increase the efficiency of both production systems, support the economies of rural areas of EU countries and finally reduce the dependency of the European Union on raw materials

imported from Third countries.
Contribution to the project
LegumesForFish objectives are fully aligned with the overarching and specific objectives of Legumes Translated and it is set to provide: • a prototype supply chain linking legume production with fish farming activities that will operate to generate knowledge currently lacking; • data and farming protocols for the alternative production of local legume varieties adapted to the pedo-climatic conditions of southern Europe; • best management practices for cultivating small pieces of land and operational model for support services to farmers; • benchmarking system for legumes meant for use in fish feeds; and • joint development of case study for the prospects of EU legume production in relation to EU aquaculture growth. • language translation support to enrich the multi-lingual platform in Greek • Specialized EIP Practice Abstracts • Organization of Regional Field day • Active support of regional and sectoral sub-networks.

Data/knowledge availability
The information to be provided to the project span the whole supply chain from legume production to fish farming performance including: 1. yield and grain quality of the crops grown; 2. data on production practices; 3. fish resource productivity in relation to different legume crops; 4. qualitative characteristics of legume species with respect to feed quality (protein content, amino acid profile, content of antinutritional factors); 5. effects of long storage on the quality of legumes; 6. levels of inclusion of the legumes in fish feeds; 7. levels of soymeal substitution in fish feeds; 8. effects on fish key performance indicators (specific growth rate, food conversion rate, survival, operational and physiological welfare indicators). This information is available in an electronic format and they are not subject to confidentially restrictions. The information will be translated to constitute an integrated food system that links land and sea and it will be the first of each kind to take into consideration resource efficiency and resilience to climate change.

14. The Waitrose Farming Partnership

Responsible participant organisation: Stonegate

Status: SME

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Context

The aim of the Waitrose Farming Partnership is to support British food suppliers, creating jobs and boosting the economy and importantly our farmers, who are stewards of the countryside. There has been quite a lot of focus recently on both the environmental sustainability of soya from South America and also traceability/long term sustainability of all supply chains within our businesses. Responding to this development, Waitrose became 2016 member of Donau Soja and started in 2017 to source soybean from continental Europe, certified according to quality standards of Donau Soja. In November 2017 Waitrose was a signatory to the 'Cerrado Manisfesto'

As a premium retailer, both Waitrose and its suppliers are interested in investigating all supply chains that could potentially be run more sustainably. There is therefore great interest in the possibility of shortening the supply chain of a product such as protein feed supplement that is currently key to the production of livestock in the UK but associated with concerns regarding carbon output and environmental transport costs of shipping it half way across the world.

The Waitrose Farming Partnership Livestock Steering Group (WFPLSG) is made up of participants from Waitrose and the group of businesses supplying livestock protein products into the Waitrose own brand and Duchy product ranges. Current soya meal usage within the group (both GM, non GM and organic) sits at around 81,000t/y. In addition the group uses over 2,000 t/y of organic full fat soya, 3,000 t of soya oil and a small quantity of soya hulls.

Group description

Working with farmers, growers and other suppliers, the Waitrose Farming Partnership works to ensure that the best standards are applied across our supply chains, giving customers confidence in the food they buy. Investment in farmers not only ensures a stable and continuing supply base, but also promotes innovation, research and development to increase productivity. The objective of the Waitrose Farming Partnership is to future-proof farming businesses.

The Waitrose Farming Partnership Livestock Steering Group (WFPLSG) is tasked with implementing programmes that contribute to a more sustainable future for UK farms and elsewhere. The group is made up of participants from each of the animal protein supply chains into Waitrose - the premium food retailer in the UK. It has been running in its present form for over 4 years, but prior to that had been running in a similar manner,

although somewhat less formally, for another number of years. The group includes members from Waitrose (including both the Director of buying for meat, poultry, fish, frozen food and agriculture strategy and also the agriculture manager) and the group of businesses supplying livestock protein products (chicken meat, pork, lamb, beef, turkey, dairy, fish, ducks and eggs) into Waitrose's own brand and Duchy ranges of products. Participants meet on at least a quarterly basis, with the aim of delivering specific projects to future-proof farming for Waitrose. A specific feed sub group has been set up within this group to look at opportunities within each business to improve both the sustainability of animal feed and feed ingredients used.

Aims and work

The overall aims of the group include:

- improving the security and continuity of supply of products;
- ensuring optimal efficiency (while delivering points of difference);
- improving environmental sustainability across the supply chain;
- improving traceability of the whole supply chain; and
- improving stakeholder engagement.

The ambition is to implement fully traceable and sustainable supply chains in the short, medium and long term, in order to future-proof farming businesses. Following discussions, all sectors believe that further supply chain development is needed to help deliver a more sustainable form of protein supplementation into each supply chain. Development of a committed supply chain is required, from farmer to end user, to enable our requirements to be met and also allow for the potential to meet any planned expansion in our production systems. We believe that we need to come together to build a committed supply chain that include farmers, stores, merchants and marketing bodies, transport actors, feed manufacturers and end users. As a group we openly discuss the practicalities of moving our supply chain forward with regards to use of sustainable raw materials across the board.

Work on research and development needs

The WFPLSG is made up of some of the most innovative and progressive farmers in the UK. The knowledge base and contacts of the group span large proportions of their relevant industry sectors and these are used specifically to identify and drive forward innovation opportunities and priorities for the group. Specific supply chains have their own trial farms and also work closely with academic partners, industry and commercial companies both inside and outside the UK on ground breaking research projects. Members of the WFPLSG are, and have over the years, been at the forefront of both publicly and privately funded research at the forefront of their respective industries. In addition, members from some of the largest livestock production businesses in the UK are involved in relevant industry bodies.

On farm trials have already been carried out by a number of partners in the WFPLSG over the past 3 years on imported European soya vs. South American non-GM soya and South American GM soya. The research has highlighted the need for the building of joined-up supply chains to allow development of contracts that ensure sustainable and traceable production, purchase and transport of European non-GM soya into the UK. In terms of the UK market, trials have also highlighted the need for work to be carried out into the varieties grown and crushing methods used, to ensure a high quality and therefore

competitive product is produced. Decisions with regards to projects to be undertaken are made using individual business knowledge, but with the aim that positive outcomes could result and be progressed across sectors.

Identified barriers and challenges to developing legume-supported farming system

Any challenge to the "status quo" of any part of the standard supply chain (which we believe this project should be directly dealing with) can be both a barrier and challenge to development. Further information is required on nutritional quality differences between EU and South American soya and, specific to our businesses, we need to investigate the practicalities of delivery, supply chain and segregation of soya into the UK and our individual supply chains. We also feel it necessary to look at specific cultivars grown and conduct agronomic work to improve, where possible, quality of product available, and to develop feeding strategy prototypes of farm animals that optimise the use of EU grown legumes.

We have previously investigated specific pricing mechanisms which could incentivise farmers to grow specific crops and feel that these also need for investigation here, as at present there is no consistent / reliable supply of this material into the UK. Barriers and challenges to transition can be summarised thus:

- quality of product available, particularly in terms of nutrient and protein levels vs. equivalent product available from South America;
- cost of quality product vs. current product available from South America;
- cost of production for farmers vs. other crops;
- development of suitable cultivars to ensure appropriate yields for arable farmers to encourage further production;
- cost effective and reliable transport, traceability and segregation of material through Europe and to the UK;
- appropriate segregation and traceability within crushing plants;
- development of long term framework agreements with farmers to support long term sustainable supply chains for all involved. It has been quoted previously that in certain parts of Europe contracts actually mean very little.

The challenge is to avoid adding extra complexity and cost into the supply chain.

Plans for innovation

Our long term ambition as a group is to replace the importation of South American soya with sustainable, responsibly sourced European soya and other legumes grown in Europe. Whilst we are aware of the availability of European non-GM soya, the ability of our group to integrate further with other more experienced members of the Actor group would help us greatly. A number of the businesses within the WFPLSG have specific on farm trial facilities, which could be used for further more detailed analysis of physical animal performance. This could include cost benefit analysis of varietal trials, different further processing and assessing sustainability of alternative feeding strategies, with an emphasis on pork production. Work has already been carried out to try to build potential supply chains with Donau Soja: to meet with potential suppliers and see how they interact with each other/crushers and transport across Europe. We have visited Europe to look at work being carried out on varieties and are keen to work more directly with Farmers. We are also keen to look at social and environmental benefits of European soya and would be interested in looking into how these factors can be measured within each of our different

supply pathways.

Expectations and ambitions for Legumes Translated

Our long term ambition as a group is to replace the importation of South American soya with sustainable, responsibly sourced European soya. To do this, we need to improve and build relationships/contact with other members of the project using a value chain approach. As an outcome from the project, we want to achieve a fully traceable and transparent supply chain of European soya into our businesses which fits in terms of nutritional quality, economics and sustainability. The ability of the WFPLSG actor group to integrate further with other more experienced members of the Actor Group could help significantly in terms of setting up of supply chains of both conventional and organic, quality European non-GM soya.

Contribution to the project

Each business within the WFPLSG is able to carry out studies into the viability of supply of European Soya into the UK. Possible studies include the nutritional consistency of the end product and its expected use in compound animal feed, how its use is valued in terms of CSR targets of our own businesses and our customer Waitrose, its viability as an alternative to South American soya in the UK market (significantly reducing food miles and improving traceability) and the economics associated with change in supply. A number of the businesses within the WFPLSG have specific on farm trial facilities, which could be used for further more detailed analysis of physical animal performance. This could include cost benefit analysis of varietal trials and different further processing.

As a group we are able to offer research resources in the following areas of animal nutrition, formulations and feeding: pig, poultry (breeder and layer) beef, dairy, sheep, farmed fish, turkey and ducks. Specifically we will:

- contribute data on our value chains;
- exchange information and best practices;
- produce extension material to be adapted and translated for other contexts;
- participate in joint development of new extension material (e.g. short videos).

Data/knowledge availability

We could provide the following data across various animal production systems:

- animal performance data to evaluate European soya feed trials/ different varieties/ crushing methods;
- cost sensitivity and analysis of using European soya; and
- information to set up pricing mechanisms.

Some of this data would be commercially sensitive but would be available within the project in an electronic format.

15. Ground for Growth	
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Context

Finnish farming systems are generally family-based and often combined with forestry in farm businesses. The mean farm size is 40 ha of arable land. Dairy farming based on forage is possible even up to the arctic circle. A majority of the population is living in the southern parts of the country, where, agriculture mainly produces grain (wheat, barley, oats, rye). Pigs and poultry are important domestic animals on top of dairy and beef cattle. Their feed is largely based on imported soybean. Soybean cannot be cultivated in Finland, but instead, traditional pea and faba bean as well as recent additions, such as lupine, could serve the feed industry. Since many consumers are now aware of the problems with intensive cattle farming, there is an increasing interest in vegetable food protein. This is one incentive for our network. Another is the fact that because of intensive grain cropping, soil quality in the south is deteorating. By increasing domestic grain legume production for feed and especially food, and establishing more grass-legume swards in the south, these problems can be addressed. However, it takes additional measures to reach these aims. Finnish manufacturers of innovative foods are limited by inadequate supply of raw materials, while Finnish farmer groups find that their ability to produce legume crops profitably is limited by their lack of experience and their desire to grow the crops is limited by the lack of high-value markets.

During 2012-2014, the Ministry of Agriculture funded project "Fabapapuaines" investigated the use of faba bean in various food and ingredient processes, and engaged with small and large producers in the food chain. As part of this project, the food technologists now engaged in the Ground for Growth network developed processes for preventing the development of off-flavors common in legume products, and then for making milk, yogurt and tofu. At the same time, private companies have developed faba bean based quick-cooking 'Härkis' and from extrudates for example 'Nyhtökaura' (pulled oat) and other products such as lupine tempeh. The company proprietors feel that they are in competition with each other for the limited quantities of food-quality beans.

Connecting Finnish farmers to the makers of innovative foods more directly will help to solve this supply-demand dilemma. However, the question of farmer experience remains. Hence, during 2015, a group of scientists formed a team, "Ground for Growth", and participated in a science-based competition and an accelerator program, Helsinki Challenge, organized by the University of Helsinki. Interactions with stakeholders were established and guidelines for the Group's activities were drawn. It had become evident that farmers need various kinds of support in order to act in a more sustainable way, and that they also need advice and information on legume production. All actors sought equal

terms for the interaction between farmers, their advisory organizations and scientists. Equally important is the engagement of consumers. Only by having enlightened consumers, will the need for more legumes on the market increase and the whole value chain be activated. Our aim is to engage in corporate social and environmental responsibility efforts by our partners.

Group description

The group was started in 2015 by a core group who applied to science-based accelerator program 'Helsinki Challenge', to address the key challenges to the usage of legumes on Finnish farms and within the food chain. The starting point for our network was a question posed to the network leader: "How can I be more sustainable?". This question evoked interest in a wider academic community, leading to planning and discussions, especially during Helsinki Challenge. An actor network, Ground for Growth was established. The Group developed further during the Challenge process, giving a group that today that consists of networks representing diverse actors along the food chain:

1. two farmers' networks: one represents 20-100 farmers (early adopters and others) in south-western Finland, with activities relating to mitigation of the eutrophication of the Baltic Sea (JÄRKI project); the other represents 400 farmers (a mix of organic, conventional, early adopters and others) in southern Finland who belong to the extension service organisation NSL, many of whose farms suffer from degraded soils due to extensive grain monoculture;
2. consumers' networks: Marttaliitto, with 48,000 members organised at local and regional levels, who are engaged in adopting sustainable household practices (language Finnish); the corresponding organisation Finlands Svenska Marthaförbund, with 10,000 members (language Swedish);
3. NGOs involved in environmental issues: Natur och Miljö, Baltic Sea Action Group, WWF (youth);
4. processors: Six SMEs producing food and food components based on grain legumes;
5. circular economy-based enterprises: biogas producers; Soilfood company;
6. germplasm providers: One rhizobium inoculant producer, one legume breeder;
7. retail: 11 bigger enterprises representing food, feed, seed and agrochemical retailers; and
8. scientists: A multidisciplinary group of nine scientists, representing soil science, BNF, agronomy, breeding and processing as well as social sciences and humanities.

Ground for Growth focuses on pulses that can be cultivated in Finland; that is, faba bean, pea and lupin on one hand and legume-containing swards that can be cultivated in the southern parts of the country on the other.

Aims and work

The general aim of the group is to promote transitions towards increased sustainability changes in the user market, science, technology, socio-cultural and policy regimes of Finland and abroad, leading to improved usage of legumes on the farm and in the food chain. The aim is reached by adopting (translating) scientific knowledge to Finnish

conditions to change the current value chain.

- **In the user-market regime,** we are interested in food product development: facilitating information flow to decrease bottlenecks and barriers. We aim at changing eating habits in the population by encouragement towards more vegetable protein in the daily food, especially domestic pulses. Outreach and interaction with consumers' organisations is crucial and already established.
- **In the science regime,** AG members are involved in four collaborations developing molecular and microbiological tools for soil health diagnostics, crucial to guide the addition of biochar and circular fertilisation with novel organic waste products. One study is integrated in the study of farmers and sustainability, while our Academy of Finland-funded project 'Papugeno' is working with its counterparts in Denmark, Canada and the UK to develop genome-based tools to accelerate faba bean breeding. Research on plant-soil-nutrient cycles revealed by identification of microbial key genes and genomes will be expanded to encompass diagnostic microbiomes in diverse legume fields, in collaboration with AG members. Via the newly established HELSUS (https://www.helsinki.fi/en/helsinki-institute-of-sustainability-scienceinstitute), we shall form research networks to increase interaction with other scientists working on sustainability transformations, to produce sustainable solutions.
- **In the technology regime,** the aim is to support niche innovations. The Group's food technologists have identified that a heat pre-treatment of seeds is necessary to prevent the development of off-flavours during wet processing of grain legumes. The next step is to facilitate the widespread implementation of this pre-treatment. A starch processor within the Group has identified an oven in its factory that is potentially suitable for this purpose and the pilot run will commence soon. Recycling of nutrients is also put into practice, with a company specialising in circular economy and biogas production from forage under establishment.
- **In the socio-cultural regime,** ethnographic work is underway to investigate farmers' attitudes towards sustainability, legume cultivation and soil health. This will further understanding of how legumes could be better incorporated in agriculture to promote soil health and the well-being of the environment and of humans. This is being conducted in combination with soil sampling on selected farms.
- **In the policy regime,** we shall promote sustainability transformations by engaging in specific questions regarding the possibilities for farmers to transform their production systems and consumers' choices. We shall promote societal change to shift focus to consider climate change and circular economy in all decisions. We will interact with policy analysts and policymakers on an ongoing basis throughout the project. These include ministries and farmers' unions. Policy briefs will be published regularly and contacts with media enhanced.

Innovative face-to-face meeting points (IMP) are the main tool used to achieve the Group's goals. These are designed to facilitate virtual and face-to-face activities and have been outlined in collaboration with the responsible marketing agent Måndag. They combine face-to-face meetings and seminars with a virtual platform, including the use of social media, and serve to provide a means for transdisciplinary, value- and experience-based co-creation of knowledge. The use of social media will be central and a study to investigate the impact of its use is on our agenda.

On a publicity front, the academic AG partners have appeared in news media to promote legume consumption and food processing companies have been contacted and encouraged to develop pulse legume processing. The increased awareness of soil health and its

importance for sustainable food production and the climate has furthermore led to some AG members being invited to participate in novel research projects looking at nutrient circulation and healthier soils.

By bringing actors of the different regimes together in the AG, creation of niche innovations will be promoted that should lead to regime changes, assisted by the opening up of windows of opportunity in the current landscape. Results of this approach are already being seen: for Nyhtökaura (pulled oat), for example, an oat expert from a national bakery enterprise participated in a panel supervising the Fabapapuaines project and recognised the opportunity for an oat-legume textured protein product. Lupin tempeh is another example, where the tempeh processor sought lupine seeds from a farmer to produce a novel food that is unique in the world.

Work on research and development needs

During the Helsinki Challenge process and thereafter, our actors have been grouped according to development interests, such as sustainable farming, soil quality, leguminous food processing and consumers' issues. Research and developments needed and desired are identified by means of discussion, facilitated by the IMPs developed with Måndag. IMP activities organized so far consist of a Helsinki Challenge breakfast with AG members and the planning of a new workshop, as well as the planning of the virtual IMP platform and following the flow through social media.

An important parallel activity was our participation in the Climate CAFE ERA-NET project, which included a workshop with farmers in an "adaptation pilot" discussing how they could adapt their farms to expected climate change. This emphasized the need for crop diversity and improved water management (drainage during water-logging episodes and irrigation during droughts).

During 2016 -17, there has been an accelerated interest in sustainability issues concerning food and soil health in Finland. The academic members of the group have become involved in discussions and activities with stakeholders and planning for future activities has taken place. In this way, our focuses have been established: soil health and the application of the principles of a circular economy to soil amendments, sustainability and farmers, legume cultivation, pulse legume processing and encouraging the cooking and consumption of legume dishes. We shall also engage in large-scale producers in their commitments to corporate social responsibility (CSR). Research funding for our projects has paved the way to deepening knowledge, but to identify more bottlenecks we should mobilise the whole group for intense and structured interaction.

Identified barriers and challenges to developing legume-supported farming system

Current food production and consumption practices are unsustainable. Landscape analysis can inform us about the challenges, which might open up windows of opportunity for change. One of the main features of the current production/consumption landscape is expectations for climatic change, including less frequent but heavier rainfall leading to alternating waterlogging and drought conditions, and warmer weather throughout the year. Another feature is Europe's general insecurity of protein supply. A further, local, challenge is the eutrophication of the Baltic Sea and the pressure this puts on (amongst other things) production agriculture to improve nutrient capture and recycling. Questions

are regularly raised in the media about appropriateness of diet, with it being generally acknowledged that too much meat is consumed for both the health of the consumer and the health of the environment. Soy currently dominates as a plant protein source in food and feed chains, but is a warm-season crop unlikely to be widely adapted to Nordic, Atlantic or Mediterranean agricultural systems for some decades. Cool-season legumes, in comparison, remain largely neglected. Barriers, meanwhile, are imposed by the conservatism of food and feed manufacturers, the lack of farmer experience, and, in particular, the lack of market for any legume crops produced.

The barriers and challenges identified above lie along the whole value chain, from producer through processor and retailer to the consumer. It has become evident that farmers need various kinds of support in order to act in a more sustainable way, along with advice and information on legume production. Farmer groups find that their ability to produce legume crops profitably is limited by their lack of experience, while their desire to grow the crops is limited by the lack of high-value markets. Makers of innovative foods meanwhile are limited by inadequate supply of raw materials and insufficient marketing skills. One very successful member of our AG is producing a product that includes legume protein fractions imported to Finland because of the lack of domestic processing capacity. Connecting farmer and producer groups can help solve the supply-demand dilemma, but the question of farmer experience will still remain.

Engagement of consumers is equally important. In 2017, the Finnish consumers' association Finlands Svenska Marthaförbund is devoting itself to cooking pulse-based dishes. Only by having enlightened consumers will the need for more legumes on the market increase and the whole chain be activated. We already collaborated in a publication describing Finnish protein crops and dishes.

Genuine interaction and co-creation of future directions for legume-supported farming systems must involve all actors. Communication across actor groups and scientific disciplines is crucial and requires inputs from everybody. Hence, we believe that including scientists in a co-creation network will be more fruitful than a top-down approach.

Plans for innovation

In Ground for Growth, farmers, consumers and their organizations, as well as representatives for NGOs and food and circular economy enterprises, work together with scientists to co-create directions for transition to increased legume production and consumption in Finnish society. The farmer is in focus and the whole actor chain is driven by a desire to increase sustainability in food production. The entire process is innovative and will increase the social capital needed for transition across disciplines.

The Interactive Innovation Platforms (IMP) form the nucleus of the transdisciplinary transition pathways. They will serve to provide a means for transdisciplinary, value- and experience-based co-creation of knowledge. With the aid of futures studies methodology, visions for a transition to more legume-based practices in society will be developed and distributed via the IMP.

Specific innovations will materialize as niche innovations as the diverse disciplines are brought together. For example, novel food products for the market, improved soil health and carbon sequestration, legume-friendly consumers and farmers enjoying a sustainable lifestyle are all outcomes we envisage to be possible.

Expectations and ambitions for Legumes Translated
Legumes Translated will be a major boost to our network activities with HEL playing a key role in coordinating transition networks. We look forward to building upon the knowledge acquired in other networks, international collaborations and exchange of experiences and to developing, piloting and applying transdisciplinary methodology in interaction with other Actor Groups, thus making use of the innovative sustainability science approach i.e. research driven by societal needs in close interaction with end-users. We hope to prompt a major change in the dominant regimes so that the penetration of legume-based foods in the food chain is greatly improved and the on-farm productivity of legumes is greatly increased. This aim can only be achieved through sustainability transformations in the different regimes, the user-market, science, technology, socio-cultural and policy regimes, especially via niche innovations, as described above. These developments would lead to a far more sustainable society and food production chain and contribute to a better environment, climate change mitigation and reduced nutrient loads entering the Baltic sea. The innovation ambitions rely not only on our domestic network, but also on sharing and learning from the other Actor Groups in the consortium. In Legumes Translated, Ground for Growth will employ a graduate scientist with a relevant background in social sciences to lead on the work of HEL. We anticipate a breakthrough that will eventually lead from models for niche innovations to a long term change in the European and Finnish food regime.
Contribution to the project
The Group can provide standard data on farms in general, or on specific farms selected according to criteria regarding crops and economy. It will produce results contributing to the understanding of barriers to farmers, consumers and policy-makers and their value to and knowledge about Translations. Our small food-processing enterprises will act as niche developers of legume-based foods and grow accordingly. Later, when supplies of raw materials are sufficient, larger enterprises will be able to develop mass-market products. A person with relevant background will be hired to coordinate Ground for Growth and the tasks assigned to HEL in Legume translations.
Data/knowledge availability
Comprehensive data on the crops grown in each field each year, including inputs and yields, are available online in national databases and in various summary statistics. Other, more sensitive data, such as financial performance, are available from individual farmers and their organizations within the actor group, mostly on paper. Other types of data, not yet specified, along the chain formed by Actor Group participants, will be collected during the activities planned. These are to be specified later.

Actor groups' knowledge

Bulgarian Legumes Network

1. Bulgarian Legumes Network	
Responsible participant organisation: AgroBioInstitute **Status:** Public Sector Research Establishment (PSRE) **Contact person:** Anelia Iantcheva **Email:** aneliaiancheva@abi.bg **Telephone:** 00359 (2) 963 54 13 **Web:** www.abi.bg **Country:** Bulgaria	

Background

The BGLN participates in the Cool-season grain; Soy; Pig; Poultry; Dairy and beef transition networks. The long term goals of BGLN are to further the availability of well-adapted grain legumes cultivars that are well-adapted to Bulgarian conditions. The network also supports the use of forage legumes, many of which currently have almost unknown nutritional benefits and environmental value. Our efforts are focused to assess the value of legumes' protein in feed and food sectors of agricultural production.

As in many other countries, the BGLN is confronted with the challenges of simple cropping systems that lack diversity. Cropping in Bulgaria is dominated by winter cereals and maize. The dominant broad-leaved (non-cereal) crop is sunflower which is a direct competitor of soybean. As with other south-east European countries, soybean is the main grain legume option and there is a history of soybean production in the country. Agronomic challenges include poor access to well-adapted cultivars and lack of early maturing cultivars that escape drought.

On the forage side there is a lack of knowledge about feeding value and how to incorrate forage legumes into feeding systems.

Knowledge compendium

Relevant strategic insights

One of the major aims of BGLN is to learn about farmers' expectations and understand the needs of farmers and producers related to production and use of legumes in Bulgaria. In this direction visits and discussions with private agricultural and egg and meat producers were organized. These visits provide clear understanding that the grain and forage legumes production in Bulgaria is not sufficient to the needs of feed producers and animal breeders. Increasing demand on the market of Bulgarian legumes crop for the moment is not relevant to the amount of locally grown legumes due to lack of processing facilities, for example for soybean. The reason for that incompatibility is the absence of enough motivated agricultural producers, for which growing of legume crops are less profitable in relation to maize, sunflower or cereals. Combining sunflower meal and cereals and cheap imported soybean meal are economically more acceptable for livestock producers that the combine feed with the component of locally produced legumes. In addition, the society still possess low purchasing ability which reduces the demand for higher process quality. In

this situation, general strategic insights of BGLN are used for the validation and promotion of the nutritional and health properties of legumes, and feed and food produced from local legumes as well as their importance for preserving the stability of agro-ecosystems and soil fertility when included in crop rotation.

Relevant formal knowledge and understanding
BGLN includes actors who provide knowledge to farmers for the growing of grain and forage legumes. Technologies for soy, common bean, lentil forage pea, forage legumes alfalfa and clover suitable for mountain conditions are developed and certified seeds from Bulgarian varieties from these crops are available from members of BGLN. Knowledge of crop breeding in this post-Soviet country is a feature of the group. Advisory services are provided for use of legumes in crop rotations. Together with the help of other research units of the Agricultural Academy, knowledge about use of legumes in diet of pigs, poultry and small scale forage production is also available. The AG also augmented knowledge based on modern research about the nutritional quality of legumes /soybean/ and it use for further food products for example egg and meat.

Relevant informal (tacit) knowledge and understanding
White and yellow cheeses are among the most wanted and most purchased food products on the market. These products are present at every Bulgarian table. In Bulgaria sheep milk and especially its products are very important for the small scale sheep farmers. Within the AG is under discussion the investigation of small sheep farms, their diet /on pasture and combine forages and their impact of the quality of related products milk and cheese.

Associated projects
At local level part of the members of BGLN participate in a project funded by Bulgarian Ministry of education the programme "Food". Our objective under this project is to promote and evaluate Bulgarian soybean varieties under climate change.

Relevant publications

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3. Georgiev, G. (2017). Analysis of the vegetation rainfall and its relation to soybean yield under non-irrigation growing conditions. *Rastenievadni nauki/Bulgarian Journal of Crop Science, 54*(4), 14-19 (Bg).
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12. Milev, G. (2012). Efect of leaf treatment with micro fertilizers on common bean (*Phaseolus vulgaris* L.), 50-th Anniversary technical university of Varna, Proceedings of Third Intern.Sc. Congress, 04-06.10.2012, Varna, Bulgaria, v. VII, pp. 126-130.
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2. German Soybean Association

Responsible participant organisation: LTZ
Status: Registered Association (e.V.)
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Background

This actor group is a member of the Soy, Food, Pigmeat and Poultry transition networks. It is represented by the LTZ which also leads the Soy Transition Network.

The German Soybean Association is the leading source of agronomic information relevant to the development of soybean cropping in northern Europe. The development of soybean cropping in northern Europe is strongly driven by concerns in value chains about protein sourcing. The Association therefore uniquely combines agronomic experience relevant to northern Europe with experience of supporting or developing value chains that address the sustainable sourcing and use of protein in food markets that are sensitised to protein sourcing issues.

Soybean cultivation is a well-established in German cropping systems and is the basis for regional value chains. The knowledge that is available to the consortium from this actor group is set out in the Transition Network Soy publication plan (Deliverable Report 2.4). This includes information and practice-oriented guidelines on all aspects of soy cultivar selection, cultivation, crop protection and processing.

Knowledge compendium

Relevant strategic insights

In Germany policy-makers have been supporting the development of protein production using legumes and oilseeds through several programmes (e.g., Eiweißpflanzeninitiative (Protein Crop Initiative) of German Federal Ministry of Agriculture; protein crop initiatives run by several regional government (e.g., Baden-Württemberg, Bavaria, Lower Saxony) for the last 10 years. This has supported applied research and the extension of knowledge to farmers and other practice professionals in organic and conventional food and feed value chains. Nevertheless the biggest rise the crop area was the result of direct policy interventions such as "Greening", especially the measure that allowed nitrogen-fixing crops to count toward the Ecological Focus Areas or regional programmes that support diverse rotations with a certain percentage (10%) of legumes in some regions. The legume area of Germany has more than doubled and in southern Germany more than tripled since 2014. The growth has been especially strong in the soybean area with increases of 25 to 50% per year to nearly 30,000 ha in 2019. The soybean is now the most important grain legume in the southern German states of Baden-Württemberg (since 2018) and Bavaria (since 2019). The soybean is the third most widely grown grain legume in Germany as a whole, behind peas and faba beans (since 2019). Commercial leaders such as ADM who have converted their oilmill on the Danube river in Bavaria to non-GMO soy from Europe are optimistic to

attain 100,000 ha of soybeans in southern Germany in the next few years. The actor group considers this to be quite realistic if the growth of soybean area continues for some more years. The natural potential for growing soybeans is even much bigger and still growing due to breeding progress and climate change. Soybean cultivation in northern Germany is still in the pioneer phase with some local lighthouse projects (organic) but still not big enough for supporting conventional economically viable value chains (problem of hen and egg).

Relevant formal knowledge and understanding

The Association has a very comprehensive knowledge resource which is available for German farmers at www.sojafoerderring.de. This includes information to guide strategic decisions such as the zoning of soybean production and the approach to cultivar choice and information relevant to planning logistics. The knowledge based covers organic and conventional production for both food and feed. The knowledge base includes the basics of establishing the crop and crop protection. The information on crop protection provides a template for all crop protection programmes which vary between countries depending on the local registration of plant protection products.

This comprehensive compendium is being made more widely available through Legumes Translated using the soy publication described in Deliverable 2.4 (Publication plans). As a result of five years of German soybean demonstration network funded by BLE, several dozens of fact sheets and videos with technical information about soybean cultivation have been created and published on the projects website sojafoerderring.de. In the project Legumes Translated they are serving as a basis for practice notes that have to be discussed with the other actor groups within the Soy Transition Network before final validation and publication in different languages (English, German, Romanian, French, Serbian, ...), which also reflect adaptions to different regional situations within Europe (North of the Alps, Central Europe, South East Europe, …).

Relevant informal (tacit) knowledge and understanding

The discussions between partners sometimes reveal different perceptions of problems and cultivation measures. This may lead to subsequent reflections and new insights in cultivation strategies within the participating actor groups and such promote further progress. Through this, the generation of formal knowledge is integrated with informal knowledge.

Associated projects

There are still some demonstration networks for legumes in Germany working (e.g. for peas and beans, Protein initiative of Baden-Württemberg) which enable cooperation on certain subjects such as transformation technologies for improvement of digestibility or seed production. Within the Danube Soya programme there are further projects.

Relevant publications from the German Soybean Association

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Schätzl, R. (2019). So rechnet sich der Sojaanbau. In: IG-Pflanzenzucht (Hrsg.): Soja made by Mittelstand. Leitfaden für erfolgreichen Anbau.

Schmidt, H.; Langanky, L.; Wolf, L.; Schätzl, R. (2019). Soja-Anbau in der Praxis. Ackerbau & Ökonomie, ökologisch & konventionell; BLE, SÖL, LfL, 107 pages.
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Würschum, T., Leiser, W.L., Jähne, F., Bachteler, K., Miersch, M., and Hahn, V. 2019. The soybean experiment '1000 Gardens': a case study of citizen science for research, education, and beyond. Theoretical and Applied Genetics, 132 (3), pp. 617-626. DOI: 10.1007/s00122-018-3134-2

3. Soy Network Switzerland

Responsible participant organisation: FIBL
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Background

The Soy Network Switzerland is a network of soy value chain stakeholders from breeding to processing. involved in three transition networks: 'Soy' and 'Food'. The overall goal is to develop and establish organic soy cultivation in Switzerland for feed and food, including the development of suitable and cost effective cropping systems and cultivars. We have different activities ongoing: organisation of farmers meetings/farm visits to promote soja growing in Switzerland in cooperation with Organic Farmers association and cantonal extension service, carry out courses about grain legumes processing for food (Tofu etc.), animate processors (food) to use Swiss grown grain legumes as a raw material and continue to promote and carry out variety trials under organic conditions and testing varieties for their suitability for tofu production, support breeding for organic conditions in cooperation with agroscope. Constraints addressed by the network include lack of soybean cultivars adapted to Swiss organic-faming conditions, particularly early-maturing cultivars.

Knowledge compendium

The Soy Network Switzerland has the following resources of knowledge and expertise that are being incorporated into the project's activities:

- We are a network of soy value chain stakeholders from breeding to processing.
- We have different activities ongoing: organisation of farmers meetings/farm visits to promote soja growing in Switzerland in cooperation with Organic Farmers association and cantonal extension service.
- Courses about grain legumes processing for food (tofu etc.) from Swiss-grown grain legumes as a raw material and continue to promote and carry out variety trials under organic conditions and testing varieties for their suitability for tofu production, support breeding for organic conditions in cooperation with agroscope.
- We maintain in cooperation with other institutions a network of soya variety trials on 4 conventional and 3 organic sites, testing varieties, and breeding lines for performance but also fast ground cover for weeds uppression, furthermore all varieties are anaysed for processability for tofu.
- We maintain an network for on farm trials for further variety testing and demonstration puroposes and to develop new cultivation techniques (Relay intercroppping)

Ongoing and already finished projects of FiBL Switzerland related to organic soy

- Relay Intercropping – Ein ressourcenschonendes Anbausystem für Soja in Mischkultur

in der Praxis weiterentwickeln 30.04.2019 - 31.12.2021.

- Entwicklung der Bio-Soja-Wertschöpfungskette in Europa (LegValue) 01.06.2017-31.05.2021
- Bio-Speisesoja Schweiz - Optimierung der Schweizer Produktionskette für Bio-Speisesoja vom Saatgut bis zum fertigen Produkt (B3S) 01.01.2016 - 31.03.2019
- Entwicklung von Selektionssystemen und partizipativer Züchtung auf Unkrautunterdrückung bzw. -toleranz für Schweizer Soja (Soybean Breeding) 01.10.2016 - 30.04.2021
- Biosoja aus Europa 01.04.2014 - 28.02.2016
- Weiterentwicklung der Biosoja-Anbautechnik (Auftrag der Bioorganisation Progana) 01.01.2011 - 31.12.2012
- Ausweitung des Sojaanbaus in Deutschland durch züchterische Anpassung und pflanzenbauliche Optimierung; Teilprojekt : Optimierung der Symbiose von Bradyrhizobien mit kühletoleranten Sojasorten (SOYA) 01.01.2011 -31.12.2013
- Entwicklung des Sojaanbaus in der Schweiz durch gezielte Verbesserungen in der Anbautechnik , 01.01.2013 -31.12.2015

Relevant publications and extension materials

- Overview of our work about organic grain legumes on the Swiss knowledge platform Bioaktuell.ch https://www.bioaktuell.ch/pflanzenbau/ackerbau/koernerleguminosen.html
- Weed management in organic soy: https://shop.fibl.org/chde/5004-fingerhacke.html
- Practice guide Organic Soja in Europe: https://shop.fibl.org/chde/1690-biosoja-europa.html
- Technical Leaflet Organic Soja : https://shop.fibl.org/chde/1023-biosoja.html
- Technical Leaflet Organic grain Legumes: https://shop.fibl.org/chde/1520-biokoernerleguminosen.html

4. Schwaebisch Hall Producers

Responsible participant organisation: Bäuerliche Erzeugergemeinschaft Schwäbisch Hall (BESH)
Status: Small to Medium-sized Enterprise (SME)
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Telephone: +49 7904 9797 60 / +49 7904-9797-73
Web: www.besh.de; www.haellisch.de
Country: Germany

Background

The actor group is involved in the Soy, Cool-season grain, (Cooperation: Poultry), (Dairy & beef) transition networks. The overall goal is to increase the use local grown legumes in the pig value chain. Soy from overseas should be replaced by at farm grown and processed legumes or at least from suppliers in the same region, country or neighbouring country.

The aim of the actor group is to provide knowledge and best practice examples on pig feeding with locally grown grain legumes to increase farmers' willingness to use them on their farms. Best practice examples will be identified among members of the actor group and the information will be summarized in practice notes and a video. This is reflected in the publication plan of the transition networks pig and poultry. Information from other actor groups and transition networks in Legumes Translated will be provided to increase cultivation of grain legumes in the region. For that purpose, also lectures, field days and excursions have been and will be organised for farmers in cooperation with partners from Legumes Translated (German Pea and Bean Network, German Soybean Association).

Knowledge compendium

The BESH actor group has insights along the whole pig value chain. It has access to farmers and farm advisors as well as its own slaughterhouse, processing and marketing of pork products. BESH also has a lot of experience in production, certification and marketing of locally produced non-GMO-meat, meat with an EU protected geographical indication (Schwäbisch Hällisches Qualitätsschweinefleisch g.g.A.) and organic meat. Supply of non-GMO protein feeds is an important factor in the production of the indicated products. Therefore BESH has a high interest and experience in sourcing non-GMO soy and also local cultivation of grain legumes.

A survey conducted among pig farmers (BESH members) has shown that many of them are home compounders. They mostly use non-GMO soy (extracted) from Europe but also other grain legumes such as peas and beans.

The survey and discussions with farmers and advisors have identified two important issues that have a negative impact on farmers' willingness to grow grain legumes. These issues need to be addressed on a political level to improve the framework for cultivation of grain legumes in Germany:

- Low competitiveness in comparison to most grains, especially wheat, due to better yields of cereals. Financial support/funding is needed to compensate for this, otherwise

farmers are not willing/able to cultivate grain legumes

- Since legumes do not need nitrogen fertilizer, legume-cropped land is generally not available for spreading manure. The expected tightening of laws regarding use of fertilizer/manure therefore may have a negative effect on the cultivation of grain legumes in areas with large livestock populations.

BESH has provided information on typical crop rotations in the region, with and without grain legumes, including economic data. This information will be used in WP 3, 4, and 5. Additionally, insights into the value chain for pig meat were given in an interview which will be used for Deliverable Report 3.3.

The information and knowledge gained during the first part of the project will be used to identify aspects of pig feeding and meat quality which should be tested in a field trial. So far two issues seem to be interesting for a follow up. Effects of feed mixtures containing soybean cake and other grain legumes on meat and especially fat quality of a local pig breed. The focus should be on feed ratios which are relevant for farmers in this region. Also, it could be interesting to test cultivation and use of new soy varieties with less antinutritive substances (no toasting required).

Associated projects

Anbau von GVO freiem Soja in der Region Krasnodar/Russland mit begleitender Implementation eines Zertifizierungsverfahrens und dessen Vermarktung nach Mitteleuropa (2007-2010)

Q-Pork Chains Nachhaltigkeit und Innovation in der Schweinefleischerzeugung: Kooperationen zwischen Wissenschaft und Wirtschaft (2009-2011), EU Framework 6

TREASURE - Diversity of local pig breeds and production systems for high quality traditional products and sustainable pork chains (2015-2019)

Relevant publications

Matthias Petig (2020): Wachstum, Schlachtkörper- und Fleischqualität der bedrohten Schweinerasse Schwäbisch-Hällisches Schwein unter besonderer Berücksichtigung von Haltungs-, Fütterungs-, und Kombinationskreuzungsvarianten, Dissertation, Universität Gießen

5. Soybean Cultivation Group in South-east Europe

Responsible participant organisation: IFVC
Status: Public Sector Research Establishment
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Web: www.nsseme.com/en/
Country: Serbia

Background

Soybean Cultivation Group in SEE is participating in following transition networks:

- Soy-based value-chains for feed and food (Soy)

The overall goal is to improve the profitability and sustainability of soybean production through the optimization of agronomic practices and knowledge interaction with farmers.

This involves:

- increasing sustainable soybean cultivation and its use in south-eastern Europe;
- integrating soybeans into cropping systems to improve the sustainability of agricultural systems, reduce nitrogen losses to the environment and it will have positive effects on soil quality and agro-biodiversity (crop diversification); and
- translating existing knowledge the improvement of crop management practices in soybean production.

Knowledge compendium

Relevant strategic insights
IFVC maintains a diverse and successful cooperation with different research facilities and commercial leaders (users of soybean seed). The project was presented to policy makers and commercial sector through existing events that IFVCNS organized/participated (fairs, seminars), the feedback on planned activities were very positive.

Relevant formal knowledge and understanding
This actor group is centred around the commercial arm of the IFVC (The NSSEME, NS). The IFVC has over 50 years experience in soybean breeding and is also involved in developing cultivation practices, production technology and all other related fields (148 NS soybean cultivars have been registered in Serbia and 192 registered abroad, out of which 50 NS soybean cultivars are on the European Common Catelogue).

The Institute have different forms of international scientific, educational and business collaboration, signing memoranda of understanding with various institutions from China, Thailand, Russia, Ecuador, Bulgaria, USA, Kazakhstan, and Iran; agreements on scientific and technical collaboration were signed with institutions from China, Russia, Hungary, Israel, and Belarus (cooperation worldwide). The Government of the Republic of Serbia in May 2018 decided that the Institute of Field and Vegetable Crops acquired the status of institutes of national importance.

Relevant informal (tacit) knowledge and understanding
Discussion among actor group member covers economic information linked to insight into the on-farm performance of soy, logistics and processing, and challenges of applying some practices. The knowledge resources that the actor group has developed and makes available to the consortium are strongly aimed at farmers (collection of economic data on institute trials, collection of data from farmers). After discussion with farmers the challenges in soybean production were assessed, and mainly this is the input for preparation of different publications. Use of material provided by the actor group will give the opportunity to improve soybean production through optimization of standard applied practices, which has direct effect on production profitability (soybean sowing, inter row cultivation, harvest, diseases and pests).

Relevant publications
List any publications that support the statement about the knowledge resources.

There are many IFVCNS publications related to soybean growing technology, but we selected the most important ones that are published in past ten years.

Hrustić, M., Miladinović, J., Đorđević, V., Sekulić, P., Mrkovački, N., Đukić, V., Balešević Tubić, S., Tatić, M., Vidić, M. Jasnić, S., Sekulić R. (2011) Soybean, Institute of Field and Vegetable Crops, Novi Sad; Bečej, Sojaprotein.

Miladinović, J. (2012) Vodič za organsku proizvodnju soje – Beograd, GIZ - Nemačka organizacija za internacionalnu saradnju GmbH; Novi Sad – Institut za ratartstvo i povrtarstvo

Balešević-Tubić, S., Miladinović, J., Đukić V., Vidić, M., lončarević, V., Ilić, A., Kostć, M., Đorđević, V., Nikolić, Z., Jasnić S., Radoslav, Sekulić., Kereši, T., Pavkov, I., Vujaković, M., Dozet, G. (2014) Semenarstvo soje – Novi Sad, Institut za ratarstvo i povrtarstvo, Novi Sad

Đorđević, V., Malidža, G., Vidić, M., Milovac, Ž., Šeremešić, S. (2015) Priručnik za gajenje soje, Danube Soya – Novi Sad, Dunav soja regionalni centar

6. Europe Soya Value Chain Development Group

Responsible participant organisation: Donau Soja
Status: SME
Contact person: Dragos Dima, Leopold Rittler
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Telephone: + 43 (0)1 512 17 44-27
Web: www.donausoja.org
Country: primarily Romania, Central Europe (Danube Region)

Background

This actor group is involved in the following transition networks

- Soy
- Food
- Pig meat
- Poultry
- Cool-season legumes (We are interested to test on the DS field days in Romania some grain legume species beside soya).

Knowledge compendium

Relevant strategic insights
Since 2012, DS works closely together with governments in central and eastern Europe to develop strategic cross-border cooperations for a more sustainable protein supply in Europe. The colloborations aim to support soya producers through knowledge exchange, through an intensified support for protein crop research and through an harmonisation of relevant biosafety standards. The following activities provide strategic insights:

1. Donau Soja Declaration of 15 governments in the Danube Region
Signed during 2013-2015
Goal: Development of an independent European supply of protein through intesified cooperation of the Danube Region countries.
www.donausoja.org/en/about-us/the-association/donau-soja-declaration/

2. Europe Soya Declaration of 19 governments in EU
signed during 2017-2019
Goal: Sustainable development of European agriculture through boosting the production of protein crops in the European Union.
https://www.donausoja.org/en/about-us/the-association/europe-soya-declaration/

3. Donau Soja Protein Strategy for Europe (2018)
Statement from the agri-food sector as represented by *Donau Soja* of a commitment to support profound change in the European protein supply. Addressing the Protein Challenge and delivering the Protein Transition requires a holistic approach based on five pillars:

- Sustainable and responsible imports (no deforestation and no destruction high-value natural areas)
- Increased production of grain legumes in Europe
- Improved use of existing and new protein resources
- Increased efficiency of protein use
- Healthier and more sustainable diets

https://www.donausoja.org/en/about-us/news/ds-protein-strategy-for-europe/

4. Development of the Non-GM Danube Region Standard
is the first regional harmonised Non-GM quality standard in South East Europe which is the basis of a new food and feed certification and labelling with a unique quality label "NON GMO Produced ", provided by *Donau Soja* and common to all markets in the region. Press release on 20 October 2016
www.donausoja.org/fileadmin/user_upload/Press/Press_Release/DS_PR_Danube_Region_Standard_20.10.2016.pdf

5. *Donau Soja* is continuously observing the soya market in Europe and provides services such as a daily price information system, Europe wide statistics for production and consumption and also for market segments (non-GMO):

https://www.donausoja.org/en/about-us/news/market-statistics/market-information/

6. Donau Soja and was involved in the European Commission's Protein Plan process in 2017 and 2018 and contributed to the Commission's conference in Vienna in November 2018. Donal Murphy-Bokern is a member of this actor group and was also involved in all stages of the Protein Plan process.

Relevant formal knowledge and understanding

Members of this AG are actors who are working in all places of the value chains of soy food and soy feed products. *Donau Soja* provides dedicated services:

- Regularly updated handbook about soya cultivation (Donau Soja Best Practice Manual).
- Seminars for producers about soya cultivation and certification according to relevant certification schemes.

Relevant informal (tacit) knowledge and understanding

Donau Soja was founded in 2012. Since then the soya acreage in Europe has doubled from 2 million hectares up to 4 million hectares due to an increasing demand in markets and due to a shift on the side of the soya producers in Central and Eastern Europe.

Before 2012, soya production had a relatively minor role for the European agri-food system. Back then, a large share of soya feed products were imported via the sea ports in the Netherlands, Germany or Italy and then transferred to the land-locked regions in Europe: e.g. Austria or Switzerland. Today, these countries are increasingly sourcing

soya the local soya consumption is sourced today from Eastern Europe.

Donau Soja contributed to this development by offering a consumer orientated brand for soya products which are certified according to the *Donau Soja* quality standards. *Donau Soja* supports its members along the whole value chain to be compliant with the core criteria of the standards: GM-free, reduced use of plant protection products and to fulfil traceability requirements.

Associated projects

Development projects

Supported by the Austrian Development Agency, *Donau Soja* works in a Strategic Partnership on "Building sustainable, inclusive and well-functioning value chains for non-GM soya and organic soya in Serbia, Bosnia and Herzogovina, Moldova and Ukraine
www.donausoja.org/en/research/partnership-programmes/ada/

Together with its consortium partner the Moldovan NGO Pro Didactica *Donau Soja* implements a project for increasing the competitiveness of the Moldovan agri-food-sector (with special focus on the soya value chain). This EU financed and ADA managed project aims to improve existing quality standards and to strengthen capacities in vocational education and training in agriculture.
www.donausoja.org/en/research/partnership-programmes/adaeu/

Research and development projects

Internet of Food and Farm 2020 and Cybele
Donau Soja leads case-studies about the applicability of IoT-based technology and the use of satellite-images in advancing soya cultivation.
www.iof2020.eu
www.cybele-project.eu/

OK-Net Ecofeed
Dissemination of knowledge for organic monogastric farms to achieve a 100% organic and regional protein feed supply.
https://ok-net-ecofeed.eu/

China-Europe Legume Improvement Alliance (CELIA)
A network of soya scientists in Europa and China who are collaborating in pre-breeding soya research activities. This collaboration is supported by a memorandum of understanding between the Chinese Academy of Agricultural Sciences and *Donau Soja*
www.donausoja.org/en/research/research-projects/china-europe-partnership/

Relevant publications

Donau Soja 2016. Effects of liberalization of Law on GMO on the soybean market in the Republic of Serbia
www.donausoja.org/fileadmin/user_upload/Activity/Projects/Country_analysis/Effects_of_liberalization_of_Law_on_GMO_on_soybean_market_in_Serbia.pdf

Donau Soja 2016. Donau Soja Best Practice Manual for soya cultivation in the Danube Region. www.donausoja.org/fileadmin/user_upload/Activity/Projects/Best_Practice_Manuals/Best_Practice_Manual.pdf

7. The German Lupin Network

Responsible participant organisation: ZALF
Status: Public sector research establishment (PSRE)
Contact person: Johann Bachinger
Email: jbachinger@zalf.de
Telephone: 0049 (0)33432 / 82-265
Web: www.lupinen-netzwerk.de
Country: Germany

Background

This actor group is involved in the Cool-season Grain Legume Transition Network.

The actor group is based on a completed German federal funded national network for lupin. The purpose was knowledge exchange, demonstration and development of lupin-supported cropping systems and value chains.

Knowledge compendium

This actor group is based around the network of practice and research-based experts in the federal-funded project. It has a great deal of practical experience with the challenges of growing and using lupin and offers a compilation of relevant sources of knowledge on topics from seeding to marketing on the network's website (e.g. Schachler et al. 2016, Kaufmann et al. 2009). Furthermore, knowledge was disseminated through field days, seminars, newsletters and symposia.

Based on the over 40 demonstrating farms, the network gathered valuable insights in successful lupin cultivation in Germany and examined detailed questions as cultivar choices, seed inoculation, seeding techniques or weed control. It benefited especially from knowledge resources of the diverse members of the network, involving next to farmers, state research centers, advisory agencies, breeders, processors and trading companies. Moreover, data was acquired and evaluated in terms of farmers' perception of constraints and opportunities of lupin production, agronomic impacts of lupin cropping, technical options to improve lupin agronomy and options for re-designing current cropping systems (Reckling et al. 2020). A range of examples on existing and working value chains for human food but also for regional feed chains were demonstrated within the project and in posters compiled on the project's website.

During the final meeting of the network in November 2019 a general review was given, results were summarized, perspectives on breeding and economic assessment and many more insights were given (Böhm 2019, Eckhardt 2019, Heilmann 2019, Gefrom 2019).
As the project was completed in the end of 2019, the actor group still provides valuable insights but the access is somehow limited. Nevertheless, the website is a comprehensive knowledge platform with numerous linkages is continued under the lead of the Gesellschaft zur Förderung der Lupine e.V. (GFL). Moreover, members of the lupin network met in January 2020 with all relevant stakeholders (lupin growing farmers, lupin breeding, agronomy, processing, feeding, administration, policy) to discuss the situation of lupin production and use in Germany. The area of lupin cultivation decreased from around 30,000 ha in 2015 to 20,000 ha in 2019 (at the same time soybean

cultivation increased to almost 30,000 ha) (see presentation by Böhme 2020). The results of a survey (conducted by ZALF) among lupin producers showed that around 40% will stop or have stopped lupin production (see presentation by Reckling 2020). There is no one single reason for a decline in lupin production e.g., low yields, yield instability (drought). There are also reasons to continue lupin cultivation e.g., for niche (food) markets or for internal feed use. Findings from the survey will also be published within Legumes Translated in form of a practice note.

Related projects

ZALF as the responsible organization of the actor group has several associated projects, some are more some less relevant for the AG:

1. INNISOY (EU Concert) 2017-2020, establishing an Innovation Network to Improve Soybean Production under the Global Change
2. LegSTABLE (DFG) 2019-2021, estimating the impact of climate on grain legumes yield stability
3. LegumeGap (SusCrop ERA-NET) 2019-2022, analysing yield gaps in faba bean and soybean
4. Biodiversify (PRIMA) 2020-2023, assessing the role of legumes to diversify (Mediterranean) cropping systems

Relevant publications

Böhm, H. (2019). Herausforderungen und Chancen der Lupine. Presentation at final meeting of the lupin network, Güstrow.
Böhme, A. (2020). Übersicht zum Lupinen-/Leguminosen-anbauin Deutschland 2019. Presentation at the GFL-Jahrestagung, Ruhlsdorf.
Eckhardt, T. (2019). Züchterische Perspektiven der Lupine. Presentation at final meeting of the lupin network, Güstrow.
Gefrom, A. (2019). Fünf Jahre Netzwerkarbeit - Rück- und Ausblick. Presentation at final meeting of the lupin network, Güstrow.
Gefrom, A. (n.d.). Poster: Thermische Aufbereitung mit dem HTS-Verfahren
Gefrom, A. (n.d.). Poster: Feuchtkornsilierung für Milchvieh
Gefrom, A. (n.d.). Poster: Lupine in der Rindermast
Gefrom, A. (n.d.). Poster: Lupine in der Schweinemast
Heilmann, H. et al. (2019). Legumiosen mit Chancen - eine ökonomische Bewertung. Presentation at final meeting of the lupin network, Güstrow.
Kaufmann, K. et al. (2009). Pilzkrankheiten und Schädlinge bei Süßlupinenarten. UFOP
Reckling, M. et al. (2020). Re-designing organic grain legume cropping systems using systems agronomy. European Journal of Agronomy 112, 125951.
Reckling, M. (2020). Entwicklungen im Lupinenanbau: Ergebnisse einer online-Umfrage. Presentation at the GFL-Jahrestagung, Ruhlsdorf.
Schachler, B. et al. (2016). Anbauratgeber Blaue Süßlupine. UFOP-Praxisinformation, UFOP.

8. German Pea and Bean Network	
Responsible participant organisation: LLH **Status:** Public extension and information service **Contact person:** Dr. Thorsten Haase **Email:** Thorsten.Haase@llh.hessen.de **Telephone:** 0049 (0)561 7299 338 **Web:** www.llh.hessen.de **Country:** Germany	DemoNet Erbse Bohne

Background

This actor group is based on the network of practice and research-based experts who are funded by the German government. The pea and bean project group aims to demonstrate and improve legume cultivation in Germany; demonstrate and improve the use of legumes in livestock feed, especially for cows, pigs and poultry; establish marketing structures for legumes (feed and food); and show the ecosystem effects of a transition to using these pulse crops. It is a national network. In Legumes Translated it contributes to the following five transition networks:

- Cool-season grain legumes
- Food
- Pigs and Poultry
- Dairy and beef
- Aquaculture

Knowledge compendium

The actor group has accummulated a great deal of knowledge and experience in the production and use of faba bean and pea in Germany. This includes agronomic and economic data collected from 75 German farms. Moreover, the group has extensive knowledge on value chains and experience in agronomic demonstration trials that it shares with the project.

Relevant publications:

Quendt, U. Robuste Alternativen - Vorteile des Anbaus von Wintererbsen und -bohnen und von Anbau im Gemenge. agrarheute 11/2018
Roth, P. Tipps für den Anbau von Ackerbohnen und Körnererbsen. LLH-Website (12 February 2019)
Roth, P. Striegeln von Ackerbohnen und Körnererbsen. LLH-Öko-Fax 07/2019
Roth, P. Blattrandkäfer. LLH-Öko-Fax 08/2019
Quendt, U. Vielfalt auf den Acker – Winterkörnerleguminosen. Landwirtschaftliches Wochenblatt (Magazin): July 2019
Roth, P. Ackerbohnen richtig lagern. Raps 3/2019: spezial Körnerleguminosen
Quendt, U. Leguminosen haltbar machen. agrarheute 08/2019
Roth, P. Ackerbohnenernte. Öko-Fax 24/2019
Roth, P. Ackerbohnen lagern. Öko-Fax 25/2019
Roth, P. N-Akkumulation durch Ackerbohnen. Öko-Fax 25/2019
Roth, P. Saatgutverfügbarkeit und Keimfähigkeit. Öko-Fax 34/2019
Roth, P. Keimfähigkeit von Ackerbohnen. Öko-Fax 39/2019
Quendt, U. Züchtung von Leguminosen. Bauernzeitung Schleswig-Holstein
Haase, T. LSV Öko-Ackerbohnen; Öko-Ackerbohnen fehlte wieder das Wasser. Landwirtschaftliches

Wochenblatt 04/2020.
Roth, P. Jetzt Ackerbohnensaatgut prüfen. Bioland-Magazin 01/2020.
Roth, P. Z-Saatgut Ackerbohne. Öko-Fax 1d/2020
Roth, P. Gemengeanbau mit Leguminosen. Landwirtschaftliches Wochenblatt 07/2020.
Roth, P. Nach Dämpfer wieder wachsende Fläche. Empfehlungen für den Anbau von Ackerbohnen und Körnererbsen. Landwirtschaftliches Wochenblatt 08/2020.
Roth, P. Knöllchenbakterien und Impfung Körnerleguminosen. Öko-Fax 04/2020.
Roth, P. Aussaat von Ackerbohnen und Körnererbsen steht an. Öko-Fax 05/2020.
Roth, P. Striegeln von Ackerbohnen und Körnererbsen. Öko-Fax 07/2020.
Roth, P. Impfung Soja, Saatbettbereitung zur Sojabohne. Öko-Fax 09/2020.

9. Swiss Lupin Network	
Responsible participant organisation: FiBL **Status:** Private research organisation (PVRO) **Contact person:** Matthias Klaiss **Email:** Matthias.klaiss@fibl.org **Telephone:** 0041 (0)62 865 7208 **Web:** www.fibl.org **Country:** Switzerland	

Background

This actor group contributes to the Cold Season Legumes Transition Network. The overall goal is to develop and establish organic lupin cultivation in Switzerland for feed and food, development of suitable and cost effective intercropping systems and identification of varieties with low content of antinutritive compounds suitable for climate and resistant to anthracnose with a very high yield potential.

Knowledge compendium

Lupin is a rather new crop in Switzerland. Blue lupines are grown for feed in intercropping systems developed and promoted by FiBL. Efforts are made to develop cultivation and use of white lupines by breeding and testing for anthracnose tolerance. We work on finding processors for white lupines for food, however the market is not yet developed. Use of extruders to produce texturised products is, however, still prohibited by the organic farmers association. Discussions about the lift of prohibition are on track.

The Swiss Lupin Network has the following resources of knowledge and expertise that are being incorporated into the project's activities:

Results from trials, dissemination material that could be translated for use in other countries, experience in cropping systems, cooperation, exchange of breeding material; and specific knowledge how to connect breeding ambitions and the needs of consumers/ users of grain legumes. These insights will be contributed to the project with benefits for the development of food and feed value chains of other grain legumes.
tolerant to anthracnosis. Futhermore we work with a network of farmers that are keen to develop new cultivation intercropping systems for blue lupins. There are efforts to introduce white lupin as a raw material for human consumpotiopn, courses about processing of grain legumes for food.

Related projects

Vielfalt der Nutzpflanzen und Netzwerke für lokale Food Systeme hoher Qualität nutzen (DIVERSIFOOD)

Züchtungsforschung zur Anthraknosetoleranz und Mischkultureignung der Lupine

10. Brandenburg Farmers' Network	
Responsible participant organisation: ZALF **Status:** Public Sector Research Establishment (PSRE) **Contact person:** Johann Bachinger **Email:** jbachinger@zalf.de **Telephone:** 0049 33432 82265 **Web:** www.zalf.de **Country:** Germany	

Background

This actor group participates in the Cool-season Grain Legume Transition Network.

Knowledge compendium

Consisting of a group of farmers with large farms of 500 ha to 4,000 ha and strong thematical overlaps, the actor group provides valuable insights in current regional cropping issues and practical experiences with legume cropping. The connection between scientists and farmers allows the testing of the practice relevance of research approaches on short notice and was utlized for Legumes Translated. Members of the actor group meet every month to discuss current issues or make field visits. The February 2020 meeting was focused around the integration of legumes. With the aid of assessed cropping systems with and without legumes based on yield, management and economic data from Brandenburg, the members discussed constraints and opportunities for increasing the cultivation and use of legumes. Yield stability of grain legumes and crop establishment of forage legumes were discussion topics. Farmers also gave new input for future cropping system analysis in terms of relevant crops and interesting assessment indicators.

Next to the results from the monthly meetings, some farmers of the network have gained interest in growing soybean. With one large farm from the network, a new landscape experiment was planned over the last month with the aim of diversifying rotations in time and scale with small-scale patch farming. Lupin and soybean are part of the diversification practices.

The actor group members' valuable input in terms of their practical experiences and formulation of research needs for the analysis of cropping systems will be integrated and reflected in practice guides concerning the economic performance and the multi-criteria validation of cropping systems.

Knowledge on constraints and opportunities for increasing the cultivation and use of legumes in Brandenburg. Selected data on yields, management and economic returns from crop production.

ZALF as the responsible organization of the actor group has several associated projects:

1. INNISOY (EU Concert) 2017-2020, establishing an Innovation Network to Improve Soybean Production under the Global Change
2. LegSTABLE (DFG) 2019-2021, estimating the impact of climate on grain legumes yield stability

3. LegumeGap (SusCrop ERA-NET) 2019-2022, analysing yield gaps in faba bean and soybean
4. Biodiversify (PRIMA) 2020-2023, assessing the role of legumes to diversify (Mediterranean) cropping systems

11. The Irish Grain Legumes Group

Responsible participant organisation: Teagasc
Status: Public Sector Research Establishment (PSRE)
Contact person: Sheila Alves
Email: sheila.alves@teagasc.ie
Country: Ireland

Background

The Irish Grain Legumes Group, lead by Teagasc, comprises of researchers, knowledge transfer specialists, agronomists, seed producers, seed merchants, feed industry representants and policy makers. They meet bi-annually to discuss the progress of the sector in Ireland and identify ways to develop it further. This actor group is represented in the Cool-season Grain Legumes; Soy; Dairy and beef; and Aquaculture transition networks. The overall goal is to identify the barriers to the development of grain legumes to provide the protein requirements of the Irish feed sector; compete in high-value international and national markets; identify the research requirements to make grain legumes viable options to Irish farmers, improve knowledge transfer from research to stakeholders; and develop initiatives/incentives to promote national plant protein sources at government level.

Knowledge compendium

Relevant strategic insights

Field beans are a high protein legume well-suited to the Irish climate with a relatively high yield potential (6-8 t/ha for autumn-sown beans and 4.5-7.5 t/ha for spring-sown). Despite this, the crop was not widely grown until 2014, with an average of 17,650 tonnes produced from 3,183 ha annually in the period of 2009-2014. The perceived variability in yield, inadequate varietal development and limited specific agronomic information (including disease control) in the Irish context are the main reasons associated with the lack of interested in the crop. In 2015, as part of the EU Agreement on CAP Reform and to counter dependence on imported protein for use in animal feeds, the Protein Aid Scheme was introduced in Ireland. This targeted nitrogen-fixing crops – i.e., grain legumes or 'protein crops'. As consequence, the harvested area of field beans quadruplicated (to about 11,000 ha/year for the period of 2015-2017). To maintain and even increase the field beans acreage, detailed information about the overall performance of the crop in Ireland is needed and the specific factors causing variability in that performance identified. Furthermore, researchers, agronomists, the wider industry and policy-makers are working together, within The Irish Grain Legumes Group, to identify other constraints and implement the sector in Ireland.

Relevant formal knowledge and understanding
The actor group has the following knowledge resources:

Comprehensive crop management data on faba beans grown in a temperate climate including cultivation systems, establishment, fertiliser input, weed, pest and disease control, yield and varietal comparisons from research and commercial trials. Production

input, financial performance, resource and environmental data are also available. Other crops, such as peas and soya, have been identifyed by the group as of interest to farmers and industry, and Teagasc supported by the other participants of the group will evaluated the performance of those.

Relevant informal (tacit) knowledge and understanding

The specialists and advisors in Teagasc have farmer clients and Seed Tech (Arvum Group) works with dedicated farmers who are optimising the performance of faba beans in Ireland, using different farming systems and under diverse soil and climate conditions. All participants in the Irish Irish Grain Legumes Group are linked to the grain legumes sector and together have an holistic understanding of it, and by working together will underping the protein crops production in Ireland.

Information on associated projects

Alternative Crops for IE (Teagasc) 2019-2022, Evaluating the suitability of new crops to Irish conditions.

Cultivations and rotations (Teagasc) 2019-2024, Determining the impact of soil cultivation systems and crop rotation on soil structure quality and crop performance in a mild climate.

ProFaba (SusCrop ERA-NET) 2019-2022, Developing improved Vicia faba breeding practices and varieties to drive domestic protein production in the European Union.

OPTI-BC (DAFM, RSF 15/S/704) 2017-2021, Optimizing production technology in Ireland for break crops (Oilseed rape and field beans).

ECT (EIP) 2018-2022, Enable Conservation Tillage (Wider adoption of sustainable conservation tillage systems).

VICCI (DAFM, RSF 14/S/819) 2016-2020, Virtual Irish Centre for Crop Improvement *(Breeding field beans that are adapted to Ireland, and can address specific needs of Irish agriculture).*

Relevant publications

S. Alves. 2020. Enhancing the Agronomy and Management of Beans. National Tillage Conference, 29 January, Kilkenny, Ireland (*oral presentation*).

L. Murphy, D. Sparkes, J. Spink, S. Alves. 2020. The effect of changes in plant populations and time of sowing on yield in Field Beans (*Vicia faba*). National Tillage Conference, 29 January, Kilkenny, Ireland (*poster presentation*).

L.C. Murphy, D.L. Sparkes, J.H. Spink, S. Alves. 2019. Optimising canopy size and structure in field beans (Vicia faba). Irish Plant Scientists' Association Meeting (IPSAM 2019), 25-27 June, Carlow, Ireland (*oral presentation*).

V. Tagkouli, D. O'Sullivan, S. Alves. 2019. Simulating breeding scenarios for faba beans. 9th International Conference on Legume Genetics and Genomics (ICLGG), 13-17 May, Dijon, France (*poster presentation*).

D. Forristal, S. Alves. 2019. Break crop research: An update. National Tillage Conference, 30 January, Kilkenny, Ireland (*oral presentation*).

M. Hennessy. 2019. Grass weed control: Utilising all the tools. National Tillage Conference, 30 January, Kilkenny, Ireland (*oral presentation*).

12. SRUC Dairy Protein Group	
Responsible participant organisation: SRUC **Status:** University **Contact person:** Richard Dewhurst **Email:** richard.dewhurst@sruc.ac.uk **Telephone:** +44 1387 263961 **Web:** www.sruc.ac.uk **Country:** UK (Scotland)	

Background

The Scottish Dairy Protein Group is a grouping of SAC farm innovation specialists and SRUC researchers who act as a knowledge exchange platform working with farmers who are aiming to optimise their use of protein and replace purchased protein feeds. This actor group contributes to the Dairy and Beef and Cool season Grain Legumes transition networks. The overall goal is to optimise the use of home-grown protein in Scotland; reduce reliance on bought-in proteins for dairy rations; and improve the supply of protein for livestock feed with greater security of supply of protein feedstuffs of a consistent quality. There is increasing interest in Scotland in reducing reliance on soybean meal.

Knowledge compendium

Relevant stratgic insights

There is specific interest in Scotland in reducing purchased protein supplements and replacing them with home-grown protein crops. The overall goals are to optimise the use of home-grown protein in Scotland; reduce reliance on bought-in proteins for dairy rations; and improve the supply of protein for livestock feed with greater security of supply of protein feedstuffs of a consistent quality. There is increasing interest in Scotland in reducing reliance on soybean meal.

Policy in Scotland is driven by the Scottish Government, historically working within the framework of the Common Agricultural Policy – but now working on new UK and Scottish agricultural policy. Researchers and advisors involved in the group are in contact with policy makers – both directly in relation to design of research and KE programmes and indirectly through their discussions with the wider industry (feed, agronomy, veterinary etc.) in relation to the consequences of policy.

Relevant formal knowledge and understanding

Scotland's Rural College (SRUC) is a knowledge-based organisation that supports the development of land-based industries and rural communities. SRUC is unique in Scotland and one of the largest organisations of its kind in Europe. It combines research, education and knowledge interaction/agricultural innovation functions.

SRUC has several well-established, relevant research themes including:

(i) devising sustainable farming systems that improve environmental quality and crop and animal performance; and

(ii) land economy, environment and society.

SRUC has a close working relationship with the farming industry. It is in contact with around 80% of Scotland's farmers through SAC Consulting Solutions. SRUC staff has extensive experience of successful involvement with European Framework projects (e.g. Legume Futures, Animal Change, Greengrass, NitroEurope). SRUC Research brings a range of science expertise spanning from crop and soil aspects (Prof Christine Watson, Dr Robin Walker, Dr Hargreaves) through to animal and feed science (Professors Richard Dewhurst and John Newbold). Professor Newbold is a recent recruit to SRUC with a long experience in technical positions in the global animal feed industry – particularly relevant is his time with global feed protein company Cargill.

Professor Christine Watson has worked on legume based crop rotations in both organic and conventional management systems, with interests in both production and the wider environment. She has a deep knowledge of the European research base in this area and can guide the consortium on opportunities arising from current research.

Professor Jos Houdijk is an animal nutritionist, whose research interest can be summarised as the nutritional sensitivity of animal production, health, disease and environmental footprint. His studies range from strategic to applied, addressing research questions in both monogastric and ruminant farm animals, and also in laboratory rodents.

Dr Cesar Revoredo Giha is an economist and team leader in Food Marketing Research. He is an applied economist specialising in the industrial organization of food markets, international trade and econometrics. He has worked as a consultant for United Nations, The World Bank, The International Food Policy Research Institute (IFPRI), the UK Department of Environment Food and Rural Affairs (Defra), the UK Home Grown Cereal Authority (HGCA), the Food Standard Agency - Scotland and the Scottish Government.

Dr Robin Walker is a research agronomist with an interest in maximising the benefits that can be made by utilising appropriate species and variety combinations in rotations, and consequently improving the overall performance of cropping systems. He works on both organic and conventional systems with a focus on maintaining productivity and quality, but with minimum environmental impact, and has developed and delivered a wide range of knowledge exchange materials through numerous routes on this topic.

Dr Lorna MacPherson is a Dairy Consultant with SAC Consulting. Before working for SAC Consulting, Dr MacPherson gained extensive experience working within the commercial animal feed industry, providing rationing for farmer clients and technical advice. She has been involved in both the development and trialling of new products and their subsequent journey to market, and has been instrumental in providing training both to farmers and internally on micro-nutrition and feed production.

Dr Kairsty Topp is an agricultural systems modeller. She has particular interests in the synthesis and analysis of data and information from cropping and livestock systems. Her research focuses on understanding the impact of changes in farm management in cropping / grassland systems on the environment, and in how an understanding of these issues can

inform economic and social models of the farming system. Richard Dewhurst is Professor of Ruminant Nutrition & Production Systems at SRUC. His research has made significant contributions at the interfaces between ruminant nutrition, product composition and rumen function and some of his most cited work has been on forage legumes.

All of the innovation specialists (advisors) have farmer clients who will be optimising their use of protein within a wide range of dairy farming systems. Dr Lorna MacPherson is particularly engaged in applied nutrition and rationing – with a focus on nutrition models and options for reducing dependence on soybean meal in rations. The group also brings in expertise from the following sectors: milk purchasers, feed supply companies, forage and plant breeding companies and veterinary surgeons. The group will contribute to and assess the relevant knowledge outputs from the project, and validate this with farmer clients, who will then optimise their use of protein within their wide range of dairy farming systems across Scotland.

Relevant informal (tacit) knowledge and understanding

We have good working relations with relevant seed merchants (Watson Seeds and Germinal) and independent agronomists who provide advice and support on legume mixtures and agronomy. The SRUC farm manager Hugh McClymont also contributes to the group – both through long experience of growing and feeding many different forages, as well as being an excellent communicator trusted by farmers in our region and across the UK.

Existing data from SRUC on cropping results from growing beans, red clover and lucerne.

Previous SRUC project on long-term feeding of low-protein diets to dairy cows (conducted in conjunction with University of Reading and Aberystwyth University over the period 2012 to 2019).

Results from feeding these forage and grain legume proteins to dairy cows – both studies at SRUC and those conducted by SRUC staff in previous positions.

Experience of nutrition consultants working with farmers growing and utilising pea/barley bi-crops.

Research farm experience and data about growing field beans and red clover for a range of studies over several years (often for different purposes – such as maintaining home-grown dairy cow diets or assessing the effects of controlled traffic management on crop yields).
Planned plot work in Scotland, growing locally-appropriate legume crops, and engage with farmers, students, consultants and researchers over the agronomy and feeding to livestock.

Knowledge of the nutritional models used to calculate nutrient requirements of dairy cows and of the nutritional values of feed ingredients, including forage legumes and pulses, needed to drive those models. We are also aware of deficiencies in both the models and the methods used to estimate nutritional values that may cause the true nutrient value of forage legumes and pulses to be over- or underestimated.

The group's expertise and reach covers home-grown protein sources and traditional

compounded feeds, as follows:

- Pulses such as field beans and peas are available as ingredients for compound feeds or as 'straights' for direct use on dairy farms.
- Forage legumes, usually in mixtures with grass species, are used for both grazing and conservation as silage. In north-west Europe the main forage legumes fed to dairy cows are red and white clover, rather than alfalfa.
- Compound feeds and on-farm rations are both formulated to deliver defined quantities of nutrients to the animals that consume them

Associated projects
Legume Futures - Legume-supported cropping systems for Europe (FP7-245216). Funding agency: European Commission. Christine Watson Scientific Coordinator. 2010-2014.

Defra AC0122: Increasing efficiency of dietary nitrogen use in dairy systems. Direct information can be provided from demonstration work in Scotland during 2016/17 and from associated research work at Reading and Aberystwyth Universities.
Farm systems data from systems research into dairy systems with all feed grown on the farm (protein sources – clover and field beans).

Lead partner and coordinator of AHDB Dairy funded research partnership Grasslands, Forage and Soil over five years; working with Harper Adams and University of Reading.This included work on cut and carry feeding systems, soil compaction and yield, lucerne as a feed for high yielding dairy cows and maximising the use of slurry on grazed grassland.
The environmental consequences of using home-grown legumes as a protein source in pig diets (Green Pig). Defra LINK LK0682.

EU - Transition paths to sustainable legume based systems in Europe (TRUE).

Inter-REG Atlantic Region - Dairy 4 Future - Propagating innovations for more resilient dairy farming in the Atlantic area.

EU - SMARTCOW : An integrated infrastructure for increased research capability and innovation in the European cattle sector.

AHDB Soils Programme Research Partnership: Management for Soil Biology and Health.
Scottish Government Strategic Research Programme 2016-2021. A wide range of sub-projects within this overall programme are relevant to crop, soil and livestock aspects of legumes and protein feeding.

AHDB - Re-defining nutrition standards for improving beef production efficiency.

Relevant publications
Sobczyński, T., A.M. Klepacka, C. Revoredo-Giha, W.J. Florkowski. 2015. "Dairy farm cost efficiency in leading milk-producing regions in Poland." J. Dairy Sci. 98:8294-8307.

Watson, C.A., Reckling, M., Preissel, S., Bachinger, J., Bergkvist, G., Kuhlman, T., Lindström, K., Nemecek, T., Topp, Cairistona, F.E., Vanhatola, A., Zander, P., Murphy-

Bokern, D., Stoddard, F. (2017). Grain legume production and use in European agricultural systems. Advances in Agronomy 144: 236-303.

Romer, D.A.M., Roberts, D.J. and Mardell, P. (2009) The influence of management decisions and external factors on the dairy farmers environmentally friendly farming objectives: the Green dairy experience. Int. J. of Agricultural Sustainability, 7: 164-175.

Dewhurst, R.J. (2013). Milk production from silage: comparison of grass, legume and maize silages and their mixtures. Agricultural and Food Science 22: 57-69.

Smith, L.A., Houdijk, J.G.M., Homer, D., and Kyriazakis, I. (2013) Effects of dietary inclusion of pea and faba bean as a replacement for soybean meal on grower and finisher pig performance and carcass quality. J. Anim. Sci., 91: 3733–3741.

Bowen, J.M., McCabe, M.S., Lister, S.J., Cormican, P. and Dewhurst, R.J. (2018). Evaluation of microbial communities associated with the liquid and solid phases of the rumen of cattle offered a diet of perennial ryegrass or white clover. Frontiers in Microbiology 9: 2389.

Zhang, S.J., Chaudry, A.S., Osman, A., Shi, C.Q., Edwards, G.R., Dewhurst, R.J. and Cheng, L. (2015). Associative effects of ensiling mixtures of sweet sorghum and alfalfa on nutritive value, fermentation and methane characteristics. Animal Feed Science and Technology 206: 29-38.

Cabrita, A.R.J., Dewhurst, R.J., Melo, D.S.P., Moorby, J.M., Fonseca, A.J.M. (2011). Effects of dietary protein concentration and balance of amino acids on productive responses of dairy cows fed corn silage-based diets. Journal of Dairy Science 94: 4647-4656.

Cheng, L., Kim, E.J., Merry, R.J. and Dewhurst, R.J. (2011). Nitrogen partitioning and isotopic fractionation in dairy cows consuming diets based on a range of contrasting forages. Journal of Dairy Science 94: 2031-2041.

Dewhurst, R.J., Davies, L.J. and Kim, E.J. (2010). Effects of mixtures of red clover and maize silages on the partitioning of dietary nitrogen between milk and urine by dairy cows. Animal 4: 732-738.

Dewhurst, R.J., Delaby, L., Moloney, A., Boland, T. and Lewis, E. (2009). Nutritive value of forage legumes used for grazing and silage. Irish Journal of Agricultural and Food Research 48: 167-187.

13. LegumesForFish

Responsible participant organisation: NIREUS
Status: Large enterprise
Contact person: Dimitris Barkas or Leonidas Papaharisis
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Telephone: 0030 2610241995; 0030 2106698187
Web: www.nireus.com
Country: Greece

Background

This actor group is at the centre of the Aquaculture Transition Network. The goals are to:

1. increase participation of raw materials in fish feed originated from EU;
2. use of by-products from EU leguminous production to reduce ecological footprint;
3. reduce dependency on the import of raw materials for fish feed from third countries;
4. interaction between local legume production and local aquaculture;
5. farming protocols for legume crops with low irrigation demands, high nutritional value for fish in a cost effective way.

Knowledge compendium

Relevant strategic insights

According to the FAO, the total amount of seafood produced and consumed expected to increase from about 125 million tonnes today to more than 150 million tonnes by 2030 with about two-thirds of this 150 million tonnes coming from aquaculture. The total from aquaculture is expected to increase from 55 million tonnes today to more than 90 million tonnes in 2030. Especially through the contribution of NIREUS, this actor group is at the forefront of this development. The experience in the group indicates that this growth in aquaculture will take place against a background of:

- no significant growth in global production of fishmeal and fish oil;
- rejection of the use of plant proteins from areas with a high ecological footprint;
- reduced availability of non-GMO cereals and soy;
- no significant growth in the production of processed animal proteins; and
- strong negotiating power of raw material suppliers.

This all leads to a need find alternative raw materials that can be produced on an industrial scale at low cost.

Our experience indicates that European legumes can gain a significant share of the raw material gap as they have a relatively high nutritional value and can be produced at a competitive cost. Specifically for Greece as the largest fish producing country in the Mediterranean, legumes production is a low-cost production and a perfect utilization of degraded lands. The major advantage of domestic legumes is that the crop costs are much lower compared to other large-scale cultivations. Fertilizers and plant protection products (pesticides, fungicides, etc.) are rarely needed. Irrigation is required only in extended dry

climate conditions. While farmers are seeking for new markets, legumes can be a profitable alternative. According to the Greek Ministry of Agricultural Development and Food, there is a substantial increase in legumes cultivation as farmers begin to understand the benefits of these crops.

Relevant formal knowledge and understanding

The LegumeforFish Actor Group has been generating, collecting and validating knowledge to support a fish feed production prototype system that will use locally grown grain legumes taking advantage of the particular climatic conditions. The actor group retains substancial knowledge on fish feeds and fish nutritional physiology gained via year-long professional experience in the fields of production and laboratory analysis. The data cover the whole supply chain from legume production to fish farming performance.

A. THESGI

- Crop production related knowledge of 8 legumes
- Quality data directly related to crop processing of 2 legumes
- Economic data – cost analysis of production, processing, logistics and marketing
- Collected data regarding to the microclimate conditions of 1 legume

B. Nireus group

- Collection of data for 3 legumes and 10 year batches for:
  - ✓ basic chemical composition (moisture, crude proteins, crude fats, crude fibers, total ash, carbonhydrates);
  - ✓ Inorganic constituents (calcium (Ca), phosphorus (P), sodium (Na) & magnesium (Mg))
  - ✓ amino acid profile
  - ✓ fatty acid profile (1 legume)

- In vivo digestibility rates of protein, lipid and starch of fish feeds containing 3 legumes in four experimental trials

C. Department of Biochemistry & Biotechnology, University of Thessaly (UTH)

- OptiFeed Services: an integrated methodology package for the determination in vitro of the digestibility and bioavailability of dietary proteins in raw materials and fish feeds.
- In vitro digestibility rates in relation to dietary protein quantity/U trypsin of 8 Legume varieties
- Levels of the two predominant protease inhibitor groups in legume seeds Kunitz trypsin inhibitor (KTI) and Bowman−Birk protease inhibitor (BBI) in 8 Legume variaties
- Data demostrating the annual variation in levels of protease inhibitors in 6 legume varieties

Currently, the actor group works to validate a benchmarking system for legumes for use in fish feeds and join development of case study for the prospects of EU legume production in relation to EU aquaculture growth.

1. Four local legumes were selected as candidate for use in fish feed.
   - Two varieties of forage Vetch (*Vicia sativa*)
   - Two varieties of forage pea (*Pisum sativum V*ar. *arvense)*
   - Two varieties of forage faba bean (*Vicia faba L*) &
   - one variety of lupin (*Lupinus albus L.*)

2. After harvesting, an adequate quantity of each variety was sent to a mill for dehulling and grinding.

3. An economical analysis of cultivations from field to fish feed factory was made in order to estimate the final market price of each legume.

4. The following data were collected through laboratory analysis:
   - Basic chemical analysis; Moisture, Crude Proteins, Crude fats, Crude fibers, Total ash. Carbonhydrates are estimated by equation
   - Inorganics; Calcium (Ca), Phosphorus (P), Sodium (Na) & Magnesium (Mg)
   - Amino acid profile
   - In vitro digestibility rates in relation to dietary protein quantity/U trypsin
   - Determination of the two predominant protease inhibitor groups in legume seeds Kunitz trypsin inhibitor (KTI) and Bowman−Birk protease inhibitor (BBI)

5. A final ranking of the candidate legumes as raw materials for fish farming was made. The four best ones were selected, which be evaluated experimentally. In particular

   - *Lupinus albus L. Var: Multitalia*
   - *Vicia faba L. Var: Tanagra*
   - *Pisum sativum Var. arvense Var: Eliza*
   - *Pisum sativum V*ar. *arvense Var: Dodoni*

6. According to their qualitative results for these four legumes the level of inclusion of the legumes in fish feeds could be up to 10% of final fish feed. This inclusion can reduce soy bean meal use by 35% and starch source (wheat meal) by 45%.

7. A small-scale trial is on progress, in order to evaluate marine fish performance indicators (specific growth rate, food conversion rate, survival). The final report is expected in mid-July 2020.

The data to be provided to the project span the whole supply chain from legume production to fish farming performance including:

1. yield and grain quality of the crops grown;
2. data on production practices;
3. fish resource productivity in relation to different legume crops;
4. qualitative characteristics of legume species with respect to feed quality (protein content, amino acid profile, content of antinutritional factors);
5. levels of inclusion of the legumes in fish feeds;
6. levels of soymeal substitution in fish feeds;
7. effects on fish key performance indicators (specific growth rate, food conversion rate, survival, operational and physiological welfare indicators).

Our knowledge on fish feeds and fish nutritional physiology are crucial for the critical assesment of legume-origin raw material concerning their use in fish feeds. Moreover, we implement unique qualitative and quantitative in vitro methods for raw material benchmarking.

Informal knowledge

- Willingness of local farmers to sign in an increased legume production
- Steps required to make legume production economically attractive
- Prospects of legume use for local livestock production
- Local capacity for legume processing according to given standards

Associated projects

July 2018 – August 2021: CROPFEED - Establishment of production protocols for feeding cows for milk production, Grant Agreement Τ1ΕΔΚ-01491, Competitiveness Entrepreneurship Innovation; Operational Programme (ERDF)

Jul 2018 – Aug 2021: Legumes4Protein - Legumes, Grant Agreement Τ1ΕΔΚ – 04448, Competitiveness Entrepreneurship Innovation; Operational Programme (ERDF)

May 2017 – April 2022: PerformFISH - Consumer Driven Production: Integrating Innovative Approaches for Competitive and Sustainable Performance across the Mediterranean Aquaculture Value Chain Grant Agreement 727610, Research and Innovation Action; H2020-SFS-23-2016.

PerfomFISH aims at improving the technical performance of the Mediterranean marine fish farming and two of the actor group members have prominent role in the project. A WP is dedicated in advancing the knowledge of the effects of feeding plant-based diets to fish and how the nutritional requirements are covered by plant-based diets. PerformFISH is a big consortium that brings together five fish producers' associations and fish feed companies providing excellent opportunities for insightful interaction.

2018-2021: Development of novel methodology for the genetic selection of fish with high food conversion capacity, Grant number 5010669, Greek Ministry of Rural Development and Food.

The project explores how genetics interact with feeding to shape food conversion capacity in marine fish. In this context, plant-based feeds are compared with conventional fish feeds and the effects on the physiology are recorded through a series of zootechnical, biochemical and molecular markers.

Relevant publications

OptiFeed: An *in vitro* system for accurate prediction of biological larval performance (2013). Hatchery Feed, Vol 1, p14-19.

Statistics of land areas and production of plant products, Greek Ministry of Agricultural Development and Food, www.minagric.gr/index.php/el/the-ministry-2/statistikes-tekmhrioshs/8510-statistika-ekt-parag-fytikonproionton

Papakosta Tasopoulou Despoina, 2012 Special agriculture: Cereals and legumes,

Adamidou Styliani, 2008. Effect of extrusion on the nutritional value of peas (Pisum sativum), chickpeas (Cicer arietinum) and faba beans (Vicia faba) and inclusion in feeds for European seabass (*Dicentrarchus labrax*) and gilthhead seabream (Sparus aurata).

14. Ground for Growth	
Responsible participant organisation: HEL **Status:** University **Contact person:** Kristina Lindström **Email:** Kristina.lindstrom@helsinki.fi **Telephone:** +358 294158854 **Web:** Under construction, Facebook: Kasvunpaikat **Country:** Finland	GROUND FOR GROWTH

Background

This actor group is involved in the Cool-season Grain Legume Transition Network and the Food Transition Network. The goal is to increase production, improve processing and enhance marketing and consumption of pulses grown in Finland (faba bean, pea and lupin) to:

- activate different actors in the value chain to get them to collaborate/interact with each other;
- to use diverse platforms such as workshops, networking events, web-based media and farm-based tutorials;
- to engage Swedish-speaking and Finnish-speaking rural advisory bodies and farmers' unions to produce information materials, videos and leaflets.

Knowledge compendium

Relevant strategic insights

Ground for Growth is a network of different actors in legume supporting value chains in Finland. This includes different experts who engage in our knowledge exchange meetings and events. The participants share the aim to increase the production and consumption of legumes in Finland. We want to support farmers and processors to produce more legumes in Finland together with the food/feed industry. However, our main interest lies is developing the plant-based food sector. Many farmers are new to growing legumes compared to other commonly grown crops in Finland such as barley, oat, wheat and rye. This means that farmers will face a learning curve.

At a societal level, there is a growing interest to reduce Finland's dependency on imported grain legumes. The policy community is emphasising self-sufficiency and increasing domestic production. For example, increasing support for plant breeding of protein crops is mentioned in the current government programme (2019). This and several nationally funded research projects, indicate a strong interest to develop and support legume production in Finland.

Commercial leaders would like to see more dialogue and knowledge exchange between different actors along the value chain to address common bottlenecks – emphasis on working together rather than tackling issues alone. These bottlenecks are often discussed in terms of the limited amount of processing facilities for grain legumes, profitability for farmers, and the low quantities of home grown raw materials for the food industry. The latter becomes an obstacle for food companies that want to market their food products as 'Made in Finland'. Nothing can substitute taste and therefore developing plant based food

products that contain legumes is by-and-large about removing or reducing off-flavours and improving the organoleptic properties in food products, while also reducing anti-nutritional factors through either breeding or processing. It also becomes important to raise consumer awareness about the environmental and health effects of using legumes in food products.

There is a growing range and availability of novel plant-based food products in Finnish supermarkets. Sustained growth requires some ingenuity from canteens and other food establishments to add more legumes and legume products in their menus and a market pull from consumers to buy more food products with legumes. Some companies have also turned to exporting Finnish legume food products abroad. Strategic work on several levels is required to ensure that bottlenecks in production and consumption do not hinder the growth of the sector. Ground for Growth interacts closely with actors from the Central Union of Agricultural Producers and Forest Owners (MTK), Rural Advisory Services (ProAgria), Natur och Miljö (Swedish environmental NGO), the Natural Resources Institute of Finland, and the Vilja-alan Yhteistyöryhmä (VYR). These are examples of organisations that influence agricultural policy in Finland.

Relevant formal knowledge and understanding

The Ground for Growth actor group is based in the University of Helsinki, a research-based organisation with strong ties to the agricultural sector. The Faculty of Agricultural and Forestry provides relevant research-based knowledge on crop science, food science, and plant breeding, to name a few.

The University of Helsinki has a wide range of substantial and relevant research in crop, animal and food sciences including sustainable intensification of agriculture, genetics, genomics and breeding, agricultural biotechnology, plant production, food production, food chemistry, food economy, food hygiene, food microbiology, food technology, food toxicology, microbiology of primary production and nutrition.

Professor Kristina Lindström has specialised in the area of sustainable legume-based agriculture and soil health. She has worked on legumes, rhizobia and biological nitrogen fixation (BNF) since 1979. She is a well- known expert on rhizobium bacteria: genomics, diversity, taxonomy, ecology, the function of the legume symbiosis, with agricultural applications. Her research now also includes sustainability aspects of BNF, especially regarding legumes and inoculation in Ethiopian and Finnish agriculture, as well as soil quality from a trans-disciplinary perspective. She has led and participated in several EU funded projects, led the Nordic network Soils and Society which organised graduate courses in the Nordic countries and in Ethiopia and initiated the Ground and Growth network in 2014.

Adjunct Professor Frederick Stoddard has worked on faba bean since 1981, publishing on pollination, disease resistances, stress resistances, quality, agronomy, breeding, genetics, genetic resources and environmental impacts. He has also published on chickpea, lentil, pea, common bean and wheat. His participated in a policy review and presentation to the European Parliament on the environmental role of legumes in the revisions to the Common Agricultural Policy in 2013. He chaired the European Innovation Platform's focus group on protein crops which made recommendations on breeding and other strategies to boost the production of protein crops in Europe. He advises farmers and agricultural consultants on grain legumes across the Nordic-Baltic region, and, particularly for faba beans, in Canada.

He made a major contribution to the challenge team Ground and Growth in 2014-15, the basis for this actor group. He currently leads the ERANET SusCrop project 'LegumeGap'.

Adjunct Professor Tuula Sontag-Strohm has worked on food science questions since 1986, publishing on cereal grain proteins and related quality questions, prolamin protein analytical questions, gluten immunology, fermentation, dietary fibre, oat beta-glucan analytical and processing questions, milling technologies and food technology of the faba bean. She has had a role as a research coordinator in projects financed by the Finnish Funding Agency for Innovation, the Academy of Finland and Ministry of Agriculture and Forestry. She has one patent accepted and a few invention awards. Dr Sontag-Strohm has contacts with a large network of the food science and technology specialists in Finland and other Nordic countries. She has acted as a chairperson of the Association of Finnish and Nordic Cereal Scientists.

Relevant informal (tacit) knowledge and understanding

Petri Leinonen, Finland's largest inoculant producer has several years of practice-based knowledge on inoculating cool-season grain legumes. Harri Arola is one of the main importers of agricultural machinery used in pea and faba bean production in Finland. He has first-hand knowledge relevant to machinery for legume production.

- Workshop results from Ground for Ground gatherings. These relate to identifying bottlenecks and enhancing value chain cooperation
- Existing data from growing faba bean, narrow-leafed lupin and other grain legumes on the University's research farm at Viikki.
- Farmer survey data
- Crop-specific results looking at yield and economic performance at a national level
- First-hand experience from farmers growing legumes related to primary processing and cultivation
- Insights from food enterprises on bottlenecks
- Information from the Vilja-alan yhteistyöryhmä (VYR). It is a co-operation platform of the Finnish cereal and oilseed sector. The aim is to improve the functioning and general efficiency of the Finnish cereal, oilseed and protein crop sector

Associated projects

- Academy of Finland projects Leg4Life and Papugeno
- ERANET SusCrop projects LegumeGap and ProFaba
- Danish Innovation Fund project NORFAB: Protein for the Northern Hemisphere

Relevant publications

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Jiang, Z., Pulkkinen, M., Wang, Y., Lampi, A.-M., **Stoddard, F.L.**, Salovaara, H., Piironen, V. & **Sontag-Strohm, T**. 2016. Faba bean flavour and technological property improvement by thermal pre-treatments. LWT – Food Science and Technology 68, 295-305. (Journal paper).

Göbüz, G., Liu, C., Jiang, Z., Pulkkinen, M., Piironen, V., **Sontag-Strohm, T.**, & Heinonen, M. (2018). Protein-lipid co-oxidation in emulsions stabilized by microwave-treated and conventional thermal-treated faba bean proteins. Food Science & Nutrition, 6(4), 1032-1039. (Journal paper)

Pulkkinen, M. J., Gautam, M. D., Lampi, A-M., Ollilainen, V-M., **Stoddard, F. L., Sontag-Strohm, T**. S., Piironen, V. I., 2015. Determination of vicine and convicine from faba bean with an optimized high-performance liquid chromatographic method. Food Research International, 76(1), 168-177. (Journal paper).

Watson, C.A., Reckling, M., Preissel, S., Bachinger, J., Bergkvist, G., Kuhlman, T., **Lindström, K.**, Nemecek, T., Topp, C.F.E., Vanhatalo, A., Zander, P., Murphy-Bokern, D. & **Stoddard, F.L.** 2017. Grain legume production and use in European agricultural systems. Advances in Agronomy, 144, 235-303. (Journal paper)

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Sell, M, Vihinen, H, Gabiso, G & **Lindström, K**, 2018, 'Innovation platforms: a tool to enhance small-scale farmer potential through co-creation', *Development in Practice*, 28 (8), 999-1011. (Journal paper).

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Manni K., Kuoppala, K., Rinne, M. 2018 Valkuaisfoorumi – Yhdessä kohti suurempaa valkuaisomavaraisuutta. Useful information on using legumes as food.

Rokka, S., Heikkilä, J., Hellström, J., Järvenpää, E., Kahala, M., Keskitalo, M., Kuoppala, K., Manni, K., Mäkinen, K., Mäkinen, S., Pihlava, J., & Tahvonen, R.L., 2018. Palkokasvit elintarvikkeena - Opas palkokasvien elintarvikekäytöstä. Useful information on using legumes as food.

Jarkko K. Niemi, Katriina Heinola & Xing Liu. 2018. Valkuaiskasvien viljelyedellytysten ja markkinoiden kehittäminen. Julkaisussa: Valkuaiskasveista Voimaa. Tuota Valkuaista -hankkeen loppujulkaisu Kekkonen H., Niemi J., Heinola K., Liu X., Sipilä A., Tuomisto J., Suvanto H., Lähdesmäki M., Enbuska M., Niskanen M., Laitila N. & Vihonen E. Luonnonvara- ja biotalouden tutkimus 66/2018. Luonnonvarakeskus. Helsinki. 22- 33. Useful insights on the legume market and preconditions to cultivating legumes in Finland.

Practice based actors' web sites:

Petri Leinonen: http://www.elomestari.fi/typpiymppi/tilaaminen.htm
Harri Arola: http://www.agrola.fi/

Useful information on faba bean and pea from VYR:

https://www.vyr.fi/fin/viljelytietoa/huoneentaulut/pa-svenska/

Actor group's ambitions, constraints and opportunities

Bulgarian Legumes Network

1. Bulgarian Legumes Network	
Responsible participant organisation: AgroBioInstitute **Status:** Public Sector Research Establishment (PSRE) **Contact person:** Anelia Iantcheva **Email:** aneliaiancheva@abi.bg **Telephone:** 00359 (2) 963 54 13 **Web:** www.abi.bg **Country:** Bulgaria	

Transition network participation
BGLN will participate in transition networks Cool-season grain; Soy; Pig; Poultry; Dairy and beef
Long-term goals of the actor group
Long term goals of BGLN are to affirm value of well-adapted grain legumes variaties, which respond well to country specifc climatic condition and respond well in crop rotations. We also aim to promote additional advantages of forage legumes as a component of forages, many of which currently have almost unknown nutritional benefits and environmental value. Our efforts are focused to assess the value of legumes' protein in feed and food sectors of agricultural production.
Information on constraints on cropping systems
The main barrier at the national level is the small area occupied by legumes and mostly used non-locally adapted varieties grown in the absence of irrigation facilities. The limited number of early varieties, high risk of decrease in yield and low purchase price of seeds and legume-derived products are also factors that act to deter the process of involment of more farmers in growing legume. A lack of knowledge and experience to grow legumes at farm level for animal feeding is another constraint.
Information on relevant legume-related constraints on livestock systems
A lack of knowledge and experience to grow forage and grain legumes at farm level for animal feeding and know their nutritional value and benefits is a main constraint on livestock systems. Other constraint is an unsufficient area ocupied by legumes, which is not enough for further animal feed production.
Information on relevant legume-related constraints on value chains
Unsufficient local legumes production for sustainable development of food and feed value chains. The other constraint is a lack of knowleadge of farmers and producers of agricultural products for the proper cultivation of legumes crops and a lack of local production capacity.
Information on opportunities
Presence of Bulgarian grain anf forage legumes varieties characterized by high adaptive capacity to the country specific climatic peculiarities and high yield. Existing innovative attitudes towards farmers, food and feed producers, consumers and society towards the high nutritional value of legumes and the well-being of humans and animals and their environmental benefits.
How will Legumes Translated help

Thanks to our participation in the project we will be able to confirm the importance of local legume varieties to farmers and their importance in the rotation of crops and their value for the environment. Our participation in the 4 transition networks mentioned above, which facilitate tracking of legumes for food and feed production,will allow us to study and assess gaps in these chains at regional level and share the results with other participants.
Data and knowledge that can be provided to Legumes Translated
Data and knowledge which BGLN will provide: • exchange of data on agro-techniques and local legumes varieties used; • exchange of data and innovative methods and approaches for the establishment of a nutritional profile of cultivated local grain and forage legumes and their performance in the transition networks. • evaluation of positive environmental impacts from legume-based agro-ecosystems; The results collected from the case studies of BGLN will be compare with the results from other Actor Groups through participation in annual meetings and workshops.

2. German Soybean Association	
Responsible participant organisation: LTZ **Status:** Registered Association (e.V.) **Contact person:** Jürgen Recknagel **Email:** juergen.recknagel@ltz.bwl.de **Telephone:** 0049 (0)7641 95789010 **Web:** www.sojafoerderring.de **Country:** Germany	

Transition network participation
Soy (leader); Food, Pigmeat and Poultry.
Long-term goals of the actor group
Implementation of soybean cultivation and value chains in Germany as a well-established element of cropping systems and basis for regional value chains.
Information on constraints on cropping systems
Seed: quality and availability Weed: efficient regulation (mech./chem.) Harvest: losses reduction (flexible cutting bar), quality optimization
Information on relevant legume-related constraints on livestock systems
Heat-treatment against anti-nutritive factors of soy for pigs and poultry necessary! Availability of facilities? Quality management? Logistics? Costs?
Information on relevant legume-related constraints on value chains
All year round availability in sufficient quantity and quality – in every year!
Information on opportunities
Big opportunties as self-sufficiance <5%; Ecological and ethical advantages compared to soy productions overseas: … have to be communicated to consumers - and accepted as to be paid for – in order to be attractive for local farmers in comparison with other crops. Problems in crop rotations with too big share of winter-crops such as rapeseed and cereals or other grain-legumes - that might be reduced by the introduction of soy.
How will Legumes Translated help
Create an awareness about advantages for farmers and consumers on a european level that might help to develop soybean cultivation and transformation also in Germany
Data and knowledge that can be provided to Legumes Translated
As proposed on our website www.sojafoerderring.de (different cultivation manuals, experiences as communicated on field events and seminaries, instructive videos, results from variety tests about a multitude of varieties (000, 00), sites and years)

3. Soy Network Switzerland	
Responsible participant organisation: FIBL **Status:** Private research organisation (PVRO) **Contact person:** Matthias Klaiss **Email:** matthias.klaiss@fibl.org **Telephone:** 0041 (0)62 865 72 08 **Web:** www.fibl.org **Country:** Switzerland	

Transition network participation
Soy, food, feed
Long-term goals of the actor group
Develop and establish organic soy cultivation in Switzerland for feed and food, development of suitable and cost effective cropping systems and varieties.
Information on constraints on cropping systems
• need for improved soy varieties for Swiss organic conditions (i.e. improved cold tolerance, suitable nutrient composition, weed suppression) responding well to the Swiss context and to organic production techniques (e.g. mechanical weed control). Especially interesting are early varieties with good yield potential and high protein content; • High yielding varieties for feed use • need for testing of existing and new varieties for anti-nutritive compounds, nutrient contents, interaction with cultivation parameters; • quality oriented production to increase share of domestic legumes in feed mixtures or for human consumption. • need for better agronomy to increase gross margin for farmers (i.e. better mechanical weed control, improved post-harvest infrastructure and technology); and • need for more on-farm trials to adapt technologies to specific production contexts • need for more extension, dissemination, demonstration
Information on relevant legume-related constraints on livestock systems
Feed soy competes with international prices.
Information on relevant legume-related constraints on value chains
Information on opportunities
Big potential for cultivation and use, mills and processors, suitable climate, good networking, farmers are increasingly interested in feed soy. From 2022 on, concentrates for organic ruminants must be of swiss origin.
How will Legumes Translated help
Exchange with other actors, knowledge transfer, cooperations
Data and knowledge that can be provided to Legumes Translated
Results from trials, dissemination material thet could be translated for use in other countries, experience in cropping systems, cooperation

4. Schwaebisch Hall Producers	
Responsible participant organisation: Bäuerliche Erzeugergemeinschaft Schwäbisch Hall (BESH) **Status:** Small to Medium-sized Enterprise (SME) **Contact person:** Christoph Zimmer / Astrid Heid **Email:** Christoph.Zimmer@besh.de /Astrid.Heid@besh.de **Telephone:** +49 7904 9797 60 / +49 7904-9797-73 **Web:** www.besh.de; www.haellisch.de **Country:** Germany	

Transition network participation
Soy, Cool-season grain, (Cooperation: Poultry), (Dairy & beef),
Long-term goals of the actor group
Increase the use local grown legumes in the pig value chain. Soy from overseas should be replaced by at farm grown and processed legumes or at least from suppliers in the same region, country or neighbouring country.
Information on constraints on cropping systems
Climate and soil conditions are different for each farm. Even in the same region are differences. New seeds and varieties or information about proper crop management do not reach farmers. Farmers fear the risk of growing new legumes and need help.
Information on relevant legume-related constraints on livestock systems
For monogastrier it is necessary to process some legumes, that the protein could be used by the animals or to reduce the effect of non-positive attributes in feed. Quite often a processing infrastructure in a reachable distance is lacking. Furthermore the use of "other legumes" or "feed ratios" may cause differences in meat or speck quality.
Information on relevant legume-related constraints on value chains
The use of legumes out of tropic regions and its side effects like deforestation, social pressure on peasants and "food/feed miles" are in critic. As well es a "protein drift" to Europe which causes problems like N-transfer to the groundwater.
Information on opportunities
The use of suitable local grown legumes can prevent a lot of problems.
How will Legumes Translated help
Knowledge transfer about seeds, processing, new plant technolieges (e.g. less aninutritional factors). Knowledge about feed compositions – tools to calculate ingriedents and economic effets.
Data and knowledge that can be provided to Legumes Translated
Demand analysis in feed networks. Experiments on farms and with meat quality in the the slaugtherhouse.

5. Soybean Cultivation Group in South-east Europe

Responsible participant organisation: IFVC
Status: Public Sector Research Establishment
Contact person: Svetlana Balešević-Tubić
Email: svetlana.tubic@ifvcns.ns.ac.rs
Telephone: +381 21 4898480
Web: www.nsseme.com/en/
Country: Serbia

Transition network participation

Soybean Cultivation Group in SEE is participating in following transition networks:

- Soy-based value-chains for feed and food (Soy) - LTZ
- Value chains based on pigmeat (Pigmeat) - BESH
- Value chains based on poultry (Poultry) - DS

Long-term goals of the actor group

The aim of this Actor group is to improve the profitability and sustainability of soybean production through the optimization of agronomy practices and knowledge interaction with farmers. Followed with this aim, long-term goals are following:

- To increase sustainable soybean cultivation and its use in South-Eastern Europe;
- Soybean integration into crop rotations will improve sustainability of agricultural systems, reduce nitrogen losses to the environment and it will have positive effects on soil quality and agro-biodiversity (crop diversification).
- Through translating existing knowledge the improvement of crop management practices in soybean production through the optimization agronomy measures will be enabled.
- Technology transfer, functional exchange among actor groups and dissemination will ensure that the best practices in soybean production will be available for farmers and soybean sector.

Information on constraints on cropping systems

Constraints in cropping systems can be seen from different perspectives (agronomic, socio-economic…):

- variability in soybean yield between years under different production conditions/years;
- input price fluctuation and decision on agronomy management practice;
- habits of farmers and the low adaptation of new proposed technologies;
- Impossibility of application of recommended practice (differ depending on region, climate, soil type, agro-ecological conditions);

Information on relevant legume-related constraints on livestock systems

- Up scaling area under soybean on-farm - competitiveness in comparison with other crops in existing crop rotations;
- Dependence on animal feed import, due to impossibility of introducing more legumes into farming systems.
- Lack of processing units (small farms/households), increasing the local processing and usage of soya, lack of availability/or economic resources, that allow the implementation of technologies that are established in developed countries.

Information on relevant legume-related constraints on value chains

Lack of capabilities to supply end-products (volume, quality) dependency on legume

import.

Information on opportunities

Technology transfer through provision of material that directly target agricultural farmers. Use of material provided by Actor group will give the opportunity to improve soybean production through optimization of standard applied practices, which has direct effect on production profitability.

Data/material are following:

- Provision of material that can fill gaps in crop management practices in soybean production;
- data from soybean farm about crop management and its relation to yield;
- provision of info sheets/leaflets with recommendation on best practices description (selected agro-technology measures);
- production of video material of particular crop management practices;

How will Legumes Translated help

Project will help and foster knowledge dissemination of research outputs related to legume crops of a wide range of stakeholders in Europe.

Data and knowledge that can be provided to Legumes Translated

- Selected local and international IFVC research data on soybean growing;
- Collected and optimized data will be available in electronic format e.g., info sheets/leaflets. (data will concern yield, crop quality and crop management).
- Multimedia material that will cover particular agro-technology measures in soybean production.

6. **Europe Soya Value Chain Development Group**	
Responsible participant organisation: Donau Soja **Status:** SME **Contact person:** Dragos Dima, Leopold Rittler **Email: dima@donausoja,** rittler@donausoja.org **Telephone:** + 43 (0)1 512 17 44-27 **Web:** www.donausoja.org **Country:** primarily Romania, Central Europe (Danube Region)	

Transition network participation

List of the transition networks being participated in:

- Soy
- Food
- Pig meat
- Poultry
- Cool-season legumes (We are interested to test on the DS field days in Romania some grain legume species beside soya)

Long-term goals of the actor group

The group is very divers due to its different members. The most uniting goal is to boost soybean production in Romania via improved cropping skills.
Donau Soja as AG facilitator seeks to develop whole soybean-supported value-chains regionally in Romania and on a continental level in Europe.

Information on constraints on cropping systems

Despite the relative large soybean acreage in Romania (170.000 ha), non-GM soya is still a new crop to most of the producers. So there is a general lack of knowledge in crop management for producing soybeans and other grain legumes. This relates to many basic cropping skills (from seedbed preparation until harvesting and storage).

Soil and water management and crop management to cope with the effects of climate change (e.g. extreme summer droughts).

Information on relevant legume-related constraints on livestock systems

The value-chain for Romanian soybeans on the Romanian market is not functioning very well. So no specific constraints can be identified at this stage.

Information on relevant legume-related constraints on value chains

Processing units for soybeans in general are insufficiently distributed/available in Romania. There is no processing unit in Romania which can provide feed in non-GM quality which is needed to access to this market segment. We think that the demand for soybean (non-GM) produced in Romania would rise if also processing units could supply it to livestock producers.

This situation is different in other countries of the Danube Region. Processing units and a functioning supply-chain can be found e.g. in Austria or in Serbia.

There is one big soybean processor in Romania. This industry is using local and imported soybeans and do not employ segregated processing lines. As a result the local soybeans

are not marketed in a GM-free quality which we consider as a hindering factor for Romanian soybean production.

Information on opportunities

We are informed that a soybean processing unit will start operating soon (probably during 2019). This processing unit will provide a pull factor for soybean production in the region.

There are soybean varieties on the market which have a low trypsin-inhibitor content. Growing these specific varieties enables livestock producer to replace parts of purchased soybean feedstuff. Successful feeding tests are made for these varieties with piglets in Austria (BOKU). This variety is used in a raw condition.

The Donau Soja field days have a good reputation in Romania. These events are since five years demonstrating basic skills in soybean crop management and provide a good opportunity for networking.

The international Donau Soja team is well connected to important market actors, relevant agronomists and livestock production experts in the Danube Region who are not linked or part of the project consortium.

How will Legumes Translated help

Learning from others best practice cropping systems using grain legumes and innovative feeding solutions by liaising with Transition Networks such as Soy, PIG meat, Poultry and Diary and beef.

Support for RO-producers to access easily relevant information for soybean production. Support of international networks for improved understanding of soybean cultivation.

Exchanging and aggregating in a structured way the existing data from trial stations, on-farm research stations and other sources on soybeans growing technology and cropping parameters (e.g. DS demo platforms 2014-2018).

Systematically observing and collecting at trial stations, on-farm demo plots and other locations the emergence of pests and diseases (biotic stress factors) to better monitor the development of these challenges. Abiotic stress factors might be included as well.
Exchanging experiences on new soybean cultivation parameters for improving farming outputs (such as micro elements impact on crop development and quality, new tillage technologies for soybeans and other grain legumes - e.g. conservation tillage).
Organizing international seminar(s) to train agricultural advisors about soybean crop management. This workshop should particularly target advisors in countries where soybean can be considered as an rapidly emerging crop (Germany, Poland, and other places in CEE).
Exploring and identifying potentials in Europe for establishing a protein-based payment scheme for soybeans. This requires also the involvement of soybean buyers and requires economic analysis work. For a solid dataset, collecting regional information on harvest soybean quality (yield, protein and oil) is necessary. It might be in addition necessary to collect further farm-level data.
Exchanging the existing field data and information on soybeans growing technology and cropping parameters for more effective agriculture practices (e.g. demo platforms 2014-2018).
Harnessing information and knowledge on new soybean cultivation parameters for improving farming outputs (such as micro elements impact on crop development and quality, new tillage technologies for soybeans and other grain legumes - e.g.

conservation tillage).
(Re)familiarizing farmers with other grain legumes (such as peas, chickpeas, beans, lentils, fava beans, lupin, etc.) and improving agriculture practices through know-how transfer through Development Guides and Practice Abstracts by enlarging the existing demo platforms with other grain legumes.

Data and knowledge that can be provided to Legumes Translated

Access to detailed data relevant for cropping in Romania.

Data of three demonstration platforms in a series of five years. Effects which have be examined: performance (to/ha) of varieties / maturity groups, seeding date, row distance, etc.

Donau Soja team in Austria (Leopold Rittler) is well linked to relevant poultry-sector specialists, agronomists and livestock production experts in Austria and further in Europe.

7. The German Lupin Network	
Responsible participant organisation: ZALF **Status:** Public sector research establishment (PSRE) **Contact person:** Johann Bachinger **Email:** jbachinger@zalf.de **Telephone:** 0049 (0)33432 / 82-265 **Web:** www.lupinen-netzwerk.de **Country:** Germany	

Transition network participation
Cool-season grain
Long-term goals of the actor group
Knowledge exchange, demonstration and development of lupin-supported cropping systems and value chains.
Information on constraints on cropping systems
Low yield levels, high yield instability, constraints with weeds, pests (especially Sitona spp.) and diseases, as well as harvesting losses.
Information on relevant legume-related constraints on livestock systems
Less constraints with feeding of ruminants
Information on relevant legume-related constraints on value chains
Lack of value chains for conventional produced lupin for feed and hardly any value chains for food sector (with some exceptions). Alkaloid concentration is often problematic in lupin for food.
Information on opportunities
Replacing imported soybean for feeding livestock. Developing value chains for human food e.g. lupin coffee, lupin yoghurt, lupin creme etc. Using lupin in the cropping system to safe nitrogen fertilizer, reduce N_2O emissions and breaking dieses cycles in cereals leading to higher yields in the crops following lupin.
How will Legumes Translated help
Demonstrate examples on existing/working value chains especially for human food but also for regional feed chains. Assess the benefits of lupin in cropping systems (fertilizer savings, reducing leaching and N_2O emissions), biodiversity etc. Assess options to increase yields and stability of lupin through improved crop management and potentially other cultivars.
Data and knowledge that can be provided to Legumes Translated
Knowledge on constraints and opportunities for increasing the cultivation and use of lupin. Selected data on yields and crop management, as well as on seed quality aspects.

8. German Pea and Bean Network	
Responsible participant organisation: LLH **Status:** Public extension and information service **Contact person:** Dr. Thorsten Haase **Email:** Thorsten.Haase@llh.hessen.de **Telephone:** 0049 (0)561 7299 338 **Web:** www.llh.hessen.de **Country:** Germany	DemoNet Erbse Bohne

Transition network participation

Cool-season grain legumes (ZALF)
Food (HEL)
Poultry (DS)
Dairy and beef (SRUC)
Aquaculture (NIRE)

Long-term goals of the actor group

The pea and bean project group aims to:

- demonstrate and improve legume cultivation on German fields;
- demonstrate and improve the use of legumes in livestock feed, especially for cows, pigs and poultry;
- establish marketing structures for legumes (feed and food);
- show the ecosystem benefits resulting from the cultivation of legumes;
- show the economic returns possible from a crop rotation that includes legumes.

Information on constraints on cropping systems

Problems in cultivation (weed competition, diseases, pests and lack of breeds);
Temporal yield instability of grain legumes is higher than that of autumn-sown cereals;
Low productivity;
Low economic gains;
Technological lock-in.

Information on relevant legume-related constraints on livestock systems

In conventional dairy farming forage is produced mainly from pure grass swards with high levels of N fertilization.
When grain legumes are to be fed to mongastric animals such as poultry or pigs, there are restrictions in terms of maximum portions in the ration due to e.g. tannin concentration

Information on relevant legume-related constraints on value chains

Gererally there is a lack of marketing structures and inadequate prices.
The high perceived risk of legume cultivation, combined with current low market prices, prevents farmers from legume cropping. Higher consumer prices for products like meat, milk and eggs are needed when produced with legumes. Further challenge exists in the communication of the additional environmental values associated with legume cultivation to farmers, and the farmers' appreciation of the advantages of these.

Information on opportunities

Collaborating with existing and forthcoming research in order to realise further knowledge transfer and to communicate practical research questions to the scientists. There are several interfaces within the Actor Group to identify and

address the research and development needs and priorities of the different actors. These include working groups, an advisory board bringing in external expertise, field days and interdisciplinary seminars. The project itself concentrates on the demonstration of pea and bean cultivation, processing and value chain development.
Legumes Translated gives the network the opportunity to share knowledge and information with other groups with common concerns linked to the development of legumes in Europe. The idea is to profit from other actors' experiences in Europe in similar or different contexts. How do they create high value food chains? How do they increase profitability of legume production at farm and market-chain levels? How do they process produced legumes? How do they assess these sources of protein? It is also an opportunity to integrate with a network dedicated to such questions and to share experiences with specific trials and partners.

How will Legumes Translated help

The Pea and Bean Network shall contribute to Legumes Translated by

- Providing data on pea and bean cultivation collected within the network
- Passing on information gathered ion EIP-projects dealing with legumes
- Authoring so called practice notes on best practice of cropping coll-season grain legumes
- Elaborate marketing structures
- Participate in the joint development of new extension material (e.g. internet platforms, short videos).

Data and knowledge that can be provided to Legumes Translated

The group has extensive data on value chains and demonstration trials that it can contribute to the project. Much of this is, however, considered confidential and work is ongoing regarding data protection and security of systems to identify the exact scope of existing data that can be provided.

9. Swiss Lupin Network	
Responsible participant organisation: FiBL **Status:** Private research organisation (PVRO) **Contact person:** Matthias Klaiss **Email:** Matthias.klaiss@fibl.org **Telephone:** 0041 (0)62 865 7208 **Web:** www.fibl.org **Country:** Switzerland	

Transition network participation

Cold season legumes

Long-term goals of the actor group

Develop and establish organic lupine cultivation in Switzerland for feed and food, development of suitable and cost effective intercropping systems and identification of varieties with low content of antinutritive compounds suitable for climate and resistant to anthracnose with a vry high yield potential. Develop seed treatment methods to prevent anthracnosis infestation.

Information on constraints on cropping systems

- higher risk for producers who cultivate legumes (lower yield stability than cereals, special equipment needed, practical experience with the crops is missing, undeveloped market);
- need for adapted varieties (anthracnose tolerance, pH tolerance, weed suppression, lodging resistance, suitable nutrient composition, no anti-nutritive compounds, early ripening, no pod shedding);
- monitoring needed in existing and new varieties for anti-nutritive compounds (bitter lupins) and nutrient content and their interaction with cultivation parameters;
- optimising production techniques to increase gross margin for farmers (relating to weeds, diseases, nutrient management);
- breeding of suitable varieties for organic production (anthracnose tolerance, low alkaloid content, weed tolerance pH tolerance etc.); and
- access to early varieties with good yield and protein content.

Information on relevant legume-related constraints on livestock systems

Content of antinutritive compounds, feed processors lack knowledge about conditioning of lupines to remove antinutritive compounds

Information on relevant legume-related constraints on value chains

Antinutritive compounds in lupines are an obstacle for further increase of lupines share in feed rations.

- cooperation with mills necessary to buy and process intercropped harvests (e.g. lupin/oat)

Information on opportunities

Huge interest of feed processors, a lot of lupines are imported, price of local organic lupines competes with international prices

How will Legumes Translated help

Exchange with other actors, knowledge transfer, cooperations.

Legumes Translated will will add a broad European dimension to communications providing the network with direct access to experience across Europe.

Data and knowledge that can be provided to Legumes Translated

Results from trials, dissemination material thet could be translated for use in other countries, experience in cropping systems, cooperation, exchange of breeding material.

- The AG has specific knowledge how to connect breeding ambitions and the needs of consumers/ users of grain legumes. These insights will be contributed to the project with benefits for the development of food and feed value chains of other grain legumes.
- Available data include:
- field performance data from on-farm trials are available from 2013 on. Data are publicly available on www.bioaktuell.ch and have partly been published in a German-speaking organic stakeholders' journal (Dierauer et al, 2015), a scientific Swiss bi-lingual journal (Clerc et al., 2015), in newspapers and at seminars;
- field performance data from an on-farm field trial, consisting of cultivar testing and intercropping partner testing for Blue (Lupinus angustifolius) and White lupin (Lupinus albus), will be available online after being published in a scientific journal;
- economic data collection (e.g. cross margins at farm level) will be one of the aims of the network but has not taken place to date, since lupin is only just starting to be grown and processed in Switzerland;
- data from sensory testing with untrained panels and collect data on consumer acceptance.

Data will be made available across sites and years in form of excel sheets at the end of the project. Data or methods on lupin processing for human or animal consumption may contain confidential data of the respective stakeholders involved.

10. Brandenburg Farmers' Network	
Responsible participant organisation: ZALF **Status:** Public Sector Research Establishment (PSRE) **Contact person:** Johann Bachinger **Email:** jbachinger@zalf.de **Telephone:** 0049 33432 82265 **Web:** www.zalf.de **Country:** Germany	

Transition network participation
Cool-season grain Soy
Long-term goals of the actor group
Knowledge exchange on cropping systems to increase the resource- and economic-efficiency
Information on constraints on cropping systems
Climate change (extreme weather), soil nutrient management, pest and disease, high yield instability and low yields of grain legumes
Information on relevant legume-related constraints on livestock systems
Only few keep livestock with no specific constraints
Information on relevant legume-related constraints on value chains
Hardly any value-chains existing for conventional produced grain legumes. Such value chains exist for organically produced grain legumes but often need to be arranged on the basis of individual contacts (and contracts).
Information on opportunities
Large demand from wholesalers for GMO-free protein feed. Using legumes in soil nutrient management. Diversification of cropping systems with legumes. Soybean as a novel crop that potentially provides higher economic returns than other grain legumes (providing higher yields, is better adapted to weather extremes).
How will Legumes Translated help
Demonstrate examples on existing/working value chains in other actor groups. Assess the benefits of legumes in cropping systems for nutrient management (fertilizer savings, reducing leaching and N_2O emissions), biodiversity etc. Assess the potential of soybean as a novel crop in Brandenburg based on experiments and experience from other soybean-farmers across Europe.
Data and knowledge that can be provided to Legumes Translated
Knowledge on constraints and opportunities for increasing the cultivation and use of legumes in Brandenburg. Selected data on yields, management and economic returns from crop production.

11. The Irish Grain Legumes Group	
Responsible participant organisation: Teagasc **Status:** Public Sector Research Establishment (PSRE) **Contact person:** Sheila Alves **Email:** sheila.alves@teagasc.ie **Country:** Ireland	

Transition network participation

Diversified of arable cropping using cool-season grain legumes (Cool-season grain); Soy-based value-chains for feed and food (Soy); Value chains based on dairy and beef (Dairy and beef).

Long-term goals of the actor group

Identify the barriers to the development of grain legumes to provide the protein requirements of the Irish feed sector
Compete with high-value international and national markets
Identify the research requirements to make grain legumes viable options to Irish farmers
Improve knowledge transfer from research to stakeholders
Develop initiatives to promote national vegetable protein sources at government level.

Information on constraints on cropping systems

Perceived variability in yield, limited varietal development and limited specific agronomy information (including disease and pest control) are deficits which need to be addressed.

Information on relevant legume-related constraints on livestock systems

There is a significant deficit in research on rates of faba beans inclusion and replacement of soyabeans in rations for animal feed.

Information on relevant legume-related constraints on value chains

Market end-users need to be assured of the value of beans (and other legumes) as a protein source in rations, and of continued supply, to ensure they will be considered as valuable native-produced protein and energy source.

Information on opportunities

Large animal feed market for protein crops with the potential to displace approx. 1.2Mt of imported protein feed. Scope to produce beans for food export markets. Scope to grow alternative crops (soyabeans; lentils; vetches; chickpeas; lupins).

How will Legumes Translated help

Knowledge and data on new breeding programs, state of the art production and processing systems and end-use of grain legumes grown in temperate climates.
Economic assessments as to the profitability of legumes within a rotation, as well as economic analyses/compatibility of different protein sources in animal feeds.
knowledge and data of suitable options for weed and disease control in faba beans.
Joint initiatives for research into the above options, as well as the possibility of licensing across a climatic region.

Data and knowledge that can be provided to Legumes Translated

Comprehensive crop management data of faba beasn grown in a temperate climate including cultivation system, establishment, fertiliser input, weed, pest and disease control, yield and varietal comparisons from research and commercial trials. Production input, financial performance, resource and environmental data are also available.

SRUC Dairy Protein Group

12. SRUC Dairy Protein Group	
Responsible participant organisation: SRUC **Status:** University **Contact person:** Richard Dewhurst **Email:** richard.dewhurst@sruc.ac.uk **Telephone:** +44 1387 263961 **Web:** www.sruc.ac.uk **Country:** UK (Scotland)	
Transition network participation	
Dairy and Beef; Cool season grain	
Long-term goals of the actor group	
Optimise the use of home-grown protein in Scotland Reduce reliance on bought-in proteins for dairy rations Livestock feed sector with greater security of supply of protein feedstuffs of a consistent quality	
Information on constraints on cropping systems	
Field beans are not commonly grown as a grain or a silage legume in south west Scotland, in part because of the warm/wet climate and disease risk. The short growing season is also a constraint for ripening, as are soil conditions at harvest. There is little experience of growing lucerne although it has potential in this area.	
Information on relevant legume-related constraints on livestock systems	
Work has been done on feeding lucerne as silage to dairy cows (AHDB Dairy, SRUC) and on feeding white clover and red clover in grass silage swards. SRUC has documented the effects of feeding a home-grown ration, including grass silage with clover, lucerne silage and field beans (Langhill systems experiment, SRUC).	
Information on relevant legume-related constraints on value chains	
Milk purchasers are reported to be starting to query the use of, or require lower inclusion of, bought-in soya bean meal (SBM) in ruminant livestock rations. It is perceived as of primary importance for human food and a pig & poultry feed ingredient. There exist alternatives to SBM, where other protein sources are treated eg by heat, to protect the structure of the protein from degradation in the rumen and confer greater benefit as a result interms of milk or meat produced. These include rapeseed meal, sunflower meal. The level of digestible, undegradable protein is raised so that the alternative can have a similar performance to SBM. Beans are a good quality addition to ruminant rations, but their supply is not consistent enough for Scottish feed manufacturers to use them all the time. If they can be grown on the farm of use they make a valuable protein and energy feed and reduce the farm's dependence on purchased feeds.	
Information on opportunities	
Development of varieties that are easier to grow with consistent yield and quality, in the cooler and wetter parts of Europe will benefit dairy producers in the UK. Learning about and taking part in trials of new legume varieties would be a good way of establishing these links and relations with suppliers of seed.	
How will Legumes Translated help	
Sharing our experience and information gained with other members of Transition	

Networks; The speed of development and of adoption of new varieties that can be home-grown should be faster because of the networks established in the project.
Data and knowledge that can be provided to Legumes Translated
Existing data from SRUC on cropping results from growing beans, red clover and lucerne; Results from feeding these forage and grain legume proteins to dairy cows; Planned plot work in Scotland, growing locally-appropriate legume crops, and engage with farmers, students, consultants and researchers over the agronomy and feeding to livestock.

13. LegumesForFish	
Responsible participant organisation: NIREUS **Status:** Large enterprise **Contact person:** Dimitris Barkas or Leonidas Papaharisis **Email:** d.barkas@nireus.com; l.papaharisis@nireus.com **Telephone:** 0030 2610241995; 0030 2106698187 **Web:** www.nireus.com **Country:** Greece	

Transition network participation

- AQUACULTURE

Long-term goals of the actor group

6. Increase participation of raw materials in fish feed originated from EU.
7. Use of by-products from EU leguminous production to reduce ecological footprint.
8. Reduce dependency on the import of raw materials for fish feed from third countries.
9. Interaction between local legume production and local aquaculture.
10. Farming protocols for legume crops with low irrigation demands, high nutritional value for fish in a cost effective way.

Information on constraints on cropping systems

The requirements of soy cultivation can be a limiting factor for the development of the crop in many areas in EU, particularly the arid southern-European areas. In addition, the small farm size and site variability and the lack of access to processing, storage and supply to the end user are key barriers to be overcome in the cropping systems in the Mediterranean.

The cropping systems develop on locally adapted varieties with low irrigation demands but higher production prices than soy.

Novel strategies and practices at the organisational, production, ecosystem, biological resources, processing, and product quality levels are sought to make local legume production competitive.

Information on relevant legume-related constraints on livestock systems

Fish have high nutritional needs for proteins, which they cover from their diet. Especially for farmed Mediterranean species (sea bream and sea bass) the minimum dietary protein requirement is 40%. To achieve this requirement, the proteinous raw materials used must have a minimum of 35% protein content. Besides protein content, bioavailability and amino acid profile are key are determining factors for efficient fish nutrition.

This is of particular importance for legumes, as they contain ingredients of protein origin that have a significant negative effect on fish health. Legumes produce and store in their seeds protease inhibitors, which are natural protectors against plant pathogens. However, protease inhibitors have been recognized as potent antinutritional factors (ANF) in animals, including fish. ANF's impair protein digestibility and amino acids bioavailability, while they can severely affect pancreatic function.

In addition, the other raw materials that are to be used in fish feed, because they mainly substitute part of the marine raw materials (fishmeal, fish oil), except from their high standards, should also have a competitive cost. In order to have a common price

comparison base, costs are expressed in €/protein unit. On the basis of current raw material prices, a competitive price for a deliverable product is that of € 10/protein unit.,
Concluding, main constraints are:

1. Legume-based raw materials with a high protein content (min 35%)
2. Balanced amino acid profile
3. Low content of antinutritional factors
4. Competitive production costs (€/protein unit) so that these raw materials can be used at a reasonable rate in fish feeds.

Information on relevant legume-related constraints on value chains

Recent statistical Market Researches show that for the E.U. market the origin of the product ranks higher than it's market price. Additionally, if this product is produced locally, then it ranks even higher.

Information on opportunities

Legume-Translated can promote a high protein raw material for fish feeds that can be produced locally enhancing local primary production. Moreover, it concerns raw materials that have already gained the international interest (e.g. Waitrose has been involved in developing fish feed using faba beans) and are thought to be able to link several sectors, such as agriculture with aquaculture.
Exploiting conditions that allow two-three crops in a single year and genetic adaptation to local conditions and low irrigation demands can be envisaged as a wider transition in the Mediterranean region that provides important ecosystem services.
Finally, this transition in locally produced locally used legumes is a great opportunity to decrease the ecological footprint of fish production.

How will Legumes Translated help

The EU is considered a pioneer in aquaculture globally in terms of innovation and knowledge generation, while gilthead sea bream and European sea bass are by volume the third and fourth most farmed fish species in the EU. However, future growth relies on securing adequate quantities of sustainably yield fish feed materials of high protein content. Legume Translated is an excellet vehicle for *LegumesForFish* to share the considerations of the aquaculture sector, present the opportunity available to legume producers and processors and set the quality requirements for use in aquaculture.
However, fish farming is only one of the several sectors relying on legumes and Legume Translated brings many sectors together to exhange best practices and manage the conflict for use in a balanced fashion. With access to high quality economic, social, environmental and policy analysis, Legume Translated is expected to offer *LegumeforFish* the support required for developing the prototype value chain and support the technological development of the benchmarking system of legumes for use in fish feeds.
Local agriculture production is expected to adjust accordingly to meet the expectations of local aquaculture production. This interaction is expected to grow to a positive feedback loop that will increase the efficiency of both production systems, and set the database for complete legume composition, which is essential for their use in fish feeds.

Data and knowledge that can be provided to Legumes Translated

The data to be provided to the project span the whole supply chain from legume production to fish farming performance including:

- yield and grain quality of the crops grown;
- data on production practices;
- fish resource productivity in relation to different legume crops;

- qualitative characteristics of legume species with respect to feed quality (protein content, amino acid profile, content of antinutritional factors);
- levels of inclusion of the legumes in fish feeds;
- levels of soymeal substitution in fish feeds;
- effects on fish key performance indicators (specific growth rate, food conversion rate, survival, operational and physiological welfare indicators).

Our knowledge on fish feeds and fish nutritional physiology are crucial for the critical assesment of legume-origin raw material concerning their use in fish feeds. Moreover, we implement unique qualitative and quantitative in vitro methods for raw material benchmarking.

15. Ground for Growth	
Responsible participant organisation: HEL **Status:** University **Contact person:** Kristina Lindström **Email:** Kristina.lindstrom@helsinki.fi **Telephone:** +358 294158854 **Web:** Under construction, Facebook: Kasvunpaikat **Country:** Finland	

Transition network participation

Cool-season grain; Food

Long-term goals of the actor group

Our long term goal is to increase production, improve processing and enhance marketing and consumption of pulses grown in Finland (faba bean, pea and lupin). We aim to:

- activate different actors in the value chain to get them to collaborate/interact with each other through our actor group;
- to use diverse platforms such as workshops, networking events, web-based media and farm-based tutorials;
- to engage Swedish-speaking and Finnish-speaking rural advisory bodies and farmers' unions to produce information materials, videos and leaflets.

Information on constraints on cropping systems

The short, cool cropping season limits the range of species and cultivars that can be grown. Faba bean is suited to the deep south, where it is often the first crop to be sown and last to be harvested. Pea cultivars (mostly soup pea) are grown somewhat further north. Narrow-leafed lupin has been established in sandy soils in the west as far north as Lapua (63°N). Few farmers know how to handle any of these crops and our surveys show that they prefer peer-to-peer information flow. Many are concerned that the investment will not be repaid as prices are too low. Springs are often dry so the window for sowing is narrow. Spring frosts are not common, but can set back seedling and vegetative-phase plants. Summers often include a period of prolonged drought and although half of all arable hectares are within a kilometre of lake or river water, irrigation is not seen as an economic option (this may change after the summer of 2018). Autumns are wet so there is little or no opportunity to establish a catch crop to retain nitrogen against leaching and denitrification, and if the rains start early, many crops (not just grain legumes) may not be harvestable. Aphanomyces root rot of pea is established in the southwest, but little seen elsewhere. Chocolate spot is the main disease of faba bean, but is seen by some farmers as useful because it defoliates the plant at the end of the growing season. So far, other diseases of legumes are relatively rare. Pea moth, pea aphid, black bean aphid and Sitona weevils are the main insect pests, along with gamma moth as a new pest last summer.

Information on relevant legume-related constraints on livestock systems

NA

Information on relevant legume-related constraints on value chains

The food industry in Finland would need an adequate supply of food quality legume ingredients and semi-finished legume products. The domestic (Finnish) fractionation products like faba bean protein concentrates are currently at a development stage, their

future could be uncertain if the legume crop production would suddenly be limited and the yearly variation in the quality becomes great. The biggest legume-related constraint for most food companies is the quality of legume (faba bean and pea) ingredients available internationally or domestically. The legume food development needs off-flavor-free and safe legume ingredients as well as fractionation products. There is interest to use legumes in the dairy-type aqueous processes, but the constraint is the beany off-flavors of legume ingredients. The texturized legumes, meat substitutes, found in the food market are mostly produced from soya protein, but other legume protein sources are technologically as good: the main constraint for producing texturized legumes from other legume protein sources is the minimal and low-quality supply.

Information on opportunities

There is a window of opportunity to promote legumes nationally, since many actors are already engaged in producing pulses in Finland. During our first year in this project, we hope to gain more information on constraints related to, for example, market access, organization and management, regulatory (policy), finance, input suppliers regarding legumes in Finland.

How will Legumes Translated help

We hope to gain information on topics related to legumes for food systems. This could be, for example:

- How to build value-chains that do not fizzle out
- Different success stories regarding legumes for food, showcasing how to bring legumes from farm to fork
- Addressing bottlenecks related to processing and cultivation

Data and knowledge that can be provided to Legumes Translated

Comprehensive data on the crops grown in each field each year, including inputs and yields, are available online in national databases and in various summary statistics. Other, more sensitive data, such as financial performance, are available from individual farmers and their organizations within the actor group, mostly on paper. Other types of data, not yet specified, along the chain formed by Actor Group participants, will be collected during the activities planned. We hope to gain more information from the participants during the next event organized in February.

About this report

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