Market developments and policy evaluation aspects of the plant protein sector in the EU

Final report

AGROSYNERGIE EEIG
November 2018

Agrosynergie
Groupement Européen d'Intérêt Economique

EUROPEAN COMMISSION

Directorate-General for Agriculture and Rural Development
Directorate C. — Strategy, Simplification and Policy Analysis
Unit C.4. Evaluation and monitoring

Contact: Yves Plees

E-mail: Yves.plees@ec.europa.eu

European Commission
B-1049 Brussels

EUROPEAN COMMISSION

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Directorate-General for Agriculture and Rural Development

2018 Agri 2018 – 0089

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Luxembourg: Publications Office of the European Union, 2018

Catalogue Number: KF-03-18-447-EN-N
ISBN 978-92-79-97237-9
DOI: 10.2762/022741

This study is conducted by the European Economic Interest Group:

Agrosynergie

Groupement Européen d'Intérêt Economique

This study was carried out by the following experts from Oréade-Brèche: Thierry Clément, Romain Joya, Célie Bresson and Cannelle Clément.

The national experts listed below also contributed to the report:

Alessandro Serra Caracciolo (Italy)
Johannes Simons (Germany)
Jordi Russell (Spain)
Leonidas Nikolaou (Romania)
Cannelle Clément (Austria)
Wieslaw Lopaciuk (Poland)

EEIG Agrosynergie includes the following two partners:

ORÉADE-BRÈCHE SAS
2084 l'Occitane - 31670 Labège FRANCE
Tel.: + 33 5 61 73 62 62
Fax: + 33 5 61 73 62 90
e-mail : t.clement@oreade-breche.fr
Represented by Thierry CLEMENT

COGEA S.r.l.
Via Po 102 - 00198 Roma ITALY
Tel.: + 39 6 853 73 518
Fax: + 39 6 855 78 65
e-mail: fantilici@cogea.it
Represented by Francesca ANTILICI

Date: November 2018

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Glossary

AA	Amino Acid
CAP	Common Agricultural Policy
CIDE	European Dehydrators' Working Group
COOL	Country-of-Origin Labelling
CP	Crude Protein
CS	Case Study
DDGS	Dried Distillers Grains with Solubles
DIV	Diversification measure of the greening regulation.
DM	Dry Matter
EC	European Commission
EFAs	Ecological Focus Area
ENSA	European Natural Soya and Plant Based Foods Manufacturers Association
EU/EU-28	European Union
EU-27	EU Member States without Croatia (HR)
EU-15	EU Member States between 1995 and 2004
EU-N13	EU Member States which joined EU after 2004
EUVEPRO	European Vegetable Protein Association
FADN	Farm Accountancy Data Network
FAO	Food and Agriculture Organization of the United Nations
FEDIOL	EU Vegetable Oil and Protein meal Industry Association
FEFAC	European Feed Manufacturers' Federation
GEPV	Plant Proteins Study and Promotion Group (French)
GM-Free	GM-Free: Product not genetically modified
GMO	Genetically modified organisms
High-pro	High Protein Meal
ICF	Industrial Compound Feed
LF	Leguminous fodders
Low-pro	Low Protein meal
LU	Livestock Unit
MS	Member State
NGO	Non-Governmental Organization
OFF	On-Farm Feed
PDO	Protected Designation of Origin
PGI	Protected Geographical Origin
PP	Plant Proteins
PPP	Plant Protection Product
PRMs	Protein-Rich Material
PRPs	Protein-Rich Plants or crop
Reg.	Regulation
RM	Raw Material
RS	Rapeseed
SB	Soya bean
SF	Sunflower
TSG	Traditional Speciality Guaranteed

UAA	Utilized Agricultural Area
UAE	United Arab Emirates
USA	United States of America
VCS	Voluntary Coupled payments Schemes

Countries taken as case studies

AT	Austria
DE	Germany
ES	Spain
FR	France
IT	Italy
PL	Poland
RO	Romania

1 INTRODUCTION

1.1 Objectives and scope of the study

This report concerns an evaluation study of the CAP measures applicable to the EU market in plant proteins, including competitiveness effects of CAP measures applied to plant proteins. It focuses on analysing market aspects relating to the protein-rich plants in the EU and assesses in this context the coherence and relevance of the CAP measures applicable to the EU market for plant proteins.

The productions studied in both parts of this report are:

- Pulses: field beans, field peas, lupines and other dry pulses (chickpeas, lentils and dry beans[1]),
- By-products (e.g. meals) of the following oil seeds: rapeseed, sunflower, soya bean and linseed,
- Forage legumes: mainly alfalfa, clover, and sainfoin.

For all of them, their uses as feed and food (when applicable) are covered as well as their main market segments including organic and GM-free uses.

For the market aspects, the main factors influencing the EU plant protein market are analysed and include:

- the supply and demand situation for plant proteins in the EU (present and outlook);
- the various sources of plant protein supply (directly from crops like pulses and forages and indirectly from by-products, like meals from oilseed crushing);
- the different possible uses of each plant protein type (for food, feed and other uses), and their market segments;
- the main drivers of the competitiveness of plant proteins in the EU, including EU-produced and imported materials and specific drivers related to significant premium markets.

With respect to the evaluation aspects developed in this report, the main CAP measures studied are:

- two measures under the greening part of the Direct Payments regulation[2], namely diversification (DIV) and Ecological Focus Areas (EFAs)
- the Voluntary Coupled Payment Schemes (VCS)[3].

When relevant, other measures are taken into account, such as Rural Development measures (E.g. agri-environmental measures), Horizontal regulations, etc. It must be noted that the evaluation part of this study is not a full-fledged evaluation as it only covers causal analysis and coherence.

The examination covers the period following the implementation of the 2013 CAP reform, notably from 1 January 2014 onwards. The geographical coverage is the EU 28.

[1] Dry beans concern dried, shelled kidney beans "phaseolus vulgaris", whether or not skinned or split (excl. for sowing), Comext category number 07133390.

[2] Regulation (EU) 2013/1307

[3] Regulation (EU) 2013/1307

1.2 Overarching concepts and key prerequisite needed

The list of plants to be studied within the framework of this evaluation encompasses protein-rich plants and materials (>15% of crude protein). To ensure clarity and understanding throughout this report, we will use the wording "protein-rich plants" or the acronym "PRP" to mention crops within the perimeter of this study, whereas the wording "plant proteins" or "PP" will be used to mention all plant proteins derived from plants (including cereals, non-legume fodder, grazed fodders, etc.).

Although this study focuses on protein-rich plants ("PRPs"), meaning mainly oilseeds, pulses and legume fodder crops, it is important to step back and look at the share of the protein plants studied in the current evaluation within the global supply of plant proteins in the EU.

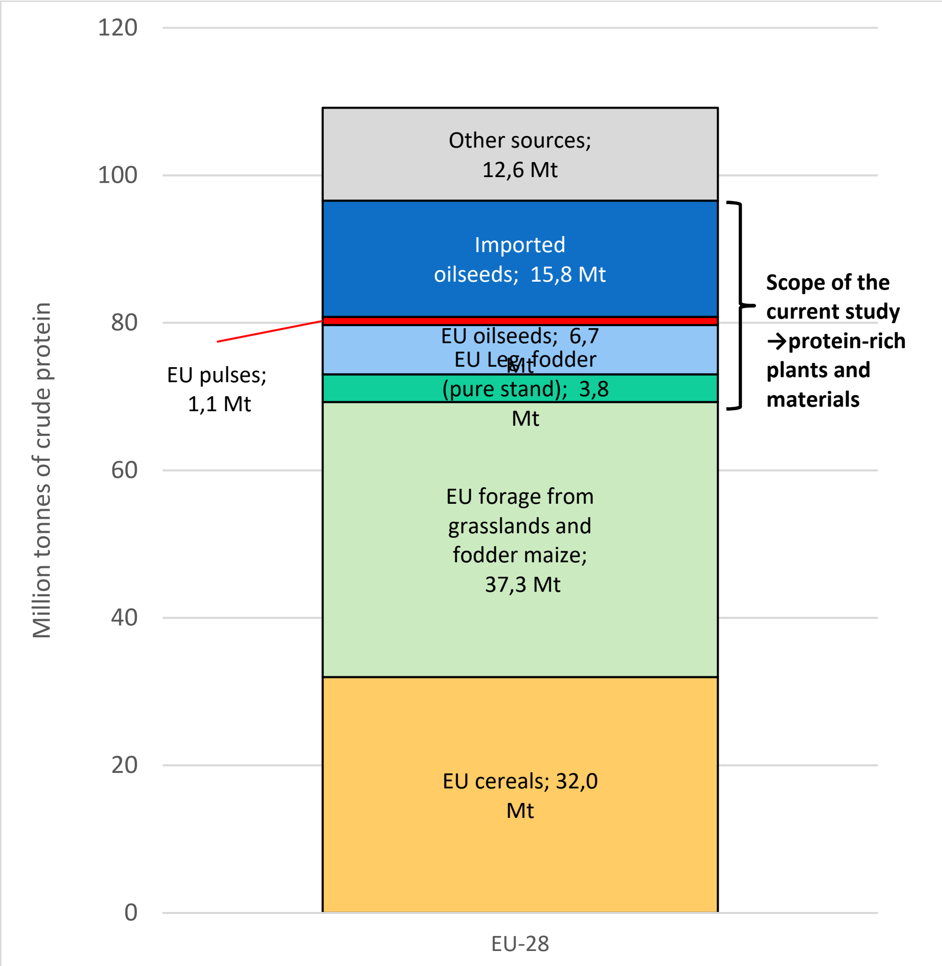


Figure 1: Breakdown of the EU-28 total Plant Protein supply (109 Mt) by taking all plant protein sources: (source: own calculations based on EUROSTAT, EU Commission protein balance sheet, (Huyghe et al., 2014), (Smit et al., 2008)).

Figure 1 provides a first glance of protein-rich plants compared to the total plant protein supply. Given the lack of data available, this graph should be taken as a first step to provide an order of magnitude, especially for grasslands, for which little data is available[4]. According to this first estimate, total protein supply is estimated at 109 Mt of crude protein. Based on this estimation, protein-rich plants and materials studied in this report account for about one-fifth to one-fourth of the total EU plant protein

[4] Crude protein supply estimates have been calculated by using various datasets. The EU Commission protein balance sheet provides estimates for cereals, oilseeds and various coproducts from PPs, aggregated in the category "other sources". For EU legume fodders, only pure stands are included (no data available for associations). The estimate is also based on a combination of various European sources: EUROSTAT, national statistics and various sources from EU research projects, especially the "multisward" project). It is difficult to estimate protein supply from grasslands as there is no official data on grasslands production and protein content. It has been roughly estimated by multiplying EUROSTAT acreage of grasslands (temporary and permanent) by an average yield of 5t dry matter/ha and 10% of crude protein. Grassland productivity mostly varies from 5 to 10t/ha Smit, H. J., Metzger, M. J. and Ewert, F. (2008) 'Spatial distribution of grassland productivity and land use in Europe', *Agricultural Systems,* 98(3), pp. 208-219.. Consequently, this estimate can be considered as conservative.

(PP) supply. Providing about 37 million tonnes of crude proteins, grasslands are the first provider of PP (one-third of the supply) and cereals the second. Imported oilseeds (including imported meals and imported whole seeds crushed in the EU) are mostly from soya bean (87%), the rest being essentially sunflower and rapeseed meals. Remaining sources (mainly by-products from the food and starch industries) account for 12.6 million tonnes[5].

It should also be taken into account that the wording "plant proteins" embraces a wide range of quality and protein contents according to the type of crop, processes, animals to be fed, etc. Protein-rich plants and materials remain highly relevant to balance animal feed diets given their high protein contents and their nutritional properties, especially in comparison with cereals that have low concentrations of protein, different amino-acid profiles and are more specialised in energy (cf. 4.1.1 + box 2). Moreover, contrary to legume crops, cereals and grass are not N-fixing crops, meaning that there is often a quantitative link between nitrogen fertilisers applied and protein production (see box 1). However, N-fixing crops such as pulses, soya bean and forage legumes are naturally able to fix nitrogen.

Box 1: The link between Plant proteins and nitrogen

The field of plant proteins is by its nature inherently linked to nitrogen. Nitrogen is a fundamental component of amino acids, which are the molecular building blocks of proteins. Thus, it is highly relevant to address plant proteins in the light of the nitrogen cycle. Dinitrogen (N_2) in the atmosphere is very stable but other forms are very reactive, although they are essential for plant growth.

All nitrogen in animals and humans originates, in one way or another, from plants or microbes because only these can convert mineral forms of reactive nitrogen (e.g. nitrate and ammonium) into organic nitrogenous compounds such as amino acids and then proteins. The availability of these basic mineral forms of reactive nitrogen is a key factor determining the productivity of crops for food and feed, including protein levels.

The 2 main pathways for production of these mineral forms of reactive nitrogen for agriculture are:

- biological nitrogen fixation in crops: a biological process occurring in natural ecosystems which allows atmospheric N_2 to be converted into mineral nitrogen (NH_3) that can be assimilated by living organisms after decomposition. This process is carried out by specific N-fixing bacteria that are associated with the root nodules of legume plants, including pulses, some oilseeds (soya only) and legume fodder addressed in this study;
- synthetic fertilizers: especially through the Haber–Bosch process, which combines atmospheric N_2 with hydrogen from methane to produce the main fertilisers used on the planet: ammonium nitrate, ammonium sulphate, or urea.

N fertiliser manufacture has partially and artificially replaced the initial role of legume crops to add nitrogen into agricultural systems, especially in Europe where pulses and legume fodders account for less than 6 % of arable lands (Schneider and Huyghe, 2015). Nitrogen being vital for crop growth and production, this observation underlines the fact that the EU strongly relies on synthetic fertilisers for its nitrogen supply, at the cost of N-fixing legume crops. It also stresses the fact that the EU mostly imports nitrogen derived from a technically free synthesis (biological fixation), especially soya from South America, to feed its livestock, generating huge nitrogen surplus in areas with high livestock density (generating some of the aforementioned adverse effects). Conversely, the EU exports nitrogen obtained from a costly fertiliser manufacture, notably through the export of cereals produced far from livestock areas, where nitrogen surplus occurs in agricultural soils.

[5] The category "other sources" includes small categories of the EU protein supply that are not covered by the main categories of the graph, namely: imported cereals + imported oilseeds + imported pulses + the "others" category of the EU protein balance sheet (Palmkern meal , Other oilseed meals, Corn Germ meal, Corn Gluten Meal, Corn Gluten Feed, Distiller's Dried Grains with Solubles, Wet Distillers Grain, Wheat bran, Wheat gluten feed, Citrus pulp, Beet pulp pellets, Molasses, Processed Proteins, Former Foodstuff).

2 Methodology

2.1 Main terms used in the report and their definitions

The main terms used in this report are detailed in Figure 2, which aims at clarifying which material falls under which class.

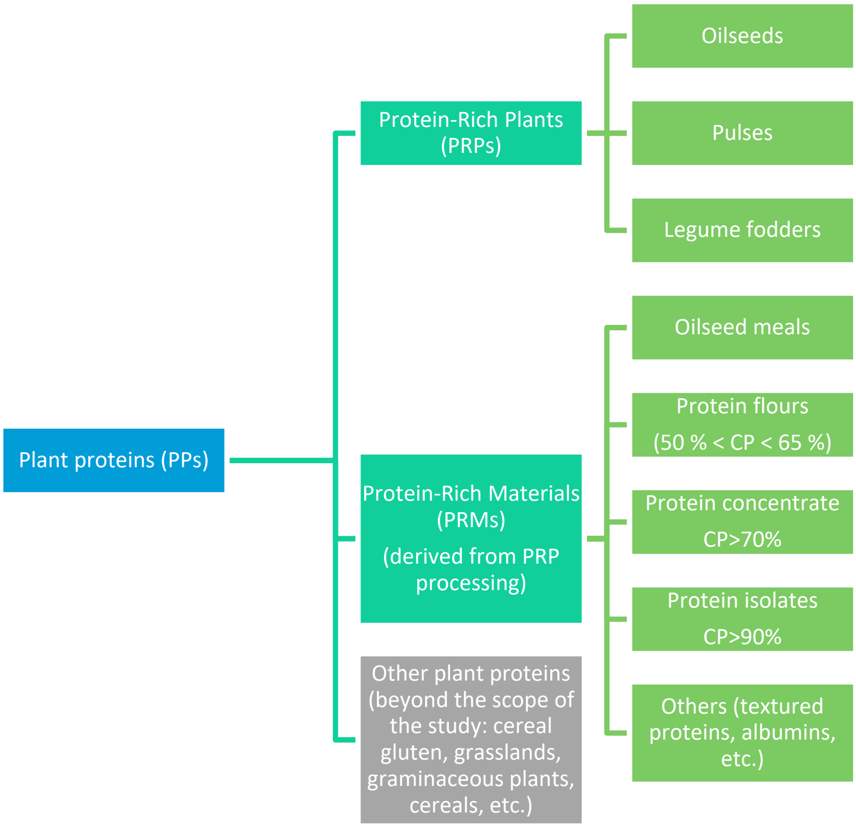


Figure 2: Categorisation of plant proteins

Other important terms for the understanding of this report are listed hereinafter:

Crude protein: calculated after measuring the nitrogen content of a food. Because each amino acid (the building block used to make protein) contains nitrogen, looking at the total nitrogen content of a food gives some insight into its protein content. However, because not all of the nitrogen in food is found in protein, using crude protein as a measurement might slightly inflate measurement of protein content. In animal feeds, crude protein is calculated as mineral nitrogen x 6.25 (the assumption is that proteins of typical animal feeds contain 16% nitrogen on average).

Legume fodder/forage legumes: forages derived from the legume family such as alfalfa (or lucerne), clover, vetches, sainfoin, etc.). Legume fodders can be cut or grazed like grass (rarely). If cut, they can be sun-dried or preserved under various forms (hay, haylage, silage, dehydrated). All processes can be conducted on the farm except dehydration, which is carried out in dehydration plants by using various sources of energy (coal, lignite, wood, biogas, etc.) [6].

Meal (Oilseed-): An oilseed meal is the by-product of the extraction of oilseed oil (rape, sunflower, soya bean, linseed). Several processes exist, resulting in different products. The meal is usually classified for marketing by its crude protein content. There are often two main categories of soya meal, the "high-protein" or "High-pro" meal, made of dehulled seeds, and the "conventional" soya meal or "low-pro". For example, for soya, the "high-protein" soya meal contains 47-49% protein and 3% crude fibre, obtained from dehulled seeds, and the "conventional" soya meal contains 43-44% protein. In

[6] In areas with wet or unstable climatic conditions, dehydration enables preserving the nutritional quality of the fodder, especially because it preserves the leaves, the part of the plant containing most of the protein content.

solvent-extracted soya meals, the oil content is typically lower than 2% while it exceeds 3% in mechanically extracted meals.

N-fixing Crops: plants that contribute to nitrogen (N) fixation include the legume family – Fabaceae – with taxa such as soya beans, alfalfa, pea, beans, lupine, peanuts, etc. Such plants contain symbiotic bacteria called Rhizobia within nodules in their root systems, producing nitrogen compounds that help the plant grow without need for extra-N fertilisation. N-fixing plants addressed in the current study are: all pulses, legume fodders, and soya.

Other terms crucial for the understanding of the study are:

Plant Proteins (PPs): all protein found in plants.

Protein concentrate/isolate: Protein concentrates and isolates are made by separating the protein fraction of seeds (mostly soya and pea) or more rarely of leaves (alfalfa) from the fibre, oil and starch fractions.

Protein-Rich Plants (PRPs) and Protein-Rich Materials (PRMs): plants and their related co-products, products with more than 15% of crude proteins.

Pulses: refers to the edible seeds of various crops (such as peas, beans, or lentils) of the legume family.

For the market study the main concepts used are:

A **spot market** is a market for currencies or commodities in which they are sold and given to the buyer immediately, rather than being sold forward (i.e. to be taken on a future date).

A **futures market** is an auction market in which participants buy and sell commodity and futures contracts for delivery on a specified future date.

A **campaign contract** (also called production contract) are contracts regulating an exchange of an agricultural production between a supplier and a buyer (e.g. a farmer and a collector) for a given quantity, at a given quality and for a delivery on a particular date in the future. The contract can also specify the price.

2.2 Data sources for the market study and the evaluation

The main following data sources are used for this evaluation study.

2.2.1 Data on policy implementation

The MS implementation choices regarding the greening measures (EFAs and crop diversification) are analysed based on their annual declaration to the European Commission for the period 2015-2017.

The case studies in seven Member States provide complementary information with regard to the main drivers of PP production, processing and trade and the observed effects of the evaluated measures as well as their potential effects in the future.

2.2.2 Data on production, trade and exchanges

Eurostat

In Eurostat, disaggregated data is only available for four N-fixing crops: soya bean, broad and field beans, field peas and sweet lupines. However, since legume fodder and fresh pulses also represent a large share of N-fixing crop area, they are analysed even though no disaggregated variables are available at this stage. There is no disaggregated data on chickpeas and lentils, which are grouped in "Other dry pulses".

Alfalfa disaggregated data exists on Eurostat but there are too many missing data points to enable analysis, thus legume fodder is studied aggregated in the category "Legume plants harvested green".

Concerning oilseeds, disaggregated data is available on rapeseed, sunflower and linseed.

Eurostat data is used to understand production volumes and yields (through the area data) of the crops/plants studied in each MS and within the EU.

Table 1: Correspondance between Eurostat and usual legume crop/plant names

Name on Eurostat		Common name	Latin name
Dry pulses	Field pea	Pea	Pisum
	Broad and field bean	Faba bean (horse bean for some imported products)	Vicia faba
	Sweet lupine	Lupin	Lupinus
	Chickpea	Chick pea	Cicer
Fresh pulses	Fresh peas	Pea	Pisum
		Chick pea	Cicer
	Fresh bean	Bean	Phaseolus and vigna spp
Rapeseed		Rapeseed / Colza	Brassica napus
Sunflower		Sunflower	Helianthus anuus
Linseed		Linseed	Linum usitatissimum
Soya bean		Soya	Glycine
Legume plants harvested green		Legume fodder: Alfalfa (lucerne), clover, sainfoin, vetch	Medicago sativa, trifolium, onobrychis, vesca

Source: own work

Comext

Comext disaggregated data is available for soya bean, soya meal, sunflower seed and sunflower meal, linseed, field peas, dry beans[7], lupine, alfalfa (meal and pellets) and other forms of legume fodder (mostly bales)[8]. Concerning rapeseed and rapeseed meal, as these categories were empty, we added up the high and low erucic rapeseed categories[9], as these were complete. Data was lacking concerning field beans, chickpeas and soya bean (before 2012). Comext has been used to show trades between the EU and the rest of the World and between Member States on the studied crops/plants.

FAO Stat

FAO Stat disaggregated data is available for soya beans, field beans, dry peas, lupines, chickpeas, lentils, rapeseed, sunflower and linseed. There is no data on legume fodders. FAO Stat is used to study production volumes and yields of the crops studied in the World to be compared to the EU-28.

Comtrade

In Comtrade, disaggregated data is available for soya bean, field beans[10], peas, chickpeas, lentils, rapeseed, sunflower seed, linseed and alfalfa. There is no data on lupine seeds. Legume fodder other than alfalfa are grouped together in "Swedes, mangolds, fodder roots, hay, clover, sainfoin, forage kale, lupines, vetches & similar forage products, whether or not in the form of pellets". We decided that this category was too broad to represent trades of legume crops harvested green other than alfalfa, therefore we only study alfalfa trades. Comtrade has been used to show trades between the EU and the rest of the World and between European member states on the studied crops/plants, when data was not usable from Comext. This mainly concerns field beans, chickpeas and soya bean (before 2012).

Resourcetrade.earth

In rare cases, data wasn't available on Comtrade but in this dataset (e.g. intra-European exchanges). This website uses mainly Comtrade data, but completed with Chatham House Resource Trade Database.

[7] "Dried, shelled kidney beans "phaseolus vulgaris", whether or not skinned or split (excl. for sowing)" (07133390).

[8] "Hay, alfalfa, clover, sainfoin, forage kale, lupines, vetches and similar forage products (excl. Swedes, mangolds and other fodder roots and alfalfa meal)" (12149090).

[9] Rapeseed category corresponds to the sum of "Low erucic rape or colza seeds 'yielding a fixed oil which has an erucic acid content of < 2% and yielding a solid component of glucosinolates of < 30 micromoles/g', whether or not broken (excl. for sowing)" (12051090) and "High erucic rape or colza seeds 'yielding a fixed oil which has an erucic acid content of >= 2% and yielding a solid component of glucosinolates of >= 30 micromoles/g', whether or not broken" (12059000). Rapeseed meal category corresponds to the sum of "Oilcake and other solid residues, whether or not ground or in the form of pellets, resulting from the extraction of low erucic acid rape or colza seeds 'yielding a fixed oil which has an erucic acid content of < 2% and yielding a solid component of glucosinolates of < 30 micromoles/g'" (23064100) and "Oilcake and other solid residues, whether or not ground or in the form of pellets, resulting from the extraction of high erucic acid rape or colza seeds 'yielding a fixed oil which has an erucic acid content of >= 2% and yielding a solid component of glucosinolates of >= 30 micromoles/g'" (23064900).

[10] Actually broad and horse beans in Comtrade

2.2.3 Literature review

The complete list of the literature review (references) is given at the end of the report.

2.2.4 Interviews at EU level

Interviews have been held at EU level, with organisations representing European farmers and operators in the sectors. The ones interviewed are:

- CIDE: European Association of Forage Processors,
- COCERAL: European association representing the trade in cereals, rice, feedstuffs, oilseeds, olive oil, oils and fats and agro-supply,
- COPA-COGECA: committee of farmers and their cooperatives in the European Union,
- ENSA: soya bean industry and plant-based food producers,
- EUVEPRO: European Vegetable Protein Association,
- EVPA: European Vegetable Protein Association,
- FEDIOL: EU vegetable oil and protein meal industry association,
- FEFAC: European Feed Manufacturer's Federation.

In most cases, the organisations invited economic operators (e.g. experts from private companies) to contribute to the discussion, especially traders, importers, processors and feed manufacturers.

2.2.5 Case studies

In order to study PRP production in detail, supply, demand, trade and their main drivers, the ToRs specified to carry out case studies (CS) in selected Member States are mainly chosen on the basis of their production and markets of the studied plants/crops. These CS include data collection, bibliography and interviews of officials, operators of the sectors and other relevant stakeholders such as researchers, technical institutes, unions, etc. From 10 to 25 semi-directive interviews have been conducted for each case study.

The final choice for these case studies is shown in Table 2 and Map 1, the Austrian CS being specifically focused on the GM-Free and organic markets.

Table 2: Choice of crops/plants and uses for the EU Member states chosen as case studies

Crops/plants	AU	DE	ES	FR	IT	PL	RO
Broad and field beans		X		X	X		
Field peas		X	X	X			
Other dry pulses & sweet lupine		X		X		X	
Rapeseed		X		X		X	
Sunflower			X	X			X
Soya	X			X	X		X
Legume plants HG	X	X	X	X	X		
Total	**2**	**5**	**3**	**7**	**3**	**2**	**2**
Feed uses	**X**	**X**	**X**	**X**	**X**	**X**	**X**
Food uses	**X**	**X**	**X**	**X**			

Map 1: Case studies locations

2.3 Methodology to conduct the evaluation of the studied CAP measures

2.3.1 Summary of past support for protein crops in the EU

Since the Second World War, the importance of grain and fodder legumes on arable lands has dropped, from around 15% of arable land to 6% in the EU. This is due to a series of reasons including the "intensification of livestock farming (gradually relying on massive imports of soya bean), competition with other crops that were more profitable, European political support for cereal productions and an increasingly unfavourable climate and pest pressure"[11]. This strong decrease in production implies that a significant share of the EU PRP supply is now covered by imports. In addition, the use of grains and processed feed (from import and from the EU) has highly increased in the livestock sector whereas the use of grass has significantly decreased, reducing the use of low protein value plants. With regard to oilseeds, the past trends are significantly different. Starting from a very limited area, they reached a significant portion of the arable land area until the MacSharry reform in 1992 setting up area-based payments.

In the context of the GATT Dillon Round in 1962, the European Commission dropped its import tariffs on oilseeds, oilseed products and non-grain feed ingredients, allowing the U.S. and other exporters to enter the European market duty free. This agreement had several consequences on EU agricultural sector:

- as soya bean imports were competitive (compared to substitutes), imported soya meal has developed as a major source of protein for animal feed and has favoured European animal productions and industry.
- because of the large demand for soya bean, Argentina and Brazil have developed their production and became the main soya bean suppliers for the EU (taking advantage of the duty-free trade with the EU).

Thirty years later, in the context of the GATT Uruguay Round negotiations in 1992 (paving the way for the Uruguay Round Agreement), the EU and the U.S. negotiated a Memorandum of Understanding on Oilseeds (often referred to as the 'Blair House Agreement'). This agreement sets limits on EU support for oilseed production:

- the supported area was capped at 5.482 million hectares[12].
- the quantity of co-products, expressed in soya meal equivalent, made available through oilseeds for non-food purposes on subsidised set-aside land, was capped at 1 million tonnes.

The agreement probably favoured soya bean imports. However, since the CAP health check in 2008 abolished the specific payment for energy crops and the set-aside regime, the agreement is generally considered (on the EU side) as no longer having an effect. However, even though it is not considered as restrictive in the framework of the current CAP, the Blair House agreement is still in force.

Table 3 shows the level of dependency of the EU in terms of protein for the animal sector, particularly on imported soya meals and grain.

Table 3: Share of the supply of plant proteins (including dehydrated fodder but excluding grass) for the feed sector in the EU for the year 2016

Protein source	EU total products feed use (Mt)	Products feed use EU origin (Mt)	EU total protein feed use (Mt)	Protein feed use EU origin (Mt)	% Feed Use of EU Origin (I) / (H)	% protein use in the feed sector
Crop grains	177.6	159.2	18.30	16.60	91%	41%
Co-products from arable land	84.1	44.6	25.57	9.77	38%	57%
Other sources	2.3	2.2	0.92	0.86	94%	2%
TOTAL	264.0	206.0	44.8	27.2	61%	100%

Source: DG Agri based on Eurostat and Comext

A range of measures including protection of the market (price support), coupled and decoupled direct subsidies, and agri-environmental schemes have been used to support protein crop production in the past. Between 1958 and 1992, various price support schemes were available for soya bean, pea, field bean and lupin. In 1989, area payments were introduced for chickpea, lentil and vetches. In the reform of 1992, price support was decoupled and replaced with area payments. These payments varied according to crop type, with soya bean receiving less than other protein crops. In the 2003 reform, all area payments were included in the Single Payment Scheme. The "protein premium", which was a top-up payment within the single payment scheme, was used until 2012 on a restricted area basis in 17

[11] Voisin *et al.* 2013

[12] The agreement allows for modification of this maximum supported area, further to enlargement of the Union. While the original maximum base area was set at 5.128 million hectares, it was increased to cover the EU15 further to the 1995 enlargement. However, no amendment of the agreement was negotiated to reflect subsequent enlargements.

Member states, including some of the main protein crop-growing countries. In addition, Lithuania, Poland, and Slovenia used specific measures available to the new Member States to support protein crops.

2.3.2 Presentation of the evaluated measures

Several measures of the CAP have an influence on the development of crops or plant cultivation. Among them the most significant ones are:

- the diversification and Ecological instruments (EFAs) of the greening part of direct payments
- the voluntary coupled payments,

Some others may also have an effect, such as some measures or instruments of the CMO, the AECMs[13] of the second pillar, the nitrate directive, but their potential effect is limited so they will be taken into account mostly qualitatively.

It is noteworthy that organic farms are not concerned by these greening requirements as it is considered that they already fulfil the environmental conditions.

2.3.2.1 Greening measure: the EFA and crop diversification measures

EFAs

The **EFA Measure** requirement[14] is to have at least 5% of the arable land of farms larger than 15 hectares (excluding permanent grassland) managed as an EFA (for instance field margins, fallow land, landscape features, buffer strips, afforested area, etc.). N-fixing crops (which include several of the crops/plants under study, but not all[15]) are one option that could be offered to farmers to comply with the EFA measure. In 2015, all Member States except Denmark allowed N-fixing crops as an EFA. For the year 2018 onwards[16], the use of plant protection products is prohibited on all areas of EFA N-fixing crops from establishment until after harvest of the N-fixing crop.

Crop Diversification

Under the crop diversification measures, most EU farmers[17] are required to grow at least two or three crops according to their farm size[18].

The crops and plants under study are rarely grown as the main crop in specialised farms and therefore would be an option for the farms to diversify their cropping patterns.

A given area of N-fixing crops declared as EFA also counts for the crop diversification measure. In other words, growing N-fixing crops can be an option for farmers (e.g. in mono-cropping farms) to comply with both measures. Furthermore, since 2018, the crop diversification requirement has not applied to farms with more than 75% of arable land used for the production of legume crops[19].

2.3.2.2 Voluntary coupled payments

Since 2015, Member States have provided **Voluntary Coupled Support (VCS)** to a list of sectors and productions (which may include several of the crops/plants under study), to the extent necessary to create an incentive to maintain current levels of production in sectors or regions where specific types of farming or specific agricultural sectors that are particularly important for economic, social or environmental reasons undergo certain difficulties[20]. Coupled support can take the form of an annual payment and is granted within defined quantitative limits in accordance with Article 52(6) of Regulation No 1307/2013. In this context, for each measure, member States shall determine a quantitative limit (QL). The limit reflects the production levels in the targeted region or sector of at least one year in the

[13] Agri-Environment-climate measures

[14] Regulation (EU) 2013/1307

[15] Sunflower and rapeseed are not included

[16] According to Regulation (EU) 2017/1155 of the European Parliament and of the Council of 15 February 2017

[17] In 2016, 75% of arable land in the EU (excluding France, for which data is unavailable) was subject to the crop diversification measure, with 63% subject to the three crop rule and 12% subject to the two crop rule.

[18] Where the arable area is 10-30 ha (and not entirely cultivated with crops under water for a significant part of the year) at least two different crops must be grown and where the arable area > 30 ha at least three crops must be grown.

[19] According to Regulation (EU) 2017/2393 of the European Parliament and of the Council of 13 December 2017

[20] Regulation (EU) No 1307/2013 of the European Parliament and the Council

period of 5 years that proceeds the year of the decision about VCS. The list of protein and oilseed crops eligible for such support is decided at Member State level and may be reviewed annually[21].

Member States may use up to 8% of their national ceilings for this support (or 13% in specific cases[22]). However, in order to maintain the protein-based autonomy of the breeding sector, Member States which decide to use at least 2% of their national ceilings to support the production of protein crops should be allowed to increase those percentages by up to two percentage points.

In 2015, 16 Member States[23] (15 in 2017, after Slovenia stopped its VCS for protein crops) decided to grant support to several protein crops (including soya bean) and two Member States[24] (one in 2017 after Spain stopped its VCS) to oilseeds other than soya bean (cf. table 4).

Table 4: Member state implementation choices regarding VCS and the EFA measure in 2015

Crop under study	Chickpea	Soya bean	Oilseeds (other than soya bean)	Lupine	Alfalfa	Pea	Fava bean[25]
AT							
BE Fl							
BE Wa							
BG	X	X		X	X	X	X
CR		X		X	X	X	X
CY							
CZ		X		X	X	X	X
EST							
FI		NS		X		X	X
FR		X			X	X	X
DE							
GR	X	NS		X		X	
HU	X	X		X		X	X
IE				X		X	X
IT	X	X		X		X	X
LV		X	X	X	X	X	X
LT				X	X	X	X
LU	X			X	X	X	X
MT							
NL							
PL	X	X		X	X	X	X
PT							
RO		X			X		
SK							
SL		X		X	X	X	X
ES	X	X	X	X	X	X	
SE							
UK En							
UK NI							
UK Sc							
UK Wal							

(green)	Selected as EFA by the MS
X	VCS (Voluntary Coupled Support)
NS	No information whether a coupled support has been implemented within VCS framework

Source: own compilation based on Member State notifications for the year 2015

2.3.3 Intervention logic of the main evaluated measures

[21] Regulation (EU) No 2393/2017 of the European Parliament and the Council of 13 December 2017

[22] i.e. in Member States which level of coupled support exceeds 5 % in at least one of the years of the period 2010-2014 or which apply the single area payment scheme until 31 December 2014.

[23] BG, CZ, ES, EL, FI, FR, HR, HU, IE, IT, LT, LU, LV, PL, SI and RO.

[24] ES and LV.

[25] Broad and field beans

2.3.3.1 *Intervention logic of the two concerned greening measures*

Figure 3 shows the intervention logic of diversification and EFAs measures, which have no specific goal concerning the production of PRP proteins but can incidentally lead to their production.

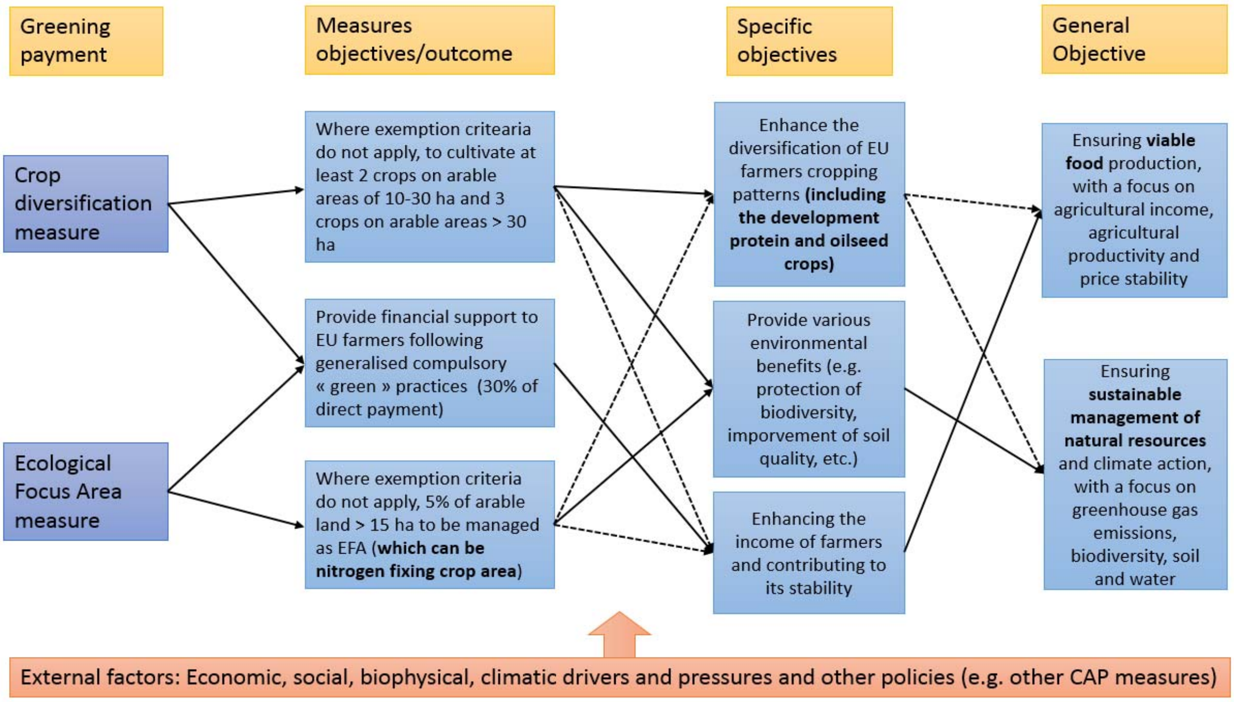


Figure 3: Intervention logic of the Greening EFA and Crop diversification measures (own work based on Regulation (EU) No 1307/2013 of the European Parliament and the Council)

This chart shows that the main goals of these two measures are environmental but as the greening payment is linked to them, they also have an effect on the agricultural income and viable food production.

2.3.3.2 *Intervention logic of the voluntary coupled payments*

Figure 4 shows the intervention logic of voluntary coupled payments, which clearly aim to increase from deprived levels (or maintain) the level of production of the concerned crops/plants.

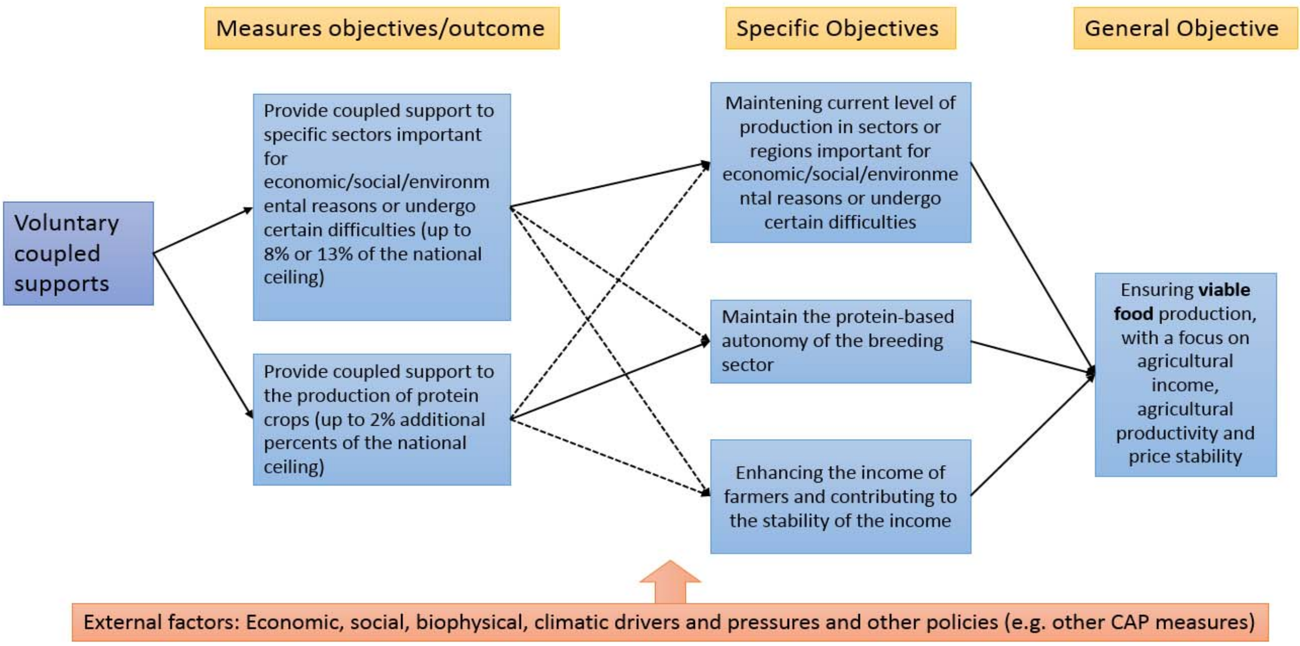


Figure 4: Intervention logic of the Voluntary Coupled Support (VCS) (own work based on Regulation (EU) No 1307/2013 of the European Parliament and the Council)

Figure 4 shows that this measure is dedicated to maintaining a certain level of production in defined regions and specifically to maintaining the protein-based autonomy of the livestock sector. In this sense, it has a direct link to PP production.

2.4 Main limitations of the methodology proposed

The main limitations of the proposed methodology are:

- the difficulty to conduct an in-depth analysis in such a time frame, and with so many value chains and stages in the value chains to be studied,
- the lack of official and harmonised data in some sectors such as forages (including farm consumption), organic production, GMO-free productions, etc.,
- the fact that some data is sensitive, particularly prices and margins along the value chains, hence it has been difficult to obtain this data from economic agents,
- the lack of geographical data at EU level to assess the economic difference between EU regions.

In addition to these general challenges, some limits related to specific evaluation questions (EQs) are presented at the beginning of the answer to each EQ in this report, in Chapter 5.

3 EU SUPPLY, DEMAND AND EXCHANGE CONTEXT FOR PRPS

3.1 *PRP supply in the EU*

Supply of the three categories of plants/crops studied in the evaluation is presented below. The first chapter presents the production and the second details the imports into the EU.

3.1.1 Oilseed production

In 2016, the world oilseed crop area[26] represented 12% of the global arable land. This share was roughly similar the 10% in the European Union, but its oilseed production mostly comes from rapeseed while it is mostly soya bean in other parts of the world.

Figure 5 illustrates oilseed production in the world and in the EU. Soya bean is by far the main oilseed produced on the planet, followed by rapeseed, sunflower and then linseed. Rapeseed is the main oilseed produced in the EU (29% of rapeseed world production). The PRP crops after that are sunflower (18% of sunflower world production), the EU soya, (contributing only to 1% of world soya bean production) and finally linseed (5% of linseed world production).

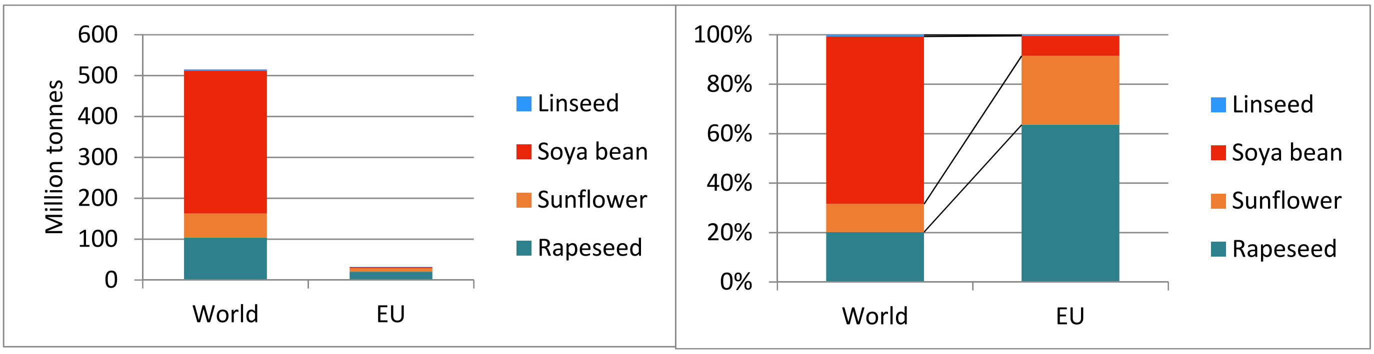


Figure 5 : Oilseed crop production in the EU and the world in 2016 (Million tonnes; FAO Stat)

Accounting for 35% of the world production, the U.S. was the main producer of soya bean in 2016[27]. Canada is the leading producer of rapeseed. Ukraine is the main producer of sunflower and Russia for linseed. The main suppliers to the EU are Brazil, the U.S. and Argentina for soya bean, Ukraine and Russia for sunflower, Australia for rapeseed and Russia, Canada and Kazakhstan for linseed.

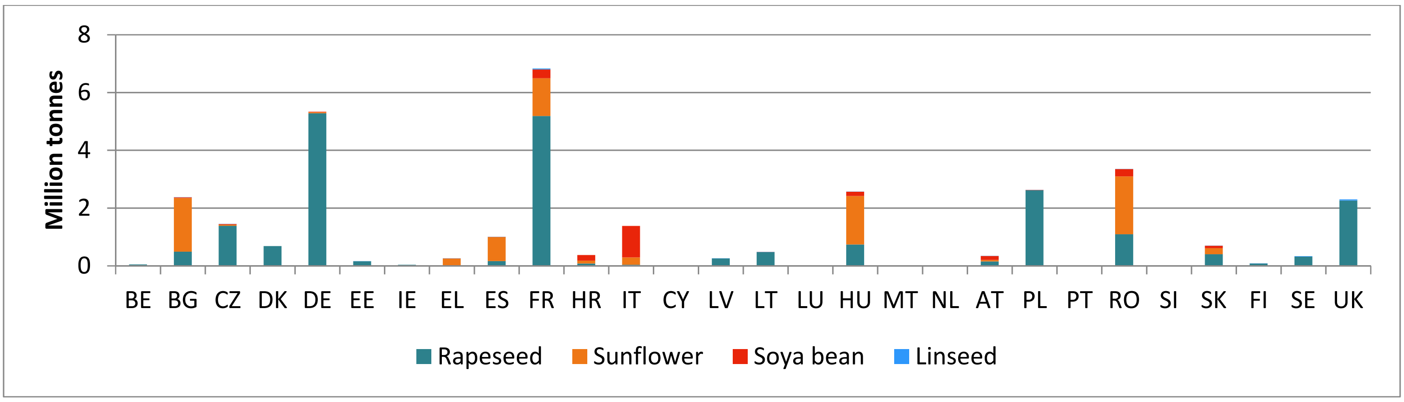


Figure 6 : Average oilseed production between 2014 and 2016 by MS (Million tonnes; Eurostat)

At the EU level (see Figure 6), the main EU producers of rapeseed are Germany (24.1% of the EU production[28]) and France (23.6%), representing together around 48% of the total EU oilseed production. For sunflower seeds, the main EU producers are Romania (23.1%), Bulgaria (21.5%), Hungary (19.4%) and France (15.1%). For soya beans, the biggest producers are Italy (42.7% of the

[26] Including Field beans, Field peas, Lupines, Lentils, Chick peas and Dry beans.

[27] Comext. Since 2018, Brazil has become the first soya bean producer.

[28] Average production between 2014 and 2016, Eurostat.

EU), France (11.8%) and Romania (10.1%). For linseed, the biggest producers are the UK, France and Sweden[29].

3.1.2 Pulse production

In 2016, pulses covered 4% of arable lands[30] in the world, compared to 2% in the European Union.

Figure 7 shows the detailed share of pulse production in the world, and the contribution of the EU to this global production. Dry beans, field peas and chickpeas are the three biggest productions in the world, followed by lentils, field beans and then lupines. In the EU, the main pulse produced is field peas[31], contributing to 16% of the world production, followed by field beans (19% of the world production). The production of chickpeas and lentils is very limited compared to the world production. Altogether, the EU pulse production accounts for 7.3% of the pulses produced globally.

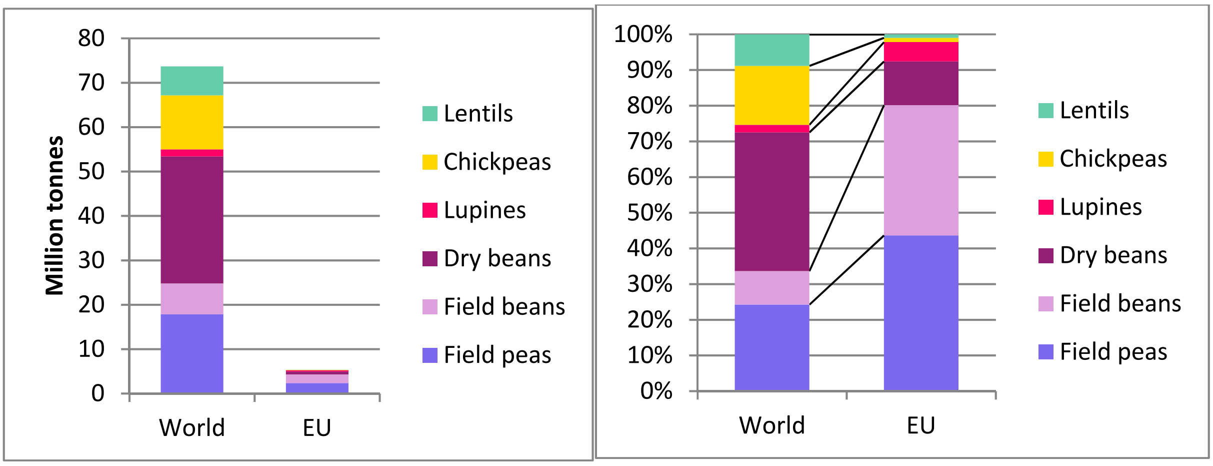
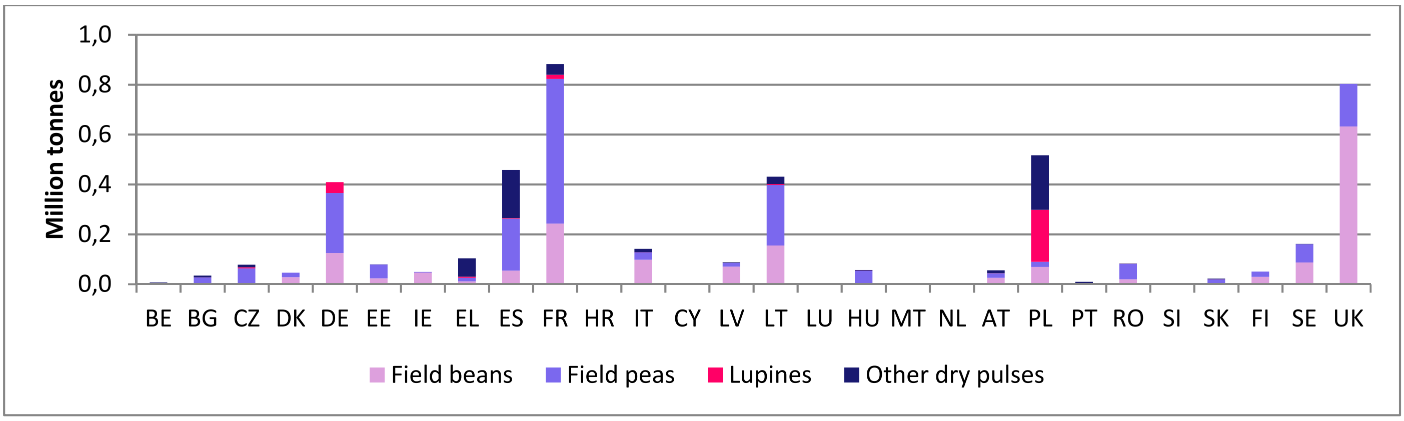


Figure 7 : Pulse production in the EU and the world in 2016 (Million tonnes; %; FAO Stat)

On a global scale, the main producer of dry beans is Myanmar[32], where dry bean is a traditional crop, usually grown just after the rice harvest or as a monsoon crop (USDA, 2018). The main producer of field peas is Canada, where it is mainly processed into soup, an important industry in Canada, but also exported both as human food and animal feed. For lentils, the main producer is also Canada, which produces 95% of the tonnage (Lentils.org). The main chickpea producer is India, accounting for about 64% of the world production. China is the leading field bean producer, with 33% of the global production.[33] Finally, Australia is the main producer of lupine, producing around 50% of the world production, mainly used to feed ruminant cattle (AgriFutures.com, 2017).

The big players supplying the EU are Canada, Argentina and China for dry beans, Canada and the U.S. for lentils and Mexico, Argentina, the U.S. and Canada for chickpeas. Russia is the main field pea supplier to the EU and field beans are not imported at all into the EU.



[29] Total EU linseed production was not available on Eurostat, thus no percentage of the EU production was calculated for linseed.

[30] Meaning Field beans, Field peas, Lupines, Lentils, Chickpeas and Dry beans.

[31] *Pisum sativum*.

[32] Myanmar exports almost its entire dry bean production to India.

[33] FAO Stat.

Figure 8 : Pulse PP average production between 2014 and 2016 by MS (Million tonnes; Eurostat)

The main producers within the EU (all PRPs combined) are France, the UK, Poland, Spain, Germany and Lithuania (see Figure 8). For field beans, the UK is the biggest producer, followed by France. The largest producers of field peas are France, Germany and Lithuania. Poland is the main producer of lupine and it is also the main producer with Spain of "other dry pulses[34]".[35]

3.1.3 Forage legume production

Data on forage legume production is not available in FAO Stat and contains many gaps in Eurostat. Figure 9 provides a first estimation (at 65% moisture[36]) based on a compilation of various data: Eurostat, data from cases studies and from the European research project "Multisward" (Huyghe et al., 2014). Figure 9 includes only legume fodders in pure stand, meaning that mixtures (e.g. mixed temporary grasslands of clover and grass forages) are not included[37]. The total production of legume fodders has been estimated at 55.6 million tonnes. This production is mainly alfalfa and clover-based.

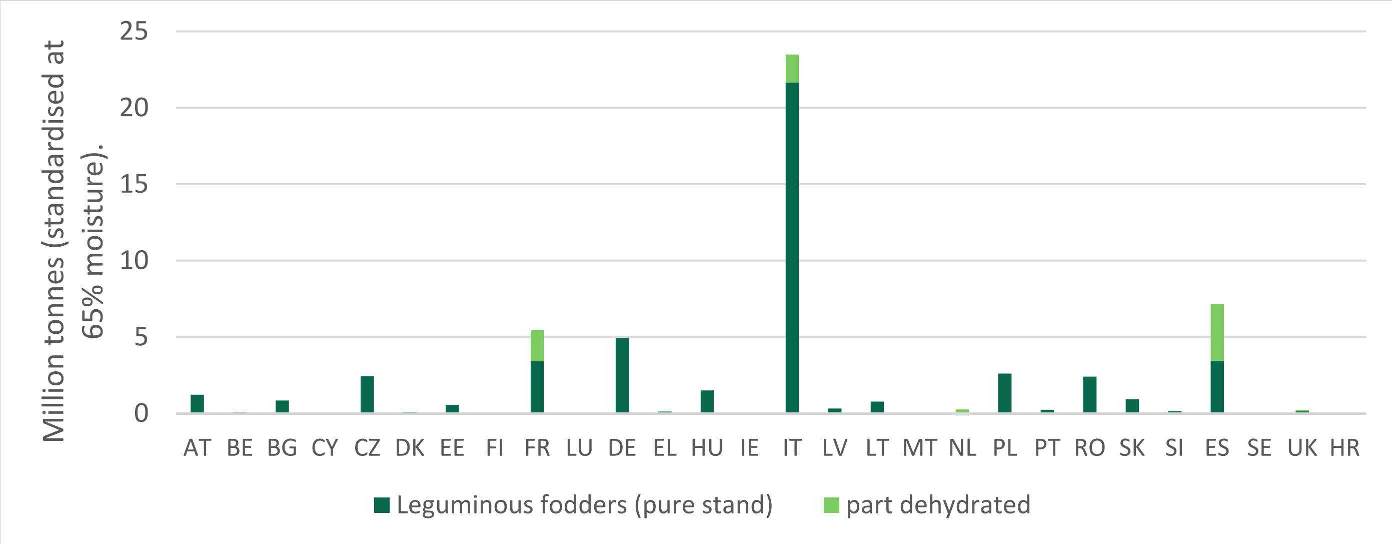


Figure 9: Total estimated legume fodder production in the EU-28 (55.6 million tonnes, standardised at 65% moisture, in line with Eurostat standard moisture).

Part of the production of legume fodder is dehydrated in dedicated plants, meaning that producers outsource the drying to a mutualised tool (often cooperative, especially in FR and DE, see chapter 4).

By combining various datasets (Eurostat, CIDE, CS data), it can be estimated that dehydration accounts for about 15% of legume fodders produced in the EU and about 18-19% in CS countries. It represents about half of the legume fodder production of Spain. The main producers of commercial dried forage (mainly alfalfa and clover) are Spain, France and Italy.

Fodder dedicated to dehydration can be produced by specialised crop farms or mixed farms. In that case, the farmers can take back all or a part of their production[38].

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[34] The category "other dry pulses" includes dry common/French beans and runner beans, chickpeas, dry lentils and dry vetches (Eurostat).

[35] See also annex 2 showing the trends in PRP crop production since 2003 in the EU for each PRP crop.

[36] The moisture content of fodders varies greatly from one type of conservation to another. For example, dehydrated or hay contains 8-12% moisture while a silage contains 60-65%, a haylage 35%, and the freshly cut product about 80%. As result, results must be harmonised to be compared. In this report (except when otherwise specified), the standard moisture content is 65%, in line with the EUROSTAT standard moisture content.

[37] Animal feed experts interviewed argue that more than half of temporary pastures in the EU (sown meadows) are a mixture of grass and LFs, meaning that the share of LFs in the protein supply might be largely underestimated in the EU. The CS France reports that 70% of sown pastures are be a mixture of grass and LFs and that the seed market shows a growth of the legume fodder share: the percentage of mixtures has grown from 15% to 23% of the market between the 2010/2011 and 2014/2015 campaigns. These mixtures contain more and more legume fodders (from 15% of LFs in 2010/2011 to 23% in 2015/2016) and are largely used for catch and cover crops.

[38] This system is particularly developed in DE (76% of the production, see Table 5) and to a lesser extent in FR (especially the western parts where dairy production is developed). Productions in Spain and Italy are more dedicated to exports and grown by specialised crop farmers, mostly in the Ebro area and the Northern parts of Italy.

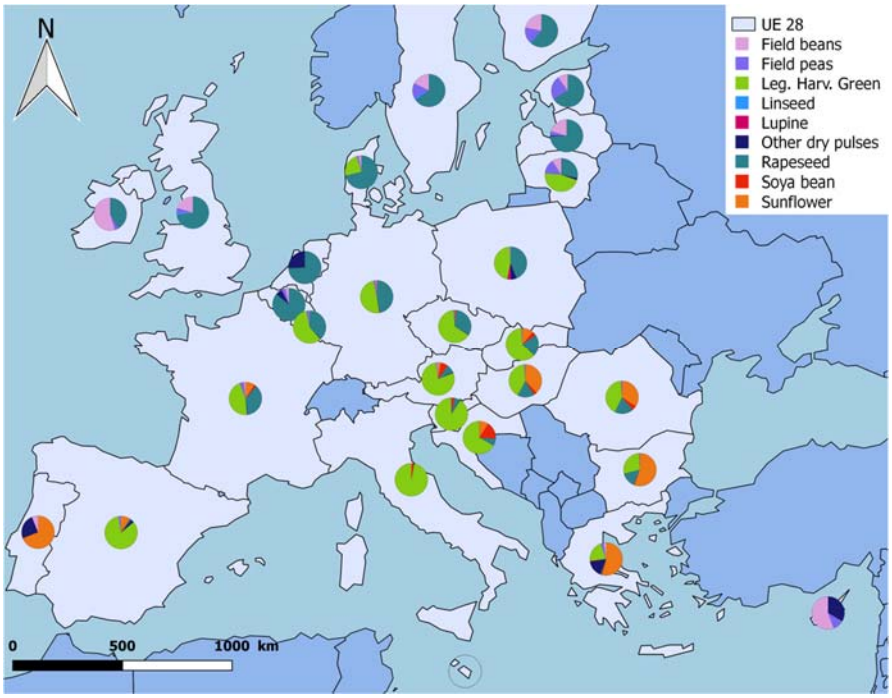
Table 5: Total estimated dehydrated fodder area in the EU-28 and in CS-Countries in 2015 (standardised at 65% moisture for comparison with above table).

	Dehydrated fodder	Dehydrated Alfalfa	Others (clover, vetches, grass)	Given back to farmers after dehydration
	Unit: 1000 t at 65 % moisture			
Germany	391	121	270	76%
Spain	3,696	3,326	370	Negligible
France	2,037	1,949	88	11%
Italy	1,823	1,383	440	Negligible
Rest of the EU	341	265	75	22%
Total EU-28	**8,287**	**7,044**	**1,243**	**6%**

Source: CIDE annual survey

3.1.4 Relative shares of PRP production within the EU

Map 2 depicts the share of each PRP within the total PRP production per MS. Northern MS around the Baltic Sea mainly produce rapeseed, field peas and field beans, which are crops more adapted to cold climates. South-eastern MS mainly produce sunflower and legumes harvested green (LHG). Legumes harvested green are also widespread in central and Eastern EU.



Map 2: Member States' share of average production of PRPs between 2014 and 2016 (Eurostat)[39]

3.1.5 Overview of PRP imports into the EU

Figure 10 underlines the importance of soya bean and soya meal imports compared to the other PRP imports. Sunflower meal and rapeseed rank third and fourth, respectively, and also represent significant imports. The other PRP imports are less significant.

[39] Data was missing for Belgium, Estonia, Ireland, Cyprus, Portugal and the UK for Legumes harvested green and for Germany for Other dry pulses and Linseed.

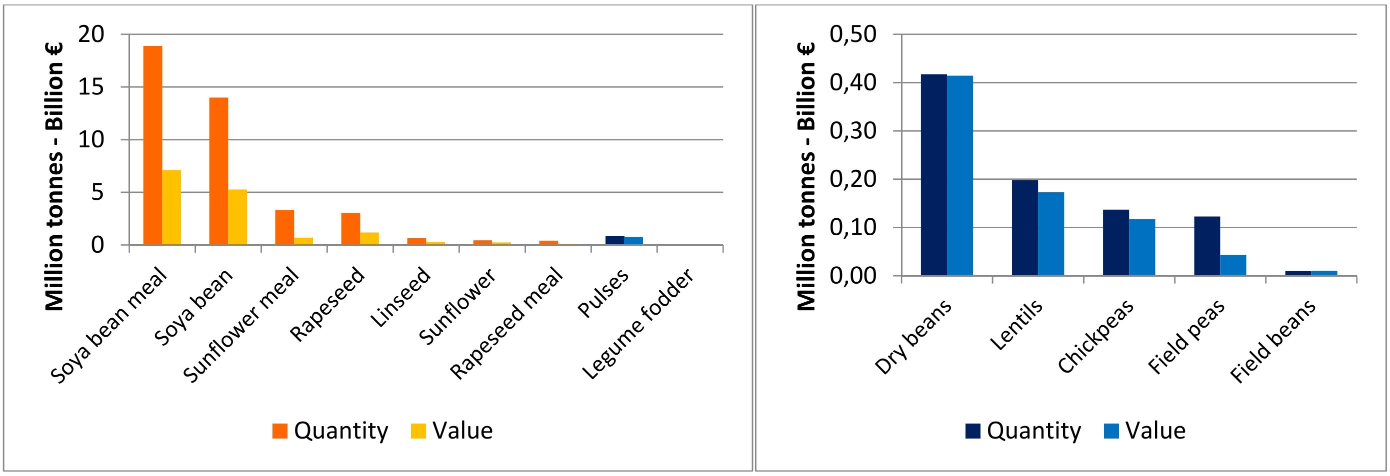


Figure 10 : Average annual EU PRP import between 2013 and 2015 (Million tonnes, Billion €; Comext)[40]

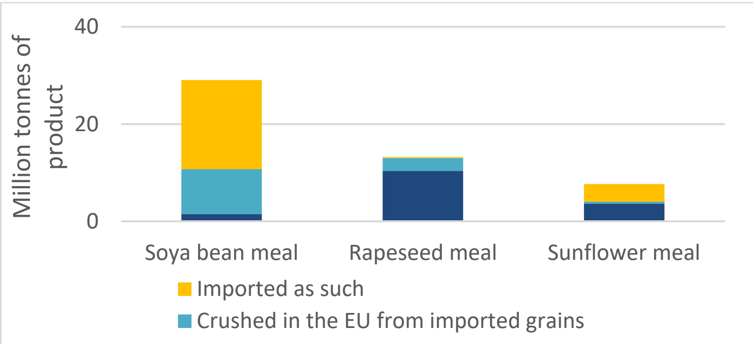


Figure 11 : Origin of oilseeds used for meal production (Million tonnes, DG AGRI, campaign 2015-2016)

Figure 11 shows the origin of seeds for meal production. For soya bean, the main part of the meals used come from meal imported as such. Rapeseed meals used in EU are mainly made with EU grain. Finally, sunflower meals used in the EU are half made with EU grain and half imported as such.

3.1.6 Total EU supply

Figure 12 underlines the fact that EU imports significant amounts of oilseed grain and meal, especially for soya. The graph also stresses the high autonomy of the EU for its legume fodder supply (explanations provided in chapter 3.3).

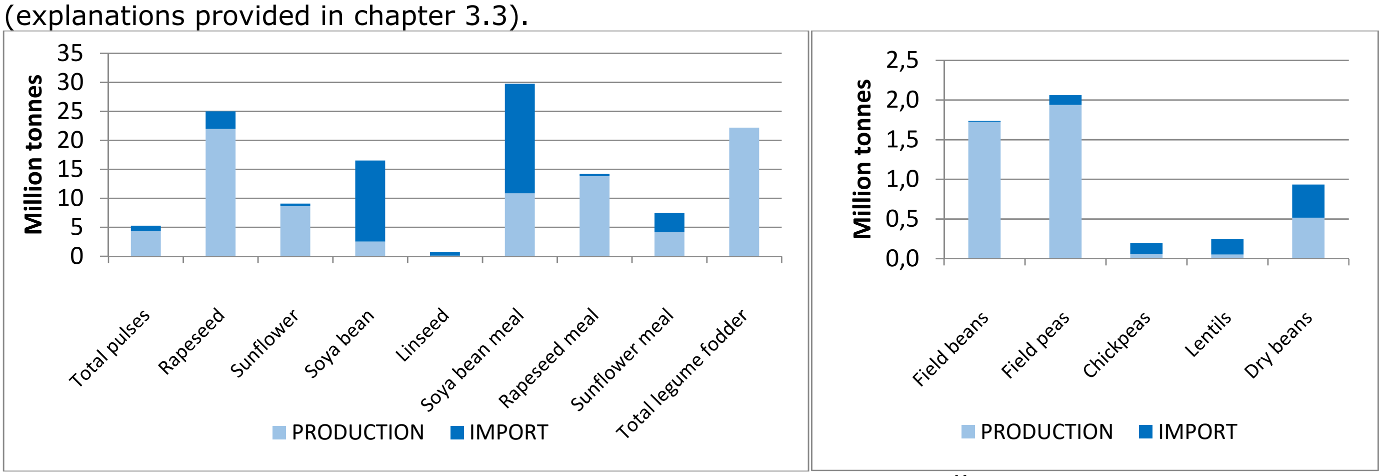


Figure 12: Supply of PRP in the EU (Million tonnes; Eurostat, Comext, FAOSTAT[41]).

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[40] As data was not available concerning field beans on Comext, Comtrade data was used for this crop.

[41] Data comes from Eurostat for production, from Comext for import and export and from FAOSTAT for Chickpeas, Lentils, Dry beans and Linseed productions as data wasn't available on Eurostat for these crops. Dried legume fodder production has been estimated according to EUROSTAT, ISTAT and MULTISWARD and import and export combining 12149090 and 121410 Comext categories.

Data for sweet lupines and alfalfa is not available, so this graph does not include these two crops.

3.1.7 EU supply chains to sustain the EU demand for PRPs

Supply chains of plant proteins encompass a great diversity of models. These different organisational arrangements depend on various criteria that have been identified during the study, such as:

- Member states (significant differences can be observed in organisational patterns, especially between the EU-15 and other MS),
- commodity markets vs high value markets,
- for high value markets, the type of market strategy used (labelling, type of negotiation, standard)
- the relative importance of by-products (oil / protein, starch / protein),
- governance (forward contracts or not, collective organisations or not, type of price negotiation, price setting),
- geographical scale,
- etc.

The paragraphs below therefore present average situations of each value chain of the studied products.

3.1.7.1 Soya bean supply chains in the EU

The EU farms produce 2.5Mt of soya bean grain[42]. Collectors deliver soya beans to oil extractors (around 2Mt[43]), to the food industry and to extruders. Oil extractors import 12 Mt of soya beans and transform it, with the grain from the collectors, into 11Mt of crush mainly going to the feed industry and into 2.5Mt of oil going to oil collectors[44].The compound feed companies also import 18.3Mt of soya meal[45] and around 2Mt of beans and process it, with the incorporation of other raw materials into compound feed, sold to intermediaries and/or then to livestock farms.

Figure 13 gives a summary of this supply chain, the size of the arrows being proportional to flows.

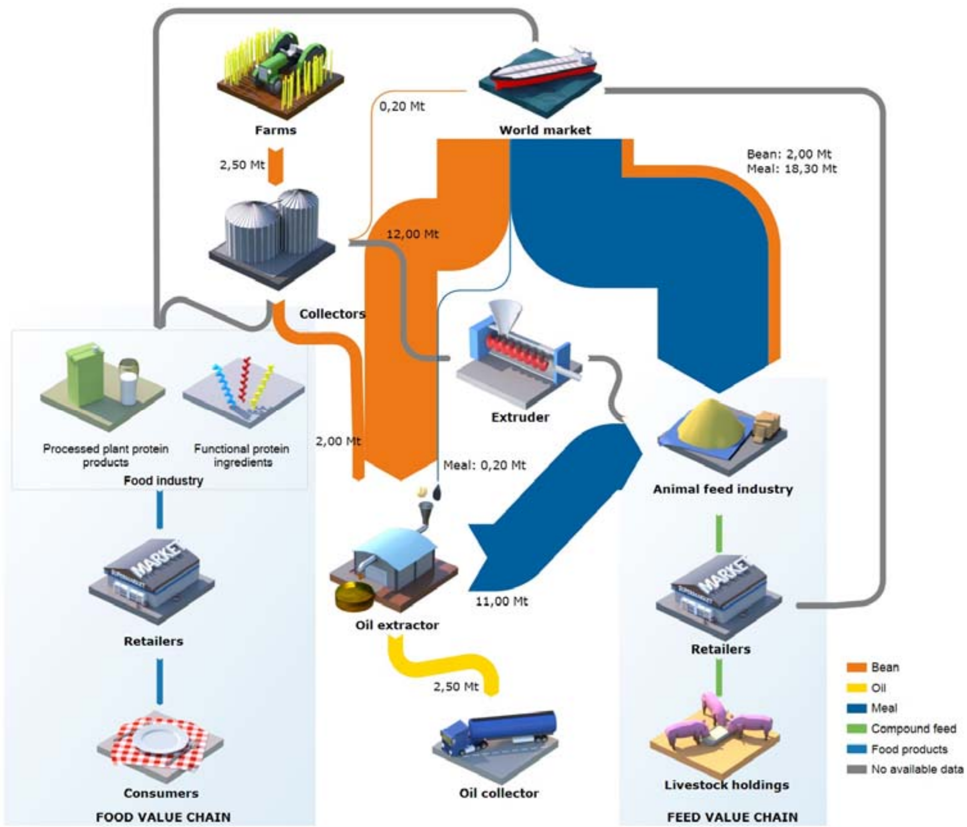

Figure 13: Main flows of materials to sustain the demand in the soya bean sector (Million tonnes, Source: own work based on several sources: Eurostat, Comext, Dg Agri, ENSA, etc. Campaign 2016-2017)

42 Eurostat.

43 DG Agri.

44 DG Agri and Terres Univia for the average oil yield of soya bean

45 DG Agri.

For this supply chain, the most significant supply comes from imports and the largest demand is for feed (98% of volume). The uses of soya bean as food are numerous, from processed plant protein products (e.g. tofu, soy drinks, etc.) to products mainly used for their functionalities (e.g. viscosity, emulsifying, texturizing, etc.). Both feed and food markets of soya bean include specific market premium segments in GM-free and organic products (see § 435 & 436).

3.1.7.2 Other oilseed supply chains in the EU

This chapter treats mainly the rapeseed and sunflower productions. EU farms produce 28.6Mt of oilseeds[46]. Collectors deliver oilseeds to oil extractors (around 26.7Mt[47]), to the food industry and directly to the feed industry. Oil extractors also import 5.5Mt of grain and process this grain into 17.8 Mt of meal[48] mainly going to the feed industry and into 13.6Mt of oil going to oil collectors[49]. Animal compound feed factories also import 3.9Mt of oilseed meal[50] and process it into compound feed (incorporating other raw materials), sold to retailers and then livestock holdings[51]. Oil collectors deliver 6.2Mt of oil dedicated to the biodiesel sector[52], exports 0.8Mt[53] and 4.5Mt to the food industry[54].

On the food side, the food industry also imports oilseed grain and produces food products that are sold to retailers and then consumers[55] (see Figure 14).

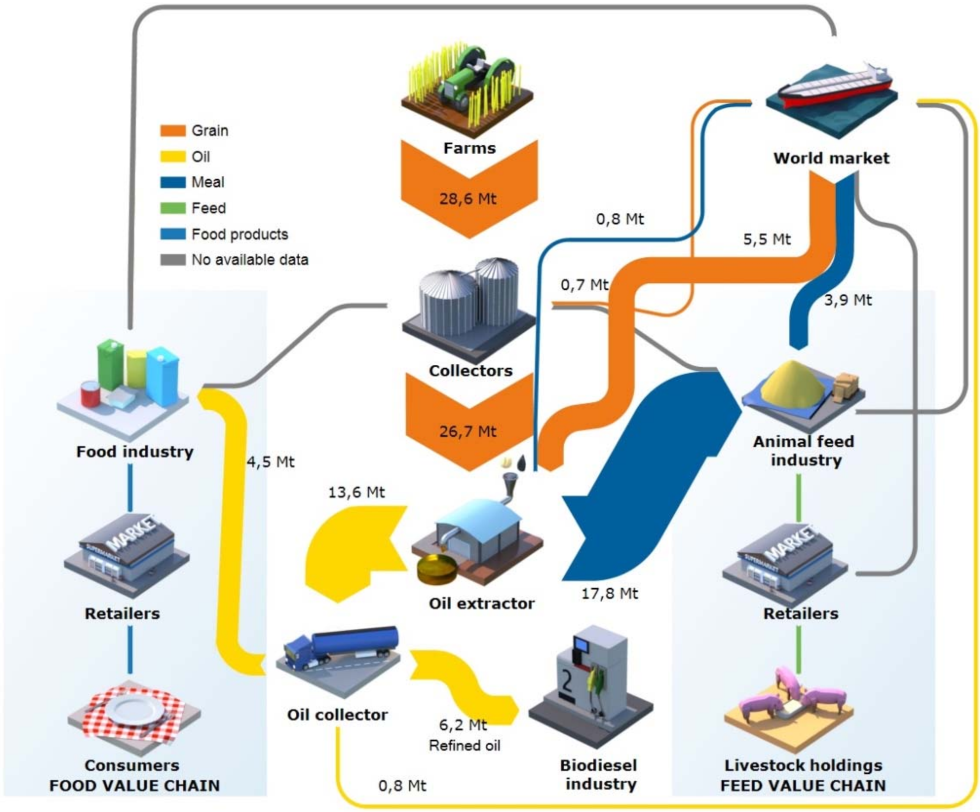

Figure 14: Main flows of material to sustain the demand in the "other oilseeds" sector (Million tonnes, Source: own work based on several sources (Eurostat, Comext, Dg Agri, FEDIOL, etc. Campaign 2016-2017)

[46] Eurostat.

[47] Own calculation based on the EU meal production, DG Agri and Terres Univia for the average oil yield of rapeseed and sunflower.

[48] DG Agri.

[49] FEDIOL.

[50] DG Agri.

[51] The compound feed arrows are not quantified, as they represent products composed of various materials and not only soya bean.

[52] USDA, FEDIOL.

[53] FEDIOL.

[54] FEDIOL.

[55] The food products arrows are not quantified, as they represent products composed of various materials and not only oilseeds

For this supply chain, the most significant supply comes from the EU itself and the demand is for food (for which oil is the main demand), the energy sector (oil for biodiesel) and feed (through meals). Both feed and food markets of rapeseed and sunflower include a specific organic premium market segment (see § 4.3.5).

3.1.7.3 Pulse supply chains in the EU

EU farms produce 5.7 Mt[56] of pulse grains[57], and part of them also directly use pulses on-farm as feed (very little data on it at the EU level). Collectors deliver around 1.2 Mt pulses to the food industry and 3.4 Mt to the feed industry. The sector also exports around 1.2Mt of pulses. In addition, compound feed factories import 0.6 Mt of pulses and process it into compound feed (incorporated with other raw materials) which is sold to retailers or for export and then to livestock holdings[58]. On the food side, the food industry also imports pulses (0.7Mt) and produces food products; these are sold to retailers or exported and eventually sold to consumers[59] (see Figure 15).

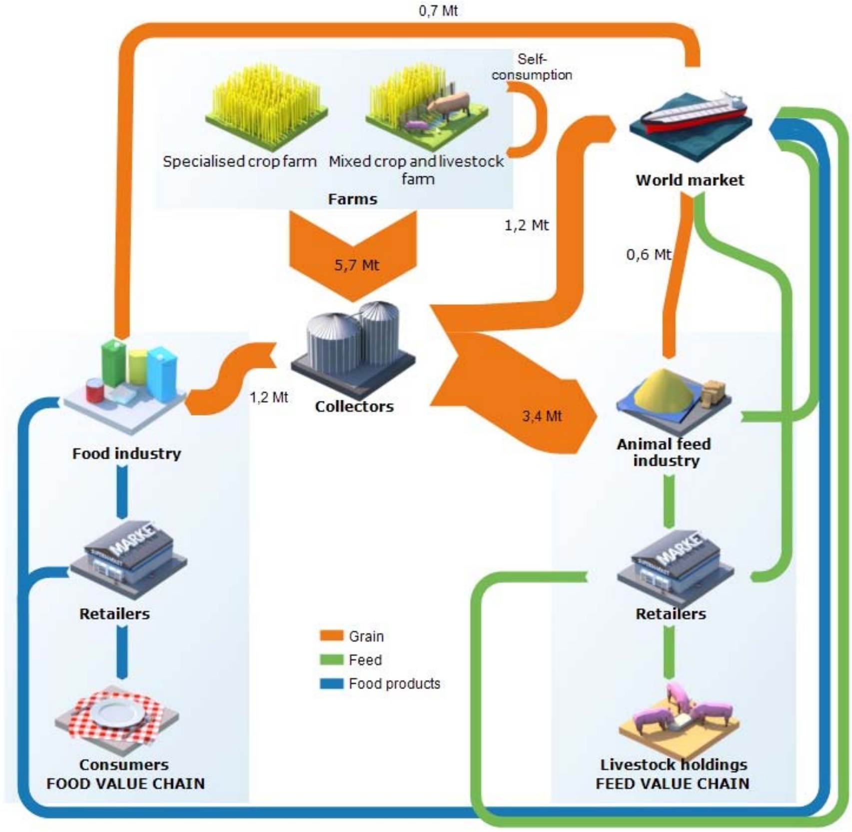

Figure 15: Main flows of materials to sustain the demand in the pulses sector (Million tonnes, Campaign 2017/2018; Source: own work based on several sources (Eurostat, Comext, Dg Agri, ENSA, etc.))

For this supply chain, more than half of the supply comes from the EU (54 %). Feed demand is higher (around 2/3) than food demand. In value terms, the food sector has developed high-margin products going both to consumers (e.g. grain used as such) and the food industry for protein extraction (mainly with peas). Both feed and food markets of pulses include specific market premium for organic products (see § 4.3.5).

3.1.7.4 Legume fodder supply chains in the EU

Forage legumes can be cultivated as pure stand or combined with other crops, mostly with other fodder grasses. Forages of legume plants are mostly self-consumed on farm under various conservation forms: hay, haylage, silage or sometimes directly grazed as such. Exchanges between farmers within a close territory are common but difficult to track because these are not reported in

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[56] DG Agri.

[57] In this figure, only field beans, peas and lupines are studied, as data for other pulse crops was not available.

[58] The compound feed arrows are not quantified, as they represent products composed of various materials and not only pulses.

[59] The food products arrows are not quantified, as they represent products composed of various materials and not only pulses.

farming statistics and often informal. In some areas, legume fodder such as alfalfa (sometimes clover) is harvested green (undried or semi-sun-dried) to be dehydrated in a dehydration plant. For quality and handling reasons, traded legume fodders are essentially sundried (hay) and dehydrated fodder (else water would be transported). After being dehydrated, fodder can be given back to the forage-producing farms to feed cattle (mixed farms) or sold to other farmers, animal feed producers, traders, and exporters. Plant processing allows forms of packaging (pellets, bales, compressed bales, small bales, meal) and allocation of harvests in drying plants enables segmenting the market with different quality products (levels of fibre, protein, energy, etc.).

• Sun-cured fodder: sun-cured fodder (hay) is normally less homogeneous and is for the domestic market. Sun-cured fodder operations include mowing, which may be combined with conditioning; turning and tedding to allow an even drying, windrowing, collection and baling.

• Dehydrated fodder: alfalfa destined for dehydration is cut in the field. After a pre-drying phase in the field, it is windrowed and transported to the fodder processing plant, either by processors or farmers.

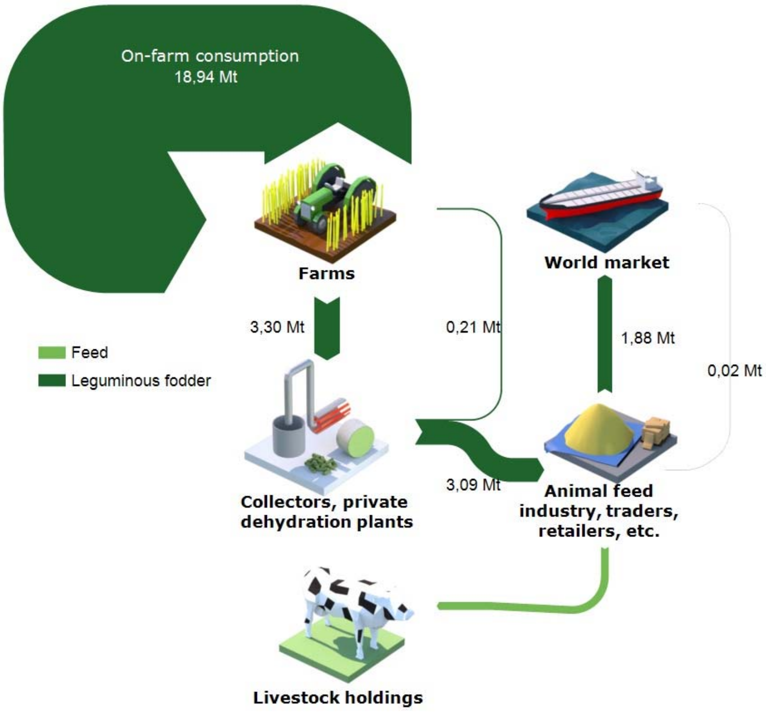


Figure 16: Legume fodder sector in the EU (Million tonnes normalized at 10% moisture, Sources: EUROSTAT, CIDE, (Huyghe et al., 2014))

Figure 16 shows the tremendous auto-consumption in livestock farms. There is nevertheless a market of dehydrated legume fodders and significant exports (cf. parts 3.1.7.4, 3.3.2, 3.5.3 and chapter 4).

3.2 EU demand for PRPs

3.2.1 Total EU demand for PRPs

Figure 17 highlight the high dependency of the EU on imports for its PRP supply and underlines the high demand for oilseed meals, especially soya meal[60]. This graph also shows the high consumption of legume fodder, ranking second after soybean meal. Rapeseed meal consumption can be explained by the wide availability (biodiesel co-product) and the competitiveness of rapeseed within the EU against other crops. PRP exports are quite marginal compared to domestic consumption and the largest PRP export is legume fodder. Consumption of dry beans, lentils and chickpeas is smaller than other PRP products because they are mainly used for food, while all the other ones are mainly dedicated to feed.

[60] Soybean is not consumed as such for feed: need for a thermic/chemical treatment to eliminate anti-nutritional factors

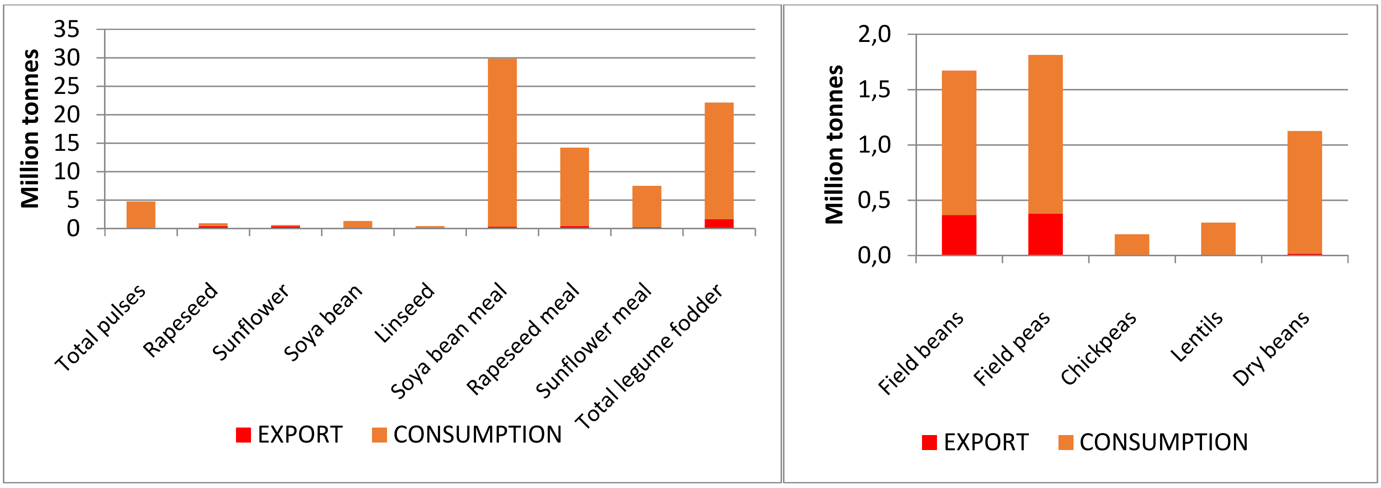


Figure 17: Demand for PRP in the EU (Million tonnes, Eurostat, Comext, FAOSTAT[61]).

3.2.2 Overview of PRP exports from the EU

Figure 18 highlights the major exports of PRP from the EU to the rest of the world, showing that the main volumes and values concerned are mostly bales of legume fodders, followed by pulses (mainly field peas and beans, mainly exported to Egypt and India for food), rapeseed meal, rapeseed and sunflower, followed by field peas, field beans, alfalfa in pellets, soya meal, sunflower meal and soya bean. The rest represents very small amounts of food products such as dry beans, chickpeas or lentils.

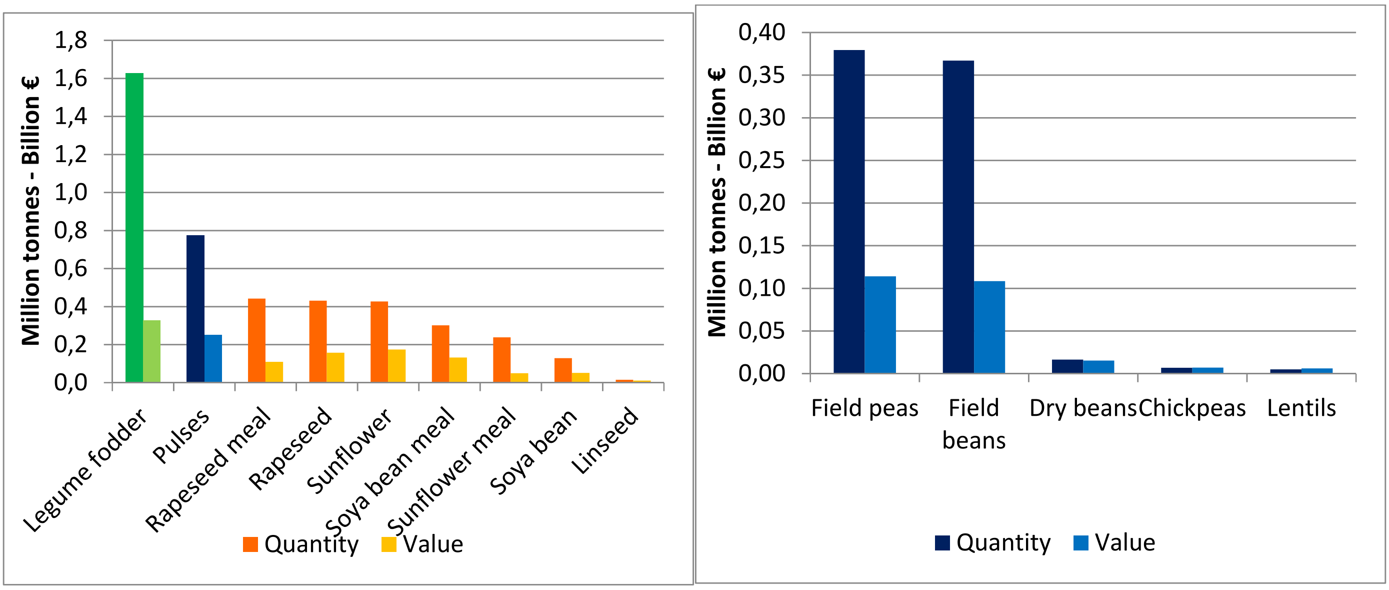


Figure 18: Average annual EU PRP export between 2013 and 2015 (Million tonnes, Billion €; Comext)

As mentioned above, the EU demand for PRP proteins tends to increase. The constant demand for meal from protein crops for livestock production has stabilised domestic consumption of plant proteins as feed.

However, since 2007-2008, the consumption of meals other than soya meal has seen an increasing growth trend. The increasing soya bean prices in the beginning of the 2000s may have forced the feed industry to use other options such as rapeseed meal and sunflower meal. Biofuel policies have also had a significant influence on this trend (see § 3.5.1).

[61] Data comes from Eurostat for production, from Comext for import and export and from FAOSTAT for Chickpeas, Lentils, Dry beans and Linseed productions as data wasn't available on Eurostat for these crops, and from FAOSTAT for Chickpeas, Lentils, Dry beans and Linseed production as data wasn't available on Eurostat for these crops. Dried legume fodder production has been estimated according to EUROSTAT, ISTAT and MULTISWARD and import and export combining 12149090 and 121410 Comext categories.

Data for sweet lupines and alfalfa is not available, so this graph does not include these two crops.

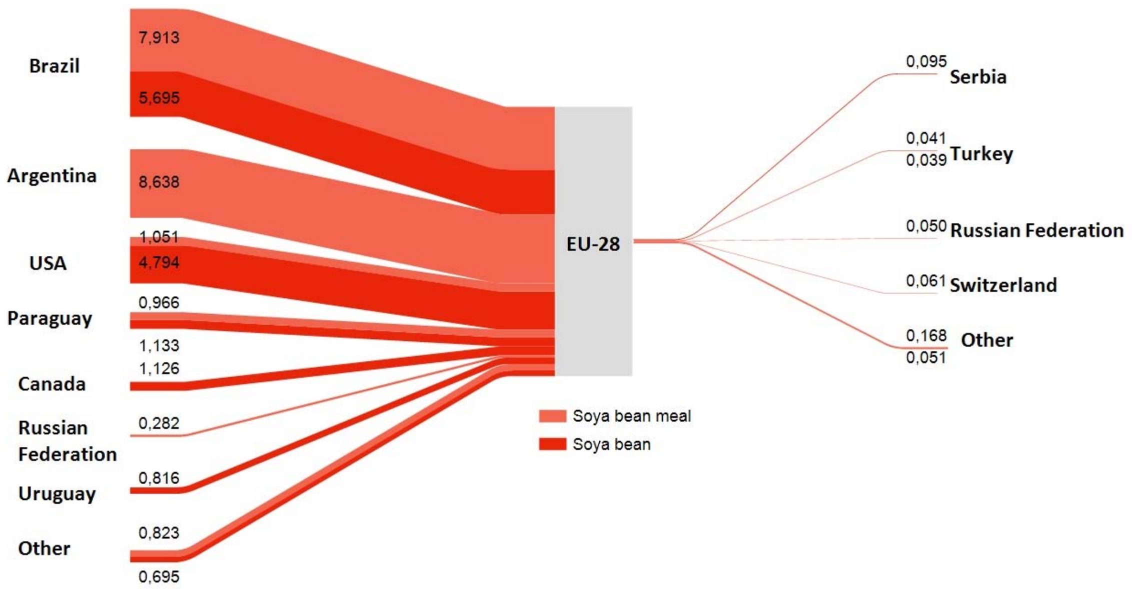
3.3 The EU PRP trade balance

3.3.1 Oilseed balance

Soya bean balance

The main importers of soya bean in the world are China, the EU, Mexico and Japan. The main exporters are the U.S., Brazil, Argentina and Canada[62].

Figure 19 shows that the EU is a big importer of soya bean and soya meal, only exporting small amounts of soya beans and soya meal to Serbia, Turkey, Russia and Switzerland. The main import comes from Brazil and Argentina, which is mainly soya meal, followed by the U.S. and Paraguay.



Total Import	EU Production	Total export
14.259 Mt (beans) + 19.673 Mt (meal)	2.340 Mt (grain)	0.187 Mt (grain) + 0.318 Mt (meal)

Figure 19 : Soya trade between the EU and the rest of the world in 2015 (Million tonnes, Comext) [63]

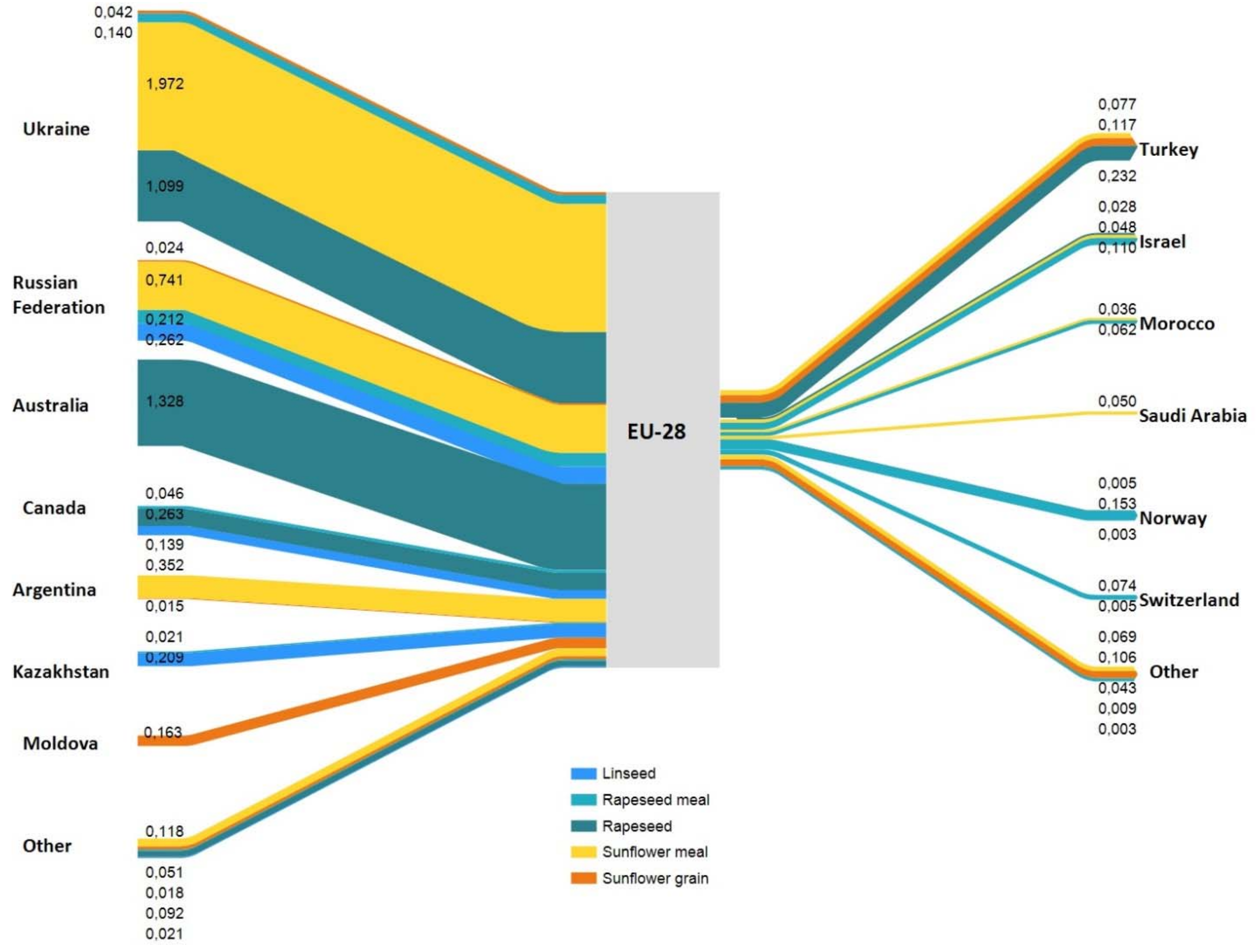
As clearly shown by Figure 19 above, the EU is a large importer of soya bean in equivalent grain and a very marginal exporter.

Other oilseeds (without soya) balance

Figure 20 represents import and export of oilseed crops and oilseed meals without soya bean. It shows that the EU is also a very big importer of oilseed (grain and meal), mainly from Ukraine, Russia and Australia. The main imports are sunflower meal and rapeseed. Besides, rapeseed meal mainly comes from Russia, Ukraine and Belarus while sunflower grain is mostly imported from Moldova. Linseed is mainly imported from Russia, Kazakhstan and Canada. Exports mainly go to neighbouring countries and the Middle East.

[62] According to Comtrade, 2016.

[63] For all the flow diagrams, we represented the main exchanges (three to five main exchanges per PRP studied). The other exchanges concerning the PRP are grouped under a single arrow named "Other". In this presentation, the sum of all the arrows of one PRP represents the total of this PRP exchanges. Data comes from Comext, however as it was not available for field beans and chickpeas, we use Comtrade for these crops.



Total Import	EU Production	Total export
3.708 Mt (grain) + 3.620 Mt (meal)	29.671 Mt (grain)	0.508 Mt (grain) + 0.722 Mt (meal)

Figure 20 : Oilseed trade (without soya) between the EU and the rest of the world in 2015 (Million tonnes, Comext)

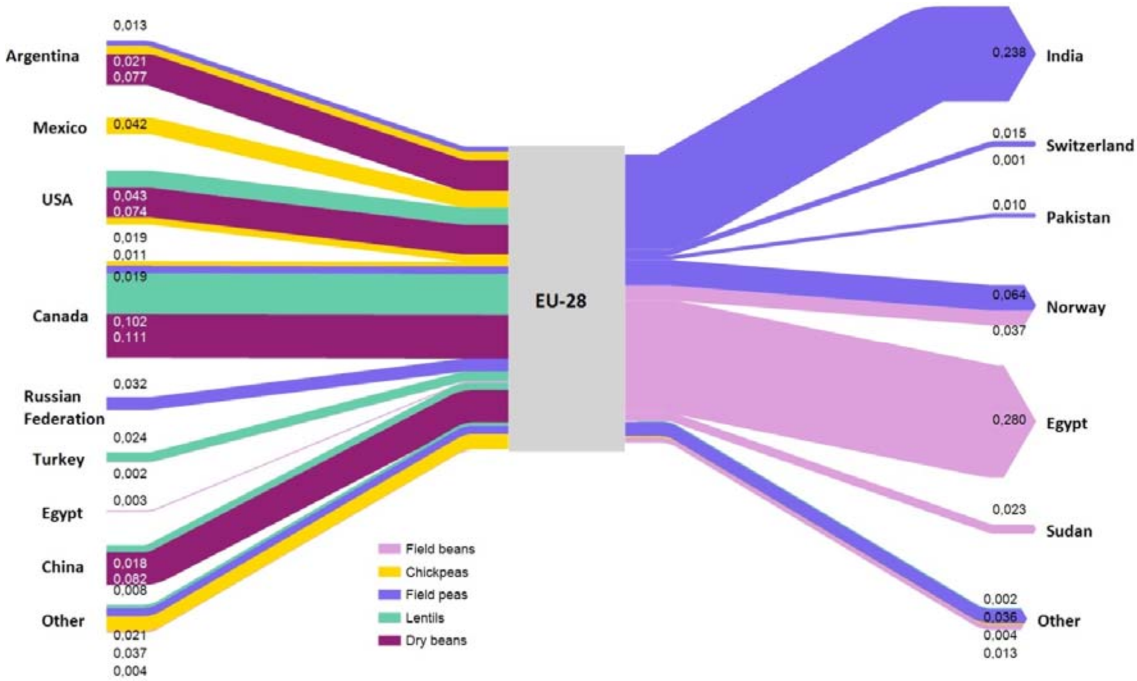
The table in Figure 20 shows a very significant autonomy of the EU for these products, partly due to the influence of the biodiesel policies, as almost half of the rapeseed meals come from this sector. The graph shows a negative trade balance, especially because the EU imports significant amounts of sunflower meals.

Pulses balance

The main importers of pulses in the world are India, followed by China, Bangladesh, Pakistan and Egypt. The main exporters are Canada, Australia, Myanmar, the U.S. and China[64].

Figure 21 highlights that the EU is a dry beans, lentils and chickpeas importer and a major field peas and field beans exporter. Dry beans and lentils are mainly imported from Canada and the U.S. and chickpeas from Mexico and Argentina. On the other hand, field peas go mainly to India and to Norway and field beans are exported to Egypt and Norway.

[64] According to FAO Stat.



Total Import	EU Production	Total export
0.744 Mt (grain)	4.321 Mt (grain)	0.723 Mt (grain)

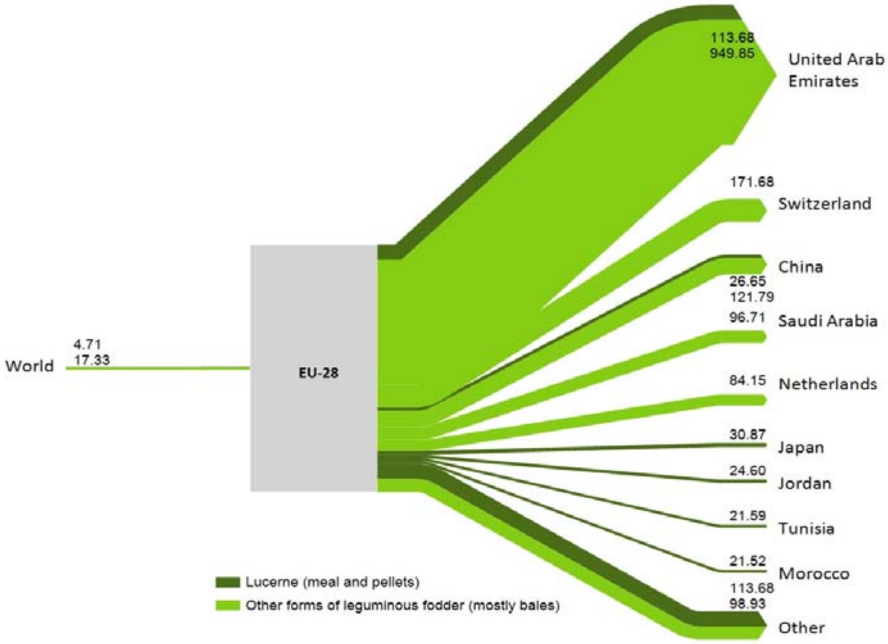
Figure 21 : Pulse trade between the EU and the rest of the world in 2015 (Million tonnes, Comext and Comtrade)

For pulses, imports and exports are relatively similar in terms of magnitude. However, it can be noticed that these trades mainly concern food productions: imported dry beans, lentils and chickpeas are used for food, while field peas and beans exported are also mainly used for food, in particular in Egypt and India.

3.3.2 Legume harvested green balance

Alfalfa

Traded alfalfa is only dehydrated alfalfa. Imports are negligible compared to domestic production and imports. The EU is a big player in alfalfa export. The main destination of alfalfa meal, pellets or bales export is the United Arab Emirates, but it is also exported to many regions of the world such as Switzerland, China, Saudi Arabia and Tunisia. In 2015, Comtrade identified 59 destinations of alfalfa export of meal and pellets from the EU. Figure 22 shows that the EU is a net exporter of legume fodders. More information about legume fodder trading is given in § 3.5.3.



Total Import	EU Production	Total export
0.004 Mt alfalfa pellets 0.018 Mt other forms (e.g. bales)	3.088 Mt dehydrated of which 208 given back to herbivore farms 21.634 Mt on-farm produced leguminous fodders – all forms	0.355 Mt alfalfa pellets 1.524 Mt other forms (e.g. bales)

Figure 22 : Alfalfa (meal and pellets) and other forms of legume fodder (mostly bales) trade between the EU and the rest of the world in 2015 (Million tonnes, Comext)

This graph shows that internal demand represents by far the main market, which is largely covered by internal production. However, a part (~7%) of the produced fodders are nevertheless exported, mainly to the UAE.

3.3.3 EU balance in crude protein

Figure 23 summarises, in million tonnes of crude protein, the four flow charts of the preceding paragraphs. It shows the relative importance of the exchanges of pulses (limited exchanges), soya bean (major importance of imports), other oilseeds (significant production) and dried legume fodder (high domestic consumption of the EU production), imported and exported from the EU.

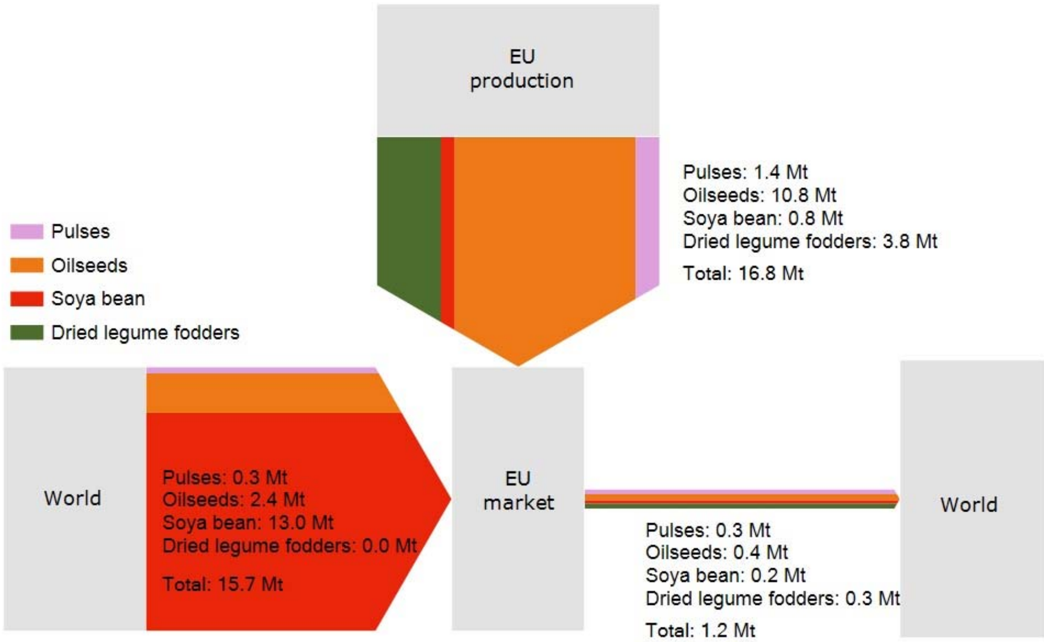


Figure 23: PRP protein balance in the EU in 2016 (Million tonnes of crude protein, own calculation based on DG AGRI, Terre Univia and Ciqual data)

This chart shows that once converted into crude proteins, the EU demand is covered at roughly equal level by two main sources: 16.8Mt of internal production and 15.7Mt of imports. However, only 1.2Mt are exported. It is thus clear that the EU has a high dependency on PRP imports for its crude protein supply and particularly on soya bean.

3.4 The case of organic and GM-free PRPs

3.4.1 Organic productions

3.4.1.1 Organic pulses

Organic pulses cover 0.6% of the global pulse areas, corresponding to almost 530,000 ha in 2016[65], with 72% located in EU and 14% in North America. The world organic pulses area has been multiplied by six since 2004 (FIBL and IFOAM, 2018)[66]. The main organic pulse producers are France (86,000ha), Canada (57,000 ha) and Poland (56,000 ha), followed by Italy, Germany and Spain. Otherwise, the countries with the largest percentage of organic pulse areas are Austria (57.6% of its pulses areas are organic), Italy (44.1%) and Denmark (40.0%). (FIBL and IFOAM, 2018).

In the EU, organic pulses cover more than 380,000 ha, representing 7.3% of EU organic arable area in 2016 and 17.9% of the whole EU dry pulses area. This high share highlights the importance of pulses in organic crop rotations.

Data concerning the EU share of each organic PRP crop was not available in detail. Table 6 shows the percentage of organic area of dry pulses out of the total production of dry pulses for the MS studied as CS. Even if data is scarce, field beans appear to be well developed in the organic segment, partly due to their use for self-consumption and the importance of rotation in this system that prohibits the use of chemical fertilisers [67].

Table 6: Area share of organic production of dry pulses in CS Member States in 2015

%	Broad and field beans	Field peas	Rapeseed
AU	62%	33%	0.4%
DE	33.2%	6.4%	0.2%
ES		No data	
FR	No data	No data	0.4%
IT	No data		
PL			0.1%
RO			

Source: CS and Eurostat, 2015[68]

3.4.1.2 Organic oilseed

At a global level, organic oilseeds[69] represent less than 0.5% of oilseed areas with 785,600 ha in 2016[70].

[65] These figures are underestimated because there is no data about three main conventional pulse producers: India, Niger and Nigeria.

[66] A part of this increase may be also explained by the growing availability of data. (FIBL/IFOAM).

[67] As with all legumes, beans are mainly used in organic systems, beside their production, to fix Nitrogen from the atmosphere.

[68] Austria data corresponds to 2016.

[69] In this chapter oilseeds correspond to soya bean, rapeseed, sunflower and linseed crops.

[70] These figures are underestimated because there is no data available for Brazilian production.

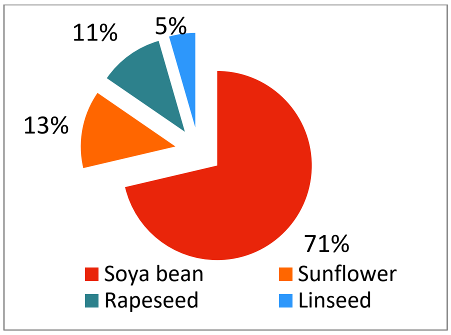


Figure 24: Organic oilseed areas in the world (2016; FIBL)

Figure 24 shows the share of each oilseed crop in the global organic oilseed area, showing that the main area is soya bean (560,457 ha) but representing only 0.5% of the global soya bean total area (conventional and organic). Soya bean is followed by sunflower (104,032 ha[71], representing 0.4% of the total sunflower area), rapeseed (85,960 ha – 0.3%) and linseed (35,159 ha-1.3%) (Julia et al., 2017). These figures show the very scarce development of oilseeds in the organic segment.

Very little detailed data was available per crop, except concerning organic soya bean.

At a global scale, the main producers of organic soya bean are China (250,000ha – representing 47% of total organic soya bean area), India (117,000ha – 22%), the U.S. (51,000 ha – 10%) and Canada (15,000 ha – 3%). These four players represent around 82% of the entire organic soya bean area (Julia et al., 2017).

Figure 25 shows global organic soya bean area and production are increasing, which is mainly driven by European consumer demand.

"Organic soya bean area is mainly located in Asia (71%) and can be broken down into 13% in North America, 11% in Europe, 3 % in Latin America and 2% in Africa (Julia et al., 2017).

In the EU, organic oilseeds cover more than 224,000ha (+6% than 2015) and organic EU oilseed area represents 1.9% of the organic EU area in 2016 and 1.9% of the total oilseed EU area. France and Romania together represent 47% of the organic oilseed areas in the EU.

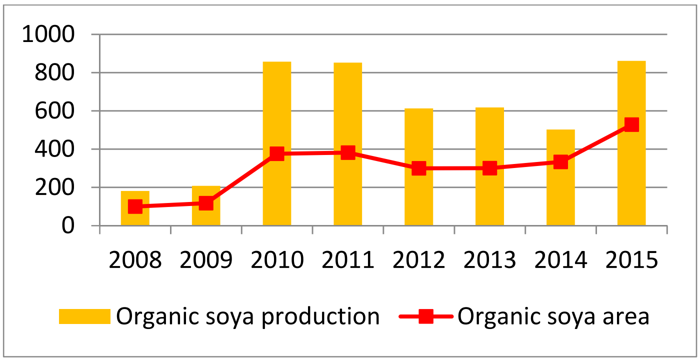


Figure 25: World organic area and production evolutions of soya bean between 2008 and 2015 (International trade center, FIBL, IISD)

Despite this fact, there are wide differences between MS organic oilseed areas, which are for example very low in the UK but covered 16% the oilseed in Austria in 2016. Otherwise, sunflower is the main organic oilseed production in the EU (78,180 ha in 2016). Romania is the largest producer (with 22,372 ha), followed by France (18,583 ha). Sunflower is followed by soya bean (72,710 ha in the EU) and rapeseed (49,791).

France is the top producer of organic soya bean with 24,615 ha and Romania is the first for rapeseed (12,811 ha).

As shown in Table 7, in comparison with the other crops under study, rapeseed is almost not developed as an organic segment, mainly due to difficulties in managing diseases and insects without chemical inputs. Sunflower organic share depends on MS, and mainly follows the organic oil market. Soya bean has a large organic share in Austria and France, going for food use; this share is lower in Romania and Italy due to a smaller demand.

Table 7: Area share of organic production of oilseeds in CS Member States in 2015

%	Rapeseed	Sunflower	Soya bean
AU	0.4%	8.9%	29.0%
DE	0.4%		
ES		1.4%	
FR	0.4%	3.0%	16.5%
IT			2.4%
PL	0.1%		
RO		2.3%	12.3%

Source: CS and Eurostat, 2015[72]

[71] The main global organic sunflower producers are Ukraine, Romania and France (Agence Bio).

[72] Austria data corresponds to 2016.

3.4.1.3 Legumes harvested green

We didn't find any data on organic forage legumes in IFOAM, FIBL and *Agence Bio France* documents. However, according to the data of the CS, as shown in Table 8 below, the organic share of legume fodder harvested green depends a lot on MS: it covers 1.8% of the total leguminous fodder harvested green area in Spain, compared to 70% in Austria.

Table 8: Area share of organic production of legume fodder in CS Member States in 2015

%	Legume fodder harvested green
AU	70.0%
DE	31.3%
ES	1.8%
FR	No data
IT	9.5%
PL	
RO	

Source: CS and Eurostat, 2015[73]

3.4.2 GM-free products

3.4.2.1 GMO and GM-Free in general

For PRPs studied in this report, Genetically Modified Organisms can exist only for soya bean, rapeseed, linseed and alfalfa. Thus, we studied GM-Free production only for these crops as the other ones are GM-Free by definition, but without any labelling.

There is very little information about GMO production and areas at a global scale, and data about GM-Free certified products is also difficult to find. One of the key documents giving data is a report made by JRC on Non-GM IP soya bean; it has been widely used in this report.

Table 9 indicates the share of GM crops within the total soya bean area for the main world soya bean producers. It highlights that the main exporters to the EU produce mainly GM soya bean and suggests that segregating GM-Free soya bean from these countries would be difficult, because it represents a small minority of the production.

As a reminder, no GM soya bean is grown in the EU.

Table 9: Adoption rate of GM crops across the main soya bean producers (% of respective area)

Country	Soya bean (% of GM crops across main area)
USA	93%
Argentina	100%
Brazil	92%
Paraguay	95%
Uruguay	100%
Canada	46%

Source: JRC, 2013[74]

3.4.2.2 The case of soya bean and GM-free markets

GM soya bean was commercially introduced in 1997. Today, at a global scale, 80% of soya is estimated to be planted with GM varieties (it is 24% for rapeseed). The EU consumed about 30 million tonnes of soya bean and derived products in 2016, of which 93% were imported[75], mainly for animal feed, and this trend is going up. However, one can also observe a growing demand for GM-Free soya bean in the EU. Thus, it has been estimated that in 2012, about 8.3% of soya bean and 11.3% of soya meal were imported as non-GM under segregation and identity-preservation schemes, accounting for 0.96 million tonnes of soya bean and 1.95 million tonnes of soya meal.

[73] Austria data corresponds to 2016.

[74] Except for Canada where the data is from 2012.

[75] DG AGRI.

As the majority of soya bean is dedicated to feed, some MS have specialised in GM-Free compound soya bean feed, such as Hungary and Sweden. They are small producers of compound feeds at the EU level but have found a high specialisation in the non-GM feed production. However, in Belgium, the Netherlands, Portugal and Spain, the use of non-GM IP soya bean in compound feed manufacturing is virtually non-existent, while these countries are relatively large producers of compound feeds at EU scale. In 2012, about 11.9% of the total industrial compound produced in the 14 countries studied by the JRC report was certified non-GM.

3.5 Key elements of past trends on the supply and demand context

3.5.1 Pulse consumption for food: different trends at regional level

Since the 1960s, the consumption of pulses has decreased, especially in Southern Member States (e.g. Greece, Spain and Portugal). Despite this decrease, Southern EU remains the area where they are the most consumed in the EU. Pulses are part of the traditional Mediterranean diets. The consumption of pulses has also significantly decreased in some eastern Member States (dropping from around 6 kg/capita/year in the 1960s to around 2 kg in 2013 in Romania and Bulgaria). Western EU is the area where pulses are the least consumed and the consumption per capita has remained stable over the last decades. Conversely, to the other regions, in Northern Europe, the consumption of pulses has increased compared to the 1960s. In the UK especially, the consumption of pulses doubled in the 1990s, and then decreased in the 2000s coming back to a level slightly higher than in the 1960s (3.5 kg/capita in 2013 compare to 2.9 in 1961) (see Figure 26).

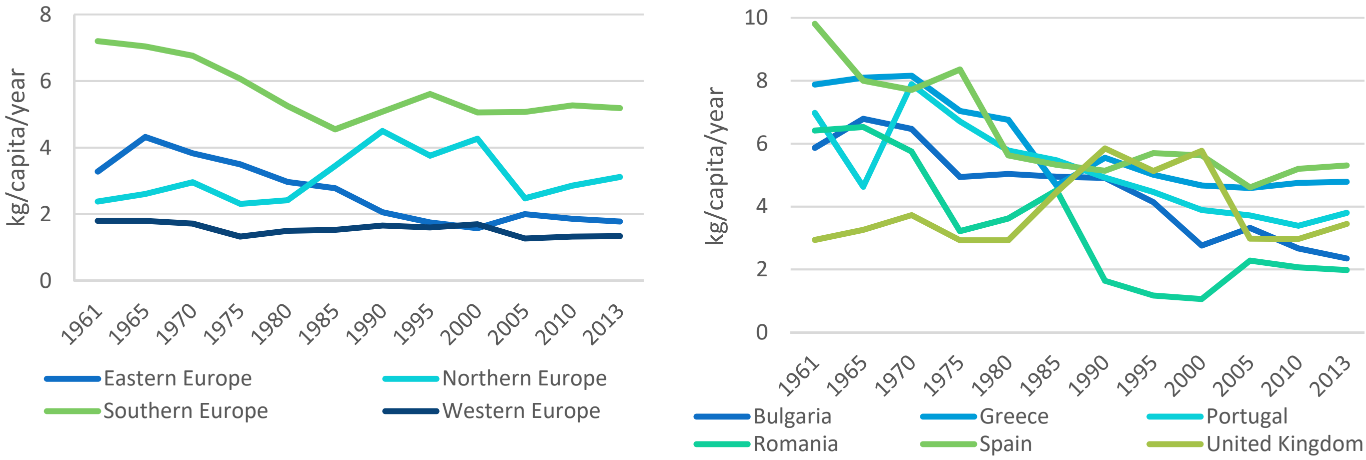


Figure 26: Average consumption of pulses in various regions and Member States in the EU (in kg/capita/year) 1961-2013 (Source: FAO – Food balance sheet)

In the framework of the study, no consolidated data at EU level could be found for the period post-2013. However, according to some experts interviewed, a resurgence of interest for pulses consumed as such can be observed in some areas (e.g. in France).

Over the same period, the production of traditional pulses grown for human consumption seems to have eroded. Initially, in the 1960s, grain legume crops that were used exclusively for human consumption (chickpeas, lentils, common beans, etc.) dominated grain legume cropping in Europe with 67% of the area. However, in the 2000s, the production of these pulses for human consumption dropped, representing only 22% of pulses production in EU in 2010. At this time, 11-15% of pea and 9-14% of faba bean produced were used for human consumption (Bues et al., 2013). This decline in the domestic use for food is linked to various drivers including rising competition from cheaper imports, especially from Canada (Schneider and Huyghe, 2015) and the replacement of pulses by meat in Mediterranean diets (Bues et al., 2013). In 2015, only 57% of the food pulses consumed in Europe were produced within the EU (Pinto et al., 2016).

Overall, since 2000, imports of the food pulses (dry beans, chickpeas and lentils) have slightly increased (cf. figure 27), especially for lentils (+ 30% between 2000 and 2016).

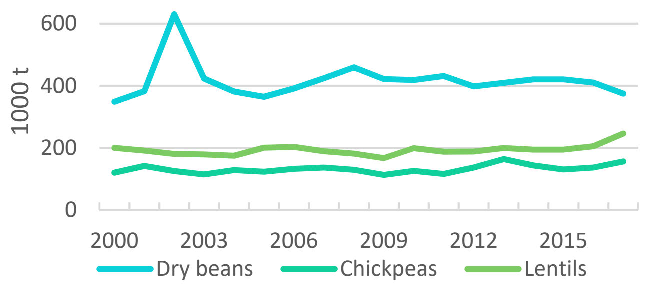


Figure 27: EU imports of food pulses (dry beans, chickpeas and lentils) 2000-2016 (Source: Comext)

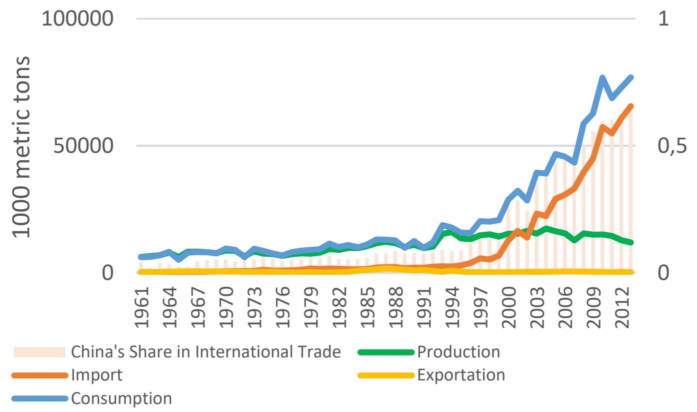
Pulses imports mainly come from Canada (29% of EU imports for pulses in 2016), the U.S. (15%), Argentina (13%) and China (10%), with differences according to the type of pulses (Comext). For instance, imports from Canada are mainly composed of lentils and various types of peas and beans consumed for food, while Argentina mainly provides chickpeas, beans and peas (consumed for food).

Within the EU, the main importers of pulses are the Member States where they are traditionally consumed, i.e. Italy (21% of EU imports of pulses in 2016), Spain (18%), the UK (17%), France (9%) and Portugal (6%) (Comext).

3.5.2 Growing demand and related tensions on soya bean global markets

EU imports of soya bean and soya meal, which are the main sources of EU imports of plant proteins, are dominated by 3 countries: Argentina, Brazil and the United States[76]. Due to this oligopolistic situation, the EU supply of soya bean (and soya meals) is very dependent on the production and feed/food policies in these exporting countries. For example, Figure 29 illustrates the case of Brazil, where internal soya bean consumption has sharply increased, mainly driven by diet changes (increased animal meat consumption, see section 3.5.2) but also an increase of domestic use of soya bean to produce and export meat products (especially chicken meat) in order to capture more value along value chains.

Furthermore, world demand for proteins has drastically increased, mostly driven by the demographic boom and diet changes in Asia, especially in China. Figure 28 shows a major change in the production/consumption soya bean balance after 1995 in China. One can observe a surge of Chinese imports since the 2000s. They represented nearly two-thirds of the soya beans traded on international markets in 2013. As can be observed on the graph, over the same period the EU's import prices of soya bean also drastically increased.



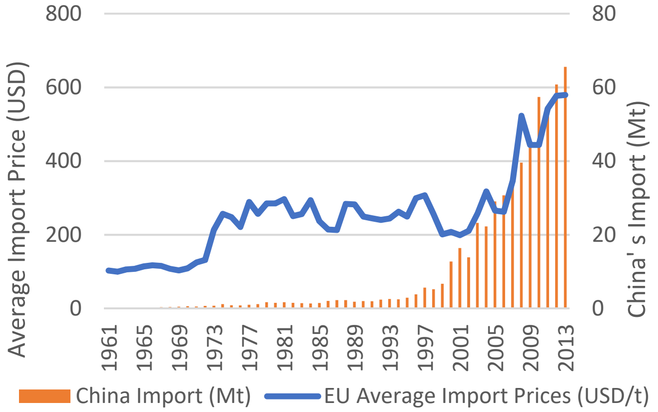


Figure 28: China's trade, consumption and production of soya bean, share of global volume traded and EU import price (FAOStat).

[76] Source: Comext.

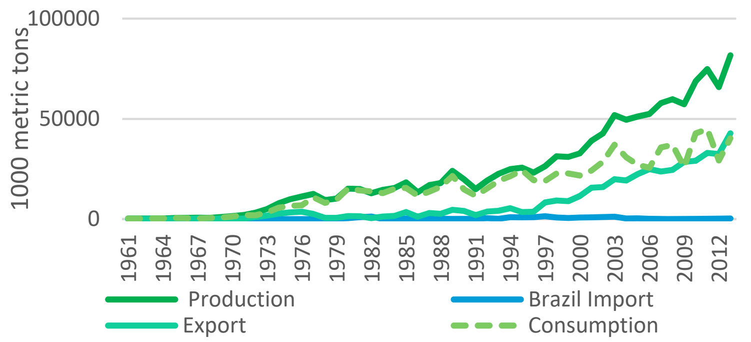


Figure 29: Brazil's trade, consumption and production of soya bean (FAOStat).

The EU demand for protein from PRPs being largely satisfied by soya imports (Cf. part 2.2.4. Import/export balances), the EU is remarkably dependent on international trade to meet its demand. The oligopolistic situation of soya bean exporter countries and the hegemony of China over volume imported tend to increase the vulnerability of the EU soya supply.

3.5.3 The changing landscape of legume fodder markets

Globally, traded fodder has grown by 65% since 2003 to reach 9 million tonnes in 2016. The U.S. is by far the leading exporter with half of traded volumes, while Australia and Spain are the second and third exporter, accounting respectively for 12 and 11% of the market. Those three countries make up three-quarters of the market. Most of the fodder traded is in the form of baled hay (79% of the market) even though EU fodder exports are more pellets. Alfalfa dominates the market. The EU share in global export is about 18%, of which two-thirds are exported to the Arabian Peninsula (UAE and Saudi Arabia). Volumes traded are largely dominated by sun-dried or plant dehydrated alfalfa (legume fodder)[77].

EU exports account for 18% of global volume traded and represent 20% of the EU production of dehydrated legume fodders, while 15% of the EU legume fodder production is dehydrated. The share of bales is growing and accounts for nearly half of EU exports, at the cost of pellets. Exports can represent a significant share of national productions. They account respectively for 75, 70 and 40% of the Spanish[78], Italian and French production.

These exports are driven by a demand concentrated on 3-4 main players: Japan, China, the UAE and Saudi Arabia. According to the European Association of Dehydrated Fodder[79], the global fodder market is rapidly changing, influenced by:

- a soaring demand from China,
- a significant and regular growth of the Arabian Peninsula market (UAE and Saudi Arabia) and the Persian Gulf (Iran),
- newcomers on the supply side (Sudan, Romania and Bulgaria).

In China, the growth of the demand for imported alfalfa is driven by the changing production practices in China's dairy industry, with an increasing number of dairy cows raised by large and modern dairy farms, which prefer using imported hay and commercial feeds. Imports skyrocketed by 261% between 2012 and 2016 and accounted for one-fifth of total imports in 2016. According to a report from USDA agricultural foreign services, the United States dominates the imported baled hay market in China, with 78 % market share in 2016, but Spain dominates the alfalfa pellet market (90 % market share) and there continues to be great demand for this type of product in China (USDA, 2017c). Spain also exports baled alfalfa hay to China, especially because the U.S. does not have market access for alfalfa pellets.

Faced with this constant and fast growth of Chinese demand on fodder markets and being very dependent on imports to feed their cattle, the UAE and Saudi Arabia are willing to secure their supply. The UAE already represents 19% of total world imports (Comtrade) and according to feedback from interviews conducted for this study, it seems that they are now investing in the EU. They have bought fodder dehydration companies in Spain and Italy and now control most of the exports from both countries. The UAE is also investing in Romania and Bulgaria, where land is leased to the Al Dahra

[77] Apart from Australia, which exports mostly oat hay.

[78] Spain's is the EU's largest dry fodder producer and exporter. Domestic dried fodder consumption, mainly by the dairy industry, is rather limited compared to production levels, which allows for an ample supply for export.

[79] Interviewed on 10 August 2018

company, as indicated by the recent investments to grow alfalfa on a single farm of 56 thousand hectares in Romania. Romania exported 76 thousand tonnes of hay in 2015, a dramatic increase from an insignificant 8 thousand tonnes in 2014.

These investments in the Black Sea region are conducted along with the Saudi Agricultural and Livestock Investment Company (SALIC). Saudi Arabia's decision to phase out forage production is increasing demand for imported high-protein alfalfa hay and an additional 825 thousand tonnes (equivalent to the entire French or Italian production) are projected in the coming years (USDA, 2017b). Saudi dairies are attempting to develop alternative sources, especially from Spain, where dried fodder area is expected to grow (USDA, 2017a).

The EU is a significant exporter of Alfalfa and will remain so, given the facts mentioned above. The European Dried Fodder Association (CIDE) underlines the fact even if the intra-EU market remains a priority, access to exportations is needed as a safety valve to buffer the volatility of the EU demand. Despite this need, access to some markets is still difficult and erratic from year to year. Compared to experienced exporters such as the U.S., the European association of forage drying plant (CIDE) reports that the EU dried fodder sector faces internal and external barriers to strengthening its exporting potential:

- no unity of export certificate delivery across countries.
- no harmonised standards at EU level to describe fodder quality. Markets being dominated by the U.S., sun-dried hay is the reference product and American quality grades are not transposable to dehydrated products. This results in a lack of knowledge regarding the EU products, difficult to grasp for importers.
- geostrategic issues (e.g. recent termination of the Iran nuclear deal by the U.S.: now extremely difficult to export agricultural products to Iran).

Aspects and issues mentioned above show that there is a significant market potential for fodder, especially driven by external demand. However, it seems that market structures and rules of the game are changing. This is a situation that must be considered when addressing dried fodder development in the EU.

3.5.4 Impact of biofuel policies on the protein plant supply in the EU

The EU legislation on biofuels started in 2003 (Directive 2003/30/EC). The objectives were the reduction of greenhouse gas emissions, to support the European agricultural production and to decrease the dependence on imported sources of energy. The EU Energy and Climate Change Package (CCP) was introduced in 2009. The Renewable Energy Directive (RED)[80], which is a part of CCP, set a goal of 20% energy used in the EU and of 10% in the transportation sector, to be obtained from renewable sources by 2020. In 2015, the EU published a new directive[81] to reduce indirect land use change for biofuels and bioliquids. This directive amends the aforementioned directive and limits the share of biofuels from crops grown on agricultural land that can be counted towards the 2020 renewable energy targets to 7%. This reduction on the usage of crop-based biofuels addresses the debate on the ILUC (indirect land use change), which is strongly associated with the idea that current biofuel policy could deteriorate the environment by its distortive power on agricultural production, both in the EU and in the world (mainly in the palm-oil exporting countries via deforestation). In 2018, the Renewable Energy Directive was reviewed (RED 2), but the maximum share of first-generation biofuels in the renewable energy mix for transport was maintained at 7%.

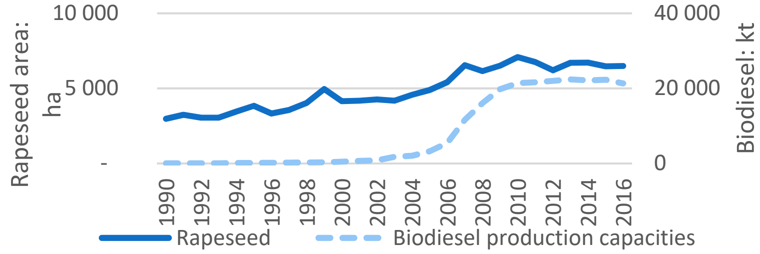


Figure 30: Link between biodiesel production capacity and rapeseed area in the EU (EUROSAT).

2003, 2009 (RED) and 2015 (the Directive addressing ILUC for biofuels) are three crucial dates for the European biofuel policy. After 2003, the European biofuel industry grew spectacularly with significant effects on domestic rapeseed production (cf. Figure 30). Since 2009, the production has plateaued.

[80] Directive 2009/28/EC of 23 April 2009 on the promotion of the use of energy from renewable sources

[81] Directive (EU) 2015/1513 of 9 September 2015 amending Directive 98/70/EC relating to the quality of petrol and diesel fuels and amending Directive 2009/28/EC

Such policies appear to be a potential significant driver of the PRP production in the EU, depending on the choices between domestic or imported productions and the type of biofuel supported or authorised by the EU regulation. The biodiesel sector currently provides the EU with 8 Mt/y of rapeseed meals, representing 45% of the EU production of this product[82].

3.5.5 Diet changes and population growth drive a soaring demand for plant proteins

Statistics from the FAO enable analysis of protein consumption changes in the last decades. Human protein demand encompasses plant and animal protein, the latter originating directly from plant protein dedicated to feed animals. Thus, it is noteworthy that 1 g of animal protein demands on average 5 g of plant protein to be produced[83]. Of course, this average conversion factor includes a wide diversity of conversion factors depending on the type of animal and plant protein consumed. Figure 31 gives an order of magnitude of indirect plant protein consumption if animal protein is converted into plant protein equivalent and shows to what extent global plant protein demand is affected when animal protein demand increases.

Global plant protein demand is driven by two main factors: diet transitions and population growth. An analysis of the FAO data over the 1961-2013 period underlines that population growth explains 64% of protein consumption growth at global level but only 26% and 48% in China and Brazil, respectively, despite a significant population growth in both countries. One can observe a constant growth of the protein intake per capita at global level. It also shows a clear transition to more animal proteins in diets.

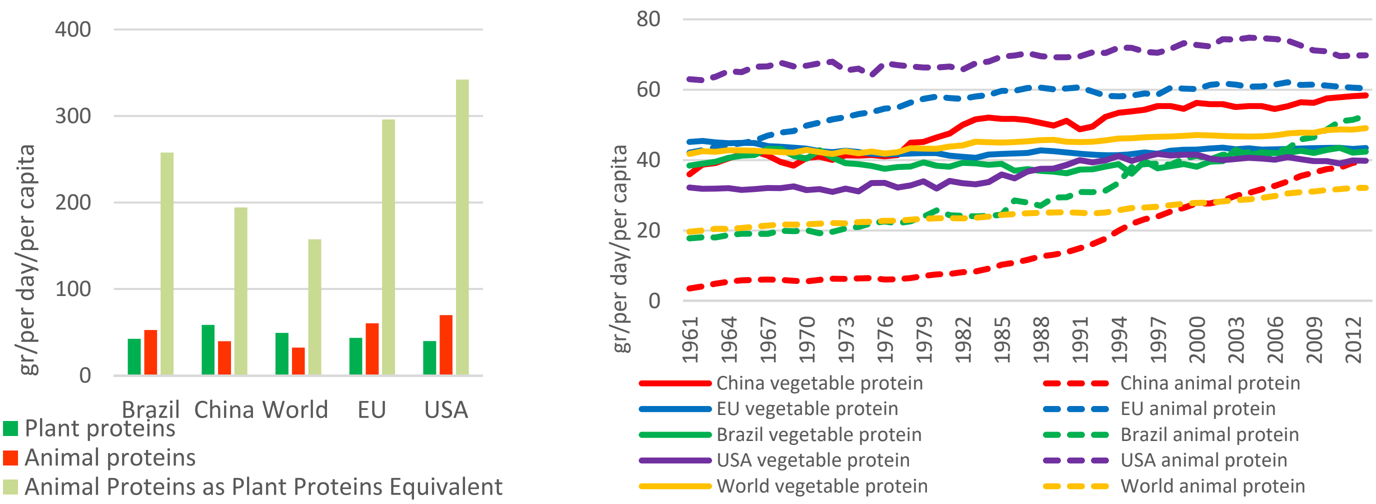


Figure 31: Protein intake per capita in various world regions (FAOSTAT 2018 and own calculations)

In developed economies such as the EU and the U.S., animal proteins are clearly dominant and have reached very high levels but have tended to stabilise or even decrease in the last decade. However, plant protein intake is much lower and stable over the period.

In transition economies such as China and Brazil, animal protein consumption has sharply increased since the 1980s while the share of plant proteins has decreased. Combined with population growth, it generates a soaring demand for plant protein. Animal protein consumption has reached 39.64 g/day/capita compared to 30g in 2003 and 14g in 1990 in China, a significant soya bean importer. In Brazil, a significant soya bean exporter, animal protein intake per capita has constantly increased and has now gone beyond plant protein consumption.

[82] Similarly, the bioethanol sector provides the EU PP sector with by-products (DDGS) also used in the feed sector.

[83] Huyghe C., 2017. Les ressources protéiques végétales utilisées en France pour nourrir les hommes et les animaux. DEMETER 2017.

3.5.6 The particular case of the organic demand

The organic market (feed and food) is clearly expanding in the EU (see Figures 32 and 33). Organic retail sales in the EU were valued at 30.7 billion €, representing the second largest single market for organic products after the U.S. The main countries consuming organic products are Germany (9.5 billion €), France (6.7 billion €), Italy (2.6 billion €) and the UK (2.5 billion €). However, the MS with the highest per capita consumption are Denmark (227€/cap) Sweden (197€), Luxembourg (188€) and Austria (177€). EU consumers spend on average 61€/pers/year for organic food, which is twice the value of the last decade, even if it is still a niche market.

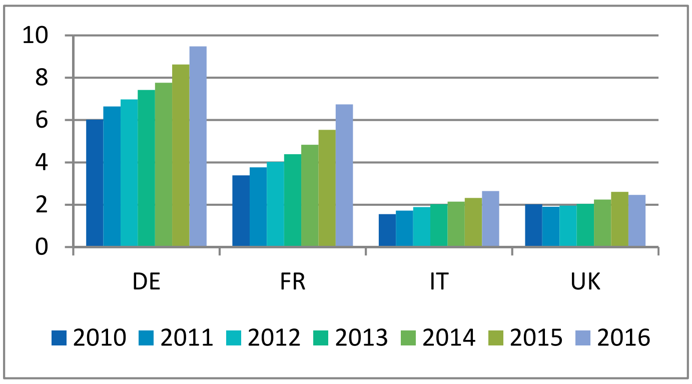


Figure 32: Organic food market in the main organic consumers: Germany, France, Italy and UK between 2010 and 2016 (billion Euros, FIBL)

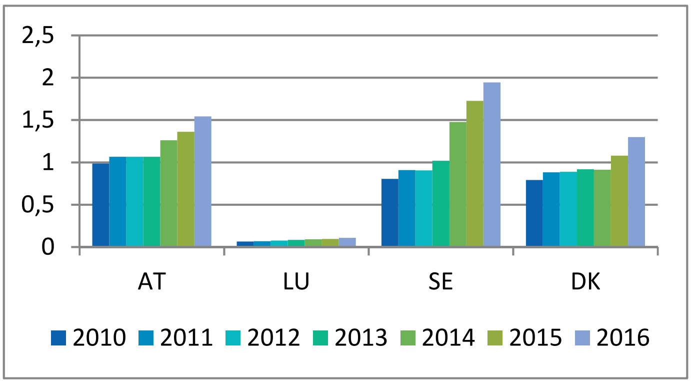


Figure 33: Organic food market in the main organic consumers per capita Austria, Luxembourg, Sweden and Denmark between 2010 and 2016 (billion Euros, FIBL)

Figure 34 presents the value of EU organic markets between 2000 and 2016 highlighting it has been multiplied by five since 2000.

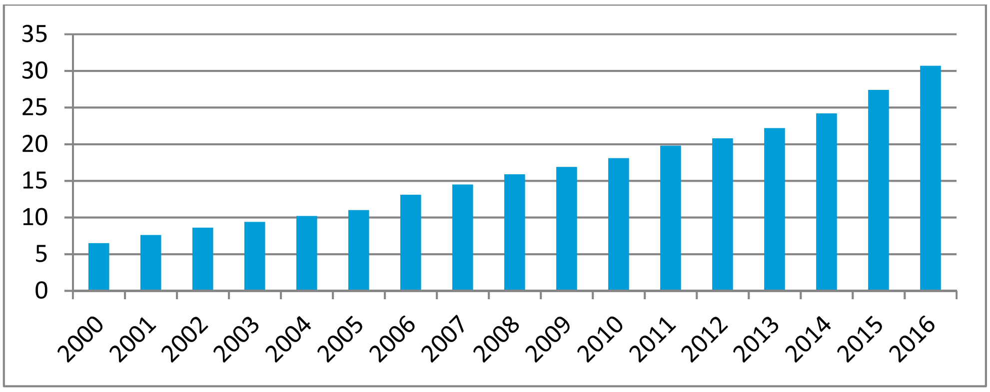


Figure 34: Total organic market in the EU between 2000 and 2016 (billion Euros, FIBL)

The EU average annual growth rate between 2014 and 2016 was 13%. The highest average annual growth rate for this period was observed in Poland (+20%), followed by Denmark and Spain (+19%), France (+18%) and Ireland (+17%).

Figure 35 shows the trends between 2014 and 2016 of the penetration rate of the organic segments in France where this data is available. All segments are increasing; the most significant developments concern eggs, milk and vegetable drinks (plus fruit juices). However, delicatessen and pork meat are almost stagnating. Figure 36 display the estimated organic retail sales per segment, in value. The highest in value concerns meat, followed by milk products, milk, eggs and finally vegetable drinks. However, the highest growth rate concerns vegetable drinks (50% between 2014 and 2016) and milk products (33%).

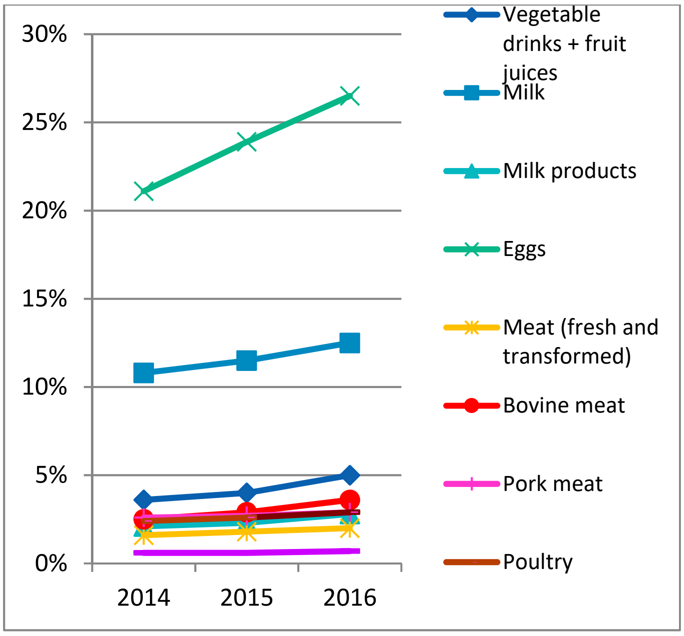


Figure 35: Penetration rate of organic segments in value in France between 2014 and 2016 (%, Agence Bio France)

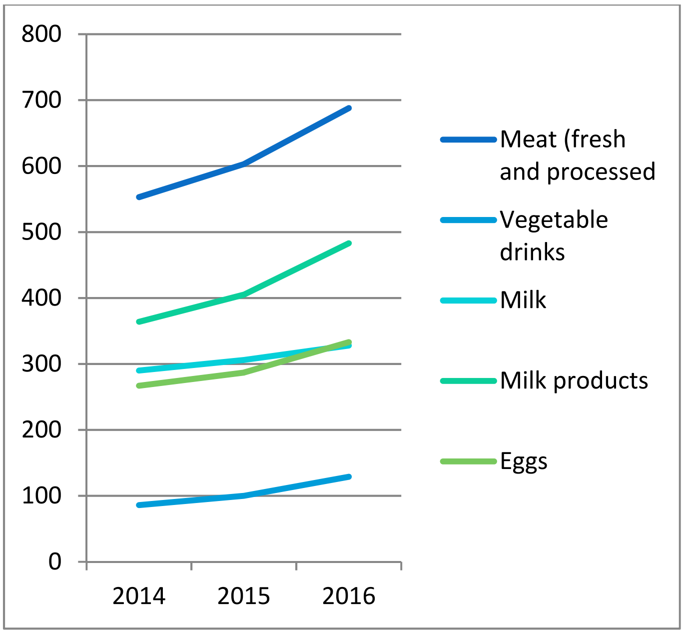


Figure 36: Estimated organic retail sales per segment in France (Million €, Agence Bio France)

These figures show that the consumption of organic products is increasing at least in Western Europe,[84] which has also an influence on the GM-Free market since organic products are by definition GM-Free.

3.5.7 Market context of the conventional feed market segment

The demand for PRPs in the conventional feed sector is driven by meat demand and the type of PRP needed is strongly related to the type of animals (cf. 4.1.2). As it is difficult to get consolidated data at EU level, the following graphs (figures 37, 38 and 39), based on EUROSTAT data, highlight the main trends for Member States studied for this report.

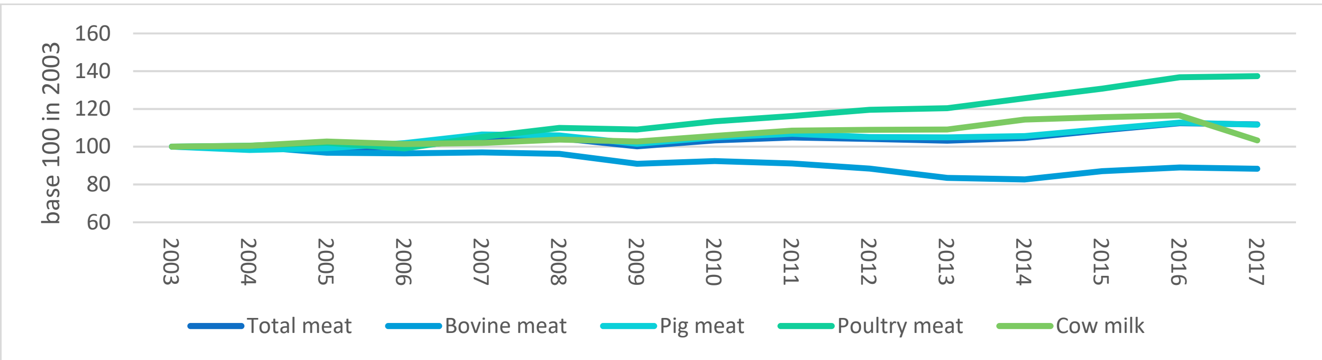


Figure 37: Past trends of meat and milk production

indices, base 100 in 2003.

[84] This is clearly less the case in Eastern Europe

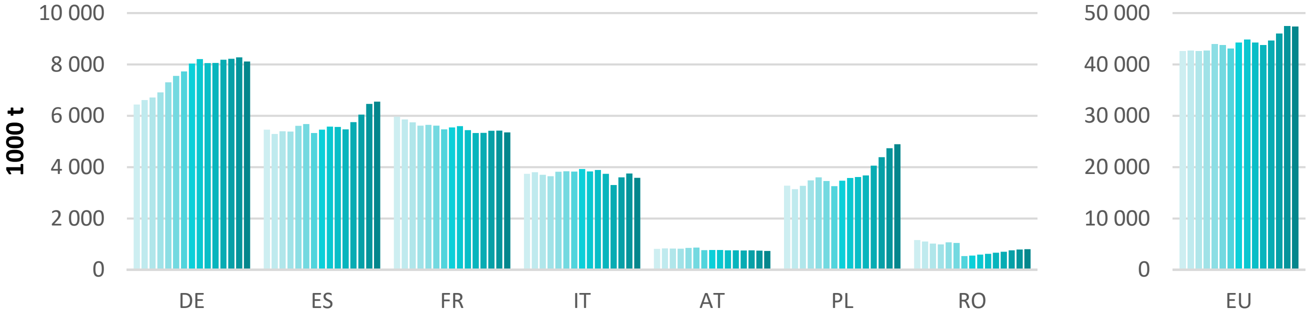


Figure 38: Meat production trends by case-study country, from 2003 to 2017.

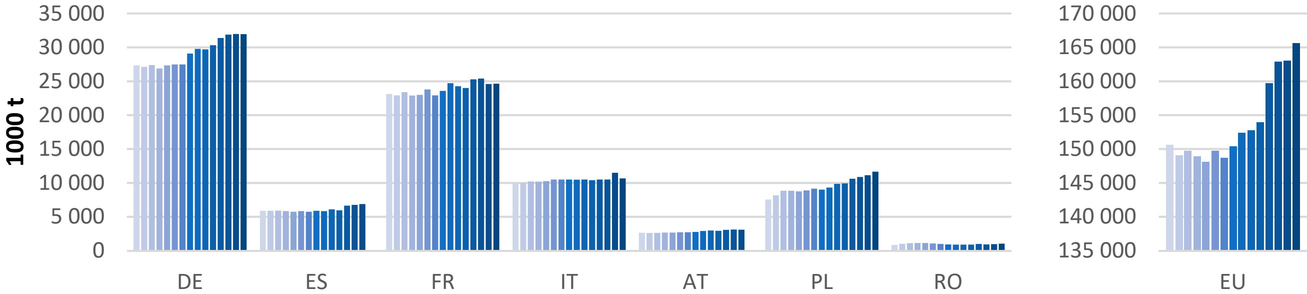


Figure 39: Cow milk production trends by case-study country, from 2003 to 2017.

Between 2003 and 2017, total meat production increased by 12 % in these seven countries studied. 75% of this growth happened in the last five years. In the same period, poultry meat production expanded by 37% and pig meat by 12%, while bovine meat production decreased by 12%. Cow milk is more stable with a 3% increase.

If more recent trends are analysed (last five years), total meat production has decreased by 4 and 3%, respectively, in Italy and Austria, while it has grown by 33% in Poland and 21% in Romania and Spain. Among the seven countries, 49% of this five-year growth happened in Poland (of which 56% is poultry meat and 25% pig meat). Regarding poultry meat, 67% of the production in the last five years took place in Poland, where poultry meat production has multiplied by 1.7 in five years.

For pig meat, growth was driven by Germany up to 2012 and is now driven by Spain and Poland (both countries account for 96% of the growth in the last five years).

Growth is more limited for milk production. Poland and Germany drive 37 and 39%, respectively, of the last five years' growth while production is steady in other countries.

This quick analysis of Eurostat data shows that Poland is becoming a major player in meat and milk production. This MS absorbs most of the poultry meat growth and plays a big role in supplying additional demand for other meats and milk. According to experts met during case studies, this growth reflects a more competitive context and the absence of barriers to increasing farm size or to building new animal farm buildings compared to western EU, where civil society and neighbours are more reluctant to accept new livestock farms, especially large-scale units. As a result, part of the production to sustain additional market demand is transferred to Poland and other EU-N13. This growth mostly concerns standard meat, while poultry premium meat and eggs are expanding in EU-15.

4 MAIN MARKET SEGMENTS, ECONOMIC DRIVERS AND OUTLOOK

This chapter analyses the sizes and the economic drivers of the main PRP market segments (see figure 40 below). A short outlook is also provided. Factors driving PRP crop producer levels are addressed at the end of the chapter as they are at the end of a demand-driven process. PRP producers also face specific risks that cannot be compared to other economic agents of the supply chains, thereby addressed in a specific sub-chapter.

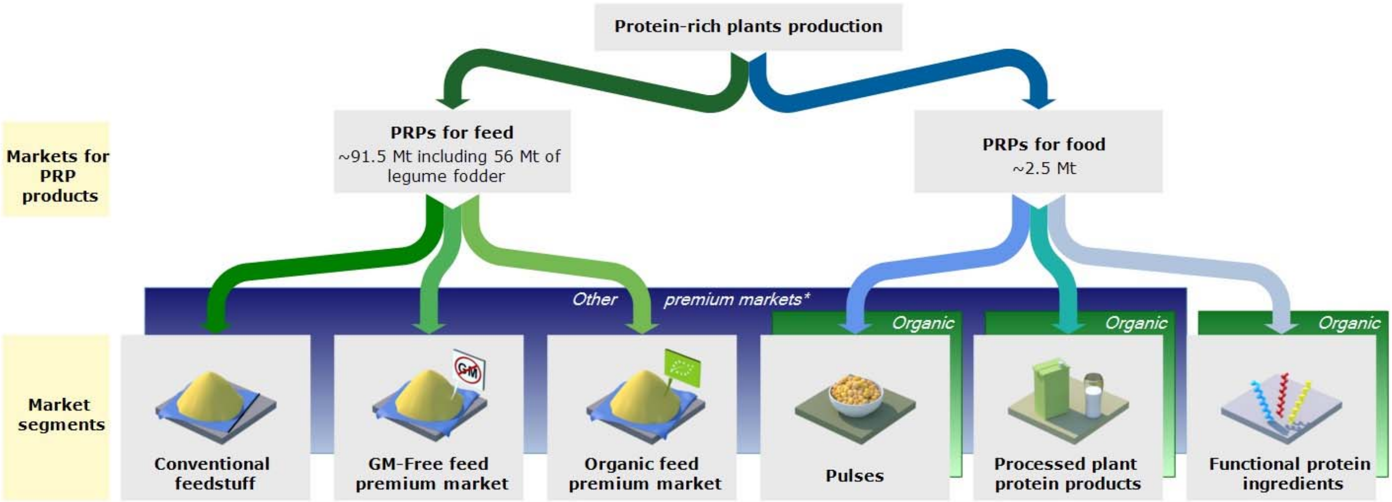


Figure 40: Main market segments using PRPs treated in this study

The chapters below deal successively with:

- FEED markets, with an initial brief presentation of the global context, and then the three main categories of market segments studied, namely: commodity/conventional, organic and GM-Free markets.
- FOOD markets, with also a brief presentation of the global context, and then the three main market segments studied, namely: pulses, processed plant protein products and functional ingredients. For these products and contrary to what has been decided for the feed sector, organic products are not considered as a specific market segment, as markets are developed for each category of products.
- PRP PRODUCERS, for which main drivers are described, with an emphasis on PRP crop competitiveness vs competitive crops.

For all these markets (except for functional proteins), various premiums (designations of origin, private/retail/NGO branding, etc.) can exist. As there exists little or no quantitative data on these markets, we have studied the impact of these premiums on the base of examples coming from the case studies carried out during the present study. They are more often presented in boxes.

4.1 *Main <u>feed</u> market segments for PRPs*

The feed market is dedicated to animal feed, namely: the main ruminants (cattle, sheep, goats), the main granivorous animals (poultry, pigs, etc.). Other animals, which account for a smaller share of the market (e.g. aquaculture, horses, pets, etc.), are included in the analysis for this study. According to our estimates, it represents 97% of the market of PRPs in volume while food accounts for the remaining 3% (6% if bulky fodders dedicated to herbivore feeding are not counted). It is noteworthy that although it cannot be estimated, food markets probably generate much more value in relative terms.

In the chapters below, we analyse the main drivers of PRP uses for the feed sector and for three market segments (cf. diagram 41 below), starting from animal farmers (end users initiating the demand) to collectors.

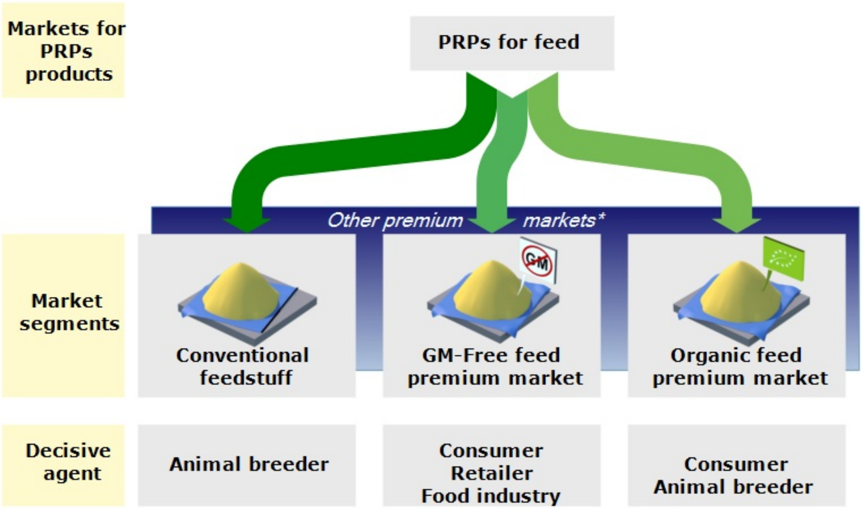


Figure 41: The three feed market segments studied and their main economic agents.

Before coming to the description of the drivers of each of the three markets studied in this study, some general context needed to start the analysis of drivers is provided.

4.1.1 Context of the feed market segments for PRPs

Animal feedstuff, including feed materials and compound feeds, are the main input into livestock production. Within the EU-28 and according to the statistical yearbook of the European Feed Manufacturers Federation (FEFAC, 2017), about 481 million tonnes of feedstuff are consumed by animal productions each year. Out of this quantity, 233 million tonnes are mostly fodder crops grown and used on the farm of origin. The balance, meaning 248 million tonnes of feed, includes cereals grown and used on the farm of origin (52 million tonnes) and feed purchased by producers to supplement their own feed resources (either feed materials or compound feed). These figures are reported in Figure 42.

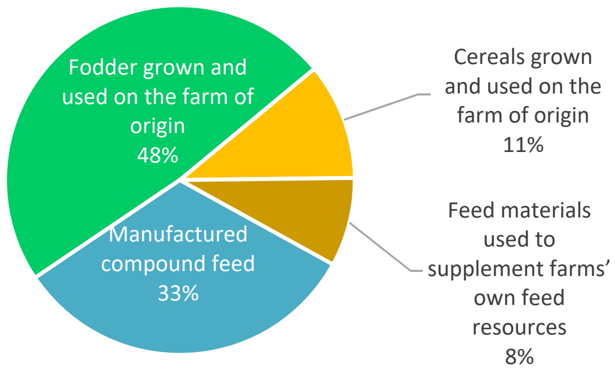


Figure 42: Origin of the 481 Mt of animal feedstuff consumed in the EU (FEFAC, 2017)

The main operators along the chain, who provide animal farmers with feed, are:

- livestock farmers themselves, who can feed their own animals with their own farm products (e.g. forages, cereals, etc.),
- traders that buy significant quantities of feedstuffs (meals, whole grains, fodders, etc.) and then sell them to farms or fed manufacturers,
- feed manufacturers that can provide farms or traders with compound feed.
- collectors that are in direct contact with PRP crop producers.

Figure 43 illustrates this chain of economic agents and applies to the three main feed market segments that will be described in this report: conventional, organic and GM-Free.

It is noteworthy that inside these three main market segments, additional sub-segments can be identified through private branding (retail, NGOs, etc.) and the three European Union schemes for geographical indications, which promote and protect names of specific meat and dairy products: protected designation of origin (PDO), protected geographical indication (PGI), and traditional specialities guaranteed (TSG). All these specific products are grouped in this report under the generic term of "premiums".

From a quantitative perspective, the main productions involved in PRP consumption are poultry, swine and dairy cattle.

For global understanding of the report, it should also be noted that leguminous fodders are produced nearly exclusively for ruminants, as monogastrics are not able to break down the fibrous part.

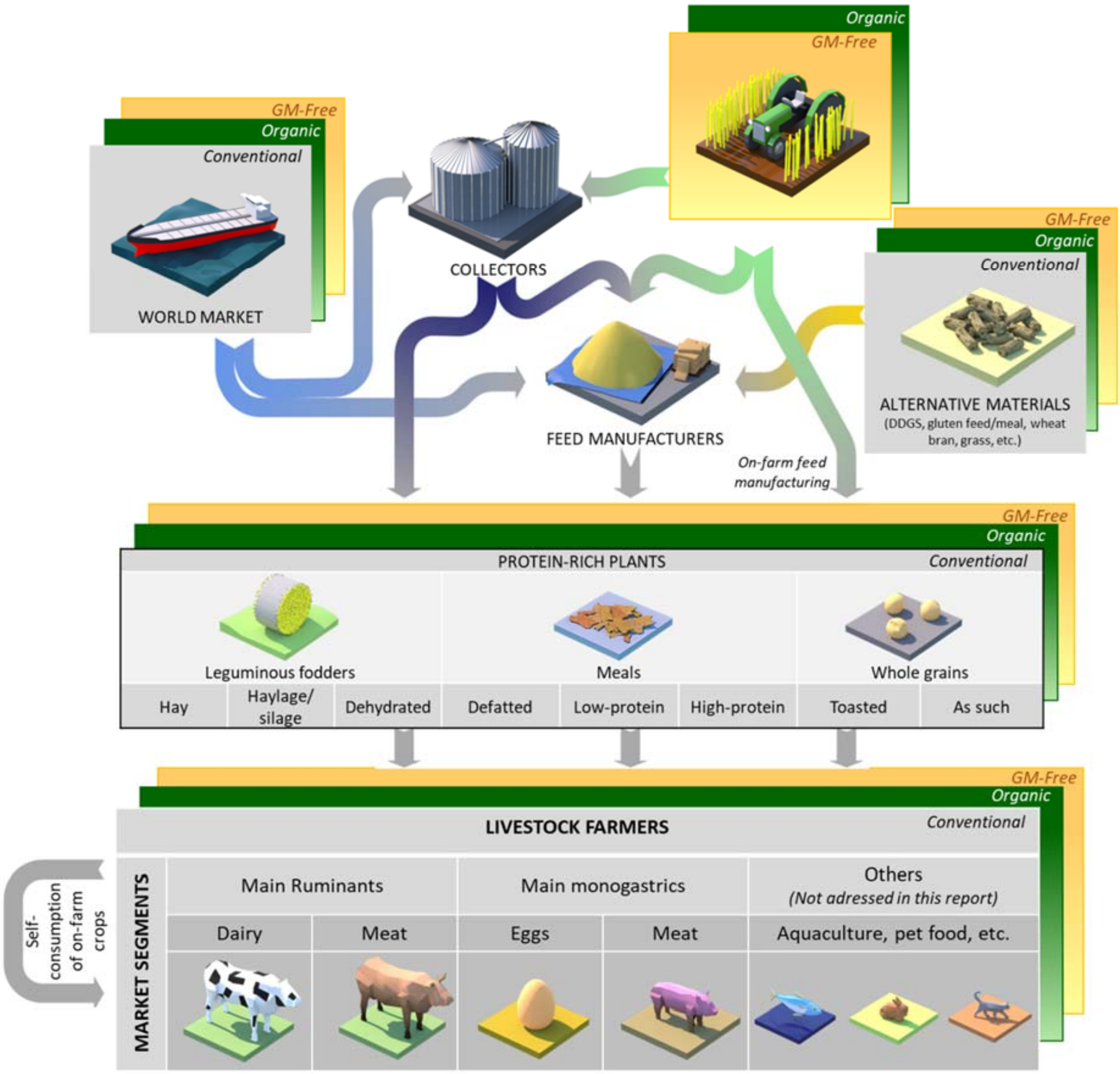


Figure 43: Overview of the main economic agents and available products to satisfy the main feed market segments

From a quantitative point of view, and to understand PRPs studied in this report in the light of the protein supply to the feed sector, it is relevant to look at tonnage of products both in mass and in crude protein equivalent. Table 10 highlights that although they already represent one-third of tonnage, oilseed meals account for nearly half of the crude protein supplied to the feed sector in the EU, of which 74% is imported. Additionally, it shows the relatively small contribution of pulses to the feed protein supply (2%). However, 96% of the protein supply from pulses is produced in the EU. The small contribution of oilseeds as such (whole grain) is related to the fact that these grains are mostly processed for oil extraction or to reduce anti-nutritional factors before being used into the feed sector. Finally, legume fodders[85] contribute to 8% of the protein supplied to the EU feed sector, even though this figure is probably underestimated, for lack of available statistic data.

Table 10: Feed use and EU origin of PRPs in the EU, converted into crude protein (2015-2016 campaign).

Unit:	Million tonnes of feedstuffs	Million tonnes of crude protein equivalent	Share in crude protein equivalent		
	Feed use	Feed use	Share in total feed use	Share imported (non-EU origin)	
Pulses (of which)	2.94	0.76	2%	4%	
Field Peas	1.25	0.28	1%	0%	
Broad beans	1.23	0.32	1%	0%	
Lupins	0.47	0.16	0%	19%	
Oilseeds: whole seed without crushing (of which)	1.80	0.50	1%	0%	
Soya beans	1.20	0.40	1%	0%	
Rapeseed	0.45	0.08	0%	0%	
Sunflower seed	0.15	0.02	0%	0%	
Oilseed meals (of which)	31.19	20.88	46%	74%	
Soya meal	31.19	14.21	32%	95%	
Rapeseed meal	13.70	4.52	10%	17%	
Sunflower meal	6.84	2.16	5%	56%	
Legume fodders	55.60	3.76	8%	0%	
TOTAL	**91.54**	**25.91**	**58%**	**31%**	

Source: European Commission (Protein Balance Sheet) and own calculations for legume fodders (fodders are standardised at 65% moisture following Eurostat standards).

4.1.2 Drivers related to the use of PRPs for the conventional feed market segment

The analysis for the conventional feed market segment is more developed than the others, as this market segment represents most of the consumption of PRPs in the EU. The analysis focuses particularly on the two economic agents that play a key role in driving the PRP demand in the conventional feed sector:

- livestock farmers, who decide how to feed their animals and how to source their feed (on-farm-produced or bought as compound feed)
- compound feed manufacturers, who are using a wide spectrum of raw materials to supply livestock producers with compound feed fitted to their requirements.

For this market segment, final consumers of animal products (mainly meat, dairy products and eggs) mostly look at quality and price but not at the detailed composition or origin of the animal feed[86].

4.1.2.1 Drivers related to the use of PRPs by livestock farmers (end-users of PRPs)

The fulfilment of animal needs

For all market segment, a wide spectrum of feed materials is available to livestock breeders:

- Cereals, either produced on-farm or purchased;
- PRPs and PRMs, either produced on-farm or purchased;
- Compound feed materials, made of various types of feed materials including PRPs/PRMs (commodity, GM-Free or organic) or alternative feed materials (gluten feed, DDGS, synthetic amino-acids, etc.);

[85] It is noteworthy that statistics developed in this report only refer to pure stand crops (no data available for crop mixtures). However, animal feed experts interviewed argue that more than half of temporary pastures in the EU (sown meadows) are a mixture of grass and LFs, meaning that the share of LFs in the protein supply might be largely underestimated in the EU. For example, in France, seed experts interviewed report that 70% of sown pastures are mixtures of grass and LFs. These mixtures contain more and more legume fodders (from 15% of LFs in 2010/2011 to 23% in 2015/2016).

[86] Contrary to consumers buying organic, GM-Free and/or PDO/PGI or any other premiums products (e.g. locally produced, with specific standards, etc.).

- Fodders (only for herbivores) mostly produced on-farm, fresh (grazed or as green forage) or preserved (hay, haylage/silage, dehydrated) which can be legume fodders (alfalfa, clover) or not.

Starch-rich crops (e.g. pea and fava beans) and lupines are usable as-is or lightly processed (dehulled or toasted). Conversely, oilseed grains are usually too oily for self-consumption on the farm. Soya bean also needs a thermal process to reduce anti-nutritional factors. Forage legumes used are generally locally produced (see § 3.3.3) on the breeder's farm directly or in the neighbouring areas (intra-territorial exchanges between farmers in the same territory).

Each raw material has a very distinct nutritional value that will drive breeders' decisions along with economic criteria. Before going further into detail and to provide a few technical prerequisites before going into the analysis, box 2 gives a summary description of the nutritional features of PRPs studied for the feed sector.

Box 2: comparative nutritional value of PRPs studied and their relative positioning in the feed material spectrum

Figure 44 compares PRPs studied and their by-products on three important criteria for the feed industry: crude protein, fat and starch contents. It shows that oilseed meals have high protein content while cereals have more starch (energy). Feed experts report them as specialised materials. In addition, pulses contain both starch and protein, so feed experts report them as intermediate materials. Forage legumes contain less protein than other protein-rich materials, but they contain fibre (not displayed in Figure 44). Fibre is essential for ruminants because it provides energy and ensures rumination, needed for the metabolism and the health of ruminants. In the field of fibrous feedstuffs, legume fodders provide generally twice more protein than grass and maize silage, while grass and maize silage provide more energy.

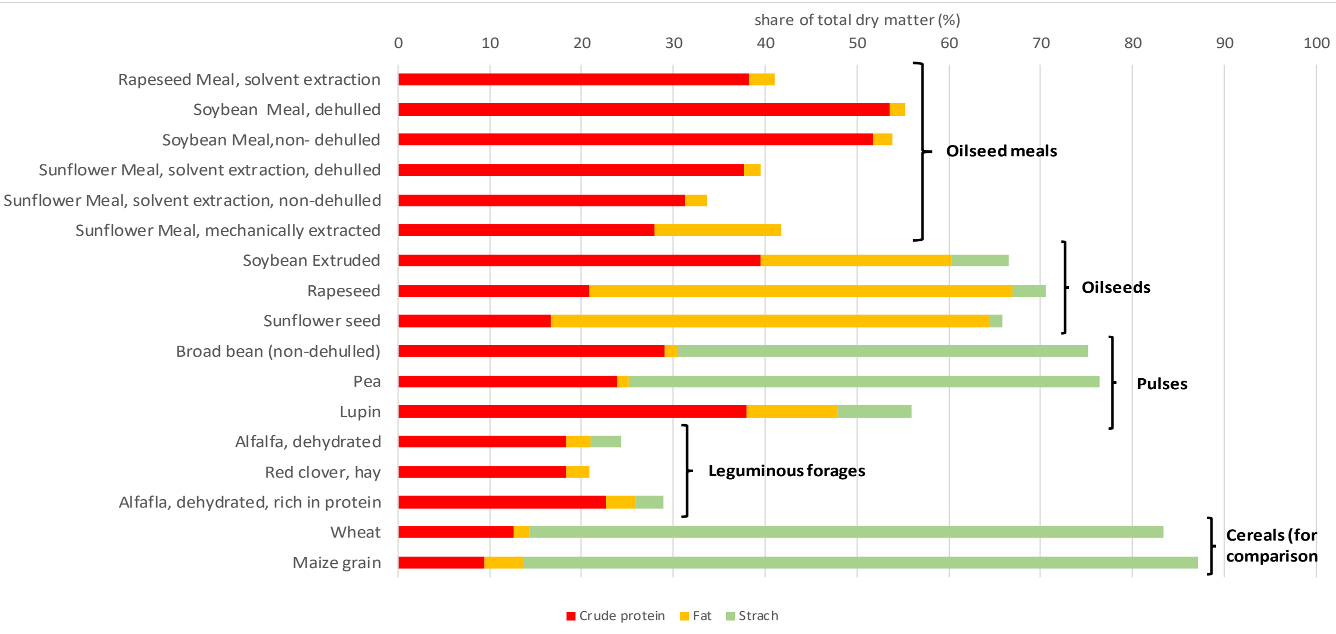


Figure 44: Simplified composition (in % of dry matter) of the main feed grains and meals used for animal feeding in the EU (source: feedipedia)

It is also worth noting that each raw material has a specific amino-acid (AA) profile. "We do not buy proteins, we buy amino acids", said a feed manufacturer interviewed. Meanwhile, animals have very specific needs. Thus, if the AA profiling of the feed intake does not match with the "ideal protein" needed by a given animal species at a given growth stage, part of the protein intake will be lost (not digested but excreted), thus resulting in a low feed conversion ratio and economic losses. A single limiting AA (often lysine) can generate significant losses if not corrected. AA optimisation can be achieved mainly through 2 mechanisms: optimisation of quantities of each material according to its AA profile and/or by adding synthetic AAs[87].

Figure 45 compares the studied PRPs/PRMs' AA contents (+ wheat for comparison) with the ideal protein for pork (Henry, 1988). In an "ideal" profile, all indispensable amino acids are equally limiting for performance, just covering the requirements for all physiological functions. Lysine has traditionally been used as a reference because it is the first limiting amino acid for growth in pigs. This figure clearly shows that the studied feed

[87] Which are not authorised in organic farming

materials have very different AA patterns, emphasising the fact that the term "protein" encompasses a wide range of qualities. The use of synthetic AAs in feed diets is a widespread technique to reduce the protein rate of formulated feeds. Such an option is of course linked to the price ratio of synthetic AAs vs other sources of vegetable proteins (Martin, 2014). Synthetic AAs are not allowed in organic productions and to produce various premium animal products.

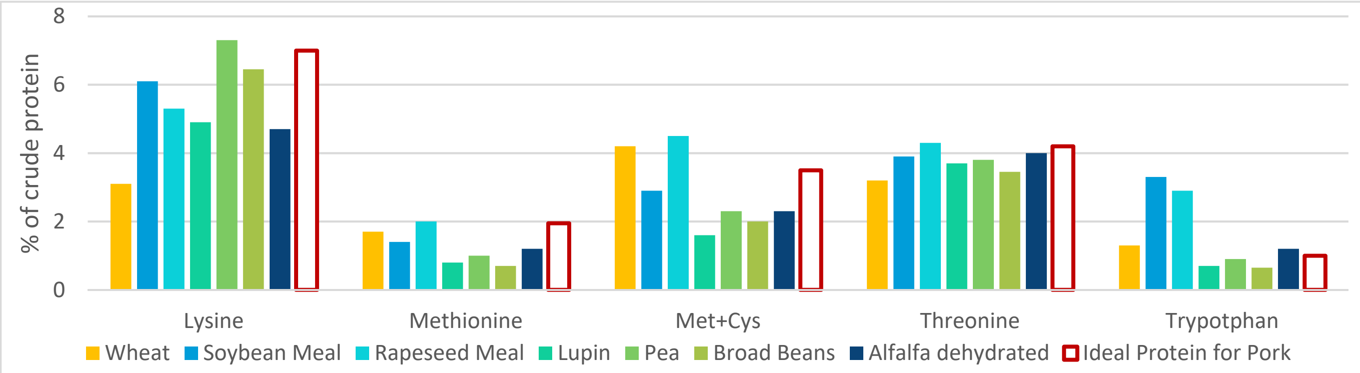


Figure 45: Amino-acid profiling of studied PRPs compared to the "ideal protein" for pork. (source: feedipedia and INRA PRODALIM).

Legume crops present common characteristics regarding their protein content:

- They present high lysine content compared to cereals (important to balance pig and poultry feed)
- Their proteins are quickly degradable in the rumen of ruminants if not processed or heated, while the objective is to increase the part digested after the rumen. Toasting, extruding and pressing allow high temperatures that can protect proteins to be degraded by microorganisms in the rumen, implying a better efficiency of the protein supply (higher digestibility).

Finally, the studied PRPs present various anti-nutritional factors that can hamper the digestibility of the feed. It is worth noting that anti-nutritional factors can be partially or fully eliminated through processing. For example:

- trypsin inhibitors of soya bean can be removed through heating (toasting, extruding, etc.),
- for rapeseed, varietal selection allowed to drastically reduce glucosinolates in the seed.

On-farm feed manufacturing and the use of PRPs/PRMs.

Most farmers producing food on-farm are looking for maximum self-sufficiency to reduce their feeding costs and decrease dependence on market fluctuations. On-farm compound feeds differ from industrial compound feeds due to a more limited number of raw materials used (Tallage et al., 2014). Like animal feed manufacturers (see 4.1.2.2), farmers must follow feed regulations and specifications related to their markets, make sure they have the appropriate supply of feed materials at the lowest cost, and that these feed materials meet livestock requirements.

On-farm feed manufacturing accounts (fodder excluded[88]) for about 37% of total feedstuffs consumed by animals (including both produced on-farm and purchased raw materials), while compound feed accounts for the remaining 63% of the feed supply. Box 3 provides additional pieces of information collected during case studies about the use of PRPs in on-farm feeding.

According to a study on modelling feed consumption in the European Union (FeedMod) financed by the European Commission (Tallage et al., 2014), the main MS concerned by on-farm feed manufacturing are, by order of importance: Germany, France, Spain, the UK, Poland, Denmark, Italy and Finland. The study also underlines that on-farm feeding is more developed in the pig sector than in the poultry sector, which is more vertically integrated, hence more dependent on upstream suppliers for feed. Cattle farms depend a lot on fodder (mostly self- or locally produced) and industrial compound feed plays a bigger role for dairy cattle (high protein needs to complement energy from fodders) than other types of cattle.

[88] Except dehydrated fodders, most rough legume fodders produced in the EU are home-grown by animal farmers and consumed by farm animals.

Based on a compilation of various sources at EU level, Figure 46 provides an order of magnitude of on-farm feed manufacturing vs compound feed in the EU for oilseed meals, pulses and cereals. Oilseed cakes require highly technical processes that cannot be performed on-farm. Moreover, on-farm feed manufacturing prevails for cereals since mixed farmers tend to use their own cereal production.

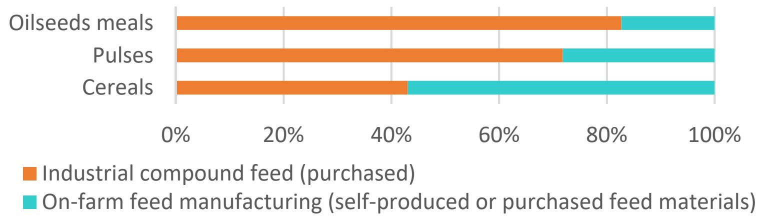


Figure 46: Share of industrial compound feed vs on-farm feed manufacturing at EU level (own compilation from various sources: EU Commission Protein Balance Sheet, EU Commission personal communications, FEFAC 201 2017)

Box 3: On-farm feed manufacturing and PRPs: feedback from case studies.

On-farm feed varies significantly between MS and the studied crops. According to interviews and data collection in the seven case study Member States, the following points can be highlighted:

- In several case study Member States (AT, DE, ES, FR and IT), field beans and field peas are traditionally produced on mixed farms to feed the herd. In Austria, this mainly concerns organic pig and cattle farms. Mobile toasting units are developing in FR and AU for pulses in the dairy sector but remain at pilot stage.
- For rapeseed and/or sunflower, seeds are rarely consumed on-farm in France and Germany (less than 5% of the production), while in Romania the share of on-farm self-consumption of sunflower could be much higher (up to 50% according to interviews).
- In Romania and according to interviews, a significant share of soya bean and sunflower produced is used on-farm to feed the livestock. There is a long tradition of small and medium-sized local oilseed extrusion in the country that is mainly used by the smaller farms. It is estimated that in every 3-4 villages[89] there is a small-scale oil press for local extrusion producing oil and meal for the use of surrounding farmers. According to Ionel (2010), in the 2000s, these small-scale oil presses were processing about 70 thousand tonnes/year of sunflower seeds, with an extraction rate of the oil of 25% (Ionel, 2010). Interviews conducted in Romania stress that sunflower processing by village presses could be much higher than that. Small livestock farmers grow sunflower on non-irrigated fields mainly for their own sunflower oil production and meal consumption for farm animals. Regarding soya bean, there is no data about the production which is pressed in village mills, but it could represent up to 75% of the country production according to the Ministry of Agriculture[90].

Table 11: Share of the production which is self-produced and on-farm used for feed in 2015 in six case study Member States[91]

	Pulses	Rapeseed	Sunflower	Soya	Source
AT	44% of field peas 18% of field beans	n.a.	n.a.	~14%	Interviews in Austria (AMA)
DE	54% (for all pulses[92])	<1%	n.a.	n.a.	Estimation based on data from the Federal Ministry of Food and Agriculture (BLE)
ES	10% (for field peas)	n.a.	no data	n.a.	Field peas: local expert elicitation Legume fodder Ministry of Agriculture (MAPAMA)
FR	~23 of field peas ~25% of field beans	~2%	~5%	~20%	Rapeseed, Sunflower, Soya: FranceAgriMer. These data include on farm self-consumption and on-farm stocks. These data also include seeds produced on farms and consequently, on-farm use is probably overestimated.
IT	no data	n.a.	n.a.	<1%	Soya bean: according to case study interviews.
RO	n.a.	n.a.	High	High	Soya and sunflower: according to interviews
n.a.: not applicable because this production is not covered by the scope of the case study					
no data: no consistent data could be obtained in the framework of the case study					

Source: case studies

For mixed farms, livestock farmers will preferably self-produce cereals (providing energy) and buy protein-rich sources, either in a formulated compound feed or raw material by raw material (implying a complex mixing stage on the farm). However, the more breeders concentrate their feed with energy from cereals (thus deconcentrating in protein), the more they will have to use a high protein meal such as high-protein soya meal to complement. In addition, given the limited storage capacity of farms in

[89] According to interview with the Ministry of Agriculture, MARD.

[90] In an interview carried out with a government representative during Romanian case study

[91] No consistent data could be found for Poland during the case study

[92] field beans, field peas, sweet lupine, chick pea and lentils

terms of number of cells, the choice of raw materials is based on a restricted number of products, but also available all year long[93]. This means formulas are not always optimised to use feed materials with an intermediate profile such as pulses or meals with lower protein content than commodity soya meal.

Consequently, alongside cereals produced or not on the farm and according to all experts interviewed through CS, the number one protein-rich feedstuff purchased to complement home-grown cereals remains soya meal. Feed experts interviewed reported that the use of imported soya meal is, for the vast majority of farmers, a habit that will take time to change. Nonetheless, local initiatives like soya bean toasting in Austria (cf. box 4) show that technological treatment can provide a direct feed value to on-farm produced soya bean.

Box 4: Toasted soya bean in Austria

Toasted soya bean in Austria[94]
In Austria, on-farm and small-scale toasting is developing. This activity represents about 20,000 tonnes (13% of the Austrian soya bean production) of soya bean per year and is mainly used for laying hens to produce GM-free eggs. Toasting soya bean can be implemented at a small-scale (a handful of farmers). According to experts interviewed, it is cost-efficient for laying hens and toasted soya is adapted to their growth. Some farmers have become interested in such processing tools and many groups of farmers have begun to use it (*EST Ecotoast* technology), pooling their investments. They report that it has made them more independent with regard to the volatility of feed prices.

Source: case studies

Drivers by type of protein-rich crop and material at the level of animal farmers.

- **Protein meals.**

Feedback from case studies shows that oilseed meals represent approximately one-quarter of the feed intake (in volume) for pig and poultry. The mix of oilseed meals used for poultry has a higher protein content for poultry, which need an intake concentrated in both energy and protein, contrary to pigs, which need lower protein content.

For ruminants (cattle, sheep and goats) and other herbivores (horses and rabbits), farmers use high-protein-content oilseed meals to balance fodder deficit in protein, especially in silage maize systems. According to CS feedback and the French Livestock Institute (IDELE), they represent about 40% of the feed bought in cattle systems (in tonnage), of which more than half is made from soya, especially in dairy systems.

Figure 47 shows a simulation made by CEREOPA[95] for the 2014/2015 campaign for France[96]. It highlights very well the differences and level of flexibility required according to the species. While poultry productions need oilseed meals with the highest content in proteins (soya bean (SB) for broilers and High-pro sunflower (SF) for laying hens), swine can accommodate meals with a lower concentration in proteins. Moreover, cattle still need soya but take good advantage of rapeseed (RS) meal and low-pro sunflower meals, especially because they can degrade the fibre fraction. These incorporation rates are the results of a trade-off between feed material nutritional value for a specific type of animal and raw material prices.

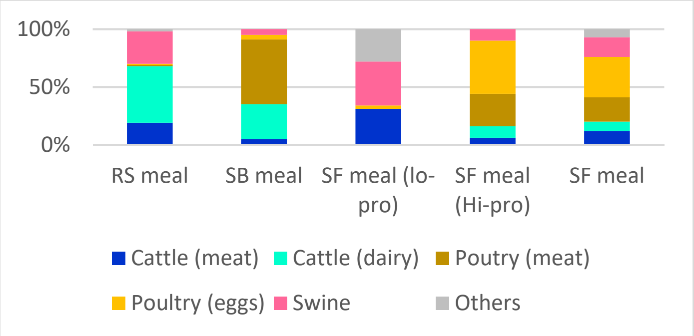


Figure 47: Distribution by species of the consumption of the 3 main oilseed meals in compound feed in FR in 2014/2015 (source: simulation from CEREOPA, in CS France).

[93] It seems that farmers who manufacture their feed are actually willing to pay slightly over the economic optimum to ensure the regularity of feeds for the animals. Farmers' reasoning is more on the overall competitiveness of the farm, where feed is a factor among others, rather than the optimisation of the feed itself. In addition, still with the aim of optimising, storage and transport, but also to limit the amount of raw materials, farmers tend to turn towards either products used in sufficient quantities in the feed or used in many formulas (e.g. for pigs: sows, post-weaning, fattening, etc.).

[94] AMA.

[95] http://www.cereopa.fr/

[96] It must be stressed that this figure only provides insights as it is just a simulation conducted for only 1 MS, especially because FR is known to use more rapeseed meal (domestic availability) and less soya meal compared with other EU MS.

- **Pulses**

Contrary to oilseeds, pulses (the most common species in the feed sector are field peas, broad beans and lupine) can be grown on-farm and used as-is (whole grain). They can contribute to a better feed autonomy, but many technical and economic barriers remain at the level of crop systems (cf. 4.3 about PRP producers).

The interest price of this feedstuff with an intermediate profile (starch + protein) is relatively easy to grasp (CARROUEE et al., 2003):

- 1 kg of field pea or broad bean = 0.8 kg of wheat + 0.2 kg of soya meal.
- 1 kg of lupine = 0.55 kg of wheat + 0.45 kg of soya

Given their current high price relative to their protein content, their low yields, their erratic availability (variable yields combined with competition with the food markets) and their intermediate nutritional profile, the use of pulses is little developed in the EU for pig and poultry systems. Poultry value chains are more vertically integrated and the incorporation of pulses in feed intake depends on compound feed composition, for which pulse incorporation remains very low for economic reasons and given a low availability. For pigs, nutritionists interviewed report that technically, there is room for medium levels of incorporation, at least much higher than current ones (cf. Table 12) but incorporation levels are limited by availability (for a consistent supply and a consistent quality) and price. Consumers demand for more meat products based on local feed drives initiatives, particularly in Western Europe (cf. Box 5 and Box 6). Such initiatives can locally impact the use of pulses in animal farms.

Box 5: Cooperation between actors along a pig value chain to develop the use of local legumes as feed in Mecklenburg-West Pomerania (Germany)

In Mecklenburg-West Pomerania (North-Eastern Germany), the swine value chain actors have gathered to launch an EIP programme called '*Einheimische Leguminosen in der Schweinefütterung*' ("local legumes in swine production").

The objective is to replace imported soymeal by domestically grown protein-rich crops, without negatively affecting productivity or meat quality. Soya bean imports are more and more negatively perceived by consumers (due to the use of GM varieties, environmental impacts in South America, etc.). The chain partners in Mecklenburg-West Pomerania had also observed a growing demand trend for more locally produced feed.

To reach this objective, the project includes research on formulas for the composition of soy-free feed. It mainly focuses on lupine, since the Mecklenburg-West Pomerania state set up a lupine network in 2015 (also in the aim of reducing dependence on imported soya bean). Peas and field beans are also included in the project.

Partners of the project are the pig breeder *Hybridschweinezuchtverband Nord/Ost*, compound feed producer *Fugema* and meat processor *LFW Ludwigsluster*. The initiative is supported by the State Research Centre for Agriculture and Fisheries, also coordinating the lupine network. The state's ministry for Agriculture, Environment and Consumer Protection (LALLF), has given financial support in the amount of €392,000 to the project (in addition to the European funds allocated in the framework of the EIP-AGRI program).

(CEREOPA, 2017, Verseput, 2016)

For ruminants, field peas and broad beans have a lower crude protein level (24-32%) than oilseed meals (35-50%) or to a lesser extent lupine (35-40%) and are more adapted to feed intake bases with a good protein level (high incorporation of grass and legume fodders) than fodder maize-based systems. Conversely, lupine may be used as a supplement to maize-based diets (CARROUEE et al., 2003). The low digestibility of protein is another barrier that could be overcome with technological treatments. Experts interviewed all agree on the significant potential for such processes but underline the need for improving processes (technological developments) and for *in-situ* trials to confirm the potential of toasting/extruding in ruminant feeding systems.

- **Legume fodders**

Most legume fodders are self-produced by animal farmers and used for herbivores only[97]. The use of LFs drastically dropped in the 1960s and the 1970s, concurrently with the growth of synthetic N-fertilisers, specialisation of agricultural areas and maize silage development (Murphy-Bokern et al., 2017). Until the beginning of the 1990s, the EU was importing low-price soya bean into the EU while protecting cereal prices. This situation led to a massive use of soya, a strong development of maize silage to complement soya meal and a decline of legume fodder (Pflimlin, 2003).

[97] It can also be used in monogastric organisms to provide fibre, but volumes are purely anecdotal. As developed in part 3.2.2.4, only a small part of legume fodders (10 to 15%) is produced to be sold in dried fodder markets (mostly through a dehydration process conducted in dedicated plants).

In addition to the nutritional value, it should also be noted that if crops have different protein contents, they also have different abilities to produce protein per unit of land. Legume fodders can produce high levels of proteins per ha, as describe for alfalfa and clover in Figure 48. Rapeseed, sunflower and fodder maize need nitrogen fertilisers (synthetic or animal manure) to produce such levels of proteins while other crops mentioned on the graph use biological N-Fixation.

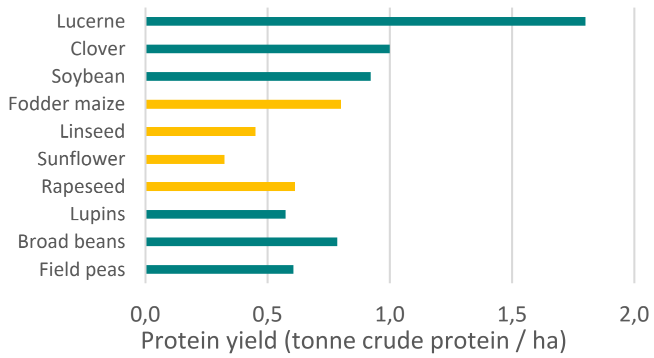


Figure 48: Average protein yield per ha in the EU (source: own calculation based on EUROSTAT, N-fixing crops in green)

Although they provide benefits[98], there are several barriers to the development of forage legumes for standard milk production, where milk is more a commodity than a product dedicated to a local dairy product process:

- Crop management cost and working time (3 to 5 cuts vs 1 for maize), as legume fodder often results in high production costs for breeders because of conservation and storing stages.
- Dominant practices and current trends in opposition to more legume fodders,
- Gross margin difference with crop substituted in the cropping system (cf. 4.3.1),

Nowadays, most breeders invoke the need to use high-protein-content oilseed meals to balance fodder deficit in protein. Systems are often based on fodder maize, which is an excellent provider of fibre and energy and enables very high yields if conducted intensively. Nonetheless, feed experts interviewed during case studies stress that the use of more legume fodder in ruminant farms is possible with negligible impact on milk/meat production and economic results. It would obviously imply a shift in feed management systems that are now locked with a massive use of protein-rich oilseed meal and high-energy-content fodders. Some experiments (Bossis et al., 2016, FÉRARD et al., 2018) on dairy cows show that replacing 30 to 50% of maize silage by alfalfa helps reduce soya meal use by 30 to 60 %. It stresses that it is possible to build inverted rations[99] in dairy cow formulation with little impact on performances. According to the authors, this type of ration can be profitable if a premium is given to consider the nutritional quality of the milk, the environmental impact or the non-GM aspect. It should also be noted that if a breeder wants to partially or totally replace the use of soya meal by increasing the protein content of fodders, it involved allocating a bigger area to legume fodders, meaning that part of the benefit from other crops (e.g. cash crops like cereals) will be lost.

Finally, it should be noted that the current trend towards more intensive and bigger dairy farms also impacts legume fodder development. Average farm size and milk intensity have regularly increased since milk quota abolishment, especially through farm concentration in more competitive areas ((Groeneveld et al., 2016). Milk producers will then have to intensify fodder production, often resulting in the development of maize silage. In addition, farm size growth often means more land fragmentation. This parcelling out of land can put a stop to grazing (not enough pasture land in the vicinity of the stable), resulting in higher needs for oilseed meals (grass contains more protein than maize). It also put legume fodder crops at a disadvantage because they require several cuts and many field operations for their conservation, making them hard to produce in scattered lands (more commuting and haulage).

Premium specifications and their impact on PRP use on animal farms.

[98] Feed management (local source of proteins, high protein yield per ha), agronomic benefits (see 4.3 on producers' drivers), animal health benefits (rumen acidosis especially), tools to diversify and secure fodder supply (autonomy and resilience to market fluctuations), compliance with environmental regulations given their sustainability, compliance with premium specifications.

[99] Common rations are composed of a base of energy-rich fodder complemented by high-protein concentrate. An inverted ration does the contrary: it is composed of a base of protein-rich fodder and the concentrate complements the missing energy.

Another incentive for the use of PRPs can be driven by local initiatives designed to generate more value on final products, based on:

- better nutritional value: omega 3, unsaturated fat, etc.,
- environmental benefits,
- better animal welfare,
- non-GM supply chains (cf. part 4.1.3).

Premiums are often reported as a strong driver to the development of legume fodder, especially for cheese-making (PDO, PGI), for which the following criteria can be added in specifications:

- ban of GM feed;
- ban of fermented feed (silage)[100];
- minimum incorporation of grass and legume fodders for quality reasons (cheese-making performance, unsaturated fat and omega 3 content, etc.).

Box 3, Box 6 and Box 7 give two examples of premium development that involve the incorporation of PRPs into feed.

Box 6: The promotion of the nutritional quality of linseed and pulses for feed in the framework of the Bleu – Blanc – Coeur initiative

In Western France in 2000, livestock farmers (along with other stakeholders such as scientists, consumers, etc.) created the association Bleu-Blanc-Coeur (BBC) to promote quality animal products (high omega-3 fatty acids) based on the use of diversified raw materials from traced supply chains for feed. It promotes the use of certain forages (grass and legume fodders) and crops (mainly linseed, but also hay, lupine, field beans, rapeseed, etc.).

The association has its own branding with specifications for a large diversity of animal products (e.g. milk, pig meat, poultry products, etc.). Specifications include a maximum limit for soya meal incorporation in feed rations (maximum limit is 5% for dairy cows and 7% for pigs in 2018) and will include in 2019 a minimum level of legumes (between 5 to 10% for poultry and pigs at the beginning).

This initiative has boosted the production of linseed, which has increased from 6,000 ha in the early 2000s to 15,000 ha in 2018 in France. On the commodity market, linseed is not competitive compared to its alternative for feed use and therefore its use by feed manufacturers on standard products is marginal. However, the added value linked to the quality and marketing of BBC products enables integration of linseed in the feed ration (Meynard et al., 2013).

In 2015, Valorex[101], thanks to the added value of the BBC label, announced its objective to replace the import of soya meal with locally produced protein-rich crops, mainly lupine and field beans. To do so, Valorex began a large R&D program, Proleval, to develop new processing and has developed two-year contracts, with either farmers or collectors, which includes a minimum price indexed to wheat prices to involve producers for the crop production, and a maximum price to limit price volatility for farmers and limit the risk of a drop of the production in the case of high wheat prices (AGRAPRESSE, 2012, Meynard et al., 2013).

Box 7: Local supply of protein plants to respond to the standards of PGI and PGO animal products

In the framework of some specific designations of origin (i.e. under quality schemes such as PGO or PDI), farmers must meet standards with regard to the feed ration given to the animals to be allowed to sell the animal products (cheese in most cases) under the designation. In many cases, they are required to use locally produced forages, which impacts the protein source in the ration.

For instance, in Italy, to produce *Parmigiano Reggiano* and *Grana Padano* cheeses (both are PGO), the rationing of the dairy cows must be based on the use of fodder from the area where the cheese is produced. For *Parmigiano Reggiano*, at least 50% of the dry matter in the fodder must come from hay (which can be made from natural meadows, polyphytic stable meadows, alfalfa and clover grass meadows) in the daily ration. According to interviews with experts in Italy, the farmers producing milk for *Parmigiano Reggiano* feed their cows with 50% locally produced alfalfa and 50% mixtures of cereals and soya beans. Therefore, 90% of sun-cured Alfalfa in Italy is self-consumed, mainly in the area of the *Parmigiano Reggiano* cheese. It would also partly explain why Italy is by far the major producer of LFs in the EU.

A local supply chain of soymeal (made from locally grown soya) has been set up in the East of France to supply

[100] Fermented feed decreases the suitability for cheese-making, especially for raw milk designations of origin. As a result, it is often banned in PDO specifications.

[101] A company specialised in grain processing for feed manufacturing, which produces 220,000 tonnes of feed per year

the demand for GM-free soya bean, especially for dairy farms producing *Comté* cheese (as required in the PGO specifications (Specification for the "COMTE" designation of origin).

. In 2016/17, 31,000 tonnes of soymeal were produced by the local extruding plant, Extrusel (to supply the *Comté* farmers as well as other demands). The extruding plant also produces rapeseed meal to supply the dairy farmers producing the *Epoisse* cheese (PGO).

Again in France, other PGO or PDI animal products require the use of locally produced feed including for the protein share, such as the *Chabichou* cheese (made from goat's milk in the west of France), *Brie de Melun* or *Brie de Meaux cheeses* (both made from cow's milk). For the *Chabichou* cheese, according to the standards, the feed ration per year must contain at least 200kg of dry matter of alfalfa or other legume plant produced locally (i.e. within the geographical area) (Specification for the "Chabichou du Poitou" designation of origin
).

4.1.2.2 Drivers related to the use of PRPs by feed manufacturers

Market shares of compound feed manufacturing

In 2016, 156.5 million tonnes of compound feed were produced by EU compounders, accounting for 23% of the world compound feed production and 80% of all purchased feedstuff in the EU (FEFAC, 2017).

Compound feed can include various types of raw materials such as: cereals, oilseeds and other protein meals, field peas and beans, dehydrated fodder, cassava and skimmed-milk powder. It also includes commercially traded agricultural by-products such as: corn gluten feed (CGF), bran, corn germ meal, sugar beet pulp, brewer's and distiller's residues (e.g. DDGS), etc. Feed components are highly substitutable among themselves (see below paragraphs about drivers for feed manufacturing).

Since 2003, the EU compound feed production has increased by 29%, mostly driven by demand for poultry and cattle feeding (Figure 49). Poultry has become the leading market in the last decade.

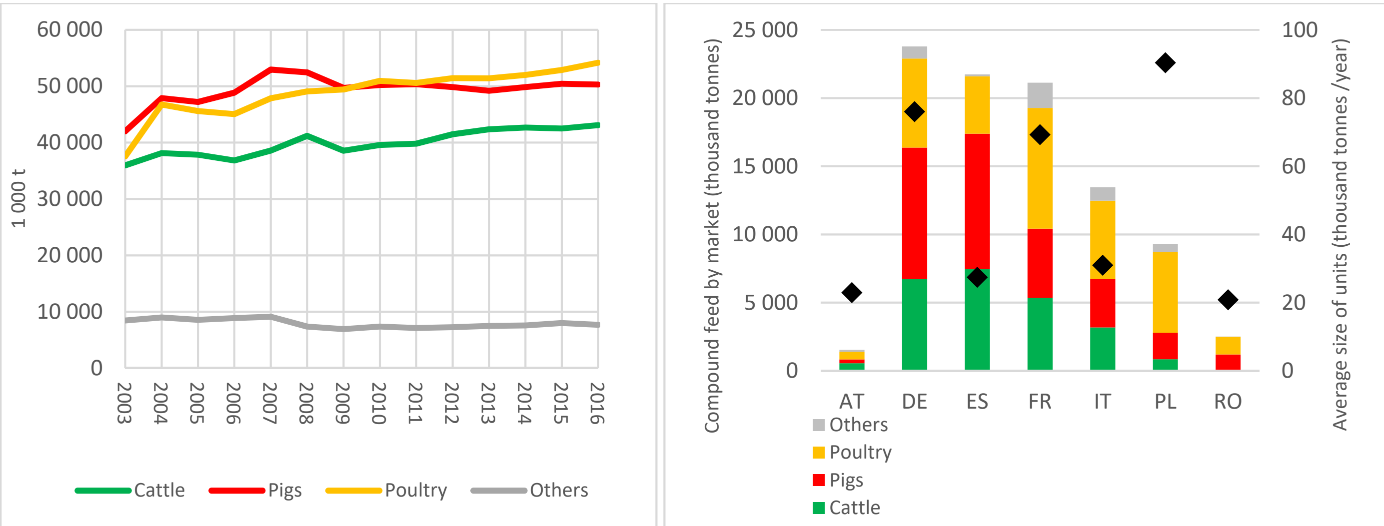


Figure 49: Compound feed production by market segment and CS country (source: FEFAC Statistical Book 2015)

Cereals account for nearly half of the quantity of compound feed consumed in the EU, while oilcakes and meals account for 28% (Figure 50). If raw materials are converted to crude protein equivalent, the share of oilseed meals rises to more than half of the consumption, while the share of cereals shrinks to a quarter. It should be noted that co-products also play an important role in the protein supply of compound feed. Compared to these big players, pulses and dried forage (mostly dehydrated alfalfa) are little represented in compound feed.

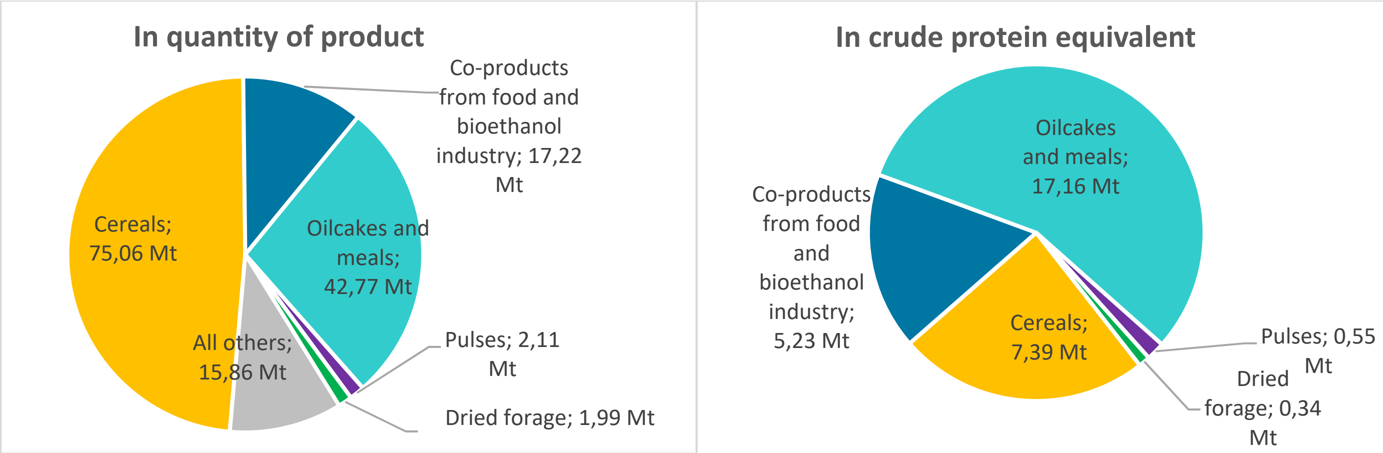


Figure 50: Industrial compound feed material consumed in the EU in 2015 in Million tonnes (source: FEFAC Statistical Book 2015 and own calculations)

Analysis of current incorporation rates of PRPs in compound feed

Compound feeds are manufactured from a mixture of raw materials designed to achieve pre-determined performance objectives among animals. Compound feed manufacturing obeys clear and simple rules:

- Raw material assembling;
- According to the nutritional value of each material;
- To obtain compound feed matching specific needs;
- At the lowest cost[102].

Feed formulation and buying are inherently linked, as formulation is a decision-making tool for commodity buyers, allowing a constant re-assessment and hierarchisation of raw materials to formulate least cost rations for a given quality standard. Quality depends on intrinsic nutritional value of products and animal ability to take advantage of each fraction of the product. It also depends on breeder requirements and specifications laid down for the final meat/dairy/egg product market. The main quality criteria are:

- Protein level; digestibility/degradability, amino-acid profile
- Other nutrients available in the given PRP (energy, fibre, minerals)
- Anti-nutritional factors such as antitrypsin factors, tannins, phytates, etc.

Feed manufacturers are not captive as long as they can maintain performances of the final product. According to the market context, they can use a large spectrum of products and switch from one raw material to another[103]. According to experts interviewed (Feed Alliance, FEFAC, Neovia nutrition, Terres Univia, CEREOPA), incorporation of PRPs in formulation is driven by 4 key factors:

1. Quality of raw materials and breeders' specifications
2. Substitution price (interest price + transaction cost)
3. Markets: volatility, liquidity, availability and hedging possibilities
4. Requirements from the sector downstream, linked to quality (type and age of animal, constraint demand from specific markets: organic, non-GM, designations of origin, minimal incorporation of cereals, veterinary/health regulations, etc.)

The incorporation rate of each feed material across feed market segments and by animal type is very difficult to evaluate as no data is available at EU level. Data from FEFAC provides global trends of feedstuff incorporation in compound feed (Figure 51). It underlines the relative growth of cereal incorporation after the MacSharry reform (lower price)[104]. It also stresses the stable and long-term predominance of oilseed meals for the protein supply as well as the constant decrease of the pulse

[102] Feed cost represents the main expense for animal farmers (up to 80% of total production cost). It is thus a central issue for the competitiveness and viability of a breeder's activity.

[103] For example, for rapeseed meal and soya bean, French feed manufacturers report that rapeseed meal use is very dependent on soya bean price. When the price ratio rapeseed cake/soya bean cake is over 73 (that has happened 13 times since 2003), rapeseed cake tends to be excluded from formulations. Conversely, if the same ratio goes below 64 (that has happened 25 times since 2003), rapeseed tends to be used at its maximum, only limited by its nutritional constraints.

[104] Resulting in a decrease of "all other feedstuffs" that were used to provide starch instead of costly cereals.

incorporation level. It also demonstrates that the incorporation of pulses[105] was much higher in the 1980s and 1990s.

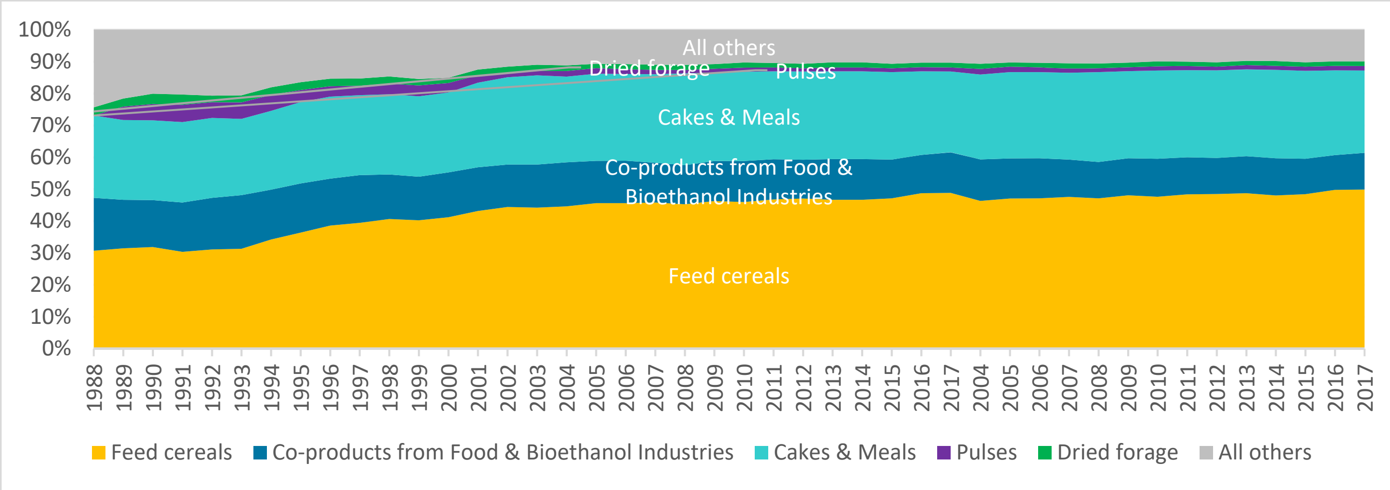


Figure 51: Feed material consumption by the compound feed industry since 1988 (source: FEFAC)

If analysed by type of production, incorporation rates vary greatly. To get an overview of incorporation level by animal type, the only CS country for which statistically representative data could be gathered at animal type level is France, thanks to an exhaustive survey of compound feed manufacturers conducted every three years by the French Ministry of Agriculture. Figure 52 reports the high use of cereals for poultry, medium for swine and low for herbivores (main market: dairy cattle). Poultry systems need a high share of protein-rich oilseed meals such as soya meals, especially because rations are cereal-based (thereby protein de-concentrated)[106]. Furthermore, pigs require lower protein-concentrated feed. It allows the use of less soya meal, more rapeseed and sunflower meal as well as field peas. Regarding ruminants, most cattle breeders produce their own fodder (providing energy) and then complement animal needs with a concentrated compound feed rich in protein. This explains why PRPs and PRMs represent nearly half of feed materials incorporated for herbivores.

	Poultry	Swine	Herbivores
Cereals	60.5%	55.8%	29.9%
Co-products from cereal processing (DGGS, etc.)	6.8%	10.2%	19.2%
Dehydrated alfalfa	s	0.1%	2.4%
Field pea	s	0.2%	0.1%
Field bean	s	s	0.1%
Linseed	s	s	0.4%
Soya bean (whole seed)	0.5%	0.5%	0.2%
Rapeseed	s	s	0.1%
Oilseed cakes	24.8%	26.2%	38.1%
Amino-acids	0.4%	0.6%	0.1%
Other feed materials (including statistical secret from above rows)	7.0%	6.4%	9.4%
TOTAL	100%	100%	100%

“s” means under statistical secret

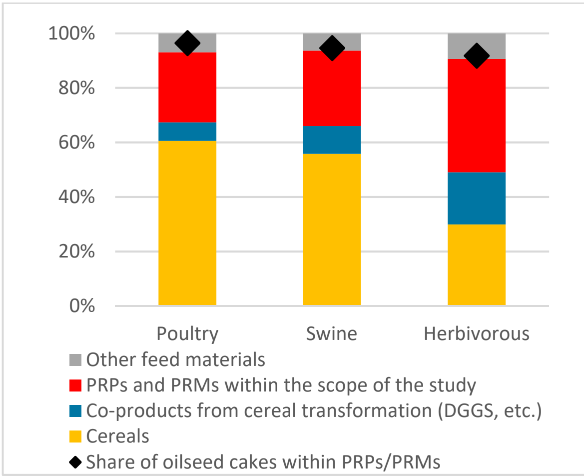


Figure 52: Incorporation rate of main feed materials by type of production in the compound feed industry in France (Source: French Ministry of Agriculture, national survey on raw materials used for compound feedstuff).

Obviously, the inherent quality of proteins and other components of PRPs (energy, anti-nutritional factors, fat content, physiological constraints, etc.) logically defines maximum levels of incorporation but it should be noted that such incorporation levels mainly reflect economic criteria. Table 12, derived

[105] This category aggregates many products but according to experts interviewed, it was mostly field pea and faba for the pig sector

[106] It should be noted that specifications for poultry labelling (PDO, PGI) often require a minimum cereal incorporation, reducing room for manoeuvre to use feed materials other than soya meal.

from research works identified during the case study in Germany, describes potential maximal levels of incorporation in feed intake for several PRPs/PRMs, according to the type of animal. Table 12 shows that incorporation levels of pulses could be much higher. Authors state that about 50% of the necessary protein supply in the pig sector in DE could be provided by pulses[107] (Weber et al., 2016a). Regarding the suitability of pulses for poultry feed, Belhof et al. (2016) state that a balanced supply with more pulses and less soya bean is possible, especially in combination with rapeseed meal or dehulled sunflower expeller (Bellof et al., 2016).

Table 12: technical maximum incorporation levels of various plant protein sources in pig and poultry feed (based on nutritional aspects)

Animal		Field peas	Sweet lupines	Field beans	Soya meal	Rapeseed meal
Pig	Piglets (phase1/phase2)	10-20%	0-5%	0-5%	15-18%	6-15%
	Fattening pigs (pre-fattening/fattening period)	20-25%	15-20%	15-25%	12-15%	5-15%
	Sows (pregnant/lactating)	8-20%	8-10%	8-15%	2-12%	5.5-10%
Poultry	Laying hens (egg production period)	30%	10%	10%	-	-
	Broiler (pre-fattening/fattening period)	25%	10-15%	20-25%	14.5-31.5%	7.5-15%

Source: adapted from (Weber et al., 2016a, Weber et al., 2016b, Plesch and Bellhof, 2016, Bellof et al., 2016)[108]

Of course, such incorporation rates hide differences: the room for pulses increases in medium and low-intensity poultry systems for example, which do not represent the majority of farms in the EU, although premiums are well developed. Authors also conclude that:

- for laying hen feed, soya meal can be totally replaced by other protein feed;
- for broiler feed, at least in the final fattening period, the use of soya meal can be reduced considerably.

Despite their differences in composition, some authors show that the amino acid profiles of pea and rapeseed meal are quite complementary (Peyronnet et al., 2010). They underline that for fattening pigs, it is easy to formulate diets with pea and rapeseed meal without any soya meal and with no impact on feeding cost. For poultry diets, peas and rapeseed meal can replace soya meal for slow growing birds but the price of feed increases. Authors stress that price ratios of pea and wheat and rapeseed and soya meals have to decrease to make pea and rapeseed meal more competitive for poultry nutrition.

Another study (ROYER et al., 2005) quantifying maximum incorporation rates in cereal-based rations with no soya bean for piglets and fattening pigs shows that rapeseed and field beans can be respectively used at 15 and 35% for piglets, and 18 and 40% for fattening pigs. The association of both raw materials enables reducing soya meal incorporation to 0-2%. For lupine, there is a ceiling at 10% of the ration due to high contents in alkaloids.

Economic reasoning of industrial compound feed manufacturing and rationale behind current incorporation rates

Aversion to change is very limited for feed manufacturers compared with other economic agents of the feed supply chain (e.g. animal farmers). However, they face economical and logistical constraints that can favour the incorporation of some products over others. In addition to its nutritional and its health/veterinary quality, the incorporation of PRPs in feed formulas is driven by the following factors: substitution price, insider bonus, advantage of "specialised" materials, market liquidity and the related price risk management, constant availability and quality.

Substitution price (Interest cost + transaction costs)

Transaction costs are an obvious barrier to incorporating a new material. Whatever the mode of exchange, a transaction generates costs in addition to the price of good/services exchanges: search costs, bargaining costs, control costs, transport/logistical costs. First, given the fact that the volume

[107] This estimation only deals with the technique of animal husbandry, independent of availability and prices, which are currently the main barrier to the incorporation of more pulses in the animal feed intake. It does not consider that market supply with pulses is very low and that the contribution of pulses to the current protein supply is of nearly no economic relevance given the current market context (at least in Germany, where the study was conducted).

[108] Based on works by Werber (2016) (for pig) and Plesch and Bellof (2016) (for poultry), this table presents the highest share that can be incorporated in the feed ratio for each stage of development (i.e. the stages mentioned in column 2).

storage in silos and unit numbers are limited, feed manufacturers tend to prefer a raw material that they can use in several compound feeds for various types of animal. Secondly, a material will not necessarily be incorporated in a formula at its interest cost, even though it starts to appear in the formulation software. Adding a new product implies more logistics (chemical analysis of samples, silo cell allocation, etc.), an increase of transportation costs as well as potential replacement of another commodity in silos. This difference between theoretical economic interest price and substitution price is illustrated for the case of pea in Figure 53. The analysis shows that in 2016, the substitution price was 35€/t lower than the interest price. This significant difference underlines the fact that substitution price is most of the time a more relevant price leverage than interest price. This would be a key element to be considered on which to effectively base a policy meant to develop PRP incorporation in feed.

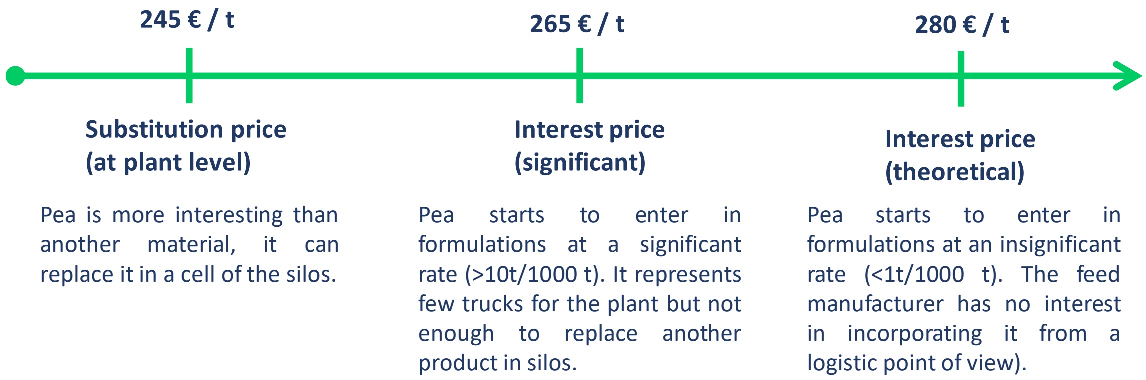


Figure 53: Example illustrating interest price vs substitution price (more relevant as a lever) for pea in 2016 in France (source: calculations from feed manufacture formulators interviewed).

Insider bonus

In addition to the difference between substitution and interest price, it can be noted that feed makers are more likely to be cautious with a new material that they are not used to dealing with (limited trust for "outsiders") compared with "insiders" (more trust, especially regarding health quality). Adding a new material also generates an extra cost related to more quality-control checking in the first stages. For example, feed experts report that this insider bonus ranges roughly from 5 to 10€ to replace dehulled high-pro sunflower from the Black sea area with an EU broad bean.

The advantage of using "specialised" vs "intermediate materials"

Feed manufacturers prefer specialised commodities, with a strong profile for one nutritional feature. For example, using highly specialised protein products such as soya meal give more flexibility and room for manoeuvre for using low cost raw materials to provide the energy part, and reciprocally for cereals when they provide energy. This partly explains the high share of soya (high protein content, good digestibility, one of the best AA profiles among PRPs) and to some extent of sunflower/rapeseed meals, as well as the high incorporation of wheat and maize (starch giving a high energy content). Figure 54 illustrates the positioning of PRPs in comparison with other products and stresses that pulses present a more intermediate profile (20-30% crude protein compared to 30-50% for oilseed meals), providing both energy and protein. Feed nutrition experts interviewed (FEFAC, NOVIA, CEREOPA, TERRES UNIVIA, etc.) report that these kinds of intermediate products are less attractive in comparison with more "specialised" commodities. Basically, the high starch content of pea and field bean means that the upward pressure on the relative value of their protein is buffered by the downward pressure on the relative value of starch. Unfortunately for pulses, ways to concentrate protein are not competitive and little developed, apart from dehulling[109].

[109] Fava/field bean dehulling is developing but we observe market cornering for aquaculture (Norwegian market), which provides a more lucrative outlet than commodity feed markets. Dehulling of field bean can enable raising the protein level by 2 to 3 points of protein, giving more flexibility to the formulator.

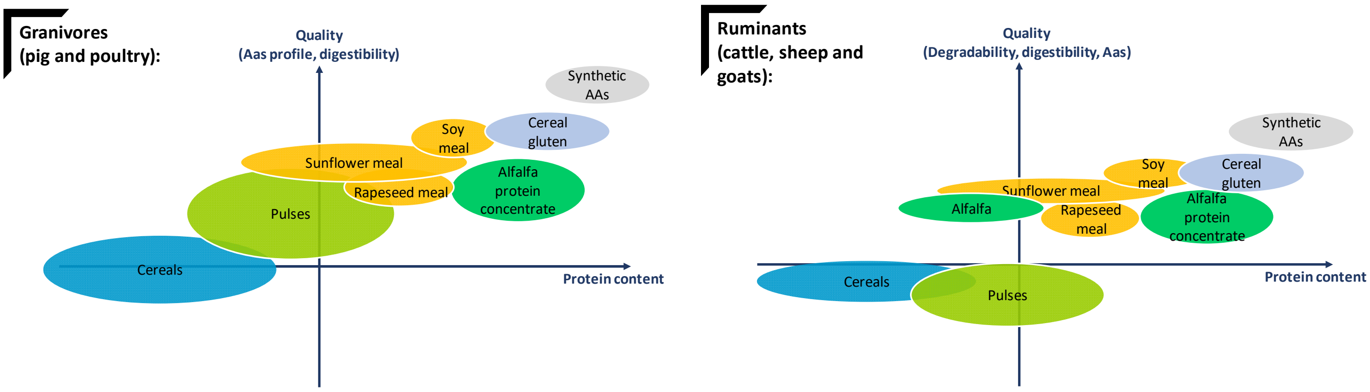


Figure 54: Relative value of studied PRPs from the point of view of feed manufacturers, for granivores (pig and poultry) and ruminants (cows, sheep and goats) (source: interview with Neovia nutrition)

Market liquidity and the related price risk management

Market structure plays a key role in the share of PRPs in animal compound feed in the EU.

According to FEFAC, the margin of feed manufacturers is around 1-2%, meaning that benefits depend mostly on volumes sold and price risk management given the high volatility of agricultural markets[110] (a wrong procurement on the market could eventually lead to negative margins). Consequently, feed manufacturers are prone to choose commodities allowing a better management of price risk.

Feed manufacturers must juggle with 3 prices: (1) hedging price at short term (stocks and already signed purchase orders), (2) SPOT (current) price (if long term hedging must be completed) and (3) future prices. The first two are used for operational formulation in the plant; future prices are needed to carry out forecasted formulations to hedge, define a supply strategy and anticipate market behaviours.

For forecasting, feed manufacturers face a small spectrum of commodities: mostly soya (CBOT), wheat and maize (CBOT + Matif) and, to a lesser extent (more limited volumes and market operation), rapeseed (Matif). According to interviews with feed manufacturers in case study MS[111] and at EU-level, the main feed companies use futures markets.

To secure long-term positions with raw materials that have no futures markets, buyers must negotiate with sellers (collectors or even producers) directly on physical markets. In that case, prices can be based on soya bean and wheat futures market prices (e.g. wheat by-products are indexed on wheat prices). For oilseeds, given the fact that the two main PRPs (soya bean and rapeseed) have futures markets, it is possible to index the price of other oilseed meals (sunflower, linseed, etc.) on futures markets. However, for pulses, the offer is limited to physical markets and some campaign agreement contracts. In addition, it is difficult to index prices on existing futures markets because no market can reflect the intermediate profile of pulses. Although it is possible to break down the value of pulses according to their relative nutritional value (e.g. pea value≈80% wheat value + 20% soya value), this kind of formula with new variables brings a complexity that is difficult to manage, especially because variables are interdependent.

Consistent availability and quality

Consistent availability (intra- and inter-annual) and quality of materials is important so as not to generate significant logistical switches in supply and silo management. The offer for pulses being limited to physical markets, with a limited and variable availability as well as a significant competition with food markets[112], a consistent and reliable supply cannot be ensured.

Another drawback lies in the fact that contrary to liquid markets for which traded product and prices are highly standardised in terms of quality, smaller physical markets are inherently linked to a high

[110] It should also be noted that, by smoothing feed price variability, feed manufacturers can be a significant buffer against volatility for farmers.

[111] FEFAC and Feed Alliance at EU level, WISIUM in France, Catalan Association of Manufacturers of Compound feed (ASFAC) in Spain and BUNGE in Romania.

[112] Sellers are more willing to keep or even store pulses to sell them on food markets, hence generating more value. Collectors and traders of pulses interviewed explained that feed market is only used to sell of the stock in no food outlet has been identified.

variability in quality, leading to an additional barrier to their adoption. This aspect was often reported for field beans, which are apparently subjected to high variability in quality.

Figure 55 shows that production and exports of pulses have fluctuated in the last decades, meaning that the availability for the domestic feed market is fragile. Consequently, feed manufacturers can hardly rely on a consistent supply of pulses from year to year, whereas they would need a stable availability to optimise feed formulations. Several experts underlined that to integrate the top ten commodities that are always used by a feed maker, the sector must be structured enough to give long-term guarantees to buyers.

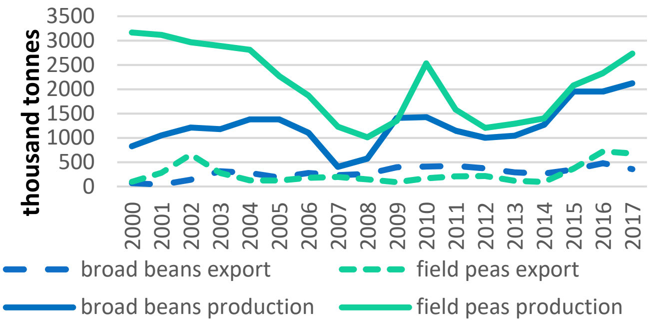


Figure 55: EU production and exportation of broad beans and field peas EU (source: EUROSTAT/COMEXT)

Therefore, the market of a given PRP must reach a critical mass that will be the trigger of positive feedback loop: the market reaches a critical size and gain in liquidity, feed manufacturers use it with long term prospects, generating demand for the PRP, hence increasing cropping area and feed use, etc.

4.1.2.3 Drivers related to the use of PRPs by other economic agents of conventional supply chains: collectors and traders

For sold agricultural products (meaning not on-farm consumed), collectors represent the main outlet for PRP producers. Collectors have storage facilities: silos, silo cells and dedicated equipment to sort, clean and dry.

The main drivers for collectors are:

- the demand: before inciting producers to produce PRPs, they must to get an initial idea of the market for such products,
- price, as collectors must guarantee a profitable price to the producers while finding a profitable outlet for their collect,
- quality/origin, which can be an important driver for some products (e.g. GM-Free soya bean, EU, etc.),
- availability, also among the main drivers for collectors as they have to reassure their buyers they will be able to provide them with given qualities and volumes in due time. For that, most of them have contractual partnerships with producers and sometimes buyers in order to secure the supply all along the chain. Some supply chains set up standards in order to provide customers with some guaranties on the origin, quality, etc. This is often the case for EU-produced soya bean.
- the competition with imported products is also among the drivers as some of these products are commodities (e.g. soya bean, rapeseed, etc.) or have significant import volumes (e.g. Sunflower High-pro). In this competition, exchange rates between currencies (e.g. €/$/Real) can play an important role in case of significant fluctuations.
- the need for specific equipment: for example, for a collector located in a highly specialised arable plain, treating four main products (e.g. three cereals and one oilseed) when adding a new crop in its portfolio implies significant investment in silos and sorting equipment. In certain regions this has been a significant barrier to the development of PRPs (Oréade-Brèche - 2017[113]). In addition to these investments, additional equipment can be requested to deal with some contaminations (mycotoxins, plant protection products, post-harvest pests, etc.). Shifting from a highly specialised system to a more diversified one can be complicated and costly.
- the aversion to change, which is the same for this operator as for the others, which leads to maintaining habits with insiders and not letting outsiders in.

As for traders, they generally buy significant volumes of standardised products dedicated to the end users or the feed industry and sell them in smaller quantities to their clients. Some of them can also be

[113] Etat des lieux de la mobilisation des Programmes de Développement Rural Régionaux en faveur de la politique agro-écologique. Oréade-Brèche 2017.

feed manufacturers. For these operators, for conventional feed, international markets drive the supply: price is the most important driver for a given quality. Exchange rates clearly impact the sourcing of raw material and their cost. Given the current growth of civil society concerns, the establishment of sustainable supply chains and sourcing (zero deforestation, social impact, etc.) is on the rise (e.g. Duralim initiative in France[114]).

4.1.2.4 Conclusion on the main drivers related to the use of protein-rich plants and materials in the conventional feed market segment

The main takeaway points of the analysis of drivers presented above are the following:

- Price risk management is a key driver for both livestock breeders and feed manufacturers. They will both favour a supply that can allow them to secure a margin.
- Transaction costs are a clear barrier to the replacement of a raw material by another in compound feed factories. Consequently, the substitution price is a more relevant indicator than the interest price on which to base a policy meant to develop PRPs incorporation in feed. It can also be noted that feed makers are more likely to be cautious with a new material that they are not used to dealing with (limited trust for "outsiders" compared with "insiders").
- To manage price variability, feed manufacturers tend to favour markets with constant availability, constant quality and with hedging possibilities. These criteria make oilseed meals much more competitive than pulses.
- By generating uncertainty when forecasting prices and availability of raw materials, the competition with food markets is an obstacle to a sustainable integration of pulses in feed.
- Mixed farmers often try to maximise cereal use. It can generate an additional demand for soya bean. Studies highlight that this search for feed autonomy could be more protein-oriented (more pulses and/or leguminous fodders) but it would require more labour and knowledge of the management of these crops, both at parcel and animal husbandry levels.
- Peas and broad beans have an intermediate profile limiting flexibility of formulation. Conversely, oilseed meals, especially soya meal, present highly specialised profiles in protein content that promote their use in animal feed.
- Technically, there is room for more peas and field beans in animal intakes. Current incorporation levels mainly reflect economic criteria and a lack in supply chain organisation to sustain an offer.
- The low digestibility of protein in pulses is a barrier that could be overcome with technological treatment. Small-scale solutions are developing in some countries/areas (e.g. mobile toasting) but are not yet disseminated or available (or not even known) in other member States. These small-scale solutions could also foster the development of on-farm consumption for locally produced soya bean and pulses.
- Legume fodders produce two times more proteins per ha than soya bean and help reduce soya meal incorporation in dairy cows intake.
- Premium markets and local initiatives are often reported as a strong driver to the development of locally/EU produced PRPs. It can imply a partial rethinking of feed systems and pave the way for more protein autonomy.

[114] http://www.duralim.org/

4.1.2.5 Outlook of the conventional feed market segment and relation with PRPs

The analysis developed hereinafter for the conventional feed market segment is based on the trends from the EU Commission Mid-Term Agricultural Outlook 2017-2030, completed with the first results from the 2018-2030 Outlook (not yet published). Such projections support a baseline that is often reiterated in the first paragraphs of this outlook. Hypotheses and assumptions from this reference document consequently underpin potential effects on PRPs developed in the current outlook. The conclusions (see chapter 6) and recommendations (see chapter 7) highlight the key issues at stake and provide suggestions that could support the setting up of plant proteins in the EU.

PRP developments after 2020 are hard to anticipate as they will take place in a new, and yet undecided, policy environment. Policies such as VCS and diversification measures under the CAP (cf. chapter 5) or the biofuel regulations (RED II, FQD and ILUC directives) have significantly impacted the EU protein supply. Other policies changes could greatly influence the willingness of farmers to sow PRPs (e.g. greening). Others may potentially be adopted to foster the development of protein crops in the EU, particularly within the framework of the current protein plan currently being drafted by DG-AGRI.

Decreased oilseed meal supply from first generation biofuels

Biodiesel production from rapeseed is expected to stabilize or slightly decrease due to recent policy changes related to the RED II directive, although the phasing out of biofuel feedstocks with high risk of ILUC (i.E. palm oil) will buffer this drop ((Jensen and Pérez, 2018). Developments in the use of vegetable oil in the last decade were driven principally by the surge of the biofuel sector (see part 3.6.3), providing significant amounts of rapeseed meal[115]. In addition to the stable incorporation target specified in the new RED II directive, the share of vegetable oils in the biofuels complex is projected to decrease in favour of waste oils and residues (DG-Agri, 2017). Other factors will decrease the demand for first generation biofuels, such as gains in engine efficiency, development of electric cars and decreased diesel share in transport fuels. Consequently, the availability of rapeseed meals for the feed industry might drop, especially because EU projections expect that total food use of oil will remain stable. With current policies and identified market drivers, it could result in stronger demand for soya bean meal, for which cropping area is expected to continue expanding beyond the EU, especially in Brazil, predicted to become the number one producer of soya in the world (Bruinsma, 2003). According to JRC projections (JRC, 2018) and Fediol, crushing of EU produced soybean will raise as the EU production is expected to increase by 1 million tonnes from 2018 to 2021 (LECOCQ, 2018), driven by a growing demand for more non-GMO feed material.

A limited growth of protein crops

Regarding protein crop availability (N-fixing crops: pulses, legume fodders and EU soya bean), these crops recently experienced a strong revival driven by a favourable policy environment, with record production in 2017/2018 (DG-AGRI, 2018b), although policy changes restricting the use of pesticides on EFAs might affect protein crop production in more intensive production regions. However, with a share of only 1.4% of total crop area, the N-fixing crop area remain limited. CAP tools like VCS are expected to continue to support protein crop production in the EU (DG-Agri, 2017). A stabilisation of the protein crop area is also predicted given the rather low prices of competing feedstuff such as maize and soya meals. However, protein crops are still in the focus of the new CAP 2020 proposal and new measures could boost their development. EU soya bean areas are also expanding rapidly, driven by the expansion of GM-Free markets (see part 4.1.4). The renewed interest in protein crops could also have a positive impact on yield developments. With growing farming experience, especially in areas where the crops were not grown before, higher yields should follow. According to DG-AGRI projections, slight yield increases (annual growth rate from 0.6% in 2008-2018 to to 1.1% over the 2018-2030 period) on a stabilising area will result in a moderate production growth in the EU, from around 1.9 million tonnes in 2016 to 2.5 million tonnes in 2030 for field peas, and from around 1.9 million tonnes in 2016 to 2.2 million tonnes in 2030 for field beans.

As stressed in the introductory chapter of this report, the area of N-fixing crops is also inherently linked to fertiliser prices, themselves correlated to oil and gas prices. According to the OECD Economic Outlook, it seems that there is consensus among oil price projections on a gradual price increase up to

[115] Rapeseed oil accounts for the largest share of the vegetable oils used for biofuels (around 62 %).

2030 but there is a great uncertainty on the extent of this surge. In any case, high synthetic N-fertiliser prices could increase the competitiveness of N-fixing crops. extra

Increased poultry/egg production and intensification of dairy systems resulting in higher oilseed meal demand

Although they still represent 90% of the PRP consumed, market shares of commodity feed markets are forecasted to decrease due the growth of GM-Free and organic markets (cf. 4.1.4 and 4.1.5). However, losing market shares does not necessarily mean it will decrease in volume, given the forecasted demand for meat products in the EU and beyond the EU. It is noteworthy that conventional or "commodity" feed markets still represent approximately 70% of the PRP demand in the EU, meaning that future behaviours of such a significant market are likely to greatly influence the landscape of PRP supply and demand in the EU.

As underlined in part 3.6.4., world population growth and diet changes related to income growth are expected to drive higher global demand for meat. FAO expects world meat consumption to increase by 14 % between 2017 and 2030: this is almost equivalent to a year's total meat production in the EU (Bruinsma, 2003). According to the medium-term outlook 2017-2030 of the European Commission (DG-Agri, 2017), this supplementary demand is forecasted to be mostly fulfilled by emerging markets themselves but it will still contribute to higher EU meat exports, as EU meat consumption is stabilising. Still, the same document forecasts that 90 % of total EU meat production will go to EU consumers in 2030.

EU per capita consumption of meat is expected to continue increasing slightly in the first years of the outlook period, especially in the EU-N13. However, as we approach 2030, per capita consumption will probably drop back towards its current level (especially in EU-15), while poultry will take some market share from other meats (JRC, 2018). However, population growth in the EU-15 should result in higher meat consumption at EU level. Market changes will follow two different patterns:

- less volume and more value in Northwest Europe: expansion of premiums, difficulties in farm capacity expansion,
- volume growth in central and Eastern Europe: cost price leadership in standard chicken, fewer difficulties in farm capacity expansion, growing demand to supply the rest of the EU.

EU meat and dairy production is thus set to expand further. For poultry, and to a lesser extent pig meat, livestock numbers will rise, while dairy production will mainly increase its productivity to sustain the growing demand (DG-Agri, 2017). Feed use is expected to rise further over the outlook period in response to more poultry and dairy production and more intensive beef production.

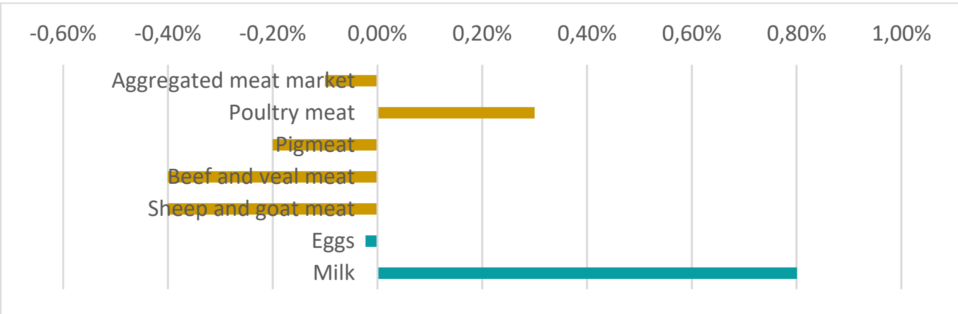


Figure 56: Projected Annual Growth of EU gross indigenous animal production (source: EU Agricultural medium-term Outlook, 2018, not yet published)

To achieve this demand, a higher use of protein meals in feed rations will be needed, especially because this growth is mainly driven by the poultry sector, the number-one user of soya bean meal in terms of incorporation rates (cf. part 4.1.3.). Given that the domestic supply of rapeseed meal will decrease, this additional demand will generate extra demand for imported soya. According to the EU Commission medium-term outlook, the first signs of higher soya meal use and import recovery were already apparent in 2016 and 2017.

As developed in part 4.1.3, the rise in dairy farm productivity (milk yield forecasted to grow by 18 % by 2030 according to DG-AGRI) resulting from the current post-quota market reorganisation (Groeneveld et al., 2016) is likely to impact dairy farm's feeding systems, especially in terms of intensity per ha of farm land but also by labour unit. Increased productivity probably means increased protein concentration of feed intake through the use of high-protein oilseed meals. Increased herd size combined with scattered land will also be a barrier to maintain grazing or grow legume fodders. Increase in labour intensity could also penalise legume fodders that are more labour-intensive than maize and limit home-growing of N-fixing crops.

Shifting from commodity-based to premium-based markets.

The frontier between conventional feed markets and high-value markets is getting blurrier, as food companies known for their standard products tend to now invest where the growth is: value-added and premium meat products. To increase margin levels, food companies try to move from standard meat to premium / value-added animal products, which can be driven by various stakeholders: industry itself, NGOs, retailers, consumers.

According to interviews undertaken for this study with economic agents from the feed industry and according to the European Feed Manufacturers Association (FEFAC), such market developments are recent but booming: GM-Free products, local origin, local/national labelling, animal welfare standards, etc. For example, feed experts interviewed for Germany, Austria and France case studies reported that GM-Free products have quickly developed in Germany and Austria and that it creates ripples in France and Poland. In France, researchers interviewed foresee that most of the French dairies might be converted to non-GM in the next 3-4 years, although such information should be taken cautiously as it only relies on expert elicitation.

Premiums growth could significantly impact future developments of PRPs because their setting up often imply a rethinking of systems (more grazing, no imported soya, minimum incorporation of local pulses/legume fodders, lower livestock density, etc.). They also observe that it often implies doing without soya as non-GM soya availability is limited, representing an important paradigm shift for most animal farmers.

It should also be noted that this need for more local protein and more environmentally friendly systems generates more demand for legume fodders (for example, projects to extract proteins from fodders (current project in Denmark) or to develop legume fodder drying with renewable energy are emerging in dairy area of western Europe (CIDE).

The need for more traceability might be another side effect of growing social concerns, implying more coordination and better guarantees on tracking and tracing. Combined with the take-off of online marketing and buying, it could be an opportunity for EU value chains, especially with emerging tools such as big data solutions and blockchains.

Furthermore, and as developed by Magrini et al. (2018), a spot feed market is not a stable market to foster long term investments for minor crops and direct subsidies are based on short term. The need to ensure a reliable supply for these premiums and quality labels could trigger the development of campaign and pluriannual contracts that would give a long-term perspective to produce PRPs for the feed industry. Pure commodity feed manufacturing relies on high raw material substitutability in feed formulas. In such a system, EU/local PRPs have no specific assets and only low prices can result in feed use. As developed in this report, such prices do not provide incentives to grow protein crops. It results in crop production decrease, low and sparse production, increased transaction costs for the feed industry and collectors, making EU PRP even less attractive for feed makers…making a full vicious circle. It also results in decreased knowledge in producing and using the products, adding another layer to hamper PRPs development. Premium and high value markets can break this negative backward loop because they provide a long-term perspective to producers and re-link consumers' demand and production.

4.1.3 Drivers specifically related to the GM-Free premium market of PRPs in the feed sector

This chapter details the main drivers related to the GM-Free feed sector for the main economic agents in feed value chains. Final consumers are the main economic agent driving this market of meat, dairy and egg products, although choices of other economic agents can significantly impact the use of PRPs or not, like retailers or animal food manufacturers. Before describing drivers at economic agent level, some context is first given to present the main key issues for the whole segment.

4.1.3.1 Context of the GM-Free feed market segment

The two PRP productions that are produced as GMOs and imported in the EU are soya bean and rapeseed. This chapter presents the soya bean case, as it is the most "risky" production on a GM-Free consideration and as GM rapeseed would concern very small volumes.

The paragraphs below detail the legislative framework, market size, production and trade of animal products grown with GM-Free soya bean.

As a reminder, all soya beans produced in the EU are GM-Free.

Legislation framework for GM products

In the EU, GMO products and their labelling are regulated, mainly, by Directive 2001/18/EC, Regulations 1829/2003 and 1830/2003. A product is considered as GM in case of any presence or use of GMO, despite the actual quantity thereof. A product is labelled as GMO if the proportion of the GM part of each food ingredient considered individually or of the feed (and of each feed of which it is composed) is higher than 0.9%.

Framework for GM-free products and labelling based on national standards

In parallel, voluntary initiatives have developed in different MS to give consumers the guarantee of products free of GMOs. While the EU GM legislation ensures a "positive labelling", consumers were more interested in "negative labelling" to be informed about the food and feed products not containing or not produced with GM[116]. Thus, two types of GM-Free labels began to develop: the government-led GM-Free labelling systems and the private ones[117]. In this chapter we focus on the first ones. In order to increase transparency and support creation of value added through quality products, several MS have put in place national GM-Free standards. Map 3 displays the different GM-Free standards existing within the EU.

Map 3: MS having created GM-free labelling for animal products fed by GM-Free feed in the EU

In 2017, Austria, France, Germany, Hungary, Luxembourg, Slovenia and even South Tyrol in Italy had their own GM-Free standards[118].

In most of these cases, standards have been created by governments, but the implementation and development are done by NGOs such as VLOG[119] in Germany and ARGE Gentechnikfrei[120] in Austria.

Since the EU legislation does not set up any rules for labelling of food and feed not concerned by mandatory labelling (under 0.9% of GM, as previously highlighted), variations in voluntary standards can be stressed from one MS to another. Table 13 highlights some differences in GM standards between MS. Private standards also have some differences, but they are not described here.

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[116] This type of labelling has also developed to enable consumers to better know if the animal products they buy come from animals fed with GMOs or not, as the EU legislation does not require it ICF GHK and European Commission (2013) *State of play in the EU on GM-free food labelling schemes and assessment of the need for possible harmonisation*..

[117] Private standards can be divided into three categories: requirements for labels focusing only on GM-Free features, requirements for labels where GM-Free is one of several attributes of the product and requirements of private supply chain standards but not using a specific label for the consumer (the consumer does not know the product is GM-Free). The third one is mainly used to avoid any scandals linked to GMOs Ibid..

[118] ARGE.

[119] Verband Lebensmittel ohne Gentechnik, meaning "Free from genetic engineering food association" (7,300 products under label in 2017).

[120] ARGE Gentechnikfrei; 3,500 labelled products in 2018.

Table 13: differences between Austria, Germany, Finland, France and Netherlands on GM-Free national standards

	AT	DE	FI	FR	NL
Threshold					
Threshold for food	<0.9%	<0.1%	<0.0%[121]	<0.1%	<0.1%
Threshold for feed	<0.9%	<0.9%	<0.0%	<0.1% and <0.9%	<0.1%
Feeding time for livestock					
Dairy	2 weeks	3 months	From birth	6 months	From birth
Pigs	Entire fattening period	¾ of life if slaughtering before 1 year old ~4 - 4.5 months	From birth	One year before slaughtering or ¾ of life if slaughtering before 1 year old	From birth
Poultry	3-day-old chick	10 weeks	From birth	3-day-old chick	From birth
Exceptions for the use of inputs based on GMOs					
Use of certain additives or enzymes where a non-GM alternative is not available	Yes	yes	no	yes	no

Source: State of play in the EU on GM-free food labelling schemes and assessment of the need for possible harmonisation, European Commission, ICF GHK and own case studies.

This table shows that differences exist at the threshold level, but also on the feeding time for livestock or the exceptions concerning the use of inputs using GMOs. Thus, some standards are stricter than others. For example, the national standard of the Netherlands is one of the strictest and only one product is labelled as GM-Free: the soya protein isolate.

One of the interesting examples is the Austrian case (cf. box 8), as it was the first country to create a national GM-Free standard.

Box 8: Austria and GM-Free labelling

Austria was the first Member State to develop a GM-Free labelling system. In 1997, a referendum took place, gathering 1.2 million signatures asking for "no cultivation of GMO, no GMO food and no patent on life". Two significant retailers (*Spar* and *Rewe*) which represented almost 70% of the market, followed consumers and committed themselves to this process. According to stakeholders interviewed, NGOs wanted to have a GMO-free labelling policy and then retailers followed them.

ARGE Gentechnikfrei is a multi-stakeholder association which has the goal of creating a reliable framework for the production, labelling and monitoring of GMO-free food, born as a result of all these events.

The EU regulation (EC) 1829/2003 was used as a basis for standards. Thus, the first standard for feed and food productions in the EU evolved in Austria in 1998. Since then it has expanded and adapted and has today one of the largest portfolio of products, with 3,500 different GM-Free labelled products. It is one of the most credible labels in Austria, according to a market research(ARGE Gentechnik-frei, 2017) and it is well accepted by Austrian consumers. GM-Free labelling has become a key purchase factor for Austrian consumers.

In August 2010, Austria reached 100% of its dairy products labelled as GM-Free; in September 2010, 100% of its eggs were labelled as GM-Free and they succeeded in doing the same for poultry (chicken and turkey) in March 2012.

The last segment to develop was pork, which is currently around 7.8% GM-Free. Stakeholders are working to introduce a certification system along the pork value chain without changing the final price and taking into account pig needs. The current calculation, based on the use of imported GM-Free certified soya bean from Latin America and Europe, shows an increase about 0.50-0.70€/kg in the meat price for a 100% GM-Free pork supply chain. Then, the success depends mainly on retailers and will face difficulties because pig meat is a very low-price market with low margins.

One of the success factors of Austrian GM-Free segment has been the involvement of retailers, which seems to be a very important feature for GM-Free value chains development as these patterns have been the same in Germany and are widely expanding. Retailers are directly in contact with consumers, so they are at the best level for listening to consumers' requests while having the ability to inspire new needs and thus create new markets.

The large majority of GM-Free labelled products are basic products, such as milk, eggs, meat. However, recently GM-Free compound products are rising, such as sausages produced GM-Free or even GM-Free frozen pizza. Certification is harder for this kind of product as it must be GM-Free for all the components including additives, spices, yeasts, etc. and some of them are currently difficult to find in the GM-Free segment. However, these developments show the rising demand for GM-Free products in Austria.

[121] Finland: threshold indicated by the national guideline.

In parallel with these developments, GM-Free standard players are working together to implement harmonisation at the EU level. An umbrella organisation is currently being created in order to establish a functioning network between GM-Free European standard and increase representativeness of GM-Free products in the EU institutions.

Market of non-GM animal products

The growing trend for labelled meat and animal products obtained through non-GM feed is particularly true for dairy products such as milk and yogurts, but also eggs and poultry[122]. Though it is growing[123], the total EU GM-Free market is difficult to quantify. However, some important GM-Free players have measured it at MS level. Table 14 shows that Austrian GM-Free market estimation was about 1.5 to 2 billion euros in 2018. This total market has an annual average increase of 10 to 15%. In Germany, the turnover was around 5.4 billion in 2017 and is estimated to be about 8 billion in 2018[124], more than half of this value being dairy products, followed by poultry meat and eggs (see figure 57).

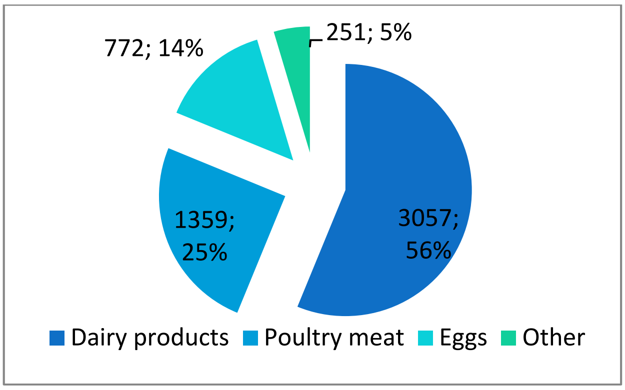


Figure 57: German GM-Free labelled products market per product segment (Million €, 2017)

German GM-Free market had a very large expansion in the last 3-4 years.[125] Table 14 also shows that 47% of the soya meal consumption in Austria is GM-Free, compared to 26% in Germany.

Table 14: GM-Free turnover and GM-Free soya bean consumption in Austria and Germany

	AT	DE
GM-Free turnover	1.5-2 billion € (2018)	~8 billion € (2018) 5.4 billion (2017)
Increase	10-15%/year	
Soya meal consumption	425 kt	3,852 kt
Including GM-free	200 kt	1000 kt
Share	47%	26%

Source: ARGE, Oil world and Donau Soja, 2018

Concerning the GM-Free market, all the MS do not have the same positioning. The main MS that are driving the development of the GM-Free market in the feed sector are Austria, Finland, France, Germany, Italy, Sweden and UK. On the other side, the MS where GM-Free represents a small or non-existent market are Spain, Portugal, Denmark and the Netherlands (JRC, 2015).

Moreover, in some MS, a GM production existed before the ban (Romania for example). In some of these places, the GM mentality can still be in the roots and major players mainly work with GM-soya bean from importation, creating a real bottleneck for GM-Free soya bean produced locally that cannot find outlets, forcing them to export the production.[126]

Regarding products, there is a bigger development of GM-Free supply chains in poultry and dairy products compared to the swine sector.[127] This difference is due to various factors: consumer demand, potential for feed autonomy at farm level, value chain organisation and market segmentation. Beyond demand, the development of GM-Free markets is also related to stakeholders' horizontal and vertical organisation, as presented in Table 15.

Table 15: Comparison of the impact of value chain integration and home-grown feed on the development of a GM-Free supply.

	Poultry	Pork	Dairy cattle

[122] CS in Germany, Austria, France.

[123] Confirmed by FEFAC.

[124] ARGE interview.

[125] In Germany, around 50% of the milk market is produced under GM-Free criteria (including organic~5to 10%), it is 60% for poultry meat (<5% organic) and 70% for eggs (~10% organic). VLOG interview.

[126] CS Romania.

[127] FEFAC.

	Poultry	Pork	Dairy cattle
Level of integration of value chains	Generally high, vertically integrated → High reactivity of the supply chain.	Low, sometimes semi-integrated value chain → Low reactivity of the supply chain.	Low, horizontal specialised. → Low reactivity of the supply chain but feed supply mostly comes from the farm itself.
Premiums development	Premiums (labels, DPO, GPI, etc.) drive the demand for GM-Free broilers and eggs.	Pig production is very standardised, with little market segmentation.	Many designations of origin (cheese) and premiums (NGO labels, private/distributors branding). Possible to combine other practices to create packaged branding (minimum grazing, autonomy threshold, etc.)
Ability to develop non-GM products	High. Vertical integration enables a high reactivity of the supply chains.	Low reactivity of the supply chain.	High.

Source: own compilation

In addition, other factors can explain the resistance of the pork sector to switch to GM-Free supply chains:

- Complications in selling the whole animal under GM-Free label. There are some parts of the animal that the consumer wants of high quality, but there are other parts ("cheap cuts") that are used by the agri-food industry and are not sold as GM-Free.
- Amount of soy needed to produce 1 kg of meat is higher for pig than poultry (chicken), generating a greater impact on the final price of pork meat.
- Difficulties in pork production to substitute soy compared to dairy cows.
- Period to feed pigs with GM-Free is too long in some MS standards as the average fattening period is 3 to 3.5 months and the period required in the standard is 4 months.[128]

Production of GM-Free soya bean for feed

By definition, the EU GM-Free soya bean production corresponds to the entire soya bean production, which accounted for 2.5 million tonnes in 2017, including around 2 million tonnes for feed[129].

<u>GM-Free soya meal</u>

As shown in Figure 58, soya meal made from EU soya bean is clearly increasing since 2012-2013, bringing a wider availability of GM-Free soya bean to the market. However, GM-Free soya meal is also produced with imported GM-Free soya bean: in 2012 the EU imported 0.96 million tonnes of GM-Free IP soya bean representing nearly half of its consumption.

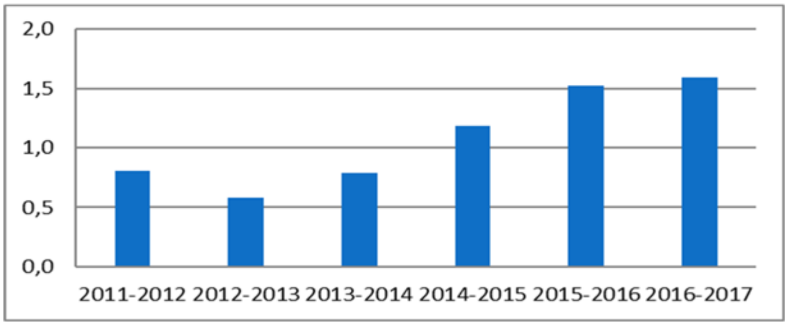


Figure 58: Soya meal from the EU soya bean production (Million tonnes, EU protein balance sheet DG Agri)

<u>GM-Free compound feed</u>

[128] Pigs are often raised on two different farms: piglet producers and farmers specialised in fattening. However, the first ones produce pigs for many different pig farms, thus difficult to convert to GM-Free system.

[129] Balance Sheet, DG Agri.

Very little data is currently available to estimate the size of the GM-Free feed market in the EU.[130] EU certified GM-Free compound feed production has been estimated at 11.9% of the total compound feed production in 2012, corresponding at this time to 15.5 million tonnes (with 130.9 million tonnes of total compound feed). Following the same trend, it should be around 19 million tonnes of GM-Free compound feed produced in the EU in 2017 (JRC, 2015). Figure 59 shows that the poultry sector is the main driving sector with 20.8% of GM-Free compound feed produced, followed by cattle (9.2%) and eventually pork (4.9%).

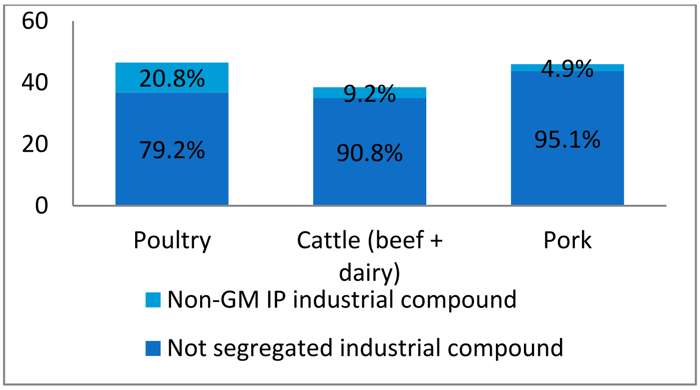
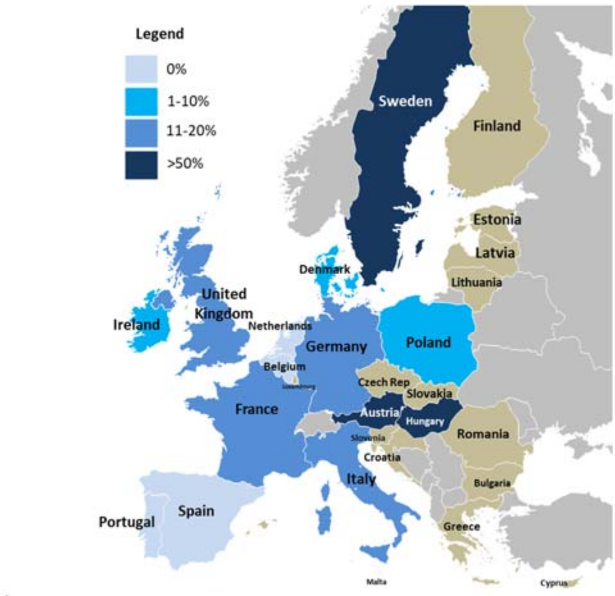


Figure 59: Production of industrial compound feed per segment (poultry, cattle and pork), non-GM IP and not segregated in 14 EU MS (million tonnes, JRC, 2012)

Map 4 shows the share of GM-Free feed in the total industrial compound feed in 2015. The highest share is found in Sweden and Hungary[131], both of which produced their compound feed almost exclusively with non-GM soya bean, representing small volumes but with high specialisation in the GM-Free sector (JRC, 2015). They were followed by Austria, where GM-Free compound feed is driven by the poultry and dairy sectors, but representing small volumes at the EU level (JRC, 2015).



Map 4: Share of the production of industrial compound feed that is GM-free, by EU MS (European Commission,

Conversely, the lowest shares were found in Spain, Portugal, the Netherlands and Belgium, with almost no production of GM-Free feed compound.

In 2012, Hungary produced 60% of all EU industrial GM-Free compound feed for pork, complemented by France, Sweden, Italy and Austria (JRC, 2015).

The largest producer of compound feed is Germany, as feed made with GM-Free soya bean is mainly driven by the production of poultry. This production represented 50% of GM-Free compound feed in Germany in 2012 and was lower for cattle and approaching zero in the pork sector. Germany is also the first GM-Free compound feed producer of the EU in terms of volume. The poultry sector is also driving the production of GM-Free compound feed in the UK (28% is GM-Free), in Denmark (28% is GM-Free), Ireland (38% is GM-Free)[132] and Poland (5% is GM-Free)[133]. In France and Italy, all of the three sectors (poultry, cattle, pork in lower share and volume) are in demand for GM-Free compound feed.

In 2012, the main producers of GM-Free compound feed (in volume) were (JRC, 2015):

- Germany, the UK and Hungary for poultry;
- France, Sweden and Germany for cattle and dairy and;
- Hungary, France and Sweden for pork.

But in terms of share, they were: Hungary and Sweden, with almost 100% of all feed segments that are GM-Free.[134]

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[130] The main reference document on this topic is the study made by the JRC on GM-Free IP soya bean, which is widely used in this chapter.

[131] This data must be nuanced a bit: a local expert indicated that GM-Free soya bean is difficult to access and currently most of the imported soya bean for Hungary is GMO.

[132] Cereopa.

[133]JRC and EC

[134] 100% for all segments are GM-Free compound feed except 91% for Sweden concerning the cattle compound feed.

Trades of GM-Free feed

In 2015, according to the JRC, about 8.3% and 11.3% of the soya bean and soya meal (cf. Figure 60), respectively, were imported in the EU as non-GM under segregation and identity-preservation schemes, representing about 2.7 million tonnes of soya meal equivalent in one year.

Thus, the main importers (in share) of GM-Free soya bean are the same as the GM-Free meat, dairy and eggs main producers: Hungary and Sweden.

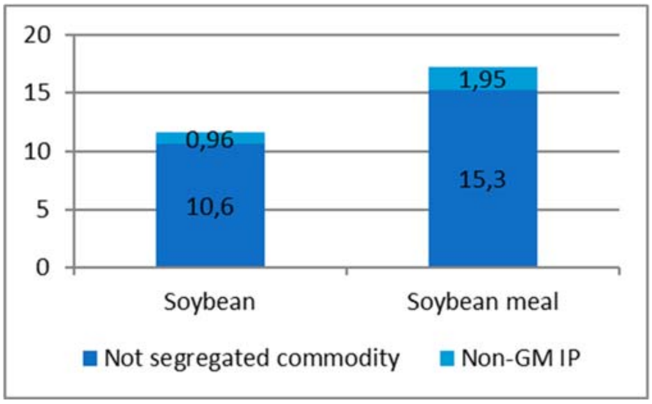

Figure 60: Extra-EU import of soya bean products in 14 MS of EU (million tonnes, JRC, 2012)

As regards the trades of GM-free soya bean in the EU[135], the main importers are:

- The Netherlands, Germany, Belgium (in volume)
- Hungary[136] and Sweden (in share)

The main GM-Free soya meal importers are:

- The Netherlands, Germany and France (in volume);
- Hungary and Sweden (in share).

One can note that the Netherlands is mainly an entry point to the EU, using very small quantities.[137]

GM-Free price premium

One of the difficulties in comparing GM-Free and GMO prices is that GMOs are not produced within the EU, so GMO prices are import prices. Additionally, these two prices do not reflect the same agricultural contexts, as GM-Free soya bean can be produced either in Brazil or in Austria, while GM soya bean, which cannot be produced in the EU, is mainly imported from Latin America, the U.S. or Canada.

As highlighted in Figure 61, GM-Free premium is very volatile was around 80€/t of soya bean beginning of 2018. Since 2013, the GM-Free premium has represented around 20-30% of the GM price, having led to premiums around 180€/t in the UK (JRC, 2015).

In addition to some one-time effects, more regular trends have been observed: at the end of the year (when stocks are becoming scarce), prices rise. Finally, traders have also found other sources of GM-Free soya bean to secure their supply and diversify the periods of production within one year, Indian production being the main example (JRC, 2015). The graph highlights that demand is increasing and in 2018 the GM-Free premium is around 85€/t for feed, which corresponds to 20-25% of the current GM price[138].

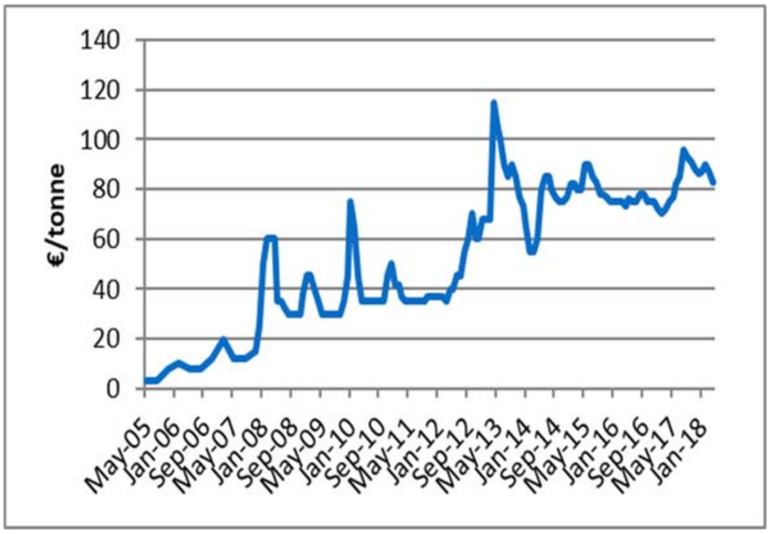

Figure 61: GM-Free premium for the 36% protein soya meal between 2005 and 2018 (€/tonne, Feed alliance, 2018)

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[135] Only 14 countries of the EU have been studied (representing 90% of the EU volume). JRC.

[136] This data must be nuanced a bit: a local expert indicated that GM-Free soya bean is difficult to access and currently most of the imported soya bean is GM-Free in Hungary.

[137] Probably also linked with the very strict GM-Free national standard.

[138] FEFAC.

4.1.3.2 *Drivers of consumers of meat, dairy and egg products produced with GM-Free PRPs*

We have little information on the difference in behaviour between conventional consumers and GM-Free meat, dairy and egg product consumers. The main information gathered is the following.

Consumer trends and NGO opinions

Consumer trends are complex and vary a lot among MS and over time. Public opinion influences them, being influenced itself by the media in different ways. It is thus difficult to measure or predict new trends, but consumers definitely have a significant impact on the GM-Free segment consumption. For example, the development of German GM-Free milk is spreading: the first markets to develop were infant milk or dairy products[139] but "classic" GM-Free milk is also widely expanding in other MS. After huge transitions to GM-Free in Austria and Germany, France should follow with a majority of its milk under GM-Free segments within 5 years[140].

Price of the final product

Even if it seems obvious that the price of the final product has an impact on the GM-Free segment market under study, it is difficult to measure it. The main difficulties in studying retail prices of animal products fed with GM-Free feed are:

- Not all the animal products fed without GMOs are labelled as such. Retailers can ask for such characteristics, without labelling it, mainly to avoid any customer complaint campaigns.
- Many products being labelled as "fed without GMOs" encompass additional good practices (see Box 9), making difficult to determine the share of the price that is due to the GM-Free characteristic.
- The effect of the label itself is difficult to measure as it would be logical to compare it with the same product, without the label.

However, according to VLOG[141], the GM-Free price premium is in fact far smaller than the price volatility of the final products, and is in consequence not seen by the final consumer. Thus, the premium of the final product is not as important a driver as could be thought at first glance.

Box 9: Going beyond GM-Free

GM-Free product prices are difficult to compare as they do not have the same features. In fact, many GM-Free labels include other requirements that are different from one to another. For example, one can observe the development of milk standards that include GM-Free feed but guarantee other aspects: minimum period of pasture, surface of pasture per animal, etc.

Haymilk in Germany guarantees a ban of a range of feedstuff including—in addition to GMOs—silage or industrial side-products like treacle. In addition, certain agricultural practices are prohibited such as fertilising with compost, and some additional prescriptions like a time period of three weeks between fertilising and using grassland. Fair milk is another example where farmers, grouped in associations, created a label guaranteeing, in addition to GM-Free feed, a stable price of 0,40€/l.

In France, *Candia* is creating a segment of milk: *Les laitiers responsables,* meaning "Responsible dairies" with more than 150 days on pasture and GM-Free feed. Lactel is also creating *L'Appel de Prés* meaning *"The call of the meadows",* a brand guaranteeing 200 days/year of pasture and more than 10 acres per dairy cow, in addition to GM-Free feeding.

In Poland, the label *Jakość Tradycja* meaning "Quality Tradition" is a system in which producers use raw materials whose origin is traceable, and which do not contain GM components. This system involves only products characterised by a traditional composition or a traditional method of manufacturing, or the special quality resulting from their traditional character or expressing their traditional character.

Source: case studies

4.1.3.3 *Drivers of retailers of GM-Free products*

Retailers have a key role in the GM-Free value chain. First, as shown in the previous paragraphs, all of the upstream players produce GM-Free material, if it is requested by retailers/consumers. GM-Free segments are interesting to develop for retailers for at least two reasons:

[139] For example, the Bell group, well known for the Kiri and Babybel, is developing GM-Free products (mainly cheese and dairy products) since 2017.

[140] According to the French Livestock Institute interview (IDELE).

[141] Verband Lebensmittel ohne Gentechnik, meaning "Free from genetic engineering food association".

Improve the brand equity part of the marketing strategy

Retailers pay more and more attention to consumers, but also NGOs and new consumption trends. Retailers' interest for GM-Free value chains shows a long-term ambition at least as important as short-term profit, which is linked with retailers marketing strategies (Punt et al., 2015).

However, even for retailers it is difficult to estimate the consumer demand and it is not because it is not expressed that it is not desired. For example, in 2016 in the Carrefour group in France, farm chicken from Auvergne, in France, "fed without GMO" was a huge success with demand four times higher than predicted (Pruilh, 2017). Thus, the role of the retailers is to try to understand consumer demand, even if it is not able to be expressed clearly.

Upgrade the added value of the product

Upgrading the added value of the products is particularly the case when retailers use GM-Free private standards, created by themselves.

Box 10: GM-Free products other than milk and eggs, the role of meat companies and retailers

In France, in spite of the information given during interviews, there seems to be a place for GM-free beyond the organic market segment. For example, the food company *Fleury-Michon* now advertises the fact that its ham is produced from pigs which have not been fed with GM crops or by-products. It can be noted that this initiative comes from a partnership between the food company *Fleury Michon* and the feed company *Avril*.

Furthermore, the food company *Loué*, which is a major actor in the chicken sector, also claims that its chickens are GM-free (meaning with less than 0.9% of GM in the total feed ration).

Carrefour also sells some pig and poultry products labelled as "fed without GM", but their website does not clarify what it means with regard to the feed ration of the animals, beyond the 0.9% requirement.

The following example shows also one of the important roles of retailers for the conservation and development of the GM-Free value chains.

Recently, new gene technologies have been discovered that could be considered as non-GMOs. *Edeka*, *Spar*, *Lidl*, *Rewe*, *Nöm*, and other companies have sent a letter to the EU President and Commissioner to explain the risk of not considering these new technologies as GMOs for the EU GM-Free market, naming two principles applying to them: the precautionary principle and the freedom of choice.

Source: Case studies

However, some other aspects can limit the development of this market at the retailers' level.

Price premium of the GM-Free soya bean

The price premium of GM-Free soya bean has an impact on the whole value chain. Thus, if it reaches too high a value, it inflates costs and in some cases retailers can decide to remove products dependent on this material from their shelves. For example, in 2012 in the UK[142], as the GM-Free price premium was very high, some retailers that were selling GM-Free poultry meat decided to switch back to regular value-chains and disengaged from GM-Free. It is especially the case for products that do not have substitution possibilities, such as poultry (JRC, 2015).

4.1.3.4 Drivers of livestock farmers using GM-Free PRP products

Livestock farmers are the users of GM-Free PRP feed products as-is. Their main drivers are:

Price premium for the livestock farmer

The average price for "GM-free" labelled poultry meat, eggs, milk and pork meat was between 12.7 and 16.4% higher than the price of unlabelled products in 2012 (JRC, 2015). However, this is an average figure[143]. As data at EU level was not available for each segment, Table 16 provides premiums related to GM-Free milk price for Austria, France and Germany. In these three MSs, the premium for GM-Free milk at farm-gate price is around 0.01€/l, representing approximately 3% of the milk price.

[142] Some other cases have been seen in Denmark and to some extent in Germany.

[143] Made on a very small sample (around 10 observations per meat segment).JRC (2015) *Markets for non-Genetically Modified, Identity-Preserved soybean in the EU*..

Table 16: Premium for dairy farmers using GM-Free products

MS	GM-Free premium for dairy farmer	Average milk price in the MS in 2017 (€/L)[144]	Approximation of GM-Free premium share in the milk price
Austria	0.01-0.02€/l[145]	0.38€	3-5%
France	0.01-0.015€/l[146] (Candia, Lactel)	0.35	3-4%
Germany	0.01€/l[147]	0.37	3%

Source: case studies

Supplementary costs

Producing GM-Free products involves additional costs. Additional costs for animal farming depend on the share of soya meal in their total feed, being 10% for dairy cows and more than 40% for broiler poultry. Regarding livestock farmers, the cost of GM-Free compound feed is 17 to 21%[148] higher than GMO feed, and depends on the threshold[149] used by the feed manufacturer. Taking into account the livestock farming cost structure and supposing that GM-Free feed is 20% higher than the conventional one[150], it would correspond to a 13% increase in total costs for broiler, 5% for dairy milk and 10% for fattening pigs (JRC, 2015)[151].

These additional GM-Free feed costs correspond to 0.020€/l for milk (for a 20% GM-Free premium) to 0.036€/l (for a +40% GM-Free premium), meaning that the premium on milk sales hardly cover the extra-cost on feeding . The additional GM-Free feed cost for broiler meat is around 0.12 (for a 20% GM-Free premium) to 0.24€/kg (for a 40% GM-Free premium) of meat and for pork meat it is around 0.15 (for a 20% GM-Free premium) to 0.30€/kg (for a 40% GM-Free premium)[152].

Importance of the downstream partners

The main reason for producers of animal food products to engage in the GM-Free supply chain is to satisfy the demand of a downstream partner.[153] This shows the importance of the downstream operators of the supply chain and in particular consumers and retailers (cf. Box 10).

Box 11: Milk: the success story of GM-Free products

Milk is the most developed GM-Free segment before eggs and broilers. It has well developed in Austria, Germany and Poland, which are GM-Free-driving MS. In Austria, 100% of the milk is GM-Free since 2010 and in Germany, dairy products represent around 50% of the total GM-Free market.[154] Moreover, milk is imported from other MS to meet the German demand.

This expansion can be partly explained by the fact it is easier to produce GM-Free milk than GM-Free broilers or pork meat. Thus, to guarantee no GMOs in the feed of the livestock, labels switch to raw materials other than soya bean[155]. Hence, in Austria, most of the dairy cows are in fact fed with DDGS from the large bioethanol plant of Agrana. In Poland they are increasingly fed with rapeseed meal. Avoiding soya bean considerably mitigates the contamination risks and facilitates the certification process.

Source: case studies

[144] European Commission.

[145] ARGE interview, 2017.

[146] Candia: Les laitiers responsables, Lactel: L'appel des prés, 2017.

[147] VLOG interview.

[148] 17% corresponds to a 0.9% threshold for the presence of GM material used by the feed manufacturer and 21% to a 0.1% threshold. JRC, 2015.

[149] The threshold can vary from 0.1% to 0.9% depending on the feed manufacturer. JRC.

[150] As a reminder, the GM-Free soya meal premium is currently around 20-25% of the GMO soya meal price.

[151] Data for 2010-2011. However, for example, if GM-Free premium rises and reaches 40% of the conventional compound feed price, the increase in total costs would be 26% for broiler, 10% for dairy milk and 19% for fattening pig. Data for 2011 for broiler and milk and 2010 for fattening pigs.JRC (2015) *Markets for non-Genetically Modified, Identity-Preserved soybean in the EU*.

[152] Data for 2011 (dairy and broiler) and 2010 for pork.Ibid.

[153] Interview conducted in the framework of the JRC report, 2015.

[154] Part of this successful story can be explained by the current milk crisis: in Germany (it is also the case in other MS such as France), the system leads to underpaid dairy farmers. Thus, even if the premiums are very low, farmers are willing to switch to GM-Free as it is preferable to conventional. (VLOG)

[155] In Germany, when switching to GM-Free value-chain, usually dairy farmers switch from soya meal to rapeseed meal, egg producers more and more decrease their soy use replaced by rapeseed and sunflower meals, but soya bean is still important in poultry and pork segments. (VLOG interview).

4.1.3.5 Drivers of other stakeholders of the value-chain: food manufacturers using GM-Free meat, milk and eggs; feed manufacturers; traders and collectors

Without a doubt, GM-Free feed supply chains are developing. This is more and more visible at retailers' level on the labelling of products. Food manufacturers using GM-Free animal products, feed manufacturers, traders and collectors[156] are driven by the same factors: importance of downstream partners, meaning that they are committing to the supply chain only if downstream stakeholders are asking for it[157], and also have additional costs for segregation, traceability and certification.

Moreover, the main reason for feed manufacturers and traders not to engage in a GM-Free supply chain is the availability of GM-Free soya bean/meal on the market.[158] This was particularly the case in 2013 (studied period of the JRC report), but since then traders have attempted to find other sources of GM-Free soya bean, especially in India[159].

Finally, GM-Free soya bean price premium is also a driver of high importance for feed manufacturers.

4.1.3.6 Summary of the drivers for the development of value chain based on GM-free soya bean

To conclude, there are two main types of GM-Free value-chains: the one based on an integrated approach where all the stakeholders are involved and each level of the value chain receives a premium, including the producer; and another driven by the reduction of the risks, where the downstream operators impose GM-Free sourcing to the upstream – in this case, the premiums could be very low or inexistent.

The main drivers for the development of the GM-Free feed segment are:

- Consumer trends and NGO opinions
- The brand equity, part of the marketing strategy for retailers and thus their willingness to be part of GM-Free market development
- Price premium for livestock farmer that encourages them to switch to GM-Free production
- And for all other value chain stakeholders (food manufacturers, feed manufacturers, traders and collectors, they are:
- Availability of GM-Free soya bean
- Importance of downstream partners
- Additional costs, mainly due to segregation from other productions
- GM soya bean premium

4.1.3.7 Outlook of the GM-Free feed market segment

If GM-Free products remain reliable in the consumers' opinion, this market segment should increase significantly in the coming years and GM-Free labelling may have a strong effect both on the import of GM feed in EU and the production of PRPs (Punt et al., 2015).

According to FEFAC, there is a growing demand for GM-Free feed, mainly influenced by the German[160] retailers' demand. However, availability of supply will be an issue if growth continues.

Interviews conducted clearly stress that the GM-Free segment will experience strong growth. The German GM-Free milk market is expanding and each month new GM-Free brands are emerging (with, most of the time, other specificities such as minimum pasture time). According to experts met, the vast majority of milk market in France and Germany will be GM-Free within five years and will probably spread to the neighbouring MS.[161] Following the Austrian example, some of the Western MS (Germany and France) will also probably develop GM-Free eggs and broiler meat[162]. On the other hand, the pork

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[156] As there isn't GM PRP production in the EU, the EU collectors are not concerned.

[157] It is also the main driver for crushers.

[158] Interview conducted in the framework of the JRC report, 2015.

[159] The India source seems to be reliable as it is forbidden to produce GM-Free mainly for religious reasons, but it is also economically interesting as the harvest season in this country starts in September, at the moment when Brazilian stocks are getting lower. Therefore, this new source can solve the issue of supply at two different levels: the potential lack of supply in absolute and the recurrent annual rise of prices due to the end of Brazilian stocks.

[160] Retailers' demand is also increasing in other MS, such as France.

[161] IDELE and VLOG interviews.

[162] IDELE interview.

segment should continue to grow even if experiencing slow development. Some other markets, smaller ones, are also expected to grow in the short term, in particular aquaculture in Germany.[163]

Moreover, the difference of MS standards can be also perceived as a system failure and could slow the development of this market[164], but rapprochements are beginning between MS to initiate an EU consensus.

4.1.4 Drivers specifically related to the organic premium market segment of PRPs in the feed sector

After giving the main contextual elements of the organic feed segment, this chapter details the drivers by economic agent of the value chains that are specifically related to the organic sector. One of the main differences between the organic market segment and the conventional one is that the final consumers look specifically for organic meat, eggs and dairy products and, in that sense, they are the main driver of these markets.

Consolidated data at EU level about organic PRPs barely exists. The main data used for this chapter comes from case studies, IFOAM and FIBL reports, and some specific interviews.

4.1.4.1 Context of the organic feed market segment

The paragraph below gives details on the markets of animal products fed with organic PRPs.

Markets of animal products fed with organic PRPs.

Table 17 focuses, in value, on the organic share of the segments under study for feed dedicated to the following produces: eggs, meat, milk and dairy products. The more developed segments are organic eggs and milk, with respectively around 20% and more than 12% of the share of the market in Austria, France and Germany as shown in the table below.

Table 17: Organic shares for retail sales values in 2016

	AT	DE	FR
Eggs	20.1%	19.4%	27%
Meat and meat products	3.5%	2.5%	2%
Milk and dairy products	10.4%	-	4%
Butter	9.3%	4.7%	6.3%
Cheese	8.9%	4.4%	1.5%
Milk	17.9%	12.1%	12.5%
Yogurt		7.7%	4.8%

Source: FIBL/IFOAM, 2016

One other interesting example is the case of Austria, illustrated in Figure 62 below treated in volume.

SEGMENT	ORGANIC	GENERAL LAST 10 YEARS
Cattle	21% of cattle heads are	↘
Dairy	17.9% of organic milk	↘
Laying	12% of laying hens are	→
Broiler	9.6% of broiler poultry are	↗
Pig	2,2% of pigs are organic	↘

Figure 62: Austrian organic share of each final PRP segment in volume (CS Austria, 2017)

The main segments concerned by the organic segment are cattle (21% of the total heads) and milk (17.9%), followed by eggs (15% of laying hens), and broiler poultry (9.6% of the total heads), and as a smaller share, pork meat (2.2% of the total heads). The arrows indicate the general trend of consumption in Austria (total segment: organic plus conventional). One can see that cattle, milk and pork meat consumption is decreasing while broiler poultry is increasing, with egg consumption stagnating. This emphasises the fact that markets are evolving differently but on average the demand for animal products that could be fed by organic PRPs is still increasing.

Production of organic animals

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[163] VLOG interview.

[164] For example, some Austrian GM-Free products cannot be sold in Germany, because of different legislations. VLOG interview.

To supply this market, EU agriculture produces organic livestock, as detailed in Table 18.

Table 18: European Union organic livestock

	Animal heads (million)	Organic share
Bovine	3.6	4.5%
Sheep	4.4	4.5%
Pigs	1.0	0.7%
Poultry	43.3	3.1%

Source: FIBL-AMI survey 2018 based on Eurostat and national data sources

The two most developed organic livestock sectors are bovine and sheep with 4.5% of the total number of heads. The last one is pigs, with only 0.7% because of a smaller demand. However, the poultry sector has the fastest grow.

Two different trends in EU-15 and EU-13

Not all MS follow the same trends and there are wide disparities within the EU. However, two main trends can be identified, between the EU-15 and the EU-13.

- In the EU-15, organic consumption is high and increasingly developed. The organic production is higher than in the EU-13, however not enough to supply the entire demand. 80% of the dried pulses and protein crops area is in the EU-15 and 50% of oilseeds.
- In the EU-13, the consumption is very low (2% of the EU organic consumption). The organic area is smaller than in the EU-15, however it is mainly dedicated to export (in particular to EU-15). Even if the market and the total organic production are smaller than in EU-15, the increase is faster in the EU-13. This is also the case for the main PRPs under study: dried pulses and oilseeds (see Table 19).[165]

Table 19: Comparison of pulses and oilseeds organic area in the EU-15 and the EU-13 in 2014

	Region	Area (ha)	Growth 2013-2014	Growth 2005-2014
Dried pulses and protein crops	EU-15	205,153	16.4%	234.9%
	EU-13	49,865	29.3%	287.6%
Oilseeds	EU-15	84,613	5.9%	108.5%
	EU-13	84,170	14.8%	155.1%

Source: Organic in Europe, prospects and developments 2016, IFOAM and FIBL, 2016.

4.1.4.2 Drivers of consumers of organic animal products

Most consumers buying organic meat, dairy and eggs products do so because they are produced with a very restricted use of pesticides, fertilisers and antibiotics, also because they are produced using better environmental practices and finally, because they respect higher animal welfare standards.[166]

The main drivers of this consumption are hence health, environmental and ethical issues. However, these drivers can be very different from one MS to another. As highlighted in the previous chapter, we identify two main consumption trends:

- In EU-15, organic consumption is well developed and expanding. Table 20 shows the organic consumption is about 58€/capita. Organic consumption is mainly driven by these MS.

Table 20: Comparison of EU-15 and EU-13 organic markets in 2014

Country group	Retail sales (Billion €)	Per capita consumption (€)	Number of producers	Land area (million ha)	Total land share
EU-15	23.5	58	194,979	7.8	6.1%
EU-13	0.5	4	62,546	2.4	4.7%

Source: Organic in Europe, prospects and developments 2016, IFOAM and FIBL, 2016.

165 However, there are also some difficulties in developing the current market. For example, traders know that Romania is not a big producer of organic PRPs, and thus rarely check in Romania when they are looking for organic soya bean or sunflower, likely showing a lack of promotion of these products in this country. (CS)

166 EPRS, Eurostat, Eurobarometer.

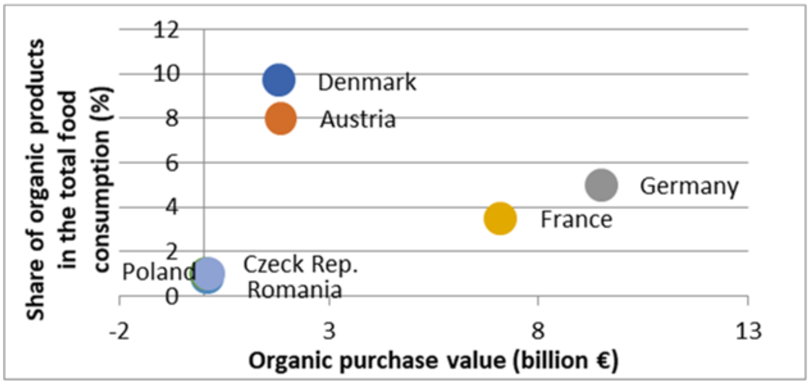

Figure 63: Organic consumption: Eastern and Western MS differences (billion €, Agence Bio France, 2016)

- In the EU-13 (e.g. Romania), where the buying power is lower, organic products are more often considered as luxury products, and most of the organic production is exported[167]. Figure 63 highlights this trend showing the lower share of organic products in Eastern MS food consumption (Poland, Romania, Czech Republic) and its lower organic purchase value, compared to Western MS (for example Austria, Denmark, Germany and France).

4.1.4.3 Drivers of organic livestock farmers

Organic regulation

Contrary to conventional animal farmers, EU organic breeders must follow EU regulations for organic production. Some aspects of the specifications to be certified organic are likely to impact directly the use of PRPs within animal farms:

- Organic livestock farming shall ensure a close functional link with the land. The feed for livestock should primarily be obtained in the farm where the animals are kept or from farms in the same region.
- The feed shall be GM-free.
- Farmers have to provide 100% organic feed to their animals in order to market their products as organic or to use the EU logo. However, the composition of the organic feed benefits from an exemption allowing 5% of conventional raw material (more details are given in the paragraph: *Availability of organic feed raw material*).
- Adaptation to biological features of animals: a minimum of 60% of rough fodders for herbivorous and natural milk for young calves.
- Growth promoters and synthetic amino acids are prohibited.
- Veterinary interventions shall give priority to natural methods such as phytotherapy, etc. The use of conventional drugs is allowed, but only in cases of extreme necessity and the waiting period following their use is doubled compared to conventional.

Providing 100% of organic material implies important constraints to balance rations in term of proteins and to find raw materials in sufficient quantities.

Difficult supply of PRPs

One of the main differences between organic livestock farmers and conventional ones is the broader use of self-consumption and their less intensive systems that use more pulses and leguminous fodders. Most of them have difficulties in finding organic PRPs and forages for their animal in the EU, meaning that the sectors rely on imports[168]. This point is directly linked with the paragraph *Availability of organic feed raw material*, in the chapter about organic feed manufacturers' drivers.

Price premium for the livestock breeder in organic conversion

As data was not available at the EU level, Austrian examples of price premiums concerning the organic final segments for feed have been studied. Tables 21 and 22 below show the price premiums of organic production for each final segment. The productions with the highest premiums (in % of the conventional price) are eggs and meat. Table 21 shows the difference in egg prices per premium segment. Although data was not available at the producer level, this data suggests that there is a premium for the livestock farmer in organic farming.

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[167] Source: RO case study

[168] For example from Togo according to stakeholders interviewed (FR CS).

Table 21: Difference in egg price per premium segment in Austria from packing centre

	Share	Price/100 units
Organic	10.70%	19 €
Free range	20%	13.34 €
Barn	67.30%	10.52 €

Source: Green Report, 2016

Table 22: Austrian price premiums between organic and conventional

RollAMA	2015
Drinking milk	22.4%
Butter	40.5%
Cheese	51.5%
Sausage and ham	60.9%
Meat including poultry	77.2%
Eggs	85.5%

Source: RollAMA in IFOAM/FIBL, 2016

4.1.4.4 Drivers of feed manufacturers of organic products

Roughly, the drivers of organic feed manufacturers are also similar to those of conventional ones such as least-cost formulation. There are nevertheless some specific differences such as:

Specific regulations for organic livestock farming;

The use of synthetic amino acids is forbidden, leading to fewer possibilities to optimise feed formulation. If the amino-acid profile of a PRP is unbalanced, the efficiency of feeding decreases, thus soya bean having a profile adapted for livestock is favoured.

Moreover, in the organic regulations, the use of hexane[169] is forbidden. Hence, organic meal concentration in protein (mainly soya bean) is reduced (from around 5 to 10% depending on the process) in comparison to conventional meals. It is a limitation for the feed manufacturer to use organic meal, as it is easier for them to use protein products with the highest protein concentration as possible.

Availability of organic feed raw material;

Organic feed materials are lacking in the EU, in particular concerning protein raw material. To deal with this issue, regulation n°354/2014[170] allows using 5% of conventional raw material for livestock other than herbivores (mainly granivores), if farmer cannot find organic products. The previous regulation (n°834/2007) should have been abolished in 2011, but it has been extended to 2021, as the shortage of organic product is still continuing. In 2011, the demand was already higher than offer, showing a self-sufficiency of 56% of crude protein in the ICOPP project[171] countries[172]. Figures were even smaller concerning amino acids: 50% of self-sufficiency concerning lysine and 40% for methionine (Früh et al., 2015).

This lack of organic feed has at least three impacts:

- Organic feed is expensive;
- Organic feed manufacturing for granivorous animals depends on conventional raw material;
- Organic feed relies for a wide part on PRP raw material imports, mainly from China, India, but also Argentina and Ukraine.

As in other EU regions, France has a deficit of organic feed. In fact, pulses are sparsely used in France. For the 2012-2013 campaign, the feed manufacturers used 8,320t of field beans and 3,320t of field peas[173]. Yet, according to a CEREOPA estimation, the potential use of field beans and field peas could be around 40,000t[174]. In 2012, the national deficit was estimated around 12,000t (+/- 2,500 t), corresponding to an equivalent of 16,300 ha of soya bean[175] (+/- 5,000 ha). Poultry currently represents 60% of these needs and pork 11%, pulses covering 16% of the offer. In addition, varieties that are commonly cultivated are not well adapted to feed use, because of the presence of anti-

[169] Hexane is a solvent used in conventional systems to improve the extraction of oil from oilseeds, leading to higher oil yields per tonne of oilseed pressed.

[170] Regulation on organic production and labelling of organic products with regard to organic production, labelling and control.

[171] "Improved Contribution of Local Feed to Support 100% Organic Feed Supply to Pigs and Poultry".

[172] Austria, Denmark, Finland, France, Germany, Lithuania, the Netherlands, Sweden, Switzerland and the United Kingdom.

[173] France Agri Mer.

[174] In 2014, 95% organic feed.

[175] A wide part of the PRP organic feed is composed of C2 soya bean, that is to say soya bean produced on farms that are in conversion to organic farming, or soya bean that has been downgraded from food use. However, in that case, the meal is used for organic feed, but the oil has difficulties to find outlets as it cannot be used as "organic" in food.

nutritional factors and tannins that limit their incorporation in the poultry feed, the main feed outlet (representing 80% of the French feed manufacture).

Furthermore, the organic feed sector will soon have to face the end of an exemption, which allows it to integrate 5% of non-organic raw material in its feed for the organic granivorous livestock (see Box 12). The end of this exemption was initially planned for 2012, then 2014 and has been postponed to 2021 mainly due to a lack of availability of organic protein sources.

Box 12: The ProteAB project in France

The Ministry of Agriculture in France funds research projects linked with the agro-ecological transition in the agricultural and rural development context. ProteAB project is one of them. Its objectives were to work on:

- Adding value to pulses in breeding
- Making a state of play of the protein offer and demand per production/region
- Improving feed self-sufficiency of monogastrics livestock farming
- Improving sustainability of the systems
- Lifting technical barriers for the production of pulses

It focused on field beans, field peas, lupines and soya bean crops and on the pigs and poultry segments.

One of the interesting results of ProteAB project is the following graph (Figure 64) which shows the supply and demand of the organic protein for the French animal sector.

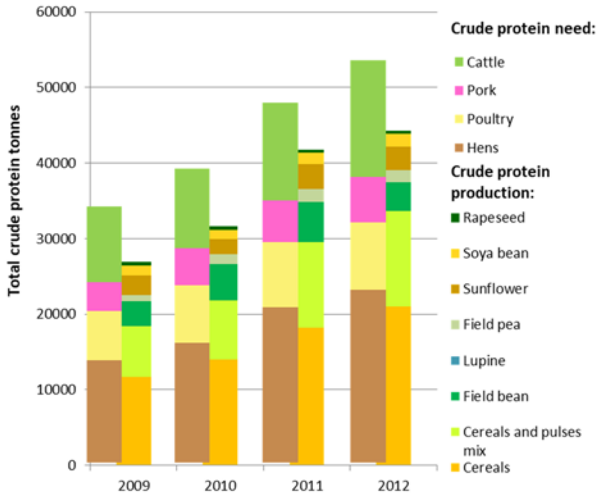

Figure 64: Trend in the French supply and demand for organic raw material for feed (Lubac 2014)

This graph highlights that in terms of volume, the main organic raw materials are cereals and mix of cereals with pulses, but pure oilseeds and pulses represent small amounts of the total production, representing in fact a small area. This small area can be explained by technical difficulties, in organic farming, mixed cereals/legumes crops are a good practice to produce without inputs. Currently, in pure crops, yields have a wide variability and are impacted by weeds, diseases, pest management and high sensitivity to climatic variations. Concerning soya bean, volumes are impacted by the significant competition with the food segment. Figure 64 also shows that the demand for organic crude protein is increasing faster than the supply, leading to an increase in the deficit between them.

Another main result is: the adoption of 100% organic would lead to the development of soya bean meal at the expense of field beans and peas. However, their use could be maintained by feed manufacturers for securing supply, traceability and quality reasons, awaiting more quantity development.

The results are detailed in the ProteAB presentation report (Lubac, 2014).

Source : ProteAB[176]

4.1.4.5 Drivers of collectors of organic products

It is difficult to store organic and conventional material in the same sites, hence most of the time these collectors specialise in organic products. Compared to conventional, they have some specific drivers:

[176] Développer les légumineuses à graines en Agriculture Biologique pour sécuriser les filières animales et diversifier les systèmes de culture. Document de référence du programme CASDAR ProtéAB, 2014, Initiative Bio Bretagne.

Availability of storing facilities

Storing organic product is more complicated than storing conventional, as the use of chemical products to limit the development of diseases and pests is forbidden, hence the equipment has to be adapted (e.g. cooling silos to avoid insect development).

Lack of business-to-business services for technological treatments

The equipment of collectors (silos, sorting tables, dehulling material, etc.) tends to be smaller in organic than in conventional, while they need more technical solutions (sorting of mixed crops, dehulling of broad beans, etc.) to face the constraints of organic regulations. Collectors of organic materials do not have sufficient R&D power to self-develop such tools and report a lack of available services to adapt and improve storing and sorting technologies. For example, a collector of organic product reported during CS France that although there is a market demand for dehulled broad beans, it is impossible to find a company to build the dehulling unit in the storing unit.

Diversity of productions

Most organic collectors generally buy the production of their client/members. As organic farms have more diversified productions, this leads the need for more storage facilities (and most of the time for smaller quantities), which increases the unit costs of operation[177].

Lack of certified collectors and thus collecting equipment

In some MS, there is a lack of certified collectors and thus collecting equipment and small/medium-sized grain storage facilities. To solve this issue in Romania for example, organic collecting is organised by farmers themselves.[178]

4.1.4.6 Summary of the drivers in the organic sector

To sum up, there are two categories of drivers concerning the organic feed market segment for PRPs: the drivers that are the same for all organic productions, and the drivers specific to organic PRPs.

The first ones concerning all organic crops are:

- The main driver for consumers is the "organic product" itself: consumers buy products for the way they have been produced. Two different trends have been observed: a wide development of the organic sector in the Western and Northern MS and a weak organic market in Eastern MS, mainly exporting their production to the Western MS.
- Livestock farmers benefit from an organic price premium that incites producing organic animals.
- Traders, retailers and food manufacturers have the same drivers mainly linked with traceability and segregation of organic products.

Collectors, in addition to segregation cost, also have specific storing technology[179] and face a wide diversity of productions compared to conventional, which multiplies the need for numerous stocking units with related costs. Additionally, organic collectors face a lack of B to B services for technological treatments, which restrains the development of medium scale units. And finally, some MS, in particular in the Eastern part of the EU, face a lack of certified collectors. There are other drivers that are specific to PRP features:

- At the livestock farmer level, the organic regulation that supports "link with the land" fosters PRP production on-farm and their use as on-farm feed. It is specifically the case for pulses, alfalfa and now soya bean (as small-scale toasting soya bean units are developing). Conversely, it is difficult for livestock farmers to find PRP raw materials such as pulses and alfalfa on the market.
- Feed manufacturers in the organic sector have specific constraints due to organic regulation, for example the prohibition of the use of synthetic amino acids and the requirement of using low-protein meals, due to the prohibition of hexane use. This fosters production with well-balanced amino acid profiles, such as soya bean, at the expense of other PRPs that must be combined. This need of combination adds a dependence of unbalanced PRPs between each other's, it is for

[177] For example, Agribio Union, which is a large cooperative in France specialised in organic products, collects more than 40 different crops in its silos.

[178] CS Romania.

[179] For example, collectors use cooling units to store organic products, as they are not allowed to use insecticides in the silos.

example the case for field pea and sunflower meal. Feed manufacturers have also faced a chronic lack of availability of organic protein-rich feed raw material (mainly rapeseed, but also soya bean and pulses) for several years and rely for a wide part on imports.

4.1.4.7 Outlook for the organic feed market segment[180]

According to the European Commission (DG-AGRI, 2018a), organic agriculture which represented almost 7% of the EU UAA in 2016, is projected to reach 19 million hectares in 2030 (11% of the EU UAA), growing by 500 000 ha per year in average. In parallel, the demand for organic products will continue to gain market shares, on both feed and food sectors.

Collectors and food manufacturers, responding to a growing societal demand for sustainable supply chains and securing their supply chains, will develop the use of contracts with organic PRP producers and organic animal farmers, guaranteeing better traceability of supply.

In line with recent trends, the demand will probably continue to grow faster than the production. Developments will probably differ for each organic PRP: in the one hand soya bean consumption is expected to grow fast, boosted by an amino-acid profile adapted to monogastric needs and the projected growth of the demand for organic poultry meat. It is noteworthy that the potential EU supply is limited in Northern EU for climatic reasons. In the other hand, peas and beans could be curbed in their development for several reasons (lack of market, low yields, pests issues, etc.), if the lack of research on varieties remains.

The next organic regulation that will apply from 1 January 2021 onwards will bring a new framework, among which the end of derogations enabling the use of 5% of conventional feed in organic feed components[181]. The link to the land will also increase: 60% of the feed will have to come from the farm itself for ruminants (70% after 2023) and 30% for monogastric[182].

Currently, the 5% of conventional raw material allowed in organic feed are composed of material with high protein content, such as maize gluten or potato protein concentrate with 65 to 70% of protein. Moving from 95% to 100% of organic raw material into organic feed in 2021 will probably increase the soya bean demand, because it is rich in protein and has an amino acid profile adapted to the remaining 5%, while other PRPs such as peas and beans need the development of supply chains that are little developed or do not exist yet (for example for the production of field beans concentrate). This change is supposed also to raise dependence on imports, mainly soya bean meal. Finally, this 100% objective will also increase the organic feed cost. The diversity of solutions such as the use of technological treatments (dehulling, protein concentration, heating, etc.), the development of new crops (e.g. hemp, nettle) or new protein sources (e. g; insects, protein concentrate from fodders), intercropping, or a better use of rangelands nutrition potential could help also to move from 95% to 100%.

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[180] This chapter will be more thoroughly treated in the next report as we have information collected but too little time to treat it in this report

[181] Except for young animals (e.g. young porks<35kg).

[182] Today, these percentages are 60% for ruminants and 20% for monogastric.

4.2 Main food market segments for PRPs

Market segments for the feed and food sectors are very different and driven by significantly distinct economic factors. Figure 65 opposite, is a compilation of various sources and shows to what extent the main protein-rich plants (PRPs) and protein-rich materials (PRMs) are used for food or feed.

Although it only provides a rough estimate (uncertainty linked to the lack of consolidated data at EU level), it shows that food use mainly concerns pulses and soya beans. Consequently, the following section focuses on the use of these PRPs.

All the by-products issued from the sorting of food products are generally used by the feed sector.

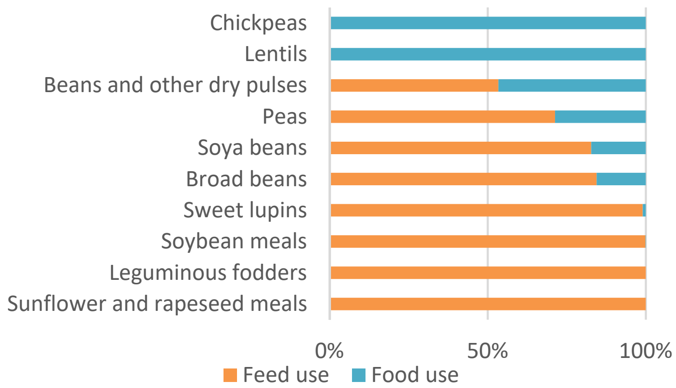


Figure 65: Distribution of PRP consumption between feed and food in the EU in 2015 (source: own compilation from various sources. EU Commission Protein Balance Sheet, EU Commission personal communications and USDA)

Plant proteins are widely used in the food sector, either in conventional or organic markets[183]. Although animal protein consumption increases at global level, the EU is seeing the emergence of low animal protein diets. Recent changes across some European countries suggest the beginning of a shift back towards plants and with less meat protein consumption, stemming from health concerns, economics and consumer choice (see § 3.5).

The consumption of PRPs for food is provided by pulses, the supply of which is be around 2 Mt of products to EU consumers and soya bean, with around 0.3 Mt (see Figure 66). Field peas are the first source of plant proteins consumed for food in the EU and represent almost a third of the consumption of pulses, while beans represent 24%. With 14, 13 and 11% of tonnage consumed, respectively, lentils, soya bean and broad beans are also well represented. Part of this consumption comes from imports.

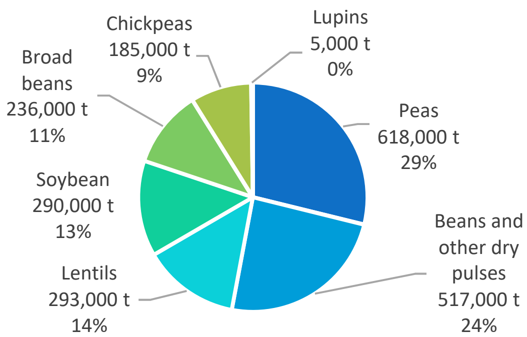


Figure 66: Pulses and soya bean[184] consumed for food in the EU in 2017/2018 in thousand tonnes
(source: DG-Agri and USDA)

The demand for PRPs in the food sector is diverse:

1) Pulses can be sold as whole grains (dry or fresh), canned or frozen, as-is or in ready-to-eat dishes, to satisfy the demand of consumers who want to consume non-processed (or low-processed[185]) PRPs;
2) They can be processed into various food products to meet the demand of consumers who want to consume plant protein-based products (e.g. preparation of pulses, meat and dairy alternatives, pulse-based snacks, specialised food, etc.);
3) They can also be processed into functional ingredients to fulfil the demand of food companies that want to meet technical or nutritional needs with functional ingredients made from PRP protein (e.g. search for specific functionalities of proteins, to produce meat substitutes, etc.).

[183] As GMO use in food is prohibited through the EU regulation No. 1829/2003 on genetically modified food and feed, the GM-Free segment doesn't exist in the food sector in the EU as all PRPs sold for food are GM-Free.

[184] Including soya bean grains and soya meals used for food. Soya meals volume has been converted in soya bean grains volume equivalent.

[185] E.g. canned pulses

While the decisive consumer of the two first market segments is the final consumer, in the third one the demand is mainly driven by the agri-food industry, which incorporates the ingredients into its products. The consumer may not even be aware that the final products consumed contain plant proteins (e.g. in the case of the incorporation of plant protein ingredients into meat preparation to improve the texture and the nutritional profile of the product).

Another difference between these market segments is the level of processing of the products. To satisfy the above-mentioned demands, PRPs go through various processing stages, from consumption as-is (whole grain) to high levels of separation of protein components (food ingredients or functional proteins) (cf. Figure 67).

Broadly, the demand for plant proteins in food can depend on two main aspects (detailed below):

- the functional and nutritional properties of PPs, mostly driven by agri-food companies to meet technical needs,
- the food consumption patterns within the population of final consumers.

These two aspects can be interdependent when agri-food companies search for specific technological properties to fulfil consumer expectations (e.g. better nutritional value). Conversely, agri-food companies can seek technological properties that are totally independent from consumers' expectations (e.g. cost reduction).

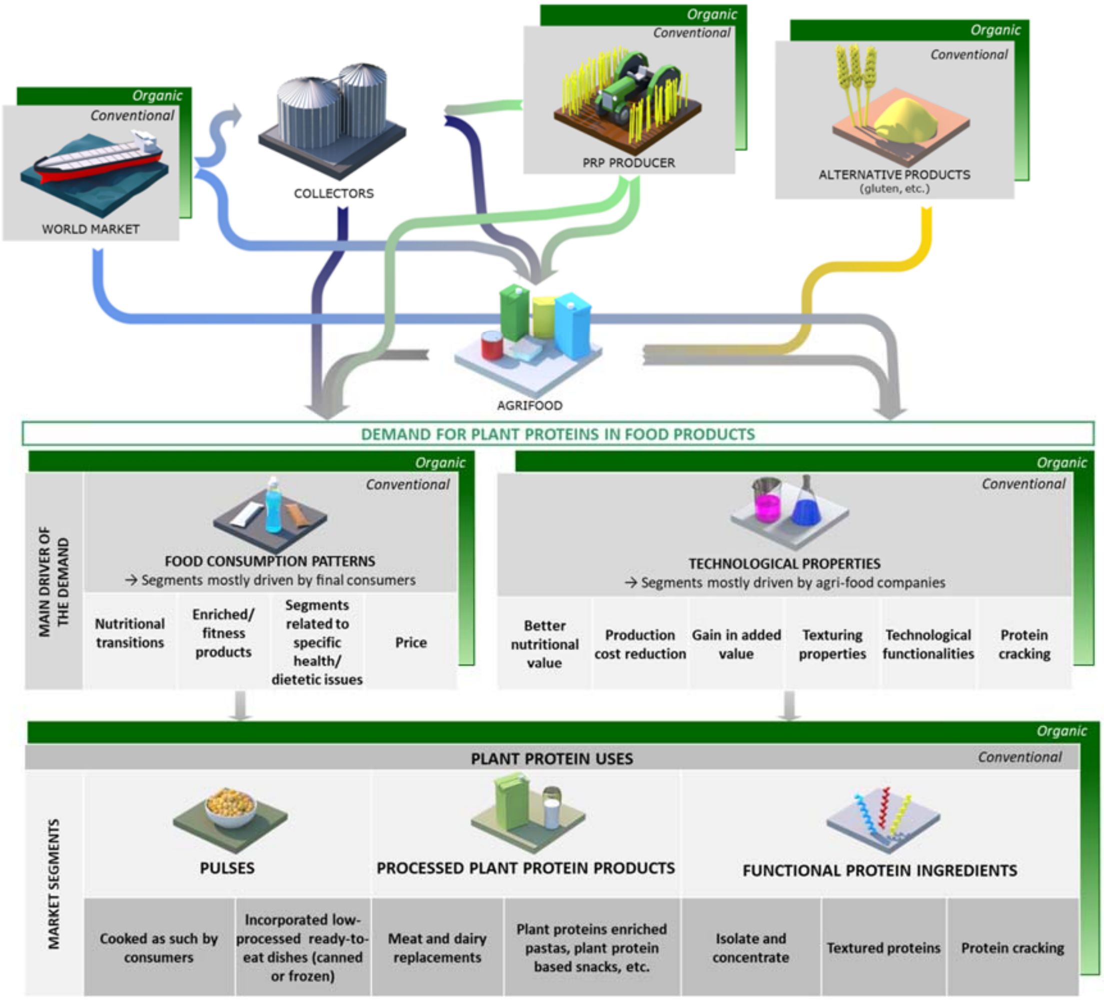
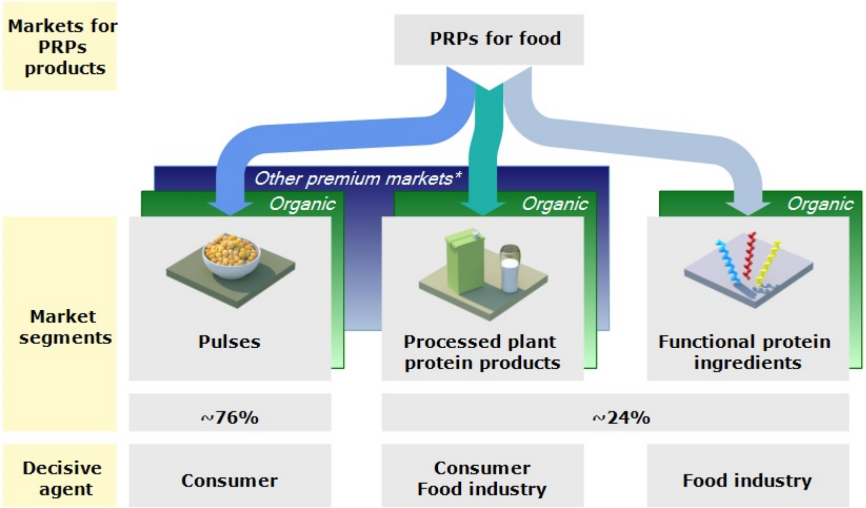


Figure 67: Main PRP food uses (own work)

Figure 68 shows the food market segments studied in the present report and the main economic agents influencing the development of the segment.



*This number excludes products made from functional ingredients

Figure 68: Food market segments studied in the report (left) and share of the volume of pulses and soya grains used for food[186] (in thousand tonnes and %) (right) (source: own estimations based on various sources[187])

According to our estimates based on data gathered during interviews, pulses consumed as whole grains represent the main share of plant proteins consumed in food with approximately 76% of tonnage (in grain equivalent before processing). The two other market segments are estimated at a quarter of total tonnages of PRPs consumed by the food sector (in grain equivalent). These first estimates should be taken cautiously as there is no consolidated data to precisely assess the amounts of grains used by each segment. At least, these first estimates provide useful orders of magnitude about flows of PRPs driven by each market segment.

4.2.1 Drivers for the market segment of <u>pulses (whole grains)</u>

4.2.1.1 Main characteristics of the demand for pulses

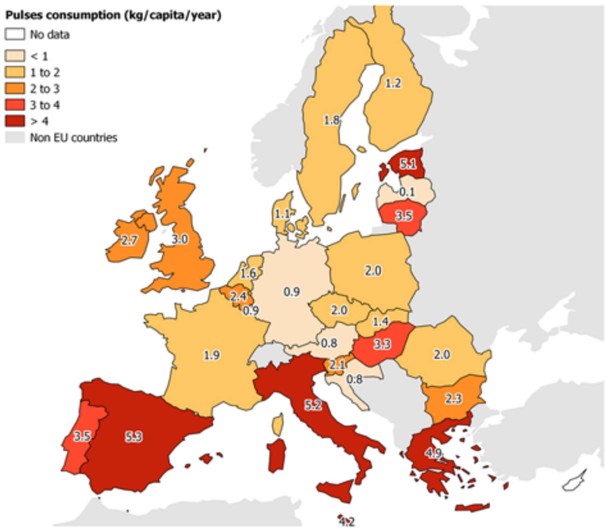


Figure 69: Pulse consumption in the EU 2011-2013 (source: own work based on FAOstat)

On average, at EU level, the consumption of pulses per capita and per year was 2.4 kg over the period 2011-2013. However, this consumption varies within the EU ranging from less than 1 kg/capita/year (in AT, DE, HR and LU) to 5.3 kg/capita/year (in Spain) (see Figure 69). The highest consumptions mainly concern Mediterranean countries (Spain, Italy, Portugal and Greece), even though some northern Member States such as Estonia (5.6 kg/capita/year[188]) and Lithuania (3.5 kg/capita/year) are also among the main consumers in the EU.

Overall the consumption of pulses in the EU has decreased since the 1960s, especially in Southern (e.g. Greece, Spain and Portugal) and Eastern Member States (e.g. Bulgaria and Romania). However, some experts interviewed observe a resurgence of interest for pulses consumed as-is, especially for chickpeas and lentils (cf. outlook section).

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[186] This data was obtained through a conservative approach based on data collected during interviews. The size of the second market segment might be underestimated. However, it gives an order of magnitude to compare the market segments.

[187] EC balance sheet for pulses and data from ENSA and EUVEPRO members

[188] The data for Estonia shows significant and unexplained inter-annual variations which seem to indicate some data inconsistencies.

The way pulses are consumed also differs among Member States depending on the local traditional consumption habits. According to experts, Southern consumers are more attached to their local dishes and are in general less likely to adopt Western food trends, compared to Northern Europeans. Consumers in Southern countries would also allocate more time to food preparation, and would therefore be more likely to buy dry pulses, while Northern Europeans show a preference for pulses in canned or frozen forms (Pinto et al., 2016).

Pulses consumed as whole grain refer to 2 sub-markets:

- Cooked as-is by consumers (purchased dried or canned).
- Incorporated into low-processed ready-to-eat dishes, hence incorporated as whole grains in canned or frozen meals by agri-food companies.

Since it concerns non-processed or low-processed products, the supply chain is generally simple. It mainly involves:

- the final consumers,
- the retailers, which can be supermarkets as well as local retailers (e.g. in open air markets),
- the food industry when the products are processed (e.g. to produce ready-to-eat dishes),
- the collectors,
- the import firms or the EU producers (depending on whether the pulses are locally produced or come from imports).

According to interviews in France and Germany[189], pulses are often imported, except when they are sold in specific market segments (e.g. premiums or short circuit value chain) which spotlight the EU origin of the grains (see Box 13).

Box 13: Dry pulses market organisation in Germany

The market segment of dry pulses consumed as such in Germany is dominated by three brands: Müller's Mühle[190], the market leader (33% of market shares in value in 2017[191]), followed by Transimpex (6%) and Wurzener (4%), as well as private labels (35%) (Mülher's Mülhe, 2018)[192]. Private labels can include products from various companies, including the three main brands mentioned. The market leader, Müller's Mühle, packed over 16 thousand tonnes of dry pulses in 2017.

According to an interview with a representative from Müller's Mühle, the sourcing is generally worldwide (e.g. from North and South America, China, other EU countries, Eastern Europe, etc.). Overall, the beans are collected by a stocking operator, then traded by an export company (if produced outside the EU) and cleaned by a specialised company before being bought by the packaging companies and sold to retailers.

Within these markets, there is a further segmentation depending on the quality or origin of the products. There are numerous quality standards across the EU for these products (see Box 14 detailing some of these premiums). There are 37 quality standards for dry pulses sold as-is (i.e. non-processed) in the EU (26 PGI[193] and 11 PDO[194], see table 23). Most of these quality standards are linked to a specific geographic origin, where these products are historically produced and consumed[195]. These products are generally sold at higher prices compared to commodity products (see Box 14).

Here are few examples:

- Castelluccio lentils in Italy (PGI),
- Giant-Elephant Beans Kastoria in Greece (PGI),
- Green lentils from the Puy ("Lentille verte du Puy") in France (PDO),
- Megeta del Ganwet in Spain (PDO) (bean).

[189] With a representative from the National Interbranch Association of Dry Pulses (ANILS) in France, and with a representative from the food company Müller's Mühle in Germany.

[190] https://www.muellers-muehle.de/

[191] According to sales to food retailers and pharmacies in 2017

[192] According to IRI 2017.

[193] Protected Geographical Indication

[194] Protected Designation of Origin

[195] For instance, according to the CBI (Centre for the Promotion of Imports from developing countries), within the EU, lentils are mostly consumed in the Mediterranean region, in particular in Spain, but also in France, Italy and Greece (see : https://www.cbi.eu/market-information/grains-pulses/lentils-grains/europe/)

	Total	PDO	PGI
Austria	1	1	0
Spain	9	2	7
France	6	2	4
Greece	8	1	7
Italia	8	2	6
Latvia	1	1	0
Poland	3	2	1
Sweden	1	0	1
Total	37	11	26

Table 23: distribution of designations of origin for dry pulses in the EU

Box 14: Example of a French origin-based market segment for lentils and difference in prices

In France, there are various designations for lentils which highlight their French (or more local) origin, the main ones being:

- Lentils from France ("Lentille de France" in French);
- Green lentils from Berry ("Lentille verte du Berry") which is protected under a PGI;
- Green lentils from the Puy ("Lentille verte du Puy") which is protected under a PDO.

These products are sold at higher prices compared to commodity products (according to a representative from ANILS):

Table 24: Producer price of three different lentil designations in France

Product	Yield	Price (conventional)	Price (organic)
Lentille de France	~2-2.5 t/ha	~500 €/t	~600-700 €/t
Lentille verte du Berry	-	~600 €/t	-
Lentille verte du Puy	~0.9-1 t/ha	~2000 €/t	~2500 €/t

Source: interview with a representative from the National Association of the Dry Pulses in France, ANILS

Regarding the consumption of organic pulses, very little data is available at EU level. According to interviews conducted in France and Spain, there is a strong demand for organic pulses and prices are higher. In Spain, organic sales represent 13.6% of total grain legume sales (MAPAMA, 2016). In France, organic lentil prices are at least 25 to 30% higher than conventional ones (see Box 14), and the current organic supply does not cover the demand, despite an organic lentil area multiplied by 10 in the last 3 years in this MS[196].

4.2.1.2 Main (economic) drivers of this segment for the different stages/actors

Main drivers for consumer of pulses (whole grains)

As explained above, this market segment is mainly driven by the final consumer demand. This demand can be influenced by various drivers such as consumer cooking habits (e.g. the reduction of the time allocated by consumers to cooking), their eating habits (e.g. their knowledge of the products), the nutritional value of pulses[197], the taste, the price, etc. (Schneider and Huyghe, 2015)

On the one hand, the consumption of pulses is boosted by vegetarian and vegan[198] diets (see Box 15), as well as their overall healthy image (Sozer et al., 2017). For some consumers, they also benefit from a positive environmental image (especially compared to meat products). In Southern European countries, they are associated with traditions and rural heritage (Pinto et al., 2016). On the other hand, pulses suffer from an outdated image and are perceived as hard to cook (Collado et al., 2017) and to digest (Schneider and Huyghe, 2015). For instance, the cooking time for lentils, which is the fastest pulse to prepare, is still two to three times longer compared to wheat pasta or rice. As highlighted by Magrini et al. (2018), major species such as wheat and rice have benefited from

[196] According to an interviewed expert from the national pulses association (ANILS)

[197] This is also true for soya bean

[198] The vegan diet consists in not eating or using animal products (e.g. meat, milk, eggs, leather, etc.)

innovations in varieties and food processing to reduce their cooking time and to offer new products, such as pre-cooked wheat, whereas less research has been done for pulses (Magrini, 2018).

Box 15: Rise of vegetarian, flexitarian and vegan diet

Europe is the region of the world with the lowest share of people who follow a vegetarian diet, with 5% of its population in 2016, compared to 19% in Asia Pacific, 16% in Africa / Middle East, 8% in Latin America and 6% in North America.

Within the EU, significant differences can be observed depending on the Member State. It is estimated that in 2017, vegetarians and vegans represented 9% of the population in Germany, 7% in the UK, 5% in France[199]. According to a survey conducted in Sweden in 2014, 10% of the population was vegetarian or vegan at the time[200]. Conversely, in Portugal, vegetarians represent 1.2% of the population[201]. The vegetarian population is increasing fast in the EU. For example, in Portugal, the vegetarian population only represented 0.3% of the population in 2007.

However, consumers of vegetarian and vegan foods do not only include strict vegetarians and vegans. More and more people replace part of their meat consumption with plant proteins, but still consume meat occasionally. These diets, defined as "flexitarian", are developing fast and can represent much more significant share of the population compared to vegetarians and vegans. For example, it concerned 34% of French households in 2017 while it was 25% two years before. In the Netherlands, flexitarians represent 55% of the population. According to a survey conducted in France, Germany, Italy, Spain and Poland, more than 30% of the population in all these Member States is actively reducing its consumption of red meat.

It is worth noticing that the organic segment is very often considered as the forerunner in all these new segments (i.e. vegan and vegetarian).

It is also worth noticing the importance of education and product knowledge on consumer eating habits. Depending on the country considered, pulses are classified under different categories in the national food pyramids (on which national nutritional recommendations are generally based), which means that they are not perceived the same way. Table 25 shows the location of pulses in the food pyramids and national recommendations in six EU Member States, one EU region and some non-EU countries (for comparison). In three of the EU Member States considered (ES, FR and the UK), as well as in non-EU countries (the U.S. and Canada), they are recognised as protein sources, while in AT, DE and IT they are classified with vegetables.

Table 25: Place of pulses in the food pyramids and national recommendations in six EU Member States and non-EU countries

	Classification	Edition	Quote from national dietary guidelines
AT	Vegetables, pulses and fruits	2010	"Eat five portions of vegetables, pulses and fruit per day. Three portions of vegetables and/or pulses and two portions of fruit would be ideal."
DE	Fruits and vegetables	2013	*No specific quote identified*
ES	Proteins	2005	"Proteins must contribute between 10% and 15% of total calories, combining proteins of animal and vegetable origin".
FR	Meat, poultry, fish, eggs, pulses and plant alternatives	2011	"Increase the consumption of starchy foods, including cereals (especially whole grain cereals, which provide fibre), potatoes, pulses, etc. They should be present at each meal."
IT	Vegetables	2003	*No specific quote identified*
USA	Meat and beans	2005	"Vary your protein routine - choose more fish, beans, peas, nuts and seeds."
Canada	Meat and alternatives	2016	"Have meat alternatives such as beans, lentils and tofu often."
UK	Proteins	2016	"Eat more beans and pulses, 2 portions of sustainably sourced fish per week, one of which is oily. Eat less red and processed meat."
Mediterranean Diet pyramid	White meat, eggs, fish and legumes	2010	"The combination of legumes (more than two servings) and cereals are a healthy protein and lipid source."

Source: own compilation based on national food programmes desk review

[199] See: https://www.statista.com/topics/3345/meat-consumption-and-vegetarianism-in-europe/

[200] Pollsters Demoskop, 2014

[201] According to a survey conducted by Nielsen Portugal in 2017, see : https://www.centrovegetariano.org/Article-620-N-mero-de-vegetarianos-quadruplica-em-10-anos.html

In addition, some customers pay attention to productions grown locally or in specific areas which could include a designation of origin. Paragraph 4.2.1 gives examples of these productions. Although they represent relatively limited volumes, experts interviewed during case studies often mention that they generate more added value.

In addition, retailers and the food industry may also encourage the consumption of pulses through their marketing strategy (e.g. by promoting the nutritional benefits of pulses, the quality of some brands or traditional products, etc.). For example, some retailers may have specific stalls for locally produced pulses or for pulses certified under quality schemes.

Main drivers for retailers of pulses

Pulses are commonly found in retailers' shelves, at least in Member States where they are commonly consumed (e.g. Spain, Italy, France, etc.). According to an interview with the ANILS in France, retailers have high margins on premium products. Regarding dry pulses sold as commodities, one can suppose that the margins are less significant and most of them come from import.

According to an expert in France[202], retailers are increasingly developing their offer of locally produced pulses. For these products, they generally require from their supplier either a French origin or an origin from a specific region in France (depending on the products). According to the same expert, EU origin is generally not relevant as it is not perceived as a local origin. These requirements limit their supply and, when the production is low[203], some products are only sold for a few months (after the harvest) before being out of stock.

Main drivers of the food industry selling pulses

The choice of the food industry selling pulses is mainly driven by its potential margins and its knowledge of the sector and products. It is also driven by the availability and stability of the supply in pulses, as well as its quality. This explains why many companies prefer to diversify their sources of pulses with imports[204]. As for companies selling pulses under PDO, PGI or other quality schemes linked to specific location of production, many supply chains are based on campaign contracts, which involve in most cases the collector and the buyer (the food company). These campaign contracts are based on quality standards.

For the food companies producing for retailers (under the retailers' brand), they must comply with specific standards set up by these retailers. For dry pulses consumed as such, they often require specific origin (see above) but also a short cooking time (which fosters the development of pre-cooked products) and organic production in some cases.

Some of the production is also exported, most on high-value markets. In this case the main drivers are related to the quality of the food product and its origin (for instance Green Lentils du Puy are exported to high value markets in Asia[205]).

Main drivers of the collectors

Regarding the collectors of PRPs, their main constraint is the need to have enough storage facilities for the different products (soya bean and pulses) and to avoid contamination with GM grains (for collectors located outside the EU) or plant protection products if they deal with organic materials. Furthermore, they must avoid weevil (*bruchus*) infections to comply with quality requirements. For pulses, the small size of the lots can involve supplementary costs of storage and segregation. In food, collectors can benefit from higher prices compared to the feed market.

These drivers for the collectors also apply to the other food market segments.

Summary of the main drivers of the market segment of PRPs consumed as-is

This segment consists mainly in pulses consumed as-is (whole grain) or cooked in preparations. For all of them, the buyer knows perfectly what it is buying and why (e.g. taste, nutritional value, etc.). In this segment there are two main categories of buyers:

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[202] A representative from a major food company packing dry pulses for retailers (under retailers' brands)

[203] Because yields are low

[204] According to interviews with various food companies in Germany and France.

[205] Source ANILS (French national Pulses Association).

- those looking for a cheap basic product. In this case most of the supply often comes from imports.
- those looking for specific products (e.g. such as PDO, PGIs, etc.) for which the first driver is the expected quality or origin, the price being less important.

Retailers provide consumers with these two categories of products at significantly different prices.

The food industry and packagers do the same, as packed products or prepared dishes mostly belong to the two above categories, the latter being generally clearly mentioned on packaging. Their main constraint is to have a sufficient and stable supply, at a given quality and sometimes for a given origin (which can be a very limited area in some cases).

4.2.1.3 Outlook for pulses (whole grain)

In the coming years, the flexitarian, vegetarian, and vegan diets are expected to increase, fostering the demand for dry pulses. In addition, several experts interviewed observe a resurgence of interest for pulses consumed as such, especially for chickpeas and lentils.

For the organic market segment, the current organic supply does not cover the demand but organic conversions are on-going and the organic area is expected to increase. Some barriers to their consumption (e.g. the cooking time, etc.) mentioned are likely to remain in this market segment since many products are not processed (i.e. dry grains). To deal with this issue, food companies are developing pre-cooked grains to respond to the demand for fast-cooking products. For instance, the food company *Sabarot* in France has invested in a pre-cooking unit and will launch new pre-cooked pulses in September 2018.

The changes in import tariffs with other countries such as the U.S.[206] can be a risk for the market segment. It should be kept in mind that the supply in the EU does not cover the demand and food companies selling pulses rely to a large extent on imports. Canada was often mentioned by the food companies interviewed as their main source for imports.

Another major risk is the increase of weevil insect (*bruchus*) damage to pulses in the EU. Weevil damage alters the appearance of the grains, which may lead to the impossibility of selling them as food (Meynard et al., 2013). For instance, in France, broad and field bean production has been impacted over the last few years and this has undermined the exports to Egypt (which used to be a major outlet, with 246,000 t exported in 2010-2011 compared to 6,000 t in 2016-2017)[207]. According to a representative from GEPV, these productions were eventually sold as feed mainly for aquaculture in Norway, at a lesser price of course.

4.2.2 Drivers for the market segment of <u>processed plant protein products</u>

4.2.2.1 Main characteristics of the demand for processed plant protein products

This segment includes a wide variety of products (e.g. tofu, soy drinks, plant protein-enriched pasta, plant protein-based snacks, etc.), which consumers know are made with plant proteins and are buying the product at least partly for this reason. In most cases these products are made from soya bean, but they can also be made from pulses. The consumer is not necessarily looking for vegetarian or vegan food, even though this demand represents a share of the market segment. Other drivers may explain the preference given by consumers to plant protein-based products such as their image, their nutritional value or their innovative characteristics (see § drivers).

The plant protein-based food product sector has developed in the EU over the past forty years. Table 26 presents the turnover of the five ENSA[208] members (that represent 75% of the plant-based food sectors in the EU[209]) which has nearly doubled in the last decade. ENSA members produce drinks (soy drinks and other plant based-drinks) as well as alternatives to dairy and meat products (e.g. tofu).

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[206] E.g. the implementation of an import tariff on red beans in 2018

[207] France Agricole no. 3745 – 27 April 2018

[208] ENSA is the European Plant-based Foods association. It was established in 2003, as the European Natural Soyfoods Manufacturers Association. Its 5 members are: Triballat Noyal, Liquats Vegetals, Nutrition et Santé, Valsoia, Alpro.

[209] With an aggregated turnover of 810 million Euros

Table 26: Annual aggregate turnover of ENSA members (million €)

	2008	2010	2012	2014	2015	2016	2017
Total turnover	464	538	618	655	779	781	811
Turnover of <u>soy</u> alternatives to dairy or meat products	464	538	546	534	585	528	539
Turnover of <u>other</u> plant-based products	n.a	n.a	72	120	194	254	272

Source: ENSA (2018)

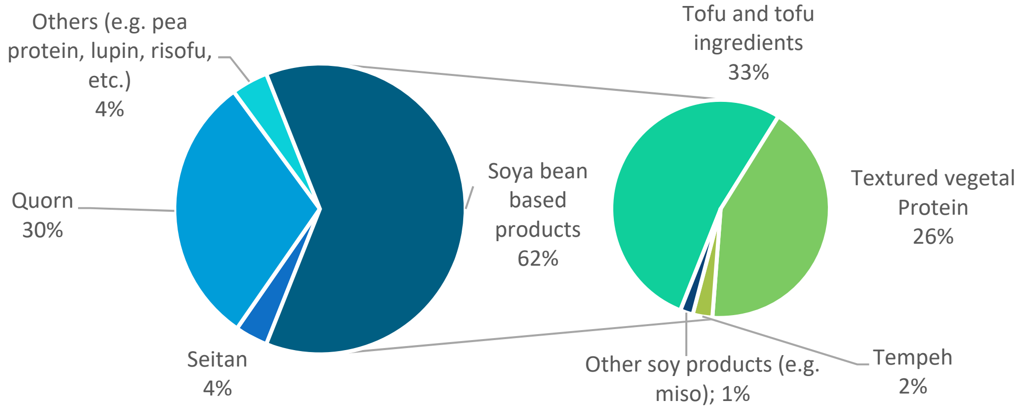
According to interviews with several ENSA members, the market for dairy alternatives is the main one in the EU. It is a mature market and has a good level of penetration in the population in several Member States (e.g. ES, BE, etc.). The meatless product (also referred to as meat substitute) sector is less mature but is developing, particularly in response to the demands of flexitarian, vegetarian and vegan people. They are different from pre-existing products such as tofu and soy drinks, as the goal is to provide the customer with products looking like meat, even in terms of structure and taste. These products are mainly made from soya concentrates or textured proteins (see section 4.2.3 about functional protein ingredients). Box 16 presents the example of 'Nutrition and Santé' that produces this type of meat substitute.

Box 16: The development of a production of meat substitutes in Southwest France

Nutrition et Santé (N&S), a food manufacturer specialising in health products, including soya bean food, is developing a chain of meat substitutes based on soya concentrates. The process took several years to be mastered, but the main difficulty was finding soya bean concentrates in the EU with a sufficient rate of proteins to allow producing these meat substitutes. The organic production is locally produced by a company operating in the vicinity of N&S. But for conventional production, which is actually the main outlet of this market, it has not been possible to find a processor in the EU able to provide this specific raw material, hence it is imported from the U.S. The objective of the factory is to find a solution to use locally produced soya bean within its own value chain.

According to various market studies, in terms of revenue, Europe was the largest market in the world for meat substitutes in 2017 (Prasannan, 2018, Mordor Intelligence, 2018, MarketsandMarkets, 2018). The market is characterised by the presence of large-scale meat substitute manufacturers including companies producing meat substitutes from soya bean and pulses (e.g. Meatless in the Netherlands), but also companies using other sources of proteins such as mycoproteins[210] (e.g. Quorn Foods in the UK). This market is dominated by a few Member States in the EU. According to a market study, in 2015, Germany, Spain, France, Italy, the UK and the Netherlands represented together 69% of the European market for meat substitutes (MarketsandMarkets, 2018, Marketsandmarkets, 2016). According to the same source, in terms of value, soya bean-based products represent 62% of the market of meat alternatives in Europe (see Figure 70).

Figure 70: Meat substitute market size by type of products in Europe in 2015 (Source: MarketandMarkets, 2016)



It is also worth noticing that over the last few years, the development of the traditional soya bean-based products such as soy drink (e.g. tonyu) has slowed down, and other plant-based products (which includes pulses-based products) are gaining market shares.

[210] Mycoproteins are protein derived from fungi, which are especially produced for human consumption.

In addition to these meat and dairy alternatives, other PRP-based products have developed over the past decade such as protein-plant based snacks, pasta or other food products. These products can be considered as innovative products and they respond to various demands from the consumers such as vegetarian food, healthy food, gluten-free, etc. (see Box 17).

Box 17: Development of innovative pulse-based food products in the EU

While many soya bean-based food products were developed during the 2000s[211], the development of pulse-based products mainly started in the 2010s. These products are innovative and offer to consumers new ways to consume PRPs. These products can be for instance: pasta made from a mix of pulses and durum wheat, meat substitutes, pulse-based snacks, etc.

The Canadian Ministry of Agriculture and Agri-Food carried out a review of new pulse-based food products launched in the EU[212] between 2010 and 2014 and they identified more than 3,500 new products (see Table 27) (AAFC, 2015). The main Member States in terms of number of products launched are the UK (with 1,014 products, or 28% of the total launches), France (766 or 21%), Germany (392 or 11%), Spain (348 or 10%) and Italy (207 or 6%)[213] (AAFC, 2015).

Table 27: Number of new pulse-based food products launched in the EU between 2010 and 2014

Year	2010	2011	2012	2013	2014	Total
Number of products	429	513	680	1,216	755	3,593

Source: (AAFC, 2015)

Of the 3,593 products identified, 35% contained chickpea ingredients, 34% contained pea ingredients, 25% contained bean ingredients, and 14% contained lentil ingredients.

The most common claims used by the new launches emphasised the use of pulses as an alternative source of protein, as well as product naturalness, convenience, and environmentally friendly aspects through packaging. 13% of the products launched were organic.

It should be noted that the organic market segment is often preferred by the food companies for innovation. Many plant protein-based food products are first launched in the organic market segment before the conventional one.

Most of these products are highly processed foods based on pulse ingredients (e.g. protein concentrates), but this trend also includes less processed products conveying a more “natural” and traditional image (Magrini and Lascialfari, 2016).

As explained in the Box 17, many new products (including meat alternatives) are based on mixes of pulses or soya bean with cereals, in order to obtain high nutritional value products. The combination of cereals with pulses is a good protein source for the human diet as it contains all nine essential amino acids[214].

According to ENSA representatives, soy foods (including meat and dairy alternatives, as well as the other new products) were initially mainly sold in specialised shops such as organic shops and pharmacies. Now, many of these products are also sold by the food companies through large-scale retail trade, with their own brand and/or for retail brands. Some products are also distributed through catering channels (school and hospital cafeterias) or still via organic shops and pharmacies (Magrini and Lascialfari, 2016).

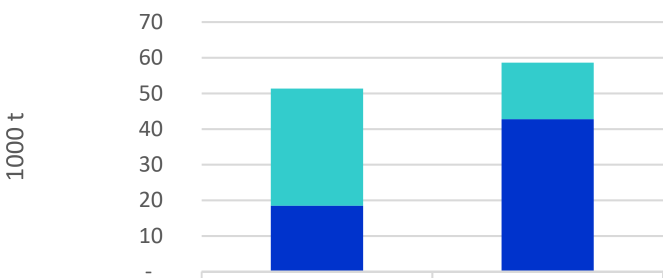
Overall, meat and dairy alternatives are mainly produced based on soya bean and, to a lesser extent, other plant proteins such as pea (but also plant proteins which are not in the scope of this study such as rice, wheat, etc.).

[211] During the 2000s, 90% of plant-based foodstuff innovations were still based on soy and wheat proteins – the two major worldwide crops.

[212] Data was collected for the following MS: United Kingdom, Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Netherlands, Poland, Portugal, Spain, Sweden.

[213] The countries with the fewest new products were Hungary, with just 16 new products over the review period, and Greece with 20.

[214] Cereal proteins are rich in methionine and cysteine, which pulses lack, and pulses are rich in lysine, which cereals lack.



	2007	2017
Non-EU (1000 t)	33	16
EU (1000t)	18	43

Figure 71: Whole soya bean consumption by ENSA members in 2017 and share of the EU sourcing (source: ENSA, 2018)

ENSA[215] members report that whole soya beans are primarily used to produce soy drinks but also tofu and other fermented products. Soya beans are also used as ingredients in certain meat-free alternatives with other purchased soy-based ingredients (e.g. soy flour, concentrate).

Soya consumption in ENSA members' factories has increased by 14% in 10 years and the share of EU sourcing in the soya bean supply surged from 36% in 2007 to 73% in 2017 (cf. figure 71). The entire soya bean used is GM-Free[216] and 22% is organic, entirely coming from the EU.

Regarding plant protein-based snacks and other innovative products, the source of plant proteins is highly diverse (soya bean and pulses but also plant proteins which are not in the scope of this study). The main pulses used in new food products (as such or after being processed into ingredients) are chickpeas, peas, beans and to a lesser extent, lentils (see Box 17).

According to the study of 12 innovative pulse-based food products in Italy and France, the sourcing strategy depends on the quantity needed. The largest firms preferred to import pulses from Canada and Turkey to ensure the regularity of quality and price competitiveness, while smaller companies use pulses produced in the Member State. Other companies use national production only partially as they have difficulty obtaining qualities and quantities needed. With regard to organic companies, they use various European suppliers because national organic pulses prices would be too high (Magrini and Lascialfari, 2016).

The availability and stability of supply is essential for food companies to reach their production objective and optimise the use of their production factors. Furthermore, the food industry needs to have a stable supply with regard to the quality of products (e.g. taste of the grains, protein content, etc.). Storage quality is also essential to ensure the quality of supply and avoid contamination with allergens (ALPRO, 2018). For these reasons, several food companies (processing soya bean and/or pulses) in the EU have developed production contracts with collectors. Since the volumes of individual farmers are often too small (e.g. the Emsland group in Germany needs a daily supply equivalent to the production of 100 ha of pea), in many cases, the food companies sign production contracts with collectors rather than farmers. Furthermore, the collectors check the quality of the grains, clean and store them. The collectors also often implement contracts with the farmers to secure their own supply. Various food companies (e.g. in Germany and France[217]) processing soya bean or pulses tend to have three-year contracts to secure their supply at medium term (compared to one-year contracts which could be seen as short-term contracts).

The main components of these production contracts are:

- The quality of the grains set up in standards (GM-free certified, specific varieties, protein content, no allergen contamination, cleanliness, etc.);
- The quantity produced.

In most cases, the buying price (farm gate price) is based on MATIF price for soya bean but can include various premiums which depend on different aspects (e.g. GM-Free, protein content, location of the production, etc.) and can widely influence the final price (cf. Box 18).

[215] ENSA: European Natural Soy and plant-based foods manufacturers Association.

[216] GMO use in food is prohibited through EU regulation No. 1829/2003 on genetically modified food and feed.

[217] E.g. the Emsland group in Germany, Roquette, Nutrition&Santé and Alpro in France.

Box 18: Definition of the buying price of soya bean according to its origin for a major soya bean-based dairy alternatives manufacturer

ALPRO, which is a major soya bean-based dairy alternative producer in the EU, has different price policies according to whether the grains come from the EU (i.e. from supply chains organised at regional level) or from Canada:

- Regarding the Canadian supply, the price is linked to SPOT prices with various premiums (GM-free premium, long-term storage premium[218], etc.);
- Regarding the EU supply, the price is negotiated. It includes quality specifications (e.g. linked to the protein content because high protein varieties have lower yields). There can be different prices between the different collectors in the EU, but prices are in the same range (broadly there is less than 10% difference). The price differences are linked to specific reasons (e.g. if the collector has made specific investment to store and sort the grains, etc.) as well as historical reasons.

Source: ALPRO Workshop in Chalon-sur-Saône, 2018

In Southwest France, in the framework of the supply chain organisation Sojadoc (see Box 19), the price of soya bean includes a premium for all these factors plus an indexation to maize price, which has been implemented to avoid drops in production when maize price is high compared to soya bean (as it was the case in 2008 for instance) and therefore further secure the supply for the food industry.

Box 19: The Sojadoc value chain in Southwest France

Sojadoc is a French interbranch association founded in 1994 to organise GM-Free soya bean production in Southwest France. It brings together 4 collectors (two cooperatives and two traders, two are organic and two conventional) and one processor (Nutrition and Nature). It was first established to create the very first GM-free soya bean food value chain in France. For that purpose, a standard was designed in 1996 to secure buyers. This standard (presently in version 22) is applied from farms to the factory and checked by certified bodies. In 2017, the production was around 15,000 t of GM-free soya bean, coming from around 500 farms, and was enough to provide 100% of the factory's supply and more (part of the production being sold to other EU food factories).

Over the past 25 years, the members of this association (a grouping of entities in competition in their markets or along the supply chain), decided to identify common interests and the related missions that they could mutualise. Initially set up to improve grain quality (e.g. research on varieties, processing, etc.), the association opened its areas of intervention to other topics such as: life cycle analysis, support for agri-environmental measures, certification of organic production in the Fair-Trade standard, and finally the development of activities to better account for biodiversity and pollinators in the farm.

From the very beginning, the relationship between farmers, collectors and the factory has been organised through three-year contracts allowing each party to secure production and supply. These contracts fix a minimum campaign price, which is indexed to the main alternative crops (e.g. maize) to limit price volatility for farmers and limit the risk of production drop in case of high maize prices. It is noteworthy that farmers are often reluctant to engage in 3-year contracts instead of annual contracts which allow them to shift to more lucrative crops from year to year.

Local producers/collectors are preferred by some food companies (e.g. ALPRO, Nutrition & Santé, etc.) rather than imported production since it allows different management of the supply (specified segmentation of quality and quantity), but above all it matches with customers' demand for local products. However, one way to secure the supply is also to diversify the geographical origin of the products (e.g. in case of sudden collapse of production in a given area). According to interviews with several members from the ENSA organisation, this is one of the main reasons why some of them avoid having a 100% EU supply for soya bean and still resort to import (mostly from Canada). For pulses in France, imports (including imports from other EU Member States) represents 90% of the industrial use of dry pulses (Schneider and Huyghe, 2015).

4.2.2.2 Main (economic) drivers of this segment for the different stages/actors

Main drivers for consumers of processed plant protein products

Similar to pulses consumed as-is, the demand from the consumers for soya bean- and pulse-based food products is mainly driven by vegetarian and flexitarian diets and the demand for healthy products (Sozer et al., 2017, Magrini, 2018). Health concerns (which include obesity and diabetes, see Box 20) are increasingly important in consumers' consumption choices, and some tend to limit meat consumption for this reason (MarketsandMarkets, 2018).

Impact of public health policies

[218] Soya bean which is collected in October cannot be consumed before January for Alpro

Box 20: Nutritional benefits of pulses and soya bean

Compared to meat, pulses and soya beans are richer in fibre[219] and carbohydrates and generally poorer in saturated fats. Their amino-acid profile is complementary to that of cereals[220], and therefore their association in processed foods results in a good balance of the nine essential amino acids. Furthermore, there is strong scientific evidence linking regular pulse consumption to lower LDL cholesterol and blood pressure (which may reduce the risk of heart disease) (FAO, 2016).

Some of these products (e.g. soyfood) also benefit from an environmentally friendly image on the consumer side. The demand for sustainable and healthy products is particularly significant on the organic market segments as organic consumers have generally a higher sensitivity to environmental and health matters (Basha et al., 2015). This drives the interest for PRPs in superfoods, meatless products, etc.

According to experts interviewed, 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 consumption of meat (flexitarian) for various reasons (e.g. health, environmental and financial aspects) (Specht and Michail, 2018). This is confirmed by some retailers' marketing strategies which promote plant protein-based products not only in vegetarian and vegan food shelves, but also in traditional meat and dairy shelves (see Box 21).

Thanks to processing methods, PRP-based food products can also respond to the demand of consumers to have more functional (especially quick and easy to cook) products. When PRPs are incorporated into mixes with rice, maize or other gluten-free cereals they can also satisfy the demand of consumers looking for gluten-free food (Magrini and Lascialfari, 2016, Sozer et al., 2017).

In addition, retailers and the food industry may also encourage the consumption of such products through their marketing strategy (e.g. by promoting the nutritional benefits of pulses) or by developing new products to respond to consumer eating patterns (e.g. ready-to-eat pulses preparations).

For instance, some retailers have developed specific strategies to promote their offer of vegetarian or vegan products (see Box 21). These products are often made from soya bean or pulses.

Main drivers for retailers selling processed plant protein products

Food retailers looking for differentiation may tend to develop their offer of innovative products or products responding to specific demand (e.g. vegetarian, vegan or gluten-free diets as mentioned below in the Box 21) (Quendt, 2017). This can be a driver for the marketing of soya bean and pulse-based food products.

However, their choice also depends on the available supply (EU produced or imported) and the expected gross margin they can obtain from these products.

[219] Pulses also contain soluble and insoluble fibre. Soluble fibre can help manage body weight, blood sugar levels and lower cholesterol. Insoluble fibres assist with digestion and regularity.

[220] Pulses have higher amounts of the essential amino acid lysine whereas cereals have higher amounts of the essential amino acids methionine and cysteine.

Box 21: Promotion of vegetarian and vegan food by retailers in some EU Member States

Some retailers have launched their own brands to promote vegetarian food in their supermarkets. For instance, the French retailer Carrefour has launched the brand "Veggie", the British retailer Sainsbury's "Love your veg!" and the German retailer Kaufland "K-take it veggie". In the three cases, the brands promote ready-to-eat meatless products and, for the Kaufland brand, dairy alternatives. These products are often innovative products (e.g. pulse-based pasta, etc.).

Figure 72: Examples of retailer brands promoting vegetarian or vegan food products (source: Carrefour, Sainsbury's and Kaufland)

According to *Carrefour* communication[221], "Veggie" products are mainly produced by French suppliers. All Carrefour shops in France, including convenience stores, offer at least some of the products from the brand Veggie. They are mainly sold in the frozen products or ready-to-eat dishes shelves, sometimes in specific stalls promoting the brand.

In parallel, *Sainsbury* has a started to sell meat substitutes in the meat shelves of its stores. The strategy here is not to target vegetarian and vegan consumers, as these consumers generally do not visit this part of the supermarket, but the products are mainly aimed at flexitarians, a market now estimated in the UK at 22 million people[222].

Even though not all EU retailers have developed their own vegetarian brand, they all have perceived the growing interest of consumers for vegetarian food. Many of them promote vegetarian or vegan recipes, often based on pulses and soya bean products, on their website (e.g. *Tesco* in the UK, *Carrefour* in France, *Kaufland* in Germany, etc.).

Main drivers for food companies making processed plant protein products

When producing processed plant protein products, food companies are firstly motivated by consumer demand for such products. Therefore, one major driver of their choices is consumer preference and the desire to meet their expectations. For instance, the idea that beans cause flatulence leads to its exclusion in many food products. Conversely, visual determinants lead to preference of chickpea and blond lentils as an ingredient for some products such as pulse-based pasta (Magrini and Lascialfari, 2016).

In order to respond to this demand, the quality of the supply and the fact that it is GM-free (for soya bean) is essential for food companies. Their choices are also driven by the need to have a secured and stable supply. For this reason, some companies interviewed do not wish to entirely rely on EU production and prefer to diversify their supply sources[223] (in case EU production collapses one year). Regarding companies seeking EU-produced materials, many supply chains are often based on campaign contracts which involve in most cases the collector and the buyer (the food company). These campaign contracts are based on quality standards (see 4.2.2.1 about the sourcing of food companies).

[221] See http://www.carrefour.fr/marques/veggie

[222] See https://theflexitarian.co.uk/2018/06/sainsburys-starts-selling-vegan-meat-alternative-naturli-in-meat-aisle/

[223] According to interviews with various food companies in Germany and France.

Food companies also seek to produce food products with good nutritional value and tend to avoid allergy risks. This latter criterion can lead to the exclusion of soya bean and lupine in food products, as they are among the 14 major food allergens identified by the EU legislation[224].

The environmental image of the products is also important for food companies as consumers give more and more importance to these issues. According to AAFC (2015), environmental considerations were part of the marketing strategy of 23% of pulse-based food products launched between 2010 and 2014 (AAFC, 2015).

The development of PRP-based food products also highly relies on the know-how of the food companies and the technologies available to them. The processing of PRPs to produce dairy and meat substitutes, superfoods (e.g. pulse-rich pasta) or to be used as functional ingredients by the agri-food industry (cf. following section about functional proteins) requires the use of specific technologies to characterise and process the raw materials (i.e. soya bean and pulse grains). While significant research and development has been done in recent years to develop the use of soya bean for food (e.g. variety development to reduce the anti-nutritional factor content of the grains or to improve the organoleptic profile), there is still a lot to be done to bridge the technological gap for pulses. The key challenges to be addressed are (Sozer et al., 2017):

- taste and off-flavour management (e.g. reduction of the beany taste for peas and beans, stabilisation of the taste of the final product, etc.),
- nutritional characterisation (determination of the amino acid profile, the digestibility, etc.),
- anti-nutritional compounds reduction (e.g. tannins),
- technological challenges (reduced product hardness, increased dough stickiness, texture improvement, etc.).

Research and development can be driven by public as well as private organisations[225]. Partnerships between research institutes or universities and food companies can strengthen the local value chains since it allows farmers to better respond to the needs of the food industry and therefore secure the demand for their products (compared to imported products for instance).

The development of new technologies to produce specific protein products (e.g. texturised protein, concentrates, fermented products, etc.) and to use them in the food sector opens opportunities to develop new products and to tailor them to the needs of specific market segments (e.g. demand for plant-based alternatives to meat and dairy, easy-to-chew proteins for elderly people, etc.). According to interviews with experts in Germany and France, the sector is dynamic. Companies are willing to invest in new products, especially for meat and dairy alternatives. Companies that are present on the market are mainly small or medium-sized companies that are driven by the expectation that the overall demand for plant-based meat or dairy alternatives will rise.

Summary of the main drivers

This segment consists mainly in processed food products made from soya bean (mainly) or pulses (to a lesser extent) and marketed as plant-based products. For these products, the use of plant proteins is a part of the marketing strategy. Plant-based products are becoming more and more popular in Western consumption patterns for various reasons such as their nutritional value, health benefits or because they are meat-free. Thanks to food processing techniques, these products are also generally convenient and easy to cook. Retailers have perceived this growing interest for vegetarian and vegan food products and have also participated in their promotion through specific brands and promotional strategies.

The food industry tends to satisfy the demand of consumers and many companies develop innovations to better respond to new trends (reduced cooking time, rising number of vegetarians, flexitarians, vegans and gluten-free diets). Their main constraint is to have a sufficient and stable supply, at a given quality and sometimes for a given origin (in most cases national or European origin).

[224] According to EU Food Information Regulation No. 1169/2011 (FIR) and Food Information for Consumers Regulation (FIC). Caterers and Food businesses are required by law to be able to provide customers with accurate information on the EU's 14 major food allergens if they are included in any of the food products they produce, sell or serve

[225] For instance, in Belgium, the food company ALPRO (producing soy-based dairy alternatives) has participated in the project "Soy in Flanders", which is a research test project led by the public institute Voor Landbouw- Visserij- en Voedingsonderzoek (ILVO), with university KU Leuven and Inagro involved as partners. This research project focuses on crop husbandry and agro-economic aspects for the cultivation of soya for food in Flanders.

4.2.2.3 Outlook for processed plant protein products

Compared to pulses consumed as-is, the market for soya bean and pulse-based food products is recent. It is developing relatively fast, as are ENSA members, whose turnover has experienced an average annual growth of 7% between 2010 and 2017.

As explained in section 4.2.2.1, the meat substitutes market is experiencing a particularly significant development. According to a report from the global market research firm Mintel, meat substitutes are one of the key trends that will impact the global food and drink market in 2018 (Mintel, 2018). As further evidence, at world level, the meat substitutes market is estimated at USD 4.63 Billion in 2018 and is projected to reach a value of USD 6.43 Billion by 2023, at an annual growth rate of 6.8% (MarketsandMarkets, 2018). Some other sources project a slightly lower (5.8%) or higher (7.7%) growth rate (Mordor Intelligence, 2018, Prasannan, 2018). The ENSA members interviewed confirmed that meat alternatives are likely to experience a higher growth rate than dairy alternatives in the following years. This feedback concerns meat alternatives made from soya bean and pulses, as well as other plant protein sources (e.g. mycoproteins). According to projections, in Europe, the Quorn market (meat substitutes made from mycoproteins) will be more dynamic than soya bean-based products market (with a CAGR of 7.5% for the period 2016-2022, compared to 5.2% for tofu and tofu ingredients) (Marketsandmarkets, 2016).

Most of the main drivers of the demand for pulses and soya bean-based food products are likely to strengthen in the future such as rising health concerns, the development of vegetarian, flexitarian and vegan diets, the reduction of the cooking time of consumers, the demand for easy-to-cook dishes, etc. The rise of flexitarian diet especially is likely to drive significant change on the market in the future as the flexitarian consumers constitute a significant share of the population (compared to vegetarians and vegans). For this reason, on the meat substitute market, the world key players preferentially target flexitarians rather than vegetarians (Mordor Intelligence, 2018).

Furthermore, the increasing gluten mistrust among consumers is expected to cause an increase in the market for gluten-free. Pulses are gluten-free by nature and they can be used with rice or corn to produce gluten-free cakes, pasta and other food products (Sozer et al., 2017).

The demand for sustainable food production is also expected to increase and it will probably boost the demand for meat substitutes in the future. According to a recent market study, environmental considerations will increasingly impact consumer consumption choices and will become a significant driver of the demand for meat substitutes in the following years (Mordor Intelligence, 2018).

Another opportunity for the sector is the potential for innovations. Many of the products in this market segment did not exist or were little represented in retail stores 10 years ago (e.g. meat and dairy alternatives, pulse-based pasta, etc.). The tremendous increase of references in supermarkets confirms this (see section 4.2.2.1 about market shelf references studies). Another proof of the importance of innovations for pulses and soya bean-based products is their presence in food innovation contests over the past few years[226]. Furthermore, the increase of the adoption level of plant protein-based food by consumers helps companies to innovate and develop product lines for soya bean and pulse-based products, which can further contribute to the growth of the market (MarketsandMarkets, 2018).

It should be noted that the organic market segment is often a precursor market for innovations. Many innovative food products are first launched on this market segment and are then produced for the conventional market[227]. These innovations aim at better addressing consumer demand but also at catching their interest. One particular tendency is to combine pulses with cereals in order to propose new products with nutritional high value (since the combination of pulses with cereals provides all nine essential amino acids). Such products can be, for instance, pasta made from mixes of wheat and pulses or pre-cooked mixes of grains.

It should be noted that in 2013, 90% of the plant-based foodstuffs innovations were still based on soy and wheat proteins (Gueguen et al., 2016). Therefore, this first round of innovations in the food sector does not seem to have favoured the use of pulses. However, according to interviews with experts from the food industry, innovations based on pulses are developing and may be preponderant in innovations in the following years. This is confirmed by the increase of pulse-based innovation in EU supermarket in the 2010s (AAFC, 2015).

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[226] For instance, in 2017, lentil-based snacks won a special prize at the European food innovation contest Ecotrophelia.

[227] According to interviews with representatives from the food industry.

Another example of potential development in the sector in the following years is the development of bioprocessing. Bioprocessing enables the improvement of the nutritional quality of pulses, e.g. soaking and germination that have been performed for a long time as a pre-treatment of legume seeds before food use. Controlled germination of cereals (or malting) has been carried out for a long time on an industrial scale, but in the case of legume seeds it has been mostly performed at household level (Sozer et al., 2017). Therefore, this technology could be further developed in the future to respond to consumer interest for healthy food.

One can expect that the constraint of the beany taste and other off-flavour of some pulses will be lowered in the future with the help of research and development of varieties.

However, in spite of the growing interest of consumers for local products, the market for these products is mainly a global market. EU food companies are facing competition with other major players in the world. The U.S., in particular, has been developing soya bean-based food products for a longer time.

Environmental considerations (linked to deforestation in South America mainly) may negatively impact the perception of soya bean by consumers in the future. Similarly, there is a risk that health concerns will lead consumers to avoid ultra-processed foods in spite of their advantages (e.g. easy-to-cook) (Magrini and Lascialfari, 2016).

Market segment developments also depend on the future of trade policies, since many food companies import at least a share of the PRPs they use. An increase of duties could be problematic in case of a low-yield year in the EU.

4.2.3 Drivers for the market segment of functional protein ingredient

4.2.3.1 Main characteristics of the demand for functional protein ingredients

This paragraph deals with PRP ingredients used for their functional properties. Contrary to the two other market segments described in this chapter, functional protein demand is not driven by the final consumer who buys the final food product but by the food industry which buys functional protein to meet its technical needs and/or improve the nutritional quality of its products or even reduce its costs. It is hence a B2B marketing.

The final consumer is not even necessarily aware that the product he or she buys contains plant protein[228]. However, this is not always the case since functional ingredients can also be incorporated in products included in the second market segment (processed plant protein products) and which are marketed as a plant protein-based product (e.g. meat alternatives).

The main functional and nutritional properties sought by processors are:

- Water retention/absorption capacity, gel formation, emulsification, foaming, palatability, mouth feel, etc.
- Improvement of the nutritional value of the product: intake of amino acids, intake of fibres, low saturated fat content, improvement of the ratio protein/fat, etc.

By choosing the correct combination of plant proteins, manufacturers can thus control the texture and mouth feel of their products while optimising yields, reducing cooking losses and costs, and making their products more appealing. Beyond these functional properties, plant proteins are also used for the protein content to substitute meat in these products (because plant proteins are cheaper than animal proteins, or in order to produce vegetarian or vegan food products).

These functionalities are used by a wide range of operators in different food sectors. Box 22 provides some examples.

[228] For instance, when consumers buy sausages in which plant proteins are incorporated, they buy it as a meat product, even though they may read on the list of ingredients that the sausage also contains plant proteins (e.g. pea or soya bean protein).

Box 22: Examples of the use of PRPs functional proteins in food products

Incorporation into meat products

PRP proteins (and also others coming from cereals) can be incorporated in the following preparations:

- Emulsified Meat products (such as hot dog-type sausages and mortadella);
- Minced meat products (such as meat patties, döner kebabs, coarse minced sausages and chili con carne);
- Whole Muscle Meat Products (such as cooked ham, cooked turkey breast and roast beef)

The use of plant protein ingredients can improve the texture of the products. Soya or pea isolates or concentrates can emulsify vegetable oil and therefore have an important role to play in ensuring the finished product has the required succulence. These plant proteins may also have a large benefit in terms of structure contribution as they have the ability to bind water and create a sliceable gel structure[229].

The incorporation of plant proteins can bring added value on specific market segments (100% plant-based minced meat preparations are sold at a higher price than 100% beef minced meat).

Bread, *viennoiserie*, and pastry products

For these sectors PP are used as milk and eggs replacements and for water retention which increases softness and the drying time. For example, lupine is a good egg replacement in pastry applications.

Meat substitutes

Plant protein ingredients can be used to produce meat alternatives, which are very similar to meat (in terms of taste, texture and aspect) and yet do not contain any animal protein.

According to an expert estimate, the protein-rich ingredients used for their functional and nutritional characteristics represent ~2Mt of proteins produced in the world, among which ~1Mt made from soya bean[230].

Within total protein-based ingredients, the share of plant protein-based ingredients used for food is about 30% (vs milk protein, egg protein, etc.) (IMPROVE, 2018, Schneider and Huyghe, 2015). This share has been increasing over the past few years. According to the European platform IMPROVE[231], the protein ingredient market has grown by 52% for plant protein-based ingredients compared to 41% for animal protein-based ingredients over the period 2012-2018. According to various sources[232], the world market for plant proteins represented 6,200 to 6,900 M€ in 2013, and could reach 9,800 M€ in 2018, which means an annual growth rate of more than 8%[233].

Since 2005, various market shelf analyses have been done in some Member States (e.g. DE, ES, FR, PL and the UK) to study the referencing of plant proteins in food products. The European association EUVEPRO[234] has conducted eight market studies: Spain (2005, 2009 & 2013), Germany (2008), Poland (2006 & 2010) and the UK (2007 & 2012) (EUVEPRO, 2018). In France, the national association for plant protein promotion (GEPV) conducts a very detailed study every two year (see Box 23).

According to these market shelf surveys, the main uses for vegetable proteins in these Member States are in meat-based preparations (non-frozen) (especially in Poland with 50% of plant protein presence in these products in 2010), dairy-alternative products (especially in Germany, where 81% of all vegetable protein presence is in this category), soups, sauces & pasta, and in bread and baked goods (especially in France, see Box 23). In Poland and Spain, the second highest product category for vegetable proteins is vegetarian products (respectively 9% in 2010 in Poland and 19% in 2013 in Spain).

This data gives an insight into the main uses in terms of number of products, but not in terms of volume sold or value. Agri-food companies and experts interviewed[235] underline the fact that soya

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[229] http://www.euvepro.eu/content/vegetarian-vegan-products

[230] According to an expert from the European platform Improve, based on FAOstat and personal data.

[231] IMPROVE, based on business Insight data

[232] IMPROVE based on business Insight data and Schneider, A. and Huyghe, C. (2015) *Les légumineuses pour des systèmes agricoles et agroalimentaires durables.* Éditions Quae. based on USDEC data.

[233] GEPV, according to Business insight - Global protein ingredient market by value, 2012-2018 - 2014

[234] EUVEPRO is the European Vegetable Protein Association, representing the interests of manufacturers and distributors of vegetable proteins for human consumption (food) in the European Union.

[235] Representatives from IMPROVE, ENSA and a major plant-based food processing company in France.

bean and pea protein incorporated into meat preparations may be the main market segment in volume, although there is no data available to confirm it (high level of confidentiality on the meat sector). Although plant proteins only represent a low percentage of the final products, it concerns huge volumes of meat preparations.

According to various plant protein ingredient manufacturers interviewed, when plant protein ingredients started to develop in the EU, they were mainly used in meat preparation (e.g. minced meat) for their functional properties (e.g. water retention, appearance of the product, etc.). Other uses, especially in vegetarian food, have developed more recently.

Box 23: Market shelf analysis of plant protein-based products in France

In France, the association GEPV[236] conducts an analysis every two years of market shelves in France referencing the plant proteins in food products (see charts below). One specificity of these studies compared to the study conducted in other Member States, is that soya bean grains are excluded from the listed of ingredients studied. Also, the method changed between 2015 and 2017 and therefore numbers cannot be compared between the two periods (i.e. 1989-2013 vs 2017)[237]. Over the period 2009-2015, the use of plant proteins in food products rocketed in France (+ 500% references in supermarkets). According to GEPV data, the main uses of plant protein ingredients in France are ready-to-eat dishes (34% of the references containing plant protein ingredients in 2015), biscuits, snacks and cereal bars (25%) and bakery wares (15%). Among these uses, ready-to-eat dishes is the one experiencing the most significant development with an increase of 46% of the products containing plant protein between 2013 and 2015. This segment represented 5.9 billion € of turnover in April 2017 with an increase of +6.4% between 2016 and 2017 (GEPV, 2018)[238].

The biscuits, snacks and cereal bars shelf has also experienced a significant increase between 2013 and 2015 (+43%). Conversely, meat preparation and dietetic products have been rather stable over the period (increase of 1-2%) (Estève-Saillard, 2016).

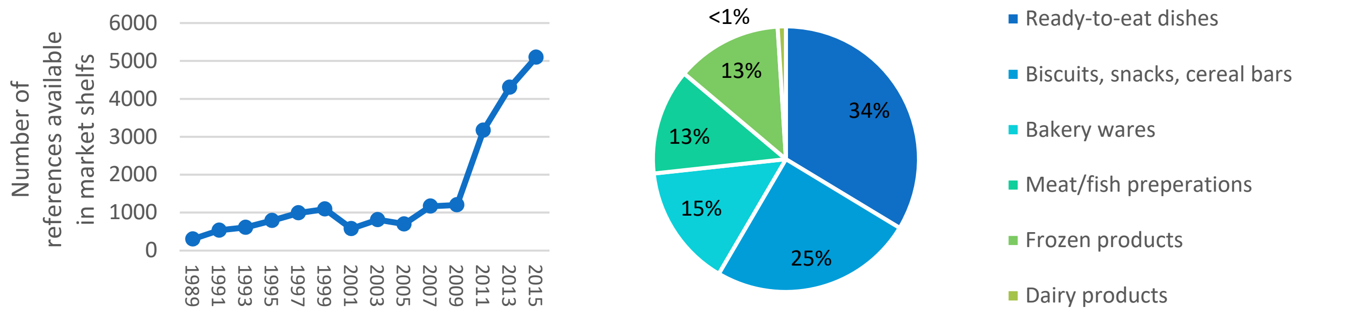


Figure 73: Number of references available in market shelves in FR 1989-2015 and distribution per type of uses in 2017 (GEPV, 2018)

Soya protein ingredients represent the main plant protein sources in the four Member States studied by EUVEPRO (i.e. DE, ES, PL and the UK). Soya bean and soya bean-based ingredients are present in more than 60% of food products sampled across all studies (EUVEPRO, 2018). In France, the main source is wheat followed by soya bean[239] (see Figure 74) (Estève-Saillard, 2016, GEPV, 2018).

[236] Plant Proteins Study and Promotion Group

[237] Around 20 stores were studied every two years over the period 1989-2015, while the 2017 survey is based on only 15 shops. Therefore the total number of references cannot be compared between the two periods.

[238] GEPV according to Iri, turnover stopped on the 02/04/2017 and including all circuits in hypermarkets and supermarkets.

[239] Conversely to EUVEPRO studies, soya bean grains are not included in GEPV studies.

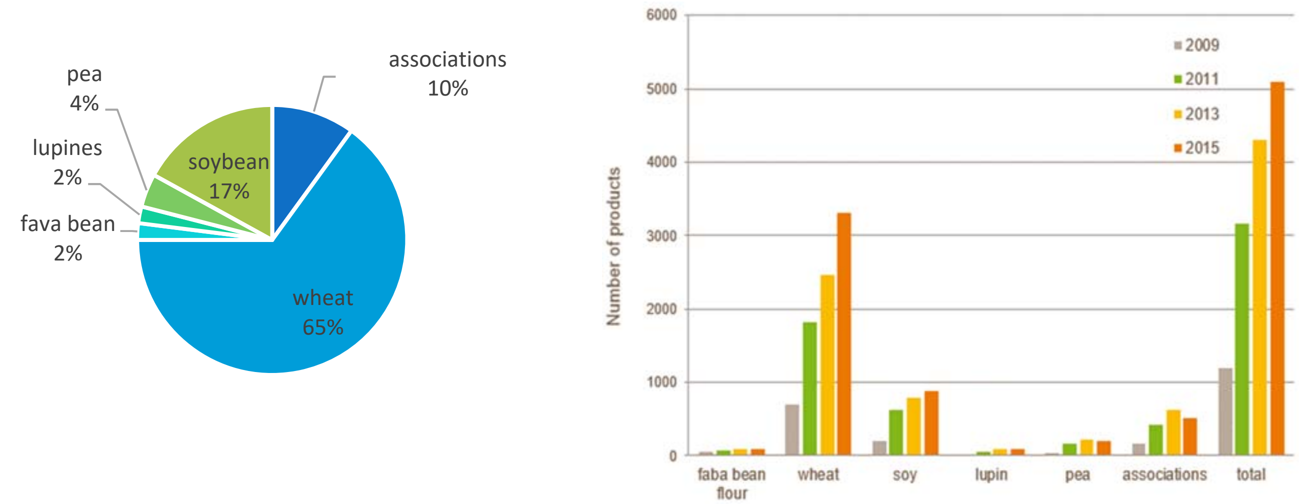


Figure 74: Distribution of plant protein products referenced in market shelves by type of crop in France (Estève-Saillard, 2016)

In the light of EUVEPRO and GEPV data, it seems that, among the PRPs addressed by this study, soya is the leading source of plant protein used in this market segment. In 2014, the main food products (in terms of volume and value) produced from soya beans by EUVEPRO members were soy flour, soy protein concentrates and soy protein isolates, for a total of 250,000 tonnes at 2 – 8€/tonne (depending on grade, from soya bean flour to soya bean isolates). Over the last five years, pea ingredients have also developed and are increasingly used by the food industries (according to an interview with a representative from EUVEPRO). One can notice some specific uses per source of protein. For instance in France, soya bean and pea proteins are mainly used in meat preparation, while broad beans are preferred in bakery wares and ready-to-eat dishes and lupines in bakery wares and dietetic products (Estève-Saillard, 2016). Even though pea protein uses are increasing, soya bean remains the main crop in term of range of protein ingredients produced (see Figure 75) (EUVEPRO, 2017).

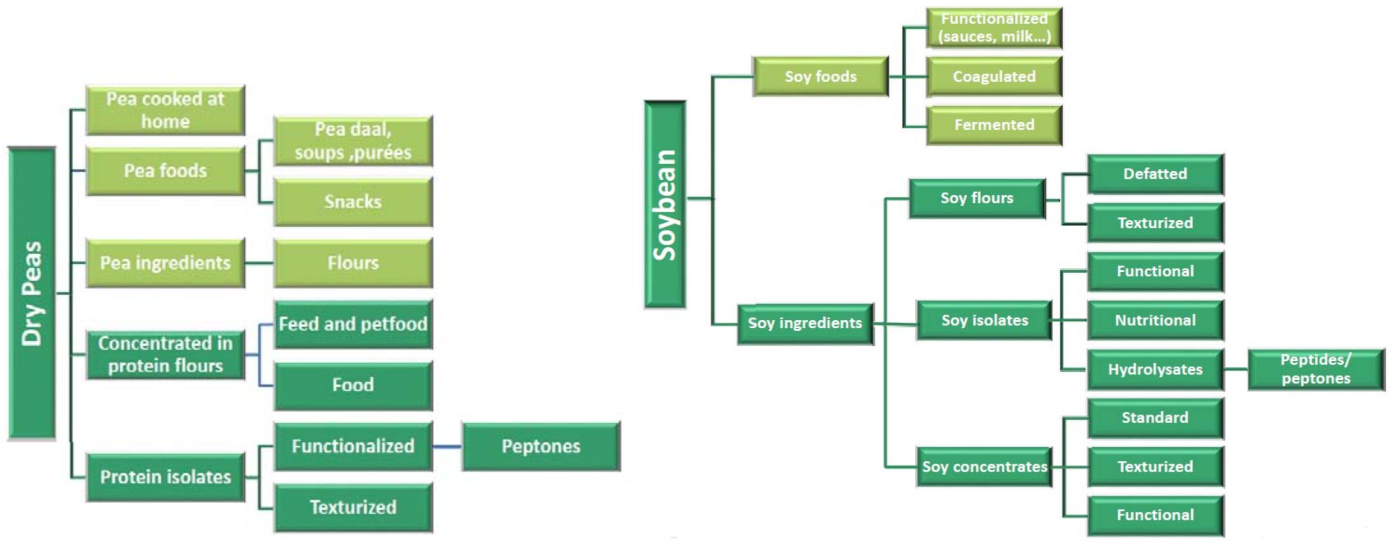


Figure 75: Range of soya bean and pea protein ingredients produced to meet the demand (EUVEPRO, 2017)

Various companies in the EU produce functional protein ingredients (e.g. textured protein, concentrates, isolates, etc.) from soya bean or pulses in the EU. There are some small or medium-sized companies (e.g. Sotexpro, etc.) in the EU but most of the volumes come from some major companies (e.g. Roquette, DuPont, etc.). According to EUVEPRO, which includes several of the main producers of functional plant protein ingredients in the EU, these companies are mainly located in Western and Northern EU (e.g. DE, FR, NL and the UK) and they mainly produce for the EU market[240],

[240] For international companies which also operate in other regions of the world, this only concerns their production in the EU.

at least for the share of the production that they produce in the EU (e.g. for Roquette, DuPont, etc.). However, according to interviews in France, EU food companies also import PRP functional ingredients from the world market. There is no consolidated data at EU level to assess the share of imports compared to EU production of functional plant protein ingredients.

With regard to the sourcing of PRPs to produce functional ingredients, there is also no consolidated data at EU level. However, interviews carried out with EUVEPRO members provide reliable insights. EUVEPRO estimates that 80% of the soya bean used by its members are imported. The situation is different for pea since most of the pea grain used by the members is produced in the EU. In many cases, it is produced near the plant where it is processed, and the supply is sometimes secured with campaign contracts (see section 4.2.2.1 about contracts).

Box 24: Pea protein ingredient production by the Emsland group in Germany

In Germany, the main food company producing pea ingredients in the Emsland Group. It is an internationally operating company that manufactures products for the processing industry based on potatoes and peas. In 2007 the company started processing peas to produce pea starch, pea protein and pea fibres. Since then the volume of peas processed by the Emsland Group has progressively increased (see Figure 76). Pea proteins can be used for food or for feed.

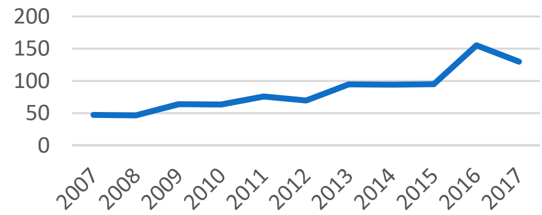


Figure 76: Pea Processing Volume of the Emsland Group 2007-2017 (1000 tonnes) (source: Emsland group)

The Emsland Group develops new market segments for the components of peas. The added value for these products is high, which motivates the interest from the company. Nonetheless, price remains relevant to be competitive on the world market. According to an interview with a representative, raw materials represent about 75% of the total costs. Therefore, pea prices play an important role in the profitability.

With regard to its sourcing of pea, the company organises the supply mainly with contracts in order to ensure a constant supply. As the volumes of individual farmers often are too small (per day the Emsland-Group needs about 100 ha of field peas), they use traders or bundlers to organise the supply. A share of the overall raw products is bought on the cash market. However, the Emsland-Group tries to establish three-year contracts with its suppliers.

Source: interview with a representative from the Emsland group

Interviews (EU-level and case studies) and the desk review did not highlight any major organic supply chain in the EU for these products, although one company[241] producing organic functional ingredients from soya bean protein has been identified. None of the EUVEPRO members have an organic value chain for the products under which they are affiliated within EUVEPRO. However, this does not necessarily mean that they do not produce organic products.

According to the GEPV market shelf survey in France, 4.3% of plant protein-based products identified are organic. It mainly concerns ready-to-eat dishes (41%), bakery wares (31%), biscuits, snacks and cereal bars (25%) and, to a lesser extent, frozen products (3%) (GEPV, 2018).

4.2.3.2 Main (economic) drivers of this segment for the different stages/players

Drivers of food companies using functional protein ingredients

According to interviews with GEPV and EUVEPRO representatives and the desk review, the main drivers for the use of PRP functional proteins in the food industry are:

- the improvement of the nutritional qualities of the products,
- the functional properties of PRP protein ingredients (texturing properties, etc.),
- the demand for meat alternatives,
- the price of PRP proteins, which is generally lower than animal proteins.

Plant proteins are generally cheaper than animal proteins and therefore can be used to reduce the production cost in meat products. As explained above (see section 4.2.3.1), protein ingredients are mostly produced by very large makers as the cracking of the plant proteins needs very specific know-how and significant equipment. These big companies are very limited in number and operate at global scales.

[241] Biolintech in France

Despite these drivers, the use of PRP protein remains limited by consumer eating habits and their perception of plant proteins compared to animal proteins (according to GEPV). Some consumers may perceive plant proteins as lower quality proteins compared to animal proteins. This risk may deter food companies from using plant protein in their list of ingredients.

Furthermore, protein ingredients are mainly incorporated into ultra-processed[242] food products (since most ingredients are already highly processed) which are generally associated with low diet quality and a higher risk of non-communicable diseases (obesity, diabetes, etc.) (Gibney et al., 2017). More and more consumers are aware of these health and nutrition issues (Ares et al., 2016) and, even though plant proteins are generally perceived positively (GEPV, 2015), it may impact the demand for ultra-processed food in the future.

Drivers of food companies producing functional protein ingredients

Regarding the companies producing PRP functional ingredients, their main driver is the demand from the food industry (i.e. the users of the functional ingredients). However, the market of functional proteins is a global market. Therefore, EU companies must be competitive on the world markets.

Similarly to the other food market segments, the availability and security of the supply is a major driver. However, the food companies producing and/or selling functional proteins based on soya bean generally manage to secure their supply with imports of final products (e.g. concentrates or isolates). For soya bean, one major driver is the non-GM character of the grains imported, which must be IP.

For peas, it is the opposite as most of the companies (e.g. Roquette in France and the Emsland group in Germany) buy the peas in the EU and are developing campaign contracts with local collectors to secure their supply.

Another characteristic of this market segment is the need for know-how to produce functional ingredients. Food companies need to have a good knowledge of the nutritional and technological characteristics of pulses and soya bean proteins and of the technological processes to extract proteins. Soya bean protein has been widely studied, but knowledge gaps remain for pulses[243].

Box 25: Examples of research and development projects to develop the processing of soya bean and pulses for food

Across the EU, various public and private organisations are involved in research and development programmes to improve the processing of soya bean and pulses for food.

In Germany, a project is funded by the German Federal Ministry of Food and Agriculture to enable a broader application use of field beans in the food sector. The objective of the project is to reduce the anti-nutritive substances (field beans are hardly used in the food sector because of the high level of anti-nutrients) and produce meal and concentrates based on field beans that can be used as valuable ingredients in the food industry. The project is named “Increase the nutritional quality of faba bean flours and concentrates by reducing anti-nutritional ingredients (*QualiFabaBean*)”. It started in June 2017 and will end at the end of January 2020 (Föste and Mittermaier, 2017).

Furthermore, in Germany, the *Frauenhofer-Institut für Verfahrenstechnik und Verpackung* (Institute for processing technology and packaging, IVV) has developed a process to texturise pea protein products and obtain a mouth feel of the products that is very similar to that of meat (according to experts in new developments on the markets for field beans and field peas).

In France, the company IMPROVE offers its services to the food and feed companies to carry out research (e.g. market study) and characterise their raw materials. They work on seeds, roots, leaves, microorganisms and insects as well as on ingredients. They can simulate or develop dry or wet processes to produce protein concentrate, isolate or hydrolysate and they can carry out compositional, functional, nutritional and organoleptic characterisation.

Source: case study interviews in Germany and France and with the ENSA organisation

Research and development is also essential to innovate and develop new products which can respond to future demands of the food industry.

Summary of the main drivers

[242] The NOVA classification of foods proposes 4 categories: unprocessed or minimally processed foods, processed culinary ingredients, processed foods, and ultra-processed foods and drinks (UPFDs). It is argued that the latter relies heavily on modifications to foods, resulting in enhanced amounts of salt, added sugar, and fat as well as the use of additives in an attempt to make this food category highly palatable Gibney, M. J., Forde, C. G., Mullally, D. and Gibney, E. R. (2017) 'Ultra-processed foods in human health: a critical appraisal.', *American Journal of Clinical Nutrition,* 106(3), pp. 717-724..

[243] According to an interview with an expert from the EU platform IMPROVE

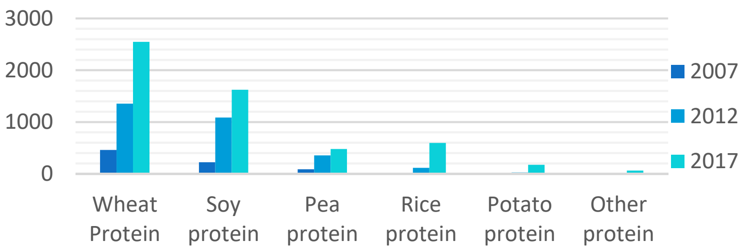
This market segment includes PRP functional ingredients used by the agri-food industry. Unlike the two other market segments described in the food chapter, the decisive user is not the final consumer, but the agri-food industry (B2B marketing). The main drivers of the agri-food industry buying these products are related to the functional and nutritional properties of PRP proteins as well as their price (which is generally lower than animal protein). Similar to the other food market segments, the availability of the supply is also a driver, but it can be easily managed with imports since the origin is generally not a constraint. However, the use of PRP ingredients in food products can be limited by the risk of a negative perception from the consumers of plant proteins compared to animal proteins.

The main drivers of the companies producing or selling PRP functional protein (which are mostly big firms) are related to the demand from the food industry and to their supply in PRPs. For soya bean ingredients, local sourcing is generally not part of their marketing strategy. Hence, they work mostly with commodities (e.g. concentrates and isolates) bought on the world market but GM-Free for soya bean. Conversely, pea ingredients are often produced from EU peas.

4.2.3.3 Outlook for the market segment of functional protein ingredients

As explained in section 4.2.3.1, the plant protein ingredient sector has developed over the last decade (with a compound annual growth rate of 8% between 2013 and 2018[244]).

Data about new products launched on EU markets gives a good insight into the trends on the market. According to a market analysis from EUVEPRO, more than 2,000 new products made from soya bean or pea proteins were launched in the EU in 2017 (see Figure 77). In 2017, the U.K., France, Germany, Netherlands and Spain launched the highest number of new products with plant proteins (including products made from wheat or rice proteins); Denmark, Ireland, France, Croatia and Italy show the fastest growth. Overall, the bakery, meat, fish & eggs, ready meals, cereals and sports nutrition categories are the categories with the highest number of new products with vegetable protein, while the soft drinks, desserts & ice cream, baby & toddlers, sports nutrition and fruit & vegetable categories show the fastest growth in vegetable protein application. According to the study, the main markets of opportunity for vegetable protein are: bakery in France; meat, fish and eggs in Spain and Germany; ready meals in France; and cereals in the United Kingdom.



CAGR	13.5%	8.4%	6.3%	39.4%	48.4%	59.5%

Figure 77: Number of new Food and Beverages tracked with vegetable protein by protein type (EU) 2007-2017 (Source: Personal communication from EUVEPRO)

One can also observe that even though soya bean is by far the main PRP used on this market segment (wheat is not included in the scope of this study), pea protein ingredients have developed fast over the past five years and are present in many new products launched. According to a representative from EUVEPRO, the development of pea protein ingredients is linked to an increasing demand from the food companies to review their formulation.

This demand may be driven by various changes such as the development of the gluten-free diet, the increasing demand for vegetarian and vegan products (from traditional consumers, as well as flexitarians), and the rising demand for high protein food. Consequently, food companies are investigating how to increase their incorporation of plant protein ingredients in their products. According to the same source, some years ago, pea protein was not competitive compared to soya bean. But improvements have been made and now it can replace soya bean proteins in some food products.

Even though there is still no mature market for rapeseed and sunflower proteins in food, many research projects are being carried out to develop their use (Estève-Saillard, 2016, Dahlberg, 2017). According to oilseed experts interviewed in France[245], the EU could be the first region in the world to produce sunflower and rapeseed concentrate for food uses.

[244] GEPV, according to Business insight - Global protein ingredient market by value, 2012-2018 - 2014

[245] From Terres Inovia

According to the literature and experts interviewed, the use of pulse ingredients (e.g. pea concentrates) is bound to increase in the future, especially in combination with cereals. Their association may lead to new applications meeting both the sensory and nutritional needs of consumers (Sozer et al., 2017, Magrini and Lascialfari, 2016, Gueguen et al., 2016).

Some emerging uses of PRP-based ingredients are developing, especially in specialised food (e.g. sport food, dietetic food, baby food, etc.) and may become major outlets in the future (Gueguen et al., 2016).

Table 28 presents the market development stages of the different PRP-based ingredients according to EUVEPRO.

Table 28: Market development stages of the different plant protein ingredients according to EUVEPRO

Market development stages	Introduction	Growth	Maturity	Decline
Soy protein		- Textured soy flours and concentrates - Hydrolysed protein - Peptides/peptones	- Functional isolates and concentrates - Soy foods - Feed soy concentrates and isolates	- Technical isolate - Defatted soy flour
Pea protein	- Textured pea protein - Functionalised isolates	- Pea isolates - Pea concentrates - Functional pea flours		- Pea foods and ingredients - Peas cooked at home
Other proteins	- Other oilseeds - Ancient grains - Canola - Pumpkin	- Potato - Microalgae - Lupine - Fungi - Oat	- Wheat gluten	

Source: EUVEPRO, 2018

One can observe in the table above many sources of proteins which are being developed and may replace soya bean in many products in the future. For instance, the use of mycoproteins to produce meatless meat has seen a tremendous increase over the past few years and shows good potential for the future.

Furthermore, EU producers of plant protein ingredients must face the concurrence of other companies on the world market (e.g. ADM, Roquette, etc.).

The market segment could also be threatened by an increase of the mistrust of consumers for ultra-processed food (see section drivers above). Some consumers seem to show an increasing interest in low-processed food which could be at the expense ultra-processed due to its negative impact on nutrition and health (Ares et al., 2016, Magrini and Lascialfari, 2016).

4.3 Drivers at the PRP producer level (crop farming) of both feed and food markets

Producers are a particular case in this analysis and as a consequence treated in a single paragraph, independently from market segments. They are crucial economic agents for the development of PRPs in the EU and they produce (or will produce) them only if the economic return is sufficient and if the risk is not too high. If the crop fails, the farmer can generate a negative margin for a given parcel/crop and then lose part of its annual revenues, while the supply chain downstream will most often manage to find another source to satisfy its demand. This point is very important for the development of EU-produced PRPs, as the relative low yields of PRPs (and their variability) compared to cereals and the resulting limited margins are barriers that significantly influence the decision of farmers to produce, or not, PRPs.

When planning crop sowing and rotation management, farmers take into account three main economic drivers:

1. The expected margin vs other crops, based on decisive criteria such as: risk management, time allocation, rotational benefits, etc.
2. Potential support measures related to a given crop. Currently, main measures are Voluntary Coupled Supports that can exist in some member states for some PRPs (cf. chapter 5).
3. The existence of accessible, viable and profitable markets to sell the harvest (including on-farm self-consumption for mixed farms).

These main criteria are developed below, bearing in mind that most of them apply both to the feed and food sectors. When differences among these segments exist, they are mentioned.

4.3.1 Expected margin vs other decisive criteria

4.3.1.1 Gross margin

As explained in EQ 3, CAP measures may impact farmers' cropping patterns for PRPs. However, these effects are generally limited at EU level (but significant effects may be observed at regional levels) (see EQ 3). Farmers' planting decisions are ultimately based on crop or rotation margin expectations.

There is a great range of gross margins for PRP crops and their alternative crops across the EU. Gross margin depends on production (sales and subsidies) and direct costs (inputs: fertilisers, pesticides, seeds). In addition, farmers take mechanisation and labour cost into account when comparing crops (then incorporated in the net margin). Experts and scientists interviewed reported that gross margins of PRPs are often too low compared to their main alternative crops such as wheat and maize, although input costs are often lower (see Table 29).

Table 29: Gross margins for studied protein-rich crops in 4 case-study countries (2015[246]) (€/ha).

€/ha		DE[247]	ES	FR	PL[248]
PRPs	Broad and field beans	148			215
	Field peas	202	133	680[249]	
	Lentils			500-600[250]	
	Sweet lupine				186
	Rapeseed	854	712	700	759
	Sunflower (irrigated)		412	350	
	Soya bean			310	
	Alfalfa		912	600	
Cereals	Barley (irrigated)		415		
	Maize (irrigated)		804	739	431
	Wheat	617[251]		780	682

Source: case studies

[246] Except for France and Germany, where the data corresponds to the year 2017

[247] The data refers to gross margins in Saxony-Anhalt in 2017

[248] According to Skarżyńska A., Production Costs and Incomes in the Production of Selected Crops in 2015-2016 – Results of the Research Under the Agrocosts System, (orig. Koszty jednostkowe i dochody wybranych produktów w latach 2015-16 – wyniki badań w systemie AGROKOSZTY) Zagadnienia Ekonomiki Rolnictwa, IAFE-NRI, Warsaw, 2017.

[249] This particularly high gross margin is linked to the fact that this data was provided by a major collector supplying the food industry in France (therefore at a higher price than feed).

[250] Excluding lentils grown under PDO/PGI.

[251] It refers to wheat with a cereal as a preceding crop

Among the different PRPs, oilseed crops generally have gross margins lower than those for cereals, except for rapeseed[252]. The gross margin of pulses is generally lower although it hides significant discrepancies. Pulses such as field peas and beans show low gross margins for feed outlets while food markets can provide high selling prices, especially through label of origins[253]. Such examples also exist for other crops such as soya bean produced in the EU in specific value chains, which can benefit from prices almost double that of their equivalent imported product (source interview ENSA 2018). It shows that gross margins can be highly different depending on the value chain in which the grains are sold.

Regarding legume fodders, it is difficult to compare the margin as they are mostly self-consumed on the farm (cf. box 26 for the case of pluri-annual legume fodders). For dehydrated legume fodders that are more cash crops, the margin is also lower than cereals or rapeseed. However, the crop effect on the following crop can compensate for this difference (see § 4.3.5.3).

Gross margins presented in Table 29 are inherently linked to their local context and it inevitably introduces a bias in the comparisons. To properly compare margins from one crop to another, it is interesting to compare them with all other things being equal, meaning in a homogeneous agronomic and economic way. Therefore, Figure 78 provides data that was compiled using data provided by an accountancy management centre in Northeast France. This accountancy centre is showcased here because it was the only one identified during case studies that internalises crop effect (rotational benefits on the following crop) in the legume crop gross margin.

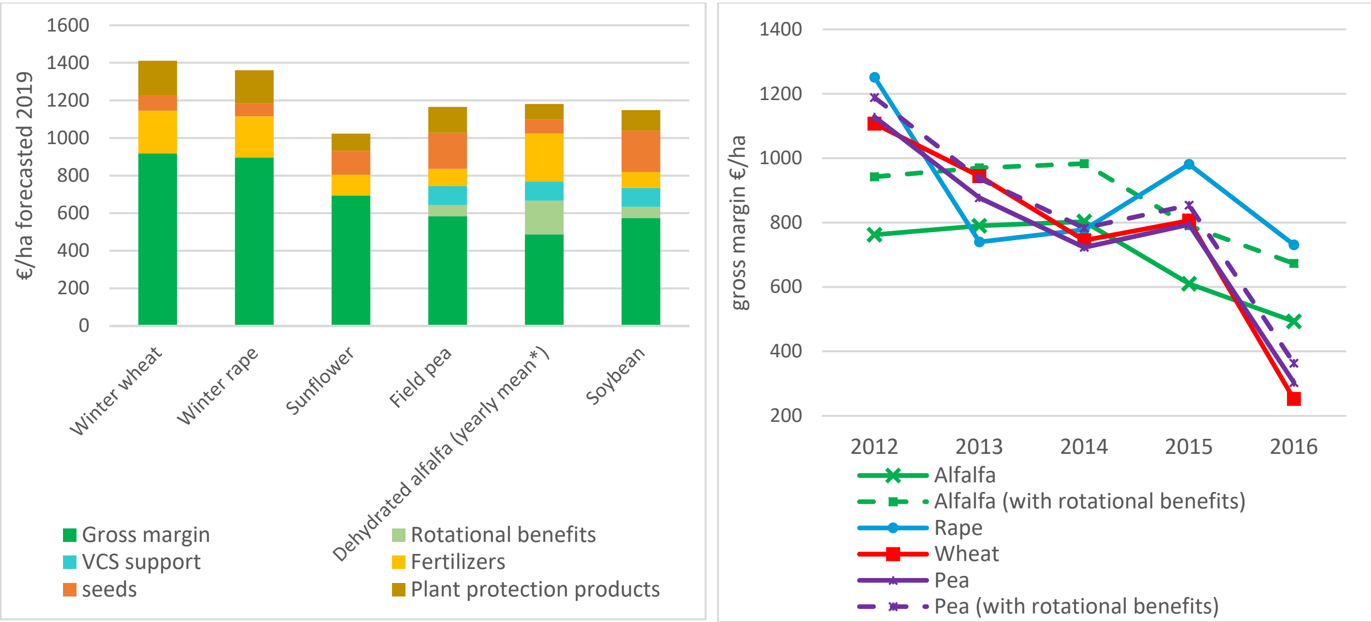


Figure 78: Comparison of gross margins and significance of monetized rotational benefits for the main crops in Champagne area in France (CDER, 2018)

**For alfalfa, which is a perennial crop, it is considered that 50% of the area is grown 2 years and 50% 3 years.*

Figure 78 demonstrates clearly the margin differences between wheat (main crop in the area) and the studied PRPs[254]. With a margin nearly equal to that of wheat, winter rape shows a high margin and is the only exception. For the remaining PRPs, the margins are much lower, resulting in a negative opportunity cost for legume crops. It also underlines the cost of seeds, especially for soya bean and field peas.

It should also be noted that the value of a crop can modify the relative value of other crops. For example, the legume futures book (Murphy-Bokern et al., 2017) stresses that if the farm price of soya bean is more than about twice that of wheat, soya bean becomes competitive with wheat in some regions of the EU. This ratio ultimately depends on the base price of protein compared with starch, set mostly by the world price of wheat, maize and soya bean. This is also true with maize, which is often the alternative crop to irrigated soya bean. Current soya bean prices can be high enough to make it

[253] For example, lentils that are sold 500 €/t in average in France, can reach 2000€/t (and 2500€/t in organic) when labelled through a label of origin (FR case study ANILS, 2018). See also Box 14.

[254]VCS support. Given the clear impact on the margin, VCS support was added to the calculation.

competitive against wheat or maize in many parts of the EU but this can change. As a result, some value chains (e.g. Sojadoc in FR, see Box 19) have linked their campaign price of soya bean to maize price in order to avoid farmers switching to maize in case of high prices of maize a given year and thus putting the supply chain in difficulty.

The price of nitrogen fertilisers can also have an impact on the relevancy of sowing LFs or not. When N fertiliser price increases, farmers may be more likely to favour the use on N-fixation to produce protein, instead of synthetic fertiliser application. For example, Humphreys et al. (Humphreys et al., 2018) have identified a tipping point in the ratio of fertiliser nitrogen price and the farm-gate price of milk in Ireland. When the ratio of the cost of 1 kg of nitrogen to the price of 1 kg of milk exceeds about 3, grass-white-clover-based production (mixed pastures) tends to be no longer economically disadvantaged[255].

Box 26: The specific case of legume fodders

This box focuses on legume fodders as among PRPs, legume fodders are quite specific: they are pluriannual, provide fibre along with proteins and are exclusively grown to feed herbivores, are mostly produced on-farm to feed farm cattle, etc. Given these features, it can be hard to address them in the same way as other crops. A wide spectrum of forage legumes is available to livestock farmers: white clover, red clover, crimson clover, Egyptian clover, Persian clover, sainfoin, alfalfa, etc. Animal farmers can have various reasons to use them:

- feed management: local source of proteins, high protein yield per ha, animal health management;
- agronomic benefits: reduction of N fertilisers, crop effect and better drought resilience than fodder maize.
- tool to diversify and secure feed systems (more autonomy and thus resilience to market fluctuations) and production cost, including price variability management,
- Compliance with regulations (climate change, biodiversity, diversification, etc.).

Despite these assets, the main barriers to legume fodder use by animal farmers are crop management cost and working time. For example, the production cost of alfalfa from sowing to warehouse (including mechanisation, handling and 23% of losses) is about 150€/tonne (Bossis et al., 2016). Obviously, this production cost depends on yield: an alfalfa producing 7t/ha will cost 160€ for one stored tonne instead of 120€ with a yield of 13t/ha. Regarding manpower needed, 11 to 15 hours are needed to manage one hectare of alfalfa compared to 8 to 10 hours for maize silage or 6 to 8 hours for Italian Ryegrass which is cut twice in a year (versus 4-5 times for alfalfa). In terms of labour cost, it can result in significant differences (cf. 4.3). Conversely, it should be noted that the number of cuts spread out over a long period make farmers more resilient to climate hazards.

Table 30: Comparison of labour time and cost to manage an alfalfa vs maize silage and a temporary grassland in a French context in 2016.

	Alfalfa	Maize silage	Italian ryegrass
Labour/ha (h/ha)	11-15 hours	8-10 hours	6-8 hours
Labour cost (€/ha)	290 €/ha	220 €/ha	200 €/ha

Source: (Bossis et al., 2016)

4.3.1.2 Rotational benefits and effects on margins

The economic performance of cropping systems is relatively complex, and the real economic performance of legumes is higher than what conventional gross margin analysis indicates. It means that the potential for economically competitive legume production is probably not fully exploited, as indicated by many authors (Schneider and Huyghe, 2015, Murphy-Bokern et al., 2017). When cultivated, PRPs contribute to rotational diversification and have various rotational benefits. The highest crop-effect is obtained through the cultivation of N-fixing crops (pulses, soya bean, and legume fodders) because they generate significant fertiliser economy for the following crop. Some authors (Brisson et al., 2010) criticise yearly accountancy management and underline the probable impact of the reduction of pea incorporation in wheat rotations. They estimate that it generated a drop of 0.42t/ha of wheat yield between 1996 and 2006. It can also positively influence wheat protein content (CELETTE. and COHAN., 2016), which is a critical market criterion for wheat markets (bread-making needs a high protein content)[256]. Figure 78 shows that when crop effects of legume fodder are internalised in the margin calculation, then legume crops appear more competitive. For example, for

[255] Nonetheless, it should be noted that this factor is not valid in areas with high nitrogen load (areas with high livestock density) where nitrogen sourcing is not an issue, given the excessive organic nitrogen load to be dealt with.

[256] It must be noted that even if rotational gross margins show the value of legumes in rotations, most farmers continue to make their decision on the annual gross margins and without internalising crop effects.

alfalfa, crop effect reaches 180€/ha, even though herbicide savings are not considered in this estimation[257]:

- 80€ related to wheat yield gain (+0.3 to 0.4t/ha) and fertiliser savings (40kg N/ha, that being 20% savings).
- 50€ of fuel saving at rotational level (alfalfa requires fewer crop operations) and a related 50€ reduction in machinery maintenance.

To a lesser extent, this crop effect is also observed with other legumes, as highlighted in Table 31 for pea and soya bean.

Table 31: Estimated preceding crop effect of preceding legume crops

Preceding crop:	Pea		Soya bean		
Crop:	Wheat	Rape	Maize	Wheat	Durum wheat
Average yield gain	+0.74 t/ha on average compared to preceding cereal	+0-0.3 t/ha compared to preceding barley	+0-0.8t/ha compared to preceding maize	often +10%	+2.34t/ha on average compared to durum wheat single cropping
N fertilisation reduction	-20 to -60kg N/ha compared to preceding cereal	-30 to -60 kg N/ha compared to preceding cereal	-30 to -40kg N/ha compared to preceding maize	No reduction in general	No reduction in general

(Schneider and Huyghe, 2015)

Murphy-Bokern, Stoddard, and Watson 2017 have also described that in a crop rotation with wheat, barley and sugar beet, the rotational margin increases from 686€/ha to 748€/ha when the portion of legume passes from ≤ 10 % to ≥ 25%.

Although it is not provided in Table 31, legumes also have a significant effect on the use of plant protection products (PPPs) at rotation level, helping to reduce PPP cost. An experiment (POURCELOT et al., 2014) conducted on 300 farms during three campaigns shows that the number of PPP treatments on farms having legumes is lower by 7 to 13% according to the campaign (5 to 13% for herbicides and 13 to 19% for other PPPs). The experiment also shows legume cropping has no impact on productivity and profitability.

4.3.2 Variability and risk management

Part of the difference in gross margins can be explained by the yield gap between the main alternative crops and PRP crops, especially pulses. The yield gap combines two factors: high variability and productivity gap compared to other crops. Experts interviewed report that overall, increases in average pulse yield have not kept pace with cereals. The EIP-Agri focus group on protein crops (SCHREUDER and VISSER, 2014) tried to quantify the yield gap based on price levels and the content of protein, starch and oil (see Table 32).

Table 32: Yield increase needed to match the wheat crop value based on price levels of starch, protein and oil

		Soya bean	Rape	Sunflower	Lupine	Field pea	Broad bean
Compared to:	Wheat	51%	13%	14%	155%	82%	73%
	Maize	116%	60%	93%	290%	176%	161%

Source: EIP Focus group on Protein, Schreuder and Visser. 2014

This table reports the calculated difference between the current yield level and a theoretical competitive yield level: the benchmark yield gap, either for wheat or maize. The experts from the EIP focus group reported that the benchmark yield gaps are partly caused by the relatively few investments made in the past decades in developing these protein crops in comparison with wheat or maize, especially in plant breeding (older and fewer varieties available on the market, as underlined in

[257] Because they are not a dominant crop in current rotations, PRPs contribute to diversification and thus help to break up weed cycles, generating herbicide savings for the following crops (mostly cereals). This is especially true for alfalfa which is a perennial crop generally grown from 2 to 4 years.

Table 33). Although such results should be interpreted carefully[258], they provide an overall idea of the yield gap to bridge in the future to make PRPs more competitive in the EU.

In addition, for oilseeds such as soya bean, rapeseed and sunflower seeds, the protein production in seed cakes is associated with a certain amount of oil that can be marketed. Conversely, starch-based seeds, such as pea and field bean produce starch which is abundantly available (e.g. through wheat, maize, potatoes, etc.) and has a lower price than oil.

Table 33: Diversity of varieties used and age of registration for PRPs (+wheat for comparison) in France

Crop	Number of varieties to reach 75% of the market	Average year of inscription of the varieties
Common wheat	45	2011
Field bean	6	2008
Lupine	3	2005
Alfalfa	21	2005
Field pea	9	2013
Soya bean	13	2011
White clover	15	1999
Red clover	19	2001
Common vetch	12	2003

Source: GNIS, personal communication

It must also be reported that most of the experts interviewed emphasised the fact that yields of protein-rich crops, especially pulses, are more variable than those of cereals such as wheat, barley and maize. They are particularly vulnerable to disease such as weevil (especially on pea and field bean) and root rot on field pea (*Aphanomyces euteiches*). This variability is a key factor at farm level as margin forecasts become a perilous exercise. Price variability comes on top of yield variability and is another key factor hampering margin forecasts.

The ability to sell the production in a feed or a food market, which greatly depends on final product quality (e.g. impact of pea and bean weevil on grain aspect[259]), also increases the margin forecast uncertainty. Conversely, soya bean and rapeseed markets, like cereal markets, have a high liquidity and the existence of futures markets allows farmers or their collectors to hedge.

4.3.3 Existence of accessible and viable markets to sell the harvest

Unless it is produced for on-farm feed consumption (see section 1.3.1.2), crop profitability also depends on the outlets that are available to farmers. Profitability is driven by key factors such as:

- Market types: feed, food, other,
- Labelled/premiums: designation of origin such as: crop directly or to be used as feed for animals integrated in a PGI/PDO/TSG, traceability (GM-Free), organic, etc.

For commodities (mainly soya bean, rapeseed and by extension sunflower in this study), prices are driven by the world market. Some of them can benefit from futures markets (see section 1.3.1.3) which helps both producers (or collectors) and buyers to respectively secure their production and supply (MATIF for rapeseed and CBOT for soya bean). Farmers may use MATIF and CBOT prices as references to make their cropping choices.

[258] There are important remarks to be made to interpret these figures. Processing and logistical costs are not included. Next, the protein price used for soya refers to soya meal (feed price). Protein concentration and quality (amino-acid profiles) are very important parameters which are not taken into account.

According to scientists interviewed in INRA, another important and natural factor explaining the yield gap lies in the fact that N-fixing crops, even with significant breeding improvement, will hardly reach yield levels of cereals. Actually, fixing atmospheric nitrogen requires energy from the plant, hence hampering the yield. Non-N-fixing crops, and especially cereals or rapeseed, can reach higher yield because farmers include synthetic N-fertilisers. This energy need is then outsourced to the industry (Haber-Bosh process) which produces N-fertilisers using fossil fuels (methane mainly). In order to temper hurried conclusions, this global perspective should be carefully considered when addressing the yield gap.

[259] In the past years, the development of some diseases has significantly hampered some food markets. For instance, broad and field bean production has been impacted over the last few years and this has undermined the French exportation to Egypt (which used to be a major outlet, with 246,000 t exported in 2010-2011 compared to 6000 t in 2016-2017) (according to La France Agricole no. 3745 – 27 April 2018). According to a representative from GEPV, these productions have been sold as feed mainly for aquaculture in Norway, at a lesser price of course. This situation naturally led to a decrease in price by around half.

In addition to futures market for the commodities, productions are also sold based on campaign contracts between farmers and collectors on the one hand, and collectors and buyers on the other hand (generally agri-food industries, but also feed manufacturers in some cases[260]). More details about these contracts are given in the food chapter.

The production can also be sold without any contractual relationship on spot markets, at current day price on a reference market, or on informal markets.

Box 28 presents the main markets (i.e. futures market, forward market based on campaign contracts or spot market with no contract) preferred by farmers for pea, rapeseed, sunflower and soya bean in the Member States case study. Box 27 details the different outlets available to farmers that sell forage legumes. Summary of drivers at the level of PRP producers

- **Box 27: Main markets used by farmers for pea, rapeseed, sunflower and soya bean in the Member States case study**

In three of the five main producing Member States[261] (i.e. FR, ES and DE), pea grains are mainly sold on spot markets when they are sold for feed. However, when they are sold for food, the food companies tend to develop campaign contracts with collectors, which may then sign campaign contracts with the farmers to ensure their supply (and to be able to honour their contract) (e.g. the Emlands group in Germany and Roquette in France try to set up campaign contracts with local collectors).

Regarding rapeseed and sunflower, some farmers may use futures markets (e.g. in FR and DE) but it is not common (hedging is managed by the collector to ensure a stable and high price for the farmer). According to case studies in FR, ES, DE, PL and RO, the production is mainly sold based on campaign contracts (in which quantity and quality are specified, but not necessarily the price, which can be spot price at the time of delivery) with the crushing plants or on the spot market. In Poland, according to interviews with experts, almost all production is sold through contracts with crushing plants or traders. In Romania, many farmers prefer to keep a share of their production for the spot market in case their yields are lower than planned (e.g. because of a drought) and they are not able to fulfil the contract (in this case the production reserved for spot is delivered to fulfil the contract).

Regarding soya bean, the interviews in the case study Member States[262] did not report any cases of soya bean produced in the EU which would be sold on futures markets. EU-produced soya is GM-free and therefore is exchanged at higher prices than commodity prices.

Dehydrated alfalfa is sold based on contracts with the dehydration plant which can be of three types: (1) quantity contract (the farmers gets a price in €/t, established before delivery and at a reference humidity content), (2) surface contracts (the farmer is committed to cultivating a given area of alfalfa) and the price is set at the end of the campaign or (3) land rental contracts (farmers rent their land to the plant, which manages the crop from sowing to harvest). If the production is self-consumed (given back to the breeder after dehydration), the producer will pay.

Source: Case studies in DE, ES, FR, IT, PL and RO

Box 28: The specific case of dehydrated fodders markets and variations across MSs

Part of the production of legume fodder (mostly alfalfa) is dehydrated in dedicated plants, meaning that producers outsource the drying to a mutualised tool (often cooperative, especially in FR and DE). Alfalfa for dehydration is cut in the field like any fodder that is not directly grazed. However, after a pre-drying phase in the field, it is windrowed and transported to a fodder processing plant by dump truck or transported by farmers with fodder wagons. Then it goes through the processing plant drier (trommel), which dries the fodder out with a 300ºC air flow. Final product moisture ranks between 12 and 14%.

To grow and sell the alfalfa to the dehydration plant, different paying schemes exist depending on the countries. These differences are detailed here for the three main producing MS, which account for about 90% of the European production (source: CIDE):

Spain: this country has about 70 dehydration plants in seven autonomous communities, even though 85% of plants are concentrated in the Ebro valley. About 75% of the area is irrigated. ¾ of plants are private and ¼ are cooperatives. The farmers sow, manage the crop, harvest it and bring it to the plant while the plant dries the residual water (low level given Spanish climate). The large majority (85%) of the alfalfa is collected and transported by fodder wagons by the farmers, while the remaining 15% is chopped and collected by forage harvesters and transported with trucks to the plant. A price is often proposed to farmers before starting the campaign, meaning that the price must be competitive enough to make sure that enough alfalfa will be grown to sustain plant capacity and market expectations.

France: the great majority of dehydration plants are cooperatives, mostly in the *Grand-Est* region (specialised

[260] E.g. the feed manufacturer Sanders which buys local soya bean in Western France as explained below.

[261] Lithuania and the UK are also among the main producers in the EU but they are not covered by the case studies.

[262] Soya bean was studied in the framework of three case studies: in France, Italy and Romania.

crop farms) and in Western France (mixed farms). The farmer sows and manages the crop until the harvest while cooperatives harvest the alfalfa, dry it and take care of the market outlet (or given back for mixed farms). The price is set after the harvest, meaning that if farmers sow alfalfa in August 2018, they will know the price in June 2020, right after the general assembly of the cooperative. The delay is particularly long, especially compared to annual crops such as wheat where the farmer often knows the price before sowing. To reassure farmers, cooperative are increasingly guaranteeing a minimum price to the farmers before sowing.

Italy: fodder dehydration happens mostly in Emilia-Romagna, Venetia and Marche. Dehydration is mostly carried out by private plants. Regarding crop management, the system is closer to the French one: the farmer sows and manages weeding and fertilisation, and the dehydration company manages field pre-drying, harvest, dehydration and commercialisation. The dehydration company takes most of the financial risk by ensuring a minimum price to the farmers before sowing. They can also guarantee a minimum price per ha and manage every single field operation, from sowing to harvest. This last system would represent more than one-third of the area grown for dehydration.

For most of the dehydration companies, alfalfa is paid according to the number of tonnes collected, meaning that the quality (e.g. protein content) is not included in the unit price calculation. This aspect negatively affects protein level of EU alfalfa (compared to alfalfa from competitors such as the U.S.), because the protein content is inversely correlated to the dry matter produced per ha (the later alfalfa is cut, the drier matter is produced and the lower the protein content is).

Source: CIDE and case studies in ES, FR and IT.

Crop competitiveness

The ability to substitute another crop and the underlying need for a given crop to be more competitive than others is an important factor. The farm area can be compared to a small market on which crops compete against each other. In all cases, developing one type of crop (e.g. legumes) will automatically lead to the reduction of others (e.g. cereals). PRP competitiveness covers a wide variety of situations. Oilseeds, especially rapeseed, generally have the highest margin, close to cereals. The trend shows that the gross margin ratio soya bean/wheat and soya bean/maize are increasing at a regular pace, making soya bean more and more profitable against its main crop competitors. Peas, field beans and alfalfa generally have the lowest gross margin. Pulses dedicated to the food market can generate high margins (up to 1000€/ha) in some GPI/PDO. PRPs are of high interest in agronomy, particularly legumes that produce their own nitrogen and provide some benefit to the following crop (e.g. wheat in yields and quality). Positive economic effects of PRPs have been proven at crop rotation level but accountancy systems hardly report it. Variability of yield and quality is a strong barrier to the development of the cropped area of pulses and long-term outlets.

Ability to find a profitable outlet and price risk management

Outlets for selling oilseeds and dehydrated legume fodders are generally supported by contracts in the value chains. This is not the case for pulses for which a wide variety of situations exist from high difficulty selling (low quality related to pests) and low prices (feed outlet), to IGP/PDO product with no difficulty selling and guaranteed profitability. The variability of the demand is another barrier to the development of pulses, especially to structure value chains in the feed sector, given the high competition with food outlets, which are more lucrative but facing inter-annual fluctuations in demand. The ability to sell through futures markets or campaign contracts (thereby hedging possibilities) is also a key point that hampers the development of PRPs. Access to the legume fodder market is difficult if there is no dehydration plant in the vicinity. Many producers would grow it for agronomic reasons, but they cannot find market outlets and drying facilities.

Research gaps and availability of knowledge to manage crops

Except for rapeseed and sunflower, most PRPs face a lack of research and development in plant breeding. This is particularly true for pulses. For soya bean, progress can still be made regarding industrial applications. Off-flavours have been reduced in the last decade. For rapeseed and sunflower, there is a high diversity and high adaptation to food and industrial needs (high erucic for green chemistry, biodiesel) and food applications (hi-oleic, hi-alphalinoleic). Regarding pulses, breeding progress is far behind dominant crops. There are few varieties and limited research on disease resistance (aphanomyces, weevil), water stress. Genetic improvement to reduce off-flavours of peas (beany taste) are still expected by the agri-food industry. Low development of acreage does not incite breeders to invest (compared with dominant crops).

Habits of producers and aversion to change must also be considered. For rapeseed and sunflower, there is a significant knowledge base available as farmers have been growing them for decades on significant areas. Conversely, soya bean is a relatively new crop in many areas and new technical knowledge background is needed to grow it. Regarding pulses, farmers used to grow them 20-30 years ago, but diseases and yield/price variability conveyed a negative reputation at farmer level.

Additional thoughts

For all legumes, if energy price and the related price of N fertilisers increase, it could create a favourable environment for their development as they depend on biological N-fixation. Societal demand for fewer plant protection products (PPPs) could also impact cropping area if more regulatory pressure is put on cropping system. Except for rapeseed, PRPs require generally less PPPs than other crops and crop effect can lower the need for PPPs on the following crops in the rotation.

4.3.4 The specific case of producers of the organic premium markets

4.3.4.1 Price differences between organic and conventional productions

One of the key drivers of organic production of PRP is the price of the crops and price fluctuations make the analysis difficult. Moreover, comparable data on products organically grown vs conventional is difficult to find at EU level. This paragraph presents the 2015 prices as a reference year, but it is only a snapshot taken at a given time.

Table 34: Price ratio between organic and conventional productions for feed at collectors' gate in 2015

	Price ratio organic/conventional produced in the EU for feed at collectors' gate in 2015	Source
Field beans	2.7	AMI[263] (in DE)
Field peas	2.5	AMI (in DE)
Field peas	2.2	ABU (in FR)
Sunflower	1.1	MAPAMA[264] (in ES)
Soya bean	2.1	Green report, 2016 (in AT)
Soya bean	2.3	N&S (FR)
Lupine	2.3	AMI (in DE)
Lentils	1.8	ABU (in FR)
Chick peas	2.1	ABU (in FR)
Linseed	3.7	ABU (in FR)
Dehydrated alfalfa	1.2	AIFE[265] (in IT)

Source: CS Austria (Green report), Germany (AMI), France (N&S/ABU), Spain (MAPAMA), and Italy (AIFE)

Data about prices at the farm gate was difficult to compare, thus it is presented at collectors' gate. Table 34 highlights the price ratio between organic production and conventional in various MS in 2015. The largest differences concern dry pulses, namely field beans and field peas and the lowest sunflower and dehydrated alfalfa. For all the other PRPs, organically grown corresponds to prices at least two times higher than conventional ones.

Moreover, at least concerning soya bean, this price depends a lot on the destination of the production. In 2012 in France, organic soya bean cultivated for food was at least 150€/t higher than soya bean for feed roughly sold around 500€/t[266]. The final destination of soya bean depends on the quality and in particular on the share of protein in the grain and it is far more profitable to produce soya bean for food[267]. Roughly, under 40% of protein, it goes to feed production[268] as well as all discarded grains.

Another important aspect is that price volatility is much lower in organic products. It could be explained by a high local demand in some MS, as it is the case in Austria and to a lesser extent in France.

[263] Agrarmarkt Informations-Gesellschaft mbh.

[264] Ministerio de Agricultura, Pesca y Alimentación. Ministerio para la Transición Ecológica (Ministry of Agriculture in Spain).

[265] Associazione Italiana Foraggi Essiccati.

[266] AgriBio Union Cooperative (CS France).

[267] ProteAB.

[268] ENSA.

4.3.4.2 Gross margins

The gross margin enables evaluation of farmers' profitability and is, by definition, an important driver when choosing the crops for rotation.

Examples are given by AgriBio Union, a French organic collector for 2017. We provide below the gross margins of the main PRPs in Southwest France for their average yields in this collector's area and compare them to the yields to reach the same gross margin in conventional.

Table 35: Gross margins corresponding to organic average yield in AgriBio Union region and the equivalent yield in conventional to obtain the same gross margin

	Yield (t/ha)	Gross margin (€/ha)	Equivalent yield in conventional for same gross margin
Chickpeas	1.2	1150	3
Irrigated soya bean	2	1000	5.2
Rapeseed	2	1000	4.9
Sunflower	1.7	750	3.7
Field beans and peas	1.8	550	5.3

Source: AgriBio Union, 2017.

Table 35 highlights that high gross margins can be obtained in this collector's region for organic chickpeas, soya bean and rapeseed; this is less the case for sunflower, field beans and field peas. It also suggests the technical difficulties in obtaining the same gross margins in conventional, as it is difficult to obtain such yields[269].

4.3.4.3 Agronomic drivers

The main agronomic drivers for organic PRPs are:

- Legumes: a fertiliser replacement

In the organic sector, oilseeds and cereals have a smaller share of the arable land (respectively 6.2% vs. 2.9% and 54.3% vs 36.1%). However, the share of grain legumes (pulses+soya bean) is higher in the organic sector in the EU (as shown in Figures 79 and 80 below, 2.6% in conventional *vs* 8.7% in organic)[270]. Since organic farmers do not use synthetic fertilisers, organic farmers need legume crops to incorporate nitrogen in their cropping systems.

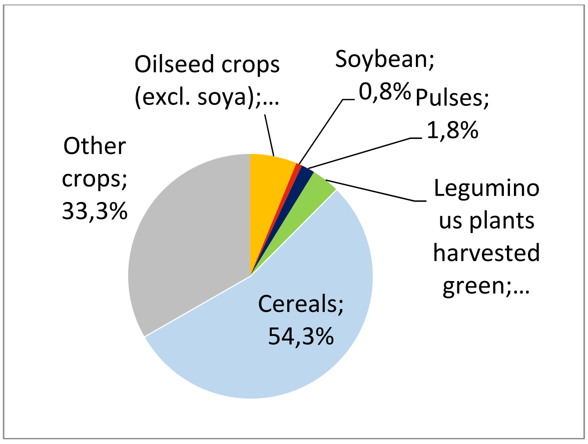


Figure 79: Share of PRP crops areas in arable land (Eurostat, 2016)

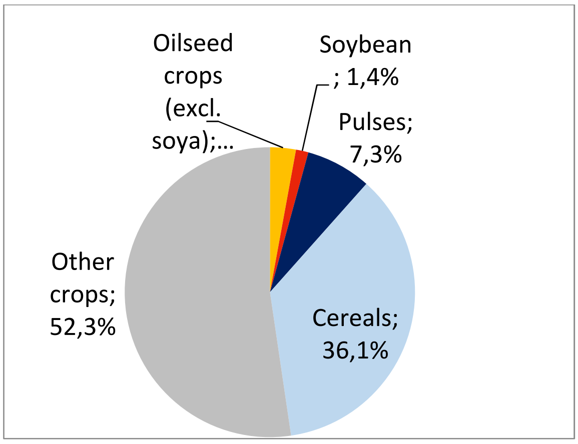


Figure 80: Share of organic PRP crops areas in organic arable land (Eurostat, FIBL, Agence Bio,2016)[271]

[269] For example, regarding soya bean, the highest national mean yields between 2014 and 2016 observed in EU are Italian with 3.79t/ha, far from the 5.2t/ha needed for a 1000€ gross margin. It is the same for rapeseed with a 2.73t/ha mean yield in the EU; the highest yields are found in Belgium with 4.03t/ha and is not reaching the 4.9t/ha, generating gross margins lower than 1000€/ha in most cases

[270] The share of organic grain legume is much higher in some MS, so that it will be difficult to grow as it is almost to the maximum of the crop rotation system. This is the case in Germany (CS Germany).

[271] Data was not available for Legume harvested green, thus it is grouped with Other crops.

- Lack of varieties and certified seeds

In some MS, the available range of organic PRP varieties is very small or even does not exist. This leads to the use of the exemption system allowing the use of conventional seeds. It is the case for example in soya bean and rapeseed in Romania.

Interviews of economic agents involved in the organic sector report that exemptions cannot replace the need for varieties truly adapted to organic systems, as conventional selection is based on conventional agriculture. Organic producers would be more interested in conventional breeding research based on more extensive criteria. For example, French growers often use Austrian or Swiss conventional seeds as they are more adapted to organic growing than the conventional French ones, (selected following more intensive criteria than Austrian or Swiss ones).

- More on-farm consumption on organic farms supported by regulation for organic farming: a positive driver for PRPs such as field peas or field beans.

Although it is difficult to measure it, case studies reported that there is more on-farm consumption on organic farms than on conventional ones[272]. This characteristic leads farmer (mainly mixed farms) to choose crops that can be consumed directly on-farm. Among PRPs, the main crops concerned are field beans and field peas and in some member states legume fodders. In Austria, most field beans and peas are consumed directly on-farm and actually a large part of them are produced organically (62% of the field beans and 33% of field peas area are organic). It is also the case for toasted soya bean, which can be easily processed on-farm thanks to mobile toasters (cf. Box 4).

4.3.4.4 *Outlet market drivers*

The main drivers in terms of outlets are:

- Lack of large-scale market/outlets in some MS

In some MS, there is little or no market for organic production, which does not allow the development of the sector. For example, in Romania the organic sunflower cultivation is mainly sold on-farm or in niche markets, such as festivals or small shops. It leads to a very limited interest from big producers to convert, which is stressed by other barriers such as problems with weeds, lack of varieties, local know-how and advice.

- High share of organic farmers using contracts

In the organic segment, a large proportion of organic farmers use contracts with collectors and/or industrials. Case studies have for example reported that it is well developed for dry pulses in the Polish feed sector, in the food sector for soya bean in France, Belgium or Austria.

4.3.4.5 *Other drivers*

Some other drivers are also important to note for the organic PRP productions.

- Lack of know-how

Case studies always reported the lack of know-how to cultivate organic PRPs, as extension services and advice are less developed than for the conventional sector. This issue was particularly significant in Romania. It was also particularly the case with organic rapeseed in France and Germany.

- Cost of the organic certification

In some MS such as Romania, small farms operate in an organic manner, but organic certification is too costly, thus they do not appear in the organic figures and do not benefit from special aid.

- Social image

In some MS such as Austria, France or Germany, it is not the same dynamic at all to be a farmer or an organic farmer. This relates to image, self-satisfaction, well-being at work, etc. and is a positive driver of the organic production.

4.3.4.6 *Summary of drivers for farmers producing organic PRPs*

To sum up, there are two categories of drivers concerning organic PRP producers: the drivers only linked to the conversion to organic systems, and the drivers specifically related to organic PRPs.

Regarding the first ones, the price difference between organic and conventional is logically to the advantage of organic production. The highest price differences with conventional have been observed

[272] in EU regulations, organic farmers must use at least 30% of the feed coming directly from the farm (for pigs and poultry)

for dry pulses and the lowest for sunflower and dehydrated alfalfa. For all other PRPs, organic generally results in prices at least twice higher than conventional. Gross margins are also two to four times higher for specific products (e.g. chickpeas) than in conventional for equivalent average yields in the French and German case studies. Another driver linked to conversion is the lack of large-scale markets in some MS, mainly in Eastern EU, such as Romania. In the same regions, the costs of certification are too high for local small producers.

The second type of drivers, inherent to organic PRPs, are the capacity of legumes to replace fertilisers and their wide use as N-fixing agents in organic farming (organic legume grain share in organic arable area is 8.7% compared to 2.6% in conventional). Furthermore, there is a lack of organic adapted and certified varieties in almost all MS, in particular for pulses. Another driver is the difficulties observed in handling weed control, in particular for soya bean and pulses. However, there is more on-farm production with a large use of field beans and peas in organic systems, which is supported by the organic regulation concerning the "link with the land"[273]. Finally, most of these value chains are built with contracts between farmers and collectors on the one hand and collectors and factories to secure all partners on the other hand.

[273] Organic farmers must use at least 30% of the feed coming directly from the farm (for pigs and poultry).

5 ANSWER TO THE EVALUATION QUESTIONS

This study includes 11 evaluation questions, covering causal analysis (1&2), coherence (EQ 3 to 10) and relevance (EQ 11).

- Causal analysis is mainly dedicated to discovering the drivers that are behind the observed phenomena.
- Coherence is defined as the extent to which the intervention under investigation does not contradict other interventions with similar or related objectives. The analysis will treat both:
    - o internal coherence, which examines how different components of a EU intervention work together to achieve their objective/s; and
    - o external coherence, which appraises how policy measures that are the object of analysis and other relevant EU or external drivers work in synergy.

The wording of the EQ is clearly oriented to external coherence with the economic drivers of the sectors. For this analysis, in all the EQ related to coherence, judgements are made in qualitative terms for each measure to see whether the relationship is a) synergistic; b) complementary; c) neutral; d) in competition; or e) contradictory. To facilitate the interpretation, the cells are colour-coded:

- Red = contradictions or competition;
- Orange = neutrality, or no particular association; and
- Green = a complementary or synergistic relationship.

Commentary is provided alongside the assessment made in the matrix to explain the assumptions that led to this judgement.

- Relevance is defined as the extent to which an intervention's objectives are pertinent to needs, problems and issues. Its analysis aims at examining whether the cause-effect relationships of the intervention logic still stand for the evaluated measures or if circumstances have changed or new issues have arisen.

5.1 *EQ 1 - Main economic drivers of the <u>feed</u> market segments*

What are the main economic drivers influencing the quantity, quality, producer price and geographical distribution of the main plant protein <u>feed</u> market segments in the EU?

The analysis should address both plant proteins produced in the EU and imported. In addition to commodity markets of PRP, the analysis will include at least the GM-Free and organic PRP market segments.

5.1.1 Understanding of the question

This EQ is focused on feed products in the EU. Among the three groups of crops studied in this evaluation, the markets for most of them fall under three different categories, namely:

- Pulses (mainly field beans and field peas) are most of the time sold as grain to be used as-is or incorporated into compounded meals by feed makers[274]
- Oilseeds are most of the time crushed for oil extraction and then used as meals to be used as such by livestock farmers or incorporated into compounded meals by feed makers[275].
- Forage legumes are most of the time produced and self-consumed on-farm. Part of them (~15%) are also produced to be dehydrated and then sold to EU livestock farmers or exported.[276]

The goal of this EQ is to find out, by market segment and along supply chains, what the economic reasoning is and which drivers influence final choices of economic agents to choose a given product instead of another.

[274] Some value chains use pulses to process first to take one of the components of the grain (e.g. starch) and the remaining meals are used like those coming from oilseeds to make compounded meals.

[275] Some oilseeds are directly used by farmers to feed their animals, but most of the volumes go to oil plants first.

[276] Some forage legumes are sold locally to neighbouring farmers but there is very little information on these exchanges often happening from farm to farm.

5.1.2 Method and limitations

Chapters 3 and 4 provide successively a description of the various PRP markets and market segments for feed and food. In this EQ which focuses on the feed market segments we present successively:

1. A brief description of the main market segments studied (and their drivers) for the three types of crops listed above.
2. The main drivers by economic agent along the supply chain for the main market segments
3. How these drivers influence the quantity, quality, producer price and geographical distribution for the main plant protein feed market segments in the EU

5.1.3 Judgement criterion 1: there are (or not) market segments in the PRP feed sector with different economic drivers

Chapter 4 details the main market segments identified for the studied protein-rich crops (meaning pulses, oilseeds and legume fodders), which are:

- the conventional market segment,
- the GM-Free market segment,
- the organic market segment.

Chapters 3 and 4 of this report show that these market segments follow very different patterns in terms of supply chains, prices, regulations and drivers. Chapter 4 describes in detail the main characteristics of these market segments. To sum up, the conventional market segment is mostly driven by two key economic agents: (1) livestock farmers, who decide how to feed their animals and how to source their feed; and (2) feed manufacturers, who can use a wide spectrum of raw materials to satisfy their demand. To feed animals, the feed industry can use a wide spectrum of raw materials, including GM feedstuffs (especially imported soya), and use least-cost formulation to provide feed matching with animal requirements and performances at the most competitive price.

The GM-Free feed market is more driven by the following stakeholders: final consumers looking for specific meat and dairy products, along with civil society organisations such as NGOs. Retailers have thus integrated the civil society demand for more GM-Free products and are also widely driving the GM-Free segment growth.

The organic feed market is clearly influenced by final consumers and retailers looking for meat and dairy products, who have strong expectations when it comes to supply chain sustainability. The organic feed market is characterised by a higher use of local legume crops (especially on-farm produced due to agronomic reasons), a wider prevalence of on-farm feed manufacturing vs purchased compound feed, a prohibition of GM feed and more constraints on sourcing as availability of organic raw materials is a key aspect of organic feed formulation.

Table 36 groups the economic drivers for the three main feed market segments and shows that there are significant differences between them.

Table 36: Main economic drivers by feed market segment

Conventional feedstuff	GM-Free premium feedstuff	Organic premium feedstuff
- Seek for standard products, with stable quality and availability. constant availability and quality + standard products. - Need for hedging solutions (or price indexation if no futures market). - Feedstuff substitution costs in factories (limited number of silos). - Competition with food. - Labour cost (especially for leguminous fodders).	- Social concerns. - GM-Free soya bean price premium (+ 80-100€) or cost of its substitution. - Availability of non-GM raw materials. - Branding and PDO/PGI. - Price premium for milk and other animal products. - Additional sourcing, segregation, storage and transaction costs. - Availability of GM-Free soya bean. - GMO regulations.	- Segregation cost of organic materials: storage, handling and pest management. - Agronomic constraints inherent to organic production. - Competition with food outlets. - Availability of organic raw material for feed. High prices in organic. - Lack of B2B services for technological treatments (dehulling, toasting, storing), especially at small scale.

Source: evaluators based on chapter 4 of this report.

5.1.4 Judgement criterion 2: the main economic agents along the different feed value chains of PRP have (or not) different economic drivers

Chapter 4 gives the main categories of drivers by agent along these three types of value chains.

For the conventional feed market segment, the analysis presented in chapter 4 focuses particularly on the two main economic agents that play a key role in driving the PRP demand in the conventional feed market, namely: (1) livestock farmers, who decide how to feed their animals and how to source their feed (on-farm produced or bought as compound feed), and (2) compound feed manufacturers, who are using a wide spectrum of raw materials to supply livestock producers with compound feed fitted to their requirements.

Globally, price risk management is a key driver for both livestock breeders and feed manufacturers, but animal farmers have fewer tools to control it, hence they follow different reasoning when sourcing feedstuffs. To formulate feed, flexibility in switching from one raw material to another to prepare feed is much lower for animal farmers than for feed manufacturers. Given a limited storage capacity on-farm and the structural adaptation needed to constantly re-formulate feed, animal farmers tend to prioritise feedstuffs that allow consistent supply and good complementarity with on-farm produced feed[277] (if any). Livestock breeders can also decide to decrease their dependence on market fluctuations by producing feed on-farm.

In the case of feed manufacturers, oilseed meals and cereals show "specialised" nutritional profiles (high protein content and low starch content or conversely) while other protein-rich crops show more "intermediate" profiles (medium content both in starch and energy). Specialised profiles give more flexibility in least-cost feed formulation than intermediate profiles, thus excluding pulses. To manage price variability, feed manufacturers tend to favour markets with high liquidity, consistent quality and availability and hedging possibilities. Oilseed meals fit better with these criteria than pulses, which are traded on small and little standardised physical markets. Adding a new material also involves replacing another one in the factory, giving a clear disadvantage to current "outsiders".

Table 37 gives a short overview of the differences between economic agents regarding the drivers that influence the use of PRPs or not.

Table 37: Main economic drivers of the feed processed plant protein product market

Main economic drivers for processed plant protein products value chains			
Traders	Collectors	Feed manufacturers	Livestock famers
Price Currency rates Quality Hedging possibilities Market liquidity Compliance with value chain requirements (e.g. "zero imported deforestation", non-GM soya, etc.).	Outlet variety (food vs feed) Price Quality Securing of the supply (campaign contract) Securing the demand (contract with traders or hedging possibilities) Specific equipment needed to sort and segregate Availability of technologies to manage pests during storage (e.g. weevils)	Price Market liquidity and reliability Hedging possibilities Consistent quality Transaction costs Feedstuff substitution cost	Price Key trade-off for autonomy: to produce on-farm or to buy Yield stability and crop management. Opportunity cost (on-farm production vs cash crops). Labour. Consistent quality Impact on animal health Premium specifications Ease of use CAP measures

Source: evaluators based on case studies and bibliography

5.1.5 Judgement criterion 3: these drivers influence (or not) the quantity, quality, producer price and geographical distribution for the main PRP feed market segments in the EU

[277] Soya meals being for most them the most appropriate.

Chapter 4 stresses that the economic drivers identified strongly impact the quantity, quality, producer prices and the geographical distribution for the main PRP feed market segments. To sum up, it can be reported that:

- Quantity is influenced by animal requirements combined with market specifications. Market structure (liquidity, supply chain reliability, etc.) also impacts choices of the feed industry in terms of volumes.
- Quality is strongly impacted by the type of market segment and its related drivers, as it implies significant differences in the production, sourcing and origin of raw materials.
- Producer price is also influenced by these drivers because they positively or negatively influence the demand, hence impacting prices. They can also generate additional requirements and specifications that will segment the offer and consequently generate a price premium.
- Geographical distribution is influenced by the development (or not) of markets in specific areas. The need for EU/local feed sourcing (organic regulations, labelling of origin, lack of trust in international markets for premium feed, etc.) influences the geographical distribution of PRP production. As developed in chapter 4, a switch from conventional to GM-Free, organic or premiums markets often implies a rethinking of feeding systems, with shifts in raw materials used.

5.1.6 Judgement criterion 4: Other drivers have (or not) an influence on PRP production

The lack of research on PRPs, even if it is not as such an economic driver, has a direct influence on PRP production, as many of the species among pulses and forages are considered as "orphan" species with a significant lack of research compared to the main crops produced in the EU such as cereals or oilseeds.

It results in lower yield, higher vulnerability to pests or water stresses, etc. Being orphan crops with few markets in comparison with dominant crops, the lack of knowledge available to grow or use (as feed) the crops can also be an additional barrier to its development. Finally, it should be noted that climate variability is another non-economic driver that strongly impacts the production of PRPs more than most of their alternative crops.

5.1.7 Conclusion of EQ 1

The three judgement criteria show that there are three main market segments in the feed sector.

These market segments are driven by various factors which depend on the market segment itself but also on the type of economic agent that can be found along the value chains. These drivers also influence the quantity, quality, producer price and geographical distribution of PRP production and uses for the main feed market segments in the EU. Figure 81 summarises the positioning of feed market segments according to market differentiation (matching consumers' expectations vs commodity) and geographical origin (undifferentiated world supply vs local origin).

It shows that conventional feed is mostly driven by commodity markets with international supply, whereas GM-Free and organic markets are bipolar with part of the supply strongly linked to consumer expectations and local sourcing and part of them more oriented to commodities and the world market. This is mainly when these productions are imposed by downstream sector requests.

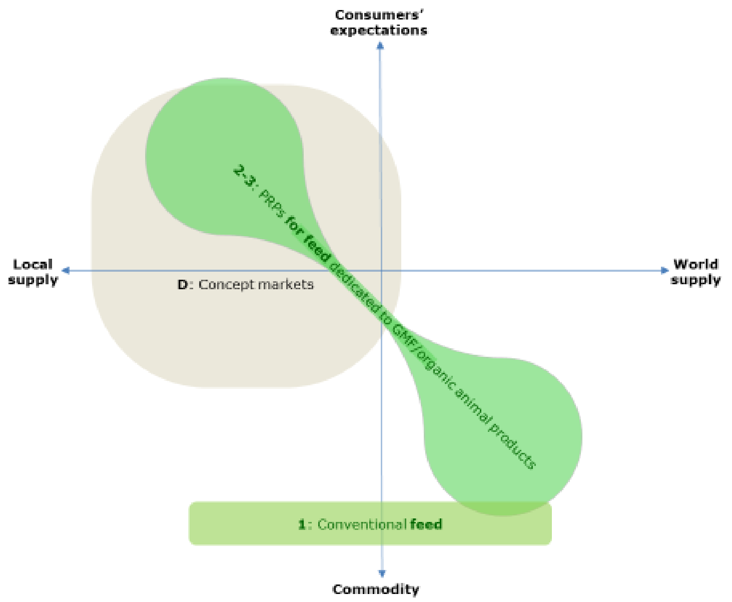


Figure 81: Theoretical illustration of the positioning of the 3 main feed market segments

5.2 EQ 2 - Main economic drivers of the food market segments

What are the main economic drivers influencing the quantity, quality, producer price and geographical distribution of the main plant protein food market segments in the EU?

The analysis should address both plant proteins produced in the EU and imported. In addition to historical PRPs food market segments, the analysis includes GM-Free, organic, and examples of geographical indication of PRP products as well emerging market segments of the PRP sectors.

5.2.1 Understanding of the question

This EQ focuses on food products in the EU. Among the crops under study, the main ones used for their protein content on the food market are pulses and soya bean. Therefore, this EQ focuses on these crops. Some other crops which are rarely used in some specific areas (e.g. sunflower in some Eastern Member States), or with very limited volumes, are not considered in this analysis.

Pulses can be sold as grain to be used as-is (e.g. lentils, chickpeas, etc.) or incorporated into preparations of the food industry, or even be processed to extract some components used as proteins (or others) in preparations in which their functionality and/or nutritional profile are the first criterion of the buyer.

Soya bean can be used in preparations in which the customer is interested as a product made with soya (e.g. tofu) but also in processes to provide proteins to be added to other food preparation (e.g. incorporation into ground meat).

The aim of this EQ is thus to find out by market segment, and even by operator along the value chains, what the economic drivers are that influence their final choice for a given product instead of another.

In terms of market segments, the main ones identified during the evaluation are the whole grain pulse market (e.g. lentils, chickpeas, beans, etc.), the processed plant protein products market and the protein ingredient market (see chapter 4), targeting the extraction of proteins for a wide variety of final users in the food sector but even in others such as cosmetics, pharmacy, etc.

5.2.2 Method and limitations

Chapters 3 and 4 provide successively a description of the various markets and market segments for feed and food. In this EQ which focuses on the food market segments we present successively:

1. A brief description of the main PRP market segments studied for the two types of crops listed above,
2. The main drivers by operator along the chain for the main PRP market segments,
3. How these drivers influence the quantity, quality, producer price and geographical distribution for the main PRP food market segments in the EU.

5.2.3 Judgement criterion 1: there are (or not) market segments in the PRP food sector with different economic drivers

5.2.3.1 Main market segments of the PRP studied in conventional production and relative importance

The main groups of market segments identified for PRP food products are:

- whole grain pulse market (e.g. lentils, chickpeas, beans, peas, etc.),
- processed plant protein products (e.g. soy drinks, tofu, etc.),
- functional protein ingredients.

As explained in chapter 4, the two first market segments are based on B2C marketing. Customers are looking specifically for these products and to a certain extent are ready to pay a specific premium for them. The last market segment is based on a B2B marketing. The protein ingredients are used for their specific functional or nutritional properties (see chapter 4). Hence for most of these markets at equivalent quality/functionality, the price is the main driver of the industry using it.

5.2.3.2 Main food market segments of the PRP studied in organic and GM-Free production

All these market segments are GM-free as required by the EU legislation. A sub-segment for organic products can be found for all these market segments even if the organic market is much more developed for the whole grain pulses and the processed plant protein products (see chapter 4).

5.2.4 Judgement criterion 2: the main operators along the different PRP food value chains have (or not) different economic drivers

Chapter 4 gives the main categories of drivers by operator along these four types of value chains.

5.2.4.1 Main drivers by market segment/type of value chain and operator of the PRP studied in conventional production

Whole grain pulse markets (e.g. lentils, chickpeas, beans, etc.)

The main economic drivers of the market segment are detailed in chapter 4. Briefly, they are:

- consumer eating habits,
- the quality of the grains,
- the image of the product (traditional, healthy, etc.),
- the rise of flexitarian/vegetarian/vegan diets,
- the availability and stability of the supply (contracts),
- EU origin/local sourcing.

The detail of the economic drivers per operator is given in Table 38.

Table 38: Main economic drivers of the whole grain pulses market

Main economic drivers for whole grain pulses value chains			
Farmer	Collector	Agri-food industry	Final consumers
Gross margin of the crop Securing of the production (contract) Existence of an outlet Knowledge on crop management Aversion to change Lack of research to improve and stabilise yields/quality CAP and other policies Demand	Demand Availability of product on a regular basis Quality Price Securing of the supply (contract) Specific equipment needed (number of silos to sort and isolate products)	Demand Availability of product on a regular basis Quality Price Securing of the supply (contract)	Consumer eating habits and convenience of the product The image of the product (traditional, healthy, etc.), The rise of flexitarian, vegetarian and vegan diets, The origin of the products

Source: evaluators based on case studies and bibliography

Processed plant protein products

The main economic drivers of the market segment are detailed in chapter 4. Briefly, they are:

- the rise of flexitarian/vegetarian/vegan diets, gluten/lactose-free,
- the convenience of the products/cooking time,
- consumer eating habits,
- the image of the products (environmentally friendly, healthy, etc.),
- the availability and stability of the supply (contracts),
- the availability of GM-free supply,
- the quality of the grains,
- EU origin/local sourcing.

The detail of the economic driver per operator is given in Table 39.

Table 39: Main economic drivers of the processed plant protein product market

Main economic drivers for processed plant protein products value chains			
Farmer	Collector	Agri-food industry	Final consumers
Gross margin of the crop Securing of the production (contract) Existence of an outlet Knowledge of the crops Aversion to change Lack of research to improve and stabilise yields/quality CAP and other policies Demand	Demand Availability of product on a regular basis Quality Price Securing of the supply (contract) Specific equipment needed (number of silos to sort and isolate products)	Demand Availability of product on a regular basis Quality Price Securing of the supply (contract)	The rise of flexitarian, vegetarian and vegan diets, Convenience of the product, Consumer eating habits, The image of the product (traditional, healthy, etc.), The origin of the products

Source: evaluators based on case studies and bibliography

Functional protein ingredients

The main economic drivers of the market segment are detailed in chapter 4. Briefly, they are:

- the functional and nutritional properties of PRPs,
- the availability and stability of the supply (contracts for peas),
- the availability of GM-free supply,
- the knowledge of the technologies and processing techniques,
- research and development of new ingredients,
- the competition with other protein sources (e.g. gluten, whey).

The detail of the economic driver per operator is given in Table 40.

Table 40: Main economic drivers of the functional protein ingredient market

Main economic drivers for functional plant protein ingredient value chains		
Farmer	Collector	Agri-food industry
Gross margin of the crop Securing of the production (contract) Existence of an outlet Knowledge of the crops Aversion to change Lack of research to improve and stabilise yields/quality CAP and other policies Demand	Demand Availability of product on a regular basis Quality Price Securing of the supply (contract) Specific equipment needed (number of silos to sort and isolate products)	The functional and nutritional properties of PRPs Price Knowledge of the technologies and processing techniques Availability and stability of the supply Competition with other protein sources (e.g. gluten, whey).

Source: evaluators based on case studies and bibliography

5.2.4.2 *Main drivers of the food market by market segment /type of value chain and operator of the PRP studied in organic and GM-Free production*

These market segments are driven by a demand from customers knowing exactly what they want and ready to pay a premium to get these products. The main markets for these products are presented in criterion 1. The premiums at producer level for organic products are variable in the EU and depend on products. Some examples are given in Chapter 4.

In terms of supply, legumes play a significant role in organic farming as, in these systems, they are used to ensure the nitrogen supply to soils, particularly in farms with no animals, in which there is a chronic deficit in nitrogen availability[278]. In these systems legumes often represent a higher proportion of the arable area[279] of farms than in conventional ones (see previous EQ).

Nevertheless, whereas the supply of legumes by organic farms is higher than in conventional ones, the sector suffers a chronic shortage of EU organic products and a wide variety of them are still imported (e.g. the majority of lentils are imported, mainly from Canada).

5.2.5 Judgement criterion 3: these drivers influence (or not) the quantity, quality, producer price and geographical distribution for the main PRP food market segments in the EU

For whole grain pulse supply chains and processed plant protein products, the economic drivers of operators clearly influence:

- the quantity produced by providing outlets to the given products, instead of importing them,
- the quality since most of these value chains imply specific quality standards which may be controlled by external control bodies,
- the producer price, as the premium paid for these products is often significant compared to regular (especially compared to prices in feed value chains) or imported products (see criterion 2).
- the geographical distribution, as the supply of these chains may be located within the EU and even in very specific regions including PDO and PGI products (see next criterion).

5.2.6 Judgement criterion 4: Other drivers have (or not) an influence on PRP production

[278] David *et al*. 2005 in Voisin *et al*. 2014.

[279] Source: Agribio Union

This criterion is already treated in EQ 1. The main conclusion is that there is a lack of research on some interesting crops (mainly pulses) because of the limited size of these markets. This vicious circle hinders the development of these crops and in addition limits diversification which has many agronomic, environmental and even economic advantages.

In addition to this, PDO and PGIs regulation play a significant role in some value chains. It can also be the case for geographical origins not protected as such but used by the companies to reassure the customer the products come from a specific area of the EU (e.g. Soya bean from Southwest France[280], or from Austria[281], etc.).

5.2.7 Conclusion of EQ 2

Food markets are almost niche markets in comparison to those for feed. This sector represents only 4 to 5%[282] of the PRP sectors. Nevertheless, their added value all along the chain is higher in relative terms as products are most of the time sold at a higher price. As explained in chapter 4, the food market can be divided into three market segments depending on their marketing organisation (B2C vs B2B), their level of processing (crude grains or low processing vs processed food products) and the consumer demand they satisfy (traditional food vs convenient food). These market segments have various economic drivers, some are common for various segments and some are specific to one. Overall, the main drivers identified relate to the consumer demand (specific diets such as vegetarian, health concerns, convenience of the products, etc.) and the agri-food industry (functional and nutritional properties of the proteins, availability and stability of the supply, etc.).

These drivers can have an impact on the quantity, quality, producer price and geographical distribution of PRP production in the EU, especially for whole grain pulses and processed plant protein products value chains.

Figure 82 summarises the positioning of food market segments according to market differentiation (matching consumers' expectations vs commodity) and geographical origin (undifferentiated world supply vs local origin).

It shows that processed plant proteins for food (e.g. tofu) are highly linked to consumer preference and local sourcing whereas functional ingredient are clearly linked to commodities and world supply. Pulses used as whole grain or low processed are bipolar with local sourcing for some products (e.g. PDO, PGI, etc.) or import at the best price for others.

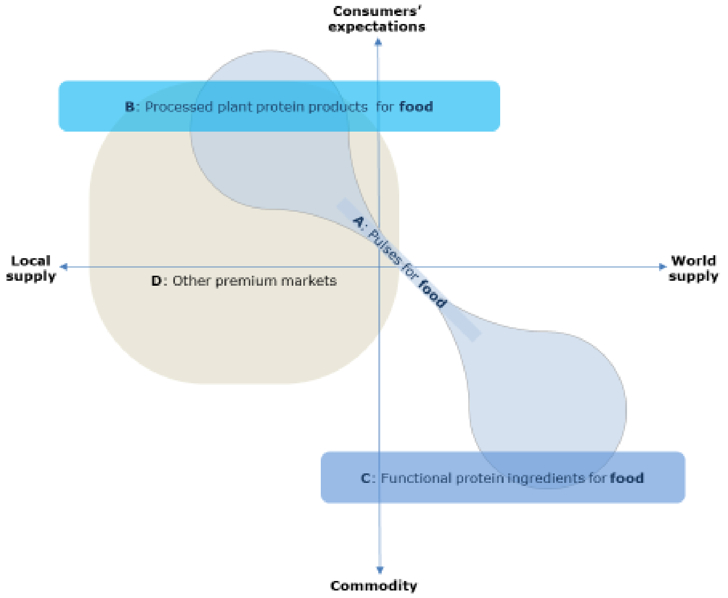


Figure 82: theoretical illustration of the positioning of the 3 main food market segments

5.3 *EQ 3 – On coherence of CAP instruments with the supply sources*

To what extent have the measures applicable to arable crops been coherent and/or complementary to the economic drivers influencing the quantity, quality, producer prices and geographical origin of the different supply sources of plant proteins to ensure a viable production of plant proteins in the EU?

The analysis in this EQ addresses PRP supply in the EU (i.e. consumed within the EU or exported) as well as their by-products (mainly meals).

5.3.1 Understanding the question

[280] Source: Nutrition et Nature. France (Soya bean from Southwest France)

[281] Source: Joya "from Austrian soya beans"

[282] Estimate based on case studies

The measures applicable to the arable sector relating to plant proteins having a potential impact on the level of cultivation are mainly:

- the voluntary coupled supports (VCS);
- the diversification measure of the part of direct payment linked to the greening payments (DIV);
- the ecological focus areas (EFAs) linked to the cultivation of legumes also linked to the greening payments of direct payments.

Some other measures can also have little effect such as:

- some Agri-environmental and Climatic Measures (AECM) linked to the cultivation of legumes
- the nitrate directive and its rules limiting the use legumes as cover;
- Etc.

We suggest focusing on the first three and treating the others qualitatively due to their limited effect on the cultivation of crops/plants producing PP. Supply is considered here as the EU production plus import.

As this EQ relates to supply, the economic drivers considered (described in chapter 4 and EQ 1 and 2) concern mostly:

- For the EU internal production, those of the producers growing pulses, soya bean for soy-food, rapeseed, sunflower and legume fodder;
- For the import, those of importers, which could be involved in several categories of activities[283]; but we will focus here mostly on food and feed makers and traders.

5.3.2 Method and limitations

As mentioned in chapter 1, this study is focused on protein-rich crops/plants (>15% crude protein). We nevertheless also study the other major sources of PP, and in particular, cereals and grasses.

In terms of effect on quantity of these measures, they have been evaluated recently (Alliance Environnement, 2017) and their effect on the cultivation of pulses, oilseeds and legumes for forage studied. We then firstly base our answer on the result of this evaluation, taking into account the potential effect of the Omnibus regulation and delegated acts that slightly modified the regulation applied in 2017[284]. It should be noted that the analysis done in the evaluation of the Greening measures mainly focuses on the crops for which data were available on the Eurostat and FADN database, i.e. three dry pulses (broad and field beans, field peas and sweet lupines), two pulses harvested green (fresh beans and fresh beans), three oilseeds (soya bean, rapeseed and sunflower) and the forage legumes (based on aggregated data for all forage legumes).

For conventional producers the three measures are concerned but for organic ones, only VCS applies as they are exempted from the greening measures.

In terms of quality and producer price, based on the result of the effect of these measures on quantity, we have made the assumption that these measures (VCS, Diversification and EFAs) have not had any influence on the quality and producer price of the concerned productions. This is consistent with the findings from the evaluation of greening measures (Alliance Environnement, 2017) and the evaluation of coupled supports (under Article 68) (Agrosynergie, 2016). In terms of geographical origin, we have collected the rare available information in the literature and our CS. The last step for this EQ is to study the effect of the other economic drivers on the supply of the studied products and then to conclude.

5.3.3 Judgement criterion 1: The implementation of VCS, Diversification and EFAs resulted (or not) in changes in the cultivation area of pulses, oil seeds and legumes for forage, compared to the previous period

In 2015, 16 Member States[285] have decided to grant **voluntary coupled support (VCS)** to <u>several protein forage legumes, soya bean or pulses</u> (see Table 4). The effects of VCS on forage legumes, soya

[283] Importers can import for different purposes: sales, processing, consumption, etc.

[284] In particular the use of phytosanitary products on EFAs in legumes has been forbidden which could limit their cultivation, some farmers preferring not to take the risk of a decrease in yield.

[285] FR, SP, IT, PL, HU, RO, CZ, BG, HR, LV, SI, EL, FI, IE, LU, LT.

bean or pulses area in EU have been analysed in the framework of the evaluation of the greening measures (as a significant external factor). The evaluation highlighted that the VCS have probably been a driver of the increase of field pea, soya bean and lupine area in the EU in 2015-2016. As for broad and field beans, it seems rather unlikely that the measure had significant impacts at EU level since similar trends can be observed in Member States with and without coupled support available.

With regard to oilseeds (other than soya bean), according to the Member States notification in 2014[286], only Latvia and Spain[287] have made use of this option and implemented a coupled support (for rapeseed only in Latvia). Given the limited level of the support (37.71€/ha in Spain in 2015) and the number of Member States concerned (only two), it seems unlikely that the measure had significant impacts on oilseeds or oilseed meal supply at EU level. Furthermore, a significant share of soya bean produced within the EU is used for food and therefore it is unlikely that soya bean production changes in the EU have significantly impacted soymeal production or import in the EU.

With regard to the **greening EFA measure**, as a result of exemptions and non-declared area (i.e. land that does not benefit from any CAP payment), in 2016, the 5% ecological focus area obligation was applied to around 68% of EU arable land (Alliance Environnement, 2017). In 2015, all Member States except Denmark allowed nitrogen-fixing crops (which includes protein-rich crops such as forage legumes, pulses and soya bean) as an EFA. The detail of which protein-rich crops have been allowed as EFA is provided in the Table 4.

Each EFA element is subject to different weighting[288], which is used to adjust the measured area of the feature and so the extent to which it contributes to achieving the 5% ratio. These weights are broadly intended to reflect the relative environmental value of different types of ecological focus area. During the first years of implementation of the EFA measure (i.e. from 2015 to 2017), the weighting factor applied to nitrogen-fixing crops was 0.7, meaning that 1m² of nitrogen fixing crops counted as 0.7m² of EFA. In 2018, this weighting factor was reviewed[289] and was set at 1[290]. This is linked to the implementation of the pesticide ban on these areas and the improved environmental benefit which can be expected.

In 2015 and 2016, at EU level the main EFA element declared by farmers was nitrogen-fixing crops (respectively 37.5% and 39.1% of the area declared as EFA). The main conclusions of the evaluation of greening measures with regard to the likely effects of the EFA measure on the nitrogen-fixing crops area in the EU are summarised in Table 39. Broadly, the evaluation showed that the EFA measure may have fostered an increase of the cultivation of the three main dry pulses (i.e. broad and field beans, field peas and sweet lupines). However, other factors have been at play (e.g. the VCS for field peas, the growing demand for EU pulses in the food sector, etc. see section 5.3.5). As for soya beans, the analysis showed that the evolution of soya bean acreage is mainly driven by market development, even though the implementation of a VCS and the EFA measure may also have participated in the increase of the area. Regarding forage legumes, the measure may have participated in the stabilisation of the area at EU level, but no proof confirms this. However, the analysis was limited by the data available (no data was available at crop level) and its consistency (the Eurostat database shows some inconsistencies or missing data for BE, CY, EE, IE, IT, PT and UK). Similarly, for fresh pulses, the data analysis done in the valuation of the greening measures did not enable identification of any proof of an effect of the EFA measure on these productions (Alliance Environnement, 2017).

Overall, for all the crops studied, the evaluation showed that even though the EFA may have had some effects on the area of some protein-rich crops, other factors have also played a role, given that dry pulses and soya bean areas had already started to increase before greening was introduced (e.g. between 2013 and 2014, see Table 41). These other factors are presented in section 5.3.5.

[286] Notification of decisions taken by Member States by 1 August 2014:

[287] Royal Legislative Decree / *Real Decreto 1075/2014*

[288] They are listed in Annex II of Regulation (EU) No 639/2014.

[289] According to Regulation (EU) 2017/2393 of the European Parliament and of the Council of 13 December 2017

[290] Meaning that 1m² of nitrogen fixing crop can now count as 1m² of EFA

Table 41: Main results of EFA measure's impacts on N-fixing crops acreage

Nitrogen-fixing crop	Trend in 2014-2015 compared with the 2012-2014 trend	Likeliness of EFA measure's impact (0 / + / ++ / +++: none / low / medium / high)
Forage legume	No significant change except in SI, BE, CY, PL and FR	+
Soya bean	Sharper increase	+
Broad and field bean	Sharper increase (UK, DK, LT, LV, EE, DK)	++
Field pea	Sharper increase (FR, ES, DE, LT, UK)	++
Sweet lupines	Sharper increase (PL mainly)	++
Fresh bean	No significant change except BE	0
Fresh pea	No significant change	0

Source: (Alliance Environnement, 2017)

For 2018 onward[291], the use of plant protection products is prohibited on all areas of EFA Nitrogen-fixing crops from establishment until after harvest of the nitrogen-fixing crop. The effect of this change has still not been analysed, but according to case studies it will probably deter some farmers from growing protein-rich crops to comply with the EFA measure. However, the evaluation of the greening measures showed that it is overall unlikely that the EFA measure is the main driver for farmers to grow these crops and therefore this change in the measure may not impact the cultivated area (but only the area declared as EFA).

The change in weighting factor[292] for nitrogen-fixing crops from 0.7 to 1 may have counterbalanced the deterrent effect of the implementation of the pesticide ban.

Under the greening crop diversification measures, most EU farmers[293] are required to grow at least two or three crops according to their farm size. The crops and plants under study are rarely grown as the main crop in specialised farms and therefore can be an option for the farms to diversify their cropping patterns. It can be noted that a given area of nitrogen-fixing crop declared as EFA also counts as a crop for the crop diversification measure. In other words, growing nitrogen-fixing crops can be an option for farmers (e.g. in mono-cropping farms) to comply with both measures. Furthermore, since 2018, the crop diversification requirement does not apply to farms where more than 75% of arable land is used for the production of legume crops[294].

The effects of the crop diversification measure on farmers' cropping patterns have been studied in the framework of the valuation of the Greening measures. More specifically, the changes in cropping patterns between 2014 and 2015 made by farmers who did not meet the crop diversification measure requirements in 2014 have been analysed for ten Member States[295]. In order to understand the extent to which these changes may have been the result of the crop diversification measure, they have been compared to the changes in cropping areas made in 2015 by farmers who were already sufficiently diversified. These analyses showed out that the crop diversification measure led to changes on less than 1% of the total arable land of the ten Member States studied.

On this area which has been diversified, among the five main crops (or crop types) introduced, four are protein-rich crops (or crop type): legume plants, pulses (i.e. peas, field beans and sweet lupines), rapeseed (rape and turnip rape) and sunflower[296]. However, these protein-rich crops can be grown to meet the requirements of both the crop diversification and the EFA measure.

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[291] According to Regulation (EU) 2017/1155 of the European Parliament and of the Council of 15 February 2017

[292] Each EFA element is subject to different weighting, which is used to adjust the measured area of the feature and so the extent to which it contributes to achieving the 5% ratio. These weightings are broadly intended to reflect the relative environmental value of different types of ecological focus area. Member States are required to apply the weighting factors that are less than 1, but can choose whether or not to apply those greater than 1. They are listed in Annex II of Regulation (EU) No 639/2014. During the first years of implementation of the EFA measure (i.e. from 2015 to 2017) the weighting factor applied to nitrogen fixing crops was 0.7, meaning that $1m^2$ of nitrogen fixing crops counted as $0.7m^2$ of EFA.

[293] In 2016, 75% of arable land in the EU (excluding France, for whom data is unavailable) was subject to the crop diversification measure, with 63% subject to the three-crop rule and 12% subject to the two-crop rule.

[294] According to Regulation (EU) 2017/2393 of the European Parliament and of the Council of 13 December 2017

[295] AT, DE, CZ, ES, FR, LT, NL, PL, RO and UK.

[296] The fifth one being fallow

Overall, the effects of each measure under study (taken individually) on the cultivation of protein-rich crops are difficult to identify and have probably been limited at EU level. However, all these measures taken together have participated in the favourable context which has allowed the increase of the cultivation of protein-rich crops in EU since 2014. This context is also linked to other factors which are identified and whose effects are analysed in the framework of the third judgement criteria (see 5.3.5).

5.3.4 Judgement criterion 2: The implementation of VCS, Diversification and EFAs resulted (or not) in significant changes in the production and geographical origin of pulses, oil seeds and legumes for forage, compared to the previous period

Since most of the measures studied include requirements set at Member State level, their effect can be different from one Member State to another. Therefore, it may have impacted the geographical distribution of the protein-rich crops under study.

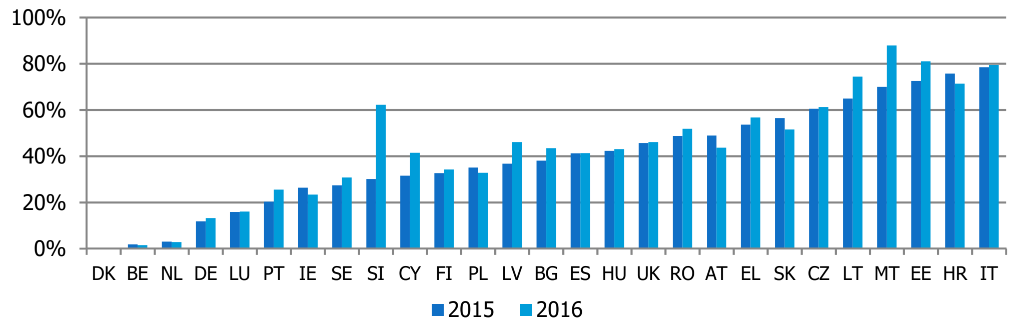
VCS

With regard to the VCS, in 2015, 16 Member States granted a coupled support to at least one of the protein-rich crops under study (see Table 4). However, the amount of support varies greatly at Member State level, and as a result the effects of the measure vary greatly also. For instance, in Romania, where the amount of the aid for soya bean planned for 2015 was among the highest in Europe (i.e. 325€/ha), the case study reported that the measure has had significant effects on Romanian farmers' cropping choices. According to interviews in Romania, this soya bean production is almost entirely sold to other EU Member States to respond to the demand for beans, oil and meals.

According to interviews in Romania, the VCS, together with the GMO ban, have enhanced interest and the development of improved high-yield local conventional GM-free soya bean varieties adapted to the country's conditions.

EFA measures

With regard to the EFA measure, all Member States but Denmark have allowed nitrogen-fixing crops as EFA, but the exact list of the crops allowed differs at Member State level. Broadly, the Member States selected mainly pulses (peas, beans, chick pea, lupine and lentils), legume fodder (alfalfa and vetch) and soya bean, proposing lists of between 6 and 18 crops (see Table 4). In addition, the proportions of EFA types declared by farmers vary between Member States. In ten Member States[297], nitrogen-fixing crops (i.e. forage legumes, pulses and soya bean) represent more than 50% of the area declared as EFA in 2016, while it is less than 25% in six Member States[298] (see Figure 83).



*Data for France not available.

Figure 83: Share of EFA NFC area before weighting factors over total EFA area (%) in 2015 and 2016 (source: (Alliance Environnement, 2017))

The main crops declared as EFA N-fixing crops vary greatly between Member States. According to the evaluation of the greening measures, the main crops declared in 2015 were: soya bean in Croatia and

[297] SI, RO, EL, SK, CZ, LT, MT, EE, HR and IT

[298] DK, BE, NL, DE, LU and IE

Austria[299]; alfalfa in Spain and Romania[300]; other legume fodders in Bulgaria, the Czech Republic and Hungary; lupines in Poland[301] and dry pulses in Latvia, the United Kingdom, Lithuania and Germany[302].

As a result, the effect of the EFA measure varies from one Member State to another. One can observe that in several Member States the main N-fixing crop declared as EFA by farmers is also the main nitrogen-fixing crop grown in the Member State. Therefore, in these Member States, the EFA measures have supported a further increase or the maintenance of traditional crops (e.g. alfalfa in Spain or lupines in Poland). In other Member States it has fostered the cultivation of crops which were broadly non-existent before 2015. For instance, in Baltic countries (i.e. EE, LT, and LV), the EFA measure has encouraged a huge increase of the broad bean and field bean area (even though part of this increase started in 2014, before the implementation of Greening) (see Figure 84). The evaluation of the greening measures confirmed that this change is at least partly linked to the implementation of the EFA measure.

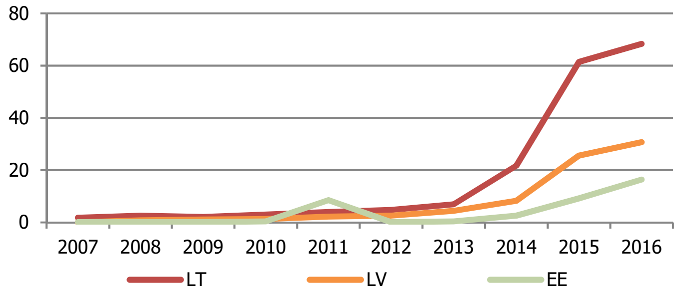


Figure 84: Broad and field bean areas in EE, LT and LV 2007-2016 (1000 ha) (source: Eurostat)

However, as explained above and according to the results of the evaluation of the greening measures (Alliance Environnement, 2017), the overall effects of the greening measures remain limited in most Member States. The cultivation of these crops is mainly market related or linked to agronomic benefits (in crop rotations) (see judgement criteria 3 and the EQ 1 and 2).

Crop diversification measure

With regard to the crop diversification measure, the measure requirements are the same in all member States with the exception of the equivalence scheme, which can be defined at Member State level (over the period 2015-2017 only 5 Member States[303] defined equivalence schemes).

Even though most rules are common, the agricultural context is different from one Member State to another, with different level of diversification of crop farms. As a consequence, the effects of the measure can differ at Member State level. This has been confirmed by the evaluation of the greening measures (Alliance Environnement, 2017). The analysis on nine Member States[304] made in the evaluation highlighted different effects. The share of arable land impacted by the measure ranges from 0.2 (in CZ) to 2.8% (in ES) among these ten Member States studied. Furthermore, farmers who had to diversify their cropping patterns did not introduce (or cultivate more) the same crops to comply with the measure. As a result, the crop diversification measure may have fostered an increase of forage legumes and/or pulses area in ES, PL and UK, while in CZ, FR and RO it may have favoured the cultivation of rapeseeds and/or sunflower. In Lithuania the measure may have enhanced the cultivation of both pulses and rapeseeds (see Table 42).

Overall, it should be kept in mind that even though differences can be observed, in the nine Member States studied, the effects concern less than 3% of the arable land.

[299] Soya bean represented 68% of the EFA N-fixing crop area in Austria in 2015

[300] Respectively 29% and 52% of EFA N-fixing crops

[301] 45% of EFA N-fixing crops

[302] Forage peas represented 38% and field beans 20% of the EFA N-fixing crop area in Germany in 2015

[303] AT, FR, IE, PL and PT.

[304] For Austria the data could not be presented in the Greening Evaluation due to confidentiality and statistical reasons.

Table 42: Most important changes in cropping patterns in the 10 case study countries of the Greening evaluation

	Crops for which the area increased	Total area impacted - absolute value (ha)	Arable land impacted (%) in the 10 MSs
ES	Legume plants, Peas, field beans and sweet lupines	317,432	2.8
DE	Rye, Barley	31,670	0.3
FR	Barley, Rape and turnip rape	34,345	0.2
PL	Peas, field beans and sweet lupines, Oat	46,004	0.5
RO	Sunflower, Rape and turnip rape	37,105	0.8
UK	Peas, field beans and sweet lupines, Oat	22,312	0.5
NL	Temporary grass, Other plants harvested green	7,059	0.7
LT	Peas, field beans and sweet lupines, Rape and turnip rape, Fallow	14,272	1.2
CZ	Barley, Sunflower	4,749	0.2
AT	Not available*	Not available	Not available

* Results cannot be presented for confidentiality and statistical reasons

Source: (Alliance Environnement, 2017)

5.3.5 Judgement criterion 3: Other factors (including other CAP measures) have had an effect on the area and/or production of pulses, oil seeds and legumes for forage, compared to the previous period

As explained in section 5.3.3, the EFA and crop diversification measures and the voluntary coupled supports have contributed to the favourable context which allowed the increase of the cultivation of protein-rich crops in the EU since 2014. This favourable context is also linked to other CAP measures, as well as other factors (i.e. outside CAP).

Within the CAP

Within the CAP, the cultivation of nitrogen-fixing crops or their introduction in rotations can be promoted under GAEC rules and/or under AECMs. These measure requirements and their effects on nitrogen-fixing crops cultivation depend on Member State choices. For instance, in the Czech Republic, farmers can grow nitrogen-fixing crops to comply with both the EFA and the GAEC 6 measures. In various Member States (e.g. PL, ES, FR and DE), the cultivation of nitrogen-fixing crops is promoted under at least one AECM. Even though these measures often concern limited area at EU level (especially for the AECMs), it may have also participated in the increase of nitrogen-fixing crops since 2015. For instance, in Germany, it was found that nitrogen-fixing crops formed a higher proportion of the total EFA area in those German Laender, where nitrogen-fixing crops are allowed as EFA and promoted under at least one AECM scheme (Zinngrebe et al., 2017). Furthermore, at EU level there is one EIP focus group on protein crops (supported under RDP funds in some Member States such as FR) which aims at improving the attractiveness of protein crops for farmers[305].

Other economic drivers

As explained in section 5.3.3, the increase of PRP area started before the implementation of the new CAP and is therefore partly linked to other economic drivers (i.e. not related to the CAP 2014-2020 measures). These other drivers are detailed in EQ 1 and 2. These drivers are mainly:

- the increasing demand for GM-Free feed products (especially for dairy value chains) (see EQ 7),
- the development of minimal legume fodder incorporation in private brands and PDOs/PGIs for dairy products,
- the development of value chains to supply the food industry (especially for soya bean and peas)[306],
- the indirect support for oilseed cultivation linked to the biofuel policy (for rapeseed and sunflower) (see below),

[305] See https://ec.europa.eu/eip/agriculture/en/publications/eip-agri-focus-group-protein-crops-final-report

[306] Interviews with representatives of the food industry highlighted that in Western EU (e.g. in France, Belgium and Netherlands) local soya bean value chains have been developed in the recent years with the support of soyfood companies (through contracts, technical supports, development of new varieties, etc.).

- agronomic drivers (as nitrogen-fixing crops, which includes forage legumes, pulses and soya bean, provide benefits to the rest of the rotation);
- pest and disease issues on pulses and limited development of varieties[307];
- farmers' habits and/or aversion to change.

Oilseed meals

Regarding oilseed meals, the other main factors that have probably impacted oilseed production in the EU since 2015 are:

- The biofuel policy for rapeseed;
- The competition with imported meals;
- Farmers' habits and/or aversion to change.

As for the biofuel policy, the Renewable Energy Directive of 2009 requires that Member States ensure that at least 10% of their transport fuels come from renewable sources by 2020. However, to limit the impact of biofuel production on land use allocations, the EU limited the share of biofuels from crops grown on agricultural land that can be counted towards the 2020 renewable energy targets to 7% (ILUC Directive). This target has been maintained in the framework of the second Renewable Energy Directive (RED II).

As illustrated in Figure 85 below, after the EU Directives, the European Union has experienced a drastic increase of its biodiesel use. This biodiesel is mainly produced from rapeseed in the EU but can also be produced from other oilseeds such as sunflower. This process provides around 55% of meals by tonne of oilseeds, with a protein content of around 40%. In 2015, 42.77Mt of oilcakes and meals were used by the compound feed industry in the EU, which represents approximately 56% of the crude proteins used by the compound feed industry (see Chapter 4).

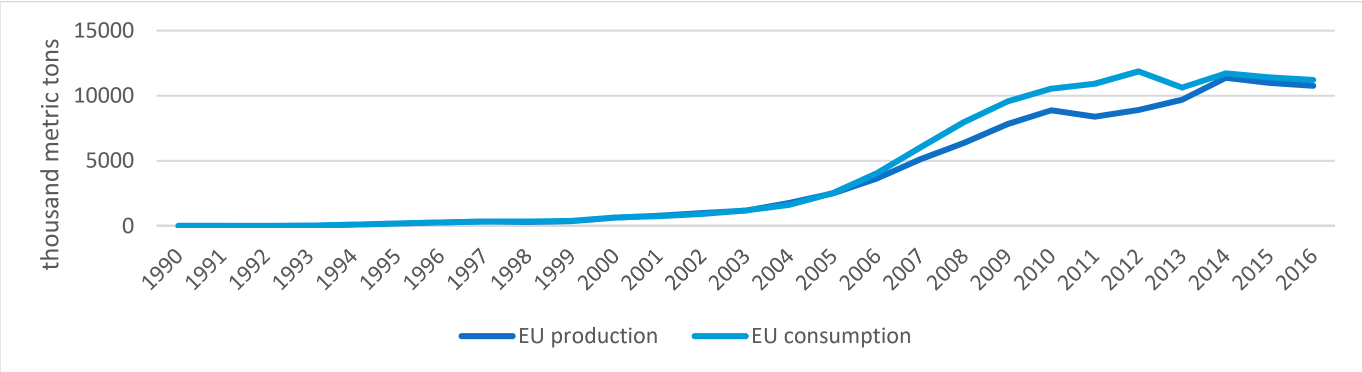


Figure 85: EU Biodiesel Consumption and Production (source: Eurostat, 2018)

However, it should be noted that although the EU energy policies boosted the demand for biofuel, rapeseed (which is the main oilseed used for the biodiesel production in the EU) area has overall remained stable over the period 2006-2016 (cf. figure 86). The increasing demand for biofuel has been partly met by an increase of the importation of biodiesel (mainly from Argentina, Malaysia and Indonesia) and rapeseed (mainly from Australia and Ukraine). When rapeseed is imported, it enhances the production of meals (as a by-product of oil) in the EU, but when biofuel is imported, it has no effect on the production of meals.

Furthermore, the renewable energy policy may have also boosted production of cereals, to make bioethanol. The by-products of this process (representing 30 to 35% of the cereals entering the process), are Dried Distillers Grains with Solubles (DDGS). They contain on average 28 to 35% proteins and also provide the feed market with very significant volumes. In 2015, 17.22Mt of co-products from the food and bioethanol industry were used by the compound feed industry in the EU, which represents approximately 17% of the crude proteins used by the compound feed industry (see chapter 4).

This shows that these by-products of industries not dedicated to the PP market provide very significant amounts of protein dedicated to feed and that a significant share of this demand is presently covered by these products.

[307] In spite of a limited production in the EU (832,000 ha in 2016) compared to other PRPs, the research to produce new soya bean varieties is still active in the EU (several companies) and some other countries are also conducting significant research on it (e.g. Canada) which provides a range of improved GM-Free varieties to farmers.

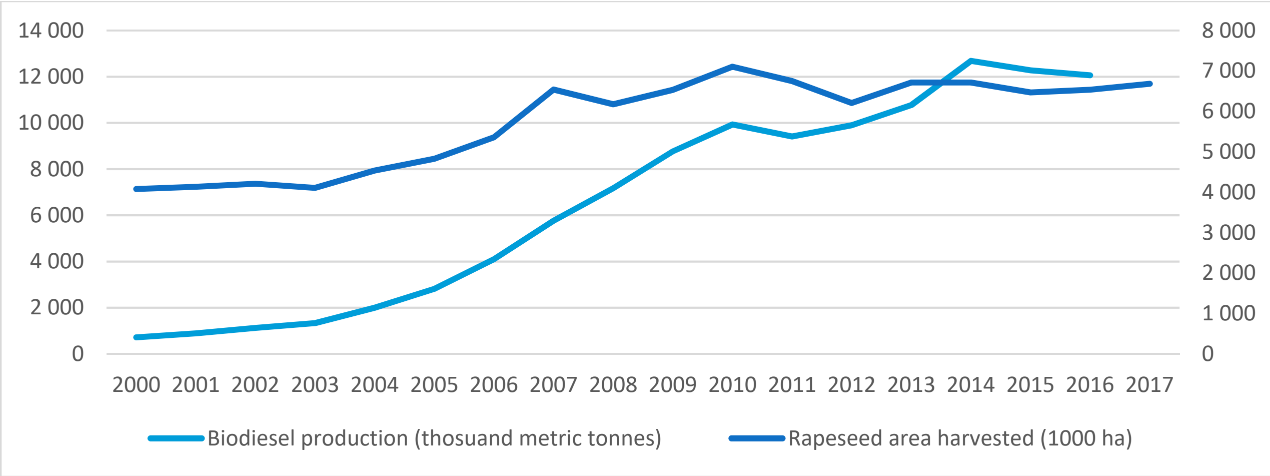


Figure 86: ***European Biodiesel and Rapeseed Production (Source: Eurostat 2018)***

5.3.6 Conclusion of EQ 3

The cropping area of soya bean and dry pulses has increased since 2015 and the implementation of the voluntary coupled supports and the greening crop diversification and the EFA measures have probably been drivers of this increase, at least in some areas. However, other economic factors within or outside CAP have also participated in the overall favourable context which has driven the increase of protein-rich crops in 2015 (compared to the situation in 2010-2014). With regard to the forage legumes and fresh pulses (grown for human consumption), the area remained stable between 2010 and 2015, and the evaluation of the greening measures did not highlight any noticeable effects of the measures under study (Alliance Environnement, 2017).

The main economic drivers influencing the production of protein-rich crops have been identified in EQ 1 and 2. Based on the result of EQ3, the following matrix presents the relationship between the measures with these drivers.

Overall, the CAP measures under study have a neutral relationship with the drivers identified in EQ 1, the main exception being supply availability and the EU origin which may be enhanced by the three measures implemented in 2015 (i.e. the Greening EFA and DIV measures and the VCS). However, the pesticide ban implemented in 2018 may deter some farmers from growing forage legumes, pulses or soya bean to comply with the measure. Furthermore, it may lead to increased yield variability for these crops (e.g. in Romania according to the case study).

With regard to the increase of the weighting factor, the potential effects are unclear since it may on the one hand make nitrogen-fixing crops a more attractive option for farmers to comply with the measure, but the farmers who grow nitrogen-fixing crops to comply with the measure may reduce their nitrogen fixing crop area.

Table 43: Assessment of the coherence between the relevant CAP measures and the economic drivers influencing the quantity and geographical origin of the different supply sources of plant proteins in the EU

CAP measures	Both feed and food		Feed		Food	
	Supply availability	Yield variability	Price	Protein content	Quality	Origin (EU)
Greening EFA measure						
Implementation of a pesticide ban on EFA area						
Increase of the weighting factor for nitrogen-fixing crops						
Greening crop diversification measure						
VCS						

	complementary or synergistic relationship		contradictions or competition
	neutrality, or no particular association		not possible to conclude

Source: own work

5.4 EQ 4 – On the coherence of the CAP instruments with the uses/demands

To what extent have the measures applicable to arable crops been coherent and/or complementary to the economic drivers influencing the different uses/demands on the EU plant proteins market to ensure a viable production of plant proteins in the EU?

This analysis had to address the current uses of plant proteins in the EU, including different market demands for feed uses, food uses and other uses.

5.4.1 Understanding of the question

This EQ is focused on the coherence of the evaluated measures, namely: VCS, Diversification and EFAs, with the different uses and demand of PP, having in mind that actually none of the studied measures is dedicated to increasing or influencing the demand for PP. It focuses on conventional markets and EQ 7 specifically treats premium markets such as organic and GM-Free markets.

The VCS aim at developing/maintaining the cultivation of the supported crops/plants. In that sense they may influence their supply and, if there is a demand for these products, they may help in meeting this demand. As for most of the studied crops, demand is higher than the EU supply; any measure which increases their production in the EU can be coherent with use and demand satisfaction.

For Diversification and EFAs the reasoning is different, as it is not the first objective of these measures (see logic of intervention of these measures in chapter 2) to develop any supply and in consequence to meet the demand for these products. We will then only check if their implementation has led to an improvement of the supply of the concerned products for those whose demand is higher than the EU supply.

5.4.2 Method and limitation

As mentioned in Chapter 1, this study is focused on protein-rich crops/plants (>15% crude protein). As context, we of course also studied the other main sources of plant proteins and in particular cereals and grass and considered them as “other factors” influencing the studied sectors.

For this question our answer is focused on the two main markets of PRP products, meaning feed and food markets. Market segments as such are treated in EQ 6. For each of them, we first compare the EU supply and then see to what extent the demand is higher (or not) than this supply. On this basis we then appraise to what extent the concerned measures influenced this supply to see how significant their role was in helping to meet the demand.

The last step of this EQ is to study the effect of the other economic drivers on the demand for the studied products and then to conclude.

5.4.3 Judgement criterion 1: There are (or not) uses and demand for the PRP products concerned by VCS, DIV and EFAs

Part of the crops and plants concerned by VCS, Diversification, and EFAs can clearly be PRP (e.g. peas, field beans and sweet lupine, legume crops, soya, oilseeds, etc.) and can supply the feed and food markets. EQ 3 gives details on the main plants/crops concerned and chapter 4 describes the main PRP markets. For both of them a significant demand exists, partially covered by the EU production (see EQ 5).

5.4.4 Judgement criterion 2: The EU demand for these PRP products is higher (or not) than the EU supply and the VCS, DIV and EFAs may have had an impact on the balance.

The paragraphs below analyse the breakdown of supply and demand by type of crop/plant. We present the share of the concerned products going to the food and feed markets.

5.4.4.1 Pulses

Pulses comprise a series of productions dedicated to the market for food and feed. Table 44 gives details on supply and demand by market type.

Table 44: Pulse market supply and demand in million tonnes and coverage and export rates (2016-17)

	Supply	Demand

Plant/Crop	Usable EU production (A) (%=A/C)	Import (B) (% = B/C)	Total available (C) (= A+B) 100%	Food *dried* (D) (% = D/C)	Feed (E) (% = E/C)	Export (F) (% = F/C)
Pulses	**5.7 (82%)**	**1.3 (18%)**	**7**	**1.9 (26%)**	**4 (56%)**	**1.2 (18%)**
Peas	2.7 (95%)	0.2 (5%)	2.8	0.7 (22%)	1.5 (54%)	0.7 (24%)
Lentils	0.06 (18%)	0.2 (82%)	0.3	0.3 (98%)	0	0.05 (2%)
Lupines	0.3 (56%)	0.2 (44%)	0.5	0.005 (1%)	0.5 (99%)	0
Chick peas	0.07 (29%)	0.2 (71%)	0.2	0.2 (82%)	0	0.04 (18%
Broad beans	1.9 (99%)	0.01 (1%)	1.9	0.2 (12%)	1.3 (66%)	0.4 (22%)
Beans and other dry pulses	0.7 (59%)	0.5 (41%)	1.2	0.5 (44%)	0.6 (50%)	0.07 (6%)

Source: own calculation based on DG Agri working document

This table shows that, on average, pulses are mostly used for feed (2/3 of the internal use). This average situation actually hides highly contrasted demand situations, from lentils and chick peas used only for food, to sweet lupines used almost exclusively for feed. In all cases a demand exists for all produced pulses. The analysis of trade and the balance between supply and demand is done in the following EQs.

As explained in EQ 3, the CAP measures may have contributed to the increase of pulse area since 2015. The increase of domestic supply for pulses has probably helped in meeting the domestic demand for both food and feed. This may have helped the food industry to respond to the increasing demand for local food products (see chapter 4 about the food market segments), especially in Western EU.

5.4.4.2 Oilseeds

For oilseeds, the situation is more complex as a small part of the production is sold as grain (less than 1%), while most of it is processed to produce oil and meals[308]. Chapter 2.1 and Table 45 show these flows.

Table 45: Oilseed market supply and demand in million tonnes and coverage and exports rates (2016-17)

	Supply			Demand			
Plant/Crop	Usable EU production (A) (%=A/C)	Import (B) (% = B/C)	Total available (C) (= A+B) 100%	Feed (D) (% = D/C)	Food (E) (% = E/C)	Other uses *(mainly oil extraction/meal production)* (F) (=C-D-E-F) (% = F/C)	Export (G) (% = G/C)
Oilseed grain	**31.0**	**19.5**	**50.5**	**1.8**		**47.8**	**0.9**
Soya bean	2.5 (14%)	14 (86%)	16.5	1.2 (7%)	>0.6[309] (>4%)	<14.5 (<88%)	0.2 (1%)
Rapeseeds	20.1 (86%)	4.7 (14%)	24.8	0.5 (2%)	Negligible	24 (~97%)	0.3 (1%)
Sunflower	8.5 (94%)	0.8 (6%)	9.3	0.2 (2%)	Negligible	8.7 (~94%)	0.4 (4%)
Oilseed meals	**29**	**22.2**	**51.2**	**49.9**			**1**
Soya bean	11.2 (38%)	18.3 (62%)	29.5	29 (98%)			0.2 (<1%)
Rapeseeds	13.5 (99%)	0.2 (1%)	13.7	13.2 (96%)			0.5 (4%)
Sunflower	4.3 (54%)	3.7 (46%)	8	7.7 (96%)			0.3 (4%)

Source: own calculation based on DG Agri Balance sheet and ENSA data

Rapeseed and sunflower seeds

Table 45 shows that most of the volumes go through oil processing first, in order to supply the oil market. Then the meals obtained go exclusively to the feed market. Most of these products are used in compound meals; the rest is provided as-is to farmers who make their own formulations. The measures under study have had no significant effects at EU level on rapeseed and sunflower production, and hence not on their demand and uses either.

Soya bean

According to estimations and interviews with experts, between 4 to 10% of the soya bean produced in the EU is used for soyfood. According to interviews, the soy-food value chains send some of their by-products (e.g. okara) to the feed market for use. For both food and feed markets, these productions are easy to sell as soya bean is generally sought after. By fostering the production of soya bean in the EU, the Greening measures (EFA and Diversification) and VCS may have facilitated the development of local value chains for the production of soy-food. However, the evaluation of Greening measures

[308] Soya bean is an exception as part of it goes to the food market, without any oil processing.

[309] Soya bean used by ENSA members in 2017

(Alliance Environnement, 2017) and interviews have pointed out that the main drivers of this development have been the growing demand for soy-food and the increasing interest of the consumers for local value chains, rather than CAP measures.

5.4.4.3 Dried legume fodders

For fodder, 99% of the demand is satisfied by the EU production and most of the volumes are on-farm produced. As shown in Table 46, legume fodders are only used for feed.

Table 46: Dried fodders market supply and demand in million tonnes (12% moisture content) and coverage and export rates (2016-17)

	Supply			Demand		
Plant/Crop	Usable EU production (A) (%=A/C)	Import (B) (% = B/C)	Total available (C) (= A+B) 100%	Food *dried* (D) (% = D/C)	Feed (E) (% = E/C)	Export (F) (% = F/C)
Dried fodder	24 722 (99%)	0.022 (1%)	24,744	0 (0%)	24,720 (99%)	1.879 (1%)

The evaluation of Greening measures has shown that at EU level the measure has not had significant effects on legume fodder production and therefore its availability for feed use.

5.4.5 Judgement criterion 3: Other factors (including other policy measures) have had an effect on the uses/demands for pulses, oilseeds and forage legume, compared to the previous period

Pulses

As explained above, various drivers may have participated in the increase of the pulse area since 2015, such as the growing demand for local value chains and for plant-based food products (see EQ 3).

Furthermore, the sales of pulses can also be hindered by quality issues. For example, over the past few years some diseases or pests have developed in the EU which hampered the development of pulses and also their trade. Several examples from case studies show that:

- Part of the beans that were still recently sold to Egypt as food are not sold there anymore due to some damage caused by weevils (various *chrysomelidae* beetles). These attacks resulted in sufficiently significant flawed appearance to downgrade the product for the feed market for salmon aquaculture in Norway.
- Similarly, peas, when they are sold as food, have a very high selling price and a good gross margin, but when damaged by diseases or climatic events, a significant price fall can be observed.

This sensitivity of pulses to diseases and pests is actually the result of their involuntary introduction and of a lack of research to find varieties better adapted so as to resist these attacks and produce more regular yields of a given quality (see EQ 3). This is also true for the resilience to climatic events. The volume of production of these products is often too low to incite the private sector to produce improved seeds. Then, time after time, these productions are abandoned by EU producers and the market is supplied by imports.

Rapeseed and sunflower

The main economic external factors that significantly influenced the uses/demand for rapeseed in the past years was clearly the biofuel context. Since 2009, various policy changes have boosted the development of the biofuel industry in the EU. This has been a major driver for the production of rapeseed (and to a lesser extent sunflower) in the EU. However, as explained in EQ 3, the increasing demand for biofuel has also been met by an increase of imports (of both rapeseed and biofuel).

To a lesser extent, over the past few years, EU rapeseed meal use has also been fostered by the growing demand for GM-free feed for the dairy sector in various Member States, especially Germany and Austria and, to a lesser extent, Poland and France.

Soya bean

Similar to pulses, the demand for EU soya bean has been boosted over the past few years by the increasing demand for vegetarian food and local food.

Moreover, Chapter 4 shows that the composition of soya bean seed is considered as one of the most adapted for feed use (and even for food) in terms of equilibrium of the various amino acids it contains. In addition, soya bean which is classified as oilseed actually has a protein content most of the time above 40% in the EU. Hence, the area of soya bean is increasing significantly each year (438,000 ha in 2010 to 832,000 in 2016) because of these specific qualities and because of a better resistance to diseases and pests than most pulses.

Legume fodders

As for legume fodders, their use and demand may have been impacted by:

- the development of minimal legume fodder incorporation in private brands and PDOs/PGIs for dairy products,
- the development of non-GM milk value chains,
- the development of the organic market, especially for dairy and suckling cow farms, where alfalfa/clover are needed as break crops and can contribute to the protein autonomy in a context of soya bean sourcing shortage.

5.4.6 Conclusion of EQ 4

For all these productions, the studied measures could have had an effect on the EU supply, but even if positive, EQ 3 shows that this effect was limited, if not even insignificant (for rapeseed and sunflower) at EU level. For pulses and soya bean, this effect is coherent with several economic drivers of the demand, namely the increasing demand for local food and the development of GM-free-feed-based value chain for poultry and dairy products in some Member States. However, in general, compared to the volume consumed, the effects of the measure are too small at EU level to observe any synergy.

Table 47: Assessment of the coherence between the relevant CAP measures and the economic drivers influencing the different uses and demands of plant proteins in the EU

CAP measures	Feed		Food		
	Animal production and feed demand	GM-free value chain development	Demand for plant-based food	Demand for local food	Demand for whole grain pulses
Greening EFA measure	neutrality	complementary	neutrality	complementary	neutrality
Greening crop diversification measure	neutrality	complementary	neutrality	complementary	neutrality
VCS	neutrality	complementary	neutrality	complementary	neutrality

complementary or synergistic relationship (green)	contradictions or competition (red)
neutrality, or no particular association (yellow)	not possible to conclude (grey)

Source: own work

5.5 *EQ 5 – On the coherence of the CAP instruments with internal and external trade*

To what extent have the relevant CAP measures applicable to arable crops been coherent and/or complementary to the economic drivers affecting the internal and external trade in plant proteins to ensure a viable production of plant proteins in the EU?

The analysis had to address both plant proteins produced in the EU and imported, as well as plant proteins supplied directly from crops (like pulses or fodder crops) and indirectly from by-products of other supply chains (like meals from oilseed crushing).

5.5.1 Understanding of the question

While none of these measures – VCS, Diversification and EFAs – is linked to trade as such, the EQ focuses on the coherence of the evaluated measures, with the internal (within the EU) and external (EU and rest of the world) trade. It focuses on conventional markets and EQ 7 specifically treats the premium markets such as organic and GM-Free markets.

As mentioned in the previous EQ, VCS aim at increasing the supply of the concerned crops/plants whereas Diversification and EFAs have, above all, environmental goals and only incidental effects on production. We nevertheless try to show to what extent these measures have influenced the internal and external trade of the concerned PRP products.

5.5.2 Method and limitation

As mentioned in Chapter 1, this study is focused on protein-rich crops/plants (>15% crude protein).

For this question we build on EQ 4 and see, for each use and demand, which ones concern internal and external trade. For those, we appraise to what extent these measures have influenced these exchanges and are coherent with them.

The last step of this EQ is to study the effect of other economic drivers on internal and external trade of the studied products and then to conclude.

5.5.3 Judgement criterion 1: There is (or not) internal and external trade for the PRP products supplied directly from crops (like pulses or fodder crops) concerned by VCS, DIV and EFAs

Chapters 3 and 4 show that there are internal and external trades of PRP products supported through VCS or concerned by Diversification and EFAs measures. These products are mainly:

- pulses: broad and field beans, peas, chickpeas, lupines, lentils, etc.,
- legume fodders,
- oilseeds (soya bean, rapeseed and sunflower) and their meals.

5.5.4 Judgement criterion 2: The main PRP crop/plant products supplied directly from crops (like pulses or fodder crops) linked to VCS, Diversification and EFAs have (or not) a significant effect on internal and external trade and are coherent with economic drivers affecting it

It has been shown in EQ 3 that VCS, Diversification and EFAs measures, when they concern PRP, have had a limited effect on production of oilseeds, pulses and fodder. However, they have probably participated in the overall favourable context for an increase of the production of some crops (e.g. soya bean and pulses) and allowed the maintenance of others (legume fodders), at least in some Member States.

Based on Chapter 3, which describes the main internal and external trades of these products, we show in Table 48 the coverage of the market by the EU production and the export rates for these three types of studied crops.

5.5.4.1 Pulses

With regard to external trade, Table 48 shows that there is for pulses a certain deficit of these productions in the EU (import represents 18% of the consumption but the exported volumes are very similar). Nevertheless, this average situation shows in fact highly contrasting situations, from broad beans for which imports represent only 1%, to lentils for which they represent 82% of the supply and almost all the demand.

Table 48: Pulse market supply and demand in million tonnes and coverage and export rates (2016-17)

	Total supply			Total demand		
Plant/Crop	Usable EU production (A) (%=A/C)	Import (B) (% = B/C)	Total available (C) (= A+B) 100%	Food *dried* (D) (% = D/C)	Feed (E) (% = E/C)	Export (F) (% = F/C)
Pulses	**5.7 (82%)**	**1.3 (18%)**	**7**	**1.9 (26%)**	**4 (56%)**	**1.2 (18%)**
Peas	2.7 (95%)	0.2 (5%)	2.8	0.7 (22%)	1.5 (54%)	0.7 (24%)
Lentils	0.06 (18%)	0.2 (82%)	0.3	0.3 (98%)	0	0.05 (2%)
Lupines	0.3 (56%)	0.2 (44%)	0.5	0.005 (1%)	0.5 (99%)	0
Chick peas	0.07 (29%)	0.2 (71%)	0.2	0.2 (82%)	0	0.04 (18%)
Broad bean	1.9 (99%)	0.01 (1%)	1.9	0.2 (12%)	1.3 (66%)	0.4 (22%)
Beans and other dry pulses	0.7 (59%)	0.5 (41%)	1.2	0.5 (44%)	0.6 (50%)	0.07 (6%)

Source: calculation based on DG Agri working document

Roughly, there are two cases:

- for broad beans and peas, the imports are very limited (less than 5%) whereas the exports are significant (22 to 24%). For these crops, the internal demand remains the main driver, but external demand is significant. As explained in EQ 3, the EFA measures have probably favoured the increase in production of field peas and broad and field beans in the EU and therefore may have favoured the exports of these productions to external food markets (e.g. in Egypt for broad and field beans). Therefore, the EFA measure has worked coherently with this driver (the external demand). As for the VCS and crop diversification measures, their effects on these productions are too limited to have had any effects on trades;
- for the rest of the products, concerning significantly the food sectors, imports are very significant, whereas exports are very limited (less than 6%) except for chickpeas, for which 18% are exported. For them, internal demand is almost the only driver. The effects of the CAP measures on these productions, except lupine, were not studied in the framework of the Greening evaluation due to data limitations[310]. As for lupine, the EFA measure (together with the VCS and the crop diversification measure) have probably contributed to the increase of the production of lupine, but there is no proof that lupine is exported from Poland. Therefore, there is no evidence that the measures under study have been coherent with the economic driver linked to the trade.

With regard to the internal trade, the main exchanges are detailed in Chapter 3[311]. Broadly, with regard to field peas, the main exporter is France, sending them to Belgium (and then to Germany), to Italy and Germany. Concerning field beans, the main exchanges come from Lithuania to Latvia (and then to France) and to the UK. Interestingly, EQ 3 shows that the EFA measure (together with the other measures under study) have probably fostered the increase of field pea production in France and broad bean production in Lithuania and Latvia; therefore, EFAs may have favoured the internal trade coming from these Member States (FR, LT and LV).

5.5.4.2 Dried fodders

As highlighted in Chapter 3, a significant part of the dehydrated fodder production in the EU is exported. The main destination of alfalfa meal, pellet or bale export is to the Arabian Peninsula, but it is also exported to many regions of the world such as Switzerland, China, Saudi Arabia and Tunisia. Therefore, the main driver of the external trades is the external demand.

Inside the EU, most of alfalfa meal and pellet trade come from France and Spain, going to Belgium, Germany and Portugal. With regard to Alfalfa bales, most of the trades come from Germany to Austria.

As explained in EQ 3, the evaluation of the Greening measures did not highlight any significant effects of the VCS, EFA and Diversification measures on legume fodder production in the EU, even though it may have participated in the maintenance of the area since 2015. No analysis was conducted specifically for dried fodder[312], but according to interviews in FR and ES, the measures may have helped maintain the area after the end of the direct support to drying plants (which was available until 2013) in some Member States (e.g. FR and ES) even though the main driver for production remains the demand.

5.5.4.3 Oilseed and oilseed meals

With regard to the external trade, as shown on Figure 87 below, the supply balance of each oilseed meal is different:

- Most rapeseed meal is produced in the EU (imports and exports are negligible compared to production), and mainly from seeds which are also produced in the EU (even though some rapeseeds are imported).
- Broadly half of the sunflower meals supplied in the EU come from imports (from the Black Sea region mainly), consisting mostly in hi-pro sunflower from this region. The rest of the sunflower meal is produced from seeds cultivated in the EU.
- Most of the supply of soya bean grains and meals comes from non-EU States mainly for feed.

[310] On the Eurostat database, the only pulses for which disaggregated data is available are broad and field beans, field peas and lupines ;

[311] For broad and field beans, field peas, lentils, dry beans and chick peas.

[312] Due to data limitations since the Eurostat database does not include data about dry pulses production in the EU.

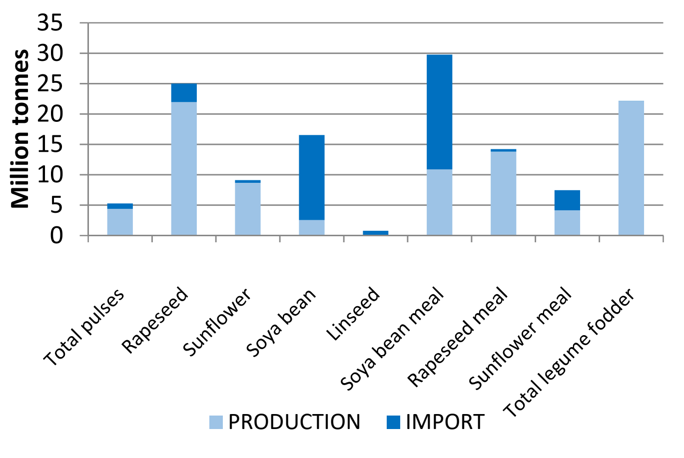


Figure 87: Supply (and export) of oilseeds and their by-products in the EU (Million tonnes; Eurostat, Comext, FAOSTAT[313]).

As explained in EQ 3, the crop diversification measure has probably been a driver for some farmers to introduce rapeseed or sunflower in their cropping patterns, but this change is limited at EU level (less than 1% of EU arable land has been impacted by the measure) and is unlikely to have impacted rapeseed meal and sunflower meal trade. Overall, the external trade of rapeseed meal and sunflower meal is mainly driven by other factors, namely the demand for oil for biodiesel and the competitiveness of hi-pro sunflower from the Black Sea region (see judgement criterion 3, below). As for soya meal, EQ 5 explains that the effects of the VCS, EFA and Diversification measures are too small to have had any impact on the imports of soya bean grains.

As for the internal trade, as explained in Chapter 3, Germany is the main importer of rapeseed, which comes mainly from France, Poland and the Netherlands (mainly as importer through sea ports). Germany is also a significant exporter of rapeseed meal, going to the Netherlands.

Sunflower grain mainly comes from Romania and Bulgaria and is sent to the Netherlands (also mainly as importer through sea ports), and sunflower meal comes mainly from the Netherlands (mostly from Black Sea countries) and sent to Belgium and the UK. Hungary sends its sunflower meal mainly to Germany.

Overall the effects of the crop diversification measure are too small to have impacted the internal trades in the EU. Interestingly, only two Member States have granted VCS for rapeseed and/or sunflower (i.e. Spain and Latvia) but are not major players in the internal trade.

As for soya bean grains and meal, the biggest volume on the internal trade concerns the distribution of imports between member states, more than the exchanges of European soya bean production. There is also some internal exchange of soya bean produced in the EU (e.g. in Romania) but these exchanges mainly concern soya bean grains used for food (and which are not crushed). One exception highlighted by the case studies is the production of soya bean cake in Eastern France, which is partly exported to Germany to supply the demand in GM-Free meal. However, this only concerns limited volumes (less than 20,000 t in 2015) and therefore this effect is negligible compared to the total volume exchanged.

5.5.5 Judgement criterion 3: Other factors (including other CAP measures) have had an effect on internal and external trade of pulses and legumes for forage

For internal and external trades, one of the main external factors is the GATT Dillon Round of 1962. In this agreement, the EU opened its border to oilseeds, oilseed products and non-grain feed ingredients, to the U.S. and other exporters, allowing their products to enter the European market duty free. One of the main effects of this agreement on pulses was the development of soya bean imports which resulted in a large decrease in pulses and other PRP use because of at least two main causes:

- The higher protein content of soya bean (and its composition) compared to pulses,
- The very competitive price of the imports in duty free.

However, the external trade of rapeseed and sunflower meal is mainly driven by other factors, namely the demand of oil for biodiesel and food and the competitiveness of hi-pro sunflower from the Black Sea region (see judgement criterion 3, below).

5.5.6 Conclusion of EQ 4

[313] Data comes from Eurostat for production, from Comext for import and export and from FAOSTAT for Chickpeas, Lentils, Dry beans and Linseed productions as data wasn't available on Eurostat for these crops. Dried legume fodder production has been estimated according to EUROSTAT, ISTAT and MULTISWARD and import and export combining 12149090 and 121410 Comext categories.

Data for sweet lupines and alfalfa is not available, so this graph does not include these two crops.

For all these productions, the studied measures could have had an effect, but even if positive, EQ 3 shows that the effect was limited. However, in some specific cases, it may have fostered the production of pulses and soya bean in exporting (in internal or external trade) Member States and therefore boosted their exports. Regarding legume fodders, there is no proof that the measures have enhanced production, but it may have helped to maintain the area after the end of direct support to drying plants (which was available until 2013) in some Member States (e.g. FR and ES). The measures have had no significant effects on the internal and external trades of oilseed by-products in the EU. Internal and external trades of oilseed by-products are mainly driven by other factors such as the competitiveness of imported products (mainly for soymeal and sunflower meal), the absence of import tax for oilseeds and their by-products on the EU border (since the agreement from the GATT Dillon Round of 1962) and the oil demand for biodiesel production.

Table 49: Assessment of the coherence between the relevant CAP measures and the economic drivers affecting the <u>internal and external trade</u> in plant proteins to ensure a viable production of plant proteins in the EU

CAP measures	Pulses				Soya bean (grain)				Legume fodders			
	EU Internal trade		External trade		EU Internal trade		External trade		EU Internal trade		External trade	
	Internal demand	External demand	Internal demand	External demand	Internal demand	External demand	Internal demand	External demand	Internal demand	External demand	Internal demand	External demand
Greening EFA measure												
Greening crop diversification measure												
VCS												

complementary or synergistic relationship — contradictions or competition

neutrality, or no particular association — not possible to conclude

Source: own work

5.6 *EQ 6 – On the coherence of CAP instruments with the development of the different <u>market segments</u>*

To what extent have the relevant CAP measures applicable to arable crops been coherent and/or complementary to the economic drivers affecting the development of different <u>market segments</u> to ensure a viable production of plant proteins in the EU?

The answer to this question had to provide a detailed analysis of the different market segments in place for plant proteins (from producers to the retailers) with regard to quantity, quality and geographical distribution.

5.6.1 Understanding of the question

Chapter 4 and EQ 1 and 2 provide information on the main uses and market segments of the PRP.

The two main market segments considered are feed (most significant volumes and trade) and food. The answer to this EQ focuses on conventional markets and EQ 7 specifically treats premium markets such as organic and GM-Free markets.

In addition to these markets, the biofuel market significantly influences the production of mainly meals of rapeseed and sunflower for biodiesel[314] for the feed market, as by-products of the production of oil,[315] but they do not concern the organic and GM-Free markets.

[314] But also meals of cereals for ethanol, through Dried Distillers Grain with Solubles (DDGS)

[315] The same is also happening with the ethanol market for cereals, which also provides PP coming from its by-products.

5.6.2 Method and limitations

As mentioned in Chapter 1, this study is focused on protein-rich crops/plants (>15% crude protein). As context, we nevertheless also study the other major sources of PP and in particular cereals and grass.

This EQ studies to what extent the studied CAP measures are coherent and/or complementary to the economic drivers affecting the development of different market segments in terms of feed and food.

Forage legumes are not concerned within the food segment. As for rapeseed and sunflower, their use as protein for food is considered as negligible.

Geographical distribution is briefly studied mainly through some examples coming from case studies.

The last step of this EQ is to study the effect of the other economic drivers on the market segments of the studied products and then to conclude.

The main difficulty concerns data availability for some value chains and the relative weight of external factors, as a very significant part of protein supply comes from cereals for feed and food and grass for feed.

5.6.3 Judgement criterion 1: The implementation of VCS, Diversification and EFAs resulted (or not) in changes in the supply and demand of the feed market for pulses, oilseeds and legumes for forage, compared to the previous period

None of the evaluated measures has an influence on the demand side of the feed markets. For supply, EQ 3 and 4 showed that the measures did not significantly impact the supply in rapeseed and sunflower. Similarly, for soya bean, even though the measure may have favoured the increase of production in some Member States (e.g. FR and RO), these effects are too limited to have impacted the global supply of soya meal for feed (see EQ 5). Furthermore, soya bean produced in the EU is GM-free and is therefore mainly used either for food or to produce animal product feed with GM-Free feed (i.e. on premium markets, which are not in the scope of this question). The measures may have encouraged the supply of pulses in some Member States (e.g. DE, ES, FR, LT and UK) for feed. Finally, no significant effect of the measure on legume fodder has been highlighted, even though it may have participated in the maintenance of the area since 2015.

5.6.4 Judgement criterion 2: The implementation of VCS, Diversification and EFAs resulted (or not) in changes in the supply and demand of the food market for pulses and oilseeds, compared to the previous period

None of the evaluated measures has an influence on the demand side of food markets. For supply, EQ 3 showed that the area of soya bean and pulses has increased since 2015 and that the EFA, Diversification and VCS measures may have contributed to this increase. Therefore, it may have boosted the supply of pulses and soya bean grains used for food. As explained above, the soya bean produced in the EU is GM-free and therefore is of particular interest for food. Furthermore, interviews with representatives from the food industry[316] in case study Member States highlighted that some food companies tend to favour local supply (with contracts) of protein-rich crops, rather than imports, in order to manage the quality of the crops, ensure the stability of their supply and limit their carbon footprint (e.g. in the framework of a marketing strategy). According to interviews in France, the CAP measures, and especially the EFA and VCS measures, have fostered the production and helped some food companies develop their local supply. However, there are worries that the implementation of a pesticide ban on EFA areas (from 2018 onward) may deter farmers from growing these crops as EFA areas and therefore reduce the incentive for pulses and soya bean production in the EU (see EQ 3).

5.6.5 Judgement criterion 3: Other factors (including other CAP measures) have had an effect on the production of pulses, oilseeds and legumes for forage, for the feed and food sectors compared to the previous period

5.6.5.1 Feed sector

As shown in EQ 1, 4 and 5, the main two external factors that influenced the feed market segments of seeds are:

[316] E.g. representatives from Nutrition & Santé and Roquette in France, Emsland group in Germany and ALPRO in Belgium (which is not a case study of Member States, but ALPRO was contacted in the framewotk of interviews at EU-level)

- the 1962 Dillon GATT agreement that allowed oilseeds, oilseed products and non-grain feed ingredients, from the U.S. and other exporters, to enter the European market duty free,
- the biofuel regulation that encourages the cultivation of oilseeds (particularly rapeseed for biodiesel) but also of cereals (for bioethanol). Both of these developments resulted in the production of by-products rich in proteins (oilseed meal for biodiesel and DDGS for bioethanol) which are used by feed makers in compound meals,
- the competitiveness of EU production compared to imported alternatives.

For fodders the main drivers are:

- the external demand for dried fodders (Arabian Peninsula mainly) (see EQ 6 and chapter 3),
- the production of fodder for self-feed consumption,
- the standards linked to PDO and PGI for some animal products (e.g. Parmigiano cheese in Italy, see chapter 4).

5.6.5.2 Food sector

As shown previously in EQ 2, 4 and 5, the main external factors that influenced the supply for the food market segments are:

- the limited supply in the EU due to erratic yields and pest and disease issues (e.g. weevil *bruchus* and *Aphanomyces euteiches*), the lack of pest-resistant and high-yielding varieties (due to limited research and development for these crops), etc. (see EQs 2 and 5),
- the competitiveness of imported pulses and soya bean grains,
- the increasing demand for local foods (e.g. PDO/PGI products, mention of the country of origin on food products, etc.),
- the increasing demand for vegetarian, vegan and gluten-free food (see chapter 4),
- the increasing demand of protein-rich functional ingredients for the food industry (see chapter 4),
- consumer eating habits and the increasing demand for convenient food (see chapter 4).

5.6.6 Conclusion of EQ 6

Overall, none of the evaluated measures has an influence on the demand side of feed or food markets.

Table 50: Assessment of the coherence between the relevant CAP measures and the economic drivers affecting the development of different <u>market segments</u> to ensure a viable production of plant proteins in the EU

CAP measures	Pulses				Soya bean (grain)				Legume fodders		Rapeseed and sunflower		Oilseed meals	
	Feed		Food		Feed		Food		Feed		Feed		Feed	
	Supply	Demand	Supply	Demand	Supply	Demand	Supply	Demand	Supply	Demand	Supply	Demand	Supply	Demand
Greening EFA														
Greening crop diversification														
VCS														

complementary or synergistic relationship — contradictions or competition
neutrality, or no particular association — not possible to conclude

Source: own work

With regard to the supply, the effects of the measures are too limited to have significantly impacted the supply for the feed sector (considering the huge volumes at stake and the limited effects of the measures). As for the food sector, the EFA and VCS measures may have fostered the development of local supply chains for food companies in some Member States (e.g. BE, DE and FR). Table 50 summarises the main conclusions as regards the coherence of the measures with the economic drivers affecting the development of food and feed market segments to ensure a viable production of plant proteins in the EU (the main economic drivers being the supply and the demand).

5.7 EQ 7 – On the coherence of CAP instruments with the development of "premium" market segments

To what extent have the relevant CAP measures applicable to arable crops been coherent and/or complementary to the economic drivers affecting the development of specialised supply chains for specific "premium" market segments to ensure a viable production of plant proteins in the EU?

Chapters 3 and 4 provide a detailed analysis of selected "premium" market segments, namely organic and GM-free market segments both for feed and food, with regard to quantity, quality and geographical distribution.

5.7.1 Understanding of the question

Chapters 3 and 4 detail the present development of PRP for both GM-Free and organic products in the EU and give details on the submarket segments of the studied PRPs. Based on this description, this EQ appraises to what extent the studied measures have had an effect on the development of these premium markets.

As organic farms are not subject to the greening measures, we thus focus for this EQ on the effect of Diversification and EFAs measures on PRP GM-free production and on VCS on both conventional and organic productions.

GM concerns only a limited number of the studied plants in the world, namely: soya bean, rapeseed, linseed and alfalfa. None of them is allowed to be cultivated in the EU and the organic productions have to be GM-free.

5.7.2 Method and limitations

The method for this EQ is to study the part taken by the studied measures versus external factors, which in the case of organic farming (OF) can be determinant. RDP measures such as M. 10 (support to Organic farming) certainly have more effects on the development of these productions than the evaluated measures.

The second step of this EQ is to study the effect of other economic drivers affecting the development of specialised supply chains for organic and GM-Free "premium" market segments.

Then the EQ analyses the coherence and/or complementarity of the evaluated measures to the economic drivers affecting the development of specialised supply chains of "premium" market segments.

The main limitation for this EQ is the lack of data, particularly at EU level.

5.7.3 Judgement criterion 1: The implementation of VCS, Diversification and EFAs resulted (or not) in changes in the GM-free market for pulses, oilseeds and legumes for forage, compared to the previous period

GM-Free soya bean producers can benefit from VCS and are subject to the studied greening measures EFAs and Diversification. For both of them it has been shown in EQ 3 that their effect was marginal on the acreage and production of PRPs but was in any case positive, meaning that they limited the decrease or even increased a little the area and production of PRPs. Hence they had a slight positive effect on these productions.

5.7.4 Judgement criterion 2: The implementation of VCS resulted (or not) in changes in the supply of organic products of pulses, oilseeds, and legumes for forage compared to the previous period

For organic production, it is slightly different, as organic producers were exempted from the greening measures. Hence only VCS can apply for these productions. As shown in EQ 3, only 16 MS have chosen to open these measures for the studied PRPs and the effects of this measure have been considered marginal at EU level, even if in some MS (e.g. Romania among the case studies) it could have had a more significant effect.

5.7.5 Judgement criterion 3: Other factors (including other CAP measures) have had an effect on the production of pulses, oilseeds and legumes for forage, of GM-free and organic products for the feed and food sectors compared to the previous period

Organic productions are developing significantly in the EU (see § 3) in some MS and benefit from specific support (e.g. M10 of the RDP) which are by far more significant drivers of the studied measures. Additionally, it has also been noted in Chapter 4 that legumes are more developed in the organic rotations than in conventional farms. Hence it appears that more significant external factors are driving the development of PRPs in the EU organic production.

For GM-Free it is almost the same: a significant change is happening now. Whereas most of the imports were done in GM soya bean some years ago, a significant demand for GM-Free products is developing in the EU meat, milk and egg sectors and represent now a real market. None of the measures have an influence on GM-Free production and import, hence they are neutral on this development.

5.7.6 Conclusion of EQ 7

To sum up, the measures under study have had positive, even though very limited, effects on organic (except for Greening measures since they do not apply to organic farms) and GM-free production of PRPs in the EU. Therefore, these measures have been coherent with the supply in GM-free and organic production. However, it should be kept in mind that these effects are limited, if not insignificant, compared to other factors within (i.e. M10 for organic farming in RDPs) and outside CAP (e.g. the growing demand for organic products).

Table 51: Assessment of the coherence between the relevant CAP measures and the economic drivers influencing PRP organic and GM-Free productions in the EU

CAP measures	Both feed and food		Comments
	Supply availability of organic products	Supply availability of GM-Free products	
Greening EFA measure	Not concerned		Little but positive effect for both feed and food in the GM-Free sectors. Organic not subject to the greening measures.
Greening crop diversification measure	Not concerned		
VCS			Little but positive effect for both feed and food in the GM-Free sectors.

complementary or synergistic relationship	contradictions or competition
neutrality, or no particular association	not possible to conclude

Source: own work

5.8 EQ 8 – On the coherence of CAP instruments with the competitiveness

To what extent have the relevant CAP measures applicable to arable crops been coherent and/or complementary to the economic drivers affecting the competitiveness of EU Plant proteins to ensure a viable production of plant proteins in the EU?

The answer to this question had to provide a detailed analysis of the key factors influencing competitiveness of plant proteins (including market prices) and the evaluators to examine the following aspects of competitiveness:

- relative competitiveness between commodity sectors,
- competitiveness of EU versus world farming,
- relative competitiveness between different geographical areas in the EU.

5.8.1 Understanding of the question

One can define the competitiveness of a product or a region producing this product as its capacity to produce it at a quality that meets the market standards, at a competitive price, providing adequate returns to producers compared to the incurred cost. In the present case it can concern mostly two stages:

- The relative competitiveness at farm level of the concerned crops/plants vs alternative crops
- The relative competitiveness of the product (in a given location) vs equivalent EU or world products.

For the first stage, at farm level, this competitiveness can be indirectly measured by the difference in gross margin (GM) of the product in the MS/region vs those of alternative crops/plants. Overall, for most productions considered, without specific support, they are most of the time hardly competitive with alternative crops such as cereals (Alliance Environnement, 2007). In most cases, agronomic reasons are leading to their production as they provide benefits to the rest of the rotation. Obligations can also lead to their cultivation such as those linked to the greening measures (Diversification and EFAs).

In addition, due to various economic (e.g. production costs) and non-economic (e.g. pedo-climatic) conditions, the competitiveness of the crops/plants under study can also differ among EU Member States and regions.

For the supply stage, in terms of competitiveness of commodities, they can be analysed through price differences (if any) between EU products and equivalent world products. This is less true for other products (e.g. niche products), for which origin and specificities (e.g. GM-free) could also be significant economic drivers.

This EQ aims thus at understanding how the studied CAP measures applicable to the arable sector have been coherent and/or complementary with these economic drivers affecting the competitiveness of EU crops/plants rich in protein content.

The main measure applicable to the arable sector relating to the competitiveness of the crops/plants and products under study is VCS. The EFA and Diversification greening measures (in the framework of greening measures) did not produce any significant change of protein-rich crop areas at EU level. As explained in the EQ 3, the greening measures have mainly contributed to a halt in the decline in the area of dry pulses and legume plants. Furthermore, the evaluation of the Greening measures done in 2017 did not identify any significant effects of these measures on prices (Alliance Environnement, 2017). However, in specific areas where the measures may have had significant effects on farmers' cropping choices, it may have had effects on local prices (e.g. on niche markets).

Some other measures can also have small effects on the competitiveness of the concerned crops/plants proteins, such as:

- some Agri-environmental and Climatic Measures (AECM) linked to the cultivation of legumes,
- the nitrate directive and its rules limiting the use of legumes as cover,
- energy regulation in the biodiesel domain leading to an increase in demand,
- etc.

We nevertheless suggest focusing on VCS and treating the others qualitatively due to their limited effect on the competitiveness of crops/plants producing PP. The main economic drivers considered have been listed in Chapter 4 and in the previous EQs.

5.8.2 Method and limitations

As mentioned in Chapter 1, this study is focused on protein-rich crops/plants (>15% crude protein). As a context, we nevertheless also study the other major sources of PP and in particular cereals and grass.

In terms of the effect of these measures on production of PP, they have been evaluated recently (Alliance Environnement, 2017) and their effect on the cultivation of pulses, oilseeds and legumes for forage studied. This part is treated in EQ 3.

In terms of the relative competitiveness of PP crops/plants vs alternative productions, one of the difficulties is the lack of data at EU level regarding the gross margins of the different productions considered vs their alternative crops. Therefore, the analysis mostly focuses on CS, literature review and data requests to some relevant stakeholders[317]).

In terms of commodity price, as we only get EU level prices of imports and exports (Comext database) at ports, the analysis also relies on CS results. For other products (e.g. niche products), the analysis is done at CS level only for the value chains present in the studied areas and open to sharing their prices and other economic driver information.

This analysis is carried out bearing in mind that there is some resistance to change at all levels of the value chains that can limit the use of a given product even at a better price (e.g. habits to use a

[317] E.g. producers organisations at EU level

maize/imported-soya meals diet for animals instead of using other sources of feed). These barriers are treated in criterion 3 on "other factors".

The main difficulty for this EQ concerns data availability for some value chains and the relative weight of external factors, as a very significant part of protein supply comes from cereals and grass for herbivores. Furthermore, while Greening measure effects have been widely studied and commented on, not much literature can be found on the effects of VCS as implemented since 2015 on the competitiveness of the crops under study.

5.8.3 Judgement criterion 1: The implementation of VCS resulted (or not) in changes in the competitiveness of pulses, oilseeds and legumes for forage, at farm level

Voluntary coupled support is paid to the farmers according to the area cultivated. Provided that the support is not captured by the downstream sectors (i.e. the buying prices drop by the amount of the support), it can lead to an increase in the gross margin of the supported crops. In this case, it can be considered that VCS have improved the competitiveness at farm level of the crops supported.

There is no coupled support available for sunflower or rapeseed, except in Latvia and Spain. Therefore, one can suppose that the measure has no significant effect on their competitiveness at EU level.

Sixteen Member States have decided to grant coupled support to protein crops (i.e. pulses, forage legumes and soya). These productions (i.e. forage legumes, pulses and soya), without specific support, are most of the time barely competitive with alternative crops such as cereals (Alliance Environnement, 2017).Therefore, one can suppose that the increase of soya and pulse area observed in some Member States after the implementation of the VCS may be linked to an increase of the gross margin of these crops compared to alternative crops. No (or very little) coupled support is available for the main alternative crops (i.e. wheat, maize, sunflower, etc.). However, it should be noted that this increase remains limited and only concerns some Member States or regions: e.g. ES and FR for field peas, PL for lupine and RO for soya bean (Alliance Environnement, 2017).

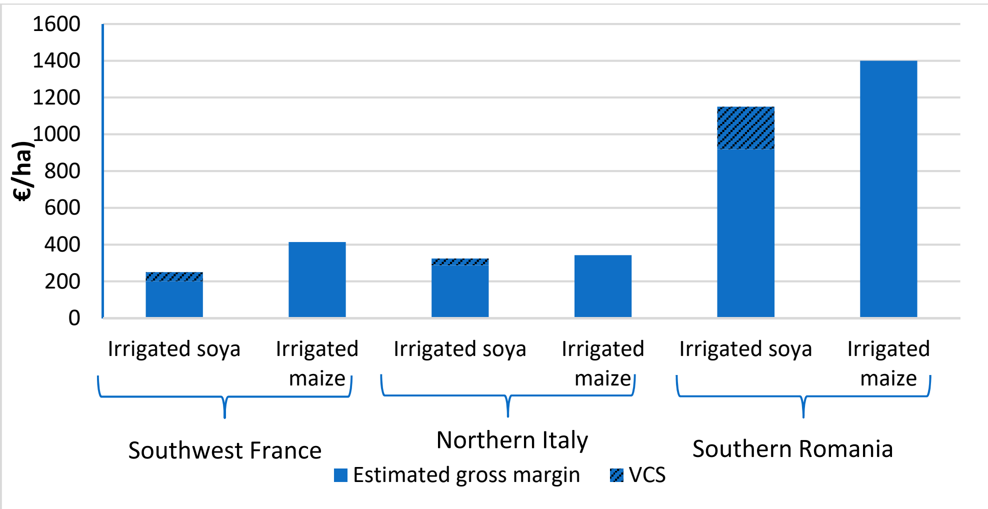


Figure 88: Gross margin of irrigated soya and maize and share of VCS in Southwest France (2017), Northern Italy (2016) and Southern Romania (2015) (Sources: Agribio Union 2017, informatore agrario 30/2016, interviews in Romania)

The gross margin of irrigated soya and maize has been calculated (cf. figure 88) in three Member States (France[318], Italy[319] and Romania[320]) where a VCS has been implemented for soya (and not for maize). Differences from one Member State to another are linked to various factors (e.g. pedo-climatic factors, price differences, etc.) including the type of farms for which data has been collected (one large farm with 2,000 ha of soya in Romania, compared to medium farms with less than 100 ha of soya in

[318] According to revenue and cost data collected by the comparative Agribio Union for the year 2017.

[319] According to informatore agrario 30/2016

[320] According to accounting data of a farmer in Southern Romania with 2,000 ha of soya.

Southwest France). One can observe that in the three cases, the VCS represent a medium share of the gross margin (from 11% in Italy to 20% in France and Romania). With VCS, irrigated soya gross margins draw near maize gross margins.

A study carried out in France for coupled support implemented over the period 2010-2014 confirms the effects of coupled support on gross margins at farm levels (see Box 29).

Box 29: Modelling of coupled support effects on soya bean and pulse competitiveness in France

In France, a study published in 2012 models the effects of coupled support over the period 2010-2014 based on historical data from 1995 to 2011. Coupled support was already available for farmers producing pulses and forage legumes in 2010-2014 in the framework of Article 68 and the level of support was similar to those implemented in the framework of the CAP 2014-2020 (respectively around 120 and 100€/ha). Therefore, these results can give an insight into the potential effects of VCS under the current period.

Based on the historical data, the study highlights that the introduction of coupled support in 2008 for pulses and forage legumes (in the framework of the health check of the CAP and at a similar level as in 2010 and then 2014) led to a significant increase in the average gross margin at farm level. Furthermore, the results from the model for the period 2012-2014 show that coupled supports counterbalance the declining trend of these crops in France. One can suppose that this effect is linked to an increase in the gross margin at farm level compared to alternative crops.

Furthermore, the model has been used with different levels of support for soya bean (with a national budget allocated to the support ranging from 0 to 9.3 M€). The results show that soya bean development follows prices, whatever the level of support. However, it should be noted that the levels of support tested are low compared to those tested for pulses and forage legumes (linked to the fact that no coupled support for soya bean was available at the time). Therefore, these results cannot be extended to the current situation.

Source: (Ramanantsoa and Villien, 2012)

The amount of support per ha for forage legumes, pulses and soya bean (according to Member State notifications for the year 2015) ranges from 36€/ha in Finland to 420€/ha in Slovenia (Agrosynergie, 2016). Therefore, the potential effects of the coupled supports on competitiveness at farm level can vary widely at Member State level.

Twelve Member States in EU-28 did not implement any VCS for protein-rich crops. Furthermore, as established in the legal framework[321], the support must be granted within defined quantitative limits, meaning that Member States must define an upper limit for the supported area. Therefore, the overall area covered by the measure remains limited and it is unlikely that any change in the EU average gross margin compared to other regions in the world changed as a consequence of the VCS.

5.8.4 Judgement criterion 2: The implementation of VCS resulted (or not) at market level in significant changes in the competitiveness of products of the EU pulses, oilseeds and legumes for forage sectors

As explained above, a share of the support granted to farmers can be captured by the downstream value chain and improve the competitiveness of the value chain at market level.

At world level, the EU is a price taker for the protein-rich crops under study (i.e. soya, pulses and forage legumes). Therefore, the measure did not have any effects on prices on the world market (and therefore on the competitiveness of the EU on commodity markets). Similarly, it is unlikely that the measure had any effects on the competitiveness of the supported protein-rich crops compared to alternative crops.

However, as explained in EQ 3, even though the measure did not have significant effects at EU level, an increase in production as a result of the implementation of the coupled support can be observed in some Member States (e.g. in Romania for soya bean). In Romania, the level of the VCS for soya is particularly high compared to the rest of the EU, with a support of 234.4€/ha in 2015. According to interviews, there are indications that the traders/industries take into account the annual VCS amount when setting their buying price. Therefore, the VCS may have enhanced Romanian competitiveness compared to other Member States on the soya bean market.

Overall, EU competitiveness for protein-rich crops relies heavily on quality and niche markets, in which EU (or specific regions in the EU) can be a price maker (e.g. GM-free soya bean, PDO/PGI pulses, etc.). The VCS may have contributed to an increase in production which stimulates quality or niche markets, and enhances their competitiveness compared to alternative products. However, products in these

[321] Article 52 of Regulation (EU) No 1307/2013

niche markets are generally sold at higher prices than commodities and VCS represent a small share of the price. Therefore, it is unlikely that VCS had any significant effect on the competitiveness of niche market products in the EU (beyond fostering the supply of raw material for these markets).

One exception can be the production of GM-free soya bean in Romania. From 2015 to 2017 (i.e. since the implementation of the VCS for soya bean), the export price of GM-free soya bean from Romania fell by 150€/t while a VCS of 234.4€/ha was implemented in 2015. The implementation of the VCS may have participated in the fall in the export price and therefore the improvement of Romania's competitiveness on the GM-free soya bean market.

5.8.5 Judgement criterion 3: Other factors (including other CAP measures) have had an effect on the competitiveness of pulses, oilseeds and legumes for forage, at farm level

CAP measures

With regard to CAP measures, the effects of the greening measures (EFA and Diversification) mostly rely on the assumption that if they lead to an increase in the production of the crops/plants under study, they may also have an impact on their competitiveness by promoting factors that can have an influence on present and future competitiveness, such as:

- the organisation of value chains at regional, MS or EU level,
- the provision of the advisory services in relation to these crops,
- the investment of stakeholders in research and development,
- etc.

The evaluation of these measures showed that they probably have not had such effects at EU level, but they may have had significant effects on production for some specific areas in the EU (see EQ 3). They may have participated in the organisation of some value chains within some Member States (e.g. in France where it has boosted the supply of soya bean for local value chains in the Southwest - for food - and East - for feed - of France). As for the provision of advisory services, there is no evidence that such investments have been made in the framework of the measure. According to the evaluation of the greening measures, most advisory actions made in the framework of the implementation of the greening measures focused on the requirements and the options given to farmers to fulfil the requirements, but not on the agricultural practices linked to the requirements (Alliance Environnement, 2017). Similarly, according to interviews in case study Member States, the area of soya, forage legumes and pulses remains overall too small to foster the interest of private companies in R&D to develop new varieties for these crops. In other words, they remain "orphan crops".

Other measures may have encouraged (e.g. AECM) or hindered (e.g. the nitrate directive rules in areas facing nitrogen surplus) the cultivation of forage legumes, pulses and/or soya bean. However, the effects are localised and insignificant compared to the VCS and greening measures. Therefore, it is unlikely that these measures had significant effects on the competitiveness of these crops (even though AECM may have improved the gross margin for these crops in some areas).

5.8.6 Judgement criterion 4: Other factors (including other CAP measures) have had an effect on the competitiveness of pulses, oilseeds and legumes for forage, at market level

Other, non-CAP, factors may have had effects on the competitiveness of pulses, forage legumes and soya bean at farm level:

- fertiliser prices (the higher nitrogen fertiliser prices are, the higher the competitiveness of nitrogen fixing crops compared to alternative crops is),
- the increasing demand for feed (due to the increasing demand for animal products at world level),
- the increasing demand for food (due to the development of meat and dairy alternatives and the use of protein plant-based ingredients, see Chapter 4),
- agronomic drivers, as nitrogen fixing crops, which includes forage legumes, pulses and soya bean, provide benefits to the rest of the rotation,
- pest and disease infection (especially the spread of weevils in the EU hinders the competitiveness of pulses),
- the regulation as regards the use of plant protection products.

As for sunflower and rapeseed, the main other factors at farm level are:

- the demand for biodiesel production (provided that it encourages higher buying prices of the crops at the farm gate),
- the habits of farmers (who are used to growing these crops in specific rotations),
- the demand for feed use.

5.8.7 Conclusion of EQ 8

The main economic drivers influencing the competitiveness of protein-rich crops have been identified in EQ 1 and 2. Based on the result of EQ 8, the following matrix presents the relationship between the measures with these drivers.

Overall, as explained in the EQ answer, the VCS potential effects are too limited (since not all Member States have implemented it and some of them have implemented a maximum area to be eligible for the support) to improve the competitiveness of the crops under study at market level (i.e. by impacting the prices). However, some potential synergies can be observed with regard to the competitiveness compared to other commodities, since most alternative crops are not supported under this measure. Similarly, since the support is not set at the same level, it may foster changes between geographical areas within the EU.

Table 52: Assessment of the coherence between the relevant CAP measures and the economic drivers influencing the competitiveness of EU Plant proteins to ensure a viable production of plant proteins in the EU

CAP measure	Competitiveness between commodity markets		Competitiveness of the EU versus world farming		Competitiveness between geographical areas in the EU	
	Gross margin at farm level	Prices	Gross margin at farm level	Prices	Gross margin at farm level	Prices
VCS						

complementary or synergistic relationship
contradictions or competition
neutrality, or no particular association
not possible to conclude

Source: own work

5.9 EQ 9 – On the relevance of CAP instruments for addressing future market developments

To what extent are the CAP measures applicable to arable crops relevant for addressing future market developments for EU plant proteins, taking into account the relevant economic drivers?

5.9.1 Understanding of the question

This question is focused on future markets. As shown in Chapter 3, PPs are one of the world's challenges in the coming decades. Consumption of meat is stabilising in some EU Member States and in the U.S., but it is increasing significantly in large intermediate countries such as China and Brazil. Tremendous growth in Africa is also anticipated in the coming decade. Hence, competition on the supply of PPs is emerging and it may directly impact the price of these commodities, mainly soya meals but not only (see chapter 4).

Furthermore, some new markets are developing, presented in Chapter 4, both in the food and feed sectors and also for the consumption of GM-free and organic products (see EQ 7). This is also true for new products for food and other uses (e.g. cosmetics). These new markets are led by the tendency to shift part of human consumption from meat to PPs (for environmental, ethical and health reasons).

This EQ therefore asks to what extent VCS, EFAs and Diversification measures are relevant for addressing these new markets.

5.9.2 Method and limitations

The method to cover this question includes:

- A description of what the possible main future markets are for PPs (taken from chapter 4), and the part of these future markets that could be covered by the studied plants produced in the EU,
- The potential effects of the studied measures on the development of the concerned production in the EU, based on the results of the previous EQ, literature review and interviews.

The main limitation of this method is the scope of the study itself, which is focused on protein-rich plants, whereas some other major EU crops are also concerned by these future outlooks such as cereals, grass, etc. which are presently (and probably in the near future) the main providers of PP in the EU. These other drivers are treated qualitatively in criterion 3 on "other factors".

5.9.3 Judgement criterion 1: There are future PP markets that could (or not) be covered by the studied crops/plants produced in the EU and a part of the future PP markets could (or not) be covered by the studied crops/plants produced in the EU

Chapter 4 presents the main future markets identified in this study thanks to a literature review and interviews of experts. It should be kept in mind that PRP development after 2020 is hard to anticipate as it will take place in a new, and yet undecided, policy environment.

The main future trends on markets to be considered are the following:

- an increase in the consumption of animal proteins and therefore demand for feed at world level,
- a decrease in rapeseed oils in the biofuel complex,
- the intensification of dairy farms in the EU resulting in higher oilseed meal demand and less room for legume fodder systems,
- a growth of premium markets in the EU for animal- as well as plant-based food,
- the development of GM-free value chains for animal products (especially for dairy and poultry products),
- a growth in organic for animal- as well as plant-based products (i.e. on feed and food market segments),
- an increase in the demand for vegetarian, vegan, gluten-free and lactose-free products,
- an increase in the demand for convenient food (e.g. ready-to-cook dishes),
- a rising importance of health and environmental concerns for consumers.

5.9.4 Judgement criterion 2: The studied measures (VCS, EFAs and DIV) are relevant (or not) for addressing future market developments for EU plant proteins

As shown in the previous EQs, the VCS, EFAs and Diversification measures have had a limited (even though positive) impact on the development of PRPs in the EU. In that sense they are relevant with the future trends identified, but their effects are too limited to actually help EU PRP productions in matching with these future prospects. They were not designed for this purpose, since the Greening measures target environmental objectives and the VCS aims at maintaining the production levels in sectors or regions that are particularly important for economic, social or environmental reasons and undergo difficulties.

5.9.5 Judgement criterion 3: Other factors can influence the coverage of future needs of PP in the EU

Other drivers are likely to influence the coverage of future needs of PP in the EU. The main drivers identified are:

- the EU biofuel policy and the decision taken in 2018 to maintain the maximum contribution of crop-based biofuels in 2020 renewable energy target at 7%,
- the research on the development of the uses of PRPs produced in the EU and of the adaptation of these crops to future demand (e.g. increase yields),
- future changes in fertiliser prices.

5.9.6 Conclusion of EQ 9

Based on the analysis from chapter 4, the main outlooks and future market developments of the feed and food markets segments have been identified. Even though the VCS and Greening measures have in general positive effects with regard to these developments, these effects are too limited to actually address future market developments for the EU PRPs.

6 CONCLUSION

6.1 Objective and method of the study

This report concerns an evaluation study of the CAP measures applicable to the EU market in plant proteins, including competitiveness effects of CAP measures applied to plant proteins. It focuses on analysing market aspects relating to the protein-rich plants in the EU and assesses in this context the coherence and relevance of the CAP measures applicable to the EU market for plant proteins. The plant proteins covered in this study are: pulses (field beans, field peas, lupines, chickpeas, lentils and field beans), oilseeds (rapeseed, sunflower and soya bean) and forage legumes (mainly alfalfa, clover, and sainfoin). The main CAP measures studied are two measures under the Direct Payments Regulation, namely diversification (DIV) and Ecological Focus Areas (EFAs) and the Voluntary Coupled Payment Support (VCS), for the period 2015-2020. The geographical scope of the analysis is EU-28.

The methodology combined empirical analysis, via quantitative methods, with qualitative analysis based on information and points of views from stakeholders and agents operating in the plant protein sectors and in their supply chains. The data collection was based on a desk review and seven case studies, some focusing on the feed sector, other on both the feed and food sectors (see below). It also includes information collected during workshops organised by the European Commission between July and October 2018: two expert protein workshops and the workshop to validate the results of the mid-term agriculture outlook 2018-2030.

6.2 The plant protein context in the EU

The list of plants to be studied within the framework of this evaluation encompasses only protein-rich plants and materials (>15% crude protein). These products account for about one-fourth of the total 109 Mt of plant protein supply in the EU. Providing about 37 Mt of crude proteins, grasslands are the most important source of plant protein, and cereals the second one. Accounting for 15.8 Mt of proteins, imported oilseeds and meals are the main source of protein-rich plants in the EU. They are mostly composed of soya bean (87%), the rest being essentially sunflower and rapeseed. Figure 91 highlights that, when converted in crude protein equivalent, imports of protein-rich plants to the EU are nearly equivalent to the EU production, respectively 16.8 Mt of imported proteins and 15.7 Mt produced proteins. It highlights the high dependency of the EU on imports of protein-rich materials and particularly on soya (83% of imports in terms of proteins). In comparison, EU exports of protein-rich crops are 13 times smaller (1.2Mt).

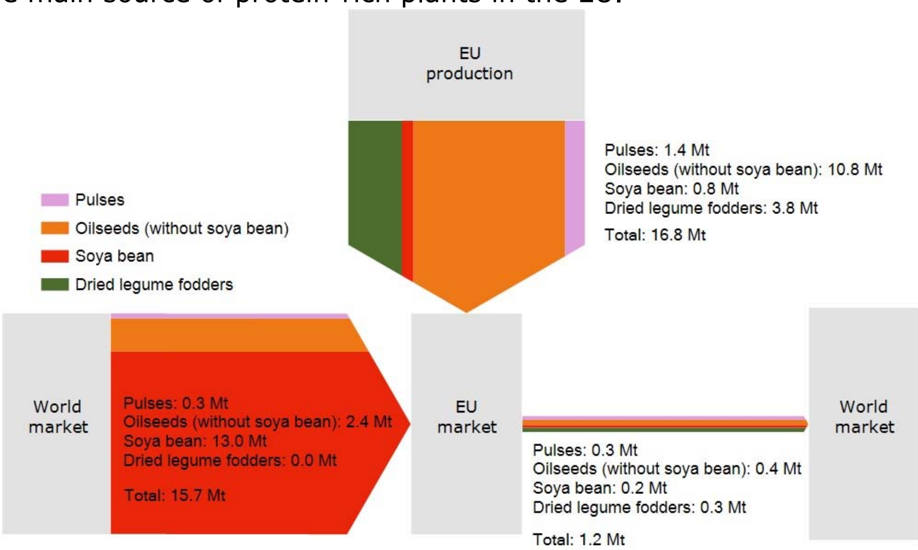


Figure 89: PRP protein balance in the EU in 2016 (unit: crude protein, sources: DG AGRI, EUROSTAT)

6.3 Main market segments for Protein-Rich Plants in the EU

The study analysed uses of protein-rich plants and economic drivers in the feed and food sectors and focused on their main market segments, namely:

- conventional, GM-Free and organic for the feed sector,
- and whole grain pulses, processed plant protein food (such as meat and dairy alternatives) and functional protein ingredients for the food industry.

Theses market segments are presented in the graph below.

Additionally, premium markets (e.g. local supply standards, private brands, PDO, PGI, etc.) are studied in parallel for each segment under consideration.

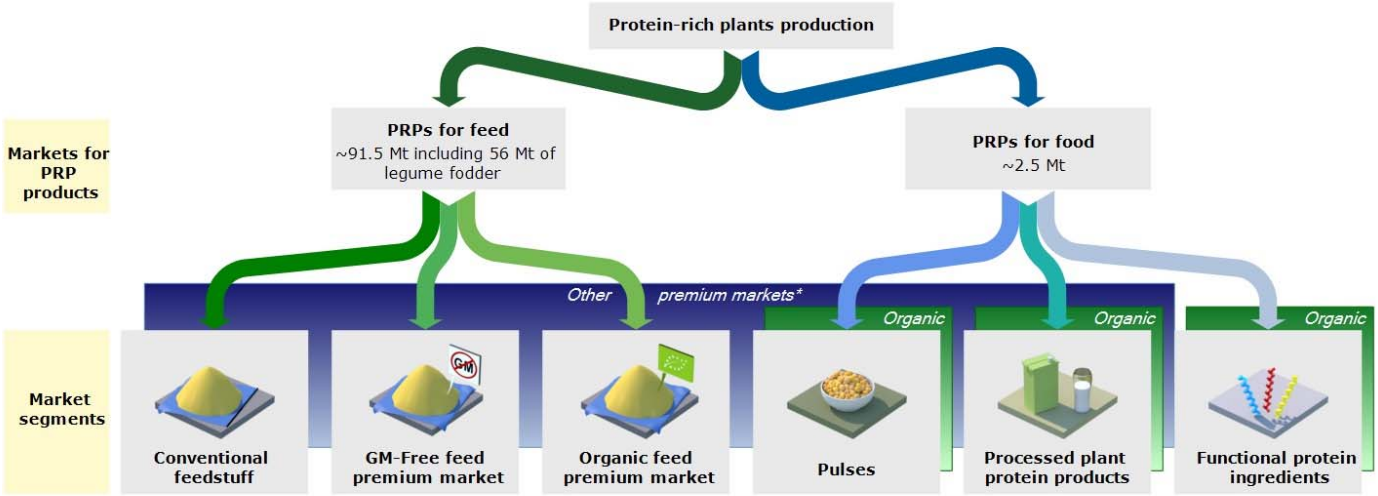


Figure 90: Main market segments using PRPs treated in this study

Feed markets account for over 94% of the protein-rich plants and materials used in the EU, the rest being used by the food sector. Oilseed meals account for 56% of the crude protein supplied to the feed sector in the EU and 74% of the demand is met through imports. On the other hand, pulses account for a small contribution to the feed protein supply in PRPs (3%) but 96% of the protein supply from pulses is produced in the EU. Legume fodders contribute to 15% of the protein supplied by PRPs[322] and are mostly self-produced by livestock farmers, although 15% of the production is dehydrated in dedicated factories. Feed markets can be divided into three main market segments: conventional, GM-Free and organic.

The conventional feed segment is mostly driven by 2 key economic agents: (1) livestock farmers, who decide how to feed their animals and how to source their feed; and (2) feed manufacturers, who can use a wide spectrum of raw materials to satisfy their demand. Consumers are not very concerned by how the feed is sourced. Other characteristics of the conventional feed market segment are listed hereinafter:

- Protein-rich crops used in feed are mainly oilseed meals (80% of crude protein used).
- Feed intake is calculated with optimised least-cost formulation with a large variety of feedstuffs.
- On-farm feeding is more energy- (cereals) than protein-oriented, especially because technological treatments of oilseeds and pulses are not developed for small scale use.
- The use of pulses and forage legumes is below technical maximum incorporation levels because it is economically not attractive.

The GM-Free feed segment is more driven by final consumers. Labelling of products containing GM plant materials is compulsory, but it does not cover products obtained from animals fed with GMO feed. Retailers have integrated the civil society demand for more GM-Free supply chains and are widely driving the development of GM-Free products, especially through the creation of private labels. Other characteristics of the GM-Free feed market segment are:

- Numerous private and national GM-Free standards provide for additional rules to set up GM-free labelled supply chains for animal products.
- GM-Free soya bean for feed is mainly imported, but often; animal farmers in conversion towards GM-Free feeding turn part of their soya bean consumption into other materials such as rapeseed, sunflower meals or by-products from the ethanol industry.

The Organic feed segment follows very different patterns. GM feed, synthetic amino-acids et meals defatted with hexane are forbidden by organic regulations. Its key aspects can be listed as follows:

- Key players: final consumers and retailers, who have strong expectations when it comes to supply chain sustainability.
- Higher use of local legume crops, including on-farm produced, especially for agronomic reasons
- Faster development in the EU-15; production more dedicated to exports in the EU-N13.

[322] It should also be kept in mind that leguminous fodders are produced nearly exclusively for herbivorous animals, as granivorous animals are not able to break down the fibrous part.

- Sourcing is based both on EU production and importation, as feed demand exceeds EU organic production, for which preference is given to food uses with higher prices.

Main economic drivers of the different feed market segments

The "specialised" profile of oilseed meals and cereals (high protein content and low starch content or conversely) makes them complementary and gives more flexibility in least-cost feed formulation than "intermediate" nutritional profiles. It is a barrier to the use of pulses. Research works show that there is room to incorporate more pulses and less soya meal from a nutritional point of view, especially for pigs. The current market context (low competitiveness compared to oilseed meals) and agronomic barriers (pests, low yields), however, make this difficult to attain.

To manage price variability, feed manufacturers tend to favour markets with consistent quality, regular availability and hedging possibilities. Oilseed meals fit better with these criteria than pulses, which are traded on small and little-standardised physical markets, with significant variations in quality and availability. Case studies led for this study stress that premium markets and local value chains often drive the development of a local protein-rich crop area because it raises the competitiveness of EU-grown pulses. To summarize, main drivers of the feed sector are listed in the following table:

Conventional feedstuff	GM-Free premium feedstuff	Organic premium feedstuff
- Seek for standard products, with stable quality and availability. constant availability and quality + standard products. - Need for hedging solutions (or price indexation if no futures market). - Feedstuff substitution costs in factories (limited number of silos). - Competition with food outlets. - Labour cost (especially for leguminous fodders).	- Social concerns. - GM-Free soya bean price premium (+ 80-100€) or cost of its substitution. - Availability of non-GM raw materials. - Branding and PDO/PGI. - Price premium for milk and other animal products. - Additional sourcing, segregation, storage and transaction costs. - Availability of GM-Free soya bean. - GMO regulations.	- Segregation cost of organic materials: storage, handling and pest management. - Agronomic constraints inherent to organic production. - Competition with food outlets. - Availability of organic raw material for feed. High prices in organic. - Lack of B2B services for technological treatments (dehulling, toasting, storing), especially at small scale.

Outlook, main insights for feed

PRP developments after 2020 are hard to anticipate as they will take place in a new, and yet undecided, policy environment. Although the area remains limited, protein crops have recently experienced a revival driven by a favourable policy environment. Protein crops are still spotlighted in the new CAP 2020 proposal and new measures could boost their development. Finally, the spread of technological treatments such as toasting, dehulling and protein extraction could increase protein content and protein digestibility, thereby improving the market value of pulses for feed.

Regarding meat markets, paths will differ according to member states: less volume and more value in Northwest Europe, volume growth in Central and Eastern Europe, especially to sustain the growing demand for poultry[323]. Meanwhile, the productivity of dairy production is projected to increase. To achieve this demand and if feed systems do not change radically, a higher use of protein meals in feed rations will be needed. The intensification of dairy systems could also result in higher oilseed meal demand and less room for legume fodder systems. The stabilisation of rapeseed oils in the biofuel complex should also reinforce the need for more soya meal.

The GM-Free market segment may continue to increase in the coming years. GM-Free labelling may have a strong effect on the sourcing of imports and could encourage the EU production of protein-rich crops and the development of technological treatment for protein enrichment. Demand for organic animal products is increasing at a fast pace. However, the organic feed demand is growing faster than the production of organic protein-rich crops. Organic areas for peas and beans have decreased while

[323] Projected to increase by 0.3% annually during the 2018-2030 period (European Commission Agricultural Outlook 2018-2030).

organic soya bean is clearly on the rise. The use of contracts between organic PRP producers, organic animal farmers, collectors and food manufacturers will probably increase.

6.4 *Food market segments*

Description of the market segments

All food segments are almost niche markets in comparison to the feed one. This sector represents only 4 to 5% of the PRP sectors in terms of volume. Nevertheless, their added value all along the chain is generally higher as products are almost always sold at a higher price. According to the types of products sold and their marketing, the food market can be divided into three market segments:

- Pulses sold as whole grains (dry, fresh, canned or frozen), cooked as such by end-consumers or incorporated in ready-to-eat dishes;
- Processed plant protein products (e.g. preparation of pulses, meat and dairy alternatives, pulse-based snacks, specialised food, etc.);
- Functional protein ingredients which are used by food companies to meet technical or nutritional needs (e.g. to replace meat protein in meat products, to produce meat alternatives, etc.).

Pulses consumed as such remain the main segment in terms of volumes and account for about three quarter of the tonnages consumed, while processed and functional PRPs account for only a quarter, despite their significant growth in the last decade. However, it should be reminded that processed products and functional proteins are more expensive, meaning that they probably represent a higher share in value than pulses.

The two first market segments are based on a B2C marketing[324] while the third one is based on B2B[325] transactions. While the decisive economic agent of the two first market segments is the final consumer, the demand of the third one is mainly driven by the agri-food industry, which incorporates the ingredients into its products. The consumer may not even be aware that the final products consumed contain plant proteins (e.g. in the case of the incorporation of plant protein ingredients into meat preparation to improve the texture and the nutritional profile of the product). Furthermore, functional ingredients are most often not directly available in market stalls but incorporated into prepared food products.

Sourcing of the grains

The sourcing strategy of soya beans and pulses is different depending on the market segment and the type of consumers targeted. For pulses, the grains are either sourced in specific areas (e.g. PDO, PGI) or locally (e.g. when the country of origin is mentioned on the packaging) or based on imports (mainly for products at low price). For processed plant protein products, the sourcing is often based on EU production with campaign contracts with collectors, such as for pulses sourced in specific areas. For soya bean, 73% of ENSA[326] members’ supply in 2017 came from the EU and 100% for organic soya bean-based products. Functional soya bean ingredients (i.e. soya bean concentrates, isolates and textured proteins) are mainly imported. The reverse is true for pea concentrates: several companies in the EU produce them based on EU production (with contracts with collectors).

[324] Business to consumer (B2C) refers to the transactions conducted directly between a company and consumers who are the end-users of its products or services.

[325] Business to business (B2B) refers to the transactions conducted between two companies.

[326] European Natural Soy and Plant-Based Foods Manufacturers Association

Main economic drivers of the different market segments

The following table presents the main drivers identified for each market segment.

Pulses (whole grains)	Processed plant protein products	Functional protein ingredients
- Consumer habits. - Image conveyed by the product: positive (traditional, healthy, etc.) or negative (old-fashioned, hard to cook, etc.). - Rise of flexitarian, vegetarian and vegan diets. - Availability and stability of supply (implying contracts). - Quality of the pulses. - EU origin or local sourcing. - Import competitiveness.	- Rise of flexitarian, vegetarian, vegan diets, gluten/lactose-free. - Convenience of products/cooking time. - Consumer habits. - Image of the products (sustainable, healthy, etc.). - Availability and stability of the supply (implying contracts). - Availability of GM-Free supply. - Quality of the grains. - EU origin and local sourcing.	- Functional and nutritional properties of protein-rich plants. - Rise of the demand for meat alternatives and products free from gluten, lactose, etc. - Availability of GM-free supply. - Availability and stability of supply (contracts for peas). - Know-how of companies. - R&D for new ingredients. - Competition with other protein sources (e.g. gluten, whey).

Outlook: main insights for food

Various factors are likely to impact food market segments in the future. First, in the coming years, flexitarian, vegetarian and vegan diets are expected to increase, stimulating the demand for pulses as well as processed plant protein products. The rise of the flexitarian diet especially is likely to drive significant changes on the market in the future, as flexitarian consumers constitute a wider share of the population compared to vegetarians and vegans. Furthermore, the increased movement away from gluten among consumers is expected to increase the demand for pulses, soya bean and their ingredients as they are gluten-free by nature. They can be used with rice or corn to produce gluten-free cakes, pasta and other food products. Additionally, health and environmental considerations will probably have an increasing impact on consumer consumption choices and may become a significant driver of the demand for plant proteins (as-is or as ingredients) as an alternative to animal proteins in the future. Another significant trend which can be observed in the EU (especially in western EU) is the rising demand for local food. Local sourcing is gaining influence in the marketing strategy of pulses and processed plant protein products. Furthermore, one can observe a reduction of the time allocated to cooking in EU households, which may further the demand for processed plant protein products and canned or frozen pulses while reducing the consumption of dry pulses. One opportunity for the sector is its potential for innovation. Many of the plant-based products produced in the EU did not exist or were little represented in retail stores 10 years ago (e.g. meat and dairy alternatives, pulse-based pasta, pea-based functional ingredients, etc.) showing the potential for development in this food sector.

6.5 Summary of drivers by market segment

Figure 91 provides a visual summary of the drivers of the market segments studied in this report. It places these segments according to two axes:

- One distinguishing the local origin by opposition to the world market, meaning imports or of origin not clearly known.
- The second representing the main decision maker between the final consumer or what can be called the market (generally represented by commodities)

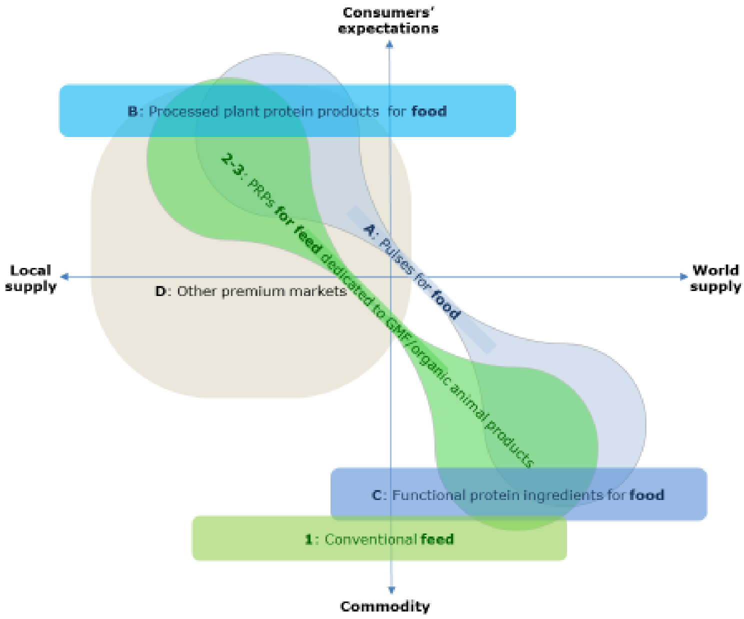


Figure 91: Theoretical illustration of the five studied market segments (own work)

6.6 Main drivers of farmers producing PRPs

When planning crop sowing and rotation management, the three main economic drivers of farmers are: the expected gross margin compared to alternative crops, the potential policy supports related to a given crop (see the following section) and the existence of accessible, viable and profitable markets to sell the harvest (including on-farm self-consumption for mixed farms). Oilseeds, especially rapeseed, generally have the highest margin, close to cereals. Soybean gross margin is improving at a constant pace compared to its main alternatives. Peas, field beans and alfalfa generally have the lowest gross margin, except in the case of specific value chains generating high prices (e.g. PDO and PGI cheese products). However, gross margin calculation generally does not consider rotational crop effects. The improvement of their yields is hindered by relatively few investments made in the past decades to develop them (development of varieties, pest and disease management, etc.). Outlets for selling oilseeds and dehydrated legume fodders are generally secured with contracts in the value chains. For pulses, a wide variety of situations exist from high difficulty in selling (low quality related to pests) and low prices (feed outlet), to IGP/PDO product with no difficulty in selling and guaranteed profitability.

High price projections for fossil fuels may impact N-fertiliser prices, potentially increasing the competitiveness of Nitrogen-fixing crops. Environmental regulations involving fewer plant protection products could also impact the cropping area, as PRPs generally require fewer plant protection products than other crops (except for rapeseed) and lower the need at crop rotation level.

6.7 Coherence and relevance of the studied CAP measures with these drivers

Following our coherence analysis, the three measures presented in this study (EFA, DIV and VCS) are in synergy or neutral with the economic drivers identified, but their effects were generally limited compared to other drivers such as the competitiveness of soya bean compared to other protein sources for feed, the demand for rapeseed oil for biofuel production, the demand for vegetarian food, etc. The pesticide ban implemented in 2018 may deter some farmers from growing legume fodders, pulses or soya bean to comply with the EFA measure.

In terms of relevance, the analyses were based on the main trends identified for the feed and food market segments. Overall, the VCS and Greening measures may have positive effects with regard to the main trends identified, but these effects would be too limited to significantly boost future market developments of EU-produced PRPs.

7 RECOMMENDATIONS

This study takes place in the framework of a global reflection undertaken by DG-Agri on plant protein production, supply chains and markets in the EU. As this study was not a full-fledged evaluation, it was not possible to provide the EC with policy recommendations.[327]. Nevertheless, it is possible based on its findings to formulate some general recommendations for the development of protein-rich plants in the EU.

As explained in the report, several PRPs under study (mainly pulses and forage legumes) have experienced limited development compared to the major crops, due to various drivers, many of them being linked to path-dependency mechanisms and lock-in effects. To overcome these lock-in effects and enable the development of these PRPs (for feed as well as for food), long-term public action would be relevant in various fields, including value chain organisation, research and public action, to work in synergy and complement the private action implemented in all the PRP value chains.

Action on value chains

This study has clearly highlighted that when developing EU-grown PRPs and related markets, value chain organisation is essential. This is highly documented in the boxes presented in this study; the value chains that have developed and for which the added value is high are those with an effective organisation from upstream to downstream. It means that they have set up adapted means such as producer organisations, multi-year contracts, standards, training, research, etc. It allows all agents of the chain to improve and secure their revenue and often contributes to a better distribution of the added value throughout the supply chain. The demand being market-driven by a concrete outlet (feed processing or agri-food companies), it also provides a long-term vision to all economic agents, encouraging them to invest in order to develop and upscale their activities. It may thus be relevant to encourage the development and the strengthening of these multi-stakeholder organisations (existing or to be created).

As underlined by the many local initiatives reported in this study, it should also be noted that local value chains and small-scale solutions, by paving the way for new systems and solutions, could provide the steppingstone to support the transition. In the same vein, initiatives to rebuild the connection between livestock systems and the territory, by supporting cooperation between arable and livestock farmers, represent another option that could provide a credible outlet for potential PRP producers.

Action on research

The study underlined the yield gap to be filled by protein crops to regain competitiveness. EQ 1 shows that when, over the last six decades, the yield of wheat increased from less than 2t/ha to 5.5 t/ha, in the same time the average yield of the studied crops (forages excluded from this estimate) increased from 1t/ha to 2.8t/ha. This yield gap is worsened by a strong vulnerability to pests and water stresses, the result of a lack of research dedicated to these "orphan" crops. This is highlighted by another study (Magrini, 2018), which shows for example that from 2000 until now, there have been close to 500 scientific publications on soya bean, whereas less than one hundred have been dedicated to pea, field bean and lupine combined. It is thus necessary to push for more research. It is noteworthy that relatively low market share of certain PRPs like pulses does not give enough incentives to the private sector to increase research efforts. Public research and public/private partnership are thus needed in the first stages, to develop varieties of PRPs with higher yields, better resistance to diseases, better quality for industrial processing, etc. Research partnerships with other part of the world to mutualise genetic resources could also speed up the process of improving varieties, like the EUCLEG project between Europe and China[328]. For example, lupine is well developed in Australia, lentils in Canada and the Middle East/India, alfalfa in China, etc.

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[327] The evaluation covered only the relevance and coherence of the main CAP measures related to PP: namely the greening measures (EFAs and diversification) and the voluntary coupled payments. Hence it was not possible based only on these two criteria to fully evaluate the effects of these measures, and in particular their effectiveness, the efficiency of their implementation and their impact.

[328] The Eucleg project seeks to reduce Europe's and China's dependency on imported plant proteins by developing legume crops. It is supported by the European Union (Horizon 2020). This four-year project unites 38 public and private partners across 13 European countries and China. The project will study a wide range of alfalfa populations in Europe and China by using new phenotyping and genotyping methods and finally better assess genetic resources.

Action on innovation

Heavy equipment is often necessary to store, segregate, sort, dehull, make dry fodder with renewable energy instead of fossil energy, etc. As technologies are not always yet widespread, this equipment is generally expensive or not even entirely developed from a technological point of view. This is particularly true for non-dominant crops such as pulses and fodders. Tools to foster research and development and give access to new technologies could increase the competitiveness of EU-grown protein-rich crops.

This study also shows that premiums and designations of origin can promote and encourage local or EU-grown PRPs[329]. This means that tools to support the establishment of standards could also help in developing chains which really promote EU production of both cereals and PRPs.

The study has also showed that pulses and soya bean can be used as food in different market segments responding to different demands. These market segments are all expected to develop (at least to some extent) in the future, but for different reasons (e.g. the rise of flexitarian diets for pulses and soya beans consumed as-is or incorporated in plant protein food products marketed as such, vs the rising interest of food companies for functional plant protein properties for PRP functional ingredients). They are also facing different threats such as potential resistance on the part of consumers to ultra-processed food in the future, etc. Overall, it is important to consider that there is not only one best way to develop PRP food value chains, pulses for instance, and that research on food must be encouraged in various directions to allow different pathways of experiments and innovations. It can be noted that innovations in food are also a lever to generate investment and to create added value, hence increasing crop competitiveness.

To meet consumer demand for attractive and quick and easy-to-cook food products, food companies must develop new processing methods and innovative food products. However, such research and development require major investments which small and medium-sized companies can generally not offer. Therefore, public and private research partnerships could be favoured to encourage innovations in the EU.

Action on knowledge transfer

Knowledge infrastructure is essential to gather initiatives, replicate them and feed future development plans with clear evidence and knowledge-sharing. A European knowledge platform on plant protein development to gather initiatives and circulate success stories as well as practical solutions could be another option.

Action on data collection and market transparency

This study clearly highlighted a lack of consolidated data about PRP development in the EU. This particularly true for organic productions, forages and premium markets. It is then highly relevant to improve data collection on prices, trade flows, production/consumption to help evidence-based policy making and policy monitoring.

Action on consumer information

For human consumption of pulses used in grain, it has been shown in this study that this consumption partly depends on the way they are classified or presented in country-specific regulation or advertising. A positive presentation highlighting their protein content and nutritional value and presenting them as “up-to-date” products (*cf.* Spanish or Canadian policies) clearly has an influence on their consumption. Some Member States could therefore review their nutrition pyramids and promotion campaigns (e.g. in school catering) to better spotlight the nutritional qualities of pulses and promote their consumption.

Innovation and technological developments have already been initiated for pea and should be maintained to ensure EU competitiveness in the future.

[329] Conversely, some poultry designations require a minimal use of cereals, which in a technical sense implies compensating this increase in low protein feed with more import soya meal in the ration. Conversely, replacing “cereals” by “grains” in specifications could overcome a significant barrier to incorporating pulses in the poultry sector.

8 ANNEX: BIBLIOGRAPHY

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