



TRansition paths to sUustainable
legume-based systems in Europe

A map of value chains for legumes used as food

Work Package: 4

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1. Executive Summary

This report is the first in a series of four detailing the EU food and feed markets for legumes and pulses. The scope of the present report is to provide insights into the processing and trade infrastructure for pulses in the EU food market. The report employs a qualitative and explorative approach, and builds on data gathering from literature, stakeholder consultations and field research. We illustrate local and international quality chains for the various forms by which legumes may be marketed in the EU, such as grains, or grain-based products and as fresh produce. Examples are provided to display the products, actors, infrastructure and trading patterns.

The EU food market offers pulses in an array of fresh produce, as well as dried, canned and frozen products in conventional and organic product types. Fresh produce is of European origin when in season and imported from many parts of the world off-season. Countries like Kenya, Guatemala and Morocco are major suppliers of fresh produce to the EU (especially for French beans and sugar snaps). This trading pattern is made possible because of the trade infrastructure implemented through EU regulations on food safety, transparency and standards, and the trading partners' compliance with quality standards such as the IFS and BRC certifications.

This report is focused on those actors in the supply chain that channel large volumes of pulses from farm to consumer market, such as dried, canned and frozen products, and fresh produce. EU production of dried pulses is approximately 4.3 m t, and imports and exports amount to approximately 740,000 t. Most imported pulses are from Canada, Argentina, and China. In the EU, dried pulses are packed and labelled by importers and milling companies for the consumer market and for the business-to-business (B2B) markets (food service and industrial applications).



Consumers of organic products are often considered as frontrunners for taking up new healthy dietary trends, and this has been observed for legumes grains including pulses and grain-based products. There are other consumer segments that show interest in legume-grain-based products but a lack of knowledge about how to use dried or canned legume grains was found to be a limiting factor for uptake by this consumer group. Companies processing dried or canned pulses are taking the lead in consumer education by providing pre-cooked pulses and ready-to-use pulse-based products that appeal to consumers' curiosity.

The canning and frozen food industries are dominated by a small number of multinational companies with strong brands and processing facilities in many countries. In addition, there are many local companies processing pulses and vegetables into a huge variety of canned, frozen and otherwise processed products. Companies in the pulse processing industry hold IFS, BRC, FSSC22000 certifications to comply with retailers' quality standards and to ensure compliance with EU regulations on food safety, product standards, traceability and labelling. Furthermore, some products are offered in the market as organic standard, and others are certified with the PGI or PDO labels (refer to section 3.2, Glossary of acronyms). The overall intention of the certifications is to ensure market transparency and a level playing field for the benefit of industry and consumers.

This report concludes that the EU food market will see an increase in demand for fresh produce and pulses over the coming years. To sustain the market-pull and have more legume-grain (especially pulses) and grain-based products in the food market, a wider range of consumer-ready products must be developed to spur consumers' demand. This trend is already evident and driven by industry. It is also a conclusion that the European market will continue to import pulses in the coming years to satisfy an increasing market volume. This requires sufficient infrastructure for trade and processing to be in place, and compliance and coherence between European and foreign quality chains.



Contents

1. Executive Summary	3
2. Background to the TRUE project.....	7
2.1 TRUE Project Executive Summary (<i>abbreviated</i>)	7
3. About the Deliverable.....	8
3.1 Scope and context	8
3.2 Glossary of acronyms, terms and their definition	9
4. Overview – Pulses in the EU	12
4.1 EU pulse supply.....	12
4.2 Pulse demand	14
4.2.1 Consumption patterns.....	14
4.2.2 Consumer perceptions and food choice.....	15
4.2.3 Range of pulse-based products.....	17
5. Fresh vegetables	19
5.1 Quality chain: green beans from Kenya to the European market.....	19
5.2 Trading fresh produce	20
6. Quality chains – Dried pulses.....	24
6.1 Examples of quality chains.....	24
6.1.1 Dried pulses in Portugal.....	24
6.1.2 Dried faba beans in Germany	25
6.1.3 Greece – major importer with local production of PGI/PDO pulses	27
6.2 Companies, products and prices.....	27
6.3 Processing infrastructure: examples of companies	29
7. Quality chains – frozen vegetables.....	33
7.1 Example of quality chains.....	33
7.1.1 Vining peas in the United Kingdom.....	33
7.1.2 Organic frozen vegetables in Danish supermarkets.....	35
7.2 Processing infrastructure - frozen vegetable industry	36
8. Quality chains – Canned pulses	39



8.1 Examples of quality chains.....	39
8.1.1 Canned beans from Croatia.....	39
8.1.2 Baked beans.....	40
8.2 Canned pulses: products, brands and prices	42
8.3 Processing infrastructure for canned pulses.....	44
9. Sustaining market-pull for pulses in the EU food market.....	46
9.1 The importance of infrastructure.....	46
9.2 Concluding remarks and recommended actions	48
References	50
Annex I - Methodology	53
Annex II - Background to the TRUE project	55
Executive summary - abbreviated	55
Work-package structure - diagram	56
Project partners - table.....	57
Objectives - Abbreviated	58
Legume Innovation Network – diagram	59
Disclaimer	60
Copyright	60
Citation.....	60



2. Background to the TRUE project

2.1 TRUE Project Executive Summary (*abbreviated*)

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 supplies 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.



3. About the Deliverable

3.1 Scope and context

The scope of this Deliverable (D4.1) is to provide an **overview of the infrastructure for trade and processing of fresh produce and dried legume-grains (mainly pulses) in the EU food market.**

The report is targeted at pulses for use as food: beans, chickpeas, lentils, peas, lupins and soybeans, and fresh produce (peas and beans). The report covers **conventional and organic products and only the food market.**

The **aim of the report** is to generate findings that can contribute to transition paths that increase cultivation of legumes in the European food system. Therefore, the present report investigates the major segments in the pulse processing industry in Europe: **frozen vegetables, canned grains (pulses), fresh produce and dried pulses.** This aims to support long-term economic growth and provide opportunities for employment across the European food system.

This report has been prepared as a joint effort of partners in the TRUE consortium. Partners have provided many examples of supply chains (mainly peas and beans) and supplemented with explanations about the infrastructure and market situation in their respective countries.

In Chapter 2, the EU supply and demand for pulses is analysed with reference to production and trade patterns, and consumer perceptions of pulses. In the following chapters, the major segments of the pulse market are investigated. For each chapter, examples of quality chains are provided to show how supply chains, processing, marketing and infrastructure function. Chapter 3 covers fresh peas and beans; Chapter 4 is about dried legume grains; Chapter 5 covers the frozen vegetable industry; and Chapter 6, the canning industry. In Chapter 7, the report's findings are compiled with recommended actions for sustaining EU market-pull for domestically grown legume grains in the food market.



3.2 Glossary of acronyms, terms and their definition

BRC Global Standard for Food Safety: internationally recognised standard for food safety, traceability and quality management and, originally introduced by the British Retail Consortium (BRC). The standard is demanded for suppliers to retailers and food processors. (https://www.saiglobal.com/en-au/assurance/food_safety/)

FSSC22000 (The Foundation Food Safety System Certification, standard 22000): internationally recognised standard for food safety and quality management. (<https://www.fssc22000.com/scheme/>)

Global G.A.P. (Good Agricultural Practice): internationally recognised standard for plant health, food safety and traceability. The standard covers the value chain from farm to distributor, and from distributor or processor to consumer. This standard is used for fruit and vegetables. (www.globalgap.org)

IFS (International Food Standard): internationally recognised standard for food safety and traceability. The standard is demanded for suppliers to retailers and food processors. (<https://www.saiglobal.com/assurance/food-safety/IFS.htm?id=1>)

Infrastructure: in this report, infrastructure frames the necessary entities required for bringing pulses into a trade and processing context. This includes structures for trade, processing entities, and the institutional framework. The latter covers regulatory aspects, certifications, and quality standards.

IQF: individually frozen food items.

KRAV: the Swedish standard for organic certification (<https://www.krav.se/in-english/>)

Mono-packs: packs containing only one ingredient, for example only frozen peas or only canned kidney beans.



PDO (Protected Designation of Origin): EU quality label for food items that are specifically linked to a certain area (origin) through the product's distinctive features such as raw materials, environmental characteristics or location. (<https://uncommoneurope.eu/pdo-and-pgi/>)

PGI (Protected Geographic Indication): EU quality label for food items that are especially linked to a location through the product's special way of cultivating and/or processing the product. (<https://uncommoneurope.eu/pdo-and-pgi/>)

PL (Private labels): retailers' own brands.

Pulses: Dried seeds from legume plants whose main resources comprise protein and starch, and which do not contain oil: such as beans, peas, chickpeas and lentils.

Grain legumes (or legume grains): defines pulses (as described above) *and* other oleaginous legume grains: such as soybean, lupin and peanut.

Pulse-based foods: Food or drink products made from pulses. The category includes products where pulses are the core ingredients. Examples could be a bag of frozen peas, canned kidney beans, or a bag of dried organic black beans. Or, processed products in which pulses are used for giving the products its characteristics. Examples of such products could be burgers made with pea protein, ready-to-cook meals with lentils or, alcoholic beverages made from pea or bean starch.

Protein transition: the changing perception of society about supply and intake of proteins. This implies a growing awareness of the predominantl y-positive and -negative environmental impact potential now associated with production of plant-based- and animal-based-proteins (respectively), and the changing diets of consumers.

Quality chains (or, quality networks): chains and interlinked chains (= networks) of businesses working together from field to market. Quality chains or quality networks can be understood in local and international contexts and be more or less intertwined.



Reefer services: refrigerated transport solution based on temperature-controlled containers. Reefer services covers transportation by land and sea of fresh produce.

Vegetables (fresh produce): fresh peas and beans.



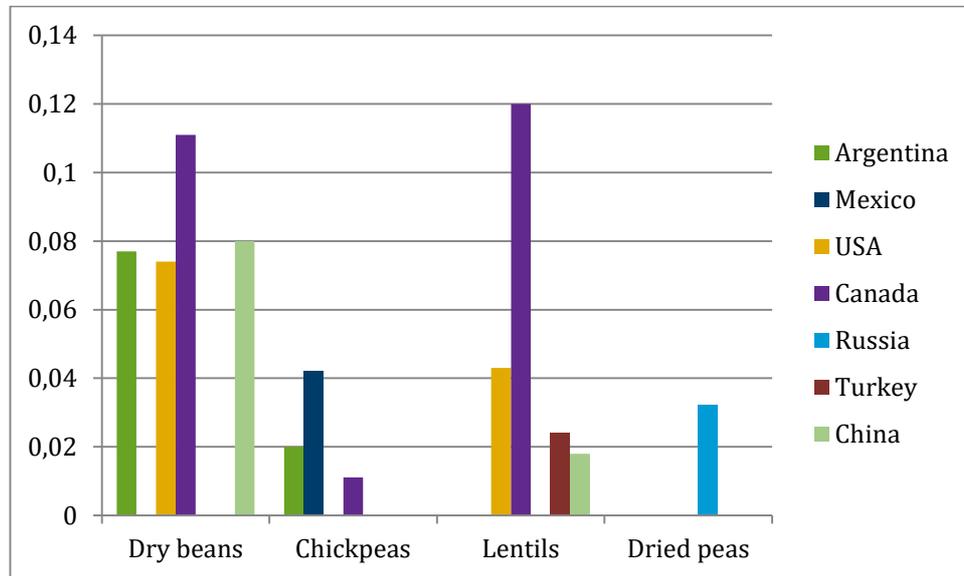
4. Overview – Pulses in the EU

4.1 EU pulse supply

In 2016, grain legumes covered 2 % of European arable land in contrast to 4 % of arable lands globally. In the EU, the main pulse produced is field peas (16 % of global production), followed by field beans (19 % of global production). The EU production of lentils and chickpeas is minor compared to global production. Total EU pulse production accounts for 7.3 % global pulse production (Agrosynergie, 2018; based on data from FAO Stat).

On a global scale, the main producer of dry beans is Myanmar, where dry bean is a traditional crop. The main producer of field peas and lentils is Canada, which holds 95 % of global lentil production. The main producer of chickpeas is India (64 % of global production). China is the leading field bean producer (33 % of global crop). Australia is the leading producer of lupins, producing approximately 50 % of the global production. The major suppliers to the EU are Canada, Argentina and China for dry beans; Canada and the US for lentils; and Mexico, Argentina, the US and Canada for chickpeas (**Figure 1**). Russia is the main field pea supplier to the EU and field beans are not imported to the EU. Field peas and beans are exported from the EU to India and Egypt for use as food (Agrosynergie, 2018). The EU trade balance for pulses for food uses shows that EU imports of pulses amounted to 744,000 t in 2015 and EU exports to 723,000 t in 2015. That year the EU production of pulses amounted to 4.3 m t (Agrosynergie, 2018; based on Comext data).

Figure 1: EU imports of pulses for food purposes, 2015, million tonnes.



(Agrosynergie, 2018; with data from Comext and Comtrade)

The main producers of pulses within the EU are France, the UK, Poland, Spain, Germany and Lithuania. For field beans, UK is the biggest producer, followed by France (Toma, 2019). The largest producers of field peas are France, Germany and Lithuania. Poland is the main producer of lupin and is also the main producer, alongside Spain, of other dried pulses.

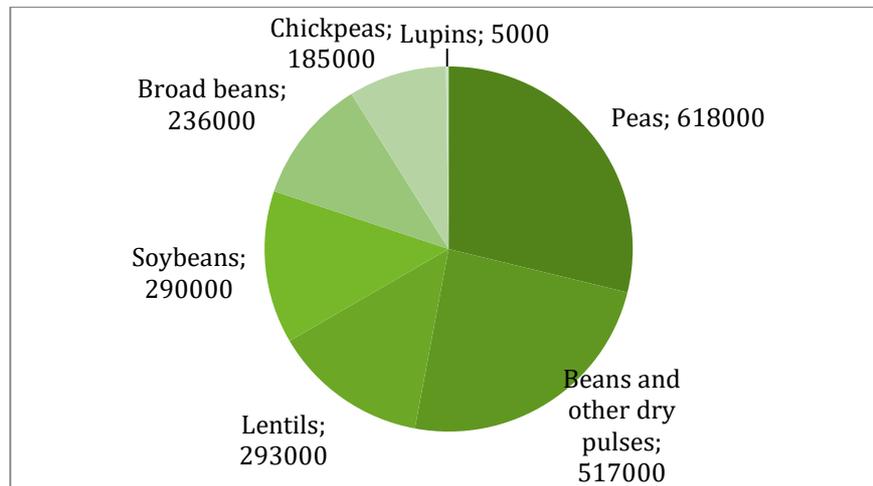
Organic pulses represent 0.6 % of the global pulse cultivation areas, corresponding to 530,000 ha in 2016, with 72 % located in EU (381,000 ha). The main organic pulse producers in the EU are France (86,000 ha) and Poland (56,000 ha) followed by Italy, Germany and Spain. The EU countries with the largest percentage of organic pulse areas are Austria (57 % of pulse area is organic), Italy (44 %) and Denmark (40 %). Organic pulses cover 7.3 % of EU organic arable land in 2016 and 17.9 % of the whole EU dry pulse area. This high proportion underlines the importance of pulses in organic farming.

4.2 Pulse demand

4.2.1 Consumption patterns

Since the 1960s, the consumption of pulses has decreased, especially in Southern EU countries (Spain, Greece and Portugal). Despite this decrease, Southern Europe remains the area where pulses are consumed the most in the EU, with pulses forming an important part of traditional Mediterranean diets. Pulse consumption has dropped significantly in Eastern European countries like Romania and Bulgaria (from 6 kg pp⁻¹y⁻¹ in the 1960s to 2 kg pp⁻¹y⁻¹ in 2013). In western EU countries pulse consumption has remained stable. In Northern and Atlantic Europe, the consumption of pulses has increased compared to the 1960s. Especially in the UK where pulse consumption has increased from 2.9 kg pp⁻¹y⁻¹ in 1960s to 3.5 kg pp⁻¹y⁻¹ in 2013. For comparison, annual per capita consumption in South Europe was 5.5 kg in 2013 and approximately 2 kg for countries in Eastern and Western Europe. **By 2017, the EU consumption of pulses for food amounted to 2 million t, plus an additional 300,000 t of soybeans** (Figure 2; Agrosynergie, 2018).

Figure 2: Pulses and soybeans consumed for food in the EU, 2017/2018, (1000 tonnes).



(Agrosynergie, 2018 with data from DG-Agri and USDA)



EU imports of food pulses (dry beans, chickpeas and lentils) have slightly increased since 2000. Import of lentils increased by 30 % between 2000 and 2016, and Canada was the main exporter. The main importers of pulses to the EU are countries where they are traditionally consumed: Italy holds 21 % of EU imports of pulses (2016), followed by Spain (18 %), the UK (17 %), France (9 %) and Portugal (6 %), (Agrosynergie, 2018; and Comext data).

Demand in the Spanish market has declined from 267,000 t in 2015 to 260,000 forecasted for 2019. However, Spain remains the largest consumer of pulses in the EU. On average, Spanish consumers eat 3.1 kg dried pulses per year; 1.25 kg of beans, 0.93 kg of peas and 0.93 kg of lentils (Clemente, 2019). Only 130,000 t were produced in Spain leading to imports of 150,000 t in 2019; some of the dried pulses are for re-export to other EU countries (Export.gov). Dried pulses account for the lion's share of Spanish pulse consumption, and demand for canned pulses have increased in recent years. This may be explained by increased consumers' demand for convenience products.

Overall, **pulses and soybeans used for food in the EU by 2017 amounted to 2.3 million t**. Of this, approximately 74 % was consumed as dried pulses, and 26 % was used by the food industry for manufacturing processed foods and drinks, and food ingredients (Agrosynergie, 2018).

4.2.2 Consumer perceptions and food choice

Recently, demand for pulses and soybeans for food has been increasing, driven by a shift in the European diet stemming from health concerns, consumer choice and availability of pulse-based products. Meat and dairy products are central food in the European diet, but consumers' eating habits are changing in favour of a more plant-based diet. Consumer perception of "protein" is a major driver, and especially for the plant-based market, many consumers regard plant-protein as healthier than animal proteins (**Table 1**). This creates demand for more pulse-based products in the retail market.

Table 1. How consumers' perception of protein is changing: example from Sweden (2018).
Extracted from (Bjurstrom and Lindgren, 2018).

Statement	Yesterday	Today
By protein we mean?	Meat and fish.	Proteins from legumes, dairy products, seafood and eggs.
We are worried about?	How vegetarians will have a sufficient protein intake.	That we have a too large intake of red meat and eat not enough vegetables.
In the meat counter in supermarkets we find?	Sausages, hamburgers, steaks.	More sausages, more mixed products made with meat and vegetables.
In the category of vegan products we find?	A narrow assortment of sausages made with soya.	A wide assortment of meat alternatives and vegetarian options.
Consumers are?	Meat-lovers or convinced vegans.	Flexitarians who sometimes choose to eat vegetarian.

(Bjurstrom and Lindgren, 2018)

A third of the people in Europe now identify as flexitarians: a consumer segment that still consumes meat and dairy products, and deliberately cuts down their intake of animal-based products in favour of more plant-based food and drink items. With the number flexitarian consumers predicted to rise by 10 % in 2017, there is a rising awareness of the health and environmental benefit of a diet that is richer in plants and includes less meat. For example, in France the number of households committing to a reduced meat intake has increased to 34 % (2017), from 25 % just two years ago. In the Netherlands, flexitarians represent 55 % of the population, and on average, more than 30 % of the EU consumers are actively trying to cut down meat consumption. The largest population of vegetarians is found in Germany (9 % of the population) followed by the UK (7 %) and France (5 %). In 2014, 10 % of the Swedish population was vegetarian or vegan, whereas only 0.3 % of the Portuguese population was vegetarian (Agrosynergie, 2018).

In the coming years, flexitarian, vegetarian, and vegan diets are expected to increase, generating demand for dry pulses, and in particular for chickpeas and lentils. The number of consumers favouring organic food products is also increasing across the EU, and for many such consumers, pulses form a significant part of an organic diet. For example, in Spain organic sales represented 13.6 % of total pulse sales (2016).



These consumer trends indicate a growing demand for alternatives to livestock-based food items, highlighting the importance of pulses in traditional Mediterranean diets, and demonstrates opportunities for developing the European food market further with more pulse-based products made available to the consumers across Europe.

4.2.3 Range of pulse-based products

Pulses (dried) are commonly found on the shelves of European supermarkets and specialty food stores (e.g. green grocers, health food stores, organic stores and similar outlets). Pulses and processed pulse-based foods and drinks are marketed as branded products or under retailers' private labels. Furthermore, pulses and pulse-based products are available to the consumer in organic varieties and certified according to PDO, PGI or other certification.

Pulses are sold in the EU food market in many formats, including the following.

- Whole grains (dried)
- Fresh produce (fresh vegetables)
- Canned
- Frozen

While many soybean-based products have been available in the market since the 2000s, the development of pulse-based products accelerated in the 2010s. These products are innovative and offer consumers new ways to consume pulses. Examples of such products include pasta made with pulses and wheat; meat substitutes made with pea protein; pulse-based snacks; or vegan yoghurt made with lupins. From 2010 to 2014, more than 3,500 new products made with pulses were introduced in the European food market, particularly in the UK (28 % of total number of launches), France (21 %), Germany (11 %), and Spain and Italy. One third of the new products contained chickpea ingredients, one third pea ingredients, 25 % were made with beans, and 14 % were made with lentils. Only 13 % of the new products were organic (Magrini and Lascialfari, 2016). The Spanish market is seeing rapid growth with new legume-based products being introduced. For example, the number of new products made with lupins has increased 22 % from 2014 to 2016, and lupins are

particularly popular in products which substitute for dairy-based items. From 2017 to 2018, the Spanish market experienced a growth of nearly 300 % in demand for dried legume-based pasta, including organic legume-based pasta. Also, demand for lentil-pate, hummus and chips (snacks) increased by 128 % (Clemente, 2019).

In broad terms, consumer demand for pulses and pulse-based products depends on food consumption patterns (e.g. traditional use of pulses in Mediterranean diets) and on the availability of processed pulse-based products. The European food market has experienced an extensive widening of the assortment of processed products made with pulses leading to a food market with a much higher diversity of pulse-based items available to the consumer.

The plant protein-based food market has experienced a shift regarding its market position, from a niche market targeting vegetarian and vegan consumers, to a wider market targeting a wider range of consumers who tend to reduce their meat consumption for various reasons (health, economic and/or environmental impact). As technology develops for the processing of pulses into a wide range of foods and drinks, the assortment of pulse-based items will increase to cater for the demand of more consumer groups. This includes mixing pulses with gluten-free grains to produce gluten-free products; introducing more ready-to-eat pulse-based products; more alcoholic and non-alcoholic plant-based drinks; products made with sprouted pulses; using new varieties of pulses and leguminous plants; and, new products meeting sustainability criteria.

In the following chapters, examples of quality chains for fresh vegetables, dried pulses, canned and frozen pulses, and processed pulse-based products are provided.



5. Fresh vegetables

5.1 Quality chain: green beans from Kenya to the European market

The European market for horticultural products is characterised by the year-round abundance of fresh supplies of a diversity of fruits and vegetables from all parts of the World. Kenya is a major producer of green beans (French beans) and this crop is exported to the EU market as fresh vegetables and canned beans. Kenya is the second largest exporter of green beans to Europe and beans are a popular cash crop for Kenyan farmers.

By 2017, the total quantity of green beans (French beans) produced in Kenya reached 62,000 t, cultivated on an area of 7,500 ha. Smallholder farms produced on 4,500 ha and large farms on more than 3,000 ha (Odee, 2019). The yields vary from about 4 to 12.5 t ha⁻¹ depending on farming practices, varieties grown and agricultural production conditions. Harvest occurs several times per year. Large farms produce 40 % of the crop (VCA4D, 2018).

There are two main post-harvest handling operations: packing to export fresh green beans, and processing for exporting canning beans. Trade relies on three types of agents: intermediary brokers buying around 80 t of beans per year from smallholders; domestic wholesale traders buying rejected crops or from farms, and retail traders buying from wholesalers. The bulk of the green bean crop is exported fresh. By 2017, exports stood at 34,000 t and the main export markets are the United Kingdom, the Netherlands and France. Production of canned beans for exports reached 2,100 t in 2017, and the main export markets are France, Belgium and the Netherlands.



Export of green beans leads to vast amounts of rejected beans, and this share of the crop are sold to public institutions (schools, hospitals etc.) or in the domestic market to consumers (VCA4D, 2018).

The success of Kenya's green bean quality chain is built on good climatic conditions, market segmentation, investments in certification schemes, value adding through packing and processing, and investments in marketing. Maintaining high quality standards is critical as exports face the risks of a ban if the current sanitary and phytosanitary standards of the EU market are not met.

5.2 Trading fresh produce

The EU is largely self-sufficient in fresh vegetables and producers can expect their crops to be moved extensively across the European market. Imports from non-EU countries account for approximately 15 % of the European market for fresh vegetables. Countries in North Africa are well positioned to supply the European market, with Morocco providing 3.2 % of the EU imports of fresh vegetables followed by Egypt. Kenya holds 0.2 % the EU imports of fresh vegetables. Fresh beans account for 9.0 % of EU imports of fresh vegetables. The Netherlands and Belgium are positioned as the main hubs for importing fresh produce to the EU. For example, ports in the Netherlands handled 367,000 t of imported fresh vegetables in 2015. Investments in reefer services (see glossary) and improved facilities at the port of Rotterdam will likely strengthen its role as a trading hub (CBI, 2015).

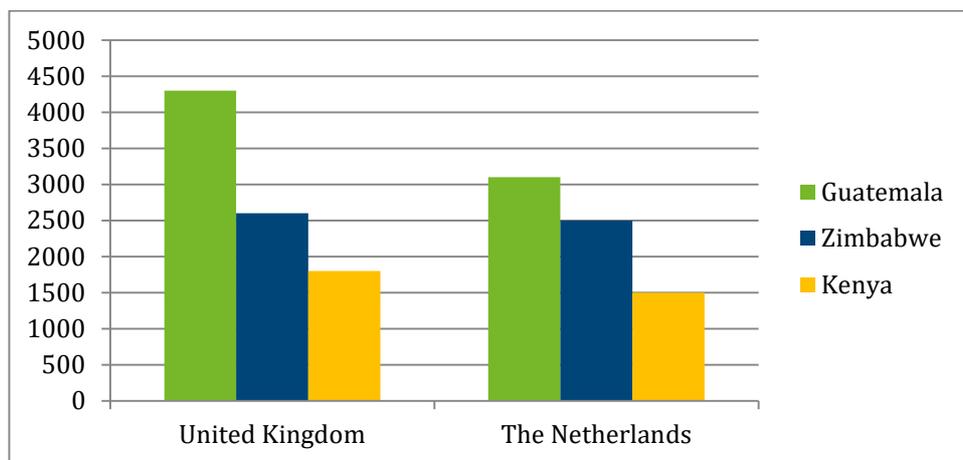
Suppliers of fresh produce to EU retail chains must comply with retailers' quality criteria and EU regulations. Concerning the quality criteria, the main issue is food safety followed by quality standards. For suppliers who want to engage in the European retail market, it is a pre-requisite to comply with an internationally recognised standard for fresh produce, and most often the required standard is GLOBALGAP. This standard covers the product's route from agricultural production to retailer, but not processing. Other recognised standards for fresh produce that can be required by retailers include IFS, BRC or the FSSC22000 standards (CBI, 2019). The standards define operating practices for mitigating food safety risks, including maximum pesticide residue levels and requirements for traceability. Food safety is also the core concern for the EU as defined in the EU General Food Law (EU Regulation No 178/2002) and EU's rules for plant health (phytosanitary

standards). In addition, suppliers to the EU food market must comply with EU rules on food labelling (EU Regulation 1169/2011) and marketing standards.

There are marketing standards defined by the EU (EU Regulation no. 1308/2013) covering fresh produce. The EU marketing standards define that only fresh produce compliant with the quality standards can be marketed in the EU. Until 2009 there were specifically defined standards for peas and beans, but these have been replaced by a general standard stating that, “*only fresh produce of sound, fair and marketable quality*”, can be traded in the EU (EU Commission, https://ec.europa.eu/agriculture/fruit-and-vegetables/marketing-standards_en). Suppliers within the EU, as well as exporters to the EU, must comply with these standards. In addition to the EU marketing standards, there are internationally agreed marketing standards for peas as defined by the United Nations Working Group on Agricultural Quality Standards (UNECE, 2018).

EU import of fresh peas from non-EU countries has increased from 24,000 t in 2013 to 30,000 t in 2017. Developing countries were the most important suppliers of fresh peas to the EU market. The main import markets are the Northern European countries where sugar snaps and mangetout peas are considered a luxury food, **Figure 3**.

Figure 3. Import of fresh peas (sugar snaps and mangetout) to the United Kingdom and the Netherlands, 2018 (tonnes).



(CBI, 2019)

Market research from several EU countries has provided insights about quality chains for fresh peas and beans to the European supermarket sector (GTI and EDA, 2018). The assortment of fresh produce spans several varieties of peas and beans and is highly seasonal. When in season, European produce dominates in the retail landscape, and imported produce fills the market gaps in European off-season. **Table 2** shows examples of imported fresh produce in late autumn. Most of the off-season produce is imported from countries in Africa and Central America.

Table 2. Examples of fresh produce from selected retailers (2018). Cropping System Type is defined as either conventional or organic.

Country	Retailer	Product	Price € kg ⁻¹	Cropping System Type	Country of origin
The Netherlands					
	Albert Hejn	Green beans	3.00	Conventional	No data
		French beans	7.84	Conventional	No data
		Soybeans	11.37	Conventional	No data
	Emté	Sugar snaps	10.00	Conventional	Zimbabwe
		French beans	No data	Conventional	Kenya
	Lidl	Runner beans	5.97	Conventional	Morocco
		Green beans	3.00	Conventional	Morocco
		Sugar snaps	7.56	Conventional	Peru
		French beans	7.16	Conventional	Kenya
		Green beans	4.22	Organic	Netherlands
United Kingdom					
	Tesco	Green beans	4.72	Conventional	Egypt
		String beans	5.18	Conventional	Morocco
		French beans	9.66	Conventional	Kenya
		Sugar snaps	7.87	Conventional	Guatemala
	Marks & Spencer	Sugar snaps	12.98	Conventional	Guatemala
		Garden peas	11.00	Conventional	Kenya
		Runner beans	7.86	Conventional	Kenya
		Boston beans	7.86	Conventional	Guatemala
		French beans	7.86	Conventional	Kenya
Denmark					
	Rema 1000	French beans	10.78	Conventional	Kenya

(Hamann et al., 2019)

a



Table 2 shows that prices in European retailers for fresh beans are generally lower than the prices for sugar snaps; the latter belonging to a premium segment in the fresh produce market. It is also evident from **Table 2**, that the European market is supplied with fresh produce by farmers in Africa and the Americas. The institutional framework developed by the EU, including trading hubs (e.g. in Belgium and the Netherlands), standards for food safety and plant health, and retailers' quality requirements makes it possible to establish intercontinental quality chains for the benefit of exporting countries and European consumers.



6. Quality chains – Dried pulses

6.1 Examples of quality chains

6.1.1 Dried pulses in Portugal

In Portugal, the main infrastructures for trading and commercialising pulses are the companies themselves. Companies buy from local or international producers and store pulses “in house”, to then distribute to retailers of all sizes. **Table 3** demonstrates that the self-provisioning rate in the Portuguese market is very low for dry beans and chickpeas, with higher levels for other dry pulses (peas, lentils, etc.). The largest fraction of the pulses is destined for the food market.

Table 3. Self-provisioning of pulses in Portugal (in 1,000 tonnes; 2014-2017).

	Usable production	International trade		Internal utilisation			Consumption per capita	% self provisioning
		In	Out	Total	Purpose			
					Feed	Food	kg	%
Total of dry pulses								
2014/2015	10	57	15	55	13	41	4.0	18.2
2015/2016	10	65	22	57	14	42	4.1	17.5
2016/2017	11	71	29	61	19	41	4.0	18.0
Dry beans								
2014/2015	2	40	9	31	//	31	3.0	6.5
2015/2016	2	43	14	31	//	31	3.0	6.5
2016/2017	2	38	21	29	//	29	2.8	6.9
Chickpea								
2014/2015	1	8	4	10	//	10	1.0	10.0
2015/2016	1	11	5	11	//	11	1.1	9.1
2016/2017	2	17	5	12	//	12	1.2	16.7
Other dry pulses								
2014/2015	7	9	2	14	13	//	//	50.0
2015/2016	7	11	3	15	14	//	//	46.7
2016/2017	7	16	3	20	19	//	//	35.0

(Vasconcelos M., 2019 based on statistics from Portugal)



There are supply markets in major cities such as Porto and Lisbon (in Portugal) that receive crops from multiple sources and organise the trade to retail by making available rented space for daily trade of all produces, including legumes. In addition, there are Producers' Markets in several cities across the country. These are places of public access, where farmers and agri-food producers sell their products directly to consumers. The characteristics of producer markets are described as follows.

- 1) The market is reserved for agricultural and agri-food producers;
- 2) the products marketed are exclusively produced by the seller; and,
- 3) the products marketed have their local origin identified.

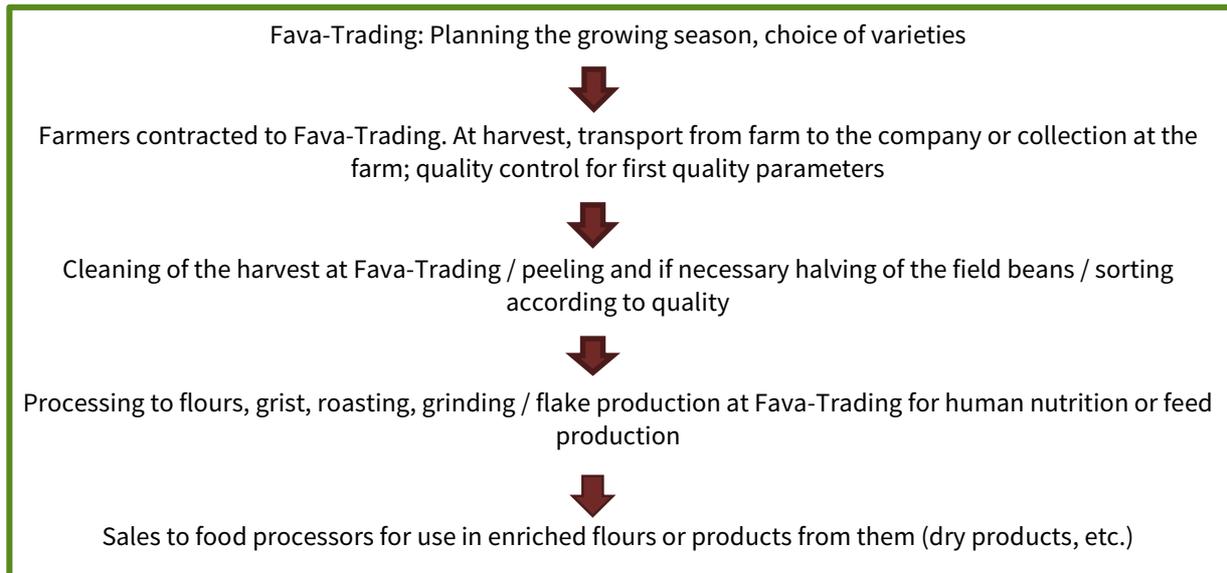
The main products marketed at the Producers' Market are fresh seasonal produce (including legume grains), as well as products processed from local raw materials. Markets operate in urban centres, have a fixed regularity (usually weekly, biweekly or monthly) and are occasionally held on dates of special events or local festivities. In Portugal, this is a traditional way of selling and marketing agri-food products from small-scale farms and artisanal manufacturers, which has gained new momentum due to recent initiatives from Town Councils, Local Action Groups and producers groups (<http://www.rederural.gov.pt/circuitos-curtos-agroalimentares/2016-06-01-13-36-46/mercado-de-produtores>).

6.1.2 Dried faba beans in Germany

An example of a local supply chain in the EU is the procurement and processing by the Company Fava-Trading GmbH (**Figure 4**). The company's strategy is to make the cultivation of field beans attractive both within the region and beyond, and to establish field beans as a regular crop rotation element. The cultivation of grain legumes in Germany has attracted the interest of farmers in recent years as a result of the protein strategy of the German government, and the promotion of greening measures. This is also due to the proven benefits of having legumes in crop rotations, and because the opportunities for marketing a pulse crop has widened. The Lower Saxony-based company Fava Trading GmbH, founded in 2017, has specialised in the marketing and utilisation of field beans in northern Germany and is the only German food company to do so. Local climatic conditions make

the area along the North Sea coast ideal for growing field beans. Fava-Trading uses contracted farmers to supply its field beans (Löhrich, 2019).

Figure 4. Field bean cultivation and processing: the case of Fava Trading GmbH.



(Ref: Löhrich N., 2019)

The company Fava Trading offers whole beans, peeled and halved beans, as well as refined products such as flours and ground raw materials. The crop is sorted according to the quality of the beans which is an important feature for meeting the demands of those buyers prepared to pay the premium price. The dried products are packed in bags of 0.5 kg for the retail market or shipped for export markets in 24 tonne containers. The company has a storage facility in the United Arab Emirates (UAE) for the international trade of field beans, and with the shipping hubs of Hamburg and Bremen nearby, Fava-Trading is in an advantageous location for developing further international trade with pulses. The company’s development plan is to improve the processing technologies used to bean produce protein isolate. In the future, other innovative marketing routes are predicted for refined products made from fava beans, such as ingredients for making bio-based products (e.g. adhesives and lubricants) and processed foods (Löhrich, 2019).



6.1.3 Greece – major importer with local production of PGI/PDO pulses

Greece imports on average 60 % of its demand for pulses, mainly from Turkey, but also from the USA, China, Mexico, Egypt and India. In 2018, Greece imported approximately 20,000 t of beans, 5,000 t of chickpeas, 12,000 t of lentils and 2,000 t of peas. In comparison, Greek exports of pulses amounted to approximately 1,200 t. Bean exports are likely to be due to unique varieties such as the famous Feneos beans.

The Greek company Dikotylon (www.dikotylon.gr) provides a range of dried legumes from the Feneos valley in Greece. The company's activities include screening, collecting, standardisation and marketing of legumes from this region. Their production is carried out using an Integrated Pest Management system. The vanilla beans and Feneos faba peas are certified as PGI and PDO products by the EU. The pulses are produced by local farmers in the Feneos valley. The PGI and PDO certified pulses are sold through supermarkets and other retail stores, and online. The main market is Greece, but the PGI and PDO pulses are also exported to many other EU countries (Mitropoulos, 2018).

6.2 Companies, products and prices

An extensive range of dried pulses are sold in the European retail market, **Table 4**. Dried pulses are usually sold as packaged products and labelled with information about the country of origin, and cultivation system as either conventional or organic. In open air markets, dried pulses are sold loose or packaged.

Table 4. Common examples of dried pulses in European supermarkets (2017-2019). Cropping System Type is defined as either conventional (Con.) or organic (Org.). PL, Private Label.

Retailer	Product	Brand (source)	Price, € kg ⁻¹	Cropping System Type
United Kingdom				
Tesco	Green split peas	Tesco PL	1.88	Con.
	Red lentils	Tesco PL	3.07	Con.
	Butter beans	Tesco PL	2.60	Con.
	Pinto beans	Tesco PL	2.72	Con.
	Soybeans	Tesco PL	3.77	Con.
	Chickpeas	Tesco PL	2.71	Con.
	Yellow split peas	Tesco PL	1.29	Con.
	Mung beans	Tesco PL	3.77	Con.
	Red lentils	Natco	2.65	Con.
	Chickpeas	Natco	2.65	Con.
	Green lentils	Natco	2.65	Con.
	Mung beans	Natco	2.65	Con.
	Denmark			
Rema1000	White beans	Delicata	3.48	Con.
	Green lentils	Delicata	3.08	Con.
Superbrugsen	Butter beans	Urtekram	11.81	Org.
	Borlotti beans	Urtekram	5.77	Org.
	Yellow peas	Biogan	4.95	Org.
	Red lentils	Biogan	5.10	Org.
	Chickpeas	Biogan	5.36	Org.
The Netherlands				
Polish supermarket	Yellow peas	Melvit	2.45	Con.
	White beans	Melvit	3.47	Con.
	Ready-to-cook mix of lentils and rice	Melvit	5.00	Con.
Emté	Green peas	Sabarot	1.78	Con.
	Red lentils	Sabarot	3.00	Con.
	Brown beans	Sabarot	3.00	Con.
Albert Heijn	Yellow lentils	HAK	3.10	Con.
Sweden				
Konsum	Chickpeas	Risenta	5.30	Con.
	Red lentils	Risenta	5.00	Con.
	Black beluga lentils	Risenta	8.30	Con.
	Red lentils	Änglamark	5.30	Org.
	Green lentils	Saltaa Kvarn	7.50	Org.
	Mix of beans	GoGreen	6.90	Org.

	Black beans (Swedish)	GoGreen	8.30	Con.
	Red lentils, green lent.	GoGreen	6.10	Con.
	Chickpeas	GoGreen	6.90	Con.
Germany				
Edeka	Dried green peas	Müllers Mühle	3.00	Con.
	Mung beans	Govinda	15.60	Org.
Hungary				
Spar	Green lentils	Teller (Canadian)	1.50	Con.
	Cow peas	Parco (Canadian)	1.50	Con.

(Hamann et al., 2019)

Table 4 shows that consumer prices for dried pulses in the retail market vary greatly between retail chains, products and countries. From the limited data available it is apparent that organic pulses are more expensive than conventionally cultivated pulses. The prices of conventional pulses, for example lentils, vary from 2.65 € kg⁻¹ (Natco product in Tesco, UK) to 8.30 € kg⁻¹ for black beluga lentils in Konsum (Sweden).

6.3 Processing infrastructure: examples of companies

Natco Foods is a company located in the UK that sources dried lentils and spices from all over the world, and sells its products in the British retail and food service market. The company exports to countries around the world. Natco Foods cleans, packs, mills and distributes pulses such as dried lentils. Natco Foods holds the BRC certificate demonstrating high level of food safety and full traceability, and the certification from the Soil Association for organic products (www.natcofoods.com).

The Polish company Melvit is a processor of pulses and cereals. The company processes 40,000 t of cereals and pulses in a single factory. The company is IFS certified and distributes its products to retailers in Poland and other EU countries (including the branches of a Polish supermarket chain in the Netherlands). The range of pulse products includes mono-packs and processed pulses, for example ready-to-cook mixes of pulses and rice (www.melvit.pl).

Lantmannen Cerealia is a vertically integrated company in agribusiness, with headquarters in Sweden and activities in 20 countries including the other Nordic countries. The company owns the brand Go Green that is used for dried and pre-cooked beans and lentils, and organic green peas and chickpeas. Since 2014, Swedish farmers have grown borlotti beans, black beans and white beans on the island Oeland. Products under the Go Green brand are marketed in Sweden, Norway and Finland (www.lantmannencerealia.com).

Systemfrugt (www.systemfrugt.dk) is a BRC certified Danish importer and packer of dried nuts, fruit and pulses. The dried pulses are sourced and packed in Turkey and distributed to retailers in Denmark as private label products. The examples in **Table 4** show products available under the Delicata private label of the Rema 1000 supermarket chain. In 2019, Systemfrugt introduced ready-to-cook pulses under the brand name *Earth Control*. The product range includes a mix of red, green and yellow lentils with Asian spices; a mix for preparing falafel; and a mix for making vegan burgers (made with chickpeas). The lentil product is produced in Italy and the mixes for burgers and falafel are made in Sweden (www.earthcontrol.dk; **Figure 5**).

Figure 5. New products under the brand Earth Control, Denmark (2019).



<https://earthcontrol.dk/produkter/veggie-boeffer/>

Rapunzel is a leading company involved in sourcing, processing and packing of organic food, located in Germany. Products include dried pulses such as red kidney-, white-, pinto-, azuki- and mung-beans, and all are sold at organic standard (www.rapunzel.de).

Sabarot, located in France, is a company specialised in sourcing, cleaning and packing of pulses and cereals. The company offers a wide range of dried pulses (lentils, beans, split peas, and chickpeas), sprouted seeds and pulses, and IQF lentils and chickpeas. Sabarot is a family-owned company that has been in business for 200 years. The company sources pulses from farmers in France and distributes the products nationally as well as to 50 export markets (www.sabarot.com). The assortment includes the famous green lentils from Le Puy; a lentil that has been recognised as a PDO product by the EU, and specialty beans such as the Tarbais and Moquette de vendee beans (both recognised as PGI products), **Figure 6**.

Figure 6. Pulses with the PGI and PDO quality labels.



Green le Puy lentils from Sabarot



Tarbais beans from a distributor in France

Müllers Mühle is the largest processor of pulses (peas, beans and lentils) in Northern Europe and is located in Germany. Its total production capacity is 120,000 t, and in 2017 the company packed 16,000 t of dried pulses (Agrosynergie, 2018). The company belongs to Goodmills Deutschland and is also one of the largest processors of rice in Northern Europe. Müllers Mühle produces branded and private label products for customers in Germany and Europe as well as supplying a wide range of processed pulses and rice to wholesalers, food service providers and industry. It is estimated that Müllers Mühle holds one third of the German market for pulses and pulse flours (Agrosynergie, 2018).



The Company holds the certificates of IFS, organic standard and kosher. The range of pulses processed includes several varieties of lentils, peas and beans, and flours made from chickpeas and red lentils (www.muellers-muehle.de).

From studying companies in the European dried pulses sector, it is clear that major operators are identifiable among companies specialised in international sourcing, and companies in the milling industry. All major companies hold at least one of the internationally recognised food safety and quality management standards as for example the IFS or BRC certificates (and some companies have both). Furthermore, those companies that offer dried pulses of organic standard are certified by (for example), the British standard according to the Soil Association, or with the EU standard for organic products. There are also examples of companies that offer products under the PGI and PDO labels for protected products in the EU. This section has shown the importance of food safety and quality management standards for sourcing and trading pulses: underlining the requirement for suppliers in Europe and third countries to comply with the recognised standards, as such standards function as entry barriers for engaging in the market.



7. Quality chains – frozen vegetables

7.1 Example of quality chains

7.1.1 Vining peas in the United Kingdom

There is minimal international trading in frozen vining peas, and the UK is self-sufficient with the exception that occasionally one of the retailers will source supplies abroad (this is speculated to be a negotiation tactic to lower UK producer prices). Exporting vining peas is uncommon, as generally the cost of transport is high and the variability in supply makes consistent customer (i.e. retailer) support challenging. The UK Vining pea industry is well established, with the crop area static at around 32,000 - 35,000 ha y⁻¹. The production area is mainly in the eastern counties of the UK from Norfolk northwards, through Lincolnshire, East Yorkshire, Northumberland, the Scottish Borders, Fife and Angus. Located around a small number of processing and freezing factories (**Table 5**), the market focusses on a premium product, freezing tender immature peas within 150 minutes of harvesting, a process known as *Speedy Peas*. This limits the distance from the factories that the peas can be grown to about 50 miles (depending upon road transport links). Approximately 150,000 t of peas are frozen each summer.

Table 5. Processing factories for vining peas in the UK.

Location	N° of factories	Ownership
Norfolk	2	1 third party processor, 1 grower group
Lincolnshire	1	Third party processor
East Yorkshire	2	Each owned by two different grower groups
Northumberland	1	Owned by a grower group
Scottish Borders, Fife and Angus	1	Owned and shared by 2 grower groups

(Vickers, 2019)

Losses of harvested material are incurred at the factory in the cleaning and grading processes and can be up to 35 % of the harvested material. Growers are paid based on frozen pea out turns, not volumes delivered to the factory gate. Prices for vining peas average about £ 300 t⁻¹ at the farm gate, making the growing industry worth approximately € 53 - 60 m y⁻¹.



Produce which does not make the premium “*speedy peas*” grade is sold into secondary frozen pea markets. Crop which is not harvested in time may also be left in field to mature fully and be harvested as a dry seed – potentially for sowing the following year. It may even be that low grade peas may be left in the field as crop residue (green manure). Occasionally batches of peas rejected at the factory are removed (at an uplift- i.e. transportation-cost) to enter the animal feed market. These are worth less than other feed stuffs, returning approximately 25 % less than a regular feed pea (this reflects their relatively high water content relative to their far drier counterparts).

Because of the very high cost of capital outlay required in production (especially in harvesting), the growing of the crop is generally organised around farmer cooperative groups. At present there are about 15 grower groups, with one or two large farmers being self-sufficient in production operations. Most cooperative groups are organised around a third-party processor (freezing company) and negotiate annual supply contracts. A small number of cooperative groups are part-invested in their own freezing factories and supply customers through a processing company they own wholly or partly.

Retail values for peas are approximately 10x the farm gate price with a total value of around € 590 m. Costs between farmer and retailer are not transparent and vary from factory to factory, though it is a reasonable assumption based upon general supply chain knowledge, that retailers demand from suppliers a minimum margin of 50 %. This leaves € 235 m in the processing, freezing, storage and distribution sector(s). If there are organic frozen peas in the market the overall proportion of the total market is negligible. This is potentially due to restrictions around contamination with non-organic product. In addition, there is the potential risk of potato fruits (also known as ‘potato berries’) which are poisonous, and may be co-harvested with organic pea (due to pesticide restrictions). This could be an issue that some factories will be unable to cope with.



7.1.2 Organic frozen vegetables in Danish supermarkets

The Belgian Company Ardo is the largest player in the European frozen vegetable industry with an annual turnover of more than € 800 m and 20 processing plants across Europe. In Denmark, Ardo has a factory for freezing (and storing) peas. In 2014, Ardo's Danish factory was operating at a financial loss. However, in 2015 2,000 ha of the southern Danish islands were cultivated with peas for the fresh freezing market, and this yielded almost 9,000 t of peas. By 2018, cultivation had increased to 3,000 ha with yield up to 30,000 t of peas (only 30 % more area but three times greater production). While approximately 25 % of the crop was cultivated organically by contracts with Ardo, farmers also considered peas as an attractive crop to produce as management demands are limited, and the added benefit of inorganic nitrogen fertiliser-use offset (peas need no nitrogenous fertiliser), and the soil-nitrogen legacy for non-legumes cultivated in the following season, plus soil functional benefits (improved soil carbon content and water holding capacities).

In Denmark, farm-gate prices for organic peas are 20 % greater than conventional peas, the latter being priced at around € 200 t⁻¹ (2014). As part of the agreement regarding the farm-gate price, Ardo bears the costs for purchasing, sowing and harvesting the peas. This influence over the cultivation practices helps ensure the necessary product qualities too. The peas from Ardo are then marketed in the Danish retail market under the brand *Frigodan*. In 2013, organic food accounted for 8 % of the Danish food market, and by 2018 this market share had increased to 13 %. A consumer survey from 2018¹ showed that 20 % of the Danish consumers appreciated that organic frozen peas were available in the retail market, and that frozen peas accounted for 77 % of peas purchased, in contrast to 17 % for fresh peas. Ardo's Danish plant is now a profitable cornerstone for organic frozen peas, and the plant also boasts exports of up to 700 t of organic frozen peas to the US market *per year* (Vincent, 2018). This example illustrates how consumer demand for organic food has contributed to maintaining and increasing the cultivation and processing of organic frozen peas in Denmark, and the importance of having a well-connected value network for bringing an organically certified crop to market.

¹ Consumer survey based on +1000 respondents among Danish consumers.

7.2 Processing infrastructure - frozen vegetable industry

The frozen foods industry in Europe includes a group multinational companies that provide frozen vegetables and other frozen foods under their own brands. Companies other than the parent company also produce for retailers' private labels. From reviews of companies' websites, it is clear that a key requirement for operating is compliance with certification schemes, notably IFS and BRC.

Table 6 details the main companies in the European frozen vegetable industry.

Table 6. Main processing infrastructure for frozen vegetables in EU (2019). Cropping System Type is defined as either conventional or organic. is defined as either conventional (Con.) or organic (Org.).

Company (HQ)	Countries of operation	Cropping System Type	Assortment
Nomand Foods (UK) www.nomadfoods.com	Germany, Italy, UK, Austria, Netherlands, Portugal, Spain, Belgium, Sweden etc.	Con. / Org.	Wide range of frozen vegetables, mixes of vegetables, and ready meals
Greenyard Group (Belgium) www.greenyardfrozen.com	Belgium, France, UK, Poland, Hungary	Con. / Org.	Wide assortment of peas, beans, mixed vegetables
Ardo (Belgium) www.ardo.com	Belgium, France, Spain, Austria, Denmark and more	Con. / Org.	Mono-vegetables, mixed vegetables, precooked and frozen pulses etc.
D'arta (Belgium) www.darta.com	Belgium	Con.	Peas, beans, bean-mix, soup-mix with peas, beans wrapped with bacon etc.
Pasfrost (Belgium) www.pasfrost.be	Belgium	Con.	Kidney beans, sliced beans, broad beans
Horafrost (Belgium) www.horafrost.be	Belgium	Con.	Peas, French beans, chickpeas
Bonduelle (France) www.bonduelle.com	France	Con. / Org.	Peas, French beans, beans, and vegetable mixes
Hortex (Poland) www.hortex.pl	Poland, EU countries, particularly in Eastern Europe	Con.	Frozen peas, beans, kidney beans.

(Hamann et al., 2019)



Nomad Foods is the biggest player in the European frozen food industry holding 14 % of the EU market for frozen foods - twice the market share of the next two companies' combined. Nomad Foods owns the brands Birds Eye, Iglo and Findus. The main markets for Nomad Foods are the UK, Germany, France, Sweden and Italy. Nomad Foods produce frozen seafood, vegetables, ready meals, poultry, pizza and potato products (www.nomadfoods.com).

One third of the European production of frozen vegetables takes place in Belgium and 10 companies operate in the frozen vegetable industry. Approximately 50,000 ha of vegetables including peas and beans are cultivated annually for the freezing industry by contracted farmers in Belgium, the Southern Netherlands, and in North France (<http://www.belgianfrozenveg.be/index.html>). A major company headquartered in Belgium is Greenyard. This company is the second largest in the frozen fruit and vegetable industry in Europe, with nine production sites in Belgium, the UK, France, Poland and Hungary, producing more than 420,000 t of frozen fruit and vegetables. One of the brands used by Greenyard is *Pinguin* (www.greenyard.group). All crops are sourced within a 40 km distance from any processing plant. The Greenyard factories are certified according to the IFS, BRC and organic standards.

Ardo is headquartered in Belgium and operates 21 factories in nine countries to produce frozen vegetables, fruit and herbs. The annual production volume is 940,000 t. Ardo supplies a wide range of frozen vegetables, precooked and frozen pulses, and mixes of frozen vegetables and pulses. The range of precooked and frozen pulses include black beans, brown and green lentils, red kidney beans, chickpeas and cannellini beans. The precooked and frozen range is marketed as, “*express pulses*” (<https://ardo.com/en/products/express-pulses>).

Hortex is a company with a long history in frozen vegetables, frozen fruits, fruit juices, and nectars (i.e. fruit juices with added sugar). The company is rooted in Poland and has developed a strong brand for frozen vegetables (peas, beans, corn and other crops) particularly in East Europe, and other EU countries. The company is owned by a venture capital fund since 2018 (www.hortex.pl).

Magnihill is a Swedish family-owned business located in Scania (Sweden). The company produces frozen fruit and vegetables with a total capacity of 14,000 t. Nearly half of the production is organic,



including organic peas and beans. The company is certified according to the Swedish KRAV standards for organic production (www.magnihill.se).

Frozen foods including vegetables are the market segment with the highest penetration of private labels across grocery categories, reaching more than 40 % of the market. The use of private labels is highest in the UK, Spain and Portugal. The use of retailers' private labels in the European market for frozen vegetables is very common. In fact, across product categories, private labels account for most sales in Europe, for example: of frozen food, 42 %; of fresh and chilled food, 40 %; and, of canned and ambient² products, 39 % (IPLC, 2015). From market research in European supermarkets many products in the frozen vegetable range are labelled as “*manufactured in the EU for retailer XX*” and these products carry the retailer's private label.

² Ambient products: Shelf-stable foods products that do not need cooling or freezing to stay edible.



8. Quality chains – Canned pulses

8.1 Examples of quality chains

8.1.1 Canned beans from Croatia

The Northwest region of Croatia is home to the “pea cluster”, which is centred round the company Podravka, a major producer of frozen and canned peas, and procurer of fresh peas. According to available information, Podravka cultivates peas on 125 ha in 2019 (95 ha on land owned by Podravka, the rest cultivated by contractors), producing a crop of 600-700 t of fresh peas in the immediate vicinity of its processing plant Kalnik, located in the town of Varazdin (north-west Croatia, bordering Slovenia and Austria). This processing factory was recently modernised (2018), with annual production capacities of 15,000 t of canned fruit and vegetables (Trstenjak and Blazo, 2019). Podravka is the largest processor of peas in Croatia, handling roughly 20 % of the national pea crop. The Company plans to cover 100 % of its production of processed peas from domestic crops by 2022. Besides processing of peas, Podravka is a leading Croatian food manufacturer, making a wide range of processed food products, from frozen and canned fruit and vegetables to organic baby food products. Their 2018 turnover was € 570 m, and they directly employ more than 6,500 staff.

Historically, Podravka is by far the largest buyer of locally produced fruit and vegetables for processing in north-west Croatia, although this long-standing role was significantly diminished in the past 5 years since Croatia's accession to the EU. Following the accession, imports of fruit and vegetables from Central and Eastern Europe for processing has increased at the expense of production by local Croatian farmers. The Podravka Company is making efforts to reverse this trend by increasing the share of locally sourced produce for its processing. The current proportion of locally sourced horticultural products including peas stands at 80 %.

Podravka's products are sold in the Croatian retail market and in neighbouring countries. The range includes frozen and canned peas, and frozen vegetables (plus peas). In addition, Podravka manufactures dried beans, canned beans and ready meals with pulses (paella, risotto etc.), **Figure**

7.

Figure 7. Examples of products from Podravka in Croatia: dry beans, baked beans, canned beans and peas, frozen peas variants.



(Ref: www.podravka.hr; Trstenjak and Blazov, 2019)

Some of Podravka's products are exported to other EU countries, Russia, and USA. The products from Podravka are traded through wholesalers and agents in the domestic and export markets. It is notable that Podravka collaborates with a Swiss distributor that also carries products under the brand name Vitaminka. This brand belongs to a Company based in Bosnia and Herzegovina, with a similar product portfolio as Podravka.

8.1.2 Baked beans

The UK is the largest market in Europe for baked beans. Research carried out shows that in a supermarket like Tesco, more than 20 different varieties of baked beans are available under brand names such as *Branston*, *Weight Watchers*, *Heinz* and Tesco's own label (Hamann et al., 2019). **Table 7** lists examples of baked beans in several European supermarkets. It is evident that private label baked beans are sold at prices below branded products, and that organic varieties are more expensive than branded products.

Table 7. Examples of baked beans in the EU retail market (2018-2019). Cropping System Type is defined as either conventional or organic.

Country	Retailer	Brand /Private label	Price € kg ⁻¹	Cropping System Type	Produced in
United Kingdom	Tesco	Tesco PL	0.70	Conventional	UK
	Tesco	Tesco PL	0.70	Organic	UK
	Tesco	Heinz	1.12	Conventional	UK
Denmark	Rema1000	Rema 1000 PL	1.30	Conventional	Belgium
Sweden	Konsum	Heinz	2.60	Conventional	No data
	Konsum	Heinz	4.10	Organic	No data
	Konsum	Coop PL	1.50	Conventional	No data
Hungary	Spar	Bonduelle	3.90	Conventional	Hungary

(Hamann et al., 2019)

Heinz is the largest producer of baked beans in the UK and the Heinz factory in Wigan is the biggest food processing facility in the EU. The factory produces 3 million cans of baked beans every 24 hours, and in each can there are on average 465 haricot beans. This requires imports from the US and Canada to meet the UK's 300 t d⁻¹ demand for haricot beans - and these are processed within few hours from arrival at the factory (<https://www.express.co.uk/life-style/food/698320/BBC-s-Behind-the-Factory-baked-beans-heinz-production-secrets>).

Another major producer of baked beans in the UK is the Princes Group Ltd. The company is a large producer of canned foods including vegetables, tuna, tomatoes etc., with several processing facilities across the EU. The Princes Group is owned by the Japanese Mitsubishi Corporation, and supplies canned pulses under the brands such as *Batchelors* and *Princes*, as well as for retailers' private labels (www.princesgroup.com).

The American company Del Monte produces a wide range of canned pulses and baked beans in its European factories. The products are available in many European markets. Canned pulses and baked beans are certified according to IFS, BRC, FSSC22000, organic and more (www.delmonteeurope.com).

8.2 Canned pulses: products, brands and prices

Canning of vegetables and pulses has a long history. Today, the range consists of well-known products like canned peas and canned green beans, but the range is widening particularly within beans, chickpeas and lentils. The canning industry is present across Europe. European exports of canned pulses (including intra-EU trade of 78 % of exports) amounted to 773,000 t in 2017. Italy is the largest exporter of canned pulses, holding nearly half of EU exports, followed by the Netherlands, Belgium and France. Hungary is the biggest producer of canned kidney beans (CBI, 2019, canned). The most important export destinations for EU canned pulses are Australia, Russia, South Africa and the United Arab Emirates.

Table 8 lists examples of the canned pulses that are available in EU retail stores. It is evident that private labels are widely used for canned vegetables. There is limited information available regarding the location of production for private label canned pulses, but it is assumed that canning takes place in Southern and Eastern European countries. A few producers of branded canned pulses have been identified such as Bonduelle, HAK and Rolnik. The canned pulse market is dominated by conventional products, and a small number of organic products have also been identified. The Swedish retailer Coop (Konsum) offers organic pulses under their private label Änglamark which is exclusively for organic products.

Table 8. Examples of canned vegetables and pulses in EU supermarkets (2019). “PL” denotes private label. Cropping System Type is defined as either conventional or organic.

Retailer (by country)	Product	Brand (PL)	Price € kg ⁻¹	Cropping System Type
The Netherlands				
Albert Heijn	Canned beans	AH ³ (PL)	1.20	Conventional
	Black-eye beans	AH (PL)	2.30	Conventional
	White beans	HAK ⁴	2.32	Conventional
	Mix of lentils and corn	HAK	8.79	Conventional
	Brown beans	Bonduelle	4.11	Conventional
	Chickpeas	Bonduelle	5.62	Conventional
	Lentils	Bonduelle	5.44	Conventional

³ AH is the private label of retailer Albert Heijn.

⁴ HAK is the leading brand in Northern Europe for preserved fresh vegetables.

	Chickpeas	Bonduelle	5.65	Organic
Emté	Brown beans	Markant (PL)	2.95	Conventional
	Green beans	Markant (PL)	2.00	Conventional
	Peas	Bonduelle	2.00	Conventional
	French beans	Bonduelle	4.22	Conventional
	Lentils	Bonduelle	2.80	Conventional
Lidl	Brown beans	Freshona (PL)	1.20	Conventional
	Peas	Freshona (PL)	2.95	Conventional
	Peas and carrots	Freshona (PL)	3.30	Conventional
	Canned beans	Bonduelle	5.96	Conventional
Polish supermarket in the Netherlands				
	Faba beans	Rolnik	1.95	Conventional
	Peas	Rolnik	2.25	Conventional
	White beans	Rolnik	1.97	Conventional
Hungary				
Spar	Kidney beans	Bonduelle	5.40	Conventional
	White beans	Bonduelle	6.10	Conventional
	White beans (Italian)	Marinna	3.52	Conventional
	Kidney beans	Spar (PL)	1.67	Conventional
Sweden				
Konsum	White beans, precooked	Änglamark (PL)	5.10	Organic
	Borlotti beans (China)	Änglamark (PL)	6.00	Organic
	Red lentils	Änglamark (PL)	5.10	Organic
	White beans (Italy)	Zeta	6.00	Conventional
	Green lentils	Zeta	6.10	Conventional
	Chickpeas	Coop (PL)	4.10	Conventional
	Kidney beans	Coop (PL)	4.10	Conventional
United Kingdom				
Tesco	Lentils	Napolina	2.50	Conventional
	Cannellini beans	Napolina	2.50	Conventional
	Cannellini beans	Tesco (PL)	1.62	Conventional
	Chickpeas	Tesco (PL)	1.60	Conventional
	Garden peas	Tesco (PL)	2.70	Conventional
	Marrowfat peas	Tesco (PL)	1.06	Conventional
	Peas	Batchelors	1.77	Conventional
Denmark				
Rema1000	Chickpeas (Belgium)	Noliko	3.75	Conventional
	Peas and carrots	Bonduelle	6.44	Conventional
	Kidney beans in chili	(PL)	2.10	Conventional
	Kidney beans	(PL)	1.30	Conventional

(Hamann et al., 2019)



Baked beans plus canned vegetables and other legume grains are marketed as branded products and as retailers' private labels. Canned pulses (and other legume grains) are made from dried grains, and canned vegetables are made from fresh- or frozen-vegetables. The most consumed types of canned pulses are kidney beans, green beans, peas, chickpeas and lentils (CBI 2019, canned). The largest markets in the EU for canned pulses are the UK, France and Germany. The markets showing the highest growth rates are the Netherlands, Denmark and Romania. The European market for canned pulses is expected to grow 2-4 % per year until 2023. Growth is stemming from consumers' interest in finding alternatives to meat, and more consumers taking to a flexitarian or vegetarian lifestyle (Derbyshire, 2017; Bjurstrom and Lindgren, 2018; Hamann et al., 2019).

8.3 Processing infrastructure for canned pulses

During the last 4 years, European production of canned pulses has decreased slightly to 1.4 m t (2017). Canned kidney beans are the biggest product. Italy is the biggest producer in the EU of canned pulses holding 46 % of the production, followed by France (34 %) and Hungary (10 %) (CBI, 2019).

Bonduelle is a major producer of canned pulses. Bonduelle is headquartered in France with canning factories in France, Hungary, Poland, Spain and Portugal. Bonduelle only produce for their brand "Bonduelle" (www.bonduelle.com).

Napolina is located in Naples (Italy) and produce a selection of canned pulses, tomato sauces, pasta and other Italian foods. Since 1965, the Napolina brand has been marketed in the UK. The assortment of canned pulses include canned butter beans, cannellini beans, chickpeas, red kidney beans, lentils and mixed beans (www.napolina.com).

Rolnik is a major canning factory based in Poland. Rolnik has three factories in Poland and one in Hungary. The products are sold across Eastern European countries, including the UK, Germany,



Russia, Australia and more. Rolnik produces a selection of canned pulses, vegetables in vinegar, and traditional Polish specialties. The company trades under the brand “*Rolnik*” (www.rolnik.pl).

HAK is the leading brand in Northern Europe for preserved fresh vegetables (presented in glass containers). The company is located in the Netherlands and trades under the *HAK* brand. HAK produces stews and soups made with pulses and preserved peas, beans and a selection of preserved pulses. Approximately 90 % of the crops are sourced from within 125 km from the factory in the Netherlands (www.hak.com).

Beauvais is a brand owned by the Norwegian group Orkla. Orkla supplies a range of organic canned pulses for the Scandinavian market, such as red kidney beans, black beans, chickpeas, cannellini beans, and beluga lentils. The organic range carries the EU organic certification logo (www.beauvais.dk).

9. Sustaining market-pull for pulses in the EU food market

9.1 The importance of infrastructure

This report has shown that processing and trade infrastructures are central to having more pulses and vegetables (fresh produce) in the European food market. Without any form of processing there are only limited opportunities for increasing the demand for pulses and vegetables. Overall, demand for pulses seems to be increasing across Europe, with processed products increasing demand. The research presented demonstrates that the companies in the European pulse industry are extending their ranges of products. For example, within dried pulses, more companies are introducing pre-cooked dried pulses and pre-cooked mixes made with pulses and rice. Such products may promote consumer interest in consuming dried pulses – particularly because consumers' cooking skills and time for cooking may be limited.

Frozen vegetables are regarded as a mature product category where innovation is needed to spur further growth. An assortment of frozen peas and beans are common to all companies in the frozen food industry. Therefore, to increase consumer interest in frozen food, companies are expanding the product ranges to include pre-cooked frozen pulses, soups, stews and mixed vegetables; also in organic varieties. The European frozen food industry is dominated by a small group of multinational companies with strong brands (e.g. Nomad Foods and Greenyard). To this group should be added a suite of companies producing for retailers' private labels. As the private labels hold approximately 40 % of the frozen vegetable market, the volume produced and traded under private labels is therefore also substantial. Proper trading and processing infrastructure, including certifications and regulations on traceability and food safety, are key elements required for developing collaboration between retailers and processors, and for having the fresh vegetables available for the frozen food industry.

An important point of entry for dried pulses into the food chain is the local and international traders and milling companies. Traders buy the pulses from farmers or exporters and sell the pulses to packers and processors across Europe. A key requirement for operating in the European food supply chain is compliance with EU regulations on food safety and marketing standards, as well as



compliance with food processors and retailers' demands for certain quality standards. Those quality standards that are most sought after are the IFS and BRC certificates, and the FSSC22000 standard. These standards should be regarded as a main mechanism facilitating trade in the food chains. This report has provided several examples of the importance of such quality standards within national and intercontinental quality chains. Examples of the intercontinental quality networks are explained in chapters about fresh produce and dried pulses, and examples of national quality chains can be found in the chapters about frozen and canned pulses.

Canned pulses are a market segment with limited growth. To sustain a market-pull, canning factories are introducing a wider range of canned pulses in conventional and organic varieties with the aim of attracting interest from a broader consumer group. Particularly consumers looking to cut down on meat, or move to vegetarian or flexitarian diets are regarded as key potential consumers for legume grains including pulses whether canned, dried or otherwise processed.

The EU holds food safety and consumer information high on the agenda and this is reflected in the requirements to processors and traders in the EU food market. The EU Food Law, the Marketing Standards, and the regulation on Food Labelling are central pieces of EU legislation that shape the "license to operate" for European and non-European actors. In fact, requirements for traceability impacts the collector or exporter of fresh produce in e.g. Africa as compliance with the EU regulations are essential for entering into the EU market. This report has demonstrated that intercontinental supply chains are formed by linking farmers in Asia, the Americas and Africa with the European market, and that compliance with standards used by European actors is the main access point for successful market penetration.

Demand for pulses is expected to grow further in the coming years as consumers' and processors' awareness and skills for processing and handling legumes as grains and fresh produce increases. Creativity with regards to developing new products and technologies that facilitate the market introduction of pulse-based products meeting consumer preferences will be important for sustaining market-pull. Consumers of organic products are often regarded as a segment of early adopters to new green foods and healthy products, including pulses. Learning from the development of processing infrastructure for organic quality chains, including the importance of a



certification system that builds on transparency and trust are central elements for developing more European and international quality networks for organic pulses.

9.2 Concluding remarks and recommended actions

One major conclusion of this report is that a key stepping-stone for sustaining EU market-pull in the food market is the range of appealing pulse-based products in the food market. This can only be achieved if proper processing and trading infrastructures are available, and with special reference to facilities for collecting, cleaning and trading pulses – including at smaller scales so that small operators may enter the market. It is also essential that actors in the quality networks evolving round diverse pulse crops and processing chains are skilled in the requirements for trading in the EU food market, including compliance with quality standards, certifications and knowledge about how the food market functions.

In the following section, we list **seven recommended actions that could be initiated for sustaining and increasing the EU food market-pull for grain legumes, pulses and products-based upon them**. The listed actions are based on this report's findings and conclusions, as well as stakeholders' recommendations.



Seven recommended actions to increasing the EU food market-pull for legume grains, including pulses, and products-based upon them.

- 1.** Identify routes to establish more facilities for collecting, cleaning and trading pulses.
- 2.** Develop an internationally recognised quality assessment system for dried pulses (to facilitate intercontinental pricing and trade).
- 3.** Sustain momentum in the food market by continuously offering new pulse-based products (to keep consumers interested); new processing technologies and ingredients are important to improve pulse-based products.
- 4.** Offer more mixed products where pulses are used as an additional ingredient (e.g. ready-to-cook mixes of pulses and sauces) in contrast to pure pulse-based products (e.g. canned pulses). These mixed products appeal to a wider consumer group.
- 5.** Promote traditional products (canned and frozen peas and beans) in contemporary recipes and by modernizing packaging and products. There are substantial volumes of vegetables and pulses in traditional quality chains.
- 6.** Promote European cultivation of peas and beans as fresh produce in farms and home gardens.
- 7.** Develop public and private measures that stimulate the formation of quality chain networks - to motivate more cultivation, processing and marketing of vegetables and pulses.



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Annex I - Methodology

The report has been elaborated with an explorative and qualitative approach. Research has been carried out during the period May 2017 to October 2019. This report builds on desk-based research combined with stakeholder consultations and in-field research. **Desk-based research** has comprised of reviewing empirical and academic literature for the period of 2016 to the present. Main sources are: industry and market reports; EU policy plans; EU regulations and quality requirements; statistics; and other sources as listed here in the References section. The aim of desk-based research has been to discern quality chain structures, trading routes, infrastructure for processing, and market trends. Furthermore, it has been an aim to cover both conventional and organic market segments and quality chains.

Partners in the TRUE consortium were also asked to provide **examples of quality chains for legume grains, pulses and fresh legume produce**. The partners have selected the quality chains on their own initiative and based on trading requirements such as that: the quality chain should be linked to the food market; it should include infrastructure for processing and trade; and it could be local or international. The aim was to have a collection of quality chains that showed diversity and represented fresh, frozen, dried, canned and otherwise processed pulses.

In-field research has been performed to investigate the selection of brands and private labels offered in many supermarkets across Europe. Field research has been carried out in the Netherlands, the UK, Hungary, Denmark and Sweden. Initially the retail market has been studied to identify major retail chains. Then, supermarkets (discount stores and premium stores) have been visited to map products, prices, brands, country of origin, and producer. The mapping has covered fresh produce, frozen food, dried and canned legume-grains including pulses. In-field research was carried out in the period October 2017 to August 2019. Thus, the prices listed may have changed since their registration. The main **insights gained regarding the processing and trade infrastructure for legumes** was allied to literature reporting various aspects of the EU food market, including imports and exports of legume-grains, pulses and as vegetables, plus retailers' branding strategies.

All prices are registered in EUR/kg based on the following exchange rates:





€ 1 = 7.45 DKK; £ 1 = € 1.18; 1 SEK = € 0.10/

Consultations with stakeholders have been undertaken at the Legume Innovation Network (LIN) workshops hosted as part of the TRUE project in the UK, Hungary, Portugal, Germany and Denmark during 2017-2019. At the LINs, market and value network sessions were organised as roundtable-discussions to identify opportunities and barriers for having more legumes in the market, to validate identified sustainability indicators for markets and value networks (Hamann et al., 2019) and, to discuss good practises for commercialisation of legumes. The market sessions and roundtables were organised as active dialogues involving the stakeholders and encouraging them to bring forward their views and experiences. The **outcome** has provided first-hand insights to challenges and opportunities for marketing of legume grains, especially pulses, and for fresh vegetable-based legume products in the food market, as well as the enablement of local, European and international trading relations.

From participating in the **European workshop about markets and supply chains** (organised by the EU Commission, Lelystad, September 2018) first-hand information about quality chains and pulses in the EU food markets was also captured.



Annex II - Background to the TRUE project

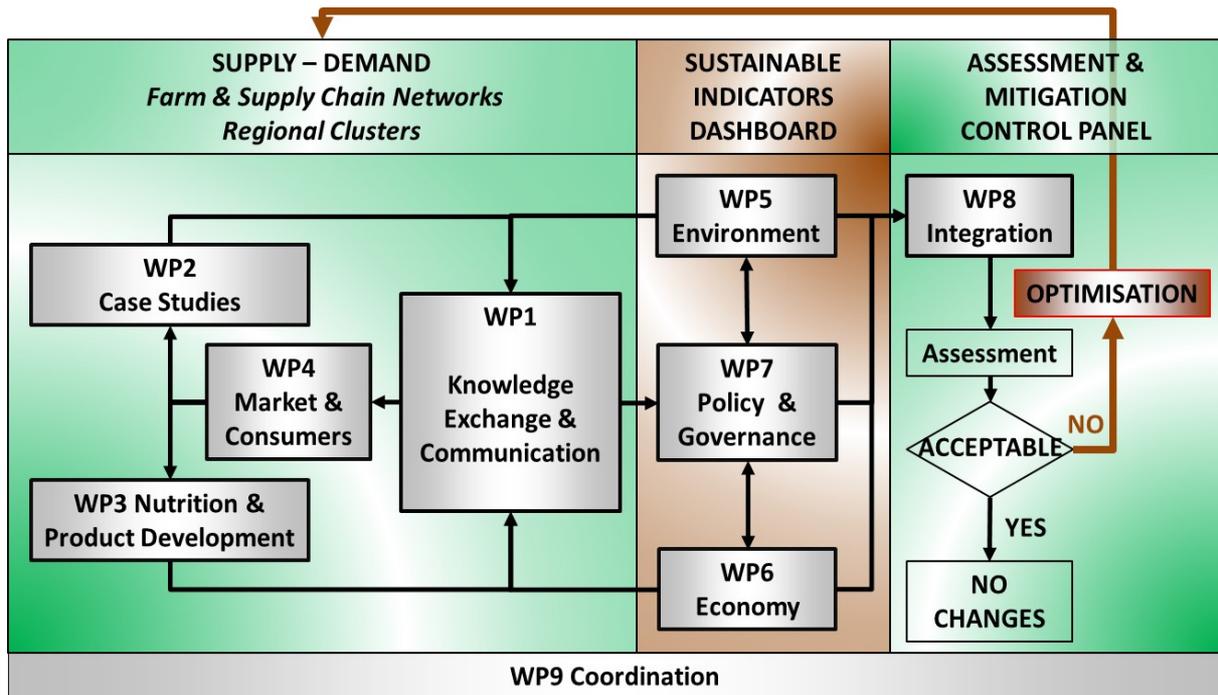
Executive summary - abbreviated

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 a *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 supplies 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 - diagram

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).



Project partners - table

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
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 Development of the Medimurje County	Croatia	Development Agency

*Coordinating institution



Objectives - Abbreviated

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*

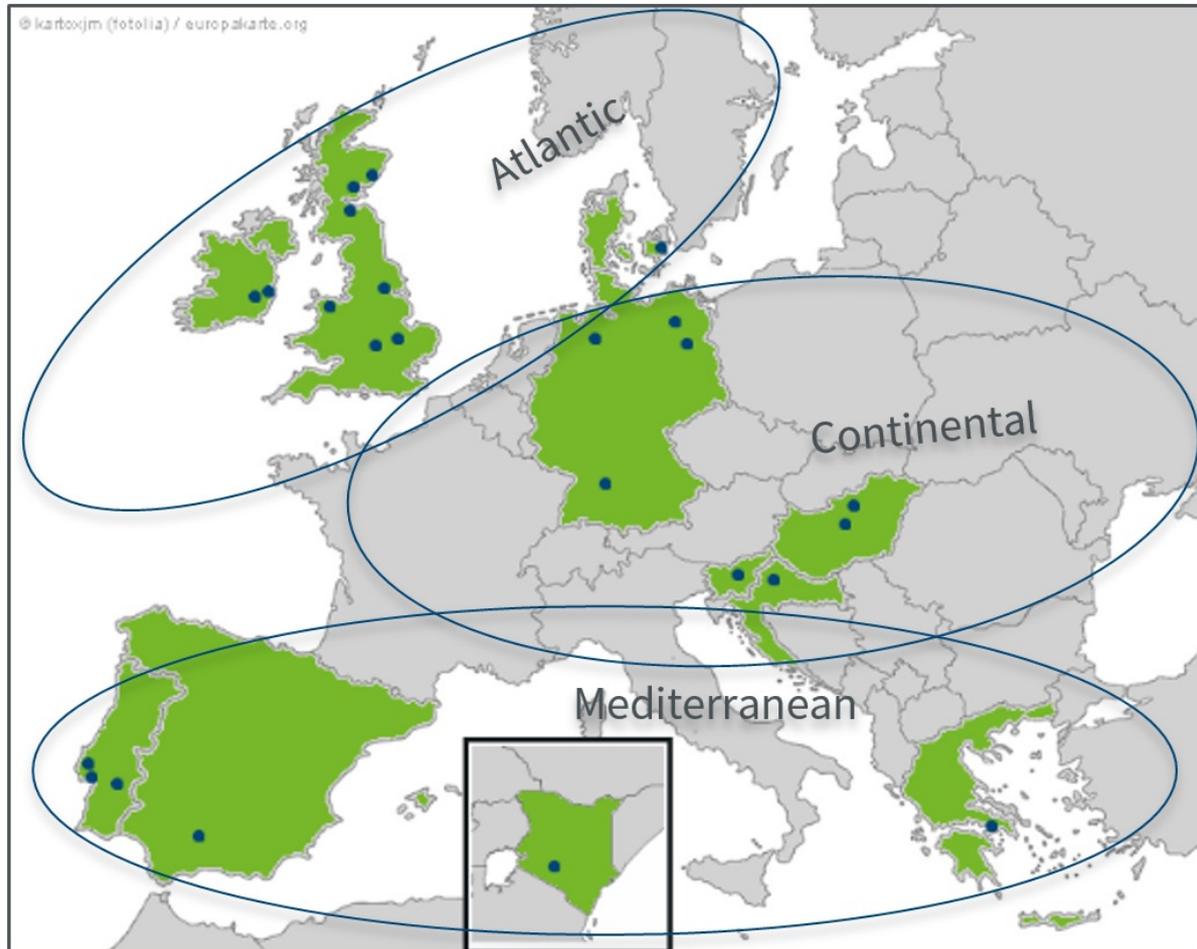
Objective 7: Enable policies, legislation and regulatory systems (ESSRG, WP7)

- *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*

Legume Innovation Network – diagram



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.



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