TRansition paths to sUstainable legume-based systems in Europe

Innovation Catalogue

Work Package: 3

Deliverable (D): D3.5 (D22)

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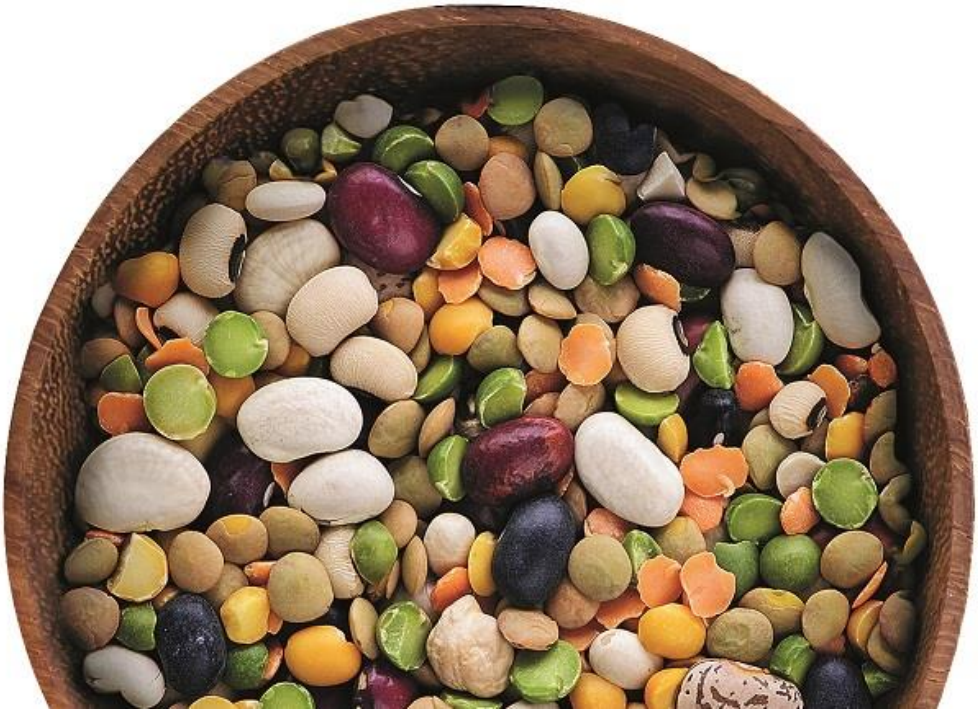

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Deliverable Description & Contributors

- **Due date:** 31st July 2021
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- **Project start date:** 1st April 2017
- **Duration:** 48 months
- **Work package:** Nutrition and product development (WP3)
- **Work package leader:** Marta Vasconcelos (UCP)
- **Deliverable Title:** D3.5 (D22) Innovation catalogue
- **Nature of deliverable:** Report
- **Dissemination level:** Public

- **Deliverable description** This report is Deliverable (D3.5) of the TRUE project. The report aims to illustrate and promote the innovation dynamics of the TRUE project to a wide group of stakeholders with the aim of emphasising how legumes positively contribute to a more sustainable agri-food systems. The report is written in plain-English terms to ensure the widest possible appeal and uptake.

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Contents

TRUE has received funding from the European Union's Horizon 2020 Research & Innovation Action under Grant Agreement Number 727973.

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1 Introduction

The TRUE Legume Innovation Catalogue showcases the advances which have emerged from the H2020-funded project Transition Paths to Sustainable Legume-based systems (TRUE). The catalogue also highlights the breadth and diversity of products that can be achieved through a multi-actor and trans-disciplinary approaches adopted by the consortium. Also, it should be noted that the TRUE consortium itself comprises and fully involves key stakeholders from across the value chain including farmers/growers, processors, extension/advisory services, academics, policy specialists, retailers, and SMEs, all of whom provide robust knowledge and expertise of agroecological production systems and value chains, and they seek to identify and enable the means to realise sustainable and healthy feed, and food for all citizens.

Legumes are widely recognised as a sustainable source of highly nutritious food and feed, often requiring no, or greatly reduced, inputs of synthetic inorganic nitrogen fertiliser. Despite these benefits, legume-based systems have not been realised in common farming practice. The main objective of TRUE is to **identify the best routes, or "transition paths" to increase sustainable legume cultivation and consumption across Europe,** and this includes the entire legume feed and food value chains. The TRUE approach aims to identify and implement a better-balance for environmental, economic- and social- securities throughout the value chain, facilitating excellent standards of nutrition to deliver improved health and wellbeing for people and animals. TRUE also responds to the urgent need for a more integrated understanding of the contributions of legumes to sustainable production systems and improved health and well-being. It considers the opportunities offered by short-food and -feed value chains and innovations, to enable nutrition security that counters two increasing forms of malnutrition: lack of food and under-nutrition *versus* food affluence and unbalanced nutrition.

In this Deliverable, a range of innovations that can trigger positive changes in current demand, patterns, and production of legume-based systems are showcased (Table 1). These innovations mainly stem from the project's innovative Case Studies, which develop and showcase a wide diversity of key legume species and production systems covering a variety of farm types, and value chains across the varying pedoclimatic or biogeographical zones of Europe (Table 2). This Deliverable also includes some detail on other legume-based or -facilitating innovations developed by from other stakeholders too.

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Table 1. Overview of all TRUE innovations

	Innovation	Country	Legume Crop	TRL
Food & Drink	Nàdar – Gin and Vodka	UK	pea, faba bean, lentil	9
	Cool Beans® -Faba Bean IPA	UK	faba bean	9
	Novel legume extrudates	Germany	pea, faba bean, lentil	9
	Lupin yoghurt	Portugal	lupin	4
	Fava Java	Portugal	faba bean	4
	BBDonuts	Portugal	faba bean	4
	PlantCakes	Portugal	lentil	6
	Vegetarian acorn sausage	Portugal	chickpea	9
Feed	Shrimp feed with lupin	Germany	blue lupin	6
	Salmon feed with faba bean concentrate	Germany	faba bean	6
	Seabass feed with lupin	Germany	blue lupin	6
	Formulation for an “easy to produce” self-made shrimp diet	Germany	lupin, faba bean, pea, vetch	9
	Formulations for Salmon diet with grain legumes	Germany	lupin, faba bean, pea, lentil	4
	Formula for Seabass diet with grain legumes	Germany	lupin, faba bean, pea, lentil	4
	Spent barley-bean	UK	faba bean	5
	Formulations for Salmon diet with spent barley-bean/green pea	UK, Germany	faba bean, pea	4
Agri	SRUC Dairy Systems	UK	lucerne, spring bean	8
	Autonomous prime mover with minimal soil footprint	UK	clover	5
	Direct drilling of cereal crops into biomass crop stubble	UK	pea, faba bean, vetch	5
	Lowering the carbon and ammonia footprints of pasture-based dairy production	UK	clover	5
	New rhizobia strains for common bean	Greece	common bean	3
	New efficient crop rotation schemes	Greece	common bean	3
	New elite rhizobia for common beans and tephrosia	Kenya	common bean, tephrosia	5
	New agroforestry practice for smallholder famers in western Kenya	Kenya	common bean, tephrosia	5
	Creating novel common bean types using grafting	Greece	common bean, runner bean	4
Method and Marketing	Comprehensive competitiveness analysis for data gathering and analysis	Croatia	All	8
	“Choose Beans” initiative	Portugal	All for food	9
	“PathFinder” -a web-based Decision Support System	Slovenia	All	7

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	Cookbook: "The Good-enough Kitchen"	Hungary	All for food	6
	Lupin-based food recipe book	Portugal	lupins	4
	Guidebook to small-scale organic cultivation of selected legume species	Hungary	chickpeas, beans	6

Table 2. Overview of TRUE Case Studies

	CS No	Affiliation, Country	Aim-scope	Legume Crop
Food & Drink	3	ADL, UK	Intercrops used for legume-based biorefining for alcoholic drinks	pea, faba bean
	12	IFAU, Denmark	Vegetarian food formulation	soybean, lupin, lentil, pea
	17	AK, Hungary	Sustainable short value chains delivering novel legume products to reconnect producers and urban consumers	bean (misc.)
	20	UCP, Portugal	New snacks and convenience products based on legumes	common bean, faba bean, soy, lentil
Feed	10	IFAU, Denmark	Organic pig feeding and home-grown legumes	lupin, faba bean
	15	AWI, Germany	Formulation of legume-based feed for aquaculture of seabass, salmon, and shrimps	lupin, faba bean
Agri	1 & 2	TEAG, Ireland	Expanding legume base pasture uptake clover-sward reliant organic production	white and red clover
	4	SRUC, UK	The use of legumes and leguminous by-products within dairy farming	lucerne, spring beans
	5	JHI, UK	Intercropping for high productivity low-input systems	peas, faba beans or vetch
	6	STC, UK	Development of PAT-led agronomy for strip-sown crop and forage-legume living mulch combinations	clover, lucerne
	18	FDM, Portugal	Ancient and heritage variety screening for higher nutritive value	common bean, lupin, lentil, chickpea
	21	AUA, Greece	Grafting roots and stems of different common bean types (to develop crop idiotypes)	common bean
	22	AUA, Greece	Use of symbiotic rhizobia to increase yield	common bean, chickpea
	24	KEFRI, Kenya	Improving yields in relay intercropped agroforestry-based systems of smallholders	common bean, cowpea
Method	9	IFAU, Denmark	Retailer-producer quality chains and innovations	lentil, pea, faba bean, French bean

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	16	REDEA, Croatia	Legumes: their potential role in Croatian agricultural production	Misc.
	19	EUR, Portugal	Initiative to promote the consumption of pulses	common bean, faba bean, soybean, lentil

Compiling the TRUE Innovation Catalogue

In this Deliverable report, innovation is defined as a new or modified product, process, service, organisational, or marketing model, in-line with the EU's 'Innovation Radar Methodology' (De Prato *et al.*, 2015).

With this definition, the novelty and impact of innovations can be characterised. For instance, some innovations may contribute to significant changes to people's lives and society, and because of that may be regarded as radical. Examples include new product categories that do not exist in the market, new applications of legume-based biomass that create new value chains or new markets, or novel technologies. Hence, radical innovations may offer a strong potential to induce systemic changes, but their uptake/implementation in existing systems or markets may be difficult due to institutional barriers or rigid structures and practices in the current system.

Innovations fall largely into one of two categories, specifically: "**changes**" or "**new**". **Changes** are improved or altered products, technologies, or processes that could be easily accepted or taken-up by relevant stakeholders as "changes" are easier to adapt to existing structures and systems than "new" innovations. These types of innovations contribute to motivate changes in behaviour or demand, or help attract attention to an issue, for example a systemic imbalance or unexploited opportunity.

The Innovation Radar Methodology further enables an assessment of the innovation maturity in terms of **Conceptual, Experimental, or Commercial** (De Prato *et al.*, 2015):

- As **conceptual,** we consider innovations at a very early stage of development for example the first phases of field or lab experiments. This would refer to the TRL levels 1-3 (Figure 1). Conceptual innovations are not yet positioned in a production or market context.

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- As **experimental,** we consider innovations that are at pilot-scale or at the level of validating technologies. This would refer to the TRL levels 4-6 (Figure 1). At this stage, some innovations would attract attention from commercial partners who would be interested in taking the innovation forward to commercialise the idea, product, or technology.
- As **commercial,** we consider innovations that are demonstrated in operating environment or at a stage where the innovation is ready for the market. This would refer to the TRL levels 7-9 (Figure 1) and include innovations that have proven to function but adjustments from demonstration to full operation are still going on.

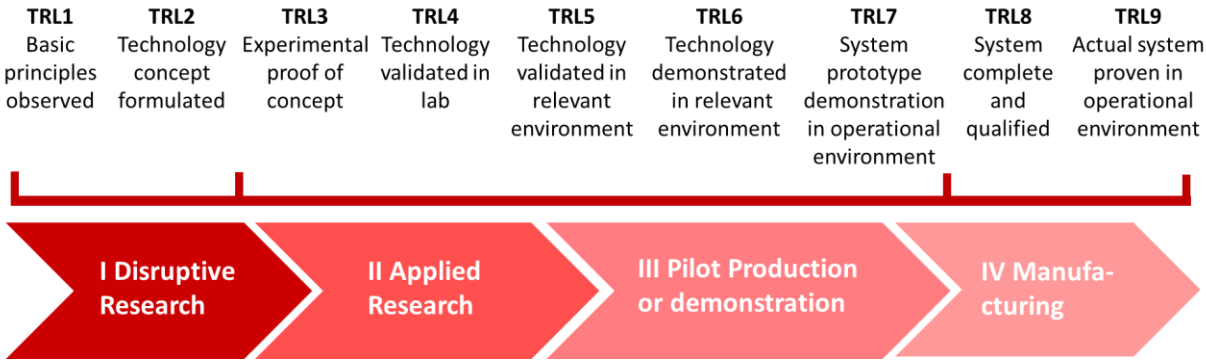

Figure 1. Technology Readiness Levels (adapted from Red Knight Consultancy)

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2 TRUE Innovations

The TRUE innovations have been divided into four categories as described below.

- **Food & Drink:** Innovations related to products for human consumption.
- **Feed:** Innovations related to products for animal nutrition.
- **Agri:** Innovations related to farming techniques and practices, and crop breeding.
- **Methods & Marketing:** Innovations related to practices, management, and collaboration.

The **Food & Drink,** and **Feed** categories include new products, improved processes, and new recipes or formulations. Such innovations are market-oriented and target end-users in the food or feed industries. These categories highlight the importance of both food and feed to allow the transition to more sustainable legume cultivation and consumption across Europe. Currently the use of legumes for feed accounts for *ca*. 90 % of the legume consumption in the EU, and food the remaining *ca.* 10 %. The **Agri** category includes innovations targeted at farm management systems, crop production practices, and crop breeding techniques, that are highly innovative practices and techniques that would allow for a better integration of legumes in current conventional and organic farming systems. Finally, the **Methods & Marketing** category, showcases initiatives, methods and e-books that aim to encourage change in current practices and understanding of the benefits of legumes.

2.1 Overview of TRUE Innovations

The **Food & Drink category** presents a variety of novel beverages and legumes-based food products targeted at consumers interested in more sustainable food and drink products. Several of these innovations have been developed to address the high CO_2 emissions of current food and drink production. For example, by using home-grown peas for the distilling process, the Nàdar Gin and Vodka have reduced the environmental footprint significantly. Similarly, the new food products made with pulses, for example PlantCakes, FavaJava drink, or the lupin yogurt, may also benefit from a reduced environmental impact. This impact is achieved from a reduced use of cereals, elimination of transportation of coffee beans, or the replacement of cow milk. By formulating innovative food and drink products with the inclusion of pulses, innovators may benefit from introducing a new product into the market and use the environmental credentials of the product for

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its marketing. This may prove a powerful tool to attract the attention from consumers. In addition, by using local resources, a manufacturer can stimulate local employment and income generation in the local rural area leading to an increasing demand for crops and ingredients that naturally belong to this area or climatic zone. The use of local resources is an important credential of several of the TRUE innovations in the **Food and Drink category**. For example, the acorn and lentil sausage and the BBDonuts have been developed using locally grown crops from rural Portugal: lentils and faba beans respectively. The environmental benefit is realised through the positive effects of legume crops on the soil and the reduced CO_2 emissions associated with less transportation. These examples show that food innovations with pulses may be significant to local communities.

The EU imports 70 % of its protein feed needs (Watson *et al.* 2017) mainly in the form of soybean. There is an urgent need to find alternative solutions to solve the protein deficit, and legumes can play a significant role in meeting the considerable demand for protein rich feed-material for ruminants, pig, poultry, and aquaculture production. The **Feed category** of this innovation catalogue presents some promising ideas for the use of EU grown legumes in compound feed for conventional and organic livestock production and aquaculture. For example, TRUE innovations have proven that new value chains can be developed by connecting novel improved co-products from breweries or distilleries with animal farmers, and feed manufacturers. The spent grain from brewed and distilled has an enhanced protein-content and -quality (compared to cereal-only derived co-products) and are now being exploited as resource for monogastric animals. Globally, aquaculture production is increasing which leads to a growing demand for fish meal as feed source. TRUE case studies demonstrated that lupins and faba beans can successfully be used as alternative protein source for salmon, seabass, and shrimps, reducing the environmental impact of aquaculture Similarly, legume crops can play a significant role for reducing the CO_2 emission for dairy farming. The innovation related to a farm management system where home-grown lucerne and spring beans were essential crops for feeding dairy cows and soil improvement.

The **Agri innovations** aim to improve or facilitate the way leguminous crops are cultivated in various farming systems. These include, for example, dairy farming in Ireland, agroforestry practices in Kenya, the identification of new elite rhizobial strains, or the development of novel machinery-based solutions. These innovations could be applied to many different farming systems and value chains across the world.

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Innovative **Methods & Marketing** is critical to raise awareness and empower end-users or value chain stakeholders. Here the innovations provide both inspiration, tools, and guidelines for stakeholders from the simple acts of encouraging legume-cultivation, -cooking and -consumption to the monitoring and assessment of whole value chains. Among the former, marketing innovations include the exemplary 'Choose Beans' initiative which helped catering operators implement pulse-based menus to help consumers make positive, pro-legume, consumption choices. Such effort has been allied to a series of TRUE Legume cookbooks, including 'Easy Peasy Legume Recipes' designed especially for children, and which has been translated into 10 different languages so far.

2.2 TRUE Innovation Catalogue

The **31 TRUE innovations** are presented by categories in the following pages.

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Food & Drink

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Nàdar – Gin and Vodka

New range of alcoholic beverages: the world's first climate positive gin and vodka made from neutral spirit (alcohol) derived from only peas.

Year introduction to market
Launched 2020

The innovating business or agency
Arbikie Distilling Ltd, Scotland, UK

Contact details
Kirsty Black, Kirsty.black@arbikie.com

Legume species trialled (to date)
Dried peas – *Pisum sativum* – although this innovation has the potential to apply to other legumes such as beans and lentils.

Target consumers and/or unique selling points
Consumers interested in sustainability, environmental impacts and where their food/drink comes from.

Improvements to traditional products
Life cycle analysis compared the pea to the usual wheat-based gin and showed the pea-based spirit to be carbon negative, -1.54kg CO_2e compared to that of wheat.

Markets (envisioned)
Currently launched in the UK, Canada, USA, and some European markets. Planned expansion into Caribbean, UAE, additional European countries and beyond. Already scaled up to full scale manufacture.

Environmental credentials of the innovation
Allocated environmental footprints for pea-gin were smaller than for wheat-gin across 12 of 14 environmental impact categories considered. Global warming, resource depletion, human toxicity, acidification, and terrestrial eutrophication footprints were, respectively, 12, 15, 15, 48 and 68% smaller, but direct land occupation was 112% greater, for pea-gin versus wheat-gin. Expansion of LCA boundaries indicated that co-products arising from the production of 1 L of wheat- or pea-gin could substitute up to 0.33 or 0.66 kg soybean animal feed, respectively, mitigating considerable greenhouse gas emissions associated with land clearing, cultivation, processing, and transport of such feed.

TRL - Technology Readiness Level Transition
During the project lifetime this innovation was progressed to TRL 9, 'actual system proven in an operational environment'.

IPR - Intellectual Property Right protection
Name trademarked and branding on-going. Patent opportunities currently being investigated.

Legume-based value chain enhancement
These legumes-based spirits demonstrate the potential of these crops as more environmentally favourable raw materials thus, in turn, creating a high value market encouraging their production.

SDGs


Communication channels
Social Media, Popular- & Trade-Press
Peer Reviewed Science Publications

Useful online resources
Arbikie Highland Estate
LCA Just the tonic!
Nàdar Gin
Nàdar Vodka

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Cool Beans® - Faba Bean IPA

New gluten free, and vegan beer produced with 30 % faba bean kernels (dehulled beans).

Year introduction to market
Launched 2020

The innovating business or agency
Barney's Beer, Scotland, UK

Contact details
Andrew Barnett, info@barneysbeer.co.uk
Kirsty Black, Kirsty.black@arbikie.com

Legume species trialled (to date)
Dried kibbled (milled) faba bean – *Vicia faba* L. – kernels (dehulled beans i.e., skins removed) although has the potential to apply to other legumes such as peas and lentils.

Target consumers and/or unique selling points
Consumers interested in sustainability, environmental impacts and where their food / drink comes from. Also, those interested in 'free from' products.

Improvements to traditional products
LCA comparing beer produced with and without faba beans in progress. Production also results in a protein enriched by-product with an increased commercial value.

Markets (envisioned)
Released as a seasonal beer in the UK. Already scaled up to full scale manufacture at Barney's Beer, Scotland.

Environmental credentials of the innovation
Substitution of typical beer raw materials with faba beans reduces the quantity of cereals utilised and the avoids the potentially negative environmental impacts associated with their production.

TRL - Technology Readiness Level Transition
During the project lifetime this innovation was progressed to TRL 9, 'actual system proven in an operational environment'.

IPR - Intellectual Property Right protection
CoolBeans® trademarked.

Legume-based value chain enhancement
These legumes-based spirits demonstrate the potential of these crops as more environmentally favourable raw materials thus, in turn, creating a high value market encouraging their production.

SDGs


Communication channels
Social Media, Popular- & Trade-Press

Useful online resources
Craft beer made in Edinburgh micro-brewery
Cool beans can do it all
Edinburgh-based Barney's Beer develops new vegan-friendly IPA made from beans

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Novel Legume extrudates

Different extrudates were developed within the TRUE project, which led to new legume-based products, *i.e.*, flakes, nuggets, crispies, balls, and protein rich noodles based on different legumes (*e.g.*, spaghetti based on yellow and green bean and spirelli pasta based on faba bean, green bean, and red lentil).

Year introduction to market
Launched 2018

The innovating business or agency
Institut für Getreideverarbeitung GmbH, Germany

Contact details
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Legume species trialled (to date)
Pea, red lentils, green beans, yellow beans, faba bean

Target consumers and/or unique selling points
The food industry and consumers in general. The extrudates produced are used as a basic material and as an additive in the production of a various types of food. This includes:

- bar;
- muesli (high protein muesli);
- sports nutrition;
- snacks; and,
- meat substitute products such as burger patties.

Markets (envisioned)
European food market

Environmental credentials of the innovation
Legume-based products provide an alternative source of protein, which reduces the environmental impact of food production such as meat-based products.

From top to bottom: balls, flakes, nuggets, pasta

TRL - Technology Readiness Level Transition
During the project lifetime this innovation was progressed to TRL 9, 'actual system proven in an operational environment'.

IPR - Intellectual Property Right protection
No IPR protection considered to date.

Legume-based value chain enhancement
An increased consumption of, for example, legume-based snacks would lead to increased demand, which would ultimately lead to increased cultivation. It is also important to inform and educate consumers.

SDGs


Communication channels
Marketing Company

Useful online resources
IGV-GmbH

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Lupin Yogurt

Lupin yogurt is prepared with dehulled lupin flour (4%), which act as a thickening agent and enrichs the product nutritionally. It also has the potential to act as a prebiotic, although further investigation is necessary.

Year introduction to market
Intended commercial launch late 2021

The innovating business or agency
Universidade Católica Portuguesa, Portugal

Contact details
Marta Vasconcelos, mvasconcelos@porto.ucp.pt
Ana Gomes, amgomes@porto.ucp.pt

Legume species trialled (to date)
Lupin

Target market use of the innovation/product
Children, as this yoghurt is rich in protein, a good source of fibre, and omega 3.

Improvements to traditional products
Lupin flour contributes to a more favourable nutritional profile of the end-product compared to traditional thickener.

Markets (envisioned)
Portuguese and European food market

Environmental credentials of the innovation
The environmental impact assessment is in progress in collaboration with the Limerick University (David Styles).

TRL - Technology Readiness Level Transition
During the project lifetime the innovation was progressed to TRL4, 'technology validated in the laboratory' – though TRL9 (actual system proven in an operational environment) should be achieved by late 2021.

IPR - Intellectual Property Right protection
No IPR protection considered to date.

Legume-based value chain enhancement
The replacement of traditional yogurt's thickener in the EU by lupin flour would significantly increase the value of pulses in agri-food systems, and lead to more nutritious products.

SDGs


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Fava Java

Legume-based drink / coffee or breakfast alternative.

Year introduction to market
Not planned

The innovating business or agency
Universidade Católica Portuguesa, Portugal

Contact details
Jazmin Osorio, jperez@porto.ucp.pt

Legume species trialled (to date)
Fresh and frozen faba beans (*Vicia Faba*)

Target consumers and/or unique selling points
General public with emphasis on people seeking for products that are a good source of fibre and protein. This product is expected to serve as a breakfast alternative to coffee and calorie-free drinks. It can be consumed warm or cold without any changes in flavour or texture alterations.

Improvements to traditional products
Fava Java was inspired by a traditional Guatemalan drink. Its formulation and flavouring are an added value and unique selling point.

Markets (envisioned)
Bio-based, locally sourced, sustainable food products. Currently there are no plans to bring this product to market.

Environmental credentials of the innovation
All the ingredients can be locally sourced regardless of location ensuring local value chain and a more environmentally friendly product. In addition, a faba bean-based drink reduces CO_2 emissions from the import and processing of coffee products in Europe.

TRL – Technology Readiness Level Transition
During the project lifetime this innovation was progressed to TRL4, 'validated in a laboratory environment'.

IPR - Intellectual Property Right protection
All rights of this product and the innovation pertain to the TRUE Project and Universidade Catolica Portuguesa. This product has not been patented.

Legume-based value chain enhancement
By consuming products made with faba beans, more interest in growing faba beans for human consumption could arise and farmers could benefit from state/European incentives.

SDGs


Communication channels
- Newsletter
- The innovation was communicated to the scientific community of Universidade Catolica Portuguesa, a tasting session was organised to perform a sensorial analysis and get the comments/suggestions of other scientists.

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BBDonuts

BBDonuts is a ready to consume healthy snack prepared with traditional Portuguese ingredients.

Year introduction to market
Not planned

The innovating business or agency
Universidade Católica Portuguesa, Portugal

Contact details
Carla Santos, cssantos@porto.ucp.pt

Legume species trialled (to date)
Faba bean (broad bean) (*Vicia Faba*)

Target consumers and/or unique selling points
Consumers, adults, and children alike who desire a healthy life. It is a source of protein and source fibre.

Improvements to traditional products
This product is a healthier alternative to existing snacks. Additionally, it contains faba bean which is a more sustainable ingredient than wheat.

Markets (envisioned)
Portuguese food market.

Environmental credentials of the innovation
This product stimulates local production, as it is composed only by traditional food ingredients. Hence it is intended to stimulate local value chains.

Communication channels
Scientific meetings, *e.g.,* TRUE webinar series 2021.

TRL – Technology Readiness Level Transition
During the project lifetime this innovation was progressed to TRL4, 'validated in a laboratory environment'.

IPR - Intellectual Property Right protection
No IPR protection considered to date.

Legume-based value chain enhancement
It uses 20% of faba bean flour promoting its cultivation and consumption. faba bean is a traditional Mediterranean crop that is underutilised despite its agronomic advantages.

SDGs


Useful online resources
The diversity of end uses for legumes - TRUE webinar series

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PlantCakes

Dry mix for sweet pancakes preparation, with the partial replacement of oat flour with lentil flour.

Year introduction to market
2021

The innovating business or agency
Universidade Católica Portuguesa, Portugal

Contact details
Carla Santos, cssantos@porto.ucp.pt

Legume species trialled (to date)
Lentils (*Lens culinaris*)

Target consumers and/or unique selling points
General public. This food product can be an alternative to regular sweet pancakes, so they can be consumed at breakfast, or as afternoon snack, *etc.* This is a premade mix allows the consumer to eat them plain, or add other flavours (*e.g.,* cocoa, cinnamon) or sides (*e.g.,* fruit).

Improvements to traditional products
This new formulation has a very rich and complete nutritional profile, as it contains both legume and cereal flours. Not only does it meet consumers health needs (high protein and fibre), but also complies with environmentally friendly diets (all ingredients are organic).

Markets (envisioned)
Bio-based, locally sourced, sustainable, high protein food products. Can be distributed throughout the EU/globally since pancakes are a trendy food, consumed across different cultures. A scale-up strategy is currently being developed with the national industry.

Environmental credentials of the innovation
The ingredients used in this recipe are all sourced from organic farming. In addition, by replacing the amount of oat flour used by lentil flour, the product benefits from the positive effects of legumes production to the farming sector and to the entire food value chain.

TRL – Technology Readiness Level Transition
During the project lifetime this innovation was progressed to TRL 6, 'technology demonstrated in a relevant environment'. TRL9 (actual system proven in an operational environment) should be achieved by late 2021.

IPR - Intellectual Property Right protection
All rights of this product and the innovation pertain to the TRUE Project and Universidade Católica Portuguesa.

Legume-based value chain enhancement
By including lentil flour as a base in their formulation, PlantCakes can increase the demand for locally grown lentils, challenging the farmers sector to include and produce new crops or increase their production.

SDGs


Communication channels
- Top10 finalist 'Ecotrophelia' Portugal 2019
- Product tasting sessions
- Winner of 'Innovation Track 2019'
- Scientific meetings

Useful online resources
TRUE webinar series

TRUE has received funding from the European Union's Horizon 2020 Research & Innovation Action under Grant Agreement Number 727973.

Vegetarian acorn sausage

A vegetarian sausage with acorn (38%) and chickpea (26,5%) as main ingredients. As far as we know, this is the first acorn-legume-based sausage. We wanted to create a vegetarian product based on acorn which is our farm icon, but with a legume component to improve texture and to increase protein content with additional benefit of being gluten-free.

Year introduction to market
2019

The innovating business or agency
Freixo do Meio, Portugal

Contact details
Ricardo Silva, rsilva@herdadedofreixodomeio.pt
Alfredo Sendim, alfredosendim@herdadedofreixodomeio.pt

Legume species trialled (to date)
Dried chickpea (*Cicer arietinum*)

Target consumers and/or unique selling points
Vegetarians, vegans, and consumers who wish to reduce their meat consumption. Also, for gluten-intolerant people. It is intended to be used as an alternative to conventional meat-based sausages.

Improvements to traditional products
The combination of acorn and legume gives this alternative a high nutritional value.

Markets (envisioned)
This product is designed for the Portuguese local market as it is the farm commercial strategy, and especially for consumer worried about environmental and food quality issues.

Environmental credentials of the innovation
Acorns are produced as a wild food product by very well adapted native oaks that grow without water and as large trees retain large amounts of CO_2. Chickpeas are small plants that are also cultivated seasonally and thus without irrigation. Both are produced in agroforestry systems with benefits for soil regeneration.

Technology Readiness Level (TRL) Achieved
During the project lifetime this innovation was progressed to TRL 9, 'actual system proven in an operational environment'.

IPR - Intellectual Property Right protection
The partner who developed the recipe abdicated from any rights.

Legume-based value chain enhancement
By increasing the offer of different types of food and new combinations. By raising awareness of the environmental costs of producing food and the need to implement more water efficient alternatives.

SDGs


Communication channels
- Newsletter
- Social media

Useful online resources
Herdade do freixo do meio

TRUE has received funding from the European Union's Horizon 2020 Research & Innovation Action under Grant Agreement Number 727973.

Feed

TRUE has received funding from the European Union's Horizon 2020 Research & Innovation Action under Grant Agreement Number 727973.

Shrimp feed with lupin

Shrimp feed for the Whiteleg shrimp (*Litopenaeus vannamei*) formulated with locally produced lupin meal replacing proportions of fishmeal.

Year introduction to market
2022

The innovating business or agency
Alfred Wegener Institute, Germany

Contact details
Matt Slater, matthew.james.slater@awi.de
Monika Weiss, monika.weiss@awi.de

Legume species trialled (to date)
Blue lupin (*Lupinus angustifolius,* cultivar Boregine) - meal from dehulled seed

Target consumers and/or unique selling points
Local shrimp farmers/small feed producers. This new formulation is a more sustainable alternative to existing conventional feed and the use of lupin reduces the cost of the feed by about 7%. Additionally, lupin appears to have an immune-stimulating effect, protecting shrimp health, and commercial efficacy of shrimp farmers. A strong immune system is crucial for the husbandry of shrimps in recirculating aquaculture systems, since medication (*e.g.,* antibiotics) does not only have a bad reputation, but also negatively influences filtration units of the system. Additionally, shrimps rely on their innate immune system which should be fostered in intensive culture.

Improvements to traditional products
It is a sustainable alternative to commercial aquafeeds with a balanced nutritional value.

Markets (envisioned)
European countries, where shrimps are produced (*e.g.,* Germany, Poland, Switzerland).

Environmental credentials of the innovation
Replacing about 30% of animal protein in shrimp feed with locally grown lupin has environmental advantages:
1. replacement of proportions of fishmeal as an unsustainable resource (overfishing problem);
2. reduced CO_2 emissions (long transportation ways of fishmeal).

Extruded shrimp feed with lupin and L. vannamei

Technology Readiness Level (TRL) Achieved
During the project lifetime the innovation was progressed to TRL 6, 'demonstration in a relevant environment'.

IPR - Intellectual Property Right protection
No IPR protection considered to date.

Legume-based value chain enhancement
Increases the demand for locally produced lupin.

SDGs


Communication channels
- Newspaper
- Scientific peer-reviewed publication
- Newsletter
- Scientific Conferences

Useful online resources
Lupin kernel meal as fishmeal replacement in formulated feeds for the Whiteleg Shrimp
Blue lupin for White Shrimp (Litopenaeus vannamei)
Ob Garnelen lupinen mögen?

TRUE has received funding from the European Union's Horizon 2020 Research & Innovation Action under Grant Agreement Number 727973.

Salmon feed with faba bean concentrate

Feed for the Atlantic salmon (*Salmo salar*) was formulated with locally produced faba bean protein concentrate replacing all soy concentrate and proportions of fishmeal from a conventional diet. The formulation was tested successfully and can be used any time.

Year introduction to market
2022

The innovating business or agency
Alfred Wegener Institute, Germany

Contact details
Matt Slater, matthew.james.slater@awi.de
Monika Weiss, monika.weiss@awi.de

Legume species trialled (to date)
Faba bean (*Vicia faba*) - protein concentrate

Target consumers and/or unique selling points
The formulated feed is intended to be used by salmon farmers/small feed producers in Europe. This new formulation is a more sustainable alternative to existing conventional feed and the use of faba bean does not only represent a more sustainable resource but also reduces the cost of the feed. The newly formulated feed does not negatively affect health or growth of the salmon.

Improvements to traditional products
It is a sustainable alternative to commercial aquafeeds with a balanced nutritional value.

Markets (envisioned)
European countries, where salmon is produced (*e.g.,* Ireland, Scotland, Norway, Denmark).

Environmental credentials of the innovation
The inclusion of 35% locally grown faba bean protein concentrate in this newly formulated feed has environmental advantages:

- all soy concentrate could be replaced by faba bean concentrate: soy in conventional diets generally comes from overseas and therefore has an unfavourable CO_2 footprint, additionally most of it is GMO soy (reduced CO_2 emission, no use of GMO material);
- replacement of proportions of fishmeal as an unsustainable resource (overfishing problem), reduced CO_2 emissions (long transportation ways of fishmeal)

Atlantic salmon (Salmo salar)

Technology Readiness Level (TRL) Achieved
During the project lifetime the innovation was progressed to TRL 6, 'demonstration in a relevant environment'.

IPR - Intellectual Property Right protection
No IPR protection considered to date.

Legume-based value chain enhancement
Increases the demand for locally produced faba bean.

SDGs

Communication channels
- Newsletter
- Scientific Conference

Useful online resources
Fava Trading
Aquaculture Europe 2021

TRUE has received funding from the European Union's Horizon 2020 Research & Innovation Action under Grant Agreement Number 727973.

Seabass feed with lupin

Feed for the European seabass (*Dicentrarchus labrax*) was formulated with locally produced lupin meal replacing all soy concentrate and proportions of fishmeal from a conventional diet. The formulation was tested successfully and can be used any time.

Year introduction to market
2022

The innovating business or agency
Alfred Wegener Institute, Germany

Contact details
Matt Slater, matthew.james.slater@awi.de
Monika Weiss, monika.weiss@awi.de

Legume species trialled (to date)
Blue lupin (*Lupinus angustifolius, cultivar* Boregine), meal from dehulled seed (fermented/unfermented).

Target consumers and/or unique selling points
Feed for the European seabass (*Dicentrarchus labrax*) was formulated with locally produced lupin meal replacing all soy concentrate and proportions of fishmeal from a conventional diet. It is recommended to ferment the lupin when feeding animals smaller than 30 g to avoid reduced growth.

Improvements to traditional products
It is a sustainable alternative to commercial aquafeeds with a balanced nutritional value.

Markets (envisioned)
European countries, where seabass is produced (*e.g.,* Spain, Portugal, Greece).

Environmental credentials of the innovation
Inclusion of 30% locally grown lupin in this newly formulated feed has environmental advantages:

- all soy could be replaced by lupin: soy in conventional diets generally comes from overseas and therefore has an unfavourable CO_2 footprint, additionally most of it is GMO soy (reduced CO_2 emission, no use of GMO material); and,
- replacement of proportions of fishmeal as an unsustainable resource (overfishing problem), reduced CO_2 emissions (long transportation ways of fishmeal).

D. labrax and extrudated seabass feed with lupin

Technology Readiness Level (TRL) Achieved
During the project lifetime the innovation was progressed to TRL 6, 'demonstration in a relevant environment'.

IPR - Intellectual Property Right protection
No IPR protection considered to date.

Legume-based value chain enhancement
Increases the demand for locally produced lupin.

SDGs


Communication channels
- Newsletter
- Scientific Conferences
- Trade fairs

Useful online resources
lupinen als Fischfutter (oekolandbau.de)
Vom Feld in den Fisch – lupine für den Wolfsbarsch

TRUE has received funding from the European Union's Horizon 2020 Research & Innovation Action under Grant Agreement Number 727973.

Formulation for an "easy to produce" self-made shrimp diet

Formulation for an easy-to-produce shrimp-feed made from only few ingredients, with about 30% of the animal protein can be replaced by various local grain legumes (products). By saving transport costs and avoid the use of less sustainable products (fish meal, GMO soy), a higher sustainability of the feed is achieved, as well as a reduced price. The diet was successfully tested with blue lupin.

Year introduction to market
2022

The innovating business or agency
Alfred Wegener Institute, Germany

Contact details
Matt Slater, matthew.james.slater@awi.de
Monika Weiss, monika.weiss@awi.de

Legume species trialled (to date)
Lupin and lupin products (flakes, protein), faba bean, faba protein, pea protein isolate, lentil, vetch (grain) (with a crude protein content ≥ 24%).

Target consumers and/or unique selling points
For aquaculture. The formulation can be used by any small-scale shrimp farmer, or feed producer who wants to use/produce a more sustainable feed by including various regional grain legumes. The feed can be easily produced in a simple pellet machine.

Improvements to traditional products
It is a sustainable alternative to commercial aquafeeds with a balanced nutritional value.

Markets (envisioned)
European countries, where shrimps are produced (*e.g.,* Germany, Poland, Switzerland).

Environmental credentials of the innovation
Replacing about 30% of animal protein in shrimp feed with locally grown lupin has environmental advantages:

- replacement of proportions of fishmeal as an unsustainable resource (overfishing problem); and,
- reduced CO_2 emissions (long transportation ways of fishmeal).

Ingredient	g/kg feed
Fish meal (CP 68%)	150
Fish oil	20
Shrimp meal (CP 64%)	90
Soybean meal (CP 48%)	205
Wheat (CP 12%)	327
Lecithin - Soy (Lipid 70%)	20
Gluten	75
Grain legume (CP ≥24%)	**100**
Cholesterol	2
Methionin	3
Lysin	3
Vitamin und Mineral Premix	5

Formulation for the "Easy to produce shrimp diet"

Technology Readiness Level (TRL) Achieved
During the project lifetime the 'product idea' (TRL4) transitioned to 'full commercial product' (TRL9).

IPR - Intellectual Property Right protection
This formula is free to use by the public.

Legume-based value chain enhancement
If small scale shrimp farmers use grain legumes (or maybe residues) this increases the value chain and the regional demand for these legumes.

SDGs


Communication channels
This innovation features in the TRUE deliverable D3.4 'Best practice guide for legume processing and inclusion in feed' (DOI 10.5281/zenodo.5148506).

TRUE has received funding from the European Union's Horizon 2020 Research & Innovation Action under Grant Agreement Number 727973.

Formulations for Salmon diet with grain legumes

Formulated feed for Atlantic salmon with local grain legumes replacing all soy.

Year introduction to market
Not planned.

The innovating business or agency
Alfred Wegener Institute, Germany

Contact details
Matt Slater, matthew.james.slater@awi.de
Monika Weiss, monika.weiss@awi.de

Legume species trialled (to date)
Lupin and lupin products (flakes, protein), faba bean, faba protein, pea protein isolate, lentil.

Target consumers and/or unique selling points
For aquaculture. These formulations can be used by any small-scale local fish farmer, or feed producer who wants to use/produce a more sustainable feed by including various regional grain legumes.

Improvements to traditional products
It is a sustainable alternative to commercial aquafeeds with a balanced nutritional value.

Markets (envisioned)
European countries where Salmon is produced.

Environmental credentials of the innovation
Replacement of soy products, reduction in transporting and import of GMO or unsustainable products.

Technology Readiness Level (TRL) Achieved
During the project lifetime this innovation was progressed to TRL 4, 'technology validated in the laboratory'.

IPR - Intellectual Property Right protection
These formulations are free to use by the public.

Legume-based value chain enhancement
If salmon farmers use grain legumes (or maybe residues) this increases the value chain and the regional demand for these legumes.

SDGs


Communication channels
This innovation features in the TRUE Deliverable D3.4 'Best practice guide for legume processing and inclusion in feed' (DOI 10.5281/zenodo.5148506).

Ingredient (g/kg)	FM	SM	LM1	LM2	LM3	FB1	FB2	Pea	Lentil	SM + LM3	SM +FB2	SM +LM3 +FB2	LM3 +FB2
Fish meal	600	150	150	150	150	150	150	150	150	150	150	150	0
Fish oil	170	170	170	170	170	170	170	170	170	170	170	170	170
Soy concentrate (65% CP)	0	350	0	0	0	0	0	0	0	150	150	150	0
Lupin Meal	0	0	350	0	0	0	0	0	0	0	0	0	0
Lupin Flakes	0	0	0	350	0	0	0	0	0	0	0	0	0
Lupin protein concentrate (54% CP)	0	0	0	0	350	0	0	0	0	200	0	200	300
Faba bean meal-dehulled seed	0	0	0	0	0	350	0	0	0	0	200	0	0
Faba protein conentrate (66% CP)	0	0	0	0	0	0	350	0	0	0	0	200	300
Pea protein Isolat	0	0	0	0	0	0	0	350	0	0	0	0	0
Lentils (whole seeds)	0	0	0	0	0	0	0	0	350	0	0	0	0
Wheat (12 CP)	160	175	5	30	130	25	180	270	5	155	100	98	110
Gluten (wheat)	40	115	295	270	170	275	120	30	295	145	200	2	90
Astaxanthin premix (8%)	5	5	5	5	5	5	5	5	5	5	5	5	5
Monoammoniumphosphat	4	4	4	4	4	4	4	4	4	4	4	4	4
Choline	3	3	3	3	3	3	3	3	3	3	3	3	3
Methionin	5	5	5	5	5	5	5	5	5	5	5	5	5
Binder (inert)	6	6	6	6	6	6	6	6	6	6	6	6	6
Vitamin und Mineral Premix	7	7	7	7	7	7	7	7	7	7	7	7	7

Diets calculated to meet the requirements of Salmo salar (Atlantic salmon) post smolt. 35% or 20% of the diets is based on an alternative legume product (fish meal (FM), soybean meal (SM), lupin meal (LM1), - flakes (LM2), - protein concentrate (LM3), faba bean meal (FB1), - protein concentrate (FB2), pea protein isolate, lentil).

TRUE has received funding from the European Union's Horizon 2020 Research & Innovation Action under Grant Agreement Number 727973.

Formula for Seabass diet with grain legumes

Formulated feed for European Seabass (*Dicentrarchus labrax*) with local grain legumes replacing all soy.

Year introduction to market
Not planned.

The innovating business or agency
Alfred Wegener Institute, Germany

Contact details
Matt Slater, matthew.james.slater@awi.de
Monika Weiss, monika.weiss@awi.de

Legume species trialled (to date)
Lupin and lupin products (flakes, protein), faba bean, faba protein, pea protein isolate, lentil.

Target consumers and/or unique selling points
For aquaculture. These formulations can be used by any small-scale local fish farmer, or feed producer who wants to use/produce a more sustainable feed by including various regional grain legumes.

Improvements to traditional products
It is a sustainable alternative to commercial aquafeeds with a balanced nutritional value.

Markets (envisioned)
European countries where Seabass is produced.

Environmental credentials of the innovation
Replacement of soy products, reduction in transporting and import of GMO or unsustainable products.

Technology Readiness Level (TRL) Achieved
During the project lifetime this innovation was progressed to TRL 4, 'technology validated in the laboratory'.

IPR - Intellectual Property Right protection
These formulations are free to use by the public.

Legume-based value chain enhancement
If small scale seabass farmers use grain legumes (or maybe residues) this increases the value chain and the regional demand for these legumes.

SDGs


Communication channels
This innovation features in the TRUE deliverable D3.4 'Best practice guide for legume processing and inclusion in feed' (DOI 10.5281/zenodo.5148506).

Ingredient (g/kg)	FM	SM	LM1	LM2	LM3	FB1	FB2	Pea	Lentil	SM + LM3	SM +FB2	SM +LM3 +FB2	LM3 +FB2
Fish meal	650	500	350	350	350	350	350	350	350	350	350	350	0
Fish oil	110	110	110	110	110	110	110	110	110	110	110	110	110
Soy meal	0	150	0	0	0	0	0	0	0	150	150	150	0
Lupin meal	0	0	300	0	0	0	0	0	0	0	0	0	0
Lupin Flakes	0	0	0	300	0	0	0	0	0	0	0	0	0
Lupin protein concentrate (54% CP)	0	0	0	0	300	0	0	0	0	200	0	150	300
Faba bean meal	0	0	0	0	0	300	0	0	0	0	0	0	0
Faba protein conentrate (66% CP)	0	0	0	0	0	0	300	0	0	0	200	150	300
Pea protein Isolat	0	0	0	0	0	0	0	300	0	0	0	0	0
Lentils (whole seeds)	0	0	0	0	0	0	0	0	300	0	0	0	0
Wheat (12% CP)	160	100	0	25	95	30	135	210	5	60	85	40	105
Weizengluten	60	120	220	190	125	190	85	10	215	110	85	30	165
Methionin	5	5	5	5	5	5	5	5	5	5	5	5	5
Binder (inert)	5	5	5	5	5	5	5	5	5	5	5	5	5
Vitamin und Mineral Premix	10	10	10	10	10	10	10	10	10	10	10	10	10

Diets calculated to meet the requirements of Dicentrarchus labrax (European sea bass) in the grow out phase. 30% or 20% of the diets is based on an alternative legume product ((fish meal (FM), soybean meal (SM), lupin meal (LM1), - flakes (LM2), - protein concentrate (LM3), faba bean meal (FB1), - protein concentrate (FB2), pea protein isolate, lentil).

TRUE has received funding from the European Union's Horizon 2020 Research & Innovation Action under Grant Agreement Number 727973.

Spent barley-bean

A novel animal feedstuff, co-produced from barley-bean beer brewery. Potential use for monogastric feeding once dried: mid to longer term.

Year introduction to market
2019

The innovating business or agency
Abertay University, UK;
Barney's Beer, UK;
James Hutton Institute, UK;
SRUC, UK

Contact details
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Kirsty Black, kirsty.black@arbikie.com

Legume species trialled (to date)
Faba beans

Target consumers and/or unique selling points
Animal feed sector (straight market in the first instance).

Improvements to traditional products
It is a sustainable alternative to commercial aquafeeds with a balanced nutritional value.

Markets (envisioned)
Animal feed sector (straight market in the first instance).

Environmental credentials of the innovation
When barley is partially replaced by beans for beer brewing, it reduces reliance on nitrogen fertilisation as beans can fix atmospheric nitrogen.

The resulting co-product as animal feed has potential to reduce reliance on soya and other protein sources, hence reducing environmental footprint associated with the production and transportation of soybean.

Spent barley-bean

Technology Readiness Level (TRL) Achieved
During the project lifetime this innovation was progressed to TRL 5, 'technology validated a relevant environment'.

IPR - Intellectual Property Right protection
No IPR protection considered to date.

Legume-based value chain enhancement
This route would introduce more beans in a primary process (beer making) to reduce the N input otherwise required for its alternative, *i.e.,* barley.

SDGs


Communication channels
- Scientific peer-reviewed publication.
- Knowledge exchange events.

TRUE has received funding from the European Union's Horizon 2020 Research & Innovation Action under Grant Agreement Number 727973.

Formulations for Salmon diet with spent barley-bean/green pea

Formulated feed for the Atlantic salmon (*Salmo salar*) based on the very promising coproduct from barley-bean/green pea beer. The high protein content and the well-balanced amino acid profile makes this co-product especially interesting for aquaculture purposes.

Year introduction to market
Not planned.

The innovating business or agency
Abertay University, UK
Barney's Beer, UK
Alfred Wegener Institute, Germany

Contact details
Kirsty Black, kirsty.black@arbikie.com
Monika Weiss, monika.weiss@awi.de

Legume species trialled (to date)
Faba bean, green pea

Target consumers and/or unique selling points
For aquaculture. These formulations can be used by any fish farmer, or feed producer who wants to use/produce a more sustainable feed.

Improvements to traditional products
It is a sustainable alternative to commercial aquafeeds with a balanced nutritional value.

Markets (envisioned)
Europe, salmon producing countries

Environmental credentials of the innovation
Replacement of Soy products, reduce reliance on soya and other protein sources, hence reducing environmental footprint associated with the production and transportation of soybean.

Ingredients (g kg^{-1})	Faba bean spent salmon diet	Green pea spent salmon diet
Fish meal (65% CP)	150	150
Soya concentrate (65% CP)	**0**	**0**
Faba bean spent - dry	**350**	**0**
Green pea spent - dry	**0**	**350**
Gluten	150	150
Wheat (12% CP)	99,4	90,4
Fish oil	126	126
Canola oil	84	84
Threonin	0	2
Methionin	5	7
Lysin	0	5
Astaxanthin premix (8%)	0,6	0,6
Monoammoniumphosphat	20	20
Vitamin und Mineral Premix	10	10
Ti02	5	5

Salmon diets based on residuals from alternative beer production

Technology Readiness Level (TRL) Achieved
During the project lifetime this innovation was progressed to TRL 4, 'technology validated a laboratory environment'.

IPR - Intellectual Property Right protection
These formulations are free to use by the public.

Legume-based value chain enhancement
The usage of the co-product leads to value chain enrichment.

SDGs


TRUE has received funding from the European Union's Horizon 2020 Research & Innovation Action under Grant Agreement Number 727973.

'Agri'

TRUE has received funding from the European Union's Horizon 2020 Research & Innovation Action under Grant Agreement Number 727973.

SRUC Dairy Systems

The research focused on assessing differences in GHG emission types stemming from high production Select merit and UK average Control merit dairy cattle managed within Low Forage and By-product housed and High Forage and Homegrown grazed systems. Investigations were carried out to determine uncertainty stemming from the variation of diet digestibility and crude protein. Novel dairy management system data were used to assess the effect of introducing home-grown legumes and co-product feeds. GHGs were calculated using SRUC's agrecalc, carbon foot-printing tool.

Year introduction to market
Not planned

The innovating business or agency
SRUC, UK

Contact details
Bob Rees, bob.rees@sruc.ac.uk
Maggie March, maggie.march@sruc.ac.uk

Legume species trialled (to date)
Lucerne, spring beans

Target consumers and/or unique selling points
Dairy farmers, researchers, policy makers and industry stakeholders with an interest in agriculture and climate change should be made aware of differences in emission source types depending on management regime and that dairy system carbon footprints should be expressed using multiple units.

Improvements to traditional products
Lower greenhouse gas emissions.

Markets (envisioned)
Dairy farmers, consultants, policy makers and stakeholders across EU.

Environmental credentials of the innovation
When comparing four dairy management systems, a localised farming regime feeding home-grown lucerne and spring beans attracted the lowest area-based emissions when not considering milk output. This more self-sufficient system was associated with the lowest emissions *per* kilogram of fat and protein corrected milk, when calculating footprints using mass allocation of feeds rather than economic allocation. Where possible foot printing calculations should incorporate variation in diet digestibility and crude protein content. Results illustrated that Control merit carbon footprints *per* unit of milk produced across each of the management regimes were significantly higher in comparison with high production Select merit animals.

Technology Readiness Level (TRL) Achieved
During the project lifetime this innovation was progressed to TRL 8, 'system complete and qualified'.

IPR - Intellectual Property Right protection
No IPR protection considered to date.

Legume-based value chain enhancement
In Scotland, localised dairy farming using home-grown forage legumes have the potential to offer environmental benefits. This self-sufficient dairy system was associated with the lowest footprint.

SDGs


Communication channels
- Scientific peer-reviewed publication
- Newsletter
- SRUC Homepage
- Social media
- Leaflet

Useful online resources
Effect of Nutritional Variation and LCA Methodology on the Carbon Footprint of Milk Production from Holstein Friesian Dairy Cows

TRUE has received funding from the European Union's Horizon 2020 Research & Innovation Action under Grant Agreement Number 727973.

Autonomous prime mover with minimal soil footprint

Facilitating innovative management of inter crops using techniques including selective mowing and treatment. Combines proven technologies and near market positioning and control technologies with innovative ideas with respect to inter crop management. The target is to overcome challenges associated with heavy prime movers (manned) when working in intercrops. Manned equipment is heavy and large footprint making high accuracy difficult to achieve while delivering cost effective solutions. Low soil pressure, high accuracy, and ability to travel in narrow intercrop lanes facilitate innovative solutions to weed management at reduced cost to the grower.

Year introduction to market
2022/23

The innovating business or agency
Manterra Ltd; Alamo Group; Trimble UK.

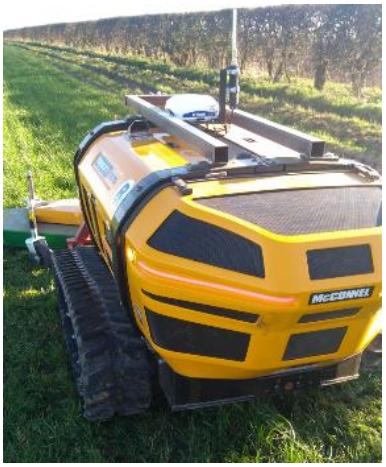
Contact details
Andrew Manfield, Hessleskew, Sancton, York YO43 4RJ. Tel: (+44) 01430 879410

Legume species trialled (to date)
Leguminous intercrops, primarily clovers, managed as intercrops for weed control and beneficial co-crop.

Target consumers and/or unique selling points
Wide scope for adoption by all scales of operation and application, to uses beyond intercrop. Addresses directly challenges of environmental degradation, and challenging economics and availability of labour, associated with traditional crop management techniques.

Improvements to traditional products
Reduction of inputs, labour savings through automation.

Markets (envisioned)
Western European and similar agriculture, where costs of inputs are high, labour is scarce, and quality requirements are high for produce. Automation will play a significant role in the future in the production of all crops in these markets.



Environmental credentials of the innovation
- Improvement in soil quality, due to reduced compaction, with improved soil organic matter and *Manterras' autonomous prime mover* reduced high CO_2 emissions during necessary remedial action.
- Accurate placement of crop management materials improved resource use efficiency considerably.
- Potential for innovative techniques – such as highly accurate and selective inter-row mowing.

Technology Readiness Level (TRL) Achieved
During the project lifetime this innovation was progressed to TRL 5, 'technology validated a relevant environment'.

IPR - Intellectual Property Right protection
No IPR protection considered to date.

SDGs


Useful online resources
Manterra Online

TRUE has received funding from the European Union's Horizon 2020 Research & Innovation Action under Grant Agreement Number 727973.

Direct drilling of cereal crops into biomass crop stubble

Normally stubble is ploughed then harrowed before sowing the next crop in conventional arable systems. In regenerative agriculture or conservation tillage, direct seed drilling (i.e. without ploughing) is caried out after the previous crop has been harvested when ripe, or directly into a cover crop. A cereal-legume crop mixture or intercrop is cut at maximum biomass, before it would normally be harvested as dry grains. The in-field crop residue then left *in situ* for 2-3 months (in Scotland) before direct drilling seed of the next crop (after herbicide treatment).

Year introduction to market
Not applicable, methods available to all for use.

The innovating business or agency
The James Hutton Institute, UK.

Contact details
Adrian C Newton, adrian.newton@hutton.ac.uk

Legume species trialled (to date)
Biomass intercrops with cereals in the field containing a high proportion of peas, faba beans or vetch, followed by nitrogen-demanding cereal, particularly winter wheat.

Target consumers and/or unique selling points
Planned rotation by farmers who have suitable direct drills, markets or uses for the forage and cereal crops.

Markets (envisioned)
This approach would inform agronomic advice to growers and crop planning. Suitable for cooler, wetter climates such as north-west Europe.

Environmental credentials of the innovation
The biomass crop with a high proportion of legumes works best with low inputs, particularly nitrogen. The subsequent cereal crop performs best with lower-than-normal nitrogen inputs too. Direct drilling reduces carbon and nutrient loss to the environment. This also reduces field operations and therefore fuel and machinery resources. The cropping carbon footprint is therefore reduced throughout the crop cycle.

Technology Readiness Level (TRL) Achieved
During the project lifetime this innovation was progressed to TRL 5, 'technology demonstrated in a relevant environment'.

IPR - Intellectual Property Right protection
No IPR protection considered to date. However, the information is of value to agronomists and growers and those evaluating a crop's carbon footprint. Its commercial value is therefore spread across agribusinesses.

Legume-based value chain enhancement
Growing more legumes in the agricultural system is essential for this to work at all but it goes together with reduced mineral nitrogen inputs. Biomass crops themselves can be used for silage, direct feeding, or anaerobic digestion for clean energy.

SDGs


Communication channels
Field events for farmers and advisors such as LEAF 'Technical days' and 'Arable Scotland' events.

Useful online resources
Adrian Newton | The James Hutton Institute

TRUE has received funding from the European Union's Horizon 2020 Research & Innovation Action under Grant Agreement Number 727973.

Lowering the carbon and ammonia footprints of pasture-based dairy production

Following rapid expansion there is an immense challenge to lower the environmental impact of dairy farming in Ireland. At Solohead Research Farm, we have designed and tested systems for lowering the carbon and ammonia footprints of milk production.

Year introduction to market
Not applicable, methods available to all for use.

The innovating business or agency
TEAGASC, Republic of Ireland

Contact details
James Humphreys, James.Humphreys@teagasc.ie

Legume species trialled (to date)
White and red clover

Target consumers and/or unique selling points
These management practices can be immediately adopted by farmers, which is important because there is an urgency in tackling these issues: particularly in relation to greater resource use efficiency, the reduction of greenhouse gas emissions avoidance of climate change impacts, and the improvement for water qualities.

Improvements to traditional products
Up to 40% lower carbon footprint of milk production compared with the national average.

Markets (envisioned)
Farmers in comparable climate regions.

Environmental credentials of the innovation
Minimized fertiliser N input and maximized nitrogen use efficiency to lower nitrous oxide and ammonia emissions. Biological nitrogen fixation by white and red clover is key to the system because there are little or no nitrous oxide or ammonia emissions from it. We have been able to lower the carbon footprint of milk produced by up to 40% compared with the national average. Likewise, we have been able to lower the ammonia footprint by up to 50%.

White-clover grass mixture (photo credit TEAGASC): despite the environmental benefits of clover-grass mixtures their uptake remains low. It has been suggested that the inclusion of clover in all new-seeded grass-pastures should be mandatory".

Technology Readiness Level (TRL) Achieved
During the project lifetime this innovation was progressed to TRL 5, 'technology demonstrated in a relevant environment'.

IPR - Intellectual Property Right protection
No IPR protection considered to date.

SDGs


Useful online resources
Lowering the Carbon Footprint of Milk Production at Solohead Research Farm

TRUE has received funding from the European Union's Horizon 2020 Research & Innovation Action under Grant Agreement Number 727973.

New rhizobia strains for common bean

The genetic and functional characterisation of indigenous rhizobia nodulating *Phaseolus vulgaris* (common bean) in Greece. New rhizobia strains were identified as potential 'elite' inoculants to improve crop performance, and biofertiliser value.

The innovating business or agency
Agricultural University of Athens, Greece

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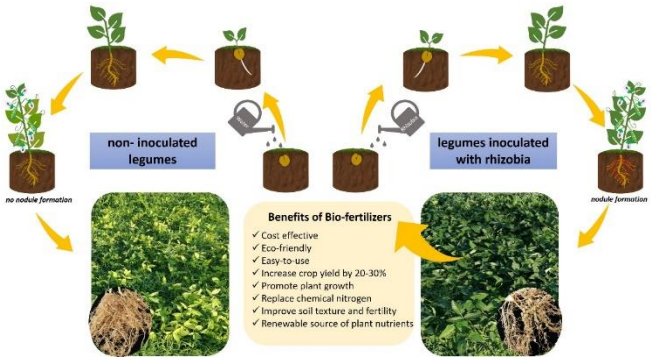
Legume species trialled (to date)
Common bean (*Phaseolus vulgaris*)

Target consumers and/or unique selling points
New rhizobium strains could be used to increase plant productivity and biofertiliser value of crop residues – reducing synthetic mineral fertiliser use. The rhizobia collection provides a natural resource pool for the selection of elite rhizobia that are more competitive and adapted to the local conditions.

Improvements to traditional products
Potential to lower greenhouse gas emissions.

Markets (envisioned)
The rhizobial collection could be used in the field as commercial microbial inoculants. Collaboration with a biofertiliser company will provide the opportunity to formulate and develop a commercial product suitable for application in the field, which could be applied in various countries over the world.

Environmental credentials of the innovation
The cultivation of common bean requires high amounts of synthetic mineral nitrogen (N) fertilisers, increasing production costs and environmental impacts. Elite rhizobia inoculants offer a more-sustainable solution, lowering mineral-N fertilisers use, minimises crop environmental footprint, reduce production costs, and increase productivity.



Effect of rhizobia-based biofertilisers on plant growth and performance.

Technology Readiness Level (TRL) Achieved
During the project lifetime this innovation was progressed to TRL 3, 'experimental proof-of-concept'.

IPR - Intellectual Property Right protection
No IPR protection considered to date.

Legume-based value chain enhancement
The use of rhizobia-based biofertilisers adapted to European soils will help to increase productivity of common bean in an environmentally friendly, and cost-effective way. These will benefit farmers and contribute to the development of "tailor-made" inoculants based on farmers' needs.

SDGs


Communication channels
- Homepage
- Scientific peer-reviewed publication
- Newsletter
- Research Gate/LinkedIn

Useful online resources
Genetic characterization at the species and symbiovar level of indigenous rhizobial isolates nodulating Phaseolus vulgaris in Greece

TRUE has received funding from the European Union's Horizon 2020 Research & Innovation Action under Grant Agreement Number 727973.

New efficient crop rotation schemes

Under mild climatic condition, the cultivation of faba bean as green manure during winter, optimises the yield and quality performance of common bean cultivated organically during the warm season.

The innovating business or agency
Agricultural University of Athens, Greece

Contact details
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Legume species trialled (to date)
Common bean (*Phaseolus vulgaris*).

Target consumers and/or unique selling points
Cultivating faba bean (a cold season legume with high nitrogen (N) fixing activity) as green manure, applying a low N input fertigation scheme (which was not recommended for green manure crops) and inoculating the faba bean with specific rhizobia enhance the organic N inputs for the subsequent crop through green manure application.

Improvements to traditional products
Potential to lower greenhouse gas emissions.

Markets (envisioned)
The rhizobial collection could be used in the field as commercial microbial inoculants. Collaboration with a biofertiliser company will provide the opportunity to formulate and develop a commercial product suitable for application in the field, which could be applied in various countries over the world.

Environmental credentials of the innovation
Adopting organic farming practices that optimise nitrogen supply through green manure is an eco-friendly approach for high productive organic systems with less environmental burden than animal manures and composts.

Technology Readiness Level (TRL) Achieved
During the project lifetime this innovation was progressed to TRL 3, 'experimental proof-of-concept'.

IPR - Intellectual Property Right protection
No IPR protection considered to date.

Legume-based value chain enhancement
High productive organic crop rotation schemes comprising N-fixing legume crops followed by N-utilizing legume crops, will promote the sustainable production of high-quality legume-based products, and will motivate the cultivation of legume species with high N-fixing activity as a renewable organic N source in organic agriculture.

SDGs


Communication channels
- Homepage
- Scientific peer-reviewed publication
- Newsletter
- Research Gate/LinkedIn

Useful online resources
Comparative Assessment of Different Crop Rotation Schemes for Organic Common Bean Production

TRUE has received funding from the European Union's Horizon 2020 Research & Innovation Action under Grant Agreement Number 727973.

New elite rhizobia for common beans and tephrosia

Rhizobial inoculants produced with the name KEFRIFIX: Root nodule nitrogen-fixing bacteria, generally known as rhizobia are packaged in a suitable carrier material (filter mud, a sugar industry waste product) to produce inoculants that can be used in the fields to inoculate target crops during planting. These inoculants contain in >109 rhizobial cells g^{-1}. Pilot tested inoculant packets (costing approximately ~ $3) resulted in bean grain yields equivalent to a crop supplied with 102 kg ha^{-1} N-based chemical fertilisers.

Year introduction to market
2022-23

The innovating business or agency
Kenya Forestry Research Institute, Nairobi, Kenya.

Contact details
Emmanuel Makatiani, tendwa2003@gmail.com

Legume species trialled (to date)
Kenyan varieties of common bean (*Phaseolus vulgaris*), tephrosia (*Tephrosia candida*).

Target consumers and/or unique selling points
Smallholder farmers in western Kenya. Inoculation of common bean and tephrosia seeds prior to planting in the field, especially in areas with low and/or ineffective indigenous rhizobia.

Improvements to traditional products
They are more effective in enhancing nodulation and biological fixation of the common beans and tephrosia compared with indigenous or previously developed standard inoculants in the region.

Markets (envisioned)
The inoculants will be widely produced and marketed in the next five years if they demonstrate broad-host range effectiveness for variety of legumes and a range of pedoclimatic conditions.

Environmental credentials of the innovation
Rhizobial inoculation enhances biological nitrogen fixation, plant growth and productivity, hence avoiding or minimising the need to apply optimal levels of nitrogen-based chemical fertilisers. Wider adoption will lead to less use or replacement of chemical fertilisers to significantly reduce GHGs, including CO_2 emissions at the landscape, regional and country scale.

Technology Readiness Level (TRL) Achieved
During the project lifetime this innovation was progressed to TRL 5, 'technology validated a relevant environment'.

IPR - Intellectual Property Right protection
No IPR protection considered to date. Collaboration with a commercial agri-business is envisioned in the future to upscale production and distribution to national markets.

Legume-based value chain enhancement
The innovation can contribute to increased sustainable production of legumes and pulses by informing the selection and development of local (EU) elite rhizobia for legumes and pulses under EU pedoclimatic conditions.

SDGs


Communication channels
- Scientific peer-reviewed publication
- Blog, newsletters/brochures
- stakeholder knowledge exchange and engagement programmes
- open days, agricultural shows

Useful online resources
Tephrosia fallow enhances grain yield of maize-common bean intercrops: Results from a demonstration trial in western Kenya

TRUE has received funding from the European Union's Horizon 2020 Research & Innovation Action under Grant Agreement Number 727973.

New agroforestry practice for smallholder farmers in western Kenya

The use of relay-intercropping of grain and woody legumes and non-legumes (cereals) enhances soil fertility/health and crop yields. Its effectiveness is enhanced by integrating the use of rhizobia inoculation and fertilisers at planting. Also, by careful later planting the companion maize and/or bean crops. Such companion cropping improves grain yields without chemical fertilisers use.

Year introduction to market
2022/23

The innovating business or agency
Kenya Forestry Research Institute, Nairobi, Kenya

Contact details
David Odee, dwodee@gmail.com
Emmanuel Makatiani, tendwa2003@gmail.com

Legume species trialled (to date)
This innovation was tested with tephrosia (*Tephrosia candida*) as a source of green biomass manure to improve subsequent or companion common bean (*Phaseolus vulgaris*) yields. In the region of study, the non-legumes cereal crops such as maize (*Zea mays*), sorghum (*Sorghum bicolor*) and finger millet (*Eleusine coracana*) are also beneficiaries.

Target consumers and/or unique selling points
Relay-intercropping aims to improve the yields and sustainability of smallholders' farms of less than 2 ha in western Kenya. The intercrop nitrogen fixing tree-based approach: (i) maintains high yields of the bean and maize crops in the first cropping season; and (ii) the green manure provided enhances grain yield in the subsequent cropping seasons.

Markets (envisioned)
Kenya, and sub-Saharan African countries. The grain yield production from smallholder farmers is mainly for their own food security, but the haulms and stalks can be used for animal feed or as green manure in for crop production. The markets are mainly local, but aggregated smallholder grain including those from large scale farms can also supply national food, feed, and bio-based industries. Besides food security, our plan is also to create awareness for national markets to drive local production for income generation.

Environmental credentials of the innovation
New improved relay-intercropping agroforestry system largely depends on green manure, which has lower greenhouse emissions compared to optimal use of chemical fertilisers.

Technology Readiness Level (TRL) Achieved
During the project lifetime this innovation was progressed to TRL 5, 'technology demonstrated a relevant environment'.

IPR - Intellectual Property Right protection
No IPR protection considered to date.

Legume-based value chain enhancement
Encouraging the adoption of appropriate fallow systems suitable for EU pedoclimatic conditions could contribute to sustainable production of legumes.

SDGs


Communication channels
- Scientific peer-reviewed publication
- Blog and newsletters/brochures
- Stakeholder knowledge exchange, engagement programmes, open days, agricultural shows

Useful online resources
Tephrosia fallow enhances grain yield of maize-common bean intercrops: Results from a demonstration trial in western Kenya

TRUE has received funding from the European Union's Horizon 2020 Research & Innovation Action under Grant Agreement Number 727973.

Creating novel common bean types using grafting

Grafting is a commonly used technique, to generate unique and improved root-shoot combinations - to enhance crop resource use efficiency, multiple stress tolerance, biomass production, and yield. However, the technique has not yet been applied as agronomic practice in bean cultivation. Grafting combinations were evaluated and the high-yielding ones were tested under single stressors *i.e.,* drought and salinity.

Year introduction to market
Not planned

The innovating business or agency
Agricultural University of Athens, Greece

Contact details
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Dimitrios Savvas, dsavvas@aua.gr
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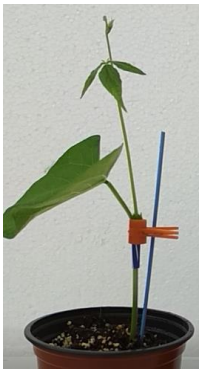
Legume species trialled (to date)
Common bean (*Phaseolus vulgaris* L.) and runner bean (*Phaseolus coccineus* L.) plants.

Target consumers and/or unique selling points
Farmers and researchers. The new grafted types are of high yield (in terms of fresh pods) and offer yield stability.

Environmental credentials of the innovation
The new grafted types can produce more fresh pods under the same nutrients' supply. Less nitrogen fertiliser inputs lead to fewer nitrogen loss as pollutants of groundwater, and lowered CO_2 emissions.



Newly grafted common bean plant

Technology Readiness Level (TRL) Achieved
During the project lifetime this innovation was progressed to TRL 4, 'technology validated in a laboratory environment'.

IPR - Intellectual Property Right protection
No IPR protection considered to date

Legume-based value chain enhancement
The new grafted types produce more yield in terms of total weight and number of fresh pods.

SDGs

Communication channels
Scientific Conferences

TRUE has received funding from the European Union's Horizon 2020 Research & Innovation Action under Grant Agreement Number 727973.

Methods & Marketing

TRUE has received funding from the European Union's Horizon 2020 Research & Innovation Action under Grant Agreement Number 727973.

Comprehensive competitiveness analysis for data gathering and analysing

Novel method for data gathering and analysis allowing a comprehensive appraisal competitiveness. Data sets for each criterion originate from a single database for all countries and products, making comparisons as accurate as possible. If there is a mistake it is built in the data for all countries and all products, so relations remain correct. It provides possibilities for attractive presentation, positioning groups of products and single products through simple and understandable graphs.

Year introduction to market
2019

The innovating business or agency
Company: SEEDEV Ltd., Croatia

Contact details
Magdalena Trstenjak, magdalena.trstenjak@redea.hr

Legume species trialled (to date)
All

Target consumers and/or unique selling points
Research centres, public institutions, education institutions and public stakeholders involved in qualitative and quantitative research. This method has been successfully used in UN FAO supported projects in seven CIS and SEE countries, to provide valuable information on which selected sectors future investments should be based and to facilitate strategic investment decisions. The methodology and tools developed for competitiveness analysis, VC prioritisation and price forecast are based on the long-term monitoring and analysis of the global production and prices, world and domestic stocks, domestic production, exports, imports, and on the estimates of futures market prices.

Improvements to traditional practices
This method is better than other existing solutions as it allows comprehensive and multidimensional approach analyses trends and share of wide data range *e.g.,* production, trade, area harvest, yield, unit value.

Environmental credentials of the innovation
The possibility has still to be discerned.

Technology Readiness Level (TRL) Achieved
During the project lifetime this innovation was progressed to TRL 8, 'system complete and qualified'.

IPR - Intellectual Property Right protection
This work was subcontracted to SEEDEV Croatia Ltd., who owns this innovation.

Legume-based value chain enhancement
None

SDGs


Communication channels
- E-mail
- Workshop

TRUE has received funding from the European Union's Horizon 2020 Research & Innovation Action under Grant Agreement Number 727973.

"Choose Beans" - Initiative

Promotion of legumes as healthy food options given their nutritional value, their economic cost and in terms of production/environmental impact and sustainability mainly to early years in schools but also in hospital and social care facilities, companies, and factories.

This innovation is based on raising awareness for the benefits of legume consumption; promoting the consumption of legumes in a healthy diet, preparing meals that include legumes a real option in EUREST's restaurants, providing more environmentally friendly alternatives in our menus and introduce more economic alternatives.

Year introduction to market
2012

The innovating business or agency
Eurest Portugal, Portugal

Contact details
Elisete Varandas, elisete.varandas@eurest.pt

Legume species trialled (to date)
All varieties available on the market, *e.g.,* beans, chickpeas, bean, peas, lentils, *etc*.

Target consumers and/or unique selling points
Implemented daily in EUREST's restaurants, which allows their costumers to take home the idea and apply it with their family.

Markets (envisioned)
Portugal but it is envisioned to be scaled up internationally.

Environmental credentials of the innovation
Plant protein is a nutritionally suitable and available foodstuff which is often considered a more-sustainable alternative (than animal protein) by the consumer, contributing to a reduced environmental impact, supporting lowered meat consumption in-line with recommended dietary and planetary-health guidelines.

Technology Readiness Level (TRL) Achieved
During the project lifetime this innovation was progressed to TRL 9, 'actual system proven in an operational environment'.

IPR - Intellectual Property Right protection
No IPR protection considered to date

Legume-based value chain enhancement
Higher consumption equal to higher demand equal to greater production needs.

SDGs


Communication channels
- Homepage
- Newsletter
- E-books
- Client/Consumers

Useful online resources
Choose Beans
A nossa história | Eurest
ESG and Sustainability | Compass Group

TRUE has received funding from the European Union's Horizon 2020 Research & Innovation Action under Grant Agreement Number 727973.

"PathFinder" – a web-based Decision Support System

This Decision Support System or 'DSS' assesses the sustainability of the whole agri-food chain, from primary production to consumption, and is based on the integration of the three sustainability pillars: environmental, social, and economic and their intersections: bearability, equitability, and viability.

Year introduction to market
2020

The innovating business or agency
Jozef Stefan Institute, Slovenia

Contact details
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Legume species trialled (to date)
The DSS considers different legumes and pulses, as it deals with different legume agri-food chains.

Target consumers and/or unique selling points
Decision makers, policy maker, scientists or other individuals who are responsible for taking actions towards more sustainable agri-food chains at the regional or national level.

Markets (envisioned)
Scientific and policy organizations, consultancy offices, ministries and governments, DEC, agricultural chambers, international organizations (*e.g.,* FAO, UN), universities and companies, *etc.*

Environmental credentials of the innovation
The DSS PathFinder assesses the environmental sustainability of agri-food chains, as one aspect of the overall sustainability of the chain and its links. It contains a module for generation of options, and suggests how to improve parts of the agri-food chain to achieve better overall or partial sustainability. It can contribute to the improvement of the environmental sustainability of the agri-food chains and lower their environmental impact.

Technology Readiness Level (TRL) Achieved
During the project lifetime this innovation was progressed to TRL 7, 'actual system prototype demonstrated in an operational environment'.

IPR - Intellectual Property Right protection
The DSS is not patented or licensed. IPR protection has not yet been fully considered.

Legume-based value chain enhancement
The PathFinder DSS assesses the sustainability of different agri-food chains. Inclusion of more legumes in the agri-food chain improves the overall sustainability in all its aspects. These positive assessments would potentially serve as an educational material and aid important decision-making processes at regional and national level, that would promote and increase the production of legumes in Europe.

SDGs


Communication channels
- Homepage
- Scientific peer-reviewed publication

Useful online resources
TRUE Pathfinder

TRUE has received funding from the European Union's Horizon 2020 Research & Innovation Action under Grant Agreement Number 727973.

Cookbook: 'The Good-enough Kitchen'

Cookbook for the smooth transition towards sustainable gastronomy. *'A good enough kitchen is just good enough… It's quite sustainable, but it's simple enough. It is quite informative, but also quite understandable. Light and objective, professionally authentic, but by no means radiates exclusivity. Following the principle of the Golden Mean'.*

Year introduction to market
Late 2021

The innovating business or agency
Agri Kulti Nonprofit Ltd., Hungary

Contact details
Gábor Bertényi, bert@agrikulti.hu

Legume species trialled (to date)
Various undeservedly neglected/underutilised ingredients, and legumes appear in at least 30% of recipes. The book covers multiple aspects of sustainable kitchen/gastronomy from seasonality to zero-waste kitchen, from farmers' markets to reducing food miles.

Target consumers and/or unique selling points
The book is specifically designed for the expanding audience that is receptive to sustainable living. To the best of our knowledge, there is no book on the Hungarian book market that clearly provides a practical overview of sustainable gastronomy, illustrated with recipes, regardless of extreme nutritional regimes. In this respect, we consider our work as a unique and gap filling innovation.

Improvements to traditional products
This book contributes to consumers choice being more sustainable and environmentally friendly.

Markets (envisioned)
Hungarian market

Environmental credentials of the innovation
The work flashes and presents some selected important topics of a sustainable and resilient lifestyle, focusing on nutrition and gastronomy, in everyday practice. In this regard, it will contribute to the promotion of sustainability and environmentally friendly products, as well as to the expansion consciously buying and dining consumer groups.

Technology Readiness Level (TRL) Achieved
During the project lifetime this innovation was progressed to TRL 6, 'technology demonstrated in a relevant environment'.

IPR - Intellectual Property Right protection
First edition of an original piece of work

Legume-based value chain enhancement
The book devotes an entire chapter to legumes as protein alternatives and undeservedly neglected/underutilized ingredients, and they appear in at least 30% of recipes.

SDGs


Communication channels
Social media

Useful online resources
Agri Kulti

TRUE has received funding from the European Union's Horizon 2020 Research & Innovation Action under Grant Agreement Number 727973.

lupin-based food recipe book

A lupin-based booklet was designed for 'Heredade do Freixo do Meio' providing examples of products that can be made with lupin. The products developed include lupin-cocoa spread, flavoured lupins, lupin wrap tortillas and/or nachos, pear and lupin cookies, roasted lupins, breaded pork with lupin flour (simple and crispy version), lupin and peanut energy balls, legume and lupin burger patties, lupin, and cheese pizza base.

Year introduction to market
2020

The innovating business or agency
Universidade Católica Portuguesa, Portugal

Contact details
Jazmin Osorio, jperez@porto.ucp.pt

Legume species trialled (to date)
Lupin

Target consumers and/or unique selling points
General public, including those interested in legume-based food products, vegetarian, or plant-based products. However, these products were designed with eggs, dairy, and oil. The book also presents new processing methods using common kitchen equipment.

Markets (envisioned)
Portugal

Environmental credentials of the innovation
All these recipes were developed with supermarket products, therefore promoting locally sourced ingredients.

Technology Readiness Level (TRL) Achieved
During the project lifetime this innovation was progressed to TRL 4, 'technology validated in a laboratory environment'.

IPR - Intellectual Property Right protection
All rights of this product and the innovation pertain to the TRUE Project and Universidade Católica Portuguesa.

Legume-based value chain enhancement
This project envisions the incorporation of lupins in other food recipes different from the traditional "brined lupins" that are widely consumed in the country.

SDGs


TRUE has received funding from the European Union's Horizon 2020 Research & Innovation Action under Grant Agreement Number 727973.

Guidebook to the small-scale organic cultivation of selected legume species

The book provides a practical guidance for the small-scale organic cultivation of legumes, from seed harvesting to usage and is based on a series of on-farm cultivation experiments carried out over a 3-year period. Basic information on the species based on-farm experiments, including the physiology, growth habit, and information related to crop-specific management practices are presented including cultivation technologies, timing of sowing, and practical insights such as crop-support systems where applicable. Sensitivity and resilience are also covered for each species, and there is a dedicated chapter dealing with characteristic pests and organic or biocontrol for plant protection.

Year introduction to market
2021

The innovating business or agency
Agri Kulti Nonprofit Ltd., Hungary

Contact details
Gábor Bertényi, bert@agrikulti.hu

Legume species trialled (to date)
Seven food legume species that are neglected, underutilised, or less known are discussed in 3 groups:

- chickpea (*Cicer arietinum*);
- phaseolus beans: common bean (*Phaseolus vulgaris*), runner bean (*Ph. coccineus*), lima bean (*Ph. lunatus*), tepary bean (*Ph. acutifolius*); and,
- vigna beans: cowpea (*Vigna sinensis*), yardlong bean (*Vigna unguiculata* ssp. sesquipedalis).

Target consumers and/or unique selling points
Key target groups are small-scale farmers, kitchen-garden owners, community gardeners, and balcony-growers. The role of legumes in small-scale and self-sufficient farming, as well as in sustainable nutrition is extremely important. However, there is a lack of support for those stakeholders focusing on domestic markets, and specifically in the form of practical knowledge and guidance for the organic cultivation of this crop group.

Markets (envisioned)
The publication could benefit a currently relatively small but expanding group. We would like to involve different professional organisations and NGOs dealing with sustainable agriculture, as well as community gene banks in the dissemination of the publication, thus trying to reach the widest possible audience. The publication will be made freely available on the Agri Kulti website and on the community interfaces.

Environmental credentials of the innovation
The role of legumes as alternative sources of protein is extremely important in sustainable and healthy diets. They can be cultivated with much less inputs and they increase the organic N-content of the soil, which makes them essential in climate-adaptive systems as well as in environmentally friendly farming.

Technology Readiness Level (TRL) Achieved
During the project lifetime this innovation was progressed to TRL 6, 'technology demonstrated in a relevant environment'.

IPR - Intellectual Property Right protection
First edition of an original piece of work.

Legume-based value chain enhancement
The publication specifically aims at promoting small-scale, organic cultivation of legumes.

SDGs


Communication channels
- Homepage
- Social media (FB, Instagram)

Useful online resources
Agri Kulti

TRUE has received funding from the European Union's Horizon 2020 Research & Innovation Action under Grant Agreement Number 727973.

3 Global Innovation catalogue

Since the beginning of the TRUE-Project in 2017, several legume-based innovations have emerged internationally. This section of the Deliverable outlines just some of legume-based innovations developed outside the project which are currently available on the market, including those from countries outside Europe. These innovations are highlighted here to illustrate the increasing global interest in innovative legume-based products, and their potential to realise more sustainable food- and feed-systems.

We note that the example global innovations defined here are by no means exhaustive and serve only to illustrate model examples outside the project, and to demonstrate the TRUE innovations in a wider and global context.

TRUE has received funding from the European Union's Horizon 2020 Research & Innovation Action under Grant Agreement Number 727973.

Variva®

Legume-based dried pasta.

Year introduction to market
2017

State of development
On the market.

The innovating business or agency
Clicks LLC, Bulgaria

Contact details
office@variva.bg

Legume species trialled (to date)
Chickpea, lentil, and cranberry beans.

Target consumers and/or unique selling points
Gluten-intolerant, vegetarian. Organic protein, and fibre rich products for human consumption.

Targeted cropped system type
Organic

Markets (envisioned)
Country, locally sourced.

Taken from The products Variva

IPR - Intellectual Property Right protection
No specified.

Legume-based value chain enhancement
Promoting consumption of locally grown pulses and traditional Bulgarian flavours such as cranberry bean (*P. vulgaris Cranberry*).

Communication channels
- Website
- Social media channels (Facebook, Instagram)

Reference
Variva

Additional information

This product was designed in a partnership with Aarhus University Denmark, Wageningen University and Trinity College Dublin. The range includes 100% green lentil-based pasta, 100% chickpea pasta and 100% cranberry bean pasta, which are available in supermarkets and local Bulgarian shops that specialise in natural and healthy products.

An LCA study was carried out by Saget, *et al.*, which showed that, "*per nutrient density unit, chickpea pasta produced 0.20 kg CO2 eq., 2.19 MJ, and consumed 0.14m3 water, representing 66% less GHG, 65% less fossil fuels, and 75% less water than durum wheat pasta*". The authors conclude that for durum wheat pasta to provide the same nutrient density than chickpea pasta, much more land and GHG emissions are needed, therefore, making the legume-based pasta, a more sustainable food product. Additionally, they recommend that the raw product of this product should be produced on a sustainable and responsible way.

TRUE has received funding from the European Union's Horizon 2020 Research & Innovation Action under Grant Agreement Number 727973.

Legumilk®
Legume-based drink

Novel method for processing legumes to produce a drink.

Year introduction to market
Published paper 2020.

State of development
Intermediate (needing further improvements).

The innovating business or agency
Lisbon University and Science and Technology Foundation (FCT), Portugal

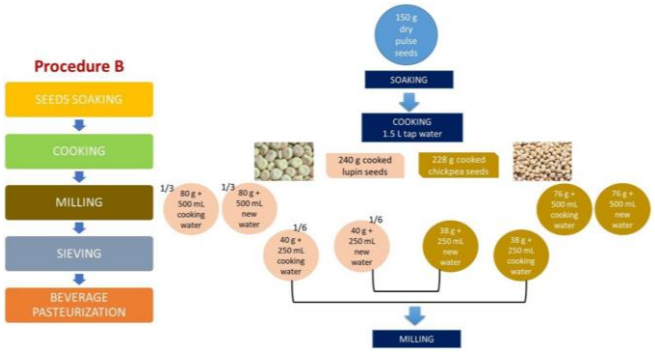
Contact details
carladuarte@isa.ulisboa.pt

Legume species trialled (to date)
Yellow and green pea, chickpea, lupin.

Target consumers and/or unique selling points
Vegetarian. Plant-based and protein rich product for human consumption.

Targeted cropped system type
Conventional

Markets (envisioned)
Sustainable production, plant-based alternative, healthy, dairy-free.



Process to eliminate the 'beany flavour' taken from Legume Beverages from Chickpea and Lupin, as New Milk Alternatives

IPR - Intellectual Property Right protection
Not specified.

Legume-based value chain enhancement
Promoting legumes as a more sustainable source of protein in comparison of nut-based and cereal drinks that need additional fortification.

Communication channels
- Scientific publication MDPI journal
- Lisbon University

Reference
Lopes, M., Pierrepont, C., Duarte, C., Filipe, A., Medronho, B., Sousa, I. (2020) Legume Beverages from Chickpea and Lupin, as New Milk Alternatives. Foods, 9(10), 1458. https://doi.org/10.3390/foods9101458.

Additional information

Researchers developed four different drink prototypes, employing yellow and green pea, lupin, and green lentils. All of these products were locally sourced and harvested in Portugal. Various processing techniques were employed to identify the best treatment to eliminate the "beany flavour" often attributed to legume-based food products. Only to find that processing outlined in the figure was the most efficient method to obtain the expected results.

The authors conclude that protein content of these drinks (1.0 - 2.4%) is higher than the 8 non-dairy drink analogues evaluated for comparison on this research. A higher production yield was also achieved with these prototypes and final remarks identify the lupin and lentil drinks as the most acceptable.

TRUE has received funding from the European Union's Horizon 2020 Research & Innovation Action under Grant Agreement Number 727973.

Meringue Shop®

Aquafaba powder blend for baking and meringue valorisation commonly waste-product aquafaba.

Year introduction to market
2017

State of development
On the market

The innovating business or agency
The meringue shop by chef Diane Forley, USA

Contact details
diane@meringueshop.com

Legume species trialled (to date)
Chickpea

Target consumers and/or unique selling points
Vegetarian. Plant-based, organic product for human consumption.

Targeted cropped system type
Conventional

Markets (envisioned)
Bio-based, allergy safe, plant-based alternative, responsible production, food valorisation.

Taken from Meringueshop

IPR - Intellectual Property Right protection
Not specified.

Legume-based value chain enhancement
Promoting aquafaba as a vegan ingredient for meringue and baking. She paired this business idea with her vegan bakery shop where she uses the chickpeas needed to create aquafaba as piecrust and legume-based nutella.

Communication channels
- Company's online shop
- New York Times article
- Online magazine article and press release

Reference
Meringueshop

Additional information

The product was developed by American chef and baker, Diane Forley, a plant-based baker, targeting the vegetarian market in New York. The concept rests on the idea of using aquafaba to make meringue powder and decorating ingredients (*e.g.*, icing and sprinkles), following a zero-waste approach. This brand and the Vör aquafaba powder brand, are the only two such product currently available on the market. Both powders are produced in the United States but Vör does offer an online distribution chain on German Amazon for the European market. The use of aquafaba for baking goes beyond meringues, producing all sorts of icing-related products such as macarons (Miss Macaron, Sugar Tables London, Mandmoiselle Macaron) and ice-cream (the Vegan Monster and Hungry and Frozen).

TRUE has received funding from the European Union's Horizon 2020 Research & Innovation Action under Grant Agreement Number 727973.

PulseON®

Novel processing technology of pulse flours. Plant cells with low starch digestibility.

Taken from Chemical, physical and glycaemic characterisation of PulseON®: A novel legume cell-powder ingredient for use in the design of functional foods

Year introduction to market
2020

State of development
Experimental phase

The innovating business or agency
Biotechnology and Biological Sciences Research Council, UK

Contact details
cathrina.edwards@quadram.ac.uk

Legume species trialled (to date)
Chickpea, green and red lentils, butter beans, red kidney beans, green and yellow split peas.

Target consumers and/or unique selling points
Plant-based, cardiometabolic disease market, diabetics, colon, and gut health.

Targeted cropped system type
Conventional

Markets (envisioned)
Bio-based, plant-based alternative.

IPR - Intellectual Property Right protection
Patent granted.

Legume-based value chain enhancement
Promoting legume-based powders to manage glycaemic and gut health.

Communication channels
- Scientific publication
- Online magazine article

Reference
Chemical, physical and glycaemic characterisation of PulseON®: A novel legume cell-powder ingredient for use in the design of functional foods (2020).

Additional information

A novel processing method for legume flours was developed. Preliminary results show that this novel method, allows an even lower starch digestibility of regular food products than the response given by the same legume ingredient but processed differently.

"*Techno-functional characteristics and starch digestibility of powders prepared from seven different pulses were compared to flours from the same source. All PulseON® powders consisted of intact plant cells with low starch digestibility (< 40% starch digested at 90 min) compared with cooked pulse flours (> 80% starch digested within 30 min) and had a higher water holding capacity and swelling power than their flour counterpart. A glycaemic study in healthy human subjects demonstrated that the chickpea PulseON® had a low-medium glycaemic index. Overall, PulseON® powders provide superior starch resistance to normal pulse flours and their glycaemic properties show promise in functional food applications to benefit cardiometabolic health*".

TRUE has received funding from the European Union's Horizon 2020 Research & Innovation Action under Grant Agreement Number 727973.

Artic Zero frozen dessert®

Novel processing method for legumes to produce Faba bean ice-cream (also called frozen dessert).

Taken from Arctic Zero

Year introduction to market
2018

State of development
On the market

The innovating business or agency
Artic Zero, USA

Contact details
Online form

Legume species trialled (to date)
Faba bean

Target consumers and/or unique selling points
Dairy-free, GMO-free, plant-based, organic, vegan, keto friendly, low glycaemic index, gluten free, kosher and allergy safe (in selected flavours).

Targeted cropped system type
Organic and Conventional

Markets (envisioned)
Bio-based, locally sourced, healthy food, plant-based alternative.

IPR - Intellectual Property Right protection
Patent granted.

Legume-based value chain enhancement
Promoting consumption of faba beans as a source of fibre, protein, and land nitrogen fixating ingredient.

Communication channels
- Company's marketing strategies
- Direct supermarket sales
- Press releases

Reference
Non-Dairy Plant-Based Frozen Desserts | Arctic Zero

Additional information

"*ARCTIC ZERO is the first faba bean base, non-dairy frozen dessert! It is rich in flavor and creamy in texture without all the fat and calories that products made with coconut, soy, and nut milk have".* Flavours include: vanilla, pistachio, cookie shake, chocolate, salted caramel, chocolate & peanut butter, mint-chocolate, cake batter, brownie, cookie dough and cherry-vanilla. The full product range is available at supermarkets and stores all across the USA but also through amazon and online websites dedicated to selling ice-cream. In 2020, the brand officially expanded into the Canadian market.

Their faba beans are sourced from local farmers and emphasise that climatic conditions in the USA allow them to grow their own products, without having to import them emphasising, *"by using regional food systems, we can centralize the growing, processing, and distribution of ingredients. This helps support local farmers and improves the environment by decreasing pollution and sulfur absorbed by plants and trees. it also means we can avoid shipping beans from across the oceans, saving the equivalent of sulfur produced by 250-million cars and substantially reducing our carbon footprint*".

TRUE has received funding from the European Union's Horizon 2020 Research & Innovation Action under Grant Agreement Number 727973.

Made with LUVE®

Range of products made with lupin protein.

taken from Downloads | Made with LUVE

Year introduction to market
2015

State of development
On the market

The innovating business or agency
ProLupin, Germany

Contact details
Online form

Legume species trialled (to date)
Lentil

Target consumers and/or unique selling points
Vegetarian, Soy-free, lactose-free, GMO-free.

Targeted cropped system type
Conventional

Markets (envisioned)
Sustainable agriculture, plant-based alternative.

IPR - Intellectual Property Right protection
Patent granted.

Legume-based value chain enhancement
Innovative processing technology for a local variety of lupins.

Communication channels
- Company's marketing strategies
- Online shop and direct supermarket sales

Reference
Made with LUVE

Additional information

A range of dairy and soy-free products using the "sweet lupin" species that is locally grown. They have a range of products that are all lupin protein-based. These include yogurt (natural, blueberries, mango, raspberry, stracciatella), popsicles (vanilla, strawberry, and chocolate), ice cream (chocolate, vanilla, strawberry and yogurt, caramel and cookies, chocolate, and cookies), low-sugar yogurt (coconut-pineapple), cheese spread (herbs, bruschetta and natural), drinks (natural and chocolate) and pudding (chocolate and vanilla).

The company attaches great importance to regionality, hence why they are only supplied by farmers from Mecklenburg-Western Pomerania.

TRUE has received funding from the European Union's Horizon 2020 Research & Innovation Action under Grant Agreement Number 727973.

Pura Vida® ice-cream

Pea protein ice cream.

Year introduction to market
2019

State of development
On the market

The innovating business or agency
Pingo Doce, Grupo Jerónimo Martins, Portugal

Contact details
Online form

Legume species trialled (to date)
Pea

Target consumers and/or unique selling points
Vegetarian, Soy-free, lactose-free.

Targeted cropped system type
Conventional

Markets (envisioned)
Sustainable agriculture, plant-based.

Taken from
Gelado Sem Lactose Pura Vida Baunilha | Produtos | Pingo Doce

IPR - Intellectual Property Right protection
Patent granted.

Legume-based value chain enhancement
Innovative processing technology destined to create a product that is soy-free and dairy-free.

Communication channels
- Company's marketing strategies
- Direct supermarket sales

Reference
Gelado Sem Lactose Pura Vida Baunilha 500Ml | Produtos | Pingo Doce

Additional information

A line of "plant-based" or "free from" ice-cream options was developed by the supermarket in 2019, which include: lactose-free ice-cream, sugar free ice-cream and gluten-free ice-cream.

This vanilla ice-cream is produced with pea protein to replace the soy or dairy base that is commonly used to produce ice-cream. This product was developed in Portugal, and it is the only product on their ice-cream line that is 100% vegetal origin. Raw materials for this product are locally sourced, which contributes to their sustainability profile.

TRUE has received funding from the European Union's Horizon 2020 Research & Innovation Action under Grant Agreement Number 727973.

Sir Kensington's vegan mayo®

Aquafaba-based mayonnaise

Year introduction to market
2016

State of development
On the market

The innovating business or agency
Sir Kensington's condiments, USA

Contact details
hello@sirkensingtons.com

Legume species trialled (to date)
Chickpea

Target consumers and/or unique selling points
Vegetarian, GMO-free, plant-based, organic.

Targeted cropped system type
Organic and Conventional

Markets (envisioned)
Sustainable agriculture, responsible packaging, bio-based, plant-based alternative, food valorisation.

Taken from Sir Kensington's | Vegan Mayo

IPR - Intellectual Property Right protection
Patent granted.

Legume-based value chain enhancement
Promoting aquafaba as a vegan ingredient for mayonnaise making through the substitution of egg.

Communication channels
- Company's marketing strategies
- Online magazine article
- Direct supermarket sales
- Restaurant agreements

Reference
Sir Kensington's | Vegan Mayo

Additional information

This vegan mayonnaise occupies only a small share of the condiment range produced by the brand. "Fabanaise" or "vegan mayonnaise", (which is how it is currently branded) is available in four different flavours such as: classic vegan mayo, chipotle vegan mayo, special sauce vegan mayo and avocado oil vegan mayo. "Sir Kensington's Fabanaise *received the 2017 FABI award at the National Restaurant Association show in Chicago, Illinois as well as the 2017 NEXTY award at Expo West for product innovation. The brand was awarded the Sofi award at the Fancy Food Show in 2015 for Special Sauce and was a 2016 finalist for Chipotle Fabanaise*".

The company is seeking to become more eco-friendly, following not only the zero-waste marketing line but in 2020, they announced their target to further support sustainable agriculture by doubling their volume of certified organic ingredients by 2023 and committed to the use of more responsible packaging by employing 100% recyclable and 100% recycled content in rigid plastics and fiber by 2022. In 2017, the company was acquired by Unilever in 2017.

TRUE has received funding from the European Union's Horizon 2020 Research & Innovation Action under Grant Agreement Number 727973.

Cuisine Soleil's® grilled lentils

Innovative processing technology of legumes to produce grilled lentils as snack.

Taken from Facebook

Year introduction to market
2017

State of development
On the market

The innovating business or agency
Cuisine Soleil, Canada

Contact details
Online form

Legume species trialled (to date)
Lentil

Target consumers and/or unique selling points
Vegetarian, GMO-free, vegetarian, Gluten-free, plant-based, organic.

Targeted cropped system type
Organic and Conventional

Markets (envisioned)
Sustainable agriculture, bio-based, plant-based alternative, healthy food.

IPR - Intellectual Property Right protection
Patent Granted.

Legume-based value chain enhancement
Promoting the consumption of legumes as snacks instead of less healthy snack alternatives.

Communication channels
- Company's marketing strategies
- Online magazine article
- Online shop and direct supermarket sales

Reference
Cuisine Soleil

Additional information
This Quebec-based company was inspired by India's traditional snack, lentils, and improved the original recipe by using sunflower oil for roasting (instead of frying) and by sourcing their product locally. They use a variety of lentil usually known as "French green lentil" in the Americas, which most likely refers to *L. culinaris puyensis*. The product is available in four different flavours, including: salt and pepper, curry, Thai and tex-mex. These grilled lentils can be purchased online as well as in Canadian, French, and Mexican supermarkets. This snack also promotes the great nutritional value that lentils provide, claiming that a package of their snack provides 40% of the iron requirements for a day, along with 16g of protein *per* 50g of product. They also claim that their products are sourced from a GMO-free location and to continue to use local short supply chain.

This product was awarded in the category of "Chocolates, snacks, desserts and baked goods- novel or improved products" in 2017 by the "Quebec Food Processing Council (CTAQ)", and in 2018 by the Gama Innovation Conference & Awards in the category of "Most innovative food product".

TRUE has received funding from the European Union's Horizon 2020 Research & Innovation Action under Grant Agreement Number 727973.

Grönsaksbullar®
Vegan meatballs

Taken from HUVUDROLL IKEA

Innovative processing technology of chickpeas and peas to produce vegan meatballs.

Year introduction to market
2015

State of development
On the market

The innovating business or agency
Ikea, Sweden

Contact details
Phone and website assistance depending on the country.

Legume species trialled (to date)
Lentil

Target consumers and/or unique selling points
Vegetarian, plant-based, sustainable production, soy-free and GMO-free.

Targeted cropped system type
Conventional

Markets (envisioned)
Sustainable agriculture, plant-based alternative.

IPR - Intellectual Property Right protection
Patent granted.

Legume-based value chain enhancement
A plant-based alternative to their traditional animal-based meatballs. They claim to have reduced their carbon footprint by half with the development of this product.

Communication channels
- Company's marketing strategies
- Online shop and direct supermarket sales

Reference
HUVUDROLL Vegetable balls, frozen - IKEA

Additional information

This product is part of a wide sustainability programme launched by IKEA aimed at reducing their carbon footprint and to provide a more "responsibly produced" line of products. These vegan meatballs are *made from a blend of chickpeas, green peas, carrot, bell peppers, corn, kale, pea starch, onion, canola oil, and spices. And they happen to be vegan, dairy-free, gluten-free, soy-free, and GMO-free.* They claim to have developed a product with less calories, less fat and 30 times smaller carbon footprint than their traditional meatballs.

The marketing strategy focusses on sustainability and carbon emissions, and target not only the vegetarian market but also consumers willing to consume less meat-based products.

TRUE has received funding from the European Union's Horizon 2020 Research & Innovation Action under Grant Agreement Number 727973.

Beanit®

Faba bean-based meat analogue.

Taken from Verso Food Oy. (2021)
Beanit | Fabalicious food for human beans!

Year introduction to market
2019

State of development
On the market

The innovating business or agency
Verso Food, Finland

Contact details
ville.viksten@versofood.fi

Legume species trialled (to date)
Faba beans

Target consumers and/or unique selling points
Vegetarian, plant-based, Nordic specialty.

Targeted cropped system type
Conventional

Markets (envisioned)
Sustainable agriculture, country, plant-based, locally sourced.

IPR - Intellectual Property Right protection
Patent granted.

Legume-based value chain enhancement
Innovative use of faba beans.

Communication channels
- Company's marketing strategies
- Direct supermarket sales
- Online magazines

Reference
Beanit | Fabalicious food for human beans!

Additional information

Beanit meat analogues is a product developed by Verso Food, a Nordic company based in Finland. … "*Finland s Verso Food is the market-leading plant-based brand in its domestic market where it sells Beanit chunks and mince. The company entered the UK market in January 2020 and has a presence in Poland, Japan and Sweden, with further international expansion planned*". The company emphasises that besides being a locally sourced and sustainable food product, this is a healthier and more nutritious option than meat. They have developed this meat analogue through a wet extrusion process, blending fava beans with pea protein and water.

This company is portrayed as a leading-company in the plant based market on Finland, bringing an opportunity for many more products to be introduced… "*Verso Food is currently the market leader in plant-based foods in our domestic Finnish markets. Our greatest desire is to introduce fava bean products to tables and plates all over the world… Our shared mission is to normalise sustainable eating. We want to invite everyone to share in our excitement, to sit together at a table serving delicious food that just happens to be plant-based and sustainable*".

TRUE has received funding from the European Union's Horizon 2020 Research & Innovation Action under Grant Agreement Number 727973.

Impulses®

Instant powder for making hummus and legume-soups.

Year introduction to market
2018

State of development
Market ready

The innovating business or agency
Faravelli on their Naturis production branch (Italy and USA)

Contact details
marketing@naturis.com

Legume species trialled (to date)
Chickpeas, green peas, lentils.

Target consumers and/or unique selling points
Food factories and alimentary companies who do not possess the technology for developing such products.

Targeted cropped system type
Conventional and Organic

Markets (envisioned)
Sustainable agriculture, plant-based, food.

Taken from Hummus on naturis.com

IPR - Intellectual Property Right protection
Patent granted.

Legume-based value chain enhancement
Innovative processing technology for an easier/faster legume-based product preparation.

Communication channels
- Company's marketing line
- Online article

Reference
Spreads | Naturis Spa Rovigo, Riso, cereali, legumi, Farine funzionali

Additional information

This Italian branch of products focuses on the development of pre-gelatinized chickpea flour varieties, allowing any food company or catering service to make a personalised order of hummus or other instant legume powder mixes to the factory.

The company ensures to adapt their instant flours to the taste and seasoning requested by the buyer. This instant powder mix requires only the addition of cold/hot water into the flour in order to obtain a product of quality, without agglomerates, phase separation nor microbial contamination.

TRUE has received funding from the European Union's Horizon 2020 Research & Innovation Action under Grant Agreement Number 727973.

Prozis'® Organic Pasta

Green pea-based pasta.

Year introduction to market
2020

State of development
On the market

The innovating business or agency
Prozis (Portugal based, produced in Italy)

Contact details
Online form

Legume species trialled (to date)
Green peas

Target consumers and/or unique selling points
Vegetarian, gluten-free, diet food, high fibre, organic and plant-based.

Targeted cropped system type
Conventional and Organic

Markets (envisioned)
Bio-based food.

Taken from Organic Pasta - Green Pea, Prozis

IPR - Intellectual Property Right protection
Patent granted.

Legume-based value chain enhancement
Innovative processing technology for an easier/faster legume-based product preparation.

Communication channels
- Company's marketing strategies
- Direct and online supermarket sales

Reference
Organic Pasta - Green Pea - Penne 250 g – Free-From & Dietary Needs | Prozis

Additional information

This green pea is part of a range of their "organic pasta" collection. This range includes dried pasta in the shape of penne and fusilli with different raw ingredients such as: Wholegrain rice & chestnut, yellow lentil, red lentil, mixed legumes (blend of chickpea, beans, lentils, and peas), green pea and chickpea.

Their marketing focusses on the fact that, "*all the ingredients in this product have been cultivated organically and responsibly, without the use of artificial or chemical pesticides, in order to ensure a sustained biodiversity, soil and ecosystem*". In terms of nutritional value, this pasta offers 10g of fibre and 20g of protein per 100g portion, which is significantly higher than wheat-based pasta options.

TRUE has received funding from the European Union's Horizon 2020 Research & Innovation Action under Grant Agreement Number 727973.

LUKAA Project

Lupin as a protein replacement of soy in animal feed.

Year introduction to market
2018

State of development
Intermediate

The innovating business or agency
Innovate UK, BBSRC and Aberystwyth University (+10 collaborating entities), UK

Contact details
ngs@aber.ac.uk

Legume species trialled (to date)
Lupin

Target consumers and/or unique selling points
Locally sourced feed, soy-free and compatible with the EU Common Agricultural Policy 'Greening' programme.

Targeted cropped system type
Conventional

Additional information

Taken from Kelvin Cave LTD (2015). Know How: Home grown feed processing and preservation Spring, p5.

Markets (envisioned)
Feed, sustainable agriculture, country.

IPR - Intellectual Property Right protection
IPR protection is currently being considered.

Legume-based value chain enhancement
Alternative protein source that can be locally grown

Communication channels
- Scientific publication
- Agronomic bulletins
- Newspapers

Reference
LUKAA Project: IBERS, Aberystwyth University

A protein replacement of 15% whole yellow lupin for soy protein fed to laying hen flock showed that *both the narrow leafed and yellow lupins can be successfully fed to laying hens without compromising performance or egg quality. There was no effect on bird growth or weight, no effect on dry matter or water intake, no effect on egg production (number or weight), no effect on bird health*. Similar positive results were found with the ruminant trials where a crop of narrow-leafed lupins was grown alongside a crop of barley. Both crops were sown and crimped to evaluate if they could be crimped, *with home-grown crimped lupin / barley concentrate diets being used for finishing lambs without any detrimental effects on productivity or carcass characteristics.* Aquaculture feeding trials also proved successful as well.

This project aims to provide updated advice to growers on the ideal conditions for growing, weed control, crop reliability along with the associated benefits that they could get under the EU Common Agricultural Policy agreement (pre-Brexit project).

TRUE has received funding from the European Union's Horizon 2020 Research & Innovation Action under Grant Agreement Number 727973.

Forage legumes

Novel feed ingredient for milking cows.

Year introduction to market
2018

State of development
Experimental phase

The innovating business or agency
University of El Salvador and University of Hohenheim, Germany

Contact details
aninut@uni-hohenheim.de

Legume species trialled (to date)
Jackbean (*Canavalia ensiformis*)

Target consumers and/or unique selling points
Alternative protein sources, locally produced, dairy, soy-free.

Targeted cropped system type
Conventional

Markets (envisioned)
Feed, sustainable agriculture, plant-based.

IPR - Intellectual Property Right protection
IPR protection is currently being considered.

Legume-based value chain enhancement
Innovative application of forage legumes as a source of crude protein in feed.

Communication channels
- Scientific publication
- Online article

Reference
Effects of feeding tropical forage legumes on nutrients digestibility, nitrogen partitioning and performance of crossbred milking cows.

Additional information

Forage legumes (*Canavalia ensiformis*) was used as an alternative source of crude protein to soy meal to feed milking cows. Results of this study demonstrated that cowpea-hay diet contained the highest levels of crude protein (out of the four diets evaluated) followed by the Jack bean-sorghum silage diet. The authors found that "*there were no differences in N secretion in milk between all dietary treatments, but the N use efficiency (in g N secreted in milk per g of N intake) tended to be higher in the Jack bean-silage diet and lowest in both the control and the cowpea-hay diet*". Compared to control diets, the milking cows had an increased feed intake with cowpea-hay feed, but milk production and cow body weight were similar for all diets. "*Both diets containing forage legumes had lower feed costs and resulted in a tendency for a higher benefit-cost ratio*".

TRUE has received funding from the European Union's Horizon 2020 Research & Innovation Action under Grant Agreement Number 727973.

Conclusion

The wide range of TRUE innovation showcased in this catalogue reflects on a fraction of the high, and still increasing number of legume-based innovations which are emerging in food- and feed value chains from around the world. These innovations demonstrate that focus is mainly upon the development of protein-rich, healthy, and plant-based food products, especially those which may be sourced locally, and whose consumption supports more-sustainable cropped systems 'at home'. These legume-based products are emerging in response to the increased demand by consumers for more healthy and sustainable food and drink products. In addition, health and sustainability have become the 'language of modern food- and drink-marketing'. Consequently, and in support of these food and drink products, cookbooks and their means by which they are marketed have emerged as important education and knowledge dissemination tools in the promotion of healthy and sustainable consumption choices. These are developed to underpin and strengthen consumer demand for legume-based products or meals in many different settings from schools and gastronomic settings to new ideas for the snack-food market.

There are also huge opportunities to use legumes in the animal- and aquaculture-feed sectors, as the largest share of imported grain-legumes is still used in animal feed production. This potential is evidenced by the TRUE and global innovations, demonstrating the successful use of locally sourced legumes for feed, especially for broilers and fish farming. The benefits of using clover, vetches and lucerne as forage crops deserve more attention – as feed resource and as part of a sustainable land management farming system. Moreover, many grassland-based production systems remain resource use inefficient, and less-productive than they could be - as they are not forage-legume supported. As such, this maintains the dependency on what is often imported (soybean-based) feedstocks. Nevertheless, TRUE innovations have demonstrated new approaches that help motivate farmers to grow more legumes or/and inspire to integrate legumes in more-diverse farming systems. Adapting these solutions, methods, and management systems to local climatic conditions, much more diverse and resilient range cropped systems could be realised.

TRUE has received funding from the European Union's Horizon 2020
Research & Innovation Action under Grant Agreement Number 727973.

In this context, and from the outset the TRUE project partners acknowledged that taking innovations from experimental to a market-ready context requires partnership. It is therefore with a view to the persistence of this vision that the TRUE- and global- innovations are offered here: to inspire entrepreneurs to fully utilise the functional diversities offered by legumes, and to realise the importance of home-grown legumes in facilitating solutions for a healthier and more sustainable agri-food and feed-systems - locally and globally (Iannetta *et al.*, 2021).

TRUE has received funding from the European Union's Horizon 2020 Research & Innovation Action under Grant Agreement Number 727973.

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Annex 1: Background to the TRUE project

Executive Summary

TRUE's perspective is that the scientific knowledge, capacities, and societal desire for legume supported systems exist, but that practical co-innovation to realise transition paths have yet to be achieved. TRUE presents 9 Work Packages (WPs), supported by an *Intercontinental Scientific Advisory Board*. Collectively, these elements present a strategic and gender-balanced work-plan through which the role of legumes in determining '*three pillars of sustainability*' – '*environment*', '*economics*' , and '*society*' - may be best resolved. TRUE realises a genuine multi-actor approach, the basis for which are three *Regional Clusters* managed by WP1 ('*Knowledge Exchange and Communication',* University of Hohenheim, Germany), that span the main pedo-climatic regions of Europe, designated here as *Continental*, *Mediterranean* and *Atlantic,* and facilitate the alignment of stakeholders' knowledge across a suite of 24 Case Studies. The Case Studies are managed by partners within WPs 2-4 comprising '*Case Studies*' (incorporating the project database and *Data Management Plan*), '*Nutrition and Product Development*', and '*Markets and Consumers'.* These are led by the Agricultural University of Athens (Greece), Universidade Catolica Portuguesa (Portugal) and the Institute for Food Studies & Agro-Industrial Development (Denmark), respectively. This combination of reflective dialogue (WP1), and novel legume-based approaches (WP2-4) will supply hitherto unparalleled datasets for the '*sustainability WPs*', WPs 5-7 for '*Environment*', '*Economics*' and '*Policy and Governance'.* These are led by greenhouse gas specialists at Trinity College Dublin (Ireland; in close partnership with LCA specialists at Bangor University, UK), Scotland's Rural College (in close partnership with University of Hohenheim), and the Environmental and Social Science Research Group (Hungary), in association with Coventry University, UK), respectively. These *Pillar WPs* use progressive statistical, mathematical and policy modelling approaches to characterise current legume supported systems and identify those management strategies which may achieve sustainable states. *A key feature* is that TRUE will identify key *Sustainable Development Indicators* (SDIs) for legume-supported systems, and thresholds (or goals) to which each SDI should aim. Data from the *foundation WPs* (1-4), to and between the *Pillar WPs* (5-7), will be resolved by WP8, '*Transition Design',* using machine-learning approaches (*e.g. Knowledge Discovery in Databases*), allied with *DEX* (*Decision Expert*) methodology to enable the mapping of existing knowledge and experiences. Co-ordination is managed by a team of highly experienced senior staff and project managers based in The Agroecology Group, a Sub-group of Ecological Sciences within The James Hutton Institute.

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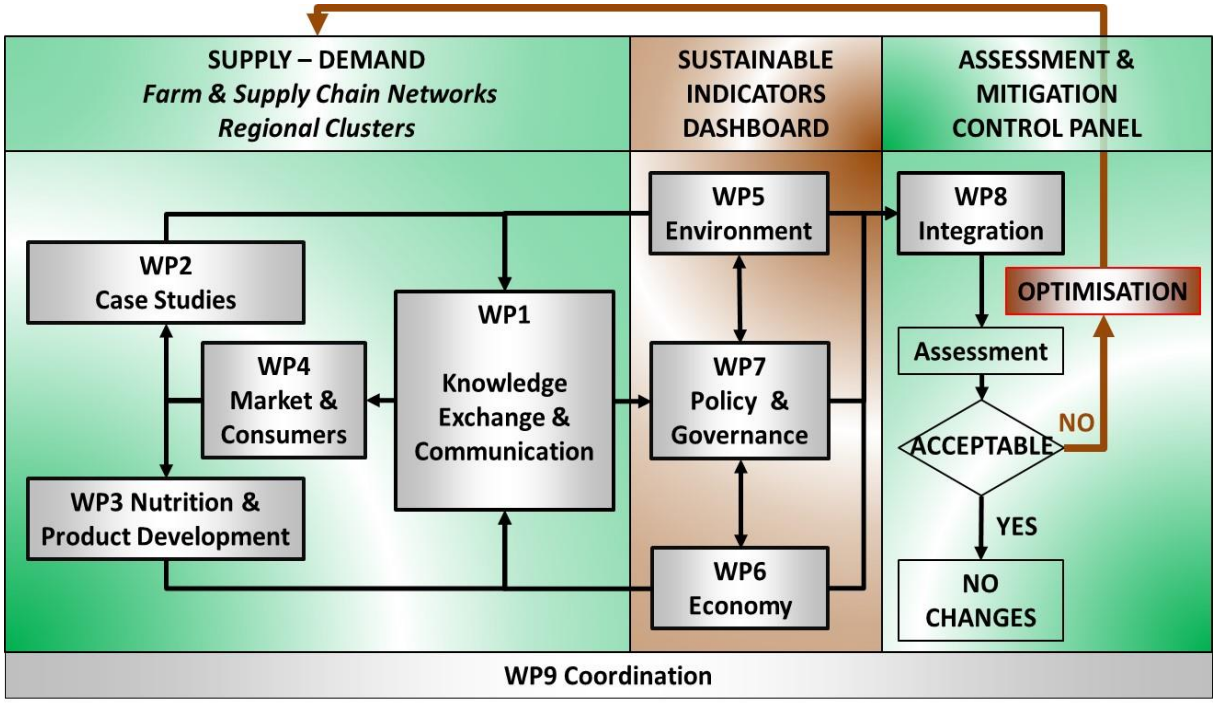
Work-package structure

The flow of information and knowledge in TRUE, from the definition of the 24 Case Studies (left), quantification of sustainability (centre) and synthesis and decision support (right).



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Project partners

No	Participant organisation name (and acronym)	Country	Organisation Type
1 (C*)	The James Hutton Institute (JHI)	UK	RTO
2	Coventry University (CU)	UK	University
3	Stockbridge Technology Centre (STC)	UK	SME
4	Scotland's Rural College (SRUC)	UK	HEI
5	Kenya Forestry Research Institute (KEFRI)	Kenya	RTO
6	Universidade Catolica Portuguesa (UCP)	Portugal	University
7	Universitaet Hohenheim (UHOH)	Germany	University
8	Agricultural University of Athens (AUA)	Greece	University
9	IFAU APS (IFAU)	Denmark	SME
11	Bangor University (BU)	UK	University
12	Trinity College Dublin (TCD)	Ireland	University
13	Processors and Growers Research Organisation (PGRO)	UK	SME
14	Institut Jozef Stefan (JSI)	Slovenia	HEI
15	IGV Institut Fur Getreideverarbeitung Gmbh (IGV)	Germany	Commercial SME
16	ESSRG Kft (ESSRG)	Hungary	SME
17	Agri Kulti Kft (AK)	Hungary	SME
18	Alfred-Wegener-Institut (AWI)	Germany	RTO
19	Slow Food Deutschland e.V. (SF)	Germany	Social Enterprise
20	Arbikie Distilling Ltd (ADL)	UK	SME
21	Agriculture And Food Development Authority (TEAG)	Ireland	RTO
22	Sociedade Agrícola do Freixo do Meio, Lda (FDM)	Portugal	SME
23	Eurest -Sociedade Europeia De Restaurantes Lda (EUR)	Portugal	Commercial Enterprise
24	Solintagro SL (SOL)	Spain	SME
25	Public Institution Development of the Međimurje County (PIRED)	Croatia	Development Agency

*Coordinating institution

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Objectives

Objective 1: Facilitate knowledge exchange (UHOH, WP1)

- Develop a blueprint for co-production of knowledge

Objective 2: Identify factors that contribute to successful transitions (AUA, WP2)

- Relevant and meaningful Sustainable Development Indicators (SDIs)

Objective 3: Develop novel food and non-food uses (UCP, WP3)

- Develop appropriate food and feed products for regions/cropping systems

Objective 4: Investigate international markets and trade (IFAU, WP4)

- Publish guidelines of legume consumption for employment and economic growth
- EU infrastructure-map for processing and trading

Objective 5: Inventory data on the environmental intensity of production (TCD, WP5)

- Life Cycle Analyses (LCA) -novel legumes rotations and diet change

Objective 6: Economic performance - different cropping systems (SRUC & UHOH, WP6)

- Accounting yield and price risks of legume-based cropping systems

Objective 7: Enable policies, legislation and regulatory systems (ESSRG, WP7)

- EU-policy linkages (on nutrition) to inform product development/uptake

Objective 8: Develop decision support tools: growers to policymakers (JSI, WP8)

- User-friendly decision support tools to harmonise sustainability pillars

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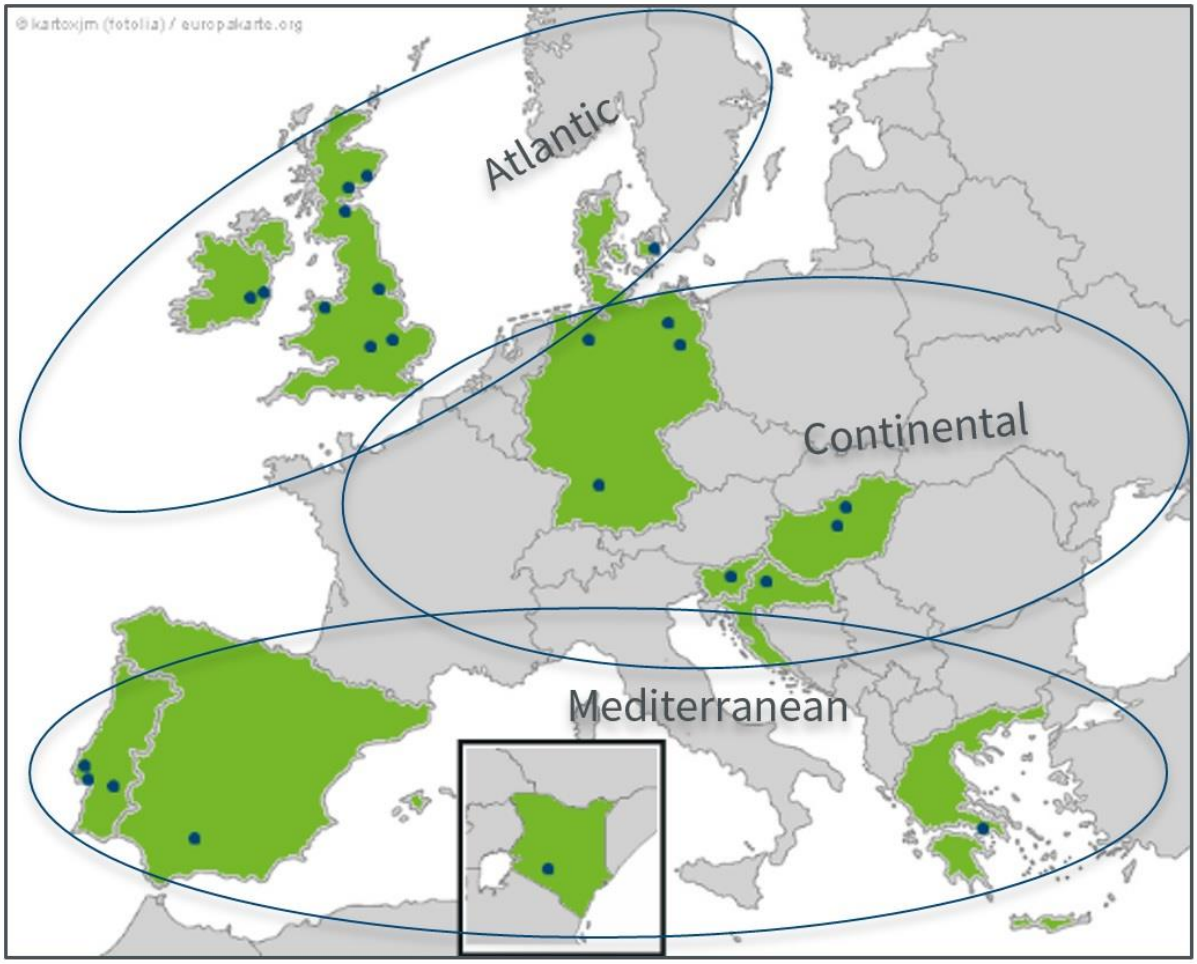
Legume Innovation Networks



Knowledge Exchange and Communication (WP1) events include three TRUE European Legume Innovation Networks (E-LINs), and these engage multi-stakeholders in a series of focused workshops. The E-LINs span three major biogeographical regions of Europe illustrated above within the ellipsoids for Continental, Mediterranean and Atlantic zones.

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Available online at: www.true-project.eu.