TRansition paths to sUstainable
legume-based systems in Europe

# Sector Modelling Scenarios for Upscaling Legume Production in the EU27+UK

**Work Package:** 6

**Deliverable:** 6.4 (D39)

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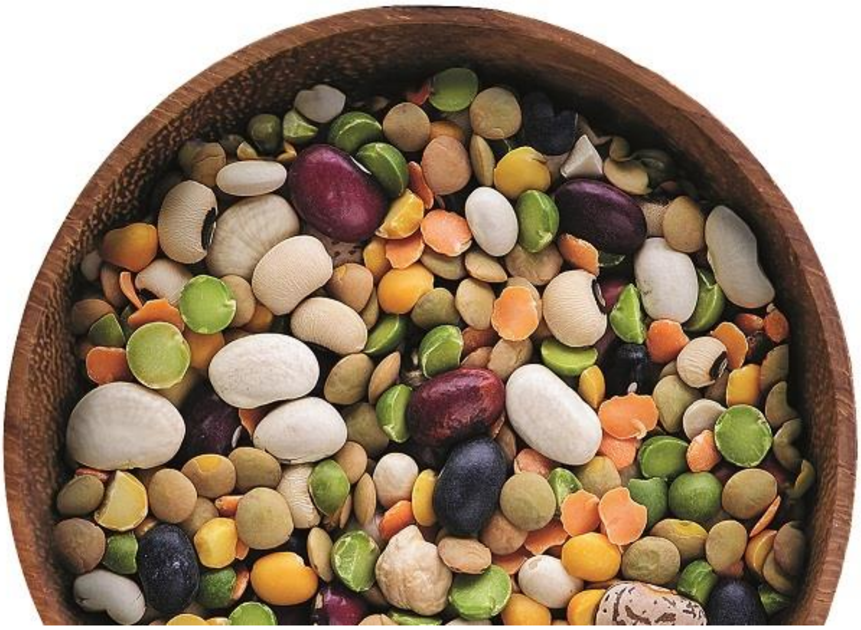

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## Deliverable Description & Contributors

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- **Deliverable Description:** This is the final report on this deliverable. It presents a methodological description of the sector model, CAPRI, and the scenarios used to examine legume production under three different pathways which were assumed to be the conditions which would lead to increase legume production in the EU27+UK. Three alternative legume production scenarios have been identified and described including changes in legume support payment (policy), dietary change (consumer demand) and soya import ban (trade). The scenario results were compared with a baseline scenario, analysed and presented in this report.



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- **Keywords**

  Legume; Sector modelling; CAPRI; Policy; Scenarios.

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## Summary

This report presents a methodological description of the sector model, CAPRI, and the scenarios used to examine legume production under three different scenarios, which were assumed to be conditions which would lead to increase legume production in the EU27+UK. The scenarios considered in this study are based on **policy- , consumer demand-, and trade-related pathways**. Under the **policy-related pathway**, a scenario with an increase in specific protein crop subsidy payment was considered and was made available to the UK and all member states of the EU. For the **consumer demand-related pathway**, it was assumed a shift of consumer preferences to plant-based protein in place of animal-based protein. A scenario with a complete ban on soya imports to the EU27+UK was considered for the **trade-related pathway**. The results suggest that the three alternative pathway scenarios have potential to increase area of production of legume crops. There is, however, a varying extent of the impact on production, prices, and effect on other agricultural commodities under these three scenarios. The protein crop subsidy scenario has the highest increase (+23%) in area of pulse production compared to the dietary change scenario (+16%) and trade-ban scenario (+6%). There is also a difference in impacts on prices and other agricultural commodities between these scenarios. The price of pulses decreased by around 6% under protein crop subsidy scenario but increased by 13% and 10% under dietary change and trade-ban scenarios respectively. The price of soya had the highest increase (+150%) under the trade-ban scenario and also have a substantial impact on other agricultural sectors. Although, overall production of legume in the EU27+UK increased under all three scenarios considered, due to less competitiveness of legume crops, the increase in production of legumes is very small under all three scenarios used in this study. Changes in different policy instrument to support a combination of these scenarios or additional policies to provide legume price incentives to improve competitiveness may be required to improve demand, price and ultimately domestic production of legumes in the EU27+UK.

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# 1. Introduction

With growing concerns of Greenhouse Gas (GHG) emissions and human nutrition, the EU and the UK policy makers see agricultural sector with a pivotal role to play to achieve both 'net-zero' emissions by 2050 and better nutrition as documented in the European Green Deal (EU, 2019) and the UK Environment Bill (DEFRA, 2020). The all-around benefits of legume crops to deal with both the concerns of GHG and human nutrition have been well documented (Luscher *et al*., 2014; EU, 2018; Oliveira *et al*., 2021; Iannetta *et al*., 2021), yet they remain as one of the most undervalued and under-utilised crop groups in the EU27+UK. However, in recent years, the EU27+UK have put efforts both directly (providing farm protein crop subsidies) and indirectly (promoting greening and crop diversity on farms) to encourage farmers to put more land under protein and leguminous plants and increase domestic production (EU Parliament, 2019; EU, 2018; UK Parliament, 2020).

For this work, we identified three potential pathways to improve legume production in the EU27+UK as either policy-, trade-, and/or consumer related. Under the policy related pathway, a policy scenario was selected where the UK and all member states (MSs) in the EU were expected to use a maximum of 2% of the national ceiling of basic payments to provide specific protein crop support payments to their farmers. The assumption behind this scenario is that a higher specific payment would encourage farmers to allocate more land under legume crops and increase domestic production of legumes. The second pathway is related to the trade of soya which is mainly used as livestock feed by the EU27+UK livestock farmers. A majority (>95%) of soya demand in the EU27+UK is fulfilled by imports from the US, Brazil, Argentina, and other countries. We implemented a total trade-ban on soya imports to the EU27+UK in this scenario with an assumption that domestic production of soya would increase to satisfy the demand for soya by livestock farmers. The final pathway is related to consumer demand for plant-based protein in the EU27+UK. It was assumed that with a consumer preferential shift toward a plant-based protein diet from an animal-based protein diet will increase the overall demand for legume products and hence make legume more competitive compared to other crops and increase domestic legume production.

A static comparative partial equilibrium model, CAPRI, was used to examine the impacts of these scenarios first on overall legume production in the EU27+UK but also on prices and other production effects of other agricultural production such as cereal crops and livestock productions. The next section provides a brief description of the CAPRI model followed by a description of the scenarios that were used for this work. Then the next section presents the scenario results, and the final section provides concluding remarks of this work.

## 2. CAPRI model

The Common Agricultural Regionalised Impact Analysis model (CAPRI) is a global, spatial, comparative static, partial equilibrium model with a focus on Europe, specifically designed to analyse Common Agricultural Policy (CAP) measures and trade policies for agricultural products (Britz and Witzke 2008). CAPRI consists of two models, a highly detailed and disaggregated supply module for Europe and a global market module, which are linked by sequential calibration such that production, demand, trade, and prices can be simulated simultaneously (Figure 1).

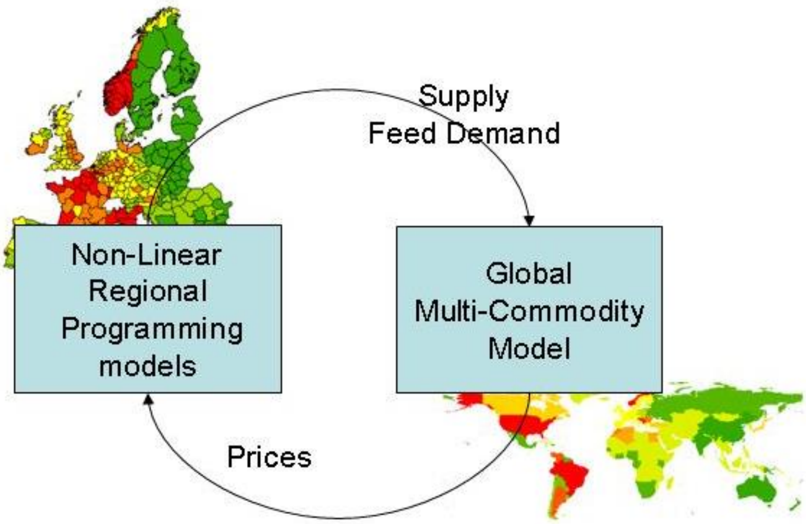


**Figure 1.** A schematic diagram of CAPRI model

The agricultural supply model consists of non-linear programming models for EU27, United Kingdom, the Western Balkans, Norway, and Turkey, which depict farming decisions in detail at the NUTS-2 (EU27+UK Nomenclature of Territorial Units for Statistics level 2). The modelling framework follows a positive mathematical programming (PMP) approach which offers a high degree of flexibility in capturing important interactions between production activities and with the environment as well as in modelling CAP and national policy measures. In the model, production functions of agricultural outputs are estimated based on historical data and trends of production and demand. The programming models comprise low- and high-intensive variants for most crop and livestock activities while a non-linear cost function captures the effects of capital and labour on the farm behaviour.

The market model is a static, deterministic, partial, spatial model with global coverage, depicting about 60 commodities (primary and secondary agricultural products) and characterising the world into 77 countries or country blocks, grouped into 40 trading blocks. Its spatial specification allows bilateral trade flows and policies between trade blocks in the model to be modelled. Within each trade block, the current version assumes perfect markets (for both primary and secondary products) so that prices for all countries move together within a market block. The parameters of the second-order flexible behavioural functions for supply, feed demand, of major processing industries and final demand are based on elasticities taken from other studies and modelling systems and calibrated to projected quantities and prices in the simulation year, while observing required theoretical properties from micro-economics.

To project the baseline and the alternative scenarios the model uses input values for the base year 2012 (which is a three-year 2011-2013 average). The model consists of a data regionalisation tool (CAPREG) and a trend projection tool (CAPTRD) which are used by a simulation tool (CAPMOD) to provide results for the projection year. For this report the projection year for the baseline and alternate scenarios is 2030. The projections for legume production, demand and trade are based on the CAP 2014 policy and trade conditions supplemented with statistical estimates and expert forecasts over the modelled period.

Apart from the rich detail on the supply side of the model, CAPRI's strengths are that it simulates results for the EU27+UK at NUTS-2 level, whilst at the same time being able to model consistently global world agricultural trade, with the EU27+UK's most important trade partners separately identified and bilateral trade flows between them and the EU27+UK accounted for. The model also allows a consistent welfare analysis and detailed analysis of agricultural policies. Therefore, CAPRI has been used frequently to analyse the impacts of agricultural, environmental and trade policies on sectoral agricultural commodities, production, and market outlook in the EU27+UK (Himics *et al.*, 2020; 2018; Fellmann *et al.*, 2017; Blanco *et al.*, 2017; Gocht *et al.*, 2016; Shrestha *et al.*, 2013; Gocht *et al.,* 2013; Blanco-Fonseca *et al.* 2010; Leip *et al*., 2010).

# 3. Modelling scenarios

This work used a baseline scenario and three alternative legume production scenarios. The baseline scenario is considered as current levels of market, trade, policies, environment, and other drivers and is used to compare and examine the effect of EU27+UK legume production under the alternative scenarios within the comparative static modelling framework. These three alternative scenarios are considered as potential pathways to improve EU27+UK legume production under a number of assumptions related to changing support policies, trade, and consumer dietary preferences.

## 3.1. Baseline scenario

The baseline scenario used in this work represents the current condition of legume production as well as policies, prices, demand, and trade relevant to legume crops in the EU27+UK. The CAPRI baseline is configured and calibrated to the latest EU agricultural outlook (EC, 2020) and environment pollution restrictions based on the latest EU Nitrate directive (EEA, 2006) and the National Emission reduction Commitment directive (EEA, 2016). The EU27+UK wide distribution of pulses at the NUTS 2 level was used to compare and validate the baseline provided in Appendix 1: EU wide dry pulses production distribution at NUTS 2 level. The baseline scenario also acts as a base for alternative scenarios where only some of the aspects of the baseline activities or drivers are changed, depending on the specific assumptions in each scenario. The baseline scenario provides projections for 2030 on the levels of market, trade, policies, environment, and other drivers under a '*business as usual*' assumption.

## 3.2. Protein crop subsidy scenario

This scenario examines changes in direct support payments to EU27+UK farmers to encourage legume production. The EU27+UK already has a protein crop and grain legume support payment system in place and 16 member states (BG, CZ, IE, GR, ES, FR, HR, IT, LV, LT, LU, HU, PL, RO, SK and FI) avail to that system under the Voluntary Coupled Payment Scheme (VCS) (see Appendix 2: Member States area claimed and total payment for protein crops). The MSs have a choice to increase their annual national ceiling for VCS by up to 2% if they decide to use at least 2% of their annual national ceiling set out in the basic act to support the production of protein crops (EU, 2020). Under this policy scenario, it is assumed that all MSs use a maximum of 2% of direct support payment to provide specific protein crop support payments to their farmers. This assumption was also adopted in an earlier study which used up to 2% of direct farm payments to legume production for a region with a ceiling of such legume payment staying below average farm direct payment per ha for that region (Kuhlman *et al*., 2017).

## 3.3. Trade-ban scenario

Soya bean is the most common legume crop that is used as livestock feed in the EU27+UK. The EU27+UK produces only 5% of soya used in the EU27+UK livestock industry domestically, and imports 95% from countries such as US, Brazil, and Argentina. This accounts for annual imports of around 14 million tons of soya bean into the EU (EU, 2019). The trade-ban scenario looks at a hypothetical condition where the EU27+UK restricts soya imports to increase domestic soya production to satisfy demand of the EU27+UK livestock industry which stays at similar levels to the baseline scenario. This scenario uses an extreme case of import restriction by placing a ban on whole soya imports to the EU27+UK. The CAPRI model has been used in the past with restrictive trade scenarios for different agricultural commodities (Lindland, 1997; Burrell *et al*., 2011; Burrell *et al*., 2014).

## 3.4. Dietary change scenario

There have been several studies which put forward a dietary change in consumer preferences as one of the mitigation measures to reduce greenhouse gas (GHG) emissions (Zhu *et al*., 2006; Tucker *et al*., 2011; Abadie *et al*., 2016; Bryngelsson *et al*, 2016). Substituting animal protein by plant-based protein has been considered as one of the options in many of these studies given climate change and health concerns. In line with these concerns, we assumed that a shift in consumer preference towards plant-based protein diets from animal-based protein diets could be a potential pathway to increase demand and domestic production of protein crops in the EU27+UK. The dietary change scenario, hence, uses a case of substitution of animal-based protein diet by plant-based protein diet and look into the impacts on legumes production in the EU27+UK.

The main assumptions used in this scenario are as follows.

- An eleven percent reduction in the EU27+UK meat consumption which is assumed to be replaced with plant protein substitutes. This assumption is based on consumer behaviour modelling work (Task 6.2)
- A substitution factor used to replace an animal-based protein diet with a plant-based protein diet is based on the Nutrient Density Unit (NDU) estimates based on an LCA work within work package 4 (Saget *et al*., 2021). The nutritional composition and NDU of a pea protein ball (representing plant-based protein) and beef meat ball (representing animal-based protein) are provided in
- **Table 1**.

**Table 1.** Summary of nutritional composition and NDU of pea protein balls and beef meat balls cooked

| Content per 100g | Pea protein ball | Beef meatballs |
|---|---|---|
| **Energy (kcal)** | 209 | 240 |
| **Protein(g)** | 22.33 | 17.5 |
| **Dietary fibre (g)** | 1 | 2 |
| **EFAs (g)** | 1.6 | 0.6 |
| **NDU** | 1.96 | 1.33 |

Source: Saget *et al*. (2021)

Under this scenario, the model converted the meat consumption quantity ($\boldsymbol{Meat_{quant}}$) to additional demand of pulses ($\boldsymbol{APulse_{quant}}$), such as:

$$\mathbf{11\%}\ X\ \boldsymbol{Meat_{quant}}\ X\ \mathbf{1.33/1.99} = \boldsymbol{APulse_{quant}}$$

The additional pulses demand is then added to the baseline level of pulses demand to complete the substitution process of the plant-based protein in the model. Technically, the demand functions for meat and pulses were shifted to meet the adjusted demand quantities under the baseline price assumptions.

# 4. Results

## 4.1. Baseline scenario

The baseline scenario represents the EU27+UK legume production under the existing production, demand, agricultural policies, trade, and market conditions. This scenario projected the area share of pulses and soya productions within total arable land in Figure 2 (for pulses) and Figure 3 (for soya) and the area of share of forage within total agricultural utilised area in Figure 4.

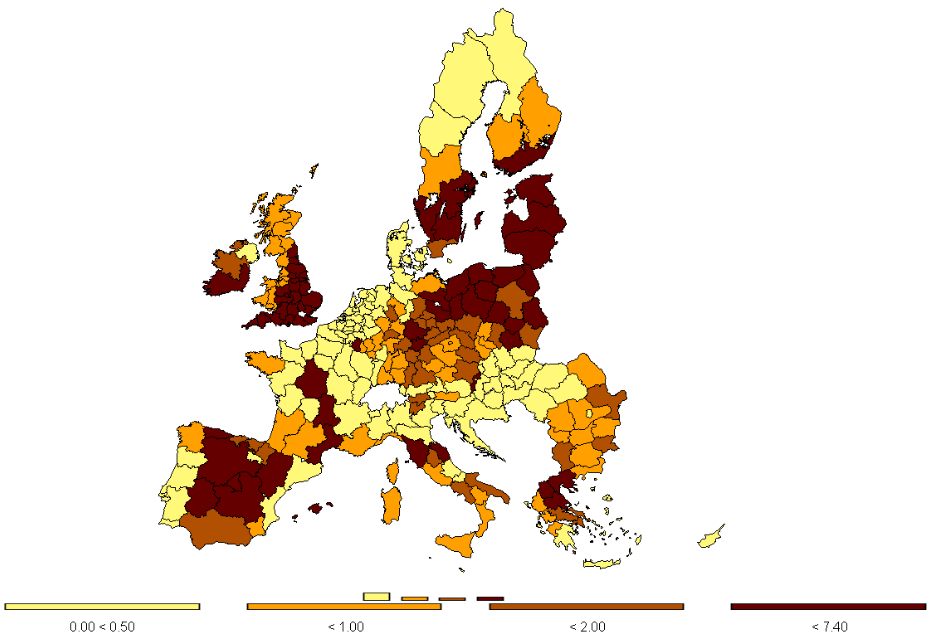


**Figure 2.** CAPRI baseline pulses production across EU27+UK (area share % in total arable land)

The results suggest that only some parts of the UK, Spain, Sweden, Italy, Romania, Lithuania, and Estonia allocates up to 7.4% of arable land cover for pulse production. Whereas a majority of MSs have less than 1% of arable area used for pulses production (Figure 2). The arable area under the baseline scenario projected to produce soya in the EU27+UK is relatively small. Except for few small regions in Italy, Slovakia, Romania, and Croatia exceeding the soya area the 5% of arable land, all other regions allocate less than 1% of arable area to produce soya beans (Figure 3). The baseline projections are in line with current shares of the EU27+UK soya production (only around 5%) in total soya demand, while most of the soya demand is satisfied from imports, particularly from the US (EuropaBio, 2019).

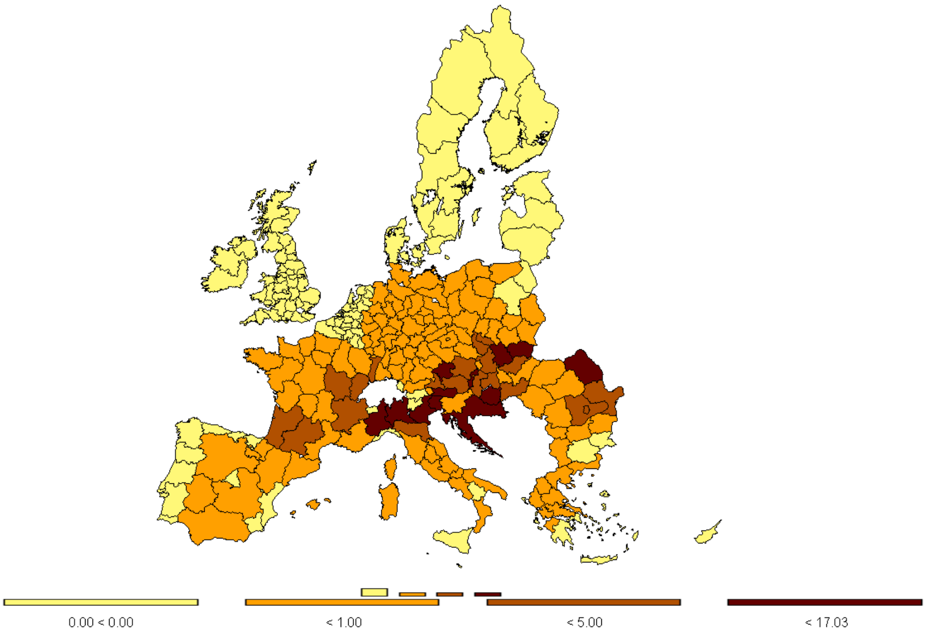


**Figure 3.** CAPRI baseline soya production across EU27+UK (area share in arable land in percentages)

The baseline projections also show a large portion of the EU27+UK total utilised agricultural area under other forage crop category which includes legume crops (peas, beans, lupin, and grass forage area). In the current conditions grassland alone covers around 33% of total utilised agricultural area in the EU27+UK (Velthof *et al*., 2014).

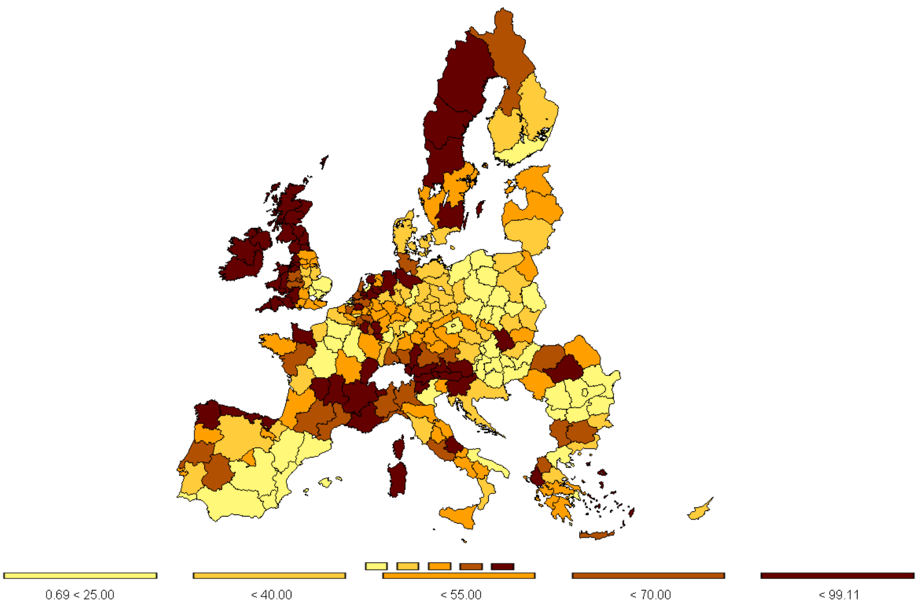


**Figure 4.** CAPRI baseline projection for the forage production across EU27+UK (area share % in total utilised agricultural area)

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## 4.2. Protein crop subsidy scenario

In this scenario, the area of production under pulses increased by 23% and quantity produced by 11% compared to the baseline. The EU farmers in a large number of MSs such as Ireland, Spain, France, Estonia, Latvia, Poland, Slovakia, Austria, and Greece exploited the VCS payment on protein crops and increased the area under pulses by 10,000 ha to 95,000 ha. (Figure 5). Farmers in the UK and some MSs such as Portugal, Germany, Lithuania, Hungary, Croatia, Hungary, Romania, and Bulgaria, however, do not change or even slightly decrease (up to -4000 ha) the area of pulse production under this scenario. These countries do not opt for protein crop subsidies. The reason could be the legumes are less competitive than other agricultural products for the allocation of VCS payments in these countries.

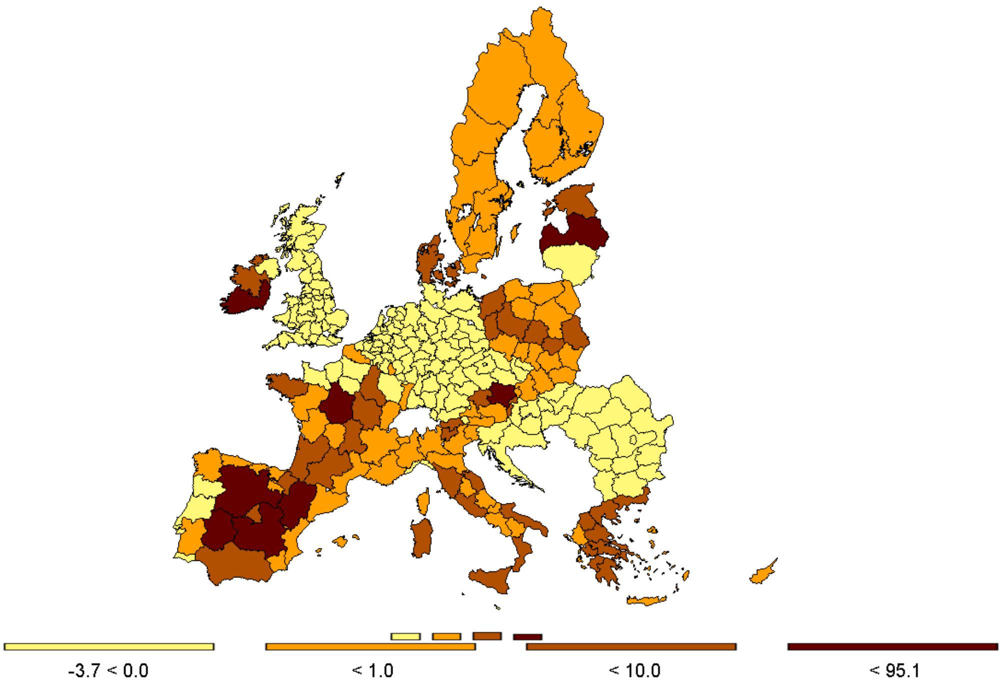


**Figure 5.** Absolute difference in area of pulses production under the protein crop subsidy scenario compared to the baseline scenario

Only a handful of countries in the EU27+UK (such as Italy and Austria) show a very small increase in the area of production for soya (Figure 6). Due to a relatively small area for soya production in the

EU27+UK, the increase in soya production area is not more than 1,500 ha. Most countries, however, do not show any change in soya production area under this scenario. There are a couple of regions such as south-western region of France and norther Austria where area of soya production is decreased but only by up to -900 ha.

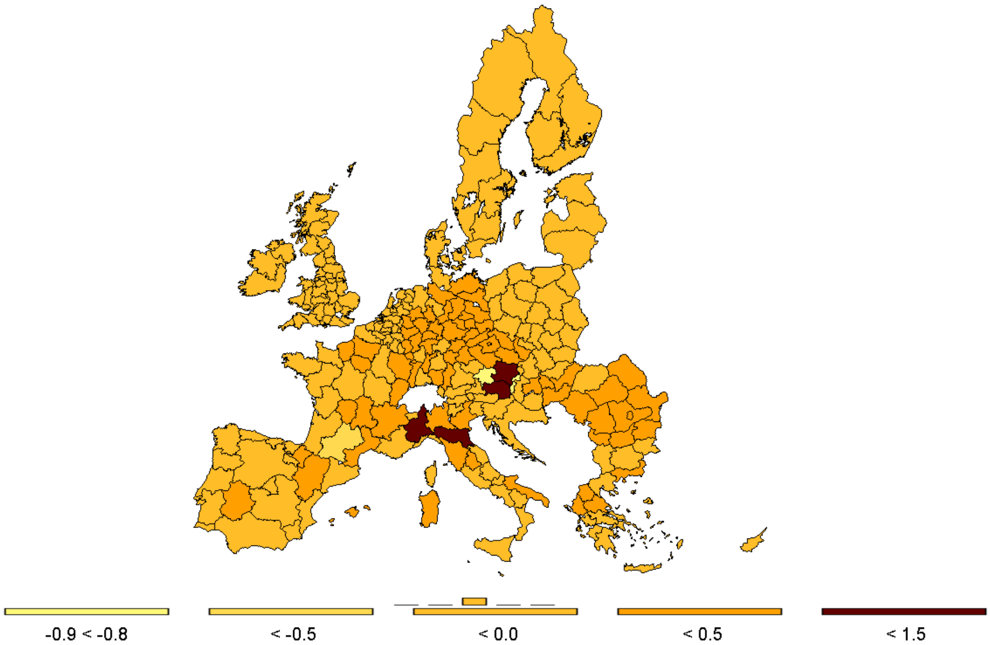


**Figure 6.** Percentage difference in area of soya production under the protein crop subsidy scenario compared to the baseline scenario

There is not a very large difference in production of pulses in top producers within the EU27+UK (Figure 7), except, for Spain and Italy where production of pulses increased by 56% and 41%, respectively, as these MSs increased protein crop subsidy from €60/ha to €206/ha in Spain and from €63/ha to €254/ha in Italy.

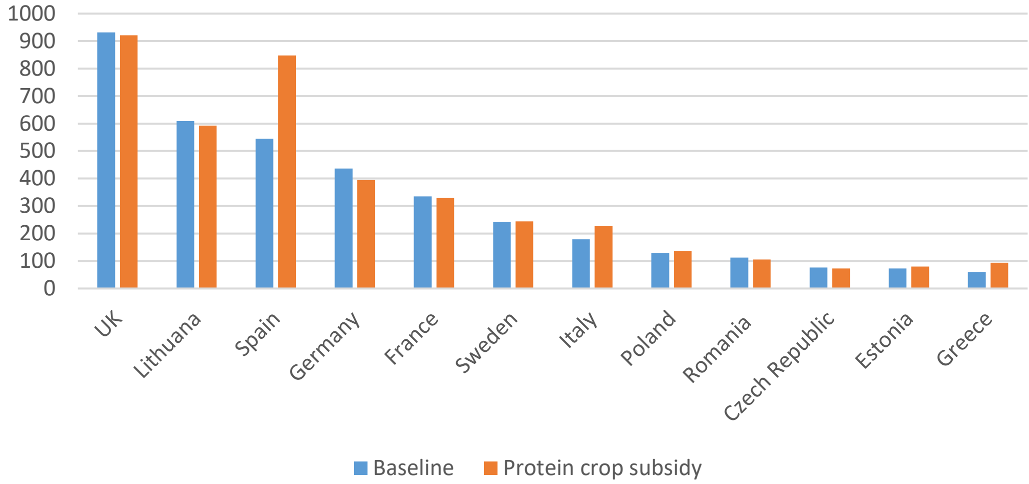


**Figure 7.** Area of production of pulses ('000 ha) in the top 12 producers under the baseline and protein crop subsidy scenarios

This increase in production area under pulses moved the supply of pulses by 13% in the EU27+UK (Table 2). There is a small increase in human consumption (+1%) and feed use (+6%) of pulses. The imports of pulses are decreased by 15%, but exports increased by 38% (although coming from low level, this increase in exports is small in absolute terms).

**Table 2.** Market balance under the protein crop subsidy scenario

| | Production | Human consumption | Feed use | Imports | Exports | Net trade |
|---|---|---|---|---|---|---|
| **Pulses** | 13% | 1% | 6% | -15% | 38% | -35% |
| **Cereals** | 0% | 0% | 0% | 0% | 0% | 0% |
| **Meat** | 0% | 0% | --- | 0% | 0% | 0% |
| **Soya** | 0% | 0% | 0% | 0% | 0% | 0% |

With respect to prices, there are only negligible changes in any of the agricultural commodities except for pulses, which show a 6% reduction in producer prices in the protein crop subsidy scenario compared to the baseline scenario (Figure 8). A higher supply in the EU27+UK of pulses production led to this reduction in producer price for pulses.


**Figure 8.** Percentage change in producer prices of different agricultural commodities under the protein crop subsidy scenario

## 4.3. Dietary change scenario

Under the dietary change scenario, there is a small but significant increase in area of production for pulses in the EU27+UK. As shown in Figure 9, more than 50% of the EU27+UK regions increase the production. Some regions such as southern UK, central Spain, Denmark, western Germany, and western Balkan regions have shown up to 30,000 ha increase in the area for pulse production compared to the baseline scenario. A majority of the EU27+UK regions, however, have a negligible change in pulse production.

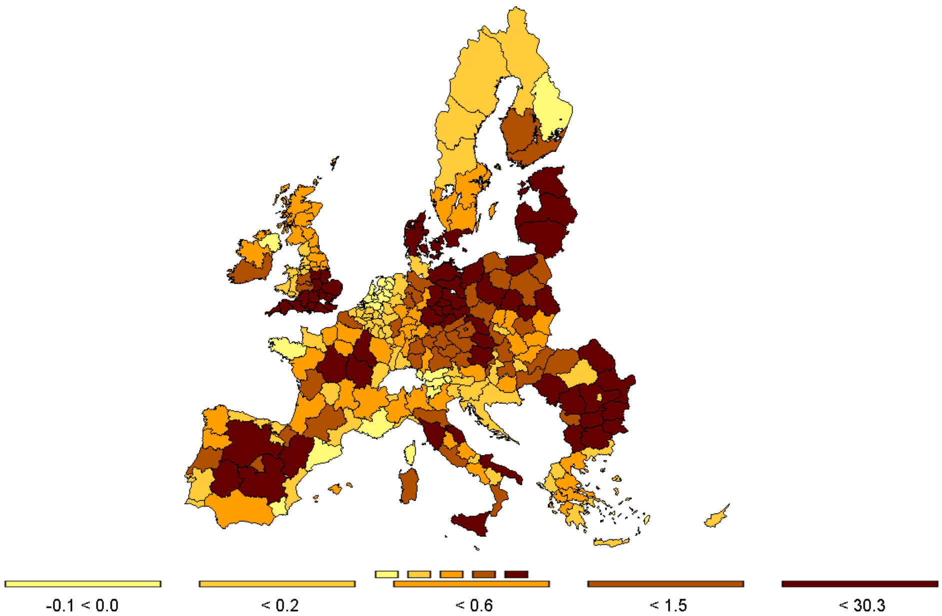


**Figure 9.** Absolute change in area of production for pulses (1000 ha) in the EU27+UK under the dietary change scenario

Regarding forage area of production, under the dietary change scenario, a majority of the EU27+UK and UK regions either show a decrease or no change in forage production area (Figure 10). There are some regions (such as southern UK, central EU27+UK and southern Italy) which show up to 5,000 ha increase in forage area compared to the baseline scenario.

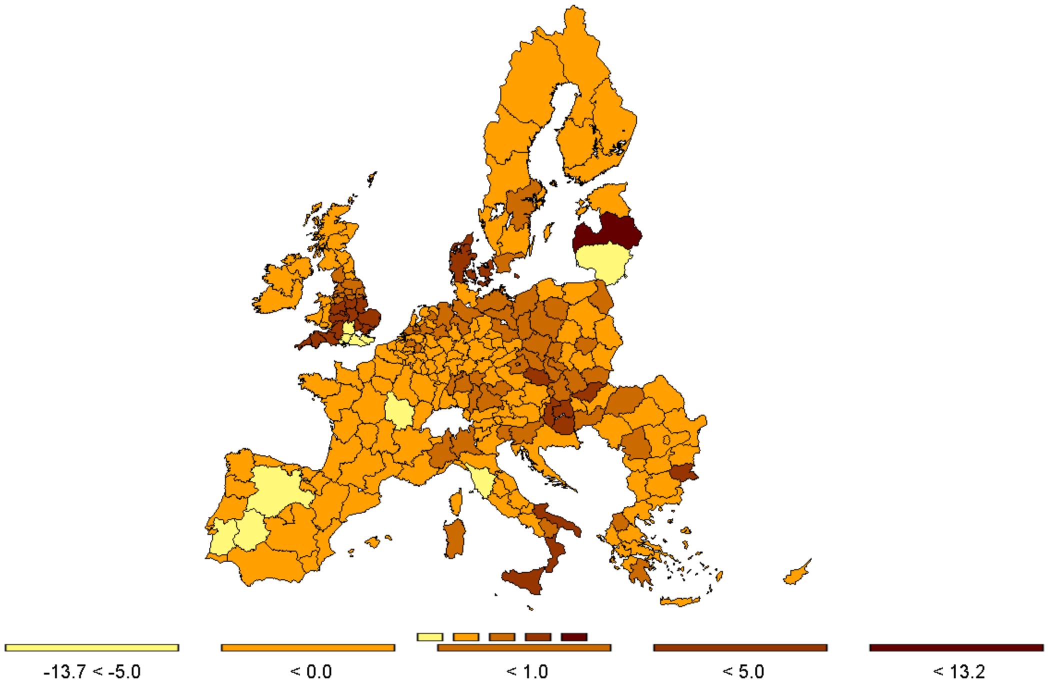


**Figure 10.** Absolute change in area of production for forage under dietary change scenario compared to the baseline scenario

The UK, Lithuania, Spain, Germany, France, and Sweden produced more than 200,000 tons of pulses each in the baseline (Figure 11). These top producers responded to the dietary change scenario, and all increased their production of pulses to varying degrees. France increased the highest (+69%) followed by Romania (+47%) and Czech Republic (+39%).

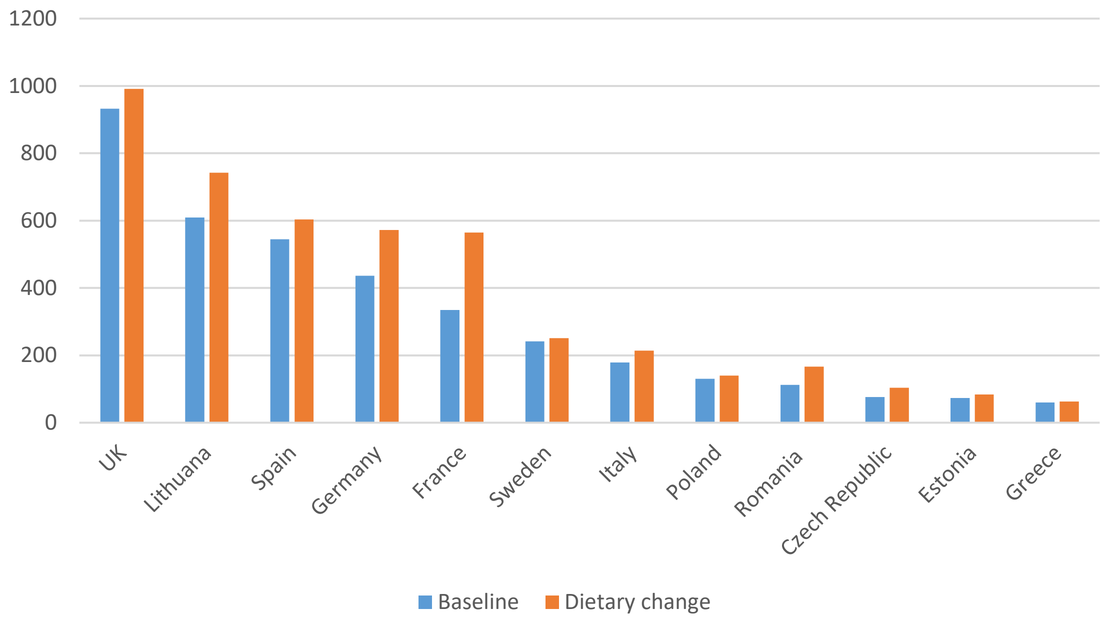


**Figure 11.** Production levels of pulses ('000 t) in top 12 producers under the baseline and the dietary change scenarios

There is a 13% increase in prices for pulses under the dietary change scenario compared to the baseline (Figure 12). The substitution to plant-based protein increased demand for pulses which is manifested by higher price for pulses. All meat prices are reduced, especially the price for beef meat, which decreased by more than 7%. There is a slight decrease in soya and cereal prices, which is mainly due to lower feed demand in the livestock sector under the dietary change scenario.

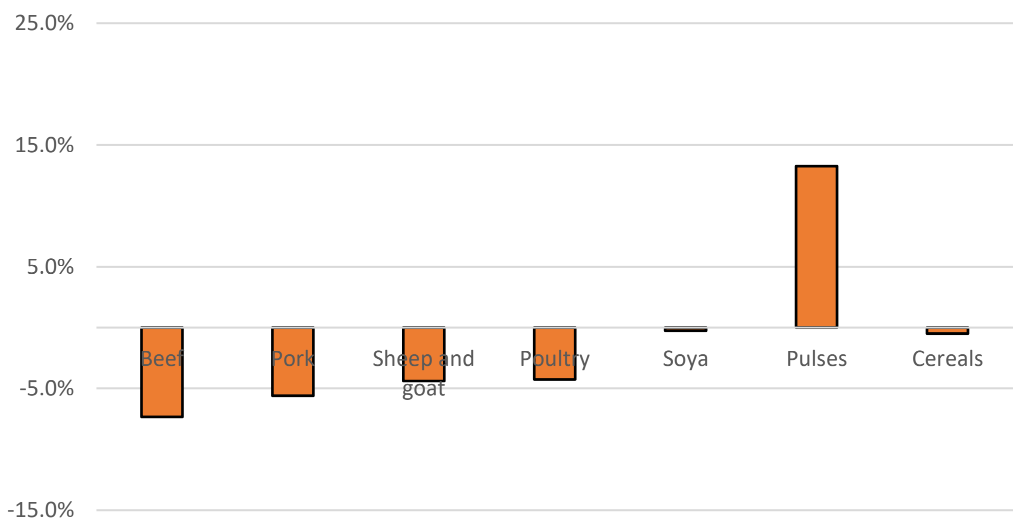


**Figure 12.** Percentage change in prices of different agricultural commodities under the dietary change scenario compared to the baseline scenario

The market balance (Table 3) clearly shows an increase in human consumption of pulses by 177% under dietary change scenario. This is because of the assumption that the EU27+UK consumer preferences for plant-based protein instead of animal-based protein is increased by 11% under this scenario. Due to the greater demand, there is a significant change in the trade balance of pulses, with larger imports and smaller exports. This is because animal-based products have been substituted under this scenario, meat production in the EU27+UK is decreased by 5%. There is a significant decrease in meat imports. As there is less demand of meat, more meat products are exported out of the EU27+UK and there is a positive trade balance. Due to decrease in meat products, use of soya and cereal in livestock feed is also decreased, which results in reduced production in the EU27+UK. These along with pulses are used lesser as livestock feed.

**Table 3**. Market balance under the dietary change scenario

| | Production | Human consumption | Feed use | Imports | Exports | Net trade |
|---|---|---|---|---|---|---|
| **Pulses** | 27% | 177% | -20% | 161% | -53% | -245% |
| **Cereals** | -1% | 0% | -3% | -3% | 1% | 5% |
| **Meat** | -5% | -10% | --- | -33% | 22% | 28% |
| **Soya** | -1% | 0% | -1% | 0% | -1% | 0% |

## 4.4. Trade-ban of soya imports

Under the trade-ban of soya imports scenario, soya harvested area increased by 266% and its supply by 275%. This significant relative increase in soya production in the EU27+UK is partly due to the small production in the baseline. Most of the southern European regions have increased the soya production area by up to 5,000 ha (each) under this scenario (Figure 13).

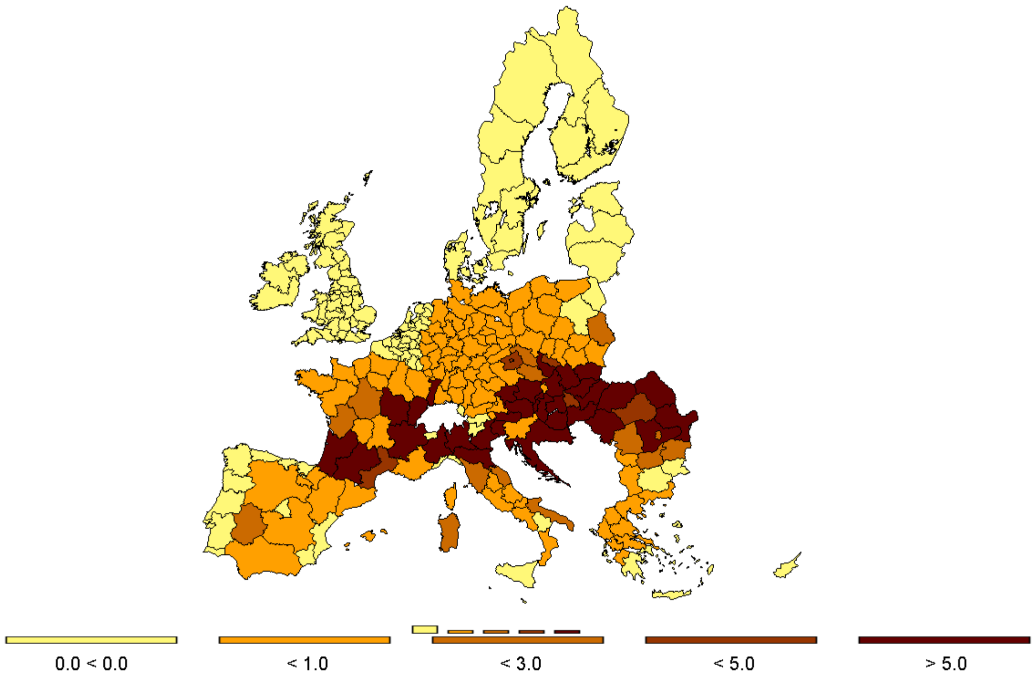


**Figure 13.** Absolute change in area of soya production (‘000 ha) under the trade-ban scenario compared to the baseline scenario

Pulses area also increases (+7%) under this scenario in the EU27+UK. Many regions, especially in central Europe, increased the pulses area by up to 18,000 ha (Figure 14). There, however, is some reallocation of area of production as some regions record a decrease in area of production for pulses under this scenario. The expansion in soybean areas leads to a reallocation of the agricultural area between arable crops. Depending on the relative profitability between cereals, oilseeds and other arable crops in the regions, the impact on pulses production can also be negative. A competitive price and suitability to expand could have influenced this shift in production area.

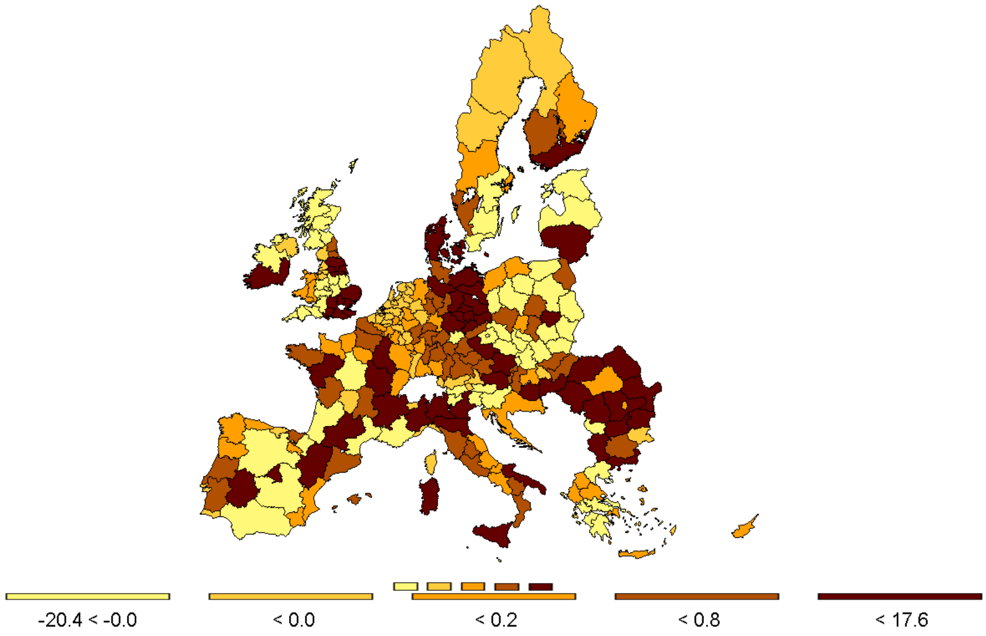


**Figure 14**. Absolute change in area of pulses production ('000 ha) under the trade-ban scenario compared to the baseline scenario

Soya imports are mainly used for livestock feed in the EU27+UK. A restriction on soya feed imports thus influenced the area of forage production in most of the regions. The fodder area increased by up to 10,000 ha in many regions such as Spain, Ireland, Denmark, and northern Italy (Figure 15). This is to offset the reduction in imported livestock feed under this scenario.

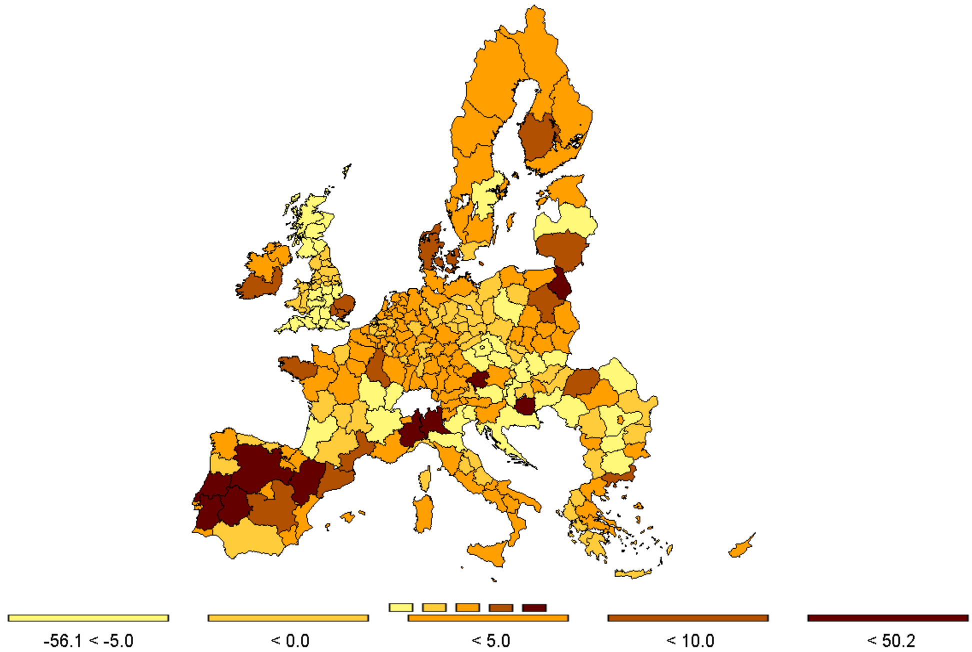


**Figure 15.** Absolute difference in area of fodder production ('000 ha) under the trade-ban scenario compared to the baseline scenario

In terms of production, there are some increases in pulse production in the top 12 countries as shown in Figure 16. Romania has the highest increase in production (+69%) followed by Italy (+41%), France (+38%) and Germany (+20%). Some of these top producers, however, decreased pulse production under this scenario such as Estonia (-44%) and Czech Republic (-34%).

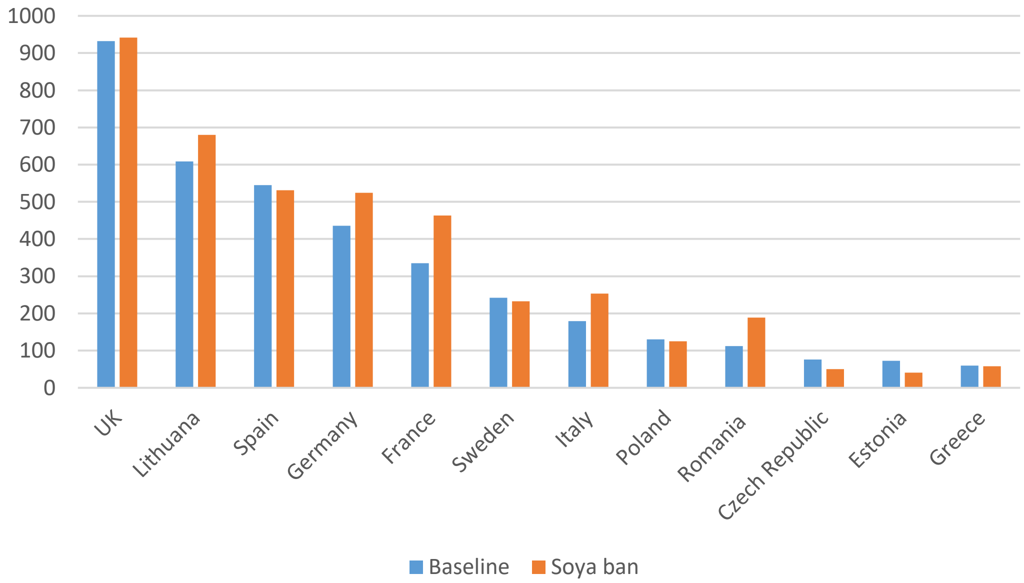


**Figure 16.** Production quantity of pulses ('000 t) of top 12 producers under the baseline and trade-ban scenarios

The price of soya under the trade-ban scenario increased by 150% compared to the baseline scenario (Figure 17). This is due to reduced supply of soya within the EU27+UK due to the import ban. This has direct impacts on livestock products such as beef, pork, sheep/goat, and poultry which have up to 5% increase in price. Other agricultural commodities such as pulses (+10%) and cereals (+1%) that are used as livestock feed have also observed an increase in their prices.

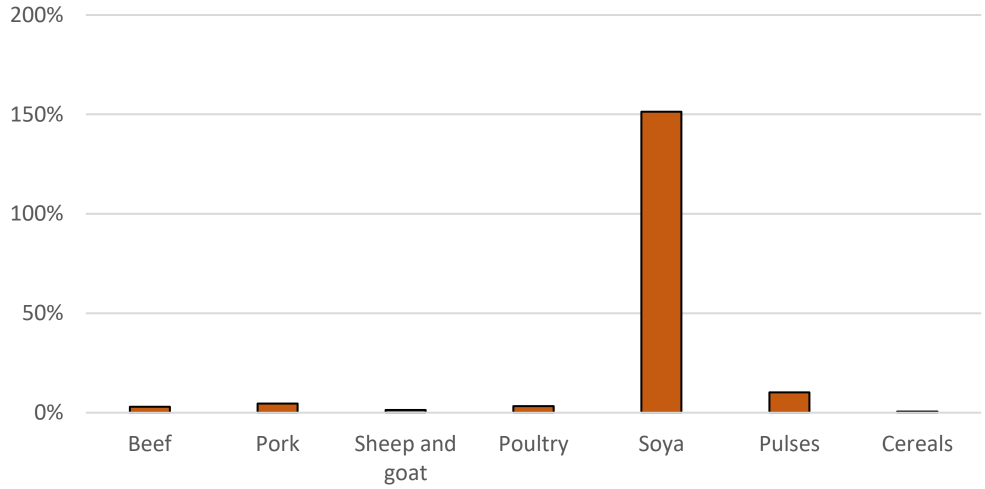


**Figure 17.** Percentage difference in prices of different agricultural commodities under the trade-ban scenario compared to the baseline scenario

As expected, production of soya within the EU27+UK has increased by 272%, but it also led to a 9% reduction in human consumption of soya beans (Table 4). The soya trade-ban has an impact on livestock sector which resulted in reduced meat production within the EU27+UK. There are less exports and higher imports to fulfil domestic demand of meat products. There is an increase in pulses and cereals for use as feed to compensate reduction in soya supply due to the trade-ban.

**Table 4.** Percentage change in market balance of soya and relevant agricultural commodities under soya import trade-ban scenario compared to the baseline scenario

| | Production | Human consumption | Feed use | Imports | Exports | Net trade |
|---|---|---|---|---|---|---|
| Pulses | 15% | -2% | 54% | 55% | -23% | -86% |
| Cereals | -1% | 0% | 1% | 9% | -5% | -5% |
| Meat | -3% | 0% | --- | 12% | -14% | -28% |
| Soya | 272% | -9% | -51% | -100% | -100% | -100% |

# 5. Conclusions

There are several potential pathways to increase legume production in the EU27+UK. We selected three pathways in this study: policy-, trade-, and consumer demand-related pathways. These are the pathways which we considered to have impacts on the EU27+UK domestic legume production. There are other potential but indirect pathways we did not consider for this study such as environment- and biodiversity-related pathways. These indirect pathways may include environment restrictions, crop rotations and cover crops *etc.* to lower GHG emissions on farms (Guardia, *et al*., 2016; Glenk *et al*., 2017; Abdalla, *et al*., 2019; Costa *et al.*, 2021). For instance, reducing the use of inorganic fertiliser can be achieved by implementing restrictive thresholds or an additional tax on use of inorganic fertiliser which may encourage farmers to increase legume crops on farms to maintain soil fertility. Liu *et al.* (2016) stated that 25% -38% reduction in carbon footprint of cereal production can be achieved by including legume crop rotation and increase in legume forage area. Besides these 'within the farm gate' pathways, there are also 'beyond the farm gate' pathways representing the legume supply and value chains including transport, processing, storage, and distribution legume products. These 'beyond the farm gate' pathways may act as barriers to develop legume market in Europe (Smadja and Muel, 2021; Balazs *et al*., 2021). A more inclusive, innovative, and sustainable development of the legume supply and value chain may support further development of legume in the EU27+UK. However, these pathways are beyond the scope of this work and hence are not considered in this report.

Our results suggest that the three alternative pathway scenarios used in this study have potential to increase area of production of legume crops. However, due to the current lower commercial competitiveness of legume crops, the increase in production of legumes is very small under all three scenarios under study. The area of production for legumes is relatively small in the EU27+UK compared to other crops. For instance, total share of pulses is less than 2% of total arable land available in the EU27+UK.

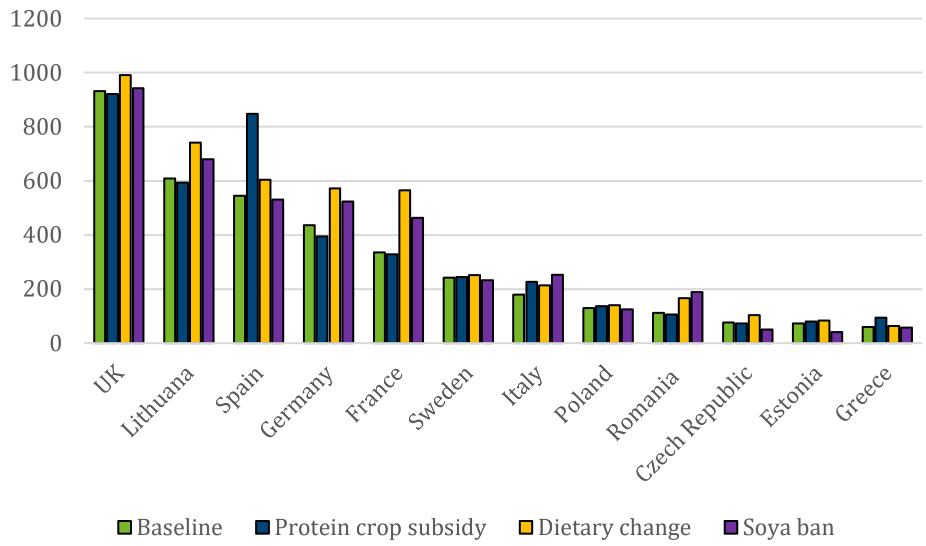


**Figure 18**. Total production of pulses in top 12 producers under different scenarios ('000 t)

There is, however, a varying extent of the impact on production, prices, and effect on other agricultural commodities under these three scenarios. For instance, the protein crop subsidy scenario has the highest increase (+23%) in area of pulse production compared to the dietary change scenario (+16%) and trade-ban scenario (+6%). There is also a difference in impacts on prices and other agricultural commodities between these scenarios. The price of pulse decreased by around 6% under protein crop subsidy scenario but increased by 13% and 10% under dietary change and trade-ban scenarios respectively. The price of soya had the highest increase (+150%) under the trade-ban scenario and has a substantial impact on other agricultural sectors. The dietary change and trade-ban scenario represented a significant impact on livestock production and other crop production that are used as animal feeds. However, it should be noted here that the trade-ban scenario is the extreme case scenario for a trade policy and may be politically sensitive.

The individual countries within the EU27+UK also responded differently under different pathway scenarios. Some countries like the UK, Germany and Lithuania decreased production of pulses under the protein crop subsidy scenario (Figure 18). These countries did not use the specific payment available under the scenario and decreased the production slightly in response to lower pulses price. Conversely, Spain, Italy and Greece benefitted from the specific payments and increased the pulse production significantly. Dietary change scenario has shown higher impacts on all countries especially in France, Germany, Lithuania, and the UK. France showed the highest

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increase with a substantial 69% increase in pulse production when dietary change is introduced. The trade-ban scenario has the highest impact on production and price of soya.

It can be summarised that the scenarios we selected for this study under three potential pathways are capable of increasing legume production in the EU27+UK. However, the increased areas of production of legume crops under all these scenarios are still very small compared to other crops. Changes in different policy instrument to support a combination of these scenarios or additional policies to provide legume price incentives to improve competitiveness may be required to improve demand, price, and ultimately domestic production of legumes in the EU27+UK. We selected three potential pathways in this study, and it should be noted that there are other potential pathways such as environment related and biodiversity related pathways not examined here, which could have additional impact on the EU27+UK legume production when considered together with the scenarios used.

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# Appendices

## Appendix 1: EU wide dry pulses production distribution at NUTS 2 level

| NUTS | Region | Arable land (ha) | Dry pulses (ha) | Dry pulses share (%) |
|---|---|---|---|---|
| AT11 | Burgenland (AT) | 152130 | 3930 | 2.58 |
| AT12 | Niederösterreich | 682440 | 13920 | 2.04 |
| AT13 | Wien | 4850 | 90 | 1.86 |
| AT21 | Kärnten | 61310 | 560 | 0.91 |
| AT22 | Steiermark | 136410 | 670 | 0.49 |
| AT31 | Oberösterreich | 290110 | 5590 | 1.93 |
| AT32 | Salzburg | 5530 | 30 | 0.54 |
| AT33 | Tirol | 8660 | 10 | 0.12 |
| AT34 | Vorarlberg | 2940 | 0 | 0.00 |
| BE10 | Région de Bruxelles-Capitale / Brussels Hoofdstedelijk Gewest | 1960 | 30 | 1.53 |
| BE21 | Prov. Antwerpen | 65540 | 50 | 0.08 |
| BE22 | Prov. Limburg (BE) | 57450 | 90 | 0.16 |
| BE23 | Prov. Oost-Vlaanderen | 99500 | 70 | 0.07 |
| BE24 | Prov. Vlaams-Brabant | 63910 | 90 | 0.14 |
| BE25 | Prov. West-Vlaanderen | 147220 | 200 | 0.14 |
| BE31 | Prov. Brabant Wallon | 56010 | 150 | 0.27 |
| BE32 | Prov. Hainaut | 155220 | 380 | 0.24 |
| BE33 | Prov. Liège | 70520 | 430 | 0.61 |
| BE34 | Prov. Luxembourg (BE) | 42730 | 810 | 1.90 |
| BE35 | Prov. Namur | 95340 | 610 | 0.64 |
| BG31 | Severozapaden | 739150 | 10510 | 1.42 |
| BG32 | Severen tsentralen | 651800 | 6320 | 0.97 |
| BG33 | Severoiztochen | 703330 | 5920 | 0.84 |
| BG34 | Yugoiztochen | 606630 | 5860 | 0.97 |
| BG41 | Yugozapaden | 164690 | 1020 | 0.62 |
| BG42 | Yuzhen tsentralen | 353100 | 1180 | 0.33 |
| CY00 | Kypros | 84250 | 450 | 0.53 |
| CZ01 | Praha | 12960 | 260 | 2.01 |
| CZ02 | Strední Cechy | 475400 | 7130 | 1.50 |
| CZ03 | Jihozápad | 439900 | 6310 | 1.43 |
| CZ04 | Severozápad | 185110 | 2840 | 1.53 |
| CZ05 | Severovýchod | 380270 | 6200 | 1.63 |
| CZ06 | Jihovýchod | 592760 | 9160 | 1.55 |
| CZ07 | Strední Morava | 266490 | 2560 | 0.96 |
| CZ08 | Moravskoslezsko | 120310 | 1180 | 0.98 |
| DE11 | Stuttgart | 309620 | 4362 | 1.41 |
| DE12 | Karlsruhe | 139280 | 2535 | 1.82 |
| DE13 | Freiburg | 138990 | 1409 | 1.01 |
| DE14 | Tübingen | 230810 | 3354 | 1.45 |
| DE21 | Oberbayern | 437180 | 4332 | 0.99 |
| DE22 | Niederbayern | 378600 | 2637 | 0.70 |

| | | | | |
|---|---|---|---|---|
| DE23 | Oberpfalz | 278590 | 4164 | 1.49 |
| DE24 | Oberfranken | 211890 | 3625 | 1.71 |
| DE25 | Mittelfranken | 238570 | 2833 | 1.19 |
| DE26 | Unterfranken | 277610 | 4261 | 1.53 |
| DE27 | Schwaben | 259780 | 1740 | 0.67 |
| DE30 | Berlin | 1010 | | |
| DE40 | Brandenburg | 1014410 | 23144 | 2.28 |
| DE50 | Bremen | 1640 | | |
| DE60 | Hamburg | 5720 | 133 | 2.33 |
| DE71 | Darmstadt | 149430 | 2108 | 1.41 |
| DE72 | Gießen | 116940 | 2562 | 2.19 |
| DE73 | Kassel | 202930 | 3494 | 1.72 |
| DE80 | Mecklenburg-Vorpommern | 1078070 | 18033 | 1.67 |
| DE91 | Braunschweig | 336740 | 2912 | 0.86 |
| DE92 | Hannover | 412420 | 2460 | 0.60 |
| DE93 | Lüneburg | 531440 | 4135 | 0.78 |
| DE94 | Weser-Ems | 613370 | 1756 | 0.29 |
| DEA1 | Düsseldorf | 151500 | 1105 | 0.73 |
| DEA2 | Köln | 175530 | 1980 | 1.13 |
| DEA3 | Münster | 324730 | 466 | 0.14 |
| DEA4 | Detmold | 264070 | 2025 | 0.77 |
| DEA5 | Arnsberg | 127750 | 1128 | 0.88 |
| DEB1 | Koblenz | 149230 | 858 | 0.57 |
| DEB2 | Trier | 89170 | 221 | 0.25 |
| DEB3 | Rheinhessen-Pfalz | 166910 | 960 | 0.58 |
| DEC0 | Saarland | 36630 | 305 | 0.83 |
| DED2 | Dresden | 274430 | 5173 | 1.88 |
| DED4 | Chemnitz | 228730 | 5312 | 2.32 |
| DED5 | Leipzig | 204350 | 3491 | 1.71 |
| DEE0 | Sachsen-Anhalt | 996170 | 27118 | 2.72 |
| DEF0 | Schleswig-Holstein | 655610 | 4217 | 0.64 |
| DEG0 | Thüringen | 609500 | 17891 | 2.94 |
| DK01 | Hovedstaden | 81210 | 1000 | 1.23 |
| DK02 | Sjælland | 439800 | 2400 | 0.55 |
| DK03 | Syddanmark | 707030 | 5100 | 0.72 |
| DK04 | Midtjylland | 701330 | 4800 | 0.68 |
| DK05 | Nordjylland | 431830 | 2500 | 0.58 |
| EE00 | Eesti | 686560 | 55420 | 8.07 |
| EL30 | Attiki | 8280 | 510 | 6.16 |
| EL41 | Voreio Aigaio | 17780 | 1370 | 7.71 |
| EL42 | Notio Aigaio | 22390 | 260 | 1.16 |
| EL43 | Kriti | 21500 | 620 | 2.88 |
| EL51 | Anatoliki Makedonia, Thraki | 336970 | 6560 | 1.95 |
| EL52 | Kentriki Makedonia | 520840 | 32870 | 6.31 |
| EL53 | Dytiki Makedonia | 187120 | 13220 | 7.06 |
| EL54 | Ipeiros | 27510 | 570 | 2.07 |
| EL61 | Thessalia | 298900 | 17910 | 5.99 |
| EL62 | Ionia Nisia | 7000 | 150 | 2.14 |
| EL63 | Dytiki Ellada | 113210 | 2030 | 1.79 |

| | | | | |
|---|---|---|---|---|
| EL64 | Sterea Ellada | 163890 | 6950 | 4.24 |
| EL65 | Peloponnisos | 36860 | 2920 | 7.92 |
| ES11 | Galicia | 182540 | 2140 | 1.17 |
| ES12 | Principado de Asturias | 18580 | 1190 | 6.40 |
| ES13 | Cantabria | 6730 | 0 | 0.00 |
| ES21 | País Vasco | 58980 | 3720 | 6.31 |
| ES22 | Comunidad Foral de Navarra | 303290 | 8860 | 2.92 |
| ES23 | La Rioja | 69080 | 1110 | 1.61 |
| ES24 | Aragón | 1471110 | 28010 | 1.90 |
| ES30 | Comunidad de Madrid | 149280 | 6750 | 4.52 |
| ES41 | Castilla y León | 3470730 | 126590 | 3.65 |
| ES42 | Castilla-la Mancha | 2636050 | 173940 | 6.60 |
| ES43 | Extremadura | 641710 | 12560 | 1.96 |
| ES51 | Cataluña | 523820 | 11180 | 2.13 |
| ES52 | Comunidad Valenciana | 104580 | 1310 | 1.25 |
| ES53 | Illes Balears | 114240 | 3500 | 3.06 |
| ES61 | Andalucía | 1536910 | 78750 | 5.12 |
| ES62 | Región de Murcia | 163430 | 210 | 0.13 |
| ES63 | Ciudad Autónoma de Ceuta (ES) | 0 | 0 | 0.00 |
| ES64 | Ciudad Autónoma de Melilla (ES) | 0 | 0 | 0.00 |
| ES70 | Canarias (ES) | 11860 | 410 | 3.46 |
| FI19 | Länsi-Suomi | 748820 | 4200 | 0.56 |
| FI1B | Helsinki-Uusimaa | 173770 | 4900 | 2.82 |
| FI1C | Etelä-Suomi | 592330 | 15100 | 2.55 |
| FI1D | Pohjois- ja Itä-Suomi | 636690 | 1800 | 0.28 |
| FI20 | Åland | 13360 | 100 | 0.75 |
| FR10 | Île de France | 564990 | 19450 | 3.44 |
| FR21 | Champagne-Ardenne (NUTS 2013) | 1254970 | 37500 | 2.99 |
| FR22 | Picardie (NUTS 2013) | 1204130 | 33240 | 2.76 |
| FR23 | Haute-Normandie (NUTS 2013) | 579600 | 14380 | 2.48 |
| FR24 | Centre (FR) (NUTS 2013) | 2014330 | 42900 | 2.13 |
| FR25 | Basse-Normandie (NUTS 2013) | 716020 | 15120 | 2.11 |
| FR26 | Bourgogne (NUTS 2013) | 1020650 | 24100 | 2.36 |
| FR30 | Nord - Pas-de-Calais (NUTS 2013) | 686910 | 6220 | 0.91 |
| FR41 | Lorraine (NUTS 2013) | 734630 | 15660 | 2.13 |
| FR42 | Alsace (NUTS 2013) | 243740 | 310 | 0.13 |
| FR43 | Franche-Comté (NUTS 2013) | 292190 | 1350 | 0.46 |
| FR51 | Pays de la Loire (NUTS 2013) | 1611870 | 20400 | 1.27 |
| FR52 | Bretagne (NUTS 2013) | 1508680 | 8880 | 0.59 |
| FR53 | Poitou-Charentes (NUTS 2013) | 1401190 | 28980 | 2.07 |
| FR61 | Aquitaine (NUTS 2013) | 817960 | 5040 | 0.62 |
| FR62 | Midi-Pyrénées (NUTS 2013) | 1506180 | 34220 | 2.27 |
| FR63 | Limousin (NUTS 2013) | 390310 | 930 | 0.24 |
| FR71 | Rhône-Alpes (NUTS 2013) | 580640 | 2980 | 0.51 |
| FR72 | Auvergne (NUTS 2013) | 604560 | 7040 | 1.16 |
| FR81 | Languedoc-Roussillon (NUTS 2013) | 254570 | 8890 | 3.49 |
| FR82 | Provence-Alpes-Côte d'Azur (NUTS 2013) | 190240 | 2390 | 1.26 |
| FR83 | Corse (NUTS 2013) | 12370 | 30 | 0.24 |
| HR03 | Jadranska Hrvatska | 38150 | 20 | 0.05 |

| | | | | |
|---|---|---|---|---|
| HR04 | Kontinentalna Hrvatska | 843460 | 3230 | 0.38 |
| HU10 | Közép-Magyarország (NUTS 2013) | 261990 | 1500 | 0.57 |
| HU21 | Közép-Dunántúl | 402240 | 2790 | 0.69 |
| HU22 | Nyugat-Dunántúl | 462380 | 1320 | 0.29 |
| HU23 | Dél-Dunántúl | 595470 | 1920 | 0.32 |
| HU31 | Észak-Magyarország | 378170 | 2060 | 0.54 |
| HU32 | Észak-Alföld | 815740 | 5600 | 0.69 |
| HU33 | Dél-Alföld | 905830 | 6000 | 0.66 |
| IE01 | Border, Midland and Western (NUTS 2013) | 100820 | 1590 | 1.58 |
| IE02 | Southern and Eastern (NUTS 2013) | 357470 | 10890 | 3.05 |
| ITC1 | Piemonte | 537930 | 2870 | 0.53 |
| ITC2 | Valle d'Aosta/Vallée d'Aoste | 150 | 0 | 0.00 |
| ITC3 | Liguria | 6630 | 80 | 1.21 |
| ITC4 | Lombardia | 722710 | 1890 | 0.26 |
| ITF1 | Abruzzo | 172500 | 4240 | 2.46 |
| ITF2 | Molise | 145020 | 1200 | 0.83 |
| ITF3 | Campania | 268620 | 2600 | 0.97 |
| ITF4 | Puglia | 675740 | 8100 | 1.20 |
| ITF5 | Basilicata | 324230 | 140 | 0.04 |
| ITF6 | Calabria | 170250 | 1430 | 0.84 |
| ITG1 | Sicilia | 714490 | 8570 | 1.20 |
| ITG2 | Sardegna | 411240 | 4440 | 1.08 |
| ITH1 | Provincia Autonoma di Bolzano/Bozen | 3230 | 0 | 0.00 |
| ITH2 | Provincia Autonoma di Trento | 3560 | 10 | 0.28 |
| ITH3 | Veneto | 553880 | 450 | 0.08 |
| ITH4 | Friuli-Venezia Giulia | 166860 | 0 | 0.00 |
| ITH5 | Emilia-Romagna | 863810 | 3910 | 0.45 |
| ITI1 | Toscana | 448520 | 8000 | 1.78 |
| ITI2 | Umbria | 223130 | 1750 | 0.78 |
| ITI3 | Marche | 388320 | 7790 | 2.01 |
| ITI4 | Lazio | 344220 | 1780 | 0.52 |
| LT00 | Lietuva | 2130250 | 231980 | 10.89 |
| LU00 | Luxemburg | 61980 | 680 | 1.10 |
| LV00 | Latvija | 1284650 | 40800 | 3.18 |
| MT00 | Malta | 9110 | 0 | 0.00 |
| NL11 | Groningen | 106990 | 70 | 0.07 |
| NL12 | Friesland (NL) | 58720 | 50 | 0.09 |
| NL13 | Drenthe | 101560 | 30 | 0.03 |
| NL21 | Overijssel | 83730 | 20 | 0.02 |
| NL22 | Gelderland | 92300 | 90 | 0.10 |
| NL23 | Flevoland | 82410 | 20 | 0.02 |
| NL31 | Utrecht | 11670 | 10 | 0.09 |
| NL32 | Noord-Holland | 77420 | 60 | 0.08 |
| NL33 | Zuid-Holland | 58070 | 330 | 0.57 |
| NL34 | Zeeland | 102340 | 1220 | 1.19 |
| NL41 | Noord-Brabant | 181680 | 210 | 0.12 |
| NL42 | Limburg (NL) | 71270 | 50 | 0.07 |
| PL11 | Lódzkie (NUTS 2013) | 755770 | 20800 | 2.75 |
| PL12 | Mazowieckie (NUTS 2013) | 1220770 | 27600 | 2.26 |

| | | | | |
|---|---|---|---|---|
| PL21 | Malopolskie | 306020 | 8200 | 2.68 |
| PL22 | Slaskie | 263160 | 6300 | 2.39 |
| PL31 | Lubelskie (NUTS 2013) | 1093830 | 52700 | 4.82 |
| PL32 | Podkarpackie (NUTS 2013) | 325550 | 8300 | 2.55 |
| PL33 | Swietokrzyskie (NUTS 2013) | 333070 | 17800 | 5.34 |
| PL34 | Podlaskie (NUTS 2013) | 694280 | 15100 | 2.17 |
| PL41 | Wielkopolskie | 1432020 | 23500 | 1.64 |
| PL42 | Zachodniopomorskie | 667360 | 32800 | 4.91 |
| PL43 | Lubuskie | 299660 | 15400 | 5.14 |
| PL51 | Dolnoslaskie | 750350 | 11300 | 1.51 |
| PL52 | Opolskie | 468580 | 5800 | 1.24 |
| PL61 | Kujawsko-Pomorskie | 922460 | 19100 | 2.07 |
| PL62 | Warminsko-Mazurskie | 684000 | 32700 | 4.78 |
| PL63 | Pomorskie | 588740 | 23400 | 3.97 |
| PT11 | Norte | 172300 | 2150 | 1.25 |
| PT15 | Algarve | 26350 | 140 | 0.53 |
| PT16 | Centro (PT) | 188450 | 3360 | 1.78 |
| PT17 | Área Metropolitana de Lisboa | 33530 | 100 | 0.30 |
| PT18 | Alentejo | 598550 | 13080 | 2.19 |
| PT20 | Região Autónoma dos Açores (PT) | 22220 | 50 | 0.23 |
| PT30 | Região Autónoma da Madeira (PT) | 1890 | 0 | 0.00 |
| RO11 | Nord-Vest | 789430 | 2140 | 0.27 |
| RO12 | Centru | 494210 | 1280 | 0.26 |
| RO21 | Nord-Est | 1166350 | 8110 | 0.70 |
| RO22 | Sud-Est | 1630830 | 21010 | 1.29 |
| RO31 | Sud - Muntenia | 1679030 | 18630 | 1.11 |
| RO32 | Bucuresti - Ilfov | 61170 | 630 | 1.03 |
| RO41 | Sud-Vest Oltenia | 1083540 | 7240 | 0.67 |
| RO42 | Vest | 908870 | 1310 | 0.14 |
| SE11 | Stockholm | 80800 | 1840 | 2.28 |
| SE12 | Östra Mellansverige | 688930 | 23790 | 3.45 |
| SE21 | Småland med öarna | 340070 | 4800 | 1.41 |
| SE22 | Sydsverige | 465880 | 5690 | 1.22 |
| SE23 | Västsverige | 570270 | 16990 | 2.98 |
| SE31 | Norra Mellansverige | 231080 | 2200 | 0.95 |
| SE32 | Mellersta Norrland | 87240 | 20 | 0.02 |
| SE33 | Övre Norrland | 101180 | 10 | 0.01 |
| SI03 | Vzhodna Slovenija | 148070 | 1050 | 0.71 |
| SI04 | Zahodna Slovenija | 27050 | 210 | 0.78 |
| SK01 | Bratislavský kraj | 66490 | 490 | 0.74 |
| SK02 | Západné Slovensko | 738150 | 7760 | 1.05 |
| SK03 | Stredné Slovensko | 209380 | 990 | 0.47 |
| SK04 | Východné Slovensko | 332490 | 2530 | 0.76 |

**Source:** Data compiled by Christine Oré Barrios, University of Hohenheim, Institute of Farm Management

## Appendix 2: Member States area claimed and total payment for protein crops

| Member States | area (ha) | € million |
|---|---:|---:|
| Bulgaria | 102,356 | 15.925 |
| Czech | 134,000 | 17.456 |
| Ireland | 4,500 | 3 |
| Greece | 151,058 | 38.623 |
| Spain | 933,046 | 44.537 |
| France | 773,448 | 148.756 |
| Croatia | 70,000 | 6.121 |
| Italy | 602,522 | 34.05 |
| Latvia | 38,449 | 6.055 |
| Lithuania | 101,400 | 13.109 |
| Luxembour | 800 | 0.16 |
| Hungary | 261,070 | 25.383 |
| Poland | 298,675 | 62.639 |
| Romania | 424,100 | 51.107 |
| Slovakia | 33,199 | 7.892 |
| Finland | 176,570 | 6.3 |
| **Average unit rate (€/ha)** | | **117** |

*Source: EU, 2019*



## Appendix 3: Background to the TRUE-Project

### TRUE Project Executive Summary

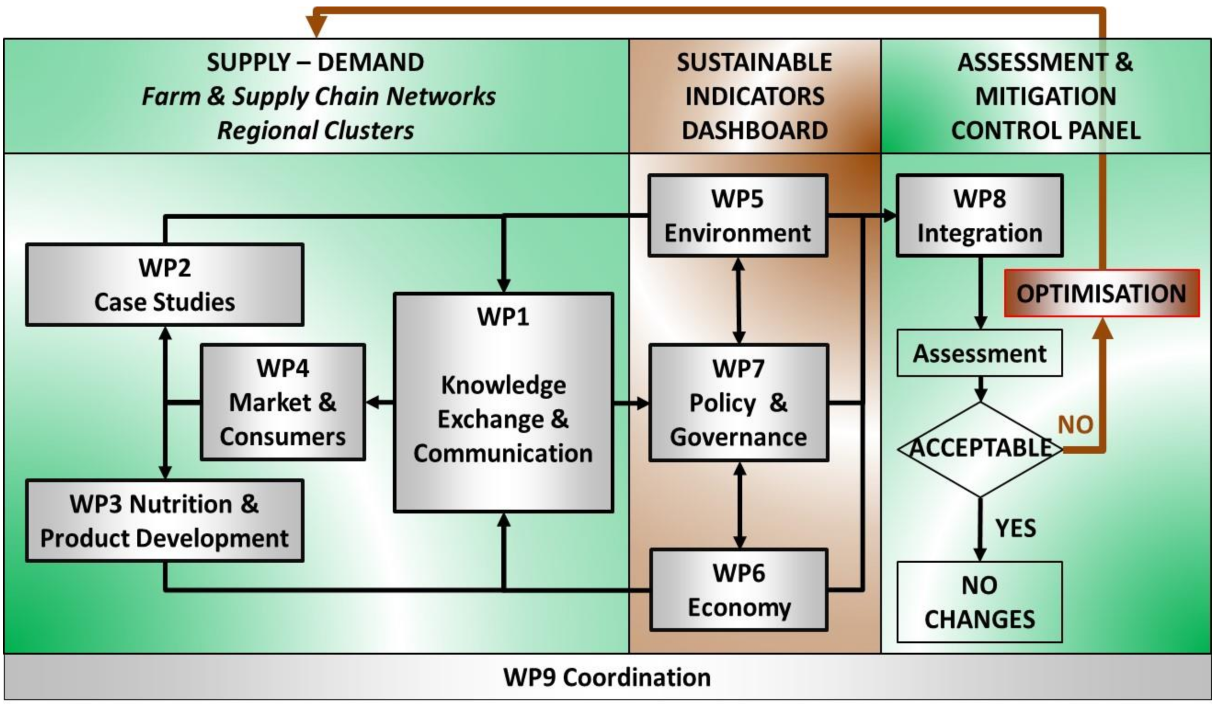
TRUE's perspective is that the scientific knowledge, capacities and societal desire for legume supported systems exist, but that practical co-innovation to realise transition paths have yet to be achieved. TRUE presents 9 Work Packages (WPs), supported by an *Intercontinental Scientific Advisory Board*. Collectively, these elements present a strategic and gender balanced work-plan through which the role of legumes in determining '*three pillars of sustainabilit*y' – '*environment*', '*economics*' and '*society*' - may be best resolved.

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



## *Work Package Structure*

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

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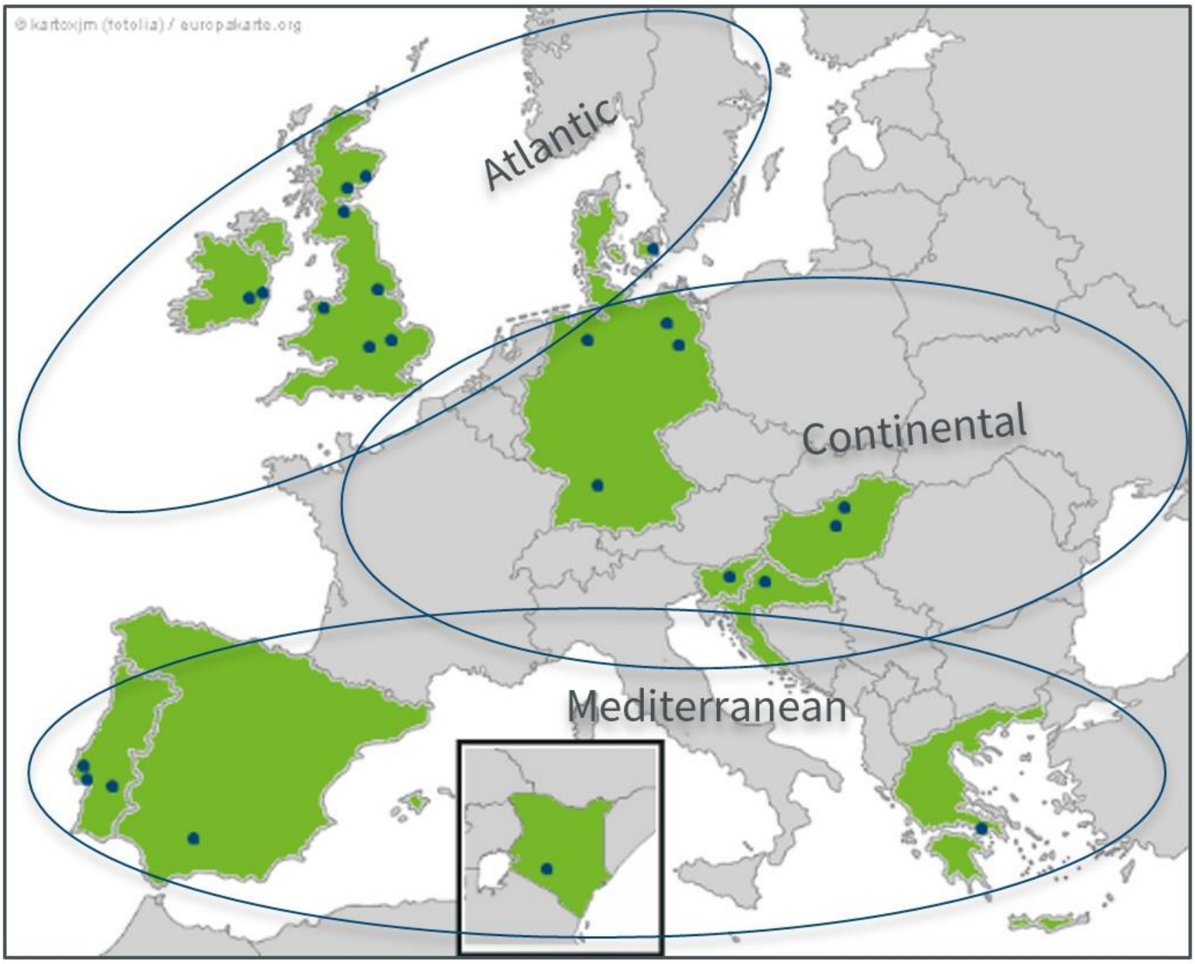
## Project Partners

| Nº. | Participant organisation name (and acronym) | Country | Organisation Type |
|---|---|---|---|
| 1 (C*) | The James Hutton Institute (JHI) | UK | RTO |
| 2 | Coventry University (CU) | UK | University |
| 3 | Stockbridge Technology Centre (STC) | UK | SME |
| 4 | Scotland's Rural College (SRUC) | UK | HEI |
| 5 | Kenya Forestry Research Institute (KEFRI) | Kenya | RTO |
| 6 | Universidade Catolica Portuguesa (UCP) | Portugal | University |
| 7 | Universität Hohenheim (UHOH) | Germany | University |
| 8 | Agricultural University of Athens (AUA) | Greece | University |
| 9 | IFAU APS (IFAU) | Denmark | SME |
| 10 | Regionalna Razvojna Agencija Medimurje (REDEA) | Croatia | Development Agency |
| 11 | Bangor University (BU) | UK | University |
| 12 | Trinity College Dublin (TCD) | Ireland | University |
| 13 | Processors and Growers Research Organisation (PGRO) | UK | SME |
| 14 | Institut Jozef Stefan (JSI) | Slovenia | HEI |
| 15 | IGV Institut Für Getreideverarbeitung Gmbh (IGV) | Germany | Commercial SME |
| 16 | ESSRG Kft (ESSRG) | Hungary | SME |
| 17 | Agri Kulti Kft (AK) | Hungary | SME |
| 18 | Alfred-Wegener-Institut (AWI) | Germany | RTO |
| 19 | Slow Food Deutschland e.V. (SF) | Germany | Social Enterprise |
| 20 | Arbikie Distilling Ltd (ADL) | UK | SME |
| 21 | Agriculture And Food Development Authority (TEAG) | Ireland | RTO |
| 22 | Sociedade Agrícola do Freixo do Meio, Lda (FDM) | Portugal | SME |
| 23 | Eurest -Sociedade Europeia De Restaurantes Lda (EUR) | Portugal | Commercial Enterprise |
| 24 | Solintagro SL (SOL) | Spain | SME |
| 25 | Public Institution for Development of Međimurje REDEA (PIRED) | Croatia | Development Agency |

*Coordinating institution

***Legume Innovation Networks***




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

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