



TRansition paths to sUustainable
legume-based systems in Europe

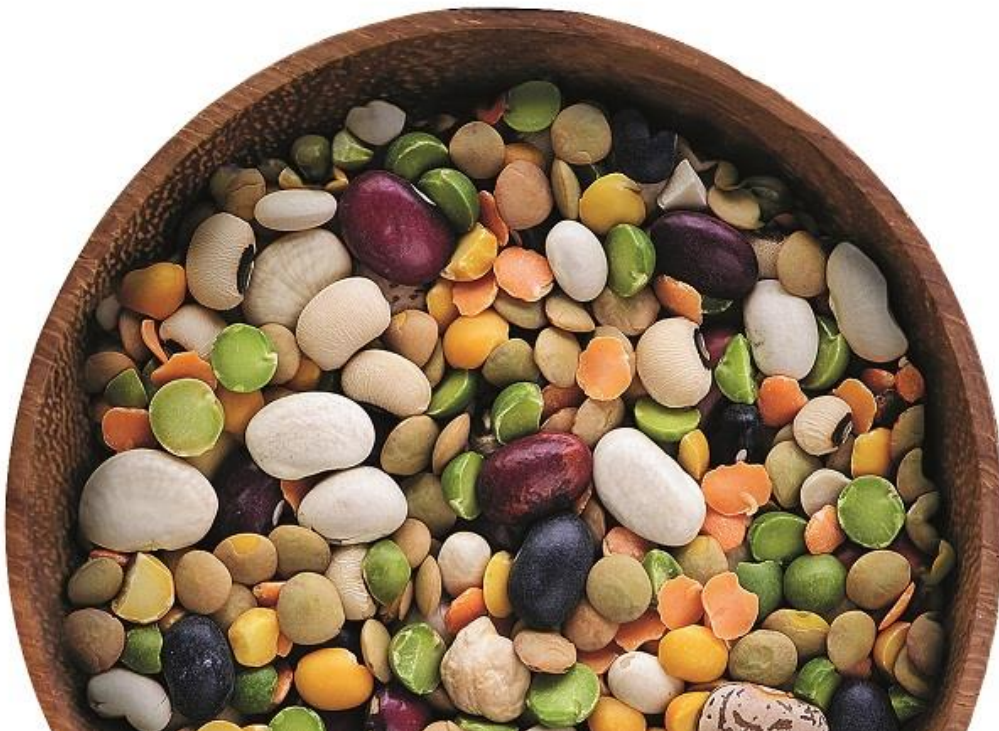
Data to institutional repository (ORPD)

Work Package: 2

Deliverable (D): D2.6 (D16)

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www.true-project.eu



Deliverable Description & Contributors

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- **Actual submission date:** October 10th 2021
- **Project start date:** April 1st 2017
- **Duration:** 54 months
- **Work package:** 2
- **Work package leader:** Georgia Ntatsi, AUA, Greece
- **Deliverable title:** Data to institutional repository (ORDP)
- **Nature of Deliverable:** ORDP: Open Research Data Pilot
- **Dissemination level:** Public

- **Deliverable description:**
All data up-loaded annually to the database will be transferred to Zenodo, the open data repository.

- **Contributors:**
AUA, JHI, CU, STC, SRUC, KEFRI, UCP, UHOH, IFAU, PIRE, IGV, AK, AWI, ADL, TEAG, EUR, SOL

- **Keywords:**
Open dataset, standard operating procedure





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1. Introduction

During the 4.5 years of the project, WP2 has coordinated the collation and storage of data and methodologies from across all TRUE project WP and CS activities. The information has been gathered in a secure (available online) data-repository, based in a secure encrypted data-server based at JHI. The data comprises a library of **Standard Operating Procedures (SOPs)** (*i.e.*, material and methods) covering techniques such as: agronomy and agronomic approaches; assessment of yield and yield qualities; measuring BNF; rhizobial culture and characterisation; soil and plant nutritional status; Green House Gas (GHG) emissions; plus legume breeding (and grafting), approaches for example. In addition, data gathered using the SOPs are also captured alongside the associated descriptive information (*i.e.* metadata). The **metadata describes experiments which gave rise to the datasets**, as well as the data itself.

In line with participation in the Open Research Data Pilot (ORDP; [OpenAIRE](#)), all SOPs have been uploaded to Zenodo and linked to the [TRUE Project Standard Operation Procedures](#). Similarly, data and associated MEF submitted to the TRUE data repository have been uploaded to [Zenodo](#), if they have been fully exploited and not been made open access elsewhere.

It is hoped that this information will contribute significantly to TRUE's legacy.



2. Participation in Open Research Data Pilot

2.1 Overview of TRUE's data

During the 4.5 years of the project, the TRUE consortium has produced a number of **experimental datasets** and deposited to the TRUE data repository once received and checked. Intended data-gathering exercises provide a high-level overview of the work carried out and of the connectivity to other data-sources, including dependencies with the work programme. These **essential metadata** explain the stored dataset to help ensure those downloading the information can interpret the data. **Specific methods or SOPs**, used to gather the data have also been produced and stored in the database. An overview of the data deposited to the TRUE data repository is provided in Table 1.

Table 1. Summary of Partners' contributions to the TRUE database

No.	Lead Partner	MEFs	SOPs	Total
1	JHI	0	4	4
2	CU	0	2	2
3	STC	6	19	25
4	SRUC	1	1	2
5	KEFRI	1	2	3
6	UCP	8	2	10
7	UHOH	1	1	2
8	AUA	9	28	37
15	IGV	2	3	5
17	AK	1	1	2
18	AWI	3	1	4
20	ADL	2	3	5
21	TEAG	1	1	2
23	EUR	1	1	2
24	SOL	1	1	2
25	PIRED	2	1	3
Total		39	71	110



2.2 Standard Operating procedures (SOPs)

The TRUE data repository contains a library of 71 Standard Operating Procedures (SOPs) covering a multiple of methods from the measurement biological nitrogen fixation, minerals and amino acids in legumes to the brewing of legumes, collection of gas sample for greenhouse gas analysis and recording protocol for new breeding projects. A number of these SOPs have been turned into practice abstracts and we believe this library could be a valuable resource for farmers, scientists and the wider public, with an interest in legumes, biodiversity and climate change. These SOPs have been made open access through [Zenodo](#) (

Table 3).

Table 2. Summary of Partners' contributions to the TRUE database

SOP	Title	Lead Partner	DOI
1	Measuring %Ndfa and biological nitrogen fixation	JHI	10.5281/zenodo.5516885
2	Isolation of single rhizobia strains	JHI	10.5281/zenodo.5516941
3	Identification of root nodules isolates by 16S-rRNA PCR	JHI	10.5281/zenodo.5516988
4	Collecting gas samples for greenhouse gas analysis and soil and lysimeter samples for nitrogen availability in soil	JHI	10.5281/zenodo.5516994
5	Measuring minerals in legume samples	UCP	10.5281/zenodo.5517012
6	Development of sustainable legume-based cropping and grassland systems and agri-food and feed chains	SOL	10.5281/zenodo.5517022
7	Controlled comparative feeding experiments for finfish	AWI	10.5281/zenodo.5517039
8	Chlorophyll Assay	AUA	10.5281/zenodo.5517043
9	Net photosynthetic rate (A), Stomatal conductance (Gs), Intercellular CO ₂ concentration (Ci), Transpiration rate ϵ	AUA	10.5281/zenodo.5517198
10	Antioxidant assay 1: ascorbate peroxidase (APX)	AUA	10.5281/zenodo.5517202
11	Antioxidant assay 2: catalase (CAT)	AUA	10.5281/zenodo.5517394
12	Antioxidant assay 3: guaiacol peroxidase (G-POD)	AUA	10.5281/zenodo.5517399
13	Antioxidant assay 4: glutathione reductase (GR)	AUA	10.5281/zenodo.5517407



SOP	Title	Lead Partner	DOI
14	Antioxidant assay 5: superoxide dismutase (SOD)	AUA	10.5281/zenodo.5517410
15	Bradford protein assay	AUA	10.5281/zenodo.5517414
16	Carbohydrate Assay 1: sugars (glucose, sucrose, fructose)	AUA	10.5281/zenodo.5553398
17	Carbohydrate Assay 2: starch	AUA	10.5281/zenodo.5554271
18	Total Amino acid content	AUA	10.5281/zenodo.5554286
19	Proline content	AUA	10.5281/zenodo.5554297
20	Total phenolics	AUA	10.5281/zenodo.5554305
21	Oxidation parameters 1: MDA	AUA	10.5281/zenodo.5554316
22	Oxidation parameters 2: hydrogen peroxide H ₂ O ₂	AUA	10.5281/zenodo.5554329
23	Oxidation parameters 3: electrolyte leakage	AUA	10.5281/zenodo.5554335
24	Tissue nutrient analyses	AUA	10.5281/zenodo.5554339
25	Soil nutrient analyses	AUA	10.5281/zenodo.5554357
26	Soil organic carbon (OC)	AUA	10.5281/zenodo.5554370
27	Nodulation (number and mean weight of nodules)	AUA	10.5281/zenodo.5554379
28	PCR sequencing analysis to test the presence of the inoculants in the nodules	AUA	10.5281/zenodo.5554383
29	WUE/NUE Based on Yield Biomass	AUA	10.5281/zenodo.5554399
30	Yield estimation in common bean	AUA	10.5281/zenodo.5554414
31	Establishment of protocol for nodule sampling	AUA	10.5281/zenodo.5555074
32	Establishment of protocol for rhizobia isolation and cultivation	AUA	10.5281/zenodo.5554426
33	Establishment of protocol for polyphasic characterization	AUA	10.5281/zenodo.5554439
34	Chlorophyll fluorescence	AUA	10.5281/zenodo.5554453
35	Recording bee visitation	CU	10.5281/zenodo.5554465
36	Measuring floral volatiles	CU	10.5281/zenodo.5554540
37	Measuring amino acids in legume samples	UCP	10.5281/zenodo.5554547
38	Cultivation experiments of Hungarian legume land races	AK	10.5281/zenodo.5554553
39	Recording protocol of new breeding project AT CRICHTON	SRUC	10.5281/zenodo.5554557
40	Rheometer legume starch characterisation	ADL	10.5281/zenodo.5554355





SOP	Title	Lead Partner	DOI
41	Data gathering and guideline-based interviews to identify possible factor to introduce new crops in Europe	UHOH	10.5281/zenodo.5554368
42	Brewing with Legumes	ADL	10.5281/zenodo.5554377
45	Expanding legume based pasture uptake	TEAG	10.5281/zenodo.5554401
46	Isolation and initial growth characterisation of rhizobia on yeast extract agar (YEMA) plates	KEFRI	10.5281/zenodo.5554405
47	Determination of the water absorption index (WAI) and the water solubility index (WSI)	IGV	10.5281/zenodo.5554420
48	Authentication of rhizobia (screening strains for nodulation)	AUA	10.5281/zenodo.5554434
49	Sensory evaluation of pasta products	IGV	10.5281/zenodo.5562447
50	Baking Tests	IGV	10.5281/zenodo.5562471
51	Identifying potentials and viable paths for legume production using Croatia as a Case study	PIRED	10.5281/zenodo.5562474
52	Production of a REcipe E-book	EUR	
53	Evaluation of crop germination and establishment	STC	10.5281/zenodo.5562495
54	Evaluation of crop canopy height and temperature	STC	10.5281/zenodo.5562500
55	Evaluation of plant growth habit in cereals	STC	10.5281/zenodo.5562502
56	Evaluation of plant length	STC	10.5281/zenodo.5562509
57	Evaluation of plant ground cover	STC	10.5281/zenodo.5562511
58	Evaluation of clover flower numbers	STC	10.5281/zenodo.5562515
59	Measuring internode lengths	STC	10.5281/zenodo.5562526
60	Sampling point-focussed harvest evaluations in cereal crops	STC	10.5281/zenodo.5562528
61	Estimating plant leaf chlorophyll	STC	10.5281/zenodo.5562547
62	Evaluating soil moisture, temperature and compaction	STC	10.5281/zenodo.5562552
63	Sampling point-focussed harvest evaluations in forage and biomass maize crops	STC	10.5281/zenodo.5562560
64	Baited trapping for assessment of slug presence and relative number	STC	10.5281/zenodo.5562571
65	Assessment of invertebrate pests and beneficials	STC	10.5281/zenodo.5562575
66	Assessment of crop disease	STC	10.5281/zenodo.5562583
67	Assessment of worm presence and relative number	STC	10.5281/zenodo.5562593



SOP	Title	Lead Partner	DOI
68	Assessment of avian and mammal numbers	STC	10.5281/zenodo.5562601
69	Brewing with faba beans – enzymes for mash optimisation	ADL	10.5281/zenodo.5562613
70	Extraction and assessment of nematodes in rhizosphere soils	KEFRI	10.5281/zenodo.5562625
71	Sampling point-focussed harvest evaluations in sugar beet crops	STC	10.5281/zenodo.5562632
72	Evaluation of cereal crop lodging	STC	10.5281/zenodo.5562638
73	Evaluation of tillering and ear number in a cereal crop	STC	10.5281/zenodo.5562644

2.3 Meta-data Entry Forms (MEFs)

Out of the 39 datasets and accomgnied MEFs uploaded to the TRUE data repository:

- 9 have been uploaded to the [TRUE datasets and meta-information | Zenodo](#) (





-
- Table 3);
 - 8 have already been published with the corresponding scientific publications (





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- Table 4);
 - 21 will be uploaded to Zenodo following full exploitation (
 -
 - Table 5).



Table 3. List of datasets and associated MEFs uploaded to Zenodo

MEF	Dataset Title	Lead Partner	DOI
8	Particle size and starch pasting properties analysis as important parameter for new food development by extrusion	IGV	10.5281/zenodo.5554168
9	Processing of legume products to new foods	IGV	10.5281/zenodo.5554180
13	Assessment of legume starches to determine rheological characteristics relevant to alcohol production	ADL	10.5281/zenodo.5554243
14	Collecting data on Hungarian traditional/local pulse varieties, on legume production, consumption and trade of food-purpose pulses in Hungary	AK	10.5281/zenodo.5554257
15	The use of legumes and leguminous by-products within dairy farming	SRUC	doi.org/10.3389/fsufs.2021.588158
19	Selection of guideline-based interview questions depending on the type of legume under study and study location	UHOH	10.3390/su13010133
23	Consumers - legume dishes Choose Beans	EUR	10.5281/zenodo.5554391
29	Determining the effect of mashing regime, protease and carbohydrase additions on viscosity development during gelatinisation of faba bean starch as well as on wort run off rate.	ADL	10.1002/jib.632
30	Policy for sustainable development (development of "Croatian Case Study - Legumes: their potential role in Croatian agricultural production") 1	PIRED	10.5281/zenodo.5554536
31	Policy for sustainable development (development of "Croatian Case Study - Legumes: their potential role in Croatian agricultural production") 2	PIRED	10.5281/zenodo.5554641



Table 4. List of TRUE datasets published with the corresponding scientific publications

MEF	Dataset Title	Lead Partner	DOI
1	Lupin (<i>L. angustifolius boregine</i>) kernel meal as fishmeal replacement for the White leg shrimp (<i>Litopenaeus vannamei</i>)	AWI	10.1111/anu.13034
5	Microbiological quality assessment of lentils for sprouting; formulation of new minimally processed sprout-based cookies and microbiological and sensory quality monitorization toward product development optimisation	UCP	10.3390/foods9040400
11	Combining cultivation of non-legume crops with appropriate legume plants in a crop rotation scheme	AUA	10.3390/agronomy10091269
12	Nodule sampling, rhizobia isolation, and polyphasic characterization of common and runner beans nodulating rhizobia	AUA	10.1038/s41598-021-88051-8
18	Combining cultivation of non-legume crops with appropriate legume plants in a crop rotation scheme	AUA	10.3390/agronomy10091269
24	Combining cultivation of non-legume crops with appropriate legume plants in a crop rotation scheme	AUA	10.3390/agronomy10091269
42	Combining cultivation of non-legume crops with appropriate legume plants in a crop rotation scheme	AUA	10.3390/agronomy10091269



Table 5. List of datasets and associated MEF to be made open-access when full exploitation is complete.

MEF	Dataset Title	Lead Partner
2	Covariance analysis of legume germplasms for their protein content, nutrient concentration and morpho-physiological traits	UCP
3	Formulation of a new faba bean tofu and sensorial analysis data for product development optimisation	UCP
4	IMPULSE – Impact of a PULSE-based partial replacement diet on metabolome and health	UCP
6	Development of sustainable legume-based cropping and grassland systems and agri-food and feed chains	SOL
10	Evaluating the nutrient solution for hydroponically cultivated common bean for succeeded bacteria inoculation	AUA
20	Lupin (<i>Lupinus angustifolius</i>) and faba bean (<i>Vicia faba</i>) as alternative protein sources in formulated feeds for the Atlantic Salmon (<i>Salmo salar</i>)	AWI
21	Covariance analysis of legume germplasms for their seed weight and protein content	UCP
22	Formulation of a new lentil-based pancake mix and sensorial analysis data for product development optimisation	UCP
25	CS 21: Novel grafted types - high yield (First experiment: Evaluating the nutrient solution for hydroponically cultivated common bean for succeeded bacteria inoculation	AUA
26	Performance of a barley crop grown with clover living mulches at STC, in the 2018 growing season	STC
27	Performance of a fodder maize crop grown with clover living mulches at STC, in the 2018 growing season	STC
33	CS 21-Novel grafted types high yield (The role of rootstock in the performance of grafted common bean cultivars)	AUA
34	Covariance analysis of legume germplasms for their seed weight and protein content (WP3.Y2.D1)	UCP
35	Formulation of a new lentil-based pancake mix and sensorial analysis data for product development optimisation (WP3.Y2.D2)	UCP
36	Productivity of cereal-legume intercrop under smallholder farms in western Kenya	KEFRI
37	Performance of a sugar beet crop grown with clover living mulches at STC, in the 2019 growing season	STC



MEF	Dataset Title	Lead Partner
38	Performance of a fodder maize crop grown with clover living mulches at STC, in the 2019 growing season	STC
39	Performance of a spring barley crop grown with clover living mulch at Manterra Ltd under differing herbicide regimes, in the 2019 growing season	STC
40	Lupin (<i>Lupinus angustifolius</i>) as alternative protein sources in formulated feeds for the European seabass (<i>Dicentrarchus labrax</i>)	AWI
41	CS 21: Novel grafted types - high yield (Fourth experiment: Evaluating the new grafted types under drought stress)	AUA

The following agreement has been reached among partners regarding the TRUE Data Management principles after the project end.

- Partners will submit all datasets and associated MEFs and SOPs of all TRUE activities **within 12 months of project end.**
- JHI will review and check the data and/or SOPs within 2 months of submission of the data.
- Data will then be uploaded by JHI to Zenodo under the terms stated by the data owner and will be released as fully Open Access under a Creative Commons Attribution 4.0 International licence (with exclusion of those involving to IP issues or to be commercially exploited further by project partners: see Section 2.1.2). However, the data uploaded may be temporarily embargoed until a maximum of 12 months after the project end-date (if requested). Data access restriction beyond the project term plus 12-month extension, may need justified to the European Commission, REA (Research Executive Agency).





Acknowledgement

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Disclaimer

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Also available online at: www.true-project.eu.





Appendix I: Background to the TRUE project

TRUE Project Executive Summary

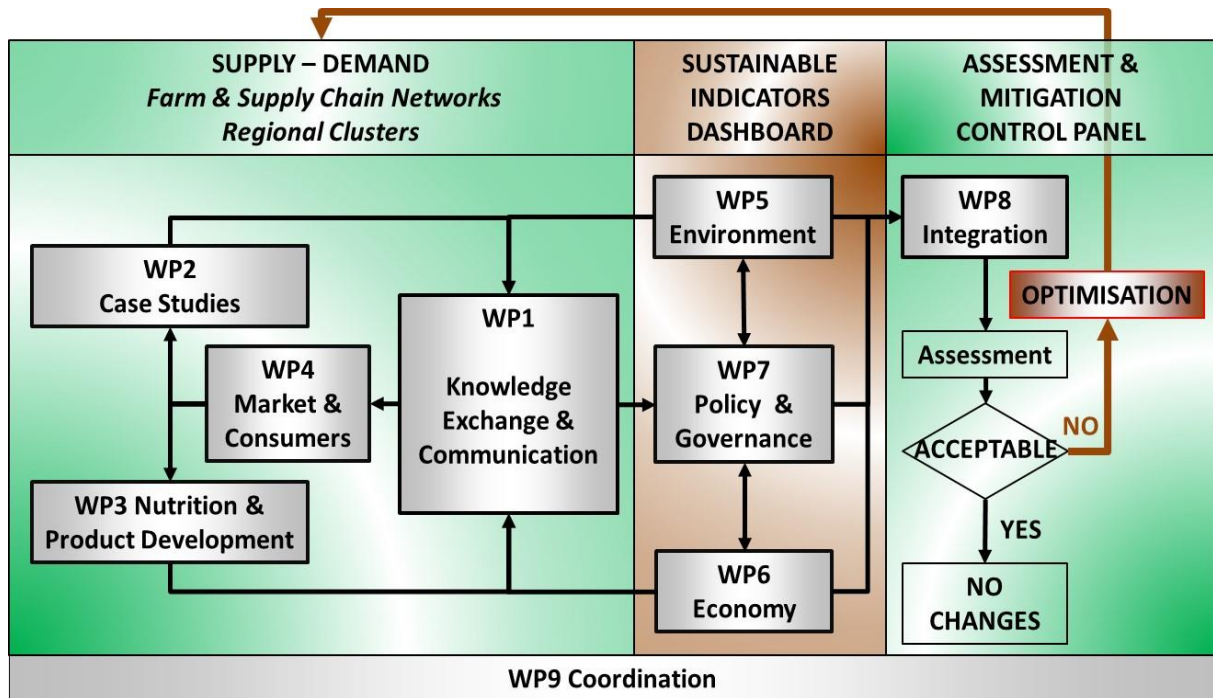
TRUE's perspective is that the scientific knowledge, capacities and societal desire for legume supported systems exist, but that practical co-innovation to realise transition paths have yet to be achieved. TRUE presents 9 Work Packages (WPs), supported by an *Intercontinental Scientific Advisory Board*. 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 Life Cycle Analysis 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.



Work Package Structure

Flow of information and knowledge in TRUE, from definition of the 24 case studies (left), quantification of sustainability (centre) and synthesis and decision support (right) (Figure 1).



Work package structure and flow of information and knowledge between work packages.



Project Partners

N°	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
10	Regionalna Razvojna Agencija Medimurje (REDEA)	Croatia	Development Agency
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 for Development of Međimurje REDEA (PIRED)	Croatia	Development Agency

*Coordinating institution





Objectives

Objective 1: Facilitate knowledge exchange (UHOH, WP1)

- *Develop a blue-print 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 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*

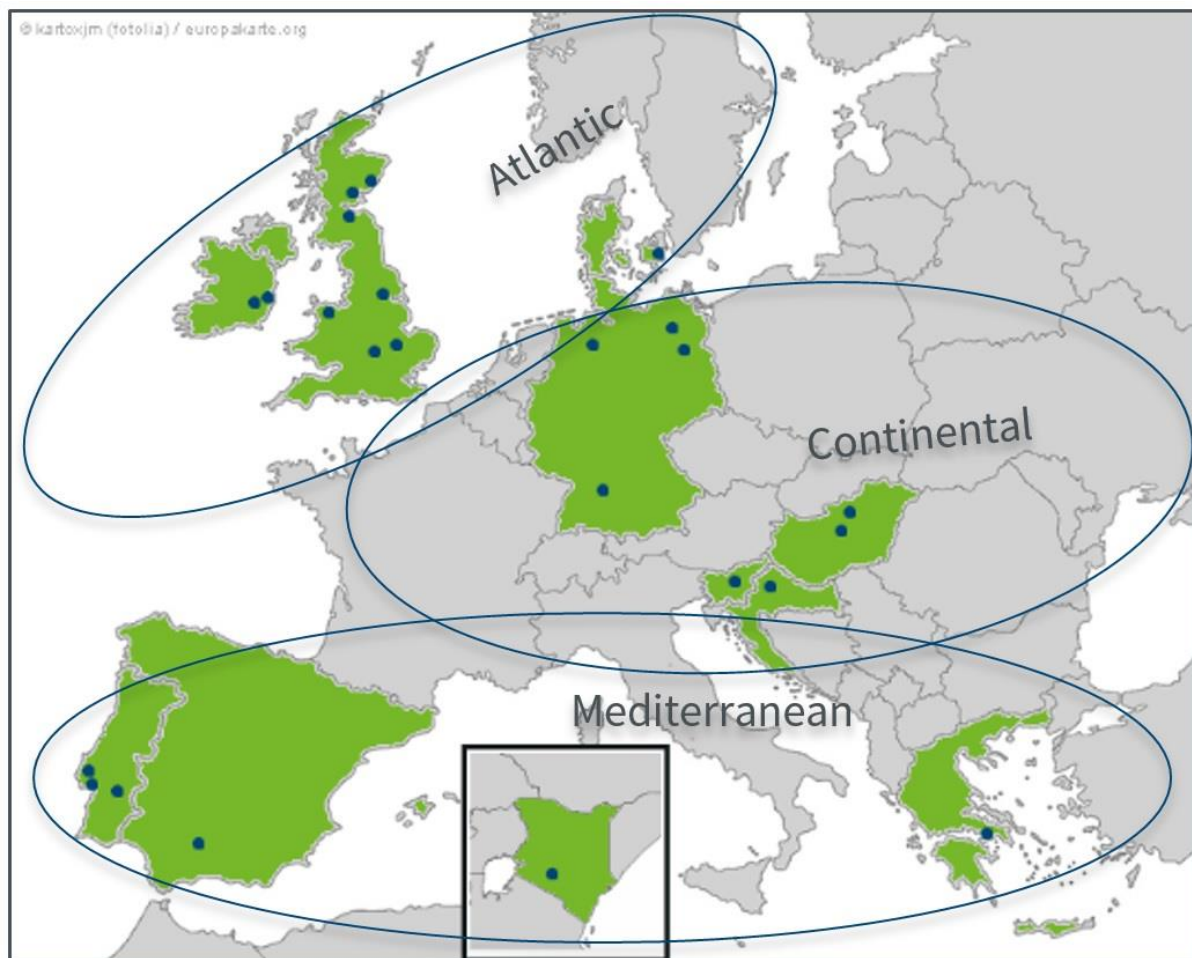
Objective 8: Develop decision support tools: growers to policy makers (JSI, WP8)

- *User friendly decision support tools to harmonise sustainability pillars*



Legume Innovation Networks & Case Studies

Knowledge Exchange and Communication (WP1) events include three TRUE European Legume Innovation Networks (ELINs) and these engage multi-stakeholders in a series of focused workshops. The ELINs span three major pedoclimatic regions of Europe, illustrated above within the ellipsoids for Continental, Mediterranean and Atlantic zones (Figure 2).



Three TRUE European Legume Innovation Networks (ELINs).

