Project acronym: PROTEIN2FOOD

Project no.: 635727

H2020-SFS-2014-2015/H2020-SFS-2014-2

Start date of project: March 2015

Duration: 5 years

D.4.1: Report on market trends of rich-protein foods at European and global levels

Due date of deliverable: 31 August 2016
Actual submission date: 06 September 2016

Universidad Politécnica de Madrid

Consuelo Varela-Ortega, Rhys Manners, Irene Blanco, Paloma Esteve, Marina Martínez (UPM)

With contributions from Francisco Kurtz (COPOSA), Joseba Aranguren Garde (COPOSA), Rianne Hanegraaf (Nature Crops), Mariët van de Noort (MFH-Pulses).

Project co-funded by the European Commission within the Horizon 2020 Programme		
Dissemination Level		
PU	Public	
PP	Restricted to other programme participants (including the Commission Services)	x
RE	Restricted to a group specified by the consortium (including the Commission Services)	
CO	Confidential, only for members of the consortium (including the Commission Services)	

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 635727.

1. Executive Summary

This report aims to analyse market trends of selected protein rich products at global, continental and EU-28 levels from 1961-2013. The report also contends to contextualise the quantitative analysis of trends of EU-28 protein production and consumption within global and continental patterns, whilst situating these EU-28 trends within historical European agricultural policy and socio-economic landscapes. Spatial patterns of consumption and production of protein products across EU-28 countries are developed within this quantitative analysis. Finally, this report develops an econometric modelling assessment to identify significant variables potentially driving such patterns of production and consumption across EU-28 countries, whilst further identifying future perspectives.

Following the introduction (**Section 2**), the report highlights the extensive database developed for this analysis in **Section 3**. The section covers the countries and regions analysed, the primary products included, and the variables included. **Section 4** develops an overview of the development of the European Union´s Common Agricultural Policy (CAP) and the supports it has provided to protein crops since its inception, to its most recent reform. In **Section 5** an analysis of historical global, continental and EU-28 aggregated trends of production and consumption of PROTEIN2FOOD crops and meat products is provided. At the EU-28 scale this section contextualises these trends within historical policy and socio-economic landscapes. This provides the background for a more detailed analysis of individual crops and animal products at a national level (EU-28 countries). This more detailed analysis is enriched by inputs from Small Medium Enterprises (SMEs) of the project. Finally, this section concludes by highlighting observed spatial and temporal patterns in consumption and production of both plant and animal proteins across EU-28 countries. **Section 6** provides econometric analysis and modelling of consumption and production of protein primary products (crops and animal products) across the EU-28. Whilst also considering the future perspective of the protein products. **Section 7** provides a summary of the analyses performed and conclusions for the work developed.

Results of the global and continental analysis of PROTEIN2FOOD crops demonstrated wide-spread declines in these crops in terms of both production and per capita consumption, but with recent suggestions of a reversal. Global and continental production of meat was found to have largely increased, particularly poultry. Per capita consumption saw universal increases in poultry, stabilisation in pork consumption in wealthier continents and increases in less wealthy, and beef consumption only increasing in Asia.

Contextualisation of the EU-28 production policy landscape suggests that the CAP had some impacts in driving production of protein crops. Other elements such as the support offered by the CAP to other crops, variable yields and low prices may also have affected expansion of protein crop cultivation. However, changes to the CAP may have arrested long long-term declines, with recent increases in production identified. In considering socio-economic factors behind consumption; health, economic and consumer choice were identified to be relevant, potentially accounting for recent reductions in meat consumption across many EU-28 countries, whilst a lack of access to information and increasing wealth may account for declines in plant based protein consumption. The detailed country level trend analysis found that PROTEIN2FOOD crops have seen considerable changes in production over the past five decades, which especially acute declines observed in countries where historically these crops were widespread. We also identified simultaneous long-term and wide-spread reductions in their consumption, which in some countries has reversed in recent years. Animal based protein production has widely increased

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 635727.

since the 1960s, with consumption seeing similar increases, but this appears to have begun to level off and even decrease in a number of countries.

Analysis of geographic and temporal patterns demonstrated that many countries traditionally reliant upon a diet rich in plant based proteins saw substantial reductions in consumption, whilst countries not traditionally associated with such protein consumption seeing recent increases. Consumption patterns of animal proteins suggest an east-west divide across Europe, where wealthier nations, in general, appear to be reducing animal protein meat consumption. However, animal protein consumption per capita was found to be in general higher in northern European countries. Growth in production across the EU-28 countries was found to be far greater for animal proteins, than plant, with few countries seeing increased plant production and simultaneous reduction in animal protein production. This analysis has highlighted suggestions of a gradual shift in dietary consumption across EU-28 countries over recent decades.

The econometric analysis supports the main trends identified in previous sections. However, it also suggests that despite significant relationships between socio-economic development and plant and animal protein consumption, most of the variance of legume and meat consumption across countries and time is explained by countries' specificities, such as culture and dietary traditions. Concerning production, significant effects of the CAP programming have not been identified. Besides the effect of prices, production of protein crops and meat is again linked to country features, such as climatic and agronomic conditions as well as competitive advantages.

Analysis of future trends suggested that protein crop production in Europe is expected to increase over the coming decade. These increases are suggested to be driven by favourable political and socio-economic environments, but this increase in production is expected to stem from increased demand for high protein animal feed products. European animal protein production is projected to increase slightly in the near future, driven by pig and poultry, with beef production expected to reduce, whilst European per capita consumption is expected to gradually reduce into the future.

From this analysis it is clear the complexity of the situation of PROTEIN2FOOD crops' production and consumption trends, not only with EU-28 countries but across the globe. Despite the apparent relevance of socio-economic development and agricultural policy in driving EU-28 trends and patterns, countries' culture and tradition concerning production and dietary choices are crucial elements that should be considered in further analyses. In this regard, food and health policies in Europe must account for this issue and should disseminate and incentivise the benefits of shifting diets and production towards plant-based protein. At the same time, the results and conclusions presented in this report evidence the need to develop attractive new protein products that take into account consumer preferences as well as producer needs, and highlight the importance of projects such as PROTEIN2FOOD and the clear necessity for its implementation and success.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 635727.

Contents

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 635727.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 635727.

List of Figures

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 635727.

List of Tables

List of Boxes

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 635727.

2. Introduction

2.1 Objectives

The objective of this report is to identify and analyse historical market trends of the protein rich crops highlighted within PROTEIN2FOOD, whilst also analysis future prospects for the protein crops markets. This market analysis will specifically consider and develop both the supply and demand side of the market, considering both production and consumption of these crops.

2.2 Background

Global shifts in dietary patterns have increasingly gained attention for their importance not only in driving deforestation (Godfray et al. 2010; Kastner et al., 2012) and biodiversity losses (Machovina et al. 2015), but increasingly climate change (Westhoek et al 2011). A key driver of these dramatic changes to fundamentally vital natural systems is the move towards diets increasingly dependent upon animal, rather than plant proteins. There has been a widespread increase in meat intensive diets, not only in western countries in the past 50 years, but increasingly globally as middle classes grow, moving away from traditional vegetable based protein diets (Vranken et al., 2014). The scale of these increases are globally dramatic, with global meat consumption increasing by almost 30% over 50 years from 61 to 80g per person per day between 1961-2011 (Sans and Combris., 2015), with animal protein now accounting for 40% of global protein intake (Boland et al., 2013). These trends are expected to continue through the 21st century, with global meat consumption expected to increase to 52kg per year (~141g/day) (Tscharntke et al., 2012), whilst beef and dairy product consumption is projected to increase by 60% by 2050 (Bailey et al., 2014). To supply the growing global desire for meat, significant increases in global herds and flocks of animals have been observed (FAO, 2016). These herds are now so great they constitute a driving force behind global deforestation (Guida Johnson and Zuleta 2013), triggering the conversion of forest to arable land, specifically soya production- a fundamental product of many livestock feeds (Bertheau & Davison, 2011). Further, these increments in demand for dairy and meat products have resulted in considerable shifts in the final use of crops to satiate the ever-increasing demand for fodder products; with De Schutter (2011) estimating that between 30 and 50% of global cereal production is now consumed by livestock.

Dietary shifts have further affected the production and consumption of high protein content crops, such as chickpeas, lentils and beans, that have been traditionally culturally and culinary important crops across many countries. The production of these crops has become increasingly less important in not only supplying protein to diets (FAO, 2013a), but also in their widespread consumption. For example, southern Europe, a region traditionally dependent upon these crops, has seen in many cases widespread reductions in both production and consumption since the early 1960s. The reasons behind such complicated and disparate patterns have been attributed to a range of factors (LMC International, 2009), with a number of barriers limiting the desire of producers to consider the protein rich crops, with barriers including both agronomic (Von Richthofen et al., 2006) and economic (Voison et al., 2014). Within Europe, supra-national policy interventions have largely centred around the Common Agricultural Policy (CAP), which throughout its various incarnations has encouraged, to varying degrees, production of these traditionally important high protein content crops (LMC International 2009).

In considering these historical changes not only within Europe but globally, this report will make a

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 635727.

detailed look at the historical trends of production and consumption of protein rich crops globally, across 5 continents and within EU-28 countries. Beyond merely highlighting these trends, the report will endeavour to explain the changes across EU-28 countries through policy and socio-economic contextualisation, and through the identification of temporal and spatial patterns in these trends.

2.3 Contents

This document presents the results of task 4.1 in PROTEIN2FOOD, and provides a review of the past trends of production and consumption of key primary protein products, with a focus on the driving factors behind these trends such as policies and socio-economic development, whilst trying to formulate future prospects. The report starts with an introduction to the objectives and background of the analysis herein presented. It follows with the description in section 3 of the database developed about the vegetal and animal protein products selected in the project in Europe and selected non-European countries. Section 4 deals with the review of the European policy context that determines protein food production and consumption. Section 5 shows the results of the analysis of historical market trends of European and globally relevant protein products at global, continental and EU-28 scale, while section 6 presents econometric modelling and analysis of future prospects for animal and plant protein production and consumption in the EU countries. Finally, section 7 elaborates on the main conclusions and key messages obtained from the analysis of the previous sections.

3. Database Development

For the purpose of undertaking the analysis of the historical trends (production, consumption and market) of the crops within PROTEIN2FOOD, a database was created. This database was developed using data collated from public databases such as FAOSTAT.

Information was initially searched for, considering only the crops highlighted within PROTEIN2FOOD, but other products such as soy, wheat, livestock and dairy products were also included within the database due to their relevance to the subject and to enrich the analysis. Soy is particularly important for livestock feed, while wheat is considered a major source of nutrients, including a major source of protein for humans.

Unfortunately, data were not available for the specified lupin species outlined in the description of work as such aggregated lupin data was included. Further, no amaranth data could be sourced, resulting in its exclusion from this analysis. The complete list of products included in the database is shown in Table 1.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 635727.

Table 1. Primary protein products included in the database

VEGETAL PRODUCTS	ANIMAL PRODUCTS
• Lentil • Chickpea • Faba bean • Lupin (general) • Quinoa • Buckwheat • Soy • Wheat	• Cattle • Pig • Poultry • Milk (whole cow) • Cheese (whole cow) • Cream (fresh) • Butter (cow milk)

Variables considered for all products are specified in section 3.2 of this document. The largest time series considered is 1961-2013, but not all countries have available data of all products for this whole time series.

Countries included within the database were those within the EU-28, Andean countries (protein crop producers), Brazil (potential future importance of protein crops agriculture), Ethiopia (regionally important producer of protein crops) and Uganda (vast experience in protein crops and partner with PROTEIN2FOOD). Table 2 shows the complete list of countries included in the database. Beyond countries, continental (Africa, Asia, Americas, Europe and Oceania) and global (sum of all continental data) data was included within the database whenever available.

Table 2. Countries included in the database

EUROPEAN COUNTRIES		NON-EUROPEAN COUNTRIES
• Austria • Belgium-Luxembourg[1] • Bulgaria • Croatia • Cyprus • Czech Republic • Denmark • Estonia • Finland • France • Germany • Greece • Hungary • Ireland	• Italy • Latvia • Lithuania • Malta • Netherland • Poland • Portugal • Romania • Slovakia • Slovenia • Spain • Sweden • United Kingdom	• Argentina • Bolivia • Brazil • Chile • Colombia • Ecuador • Peru • Ethiopia • Uganda

[1] Belgium and Luxembourg have been combined for the analysis due to data for these countries being largely combined in public data banks pre 2000.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 635727.

3.1 Sources of Data

All data included in the database were sourced from FAOSTAT, World Bank and UN Comtrade public databases.

FAOSTAT was selected as the main source of data due to its wide availability of variables, time series and countries, along with the assurance of consistent application of data processing methodologies.

3.2 Variable Selection

The variables selected for the study cover four dimensions identified as relevant for the analysis, namely production, market, consumption and socio-economic and demographic variables. The following is a brief description of the variables considered within the database for all countries.

Production variables:

- Arable land (ha): Land used for agriculture, either cultivated or not. According to FAO "*Arable land is the land under temporary agricultural crops (multiple-cropped areas are counted only once), temporary meadows for mowing or pasture, land under market and kitchen gardens and land temporarily fallow (less than five years)".*
- Area Harvested (ha): Area from which crops where gathered. According to FAO *"Area harvested, therefore, excludes the area from which, although sown or planted, there was no harvest due to damage, failure, etc. If the crop under consideration is harvested more than once during the year as a consequence of successive cropping, the area is counted as many times as harvested".*
- Agricultural Area (ha): Total country area dedicated to all agricultural activities.
- Proportion of arable land (%): Arable land expressed as percentage of the total area (excluding area under inland water bodies).
- Production (tonnes): Total amount of crop harvested.
- Stocks (no.): Livestock population.
- Yield (tonnes/ha): Amount of production harvested per unit of cultivation area.
- Yield/carcass weight (Kg/animal): Amount of edible meat per animal.
- Gross Production Value (constant 2004-2006 million US$): Standard measurement of the value of a good or service produced by a region/country in a given period of time.

Market variables:

- Annual Producer Prices (USD/tonne): According to FAO *"Producer prices are prices received by farmers for primary agricultural products (crops, live animals and livestock primary products). Time series refer to the national average prices of individual commodities comprising all grades, kinds and varieties (...) collected at farm gate or first-point-of-sale".*
- Import Quantity (tonnes): Quantity of a good produced and bought abroad.
- Import Value (USD): Economic value of a good produced and bought abroad.
- Export Quantity (tonnes): Quantity of a good domestically produced and sold abroad.
- Export Value (USD): Economic value of a good domestically produced and sold abroad.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 635727.

Consumption variable:

- Domestic Consumption (tonnes): Quantity of goods and services used within a region/country, either domestically produced or bought abroad. This variable is calculated as [*domestic production + imports – exports*].

Socio-economic and Demographic variables:

- GDP/Capita (PPP USD 2010 constant): National GDP divided by population.
- Population (1000 persons): Number of persons inhabiting a region/country for a given year.
- Rural population (%): Percentage of total population living in rural areas.
- Urban population (%): Percentage of total population living in urban areas.
- Population aged 0-14 (%): Percentage of total population aged < 14 years old.
- Population aged 15-64 (%): Percentage of total population aged between 15 and 64 years old.
- Population above age 65 (%): Percentage of total population aged > 65 years old.
- Education Expenditure (%): Percentage of total governmental annual expenditures.
- School Enrolment in Tertiary Studies (%): Ratio of population enrolled at tertiary level at public and private schools.

An overview of the variables and data (year 2012) considered for the analysis is provided in Annex 1.

4. Review of policy context for protein products

This section aims to contextualise the trends of the PROTEIN2FOOD crops within the European policy landscape. It will consider and describe the history and evolution of the Common Agricultural Policy, concentrating on this EU wide policy for brevity and allowing for cross-country comparisons. The policy review will specifically concentrate upon the evolution of the CAP offering insights into how each new reform has encouraged or discouraged the production of those crops analysed as part of PROTEIN2FOOD.

4.1 CAP support for Protein Crops

The Common Agricultural Policy (CAP) was introduced to the European Common Market, following discussions in the Treaty of Rome and Stresa Conference before ratification and implementation in 1962. Since its inception in post war, unified Europe, the CAP has become a central pillar to Europe and fundamental to the European Union. The importance of the CAP is so acute, that in its present form it accounts for ~40% of the EU[2] budget, almost €58 billion. Initially introduced to encourage food security, and stabilise European agricultural markets through the development of price supports (European Parliament, 2013), the CAP now provides financial support to farmers across all EU-28 countries, far beyond its original remit of the 6 members of the Common Market.

However, since its formation in 1962, the CAP has seen considerable reforms (Figure 1), responding to agricultural markets and positive and negatives outcomes of its implementation. In their review of European agricultural policy the OECD (2014) suggest that the evolution of the CAP has beneficially orientated agriculture in Europe, moving slowly away from initial price supports and payments based on production, towards a system that encourages producers to directly respond to markets.

[2] The abbreviation 'EU' should be considered in place of the contemporary name for the grouping of countries within Europe at the time, before establishment of the European Union through the Masstricht Treaty of 1993.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 635727.

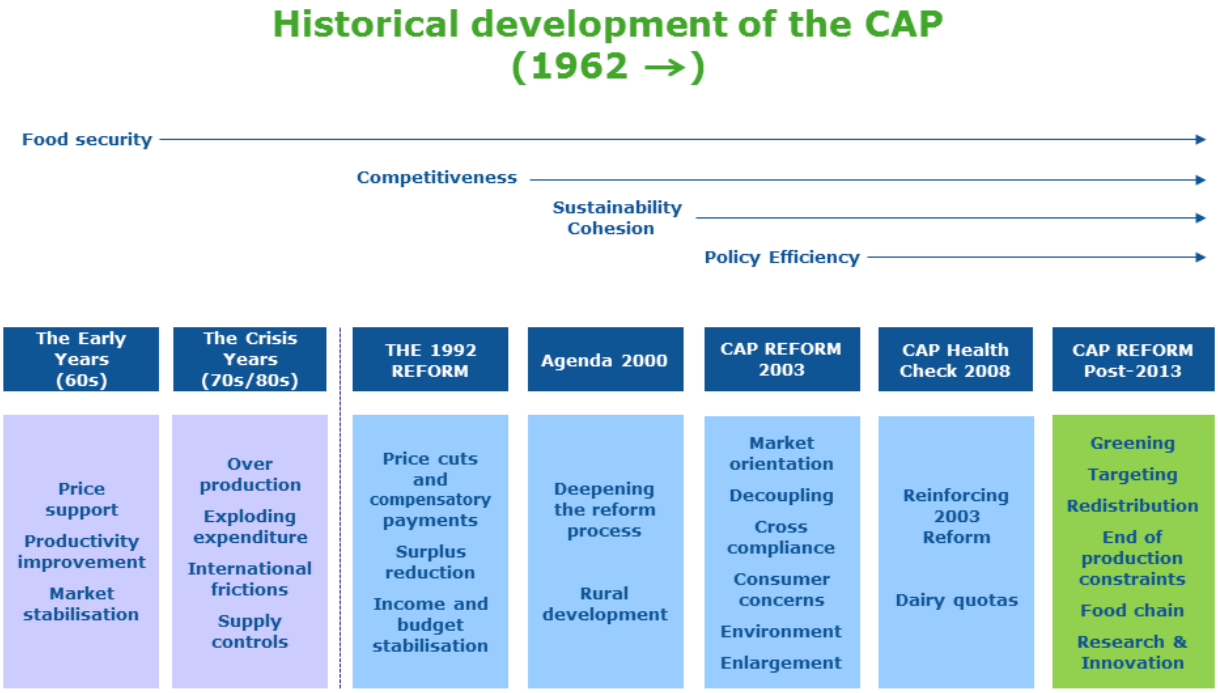


Figure 1. Schematic of historical CAP development and reform since its inception in 1962. Source: European Commission

Throughout its evolution and various reforms, the CAP has provided support in various formats to protein crops across the EU. The following section will contextualise the evolution of these supports, including where possible, supports applied at the national level, rather than just EU-wide application.

4.1.1 From inception to Agenda 2000

The CAP was initially developed with a number of key concepts in mind, firstly to improve European agricultural productivity, whilst providing an improved standard of living for those working within agriculture. Further it was introduced to ensure availability of food for European consumers, whilst stabilising agricultural markets.

This following section will consider the early developments of the CAP and how certain systems were developed specifically for those crops that are now analysed with PROTEIN2FOOD, through MacSharry reform and will finish with Reform 2000.

Early Years

From the origin of the CAP through its early years, there were no direct supports offered towards cultivation of protein rich crops. It was not until geo-political actions and price rises in 1973 resulted in the EU offering support to soya[3] in 1974. In response to the US embargo of soya exports and increases in prices,

[3] Although not directly included within PROTEIN2FOOD, it would be remiss not to include the supports offered to soya considering it is the most important protein crop globally, in terms of demand and supply.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 635727.

the EU (European Economic Community at the time) used the CAP to encourage self-sufficiency from European grown soya through the implementation of 1974 price supports or 'deficiency payments'. These payments involved a subsidy, offered by the EEC, which covered the difference between a guaranteed EEC minimum price and the actual market price, with the intention or reducing the EEC's dependence on externally sourced soya (European Parliament, 2013). In 1979, the payments of these supports were moved from the producers, to processors.

Similarly to that of the intervention in 1974, the EEC introduced in 1978 supports to peas, faba beans and lupins grown for livestock consumption, once again in the shape of deficiency payments. LMC International (2009) suggest that this particular support intervention was made due to the fact that protein crops were not protected from competition and that tariffs placed on imported products were minimal, therefore deficiency payments were introduced to stabilise prices for producers, whilst ensuring supply.

Unfortunately, from 1978 onwards these payments resulted in competition between the supply available for end users, as payments were tied to production destined for animal feed, rather than human consumption. To respond to this unforeseen competition, the EEC introduced the same measures for production directed to human consumption as to animal in 1982.

A further unforeseen consequence of the introduction of deficiency payments was in their encouragement of production of peas, faba bean and lupins at the expense of what the CAP literature describes as grain legumes, including chick peas, lentils and vetches (European Parliament, 2013). In response, uniform area payments of 75 ECU (European Currency Unit) per hectare were applied in 1989 up to a maximum guaranteed area of 300,000 hectares. These payments were applied to both production destined for animal feed and human consumption of chick pea and lentil, whilst only applied for feed production of vetch.

MacSharry Reform (1992)

The MacSharry Reform represents one of the biggest shifts of the CAP, moving supports from products to producers, or in other words, from price supports to income supports (European Commission, 2016a). The reform had multiple aims including; diversifying, stabilising and improving competitiveness of European agriculture, whilst also considering for the first time the environmental impacts of European agriculture (European Commission, 2016a). It should also be noted the context within which the 1992 reform was formulated, with the reforms made following extreme pressure place upon the EU from trade partners during the Uruguay round of the General Agreement on Tariffs and Trade (GATT[4]). This may have push the EU into creating the more transparent support system offered as part of this reform, whilst also encouraging the decoupling of income supports from production supports.

In relation to protein crops and specific grain legumes, area related direct payments were developed with higher payments offered to protein crops (pea, faba and lupins) compared with crops such as soya. In 1993, a basic payment for Pea, faba and lupins was introduced at 65 ECU/t increasing up to 79ECU/t (European Parliament, 2013a). Payments for grain legumes (chickpea, lentil and vetch) started at 150 ECU/t in 1995, rising to 181 with a maximum guaranteed area supported by these payments of 400,000 hectares in 1996.

Soya, however only received 47.5 due to it being categorised as an oil crop (LMC International, 2009), but was then subject to the Blair House Agreement between the USA and EU restricting the area supported for soya production to 5.48 million hectares.

[4] Precursor to modern World Trade Organisation (WTO)

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 635727.

Agenda 2000

The turn of the millennium saw further changes to the CAP, not only in the introduction of the Euro to policy, but also in the Agenda 2000 reforms. Agenda 2000 also saw the formation of the two pillars of the CAP, with one concentrating upon production and second on support to rural areas, evidenced by the introduction of policies for rural development (European Commission, 2016b). Further, the Agenda 2000 saw agri-environmental schemes becoming compulsory to EU member states, with the aim of the reform being to protect the diversity of European farming systems (European Commission, 2016b).

These reforms negotiated in 1999 and implemented between 2000/1, saw reductions in the amounts paid for protein crops. In particular, the amount paid per tonne of protein crops was reduced from 79ECU per tonne in 1993 to 72.5€ per tonne in 2000, multiplied by a regional reference yield. Oilseed crop supports, including soya, were set at 9.5€ per tonne, multiplied by a regional reference yield.

Further, changes were also made to grain legumes (chickpea, lentil and vetch) with separate maximum guaranteed area applied, where previously they were grouped as one. This introduction was made to counter the previously exceeded areas of vetch (European Parliament, 2013).

4.1.2 The 2003 Reform and the Health Check

The 2003 reform, in sync with the CAP's historical adjustments to European society and economy developed upon the aims of improving competitiveness and sustainability of European agriculture, whilst simultaneously encouraging rural development.

The 2003 reform saw a further considerable shift, the biggest since the MacSharry reform 11 years previously, aiming to enhance the competitiveness of the European agricultural sector (European Commission, 2016c). This reform further moved the fundamental objectives of the policy from supporting production to supporting producers through the process of 'decoupling'. To move away from production based payments, producers were supplied with payments not in relation to their production but to the subsidies they had previously received (European Parliament, 2013). The 2003 reform also saw the introduction of 'cross-compliance'.

The Single Farm Payment (SFP) scheme, that replaced the previous production support schemes, was fully introduced across all EU member states (MS) from 2005-2007; this payment provided a single payment for maintenance of agricultural land in viable condition. The provision of the SFP was made subject to compliance (cross-compliance) with environmental and animal health and welfare legislation (Statutory Management Requirements, SMRs), whilst also considering the demonstration of Good Agricultural and Environmental Conditions (GAECs).

Then, to improve the adaptability of European agriculture, the European Commission implemented in 2009 a full assessment of the CAP, and specifically, the 2003 reforms, known as the CAP Health Check. The aim of this review was to further support and advance towards the 2003 CAP reform goals, to aid agriculture in responding to market signals, climate change and resource management through reductions in legislative restriction (European Commission, 2016d).

With respect to those crops considered within PROTEIN2FOOD, MS were given a number of means for providing support during the periods following the 2003 reform and the Health Check. Three examples of such support mechanisms being the application of complementary national direct payments (CNDPs), protein premiums, and the option to continue coupled payments. Through the use of CNDPs, Lithuania, Slovenia, Hungary, Estonia and Poland directed support towards protein crops. The protein payment was

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 635727.

the most widely implemented, across 17 MS, and consisted of a payment of €55.57 per hectare subject to a maximum guaranteed area across the EU of 1.65 million hectares by 2006 (LMC International, 2009), offered on top of the SFP. Coupled payments for cereals, oil crops and protein crops were also available and could be applied up to 20% of MS budgets, but the SFP would be reduced proportionally, this measure was applied by France and Spain (European Parliament, 2013). However, as part of the streamlining effort by the EU following the Health Check, the protein premium was totally decoupled by 2012, with the harvest of 2011 being the last time it could be applied. The premium from 2011 onwards was fully incorporated into member states SPF Schemes.

Further, Article 68 of the regulation for direct support schemes of the CAP (European Commission, 2009) offered considerable flexibility to member states to use up 10% of payments towards specific crops for a range of pre-defined purposes. Use of Article 68 was widely applied (Finland, France, Lithuania, Poland, Slovenia and Spain) to support leguminous crops under Pilar 1. These countries applied various support structures, but the payments made for such crops include; 78€/ha in Finland, 100€ rising to 140€ between 2010 and 2011 in France, 164€/ha in Poland in 2012 (European Parliament, 2013a) and 100€/ha in Spain in 2013 applied across almost 10,000 hectares (MAGRAMA, 2013). As part of Pilar 2, application of agri-environmental schemes of Article 39 were a widely implemented means of supporting protein crops (European Parliament, 2013). To qualify for these schemes, applicants must apply practices over 5 years, defined by member states to be beneficial to the environment or to the welfare of animals.

4.1.3 CAP Post 2013

Following more than two years of negotiations, the CAP post 2013 (applicable from 2014-2020) was designed to provide a more competitive and sustainable agriculture across EU countries (European Commission, 2013a). As part of this new reform, farmers are rewarded for the services they offer to the European public and biodiversity, as such a new instrument was introduced to Pilar one- 'greening' (European Commission, 2013a).

The agreed CAP reform of 2013 maintains the two pillars of previous reforms, but improves links between them to provide integrated policy supports. The reform has been designed to sustainably adapt European agriculture to an increasingly competitive global market (European Commission, 2013a). The new reform also provides greater flexibility to member states for the implementation of policy instruments within Pilar 1.

According to the new reform, and to make for fairer distribution of financial supports, direct payments have been moved away from a system based upon historical data. Further, 30% of the national CAP budgets will be linked to ´greening´ payments, rewarding farming practices and farmers who perform environmentally beneficial agronomic techniques, subject to cross compliance (European Commission 2013b).

As part of greening and beyond the Basic Payment Scheme, producers are eligible for receiving payments for respecting beneficial environmental and climatic agricultural practices. The compulsory greening scheme, comprising 30% of member states' annual budgets, aims to maintain grasslands, encourage crop diversification and maintain ecological focus areas (European Commission, 2013a). The three basic features of the greening being; maintaining permanent grassland, crop diversification and the maintenance of 'ecological focus areas' (EFAs). These EFAs provide the framework for the inclusion of PROTEIN2FOOD crops within greening, specifically protein crops and legumes.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 635727.

Application of greening in Spain for example has resulted in considerable changes, with the area dedicated to protein crops increasing by 34% from 2014 to 2015, whilst legumes increased by 3% (MAGRAMA, 2015). In more detail though, the results have resulted in a 7% decline in lentil planted area, 4% reduction in chick peas, and 301% increase in faba beans (MAGRAMA, 2015).

5. Historical Market Trends of European and Globally significant protein products

This section presents an analysis of historical trends of production and consumption of selected protein products globally, across continents and within EU-28 countries. The products analysed include protein rich crops such as lentils, quinoa, buckwheat, chickpeas and animal protein products such as meat and dairy products. Firstly, this section describes patterns of consumption and production of certain products at the global scale, before offering more detail by analysing trends at the continental level. Secondly, it develops an aggregated analysis at the EU-28 level, linking production and consumption patterns with policy and socio-economic contexts, to identify the main driving forces behind these trends. Thirdly, it offers a product by product analysis in EU-28 countries of the trends of production and consumption in the main producer and consumer countries, along with an aggregated 'other EU' countries (EU countries minus the major producers). Finally, it formulates an analysis of temporal and spatial patterns in production and consumption of plant and animal proteins across EU-28 countries

5.1 The Bigger Picture

Production and consumption of protein products have changed considerably both spatially and temporally, over recent decades. As a means of analysing these trends across both space and time the following section will analyse production and consumption of protein products at a global scale, before considering the same patterns at a continental level. These two approaches will offer a contextualisation of the changes seen across EU-28 countries, allowing the patterns identified at the EU-28 level to be considered against continental and global backdrops. To understand why the trends may have occurred in EU-28 countries consideration will be made of the policy and socio-economic backgrounds that may have driven such trends.

5.1.1 Global and Continental Consumption and Production

The following two sections highlight and briefly analyse global and continental patterns of PROTEIN2FOOD crops and meat products to offer a perspective of how changes in EU-28 countries may be changing relative to global patterns.

5.1.1.1 PROTEIN2FOOD Crops

The patterns of production and consumption of PROTEIN2FOOD crops have changed during the past half century, with the scale of the change in consumption demonstrated in Figure 2 and Figure 3. However, due to how we calculated consumption (production + imports – exports), and the assumption that all production and domestic supply is destined for human consumption, as no crop specific data was available for exact proportions of production consumed as food, rather than feed. The FAO provide food balances for

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 635727.

a number countries and certain crops/ crop groupings, however, they do not provide information for each crop within this analysis but groupings (beans, peas and pulses). In 2010, Spain for example saw human consumption of 86% of bean domestic supply (production + imports – exports), 55% of pea and only 51% of pulses (FAO, 2013a). On the contrary, the UK consumed 18% of beans as food, 95% of peas and only 5% of pulses (FAO, 2013a), demonstrating the considerable dietary differences across only Europe. Further, this analysis does not discount losses in the supply chain from farm to fork, which may further reduce actual per capita consumption; Westhoek et al (2011) suggest that roughly half of animal proteins are lost during preparation. Therefore, despite the obvious problems and potentially inaccurate results, without more detailed crop specific data, we have assumed human consumption to be 100% of domestic supply (production + imports - exports). Therefore, we have not included a production figure, as global production under our assumption is equal to global consumption.

Figure 2 highlights the increase in total global consumption of the PROTEIN2FOOD crops (quinoa, lupin, faba bean, buckwheat, chick pea and lentil), unfortunately we were unable to source amaranth data and it has therefore not been included. From 1961-2013 total global consumption of PROTEIN2FOOD crops increased by more than 50%, increasing from 16.5- 26.1 million tonnes. During this period, individual crops have gone through considerable changes, with quinoa almost quadrupling (0.03-0.1 million tonnes), whilst lupin increased from 0.63-0.77 million tonnes, after peaking at 2.1million tonnes in 1999. Faba bean total consumption was found to be relatively stable around 4 million tonnes, whilst buckwheat consumption dropped from its peak of 4.96 million tonnes in 1992 to 2.26 million tonnes in 2013. Chick pea total global consumption was observed to be relatively stable at around 7 million tonnes, up until the mid 2000s and almost doubled to 13.3 million tonnes. Finally, total lentil consumption increased greatly from 0.85- 5.3 million tonnes.

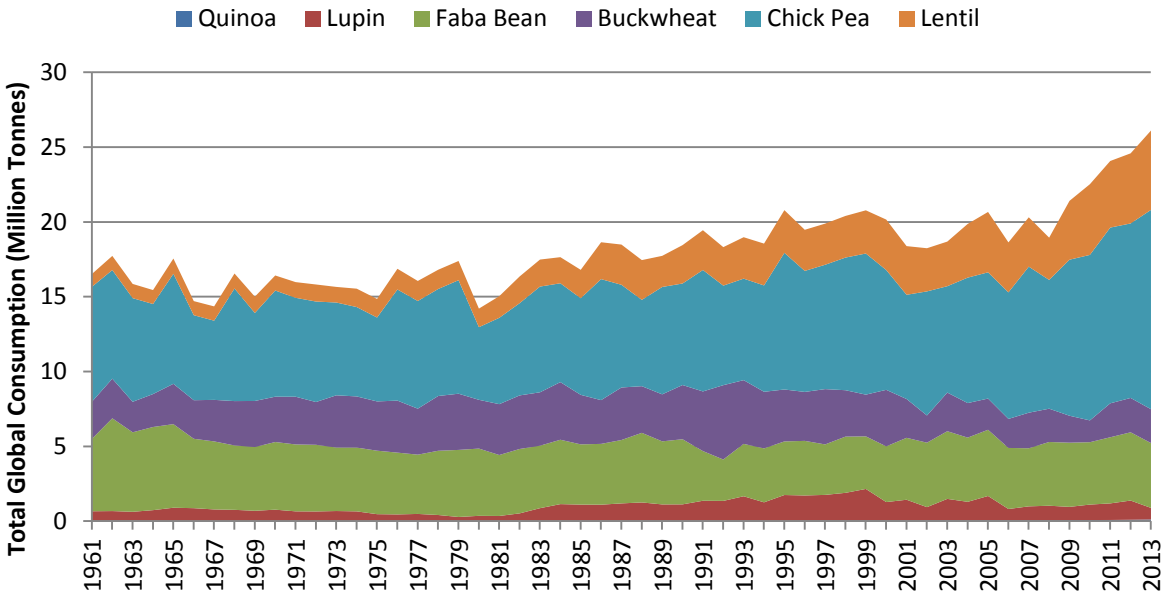


Figure 2. Global consumption of Protein2Food crops in million tonnes

In contrast to the previous figure, Figure 3 offers an insight into the global trends of per capita consumption of the PROTEIN2FOOD crops. Unlike the results for total consumption, per capita consumption appears to have undergone long-term declines from the early 1960s until the late 2000s where there appears to be an increase in consumption. In 1961, global per capita consumption of quinoa, lupin, faba, buckwheat, chick pea and lentil stood at 5.37kg/person before slowly dropping to a nadir point of 2.82kg in 2008, increasing to 3.6kg/person in 2013.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 635727.

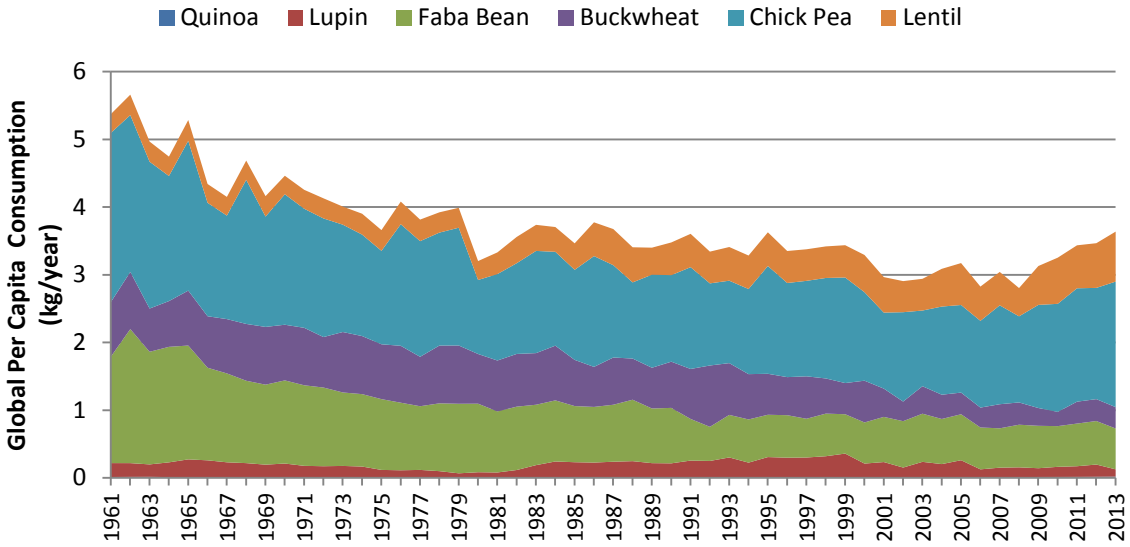


Figure 3. Global per capita consumption in kg/ year

The majority of PROTEIN2FOOD crops appear to have seen declines in per capita consumption during the study period; buckwheat (0.81-0.32kg/person/year), faba bean (1.57-0.60kg/person/year), chick pea (2.49-1.85kg/person/ year), and lupin (0.21-0.10kg/person/year). On the other hand, lentil per capita consumption almost tripled from 0.27-0.73kg/year, whilst quinoa consumption increased by almost 50% from 0.011-0.015kg/ year between 1961 and 2013. This figure suggests that despite a recent upturn in consumption, especially in chick pea and lentil, that global consumption of the crops included within PROTEIN2FOOD are apparently in long-term decline.

In consideration of the previous two figures, it is important to offer a more detailed perspective of where changes in consumption and also production are occurring. To provide this detail the following two figures present global and continental[5] data for the production and consumption of the PROTEIN2FOOD crops. This analysis is presented as the sum of all the PROTEIN2FOOD crops at the continental level, once again as with the previous figures amaranth has not been included due to a lack of data.

As previously mentioned, under the assumptions of consumption analysis (production + imports – exports) the world results in Figure 4 mirror those of Figure 2, as global consumption should equal global production. However, Figure 4 offers an insight into the continents driving these production changes across the globe. What is most immediately evident from this figure is the considerable importance of Asian production, accounting for well over 50% of world production. Asian production, despite going through a number of cycles appears to be relatively stable with production fluctuating between 12-14 million tonnes throughout the analysed period. However, Asian production rose above 14 million tonnes in 2011 and finished at 15.75 million tonnes in 2013, apparently driving the almost identical increase in global production.

[5] Continental data has been sourced from FAOStat, therefore European data and results may differ from later analysis due to inclusion of non-EU-28 countries (e.g. Russia).

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 635727.

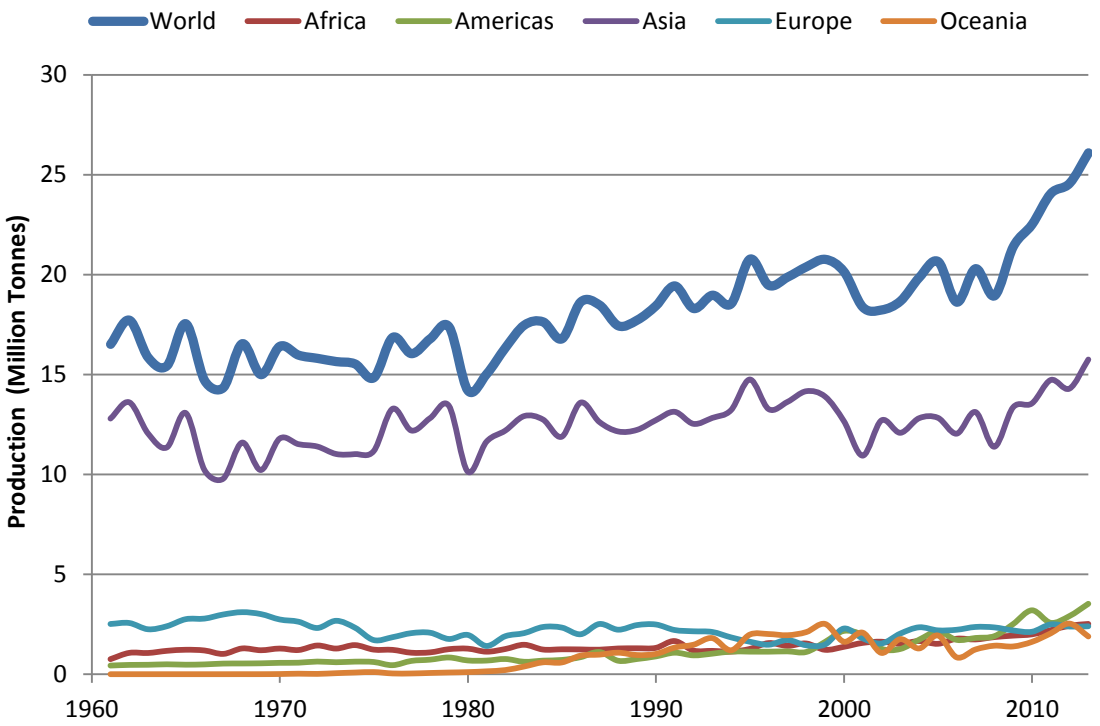


Figure 4. Global and continental Protein2Food crop production in million tonnes

Looking at the other continents, one can see the considerable gulf in scale of production with Europe being the second producer of PROTEIN2FOOD products up until the mid 1990s before Oceania and the Americas fluctuated as secondary producers. European production up until the mid 1990s remained more or less above 2 million tonnes before dropping to a low of 1.45 million tonnes in 1998, rising to 2.4 million tonnes in 2013, almost returning to production levels seen in 1961 (2.51 million tonnes). Production in the Americas and Oceania saw notable increases with American production increasing almost ten-fold from 0.43-3.53 million tonnes. Production in Oceania saw even greater growth increasing from just 0.001-1.89 million tonnes from 1961- 2013. African production, although not seeing such dramatic increases almost quadrupled from 0.76-2.51 million tonnes.

Finally, to complete this global analysis Figure 5 presents the global and continental per capita consumption patterns of PROTEIN2FOOD crops (excluding amaranth). Unfortunately, due to a lack of trade data for Oceania, this continent has been excluded from the per capita consumption analysis. The first impression from this figure is the apparent global decline in per capita consumption, as demonstrated by Figure 3. However, the world pattern of reduced consumption is not wide-spread across the continents, but is apparently driven the dramatic decline in consumption across Asia, where per capita consumption halved from a high of 7.72kg/person/year in 1962 to 3.70 kg/person/year in 1994 before slowly rebounding to 4.18kg/person in 2013. It is perhaps unsurprising considering the huge population disparity between Asia and other continents that the world pattern largely mirrors the pattern of Asian consumption.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 635727.

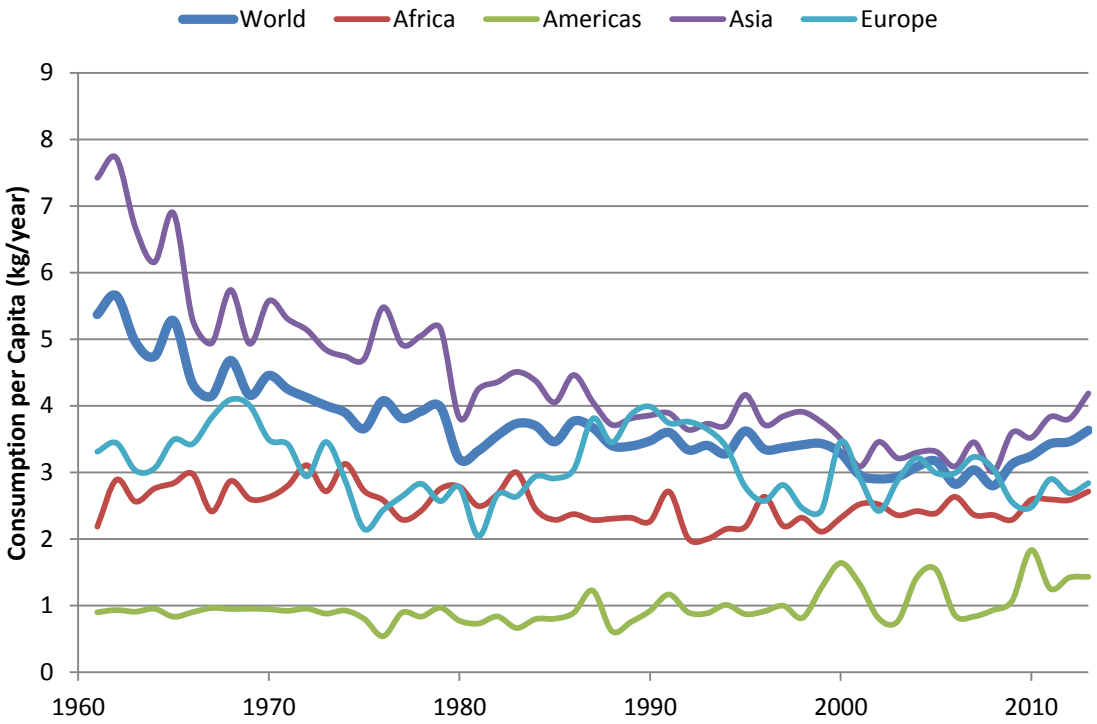


Figure 5. Global and continental per capita Protein2Food crop consumption

Per capita consumption patterns in other continents demonstrate somewhat disparate patterns, with European consumption fluctuating considerably from a high of 4.09 kg/person in 1968 to a low of 2.04 kg/person in 1981 followed by further cycles in the late 1980s/ early 1990s. African per capita consumption of PROTEIN2FOOD crops appears more stable, cycling between 2-3kg/person/year during the last half century. Finally, the Americas demonstrate the lowest consumers of these crops with annual per capita consumption remaining relatively stable around 1kg up until the turn of the millennium after which consumption rose to 1.43kg/person in 2013.

From this brief analysis of global and continental production and consumption of PROTEIN2FOOD crops over the past half century, a number of points should be reiterated. Firstly, despite global production and total consumption increasing or stabilising, especially since the turn of the millennium, per capita consumption has been declining globally-apparently driven by declines in Asian consumption. Secondly, per capita consumption patterns of all PROTEIN2FOOD crops in other continents appear to be either stable or slowly increasing. Thirdly, per capita consumption patterns of individual PROTEIN2FOOD crops have seen variable change with only quinoa and lentils seeing per capita consumption in 2013 higher than in 1961. However, this masks recent increases in further crops such a chick peas since the turn of the millennium following similar patterns in production, total consumption and per capita consumption of PROTEIN2FOOD crops most notably from 2008 onwards.

5.1.1.2 Meat Products

Global meat production and consumption have seen considerable changes over the past 50 years, with Figure 6 and Figure 7 demonstrating the extent of these changes since the early 1960s. Similarly to the PROTEIN2FOOD crops, we have only included global consumption patterns, as under our assumptions of

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 635727.

calculating consumption (production + imports – exports) global production is equal to global consumption under this assumption.

Figure 6 highlights the steady increase in global consumption of the three meat products from 1961-2013, with total meat consumption increasing by almost 500% from 62.4-289.6 million tonnes. Poultry seeing the greatest increase rising from 8.9- 108 million tonnes from 1961-2013, whilst global pork consumption increased from 24-113 million tonnes, and beef consumption more than doubling from 28.8-67.9 million tonnes.

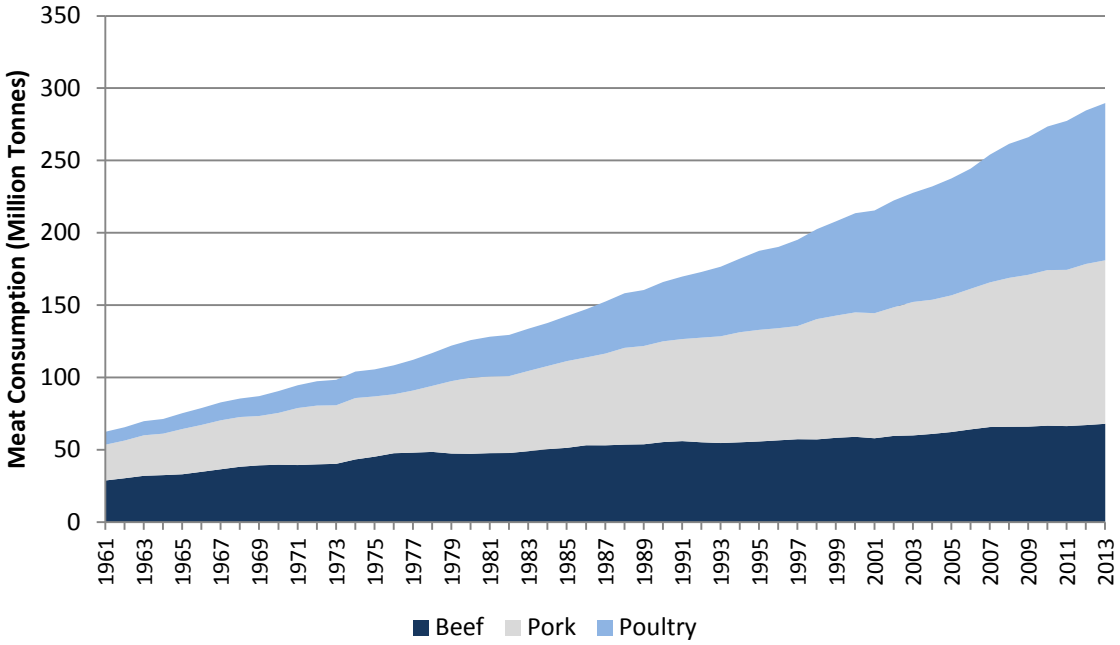


Figure 6. Total global consumption of meat products in million tonnes

Figure 7 puts Figure 6 into perspective by considering population growth during the period of analysis from 3.1- 7.1 billion people and offering a perspective on per capita consumption. Figure 7 demonstrates a similar, but somewhat less dramatic pattern of increase in per capita consumption of beef, pork and poultry suggesting that global per capita meat consumption has almost doubled from 20.5- 40.3kg/person/year since 1961.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 635727.

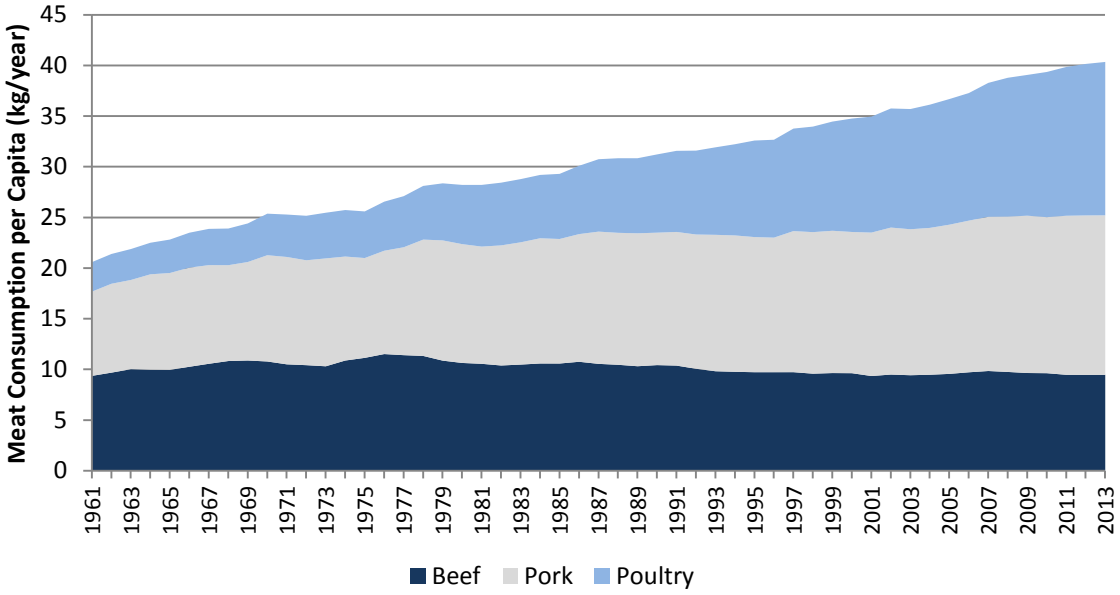


Figure 7. Global per capita consumption of meat products in kg/person

Globally, per capita beef consumption peaked in 1976 at 11.5kg/person, dropping to 9.45kg in 2013, perhaps supporting Marquer et al. (2014) and their suggestion that consumer purchasing power may be significantly tied to beef consumption. This observation that consumers increasingly move away from this expensive form of meat towards cheaper products such as pork and poultry is clearly supported globally by Figure 7, which demonstrates a huge increase in per capita consumption of poultry and pork. Pork per capita consumption increased from 8.3kg/person in 1961, to 15.7kg/person in 2013, whilst poultry rose dramatically from just 2.9kg/person in 1961, to 15.1kg/year in 2013.

The information highlighted in these previous figures is useful for gauging the extent of changes of consumption, however it does not offer detail as to where these changes are occurring and what regions might be driving these consumption patterns. Therefore, to offer a more complete perspective the following figures offer a breakdown of production and consumption across continents[6].

Figure 8 demonstrates a number of curious patterns, not only that the Americas and continental Europe up until the early 1990s produced roughly similar amounts of beef (~20 million tonnes). But since 1990, European production of beef has halved from 20 million to just over 10 million in 23 years. During the same period production in the Americas increased by ~30% and appears to have stabilised at around 30 million tonnes. Asian production almost quadrupled since 1980 (4.72-17.6 million tonnes), whilst in Africa and Oceania, production increased greatly. Africa saw production almost double from 1980 (3.16-6.29 million tonnes), whilst Oceania increased production from 2.1-2.9 million tonnes during the same period. This figure demonstrates that not only is Europe a continental outlier in the global increase in beef production, but also the sheer-scale of global production increases in just over 50 years.

[6]As with global PROTEIN2FOOD crop analysis, continental data has been sourced from FAOStat, therefore European data and results may differ from later analysis due to inclusion of non-EU-28 countries (e.g. Russia).

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 635727.

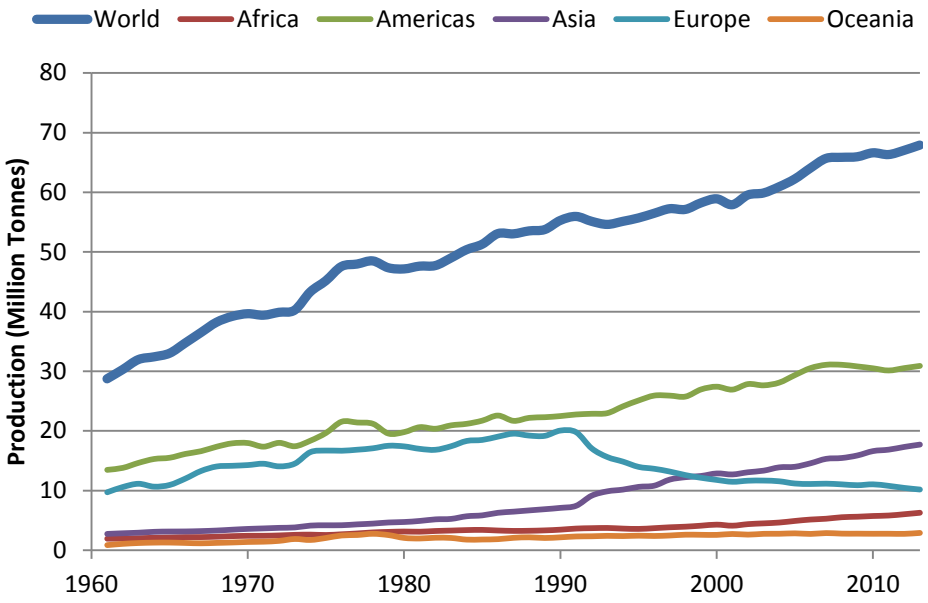


Figure 8. Global and continental beef production in million tonnes

The global consumption patterns of beef (Figure 9) are starkly different to that of production, with global per capita consumption remaining relatively stable, increasing from 9.35kg/person in 1961 to 9.45kg in 2013. Consumption in Oceania peaked in 1976 at 68.4kg/person before a long-term reduction to 25.3kg/person in 2013. In contrast, consumption in the Americas has been remarkably stable during the half century under study, varying between 30.7kg in 1961 to 29.6kg in 2013, with an identical peak in consumption of that of Oceania in 1976 at 37.6kg/person. Asia offers the only example of continent with long-term increases in per capita consumption, increasing from 1.6- 4.5kg/person from 1961-2013. Whereas, both Africa and Europe have seen per capita reductions, in the case of Africa steadily reducing from 6.69- 5.98kg/person, whilst European consumption peaked at 44.9kg/person in 1990 before declining to 21.1kg/person in 2013.

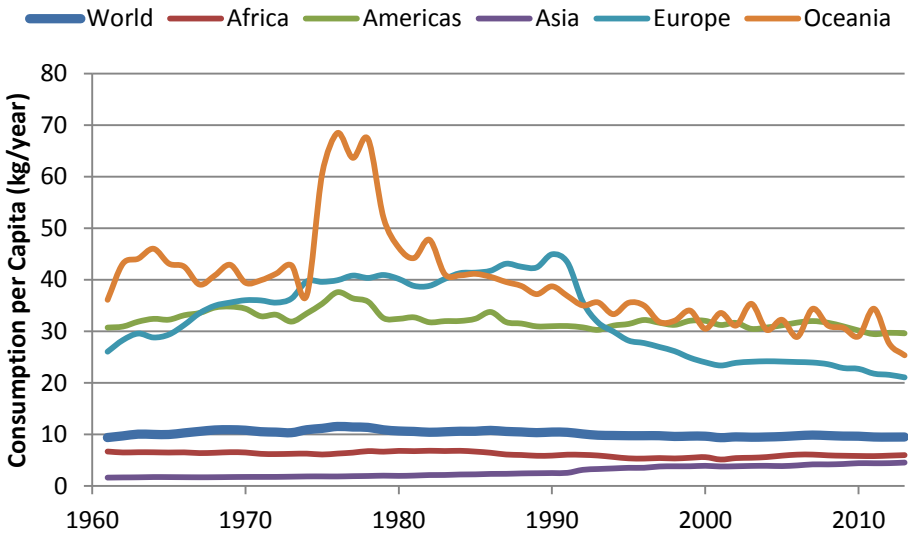


Figure 9. Global and continental per capita beef consumption

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 635727.

Like beef production, global poultry production (Figure 10) has increased greatly since the early 1960s, however the rate of such increases have been far more extreme. Globally, poultry production has increased from 8.9-108.6 million tonnes demonstrating the enormous growth in the demand for this meat product. The Americas and Asia appear to be most responsible for such extensive growth, with American production growing from 4- 45 million tonnes, whilst Asian production has grown even more dramatically from 1- 38 million tonnes. Africa although not showing such extreme patterns of total growth, grew by over 1000% from 0.36- 5.04 million tonnes. Similarly, Oceania's production grew enormously from 0.05-1.29 million tonnes. European production although showing long-term growth, once again appears to buck the global trend of almost exponential growth, with production growing from 3-18 million tonnes from 1961-2013.

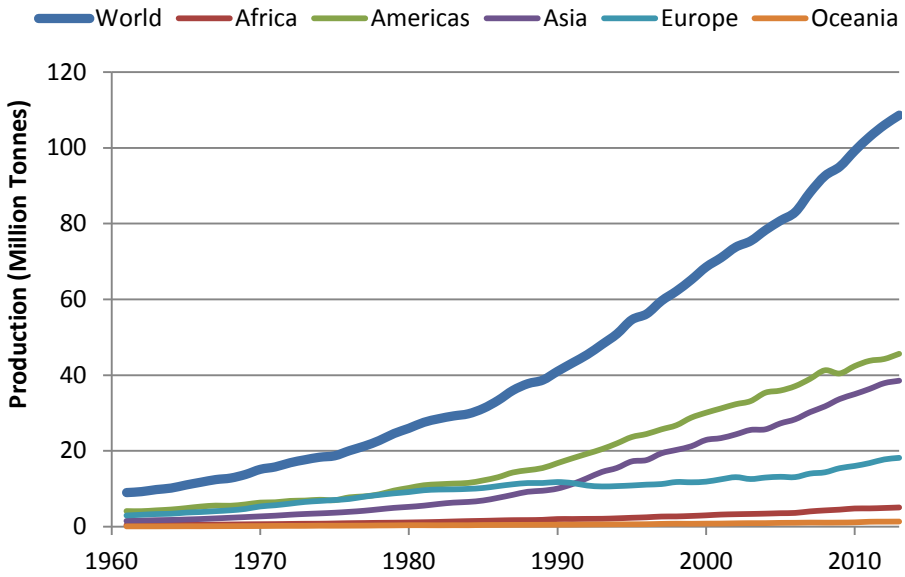


Figure 10. Global and continental poultry production in million tonnes

Following patterns of production, global and continental consumption of poultry (Figure 11) has risen considerably from 1961 onwards, across all continents. The Americas, Europe and Oceania, the biggest per capita consumers, all saw increases in consumption, contrasting with beef consumption. The Americas as the largest global consumers increased consumption from 9.19-39.1 kg/person from 1961-2013, whilst European consumption grew to a peak of 25.9kg/person in 1990 before declining throughout the 1990s and then increasing to 34.1kg/person in 2013. Consumption per capita in Oceania has seen an almost ten-fold rise in consumption from 3.76 in 1961- 35.1kg/person in 2013. There is a considerable difference between these three continents and Africa and Asia, which have equally long-term increases with Asian consumption rising more rapidly than that of Africa since the early 1990s. Asian consumption has risen from 1.2-5.9kg/person during the study period, whilst Asian consumption rose even further from 0.8-9.8kg/person. This multi-continent pattern of growth helps to explain the steady increase in global per capita consumption from 2.9- 15.1kg/person.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 635727.

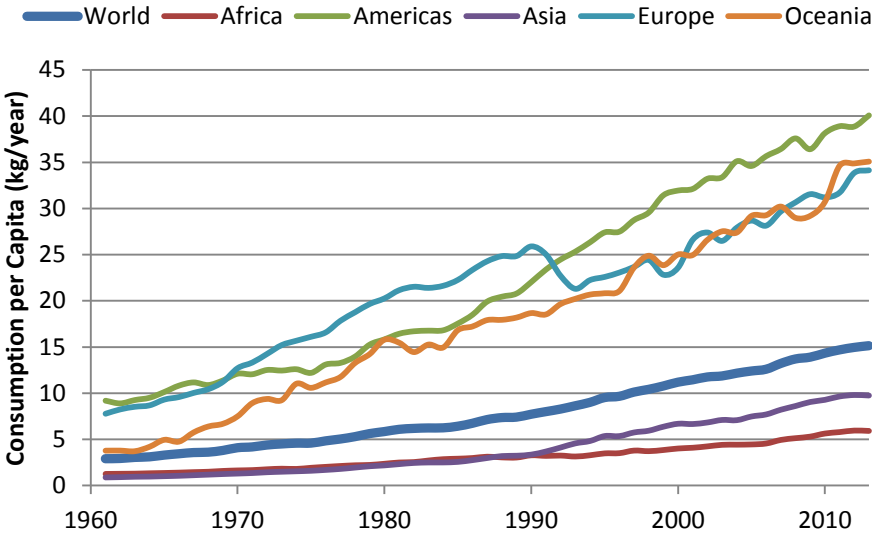


Figure 11. Global and continental poultry per capita consumption

Like poultry production, global pork production has experienced long-term global growth from the 1960s onwards. From Figure 12, the apparent driver behind this global increase has been Asia, becoming the globe's largest producer of pork in the late 1980s. During this period, Asian pork production has grown from 10.6 in 1976 to 64.4 million tonnes in 2013. Europe, up until the late 1980s the world's biggest producer, saw steady increases up until a peak in 1987 of 28.4 million tonnes, with production apparently stabilising during the 1990s and 2000s at around 27 million tonnes. Production in the Americas almost tripled, rising from 7.23-19.6, whilst African production increased from 0.18- 1.3 million tonnes. Oceania's production more than doubled from 0.17-0.49 million, but saw declines in production from a high of 0.55 million tonnes in 2003.

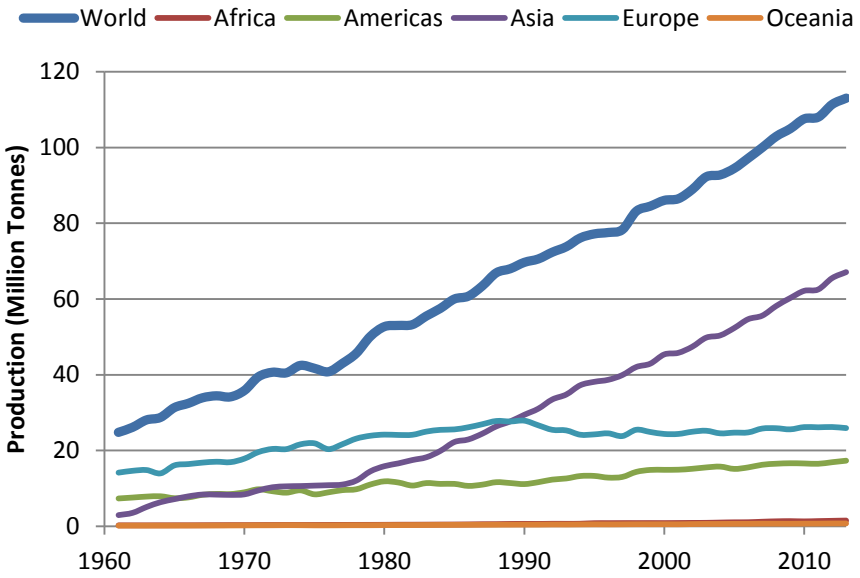


Figure 12. Global and continental pork production

Global pork consumption is dominated by Europe being more than double that of the second largest consumers- Oceania. European consumption peaked at 62.3 kg/person in 1988 before reducing and stabilising around 50kg/ person since the turn of the millennium. Consumption in the Americas has remained relatively stable, around 17kgs/person; whilst in Oceania it increased from 10.6- 18.2kg/person. Asia following its patterns of beef and poultry consumption saw long-term increases in its consumption, with growth being especially rapid since the 1980s, increasing from 1.68- 15.6kg/person. African

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 635727.

consumption although notably lower than the other continents, almost doubled from 0.69-1.32kg/person. Globally, consumption of pork almost doubled during the 50 years from 1961, increasing from 8.04- 15.7kg/ person.

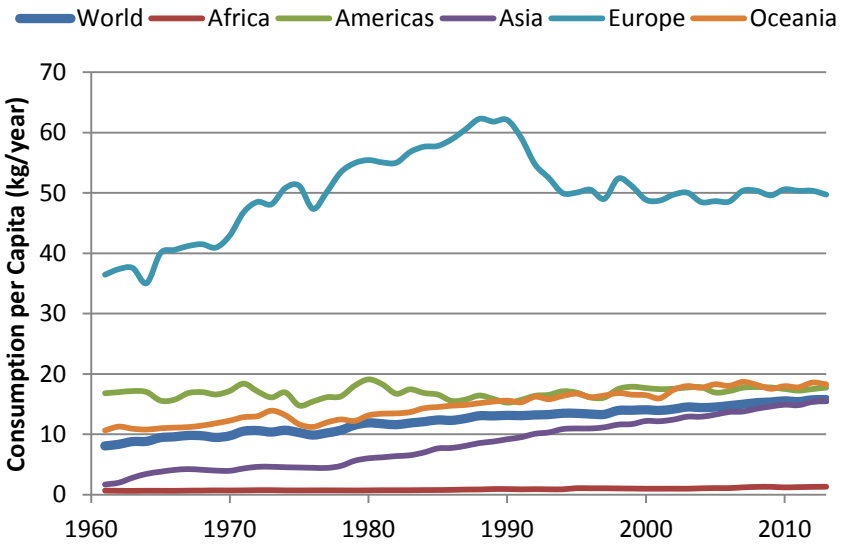


Figure 13. Global and continental pork per capita consumption

This brief analysis of the global and continental patterns of both production and consumption of animal products (beef, poultry and pork) have demonstrated the global increases in production and consumption of meat products since 1961. By looking individually at these meat products and at the continental scale, we have identified that beef production is increasing globally, with the exception of Europe. Consumption of beef reduced in Africa, Europe, the Americas and Oceania, whilst increasing Asia. In contrast poultry and pork production increased globally, with consumption of poultry increasing across all continents. Pork consumption however, increased globally apart from in the Americas and Europe where it was observed to have reduced or stabilised.

The results seemingly confirm Marquer et al. (2014) at the global scale, and the suggestion that consumer purchasing power may be significantly tied to beef consumption, with consumers increasingly moving away from this expensive form of meat towards cheaper products such as pork and poultry. The results may also be explained by Westhoek et al. (2011) who suggested that patterns of meat product consumption, such as poultry can been attributed to convenience, cost and ease of production Finally, that some of the greatest increases in both production and consumption of these meats products have been seen in Asia and in some case Africa, apparently confirm the importance of economic development in driving meat consumption (Vranken et al., 2014).

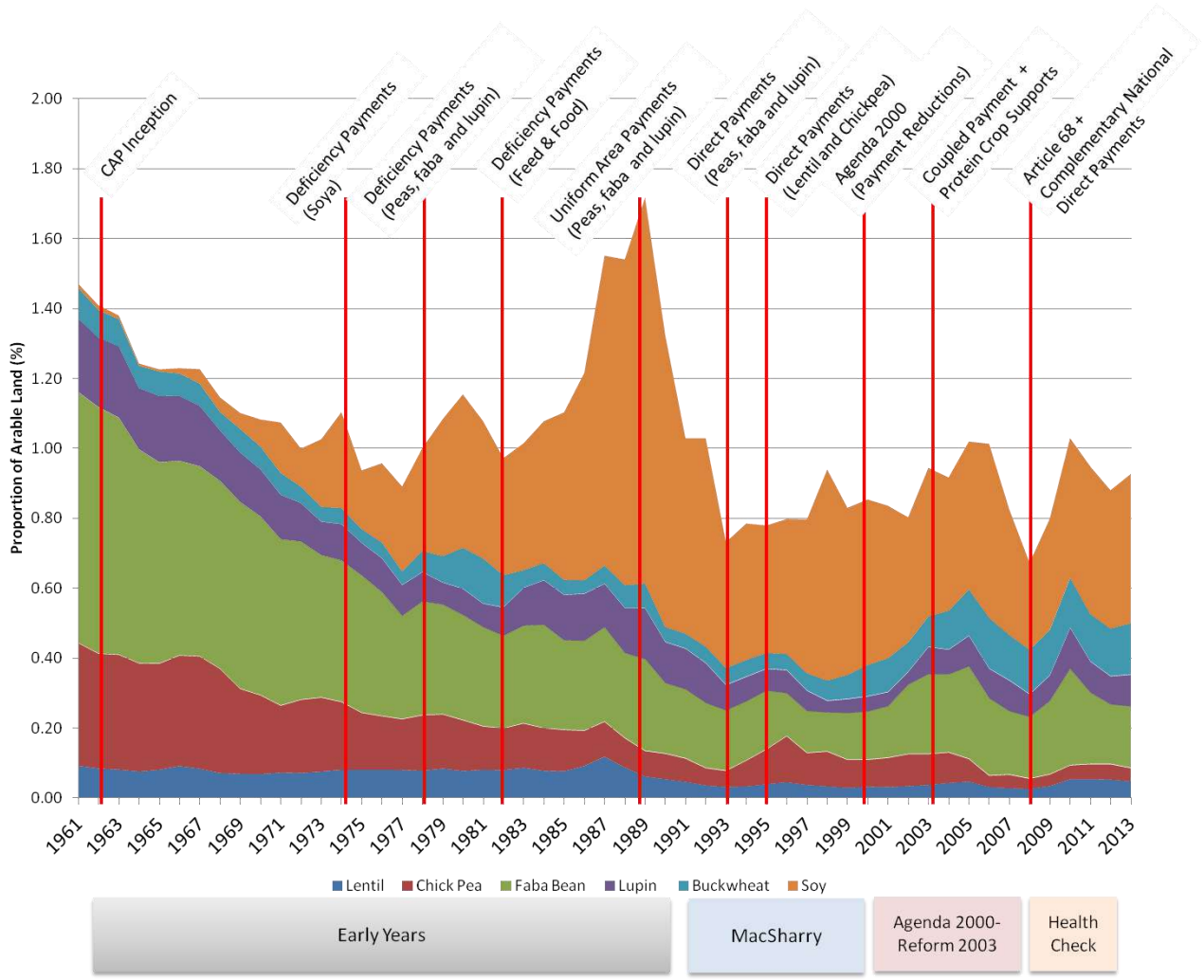
This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 635727.

5.1.2 EU-28 Consumption and Production

Following the contextualisation made in the previous section, the following will analyse EU-28 consumption and production of protein products. Further, it will attempt to contextualise the trends in these products within the policy and socio-economic landscapes.

5.1.2.1 Production and Policy

Within the context of PROTEIN2FOOD, the CAP has supported to various degrees those crops considered within the project. However, without directly contextualising the production of these crops, it is difficult to ascertain how effective it has been in supporting the PROTEIN2FOOD crops throughout Europe. Therefore, to get a better idea of its potential impacts, the following section is dedicated to analysing the historical trends of PROTEIN2FOOD crops, across EU-28 countries, highlighting where CAP interventions may have encouraged/ discouraged production. Further, and to offer a more detailed picture, contextualisation has also been made of changes in consumption within the European socio-economic landscape over the past 50 years.



Note: soy production also included from 1961-2013, with relevant EU CAP policy changes overlaid.

Figure 14. Proportion of arable land within EU-28 countries dedicated to P2F crops' production.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 635727.

Figure 14 demonstrates the evolution of arable land dedicated to PROTEIN2FOOD crops (+ soya) since 1961, as a proportion of total arable land across EU-28 countries. Imposed upon this figure are the EU supra national policy events (CAP reforms), which may have directly affected PROTEIN2FOOD crops. Firstly, it is apparent that protein crops such as lentils, chick peas and buckwheat collectively consist of a minor and largely declining proportion of the European arable area. Excluding soya, these crops even at their peak consisted little over 1.4% of the total cropped area, with faba beans being the largest constituent. At its nadir in 1998, PROTEIN2FOOD crops covered as little as 0.34%, stemming from a reduction in faba bean planted area from 0.70% to 0.11%. The long-term downward trend from 1961-1998, has apparently been arrested and slowly reversed, increasing to 0.5% in 2013. These general reductions in planting area have differentially affected PROTEIN2FOOD crops, chick pea in particular seeing precipitous drops, whilst buckwheat has seen considerable expansion.

To improve the understanding of why the past 50 years of agronomic developments have resulted in such wide-scale decreases and unbalanced reductions, it is imperative to contextualise them within EU policies. As mentioned in Section 4, the then European Economic Community (EEC) introduced aids aimed at crops included within PROTEIN2FOOD in 1978, in the form of deficiency payments for faba beans and lupins. The impact of these payments, in terms of cultivated area, appear to be very limited considering Figure 14, where potentially their introduction stabilised lupin cropped area, after it had reduced from 0.09% in 1977 to 0.08% in 1978, and levelled at 0.07% up to 1981. Faba beans show a similarly limited response to the introduction, in fact the area dropped annually from 1978-1984, reducing from 0.33- 0.28%. In 1982, however the EEC altered the stipulations of the payment, allowing crops destined for feed purposes and food purposes to be covered, this change in coverage appears to have had a positive effect, with both faba bean and lupin area increasing. However, one of the unforeseen consequences of the introduction is that they may have discouraged the production of other protein crops such lentils and chickpeas (European Parliament, 2013), perhaps helping to explain the post 1978 decline in chick pea planted area.

In 1989, responding to a number of unforeseen consequences previously described (European Parliament, 2013), uniform area payments were introduced (75 European Currency Unit (ECU)) per hectare of chick pea and lentil, with a maximum guaranteed area of 300,000 hectares. However, following Figure 14 it appears that despite this area payment, it resulted in very little encouragement of lentil and chickpea production across European countries, with lentil planted area reducing from 98,675 hectares in 1988 to 42,902 in 1992. Similarly, chick pea production saw considerable reductions during this period reducing from 93,481 hectares to 57,283 from 1988-1992.

The Macsharry Reform (1992) brought about some of the biggest changes to the CAP since its implementation 30 years earlier, resulting in considerable changes to the support system in place for producers of protein rich crops across Europe from the early 1990s onwards. The movement of supports from products to producers, through the introduction of income supports, with particularly attractive supports developed for protein crops such as peas, faba beans and lupins, with a payment of 65ECU/t introduction in 1993, rising to 79ECU/t in 1994 (European Parliament, 2013). Income supports offered to chickpea and lentil production were considerably higher, with the 1995 introduction of 150ECU/t, rising to 181 in 1996.

The impact of these reformed supports appear to have been considerable with chickpea planted area increasing by almost 50%, whilst lentil area increased by almost 15% from1995-1996 (Figure 14). Although these increases may not be wholly attributable to these payments, their introduction appears to have arrested a general reduction in planting area during the late 1980s and early 1990s. The support provided for faba beans, appears to have had very little effect with EU-28 production area reducing by almost a third between 1993 and 1996 (Figure 14)

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 635727.

Although not so extreme, lupin cultivated area also reduced during the same period by just over 10%. Following these mid 1990s introductions, cultivated area saw a period where lentils, chickpea, faba beans and lupins fluctuated in a downward pattern towards the new millennium, whilst buckwheat continued its upward trend beginning in 1990.

The turn of the millennium saw further changes in the CAP, with the Agenda 2000 reform, widely implemented between 2000/2001, resulting in reductions to the payment paid to protein crops from 79ECU to 72.5€ per tonne. This reduction appears to have had little effect upon lupin production, whereas faba bean production continued to increase, with a 4% increase in area planted between 2000 and 2001, and 40% increase between 2000 and 2002.

Perhaps one of the most notable responses of European protein crops was to the 2003 reform, which saw the introduction of decoupled payments, whilst still offering support for protein crops through the protein premium coupled payment. These reforms resulted in EU wide support for protein rich crops, reducing from an estimated €500-70 million between 2004 and 2005 (European Parliament, 2013). During this period lentil planted area grew by 8% from 2004-2005 and then reduced by 45% from 2005 to 2008, whilst chick peas and faba beans followed similar patterns. Lupin area appears to have stabilised during the post reform period.

The year 2008 appears to represent another low-point in the planting of protein rich products across Europe, apparently coinciding with a period of extreme uncertainty in Europe following the global financial crisis. During this period of uncertainty, the CAP went through a health check streamlining, aiding it to better respond to market signals and climate change. The health check saw the eventual removal of the protein premium by 2011 and its total inclusion within EU member states Single Payment Schemes.

As part of the multi-pillared CAP and the changes stemming from the Health Check during this period, there were a number of options available for individual member states to provide support for protein rich crops. Including, and most frequently applied Article 68, which allowed member states to use up to 10% of payments towards certain crops, including leguminous protein rich crops. Further, as part of Pilar 2, Article 39 could be applied for promoting legume and protein crop production. It appears that the applicability of Articles 68 & 39 coincided with an apparent response by producers, especially for protein rich crops. Lentil (101%), chick pea (46%), faba bean (14%), lupin (36%) and buckwheat (5%) all saw increases in planted area between 2008 and 2011, suggesting considerable positive responses by European farmers which could be attributed to the supports applied by Articles 68 & 39.

Finally, without European wide data for the planted areas for 2014 and 2015, it is very difficult to gauge the impacts of the recent (2014) reforms to the CAP. However, from recent statistics released in Spain, they are suggestive that they have had disparate impacts upon the planting of protein rich crops. Spain saw a 15% increase in pea planted area, 300% increase in faba bean cultivation, but a 22% reduction in lupin from 2014-2015, whereas, chickpeas saw a 4% reduction and lentils a 7% reduction (MAGRAMA, 2015).

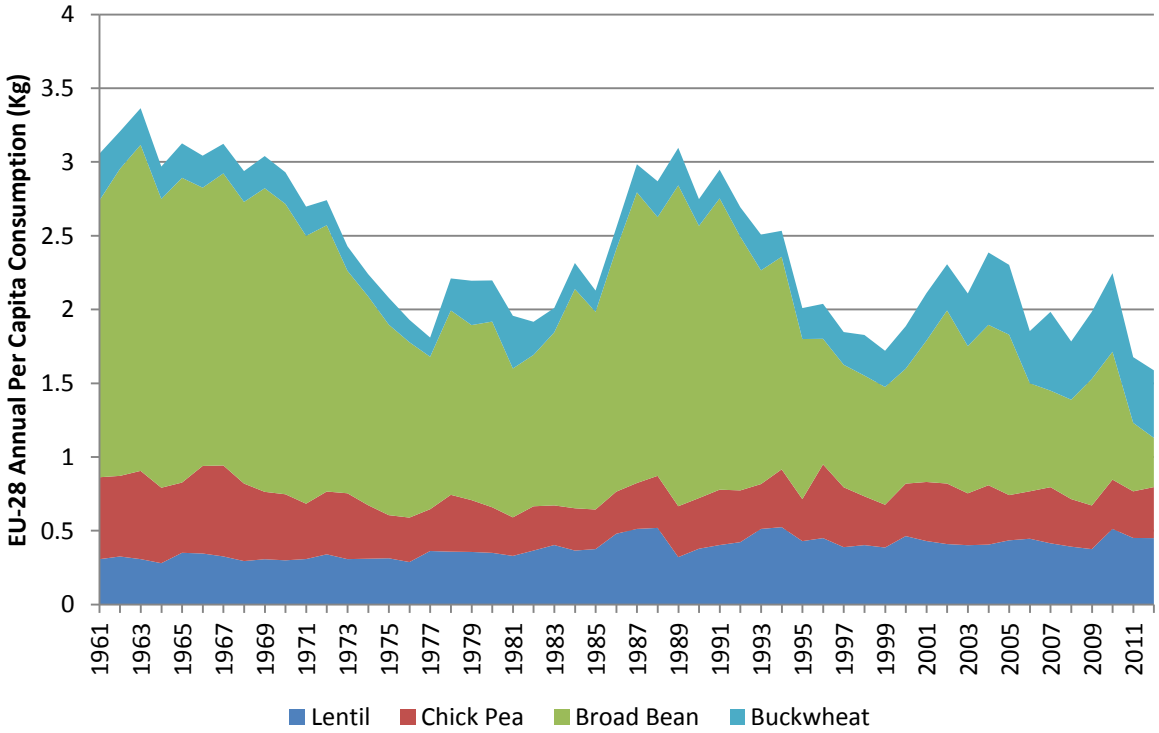
This brief review of the CAP and its potential impacts on planted areas of protein crops across Europe suggest some responses by farmers. In particular, recent changes to the CAP have apparently resulted in a reversal of the long-term decline planted area. However, the decision making behind what crops to plant on an annual basis are far more complicated than considering the scale of supports provided by the European Union. As highlighted by the European Parliament (2013), farmers must also consider agronomic considerations such as yields and margins.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 635727.

5.1.2.2 Consumption and Socio-Economic Development

To provide a more coherent contextualisation of the trends of protein rich products across Europe, it is prudent to consider both supply and demand. The supply side having been contextualised within the policy landscape of Europe, the demand side will be similarly contextualised but considering socio-economic factors and development that may drive such trends. As part of this analysis, and following previous sections, an assumption has been made that all production and domestic supply (production + imports – exports) is destined for human consumption.

De Boer et al (2006) demonstrated the relative stability of European plant based protein consumption during the forty year period from 1961 onwards, whilst also demonstrating the considerable increase in animal protein consumption. Animal proteins were found to contribute considerably more to European protein consumption than plant proteins (de Boer et al., 2006). Their analysis also noted the increasingly limited importance of pulses, including some PROTEIN2FOOD crops, in the European diet where Spain was identified to have the greatest proportion across EU-15 countries at 3.7g/day, or roughly ~3% of daily protein intake (de Boer et al., 2006). This limited contribution is supported by the updated analysis herein provided, which demonstrates the continued limited per capita consumption of PROTEIN2FOOD crops across Europe. In 2012, EU-28 consumption of PROTEIN2FOOD crops was ~1.5kg/year, continuing the considerable decline in consumption in the 51 years from 1961-2012 (Figure 15), with a European scale reduction of roughly 50%. Considering the crops of PROTEIN2FOOD, per capita consumption is variable, with roughly 0.4kg/yr of both lentils and buckwheat consumed in 2012, both having shown growth during the 51 years from 1961. In contrast, chickpea consumption declined during most of this period, but appears to have recently stabilised at around 0.3kg/capita/year. Broad beans have seen the biggest decline from roughly 1.8kg in 1961, to 0.3kg/capita in 2012.



Note: Soya not included

Figure 15. Consumption of PROTEIN2FOODcrops across EU-28 countries from 1961-2013

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 635727.

These declines have been previously attributed to movement away from plant based proteins, especially due to increases in wealth allowing for purchasing more expensive proteins, like animal based proteins (FAO, 2016). Schneider (2002) suggest that factors that limit European consumption of plant based proteins, in particularly pulses, are due to competition from cheaper protein products, and due to the lack of innovation for products suitable to modern consumption patterns. Following this suggestion, one must contextualise these patterns against other sources of protein in the European diet, including meat and dairy, to understand the increasingly limited contemporary importance of PROTEIN2FOOD crops to the average European. Sans & Combris (2015) observed that during the 40 years from 1961-2001, global per capita meat consumption rose from 23.1 kg- 42.2kg, with similar levels of growth observed for dairy products. In developed countries, animal based proteins have been observed to represent up to, or even exceed 40% of dietary intake by mass (Machovina et al., 2015). These points have been duly supported across Europe, where the supply of animal proteins has increased significantly in European diets (de Boer et al., 2006).

European meat consumption (Figure 16) shows a clear surge in consumption, especially in pork and poultry from the 1960s onwards, following a similar pattern later observed in developing countries (Delgado, 2003). However, Figure 16 suggests recent stability (post 1990) of aggregated per capita meat consumption (~76kg/year), but once disaggregated both beef and pork consumption appear to have declined since the 1990s with respective peaks at 22.3kgs/yr in 1991 for beef and 45.8kgs/yr in 1999 for pork.

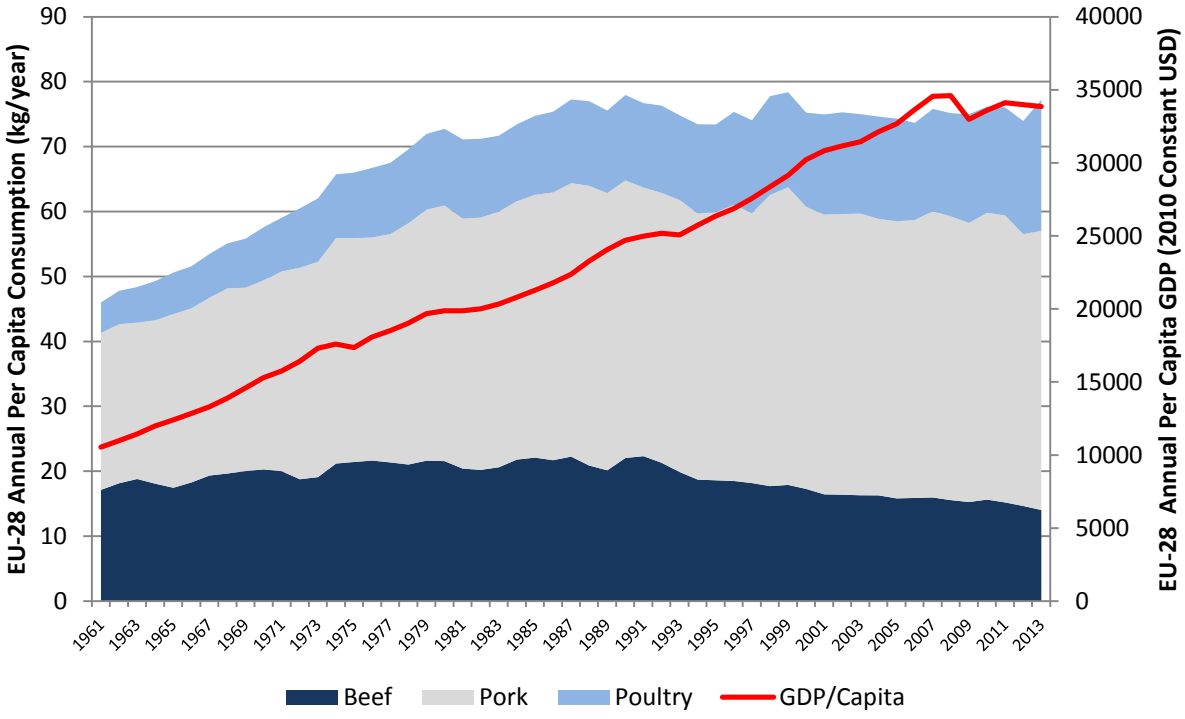


Figure 16. EU-28 per capita annual meat consumption from 1961-2012 in kilograms and EU-28 per capita income in constant 2010 USD.

Poultry appears to be the only product to show per capita increases, increasing from 14.5kgs/yr in 2000, to 17.4 in 2012. Figure 16 appears to demonstrate the initial signs of per capita reductions in aggregated European meat consumption. This therefore begs the question as to what factors are behind such disparate patterns of consumption across Europe since the early 1960s, with meat consumption increasing rapidly, stabilising and apparently now reducing; whilst plant based protein consumption has shown precipitous declines.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 635727.

If we consider total, rather than per capita consumption across Europe, the results (Figure 17) suggest a similar decline in beef consumption, following a peak of 10 million tonnes in 1991, which as of 2013 was 7.3 million tonnes. However, both pork and poultry total consumption have increased considerably, with EU-28 pork consumption more than doubling between 1961 and 2013 from 9.3-22.4 million tonne, with this consumption appearing to have stabilised around 22 million tonnes since the turn of the millennium.

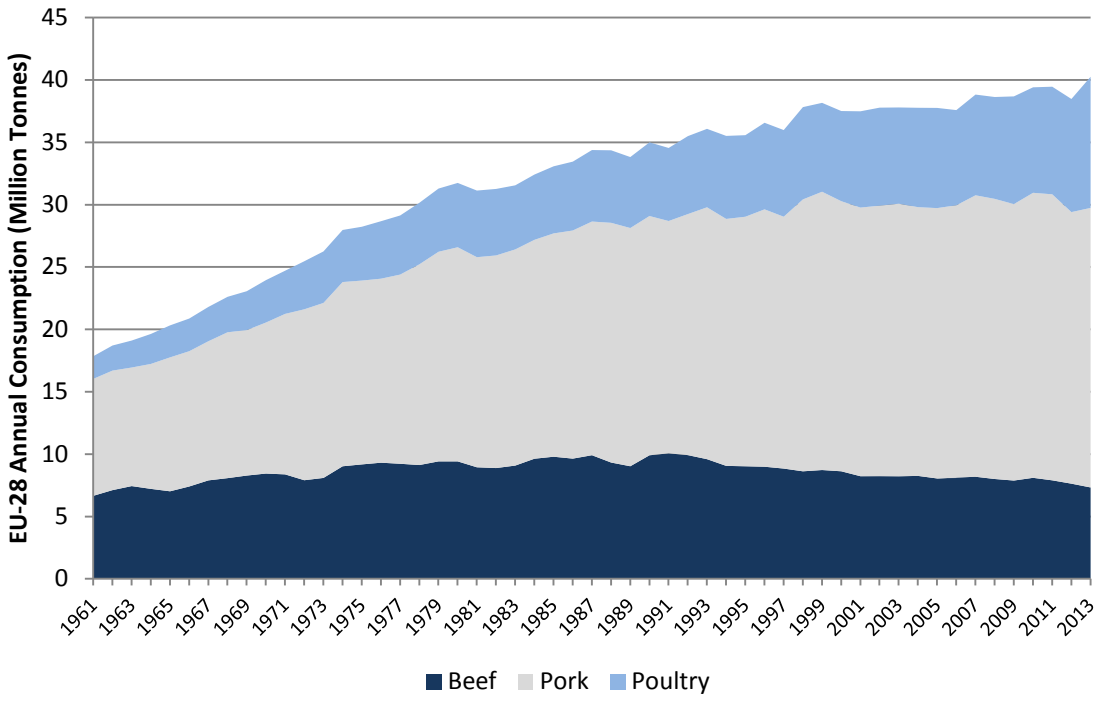


Figure 17. EU-28 total annual meat consumption from 1961-2012 in million tonnes.

Poultry consumption across EU-28 countries on the other hand has increased dramatically from just 1.8 million tonnes in 1961, to 10.5 million tonnes in 2013. Figure 17 demonstrates that despite the apparent decline in per capita consumption of meat (Figure 16), the increase in EU population over the past half century has driven total consumption, and this trend is apparently continuing.

There is a wealth of research behind the factors that drive the patterns of consumption (Delgado 2003; Tilman et al 2011; Kastner et al., 2012). Considering meat consumption Rivers Cole & McCoskey (2013) and Vranken (2014) have demonstrated that consumption may follow similar patterns to a Kuznets curve, with consumption increasing with per capita wealth. This incremental rise in consumption continues until an inflexion income level is reached, estimated to be $32,000 per capita (Vranken et al., 2014), after which consumption is understood to gradually decline. To ascertain whether such a pattern is observable across Europe, and whether such an inflexion point has been reached, and may be responsible for stabilising EU-28 meat consumption, a trend line of GDP/ capita (in 2010 constant USD) has been applied to Figure 16, representing EU-28 average values. However, looking at this figure, it appears that consumption of meat products stabilised in the early 1990s, with EU-28 wide per capita income of roughly $25,000. This suggests that in Europe (as an aggregate of EU-28 countries), the inflexion point has come at incomes lower than those estimated by Vranken et al. (2014).

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 635727.

Further, consideration should also be made of the patterns of meat products consumed, for example increases in poultry consumption have been attributed to convenience, cost and ease of production (Westhoek et al., 2011). This cost factor has been supported by Marquer et al (2014) who suggest consumer purchasing power may be significantly tied to beef consumption, with consumers increasingly moving away from this expensive form of meat towards cheaper products such as pork and poultry. Whilst loss of consumer confidence may have further driven consumers away from beef, due to health and food safety concerns (van Wezemael et al. 2010; Kearney 2010).

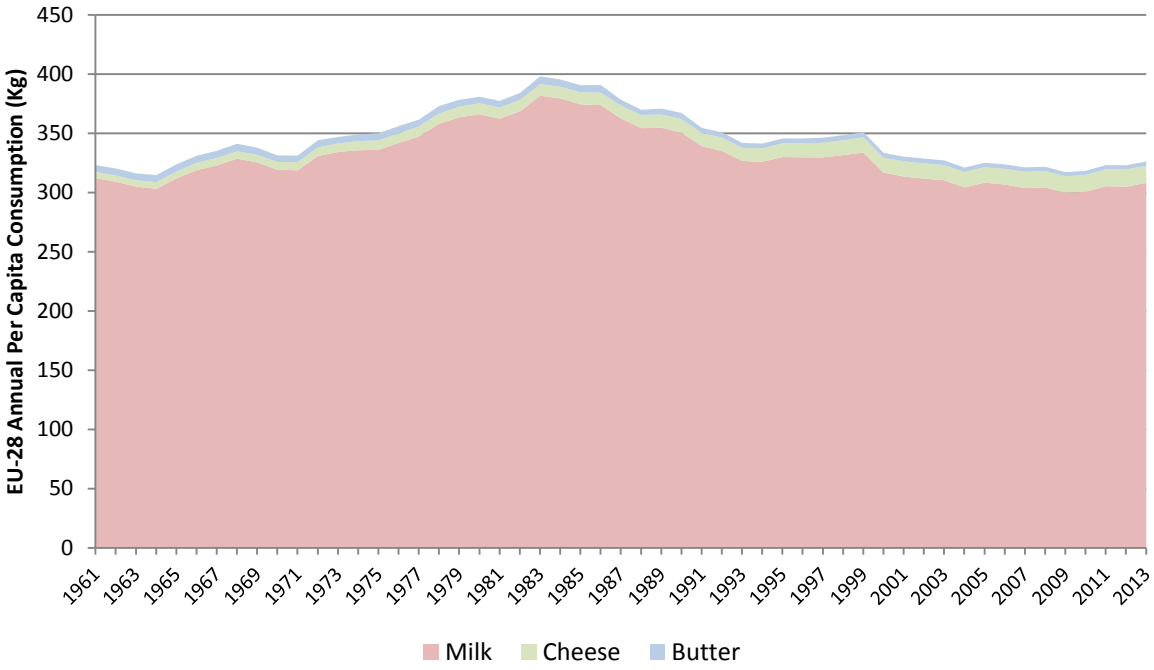


Figure 18. EU-28 per capita annual dairy consumption from 1961-2012 in kilograms.

In terms of dairy products (Figure 18) there appears to be a clear reduction in per capita consumption since a mid 1980s peak, with milk consumption in 2012 (304kgs) being the lowest it has been since 1964. This decline in milk consumption, has been identified previously with Duffey & Popkin (2007) attributing its decline to increases in the consumption of other beverages, with Cavadini et al. (2000) supporting this suggestion that increased choice may have driven consumer choice of milk. Butter has also seen considerable declines, reducing from a high in 1986 of 6.45kgs to 3.57 in 2012. Cheese is the only dairy product to have seen an increase in per capita consumption, rising by almost 300% between 1961 (5.19kgs) and 2012 (14.55kgs) The increase in cheese consumption, as well the apparently stabilised pattern of dairy product consumption, may demonstrate the considerable dietary benefits of their consumption, in comparison to cost. Drewnowski (2011) suggests that dairy products offer a nutrient rich, low cost product making ideal contributions to a rounded diet, with Prentice (2014) demonstrating the considerable health benefits, which may account for the relatively recent stability, post 2000, in dairy consumption.

It seems clear that a number of socio-economic factors may account for the patterns in PROTEIN2FOOD products, meat and dairy consumption. Health (van Wezemael et al. 2010; Kearney 2010; Westhoek 2011; Drewnowski 2011) and economic considerations (Drewnowski 2011; Marquer et al. 2014), as well as increased products choice appear to be particularly strong drivers in consumption of meat and dairy. Whilst contrastingly, apparent moves towards cheaper protein sources, and a lack of information concerning the benefits of plant based proteins (Schneirder 2002) may contribute to these patterns of low plant based

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 635727.

protein consumption. The results from this analysis suggest that EU-28 countries have seen widespread reductions in plant based proteins and stabilisation/ moderate declines in animal protein consumption.

As demonstrated in the previous section European (continental, not EU-28) meat consumption was observed to follow similar patterns of consumption as other more developed continents (including the Americas and Oceania). Europe, the Americas and Oceania were observed to reduce beef consumption and have stable or stabilising pork consumption. Africa and Asia were seen to increase pork consumption, with Asia also increasing consumption of beef. Finally, all continents were observed to increase poultry consumption. These results suggest that EU-28 patterns of meat consumption are similar to continental Europe, the Americas and Oceania with EU-28 countries perhaps slightly ahead of the reducing or stabilising consumption of beef and pork in wealthier regions but within the global pattern of increased poultry consumption.

5.2 Patterns of EU-28 Protein Production and Consumption

Production and consumption of protein rich crops have shown considerable variance across EU-28 countries in recent decades, such variance in the production side have been attributed to various contributing factors including preference for other crops such as cereals (Von Richthofen et al. 2006), farm intensification, abandonment of traditional systems (Voison et al. 2014), and yield variability (Stoddard 2013). To ascertain the extent of this variance, we will analyse the trends of protein rich crops and animal based production across Europe since the early 1960s. Further, examples of uses of these products by end users have been included thanks to contributions from the SMEs of PROTEIN2FOOD.

5.2.1 Protein2Food and other Protein Crops

Lentil

The evolution of European production of lentil has seen dramatic changes over the fifty years since 1961. Analysis of FAOStat (FAO, 2016) data suggests that principal historical producers of this crop are largely concentrated in Southern Europe, with France and particularly Spain being the primary producers. Figure 19, highlights the production trends of these two important producing nations, whilst also offering a European total that excludes Spain and France.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 635727.

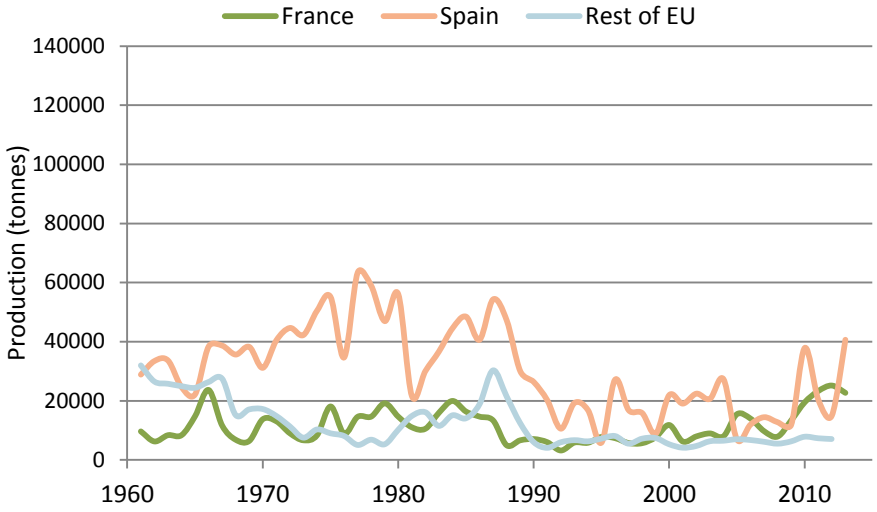


Figure 19. Lentil production in tonnes.

Spanish and French production has experienced considerable variability since 1961-2012, ranging, in the case of Spain (the principal EU producer), from 28.9 thousand tonnes in 1961 to 6.3 in 1994, and growing up to 40.7 thousand tonnes in 2012. In the rest of the EU lentil production has followed a downward trend, reducing from 31 to 7 thousand tonnes. However, this ignores the considerable variability in production during the intervening years, with 2012 production appearing to be representative of recent sustained increases. Spanish production saw considerable increases through the 1960s to the later 1970s, up to a high of 63.4 thousand tonnes, before crashing to a third of that in the early 1980s. After a recovery period during the eighties, it followed another crash in the late 1980s and early 1990s. Around the 2000s Spanish lentil production saw lower amplitude instability oscillating around 20 thousand tonnes, with important increases in 2010 and 2012.

Similar patterns of peaks and troughs can be seen in France and across Europe in general, with non Spanish and French production peaking in the late 1980s, at around 30 thousand tonnes before falling to a relatively stable value around 7 thousand tonnes up to the present. The considerable fluctuations in lentil yields (FAO, 2016) over recent decades may help to explain such widespread reductions in production, with farmers potentially moving towards more stable crops. Von Richthofen et al. (2006) highlighted the desire of European farmers to move towards more stable crops, in place of perceived instability of crops like lentil. Recent producer price rises (FAO, 2016) may help to account for recent (post 2000) increases production, especially evident in both France and Spain.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 635727.

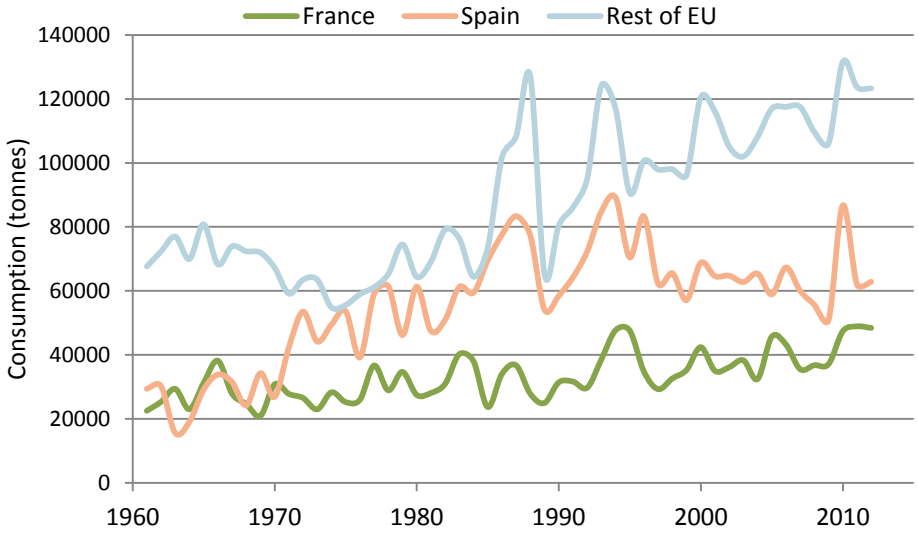


Figure 20. Lentil consumption in tonnes.

In contrast to production, lentil consumption (Figure 20) has seen a steady increase since 1961, not only in producing nations like Spain and France, but across Europe. European consumption has almost doubled since 1961, although not showing such extreme variability France shows a similar upward trend in consumption, whilst Spain's consumption pattern appears to mirror that of the EU, up to the 1990s before stabilising. These historical consumption and production trends suggest that these trends are gradually moving apart rather than together, suggestive of the EU's increased dependence upon non-EU imports to support demand. Although these increases in consumption may be attributable to Europe's increased population over the previous 50 years, increased awareness about the health benefits of lentil consumption (Patterson et al 2009; Zare et al 2012) and the relatively low price may have also contributed to EU-28 wide increase in consumption.

Box 1 presents an example of the usage of quinoa by COPOSA, a SME of the PROTEIN2FOOD project.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 635727.

Box 1. Uses of lentils by COPOSA

- **Which food products do you make with lentil?**
  - Cooked dishes: **Lentil stew**
  - **Seitan with lentils**
  - **Lentil seitan steaks**, (breaded, pre-fried, ready to eat).

- **Where do you buy lentil? Have you changed suppliers in recent years, or have they remained the same? Why?**
  We buy organic green Lentil (castellana variety) through an importer. The origin is Canada. We have not changed the supplier because we are very satisfied with the service provided and with the agreed prices (very competitive).

- **Do you encounter any limitations in buying and using lentil? (e.g., high and variable prices, legal restrictions, supply shortages, etc.)**
  The main limitations encountered are: time of harvest, pests and the particular idiosyncrasies of each country

- **How much do you pay for lentil (e.g. in €/kg)? Have you observed any representative change in these prices over the last years?**

	Aug. 2016	July 2015	Aug. 2014
Organic Green Lentil Castellana **(€/Kg)**	3.60	1.75	1.75
Organic Brown Lentil **(€/Kg)**	2.51	2.21	1.50

(Fee Price for: 1,000 kg in bags of 25 Kg / goods at destination)

- **Which countries and market segments are the main buyers of your final products? Comment on the evolution of sales of your products over recent years.**
  The purchasers for our products are mainly the developed countries of Europe and the USA. These are the current and potential markets. The evolution of our sales has been stable with a slight decreasing.

- **Where do you sell your lentil-made products? At what prices?**
  We sell our lentil-made products all over the Spanish territory through many distribution channels: the modern distribution, specialized chains of organic products, regional distributors, specialized distributors and distributors for Hotels and Restaurants. We sell our own brands and also under white label. Our sell prices are aligned with the reference markets.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 635727.

- **Please, provide your view on the future evolution of lentil as a raw material for your business.**
  - **Will you continue using lentil?**
    Yes, COPOSA will continue using lentil as a row material, and our goal is to increase the lentil-based products portfolio.
  - **Are consumers demanding lentil-made products? Why?**
    Yes, the consumers are demanding such products because of its connotation of healthy products. These are "trendy foods" and we think that there is still way for further growth.
  - **What do you think would be the key to improve the sales of lentil-made products?**
    In our case, we think that the keys to improve our sales are: constant innovation and development of new products. Other important factors (among others) are price stability, supply stability and governmental policies supportive to the increase of such products.
  - **Which obstacles should be overcome?**
    The main obstacle that we have to overcome is the misinformation about the advantages of consuming these products compared to the current staple diet.

Source: Own elaboration (contribution from COPOSA)

Chickpea

The historical trends of chickpea production (Figure 21) and consumption (Figure 22) appear to show long-term declines in supply, whilst relatively recent increases in demand.

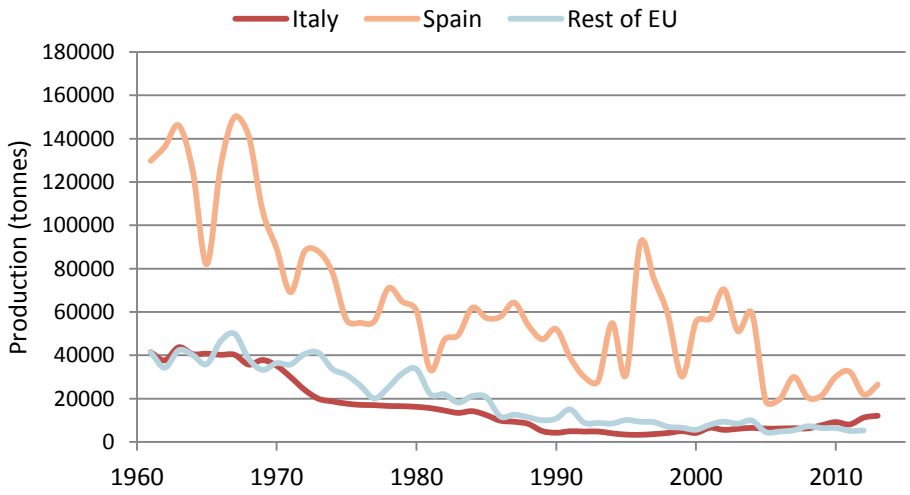


Figure 21 . Chickpea production in tonnes

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 635727.

Figure 21 demonstrates the sharp decline in production in the two biggest European producers (Spain and Italy), especially acute in Spain where production in 2012 represented ~15% of 1961 production, whilst Italy's contemporary production is roughly 38% of production in 1961. Production in other EU countries has seen equally precipitous declines since the early 1960s; by 2012 production across Europe was 14% (5303 tonnes) of 1961 production. Whilst Spanish yields have remained relatively stable around 0.4 tonnes per hectare (FAO, 2016), prices have fluctuated greatly reaching highs of $1200 per tonne in 1992, to just over half that by 2002 (FAO, 2016) potentially discouraging production. Further, farmer preference for cereal crops rather than grain legumes, or protein crops may also be contributing to these observed reductions (Vosin et al. 2014).

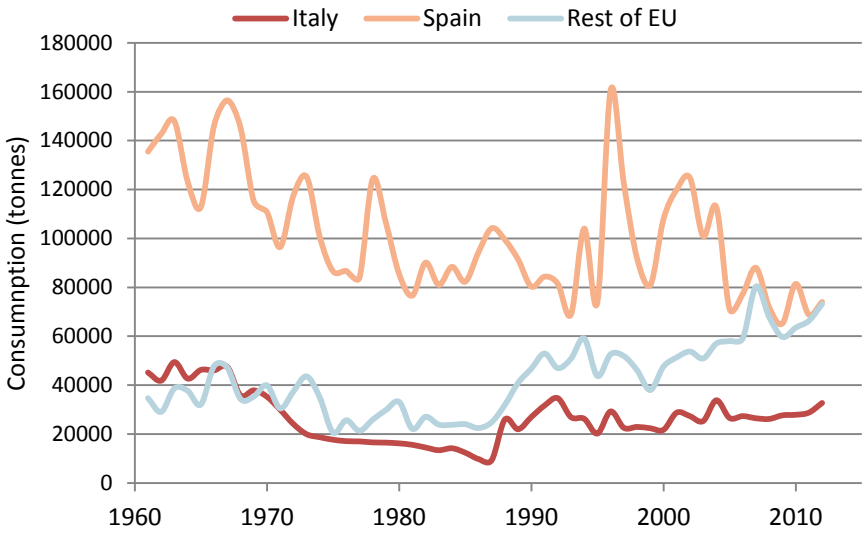


Figure 22. Chickpea consumption in tonnes.

Spain, Europe's largest consumer (Figure 22) of chickpeas, has seen a similar pattern of declines in consumption, as with production. In 2012, Spanish consumption was 19% of that of the early 1960s, whereas Italian consumption had declined to 27% of its 1960s level. Curiously, in other EU countries consumption has doubled, with the findings of Patterson et al (2009) and the demonstrated health benefits of pulses, perhaps helping to explain the gradual increase in consumption across the EU countries, with consumers becoming increasingly aware of the benefits of consumption. Figures Figure 21 and Figure 22 suggest the increasing importance of non-EU imports to satiate European demands for chick peas.

Box 2 presents an example of the usage of quinoa by COPOSA, a SME of the PROTEIN2FOOD project.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 635727.

Box 2. Uses of chickpea by COPOSA

- **Which food products do you make with chickpea?**
  - Cooked dishes: **Chickpea stew**
  - **Chickpea seitan**
  - **Chickpea bistec** (individually packaged and ready to eat)

- **Where do you buy chickpea? Have you changed suppliers in recent years, or have they remained the same? Why?**
  We buy organic chickpea No.8 through an importer. The origin is Turkey. We have not changed the supplier because we are very satisfied with the service provided and with the agreed prices (very competitive).

- **Do you encounter any limitations in buying and using chickpea? (e.g., high and variable prices, legal restrictions, supply shortages, etc.)**
  The main limitations encountered are: time of harvest, pests and the particular idiosyncrasies of each country.

- **How much do you pay for chickpea (e.g. in €/kg)? Have you observed any representative change in these prices over the last years?**

	Aug. 2016	July 2015	Aug. 2014
Organic Chickpea (No.8) **(€/Kg)**	2.48	1.84	1.95

(Fee Price for: 1,000 kg in bags of 25 Kg / goods at destination)

- **Which countries and market segments are the main buyers of your final products? Comment on the evolution of sales of your products over recent years.**
  The purchasers of our products are mainly the developed countries of Europe and the USA. These are the current and potential markets. The evolution of our sales has been stable with a slight decreasing. We observe in the market increased sales of "chickpea spread".

- **Where do you sell your chickpea-made products? At what prices?**
  We sell our chickpea-made products all over the Spanish territory through many distribution channels: the modern distribution, specialized chains of organic products, regional distributors, specialized distributors and distributors for Hotels and Restaurants. We sell our own brands and also under white label. Our sell prices are aligned with the reference markets.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 635727.

- **Please, provide your view on the future evolution of chickpea as a raw material for your business.**
  - **Will you continue using chickpea?**
    Yes, COPOSA will continue using chickpea as a row material, and our goal is to increase the chickpea-based products portfolio.
  - **Are consumers demanding chickpea-made products? Why?**
    Yes, the consumers are demanding such products because of its connotation of healthy products. These are "trendy foods" and we think that there is still way for further growth.
  - **What do you think would be the key to improve the sales of chickpea-made products?**
    In our case, we think that the keys to improve our sales are constant innovation and development of new products. Other important factors (among others) are price stability, supply stability and governmental policies supportive to the increase of such products.
  - **Which obstacles should be overcome?**
    The main obstacle that we have to overcome is the misinformation about the advantages of consuming of these products compared to the current staple diet.

Source: Own elaboration (contribution from COPOSA)

Faba Beans

From Figure 23, it is evident that faba beans are the most produced of PROTEIN2FOOD crop, with Italian production alone breaching 400,000 tonnes in the early 1960s. Since these highs, Italian production has declined rapidly to less than a quarter of this, with 95,000 tonnes produced in 2012. Similar, although not such acute declines have been seen in Spain, where in 2012 production represented less than a quarter of production in 1961. On the contrary, the UK has seen prolonged, yet variable, increases since the early 1970s, with the UK becoming Europe's principal producer in the early 1990s and has since fluctuated, along with Italy around 100,000 tonnes. Faba bean crop has consolidated as the most important leguminous crop, in terms of production, with a considerable increase across the other EU-28 nations. These increases have been most notable during the mid 1980s, and more recently since the turn of the millennium, with production in 2012 just over 300,000 tonnes (not including the UK, Italy and Spain).

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 635727.

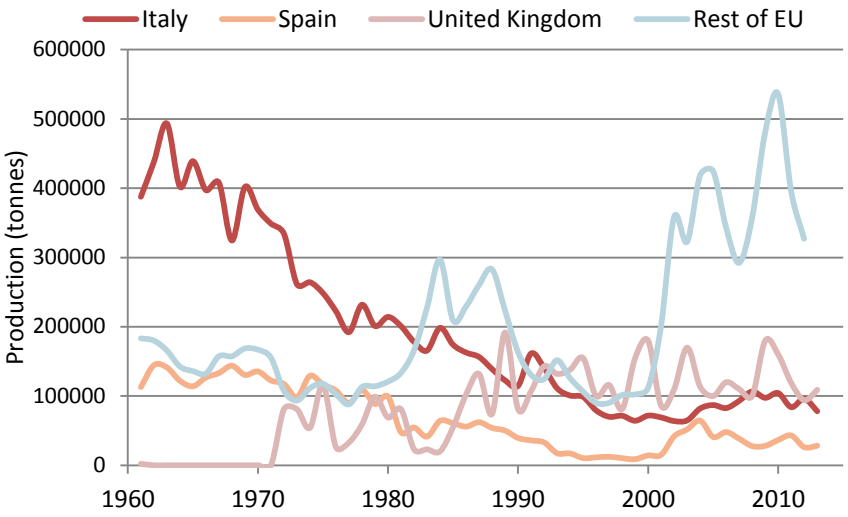


Figure 23. Faba bean (broad bean) production in tonnes.

The patterns of faba bean consumption are somewhat more complicated, with countries on a number of occasions moving into negative values[7]. Briefly reviewing Figure 24 it is clear that consumption shows considerable variability, with an EU-wide peak in consumption during the mid-late 1980s, followed by declines as noted by Italy, Spain and the other EU nations. The UK demonstrates a curious pattern, showing very little if any consumption, which considering trade data (FAO, 2016) is due to large exports. This pattern is continued until 2010, when its consumption values turn negative, and UK exports surpass both production and imports, resulting in negative consumption. This may suggest that the UK during this period may have been exporting surpluses from previous years.

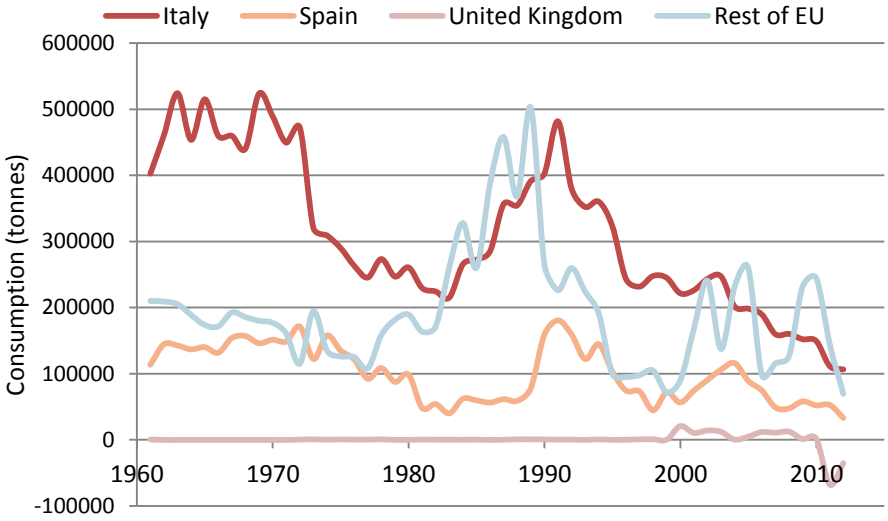


Figure 24. Faba bean (broad bean) consumption in tonnes.

[7] Note that consumption is an estimated variable, calculated as production + imports – exports.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 635727.

Buckwheat

The production of buckwheat (Figure 25) in the EU is dominated by France (green) and Poland (dark blue), with European production led by Poland from the 1960s until the turn of the millennium. The drastic increase in French production was preceded by a steady decline from the 1960s to the mid 1980s, where the lowest production of only 6 thousand tonnes was seen in 1985. Poland has followed a distinct trajectory, with production peaking in 1981 at 130 thousand tonnes, followed by a considerable crash in production in the mid 1980s. However, since the turn of the millennium Polish buckwheat production has steadily increased and in 2012 was 28% higher than 2000. The other European countries have seen considerable growth in production since the early 1990s. This slow increase in production across the principal producers may in part be due to its benefits as a cover crop and its environmental benefits (Radics and Mikóházi, 2010).

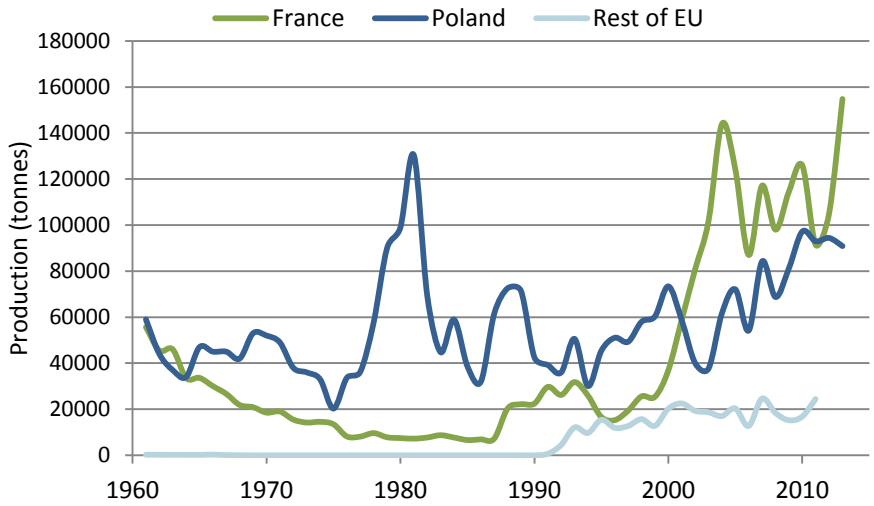


Figure 25. Buckwheat production in tonnes.

Buckwheat consumption (Figure 26) appears to follow almost identical patterns as production, suggesting that EU-28 consumption of buckwheat is almost entirely self-sufficient. The consumption of buckwheat has been slowly increasing in Poland since the early 2000s, and in France has almost quadrupled since the year 2000. Finally, consumption across the other European countries has doubled since the mid 1990s, perhaps accountable due its potential uses for gluten free products (Alvarez-Jubete et al, 2009), and its antioxidant properties (Holasova et al. 2002), along with its potential as livestock feed (Radics and Mikóházi, 2010).

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 635727.

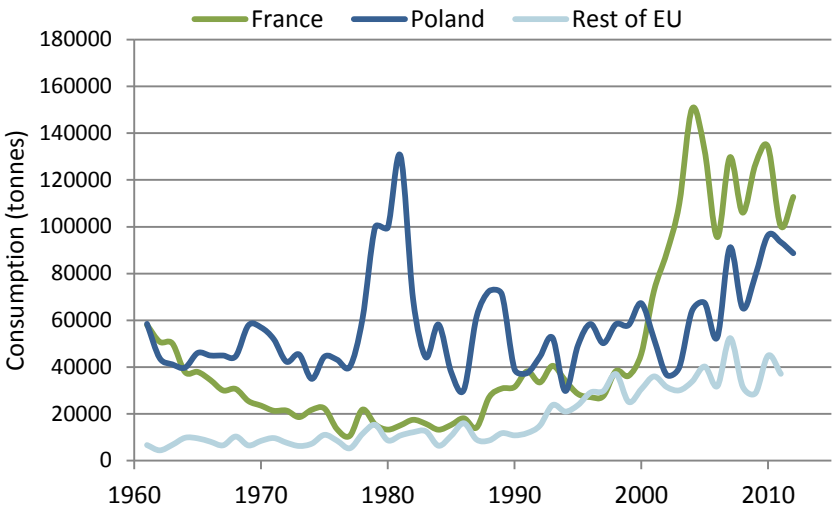


Figure 26. Buckwheat consumption in tonnes

Quinoa

Although production of quinoa is slowly spreading across Europe, there remains a dearth of reliable data of its European production. Therefore, analysis will be made of Latin American production, along with European trade data to highlight trends of European imports. Using this trade data, we can also demonstrate the relationship between exporting and importing nations and identify temporal and spatial trends.

Quinoa production in Latin America (Figure 27) is dominated by Bolivia and Peru, with Ecuador also producing annual harvests. Up to the turn of the millennium production was relatively stable with Bolivian and Peruvian production slowly increasing from the 1970s-1990s with production largely destined for local consumption. However, since the year 2000 and most noticeably 2010 onwards, production has increased dramatically, with Peruvian production more than quadrupling between2000-2013, and Bolivian production following similar patterns. The FAO highlighted that increased production has responded to global increases in popularity of quinoa, which benefits from limited international trade tariffs, as well as few biological barriers (FAO, 2013b).

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 635727.

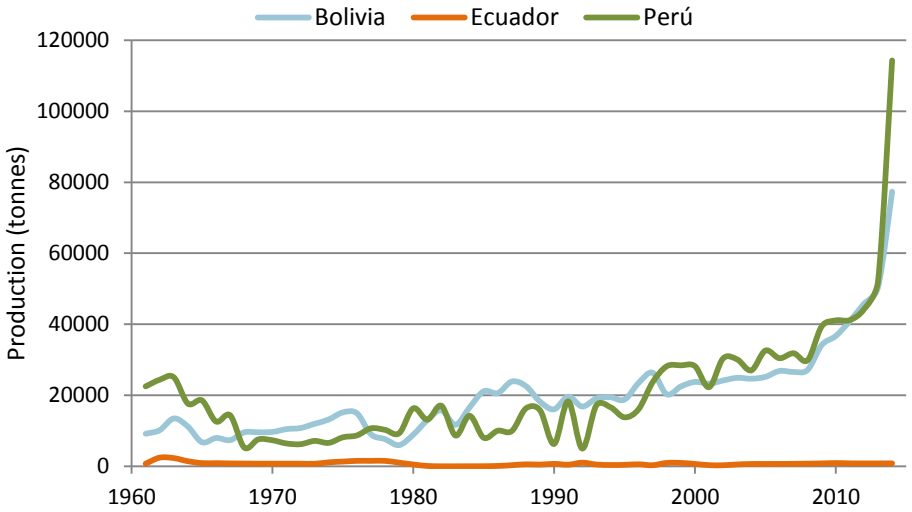


Figure 27. Quinoa production in tonnes.

This increase in production may be in response to changes in consumers' desires and their increased move towards nutritious, healthy food choices FAO (2013b). These desires are perhaps most easily recognised in Figure 28, demonstrating the European imports of quinoa from the three principal producers during the period 2009-2014. These years have been selected to identify whether the huge increase in production between 2009- 2013 is mirrored in European imports during the same period.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 635727.

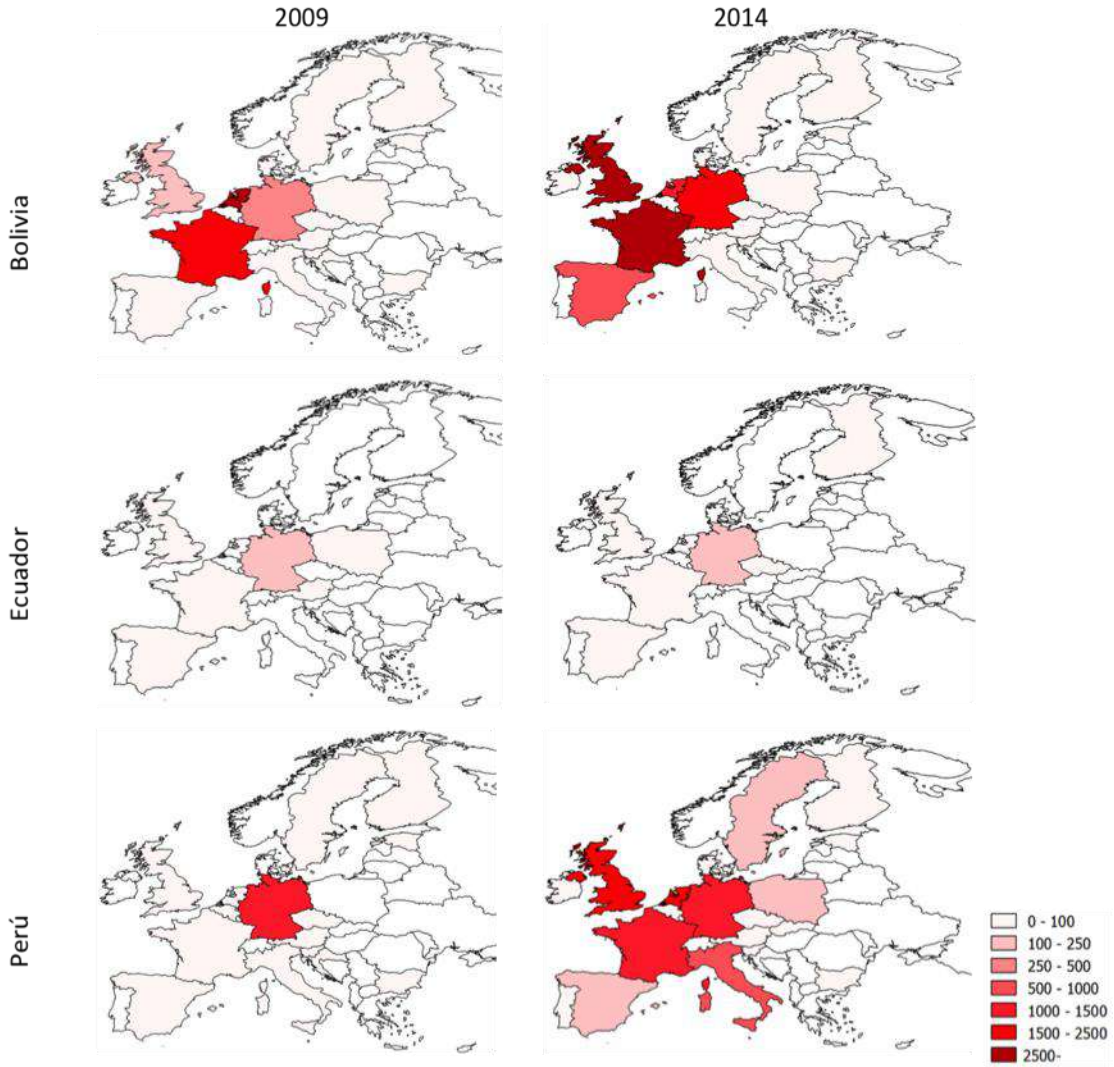


Figure 28. European quinoa imports (tonnes) from the biggest exporters, Bolivia, Ecuador and Peru (2009 to 2014)

Figure 28 demonstrates considerable increase in imports of quinoa during the 5 year period from 2009. Import increases are apparently dispersed, moving away from just a handful of importers in 2009, to a pan-continental expansion by 2014. Peru offers a particularly good example of this, where imports are dominated in 2009 by Germany, but by 2014 considerable levels of imports are spread across the UK, France, Germany, the Netherlands and Italy. Bolivian imports also show a similar pattern, with the UK and France being the biggest importers by 2014.

Boxes 3 and 4 present examples of the usage of quinoa by COPOSA and Nature Crops, SMEs of the PROTEIN2FOOD project.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 635727.

Box 3. Uses of quinoa by COPOSA

- **Which food products do you make with quinoa?**
  - Vegetable frankfurter **sausages**
  - Vegetable **burgers** ready to eat

- **Where do you buy quinoa? Have you changed suppliers in recent years, or have they remained the same? Why?**
  We buy Grain of Organic Quinoa of 2mm through an importer. The origin is Bolivia and Peru. We have not changed suppliers because we are very satisfied with the service provided and with the agreed prices, which are very competitive.

- **Do you encounter any limitations in buying and using quinoa? (e.g., high and variable prices, legal restrictions, supply shortages, etc.)**
  The main limitations encountered are: time of harvest, pests and the particular idiosyncrasies of each country.

- **How much do you pay for quinoa (e.g. in €/kg)? Have you observed any representative change in these prices over the last years?**

	Aug. 2016	**July 2015**	**Aug. 2014**
Grain of Organic Quinoa (2mm) **(€/Kg)**	3.62	6.12	7.84

(Fee Price for: 1,000 kg in bags of 25 Kg / goods at destination)

- **Which countries and market segments are the main buyers of your final products? Comment on the evolution of sales of your products over recent years.**
  The purchasers of our products are mainly the developed countries of Europe and the USA. These are the current and potential markets. The evolution of our sales has been of consolidated growth.

- **Where do you sell your quinoa-made products? At what prices?**
  We sell our quinoa-made products all over the Spanish territory through many distribution channels: the modern distribution, specialized chains of organic products, regional distributors, specialized distributors and distributors for Hotels and Restaurants. We sell our own brands and also under white label. Our sell prices are aligned with the reference markets.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 635727.

- **Please, provide your view on the future evolution of quinoa as a raw material for your business.**
  - **Will you continue using quinoa?**
    Yes, COPOSA will continue using quinoa as a row material, and our goal is to increase our quinoa-based products portfolio.
  - **Are consumers demanding quinoa-made products? Why?**
    Yes, the consumers are demanding such products because of its connotation of healthy products. These are "trendy foods" and we think that there is still way for further growth, especially boosted by advertising campaigns of large multinationals.
  - **What do you think would be the key to improve the sales of quinoa-made products?**
    In our case, we think that the keys to improve our sales are constant innovation and development of new products. Other important factors (among others) are price stability, supply stability and governmental policies supportive to the increase of such products.
  - **Which obstacles should be overcome?**
    The main obstacle that we have to overcome is the misinformation about the advantages of consuming these products compared to the current staple diet.

Source: Own elaboration (contribution from COPOSA)

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 635727.

Box 4. Uses of quinoa by Nature Crops

- **Which food products do you make with quinoa?**
  - Organic gluten-free **burgers** with quinoa (vegetable, apple & curry, onion)
  - Organic gluten-free **bars** (prunes, almonds & sesame, strawberry & chocolate, chocolate & almonds)
  - Organic gluten-free **instant soups** (vegetable, pumpkin, chicken-herbs, tomato)

- **Where do you buy quinoa? Have you changed suppliers in recent years, or have they remained the same? Why?**
  We buy our quinoa in Bolivia and Peru. We didn't change suppliers because we prefer a long time relationship.

- **Do you encounter any limitations in buying and using quinoa? (e.g., high and variable prices, legal restrictions, supply shortages, etc.)**
  Before buying we check if gluten or pesticides are present. In case we detect some, we reject the batch.

- **How much do you pay for quinoa (e.g. in €/kg)? Have you observed any representative change in these prices over the last years?**
  We pay market related prices.

- **Which countries and market segments are the main buyers of your final products? Comment on the evolution of sales of your products over recent years.**
  2015: UK, the Netherlands, Belgium, Iceland
  2016: UK, the Netherlands, Belgium, Iceland, Dubai, Greece, France, Spain, Portugal

- **Where do you sell your quinoa-made products? At what prices?**
  We sell them to retailers, via distributors, wholesale and food stores.

- **Please, provide your view on the future evolution of quinoa as a raw material for your business.**
  We will continue to use quinoa. What we see is that we have to teach consumers to eat quinoa. The 'standard consumer' still does not know how to eat quinoa. Therefore, we develop and introduce lots of new products. Our focus will be final products instead of seeds.

Source: Own elaboration (contribution from Nature Crops)

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 635727.

Lupin

In the analysis of lupin, data could only be sourced for lupins in general, rather than individual species (blue, Andean, white) outlined in the description of work of PROTEIN2FOOD. Further, data was only obtainable for production, no trade data was available, making consumption (production + imports – exports) analysis following the same process as for previous crops impossible.

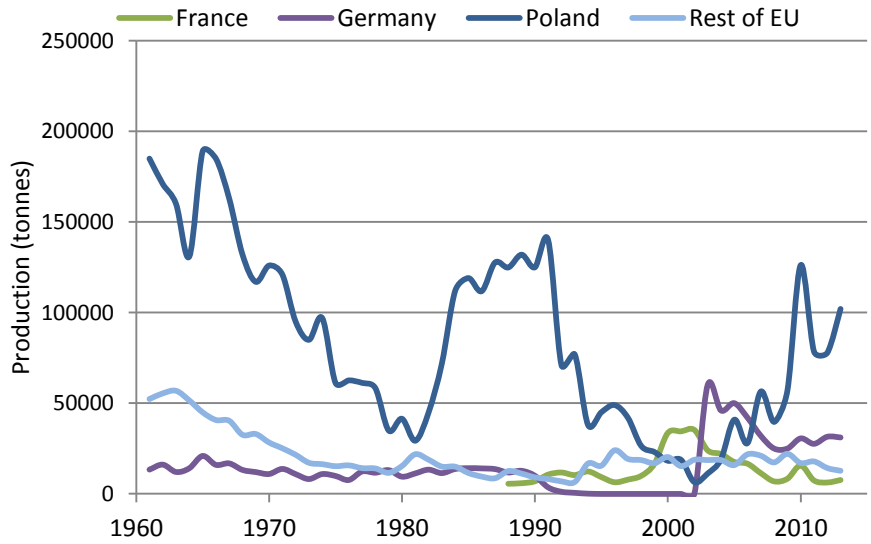


Figure 29. Production of lupin across Europe represented in tonnes.

From Figure 29 it is evident that European lupin production is dominated by Poland from the 1960s onwards, with only a brief period during the mid 2000s where Germany became the principal producer. However, in spite of being the principal producer in Europe, Poland has seen considerable fluctuations from its high in the mid 1960s, to a recent revival from the mid 2000s onwards. Since the high production point in the mid 1960s, Polish lupin production reduced from a high of 189,000 tonnes, to a low of 29,310 tonnes in 1981. This long-term decline was followed by another peak in 1991 of 140,000 and an equally dramatic reduction to 6,477 tonnes in 2002. German production has also seen considerable variations, especially since the late 1990s. From the early 1990s to the early 2000s German production was zero, but in 2003 there was a peak of 60,000 tonnes followed by a 50% decline to 31,500 tonnes in 2012. Finally, the other EU countries show relative stability of production following a steep decline, which mirrored that of Poland during the 1960s- 1980s. These relatively low levels of production may be attributable to the perceived lack of profitability of these crops, despite acknowledged agronomic benefits (Von Richthofen et al. 2006).

Box 5 presents an example of the usage lupin by MFH-Pulses, an SME of the PROTEIN2FOOD project.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 635727.

Box 5. Uses of lupin by MFH-Pulses

- **Which food products do you make with lupin?**
  - Organic white lupin in a jar

- **Where do you buy lupin? Have you changed suppliers in recent years, or have they remained the same? Why?**
  MFH-Pulses organizes the cultivation of the lupin in the Netherlands. One farmer is cultivating organic *Lupinus albus* (*var. dieta*). The lupin is cultivated in the middle of the Netherlands, near the river close to Wageningen. The introduction of the product took place in 2015 and it was satisfying both for MFH-Pulses and the client EKOPLAZA (an organic supermarket). MFH-Pulses has not changed supplier since then.

- **Do you encounter any limitations in buying and using lupin? (e.g., high and variable prices, legal restrictions, supply shortages, etc.)**
  Due to higher sales than expected, we had to produce more jars before the new dutch organic crop *Lupinus albus* was available. Almost all the organic *Lupinus albus* was sold out in Europe, but MFH-Pulses managed to buy some extra *Lupinus albus* in Germany at a much higher price. Due to the fact that *Lupinus albus* is little cultivated in Europe the availability, quality and price is fluctuating easily.

- **How much do you pay for lupin (e.g. in €/kg)? Have you observed any representative change in these prices over the last years?**
  MFH-Pulses is buying the raw material (*Lupinus albus var. dieta*) directly from the farmer at 0.8 €/kg. Within a jar there are about 100g of lupin. The production cost for each jar is 0.32 €/jar. MFH-Pulses sells each jar for 0.85 €/jar to EKOPLAZA, which in turn sells the jar in the store to customers for 2€/jar.
  The german organic *Lupinus albus* that was needed to be bought as almost the last product available had a cost of 2.30 €/kg (raw material).

- **Which countries and market segments are the main buyers of your final products? Comment on the evolution of sales of your products over recent years.**
  MFH-Pulses is selling organic lupin in a jar only to one supermarket in the Netherlands (EKOPLAZA), but it is planned to start selling this product also to Germany and the Scandinavian countries.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 635727.

- **Where do you sell your lupin-made products? At what prices?**
  MFH-Pulses sells the lupin in a jar to EKOPLAZA, the biggest organic supermarket in the Netherlands which has 71 stores in the country.

- **Please, provide your view on the future evolution of lupin as a raw material for your business.**
  MFH-Pulses will continue with lupin as a raw material. Lupin is unique regarding its high protein and fibers content, in combination with specific health benefits. Lupin is a relatively new product, which is interesting for an organic supermarket.

  Obstacles for the production/commercialization of lupin in a jar are not known. To approach a wider consumer group there should be more marketing done. This is necessary when we would want to introduce conventional (not organic) lupin in jar. conventional supermarkets don't want the lupin so far because it's too exotic.

Source: Own elaboration (contribution from MFH-Pulses)

Amaranth

Unfortunately temporally and spatially extensive data, uniform enough for trend analyses was not available for amaranth.

Soya

Although soya is not explicitly highlighted in PROTEIN2FOOD, it would be remiss not to provide a brief analysis of the historical trends of its production and consumption across Europe, considering its importance as a protein rich crop. Figure 30 demonstrates the dominance of Italy in European soya production, followed by Romania and France. Italian soya production saw a dramatic increase up to its peak in the late 1980s at just below 1.8 million tonnes, before slumping to roughly a third of that in the early 1990s. This dramatic decrease was followed by a later 1990s rally to just over 1.2 million tonnes before hovering around 500,000 tonnes during the first decade of the new millennium.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 635727.

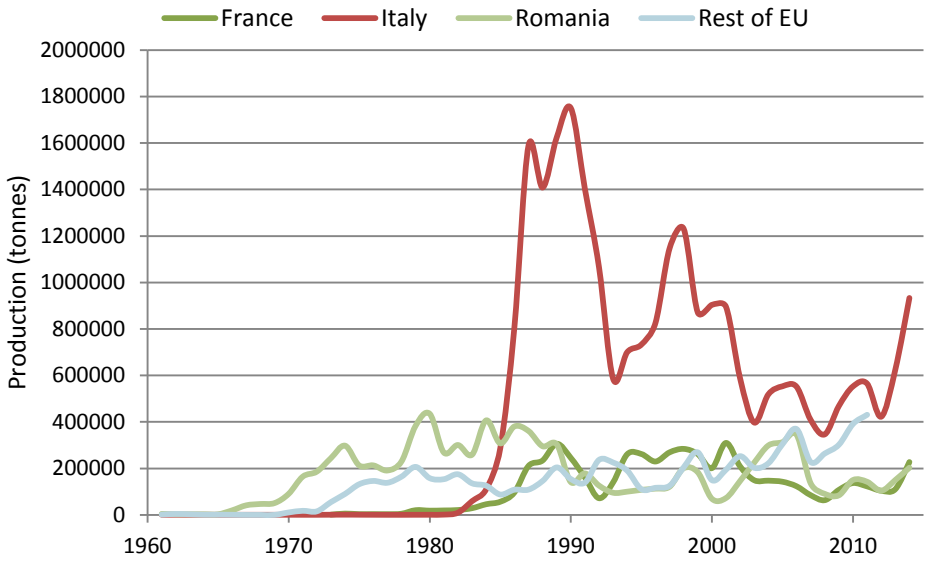


Figure 30. EU-28 soya production in tonnes.

Although not as acute, Romania (light green) has seen fairly dramatic variations in its production since the mid 1960s, with its production hovering between 200,000-400,000 tonnes from the 1970s until the early 1990s. The considerable reductions during the 1990s (especially in Italy) may be implicit of the impacts of the Blair House Agreement (1992) between the EU and the USA, and the Berlin agreement (1999) (Bertheau & Davison, 2011). Other EU countries' production has been relatively stable, generally fluctuating around 200,000 tonnes, before recently doubling to over 400,000 in 2011.

The sheer importance of soya and in particular imported soya to European plant based protein consumption can be seen in Figure 31. From 1961 to the early 2000s soya consumption has been increasing dramatically from just below 2 million tonnes, to just short of 16 million.

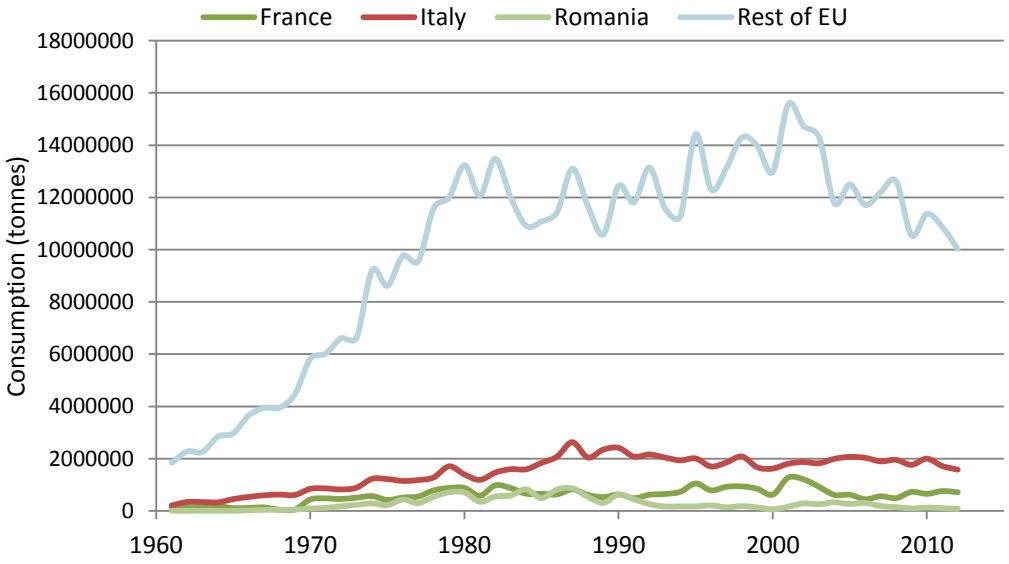


Figure 31. EU-28 soya consumption in tonnes

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 635727.

According to Bertheau & Davison (2011) high costs of livestock feed grains was one of the primary drivers of increased consumption in Europe, with soya bean meal used as a cheaper replacement for feeds. Further, unfavourable climatic conditions and smaller farm surfaces, all contributed to limited European production of soya, and Europe's dependence upon imports to satiate increased demand for cheaper livestock feed (Bertheau & Davison, 2011), with a small fraction of consumption destined for food-stuffs (Gelder et al., 2008). Further, the long-term increase in consumption of soya across Europe may mirror the trends in meat consumption, with soya bean meal becoming increasingly important as a feed stuff, especially since the 2001 ban of meat based meal following the outbreak of mad-cow disease (Bertheau & Davison, 2011). This may be reflected in the EU-28 trend of consumption, with a spike post 2001 (Figure 31), followed by a decline into the mid 2000s. This general decline post early 2000s may be representative of wider European consumer patterns, with a general decline/ stagnation in European meat consumption.

5.2.2 Meat and Dairy Products

Beef

Figure 32 highlights the evolution of beef production (in tonnes) over the 51 year period from 1961-2012. The four principal producers of beef are highlighted, including France, Germany, Italy and the UK, along with an aggregated value for the other EU-28 countries. The two major producers of European beef- France and Germany- have shown similar patterns in production since 1961, increasing to a peak of around 2 million tonnes in the early 1990s. However, in 1991/2 both countries saw precipitous declines which continued through the mid 1990s, in Germany (~30%) and in France (~20%). These declines continued, less severely, into the 2010s, where contemporary German production is around 1.1 million tonnes, whilst French production stands around 1.45 million tonnes. This pattern of peak production in the early 1990s, followed by a steady decline towards the year 2010 is roughly mirrored in Italy, the UK and the rest of the EU-28, which such a pattern explained by a variety of factors, including beef's relatively small profit margin and low profitability (Marquer et al., 2014).

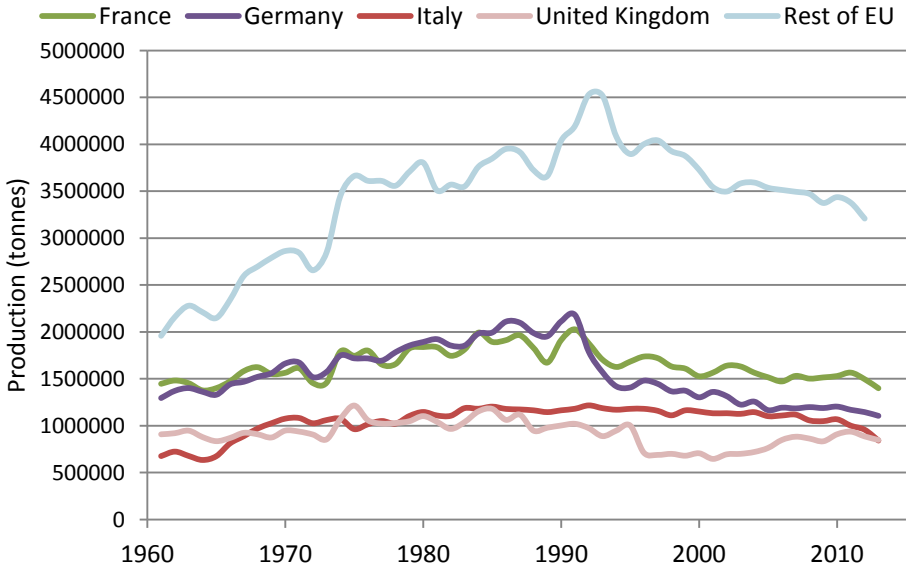


Figure 32. EU-28 beef production in tonnes.

The consumption of beef (Figure 33) is almost identical to that of production, suggesting that EU is largely self sufficient. Beyond the economic factors suggested to have driven the downward trend in production, consideration must also be made of what may be causing the patterns in consumption. Marquer et al. (2014) suggest that consumer purchasing power may be significantly tied to beef consumption, with

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 635727.

consumers increasingly moving away from this expensive form of meat towards cheaper products such as pork and poultry. Further, the decline in both production and consumption starting in the early 1990s may also reflect a loss of confidence in European beef, due to health and food safety concerns (van Wezemael et al. 2010) following the Mad-Cow diseases outbreak across parts of Europe in the early 1990s.

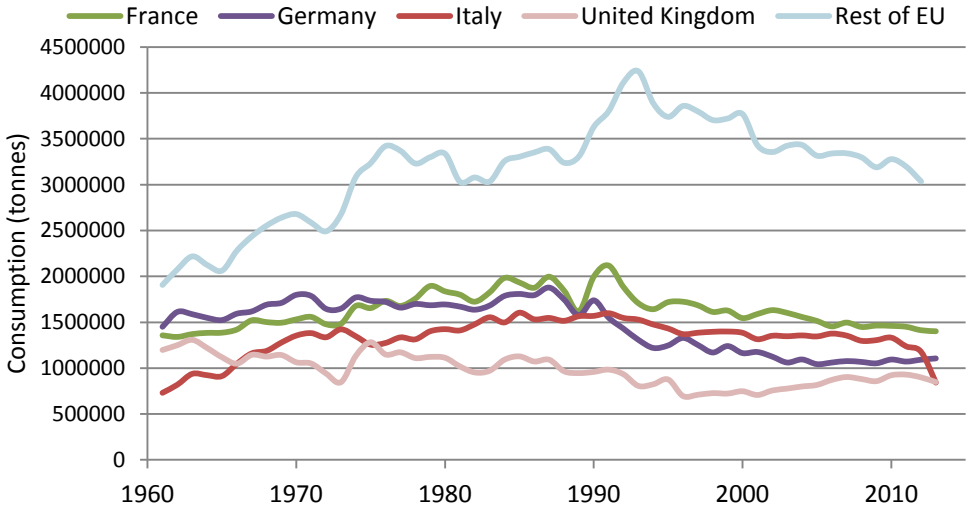


Figure 33. EU-28 beef consumption in tonnes.

Pork

European pork production (Figure 34), much like that of beef has seen considerable changes during recent decades. Firstly, it is clear from the production of the aggregated other EU-28 countries (blue trend line) that production across Europe is diverse, contrasting to beef and the protein rich crops, where one or two countries largely dominate. Further, from this trend a clear increase in production until the late 1990s is evident, with production more than doubling in the four decades between 1961 and 2001 across the EU-28, with production peaking in the late 1990s at just under 14 million tonnes, before dropping to just under 12 million tonnes in 2012. Germany and Spain show similar patterns of growth with Spanish production growing to just under 4 million tonnes in 2012 from 239,268 tonnes in 1961, whilst German production grew from 2.6 million tonnes in 1961 to 5.4 million tonnes by 2012. Whilst not growing to such an extent France also grew, although at steadier rate from 1.2 million tonnes to 2.1 million tonnes from 1961 to 2012.

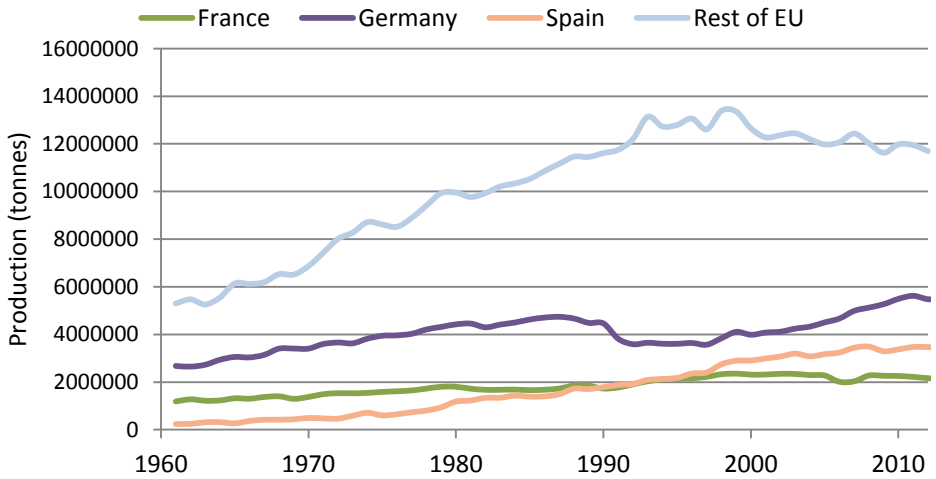


Figure 34. EU-28 pork production in tonnes.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 635727.

Similarly to that of beef production and consumption, the trends of pork follow similar trajectories, suggesting once again that European consumption (Figure 35) is largely satisfied by European production. A noteworthy difference being in the other EU-28 countries, where it appears that production is responding to consumption and has reduced to almost identical levels of production as consumption. According to Marquer et al (2014) this differential in the decline in production and consumption can be attributed to reduced profits in the pig meat market, with increased animal welfare directives resulting in increased costs, with resulting impacts being especially acute on smaller farms. It also demonstrates that despite the apparent downward trend, high levels of consumption continue potentially accounting for consumer preference movement from beef to cheaper products like pork (Marquer et al., 2014).

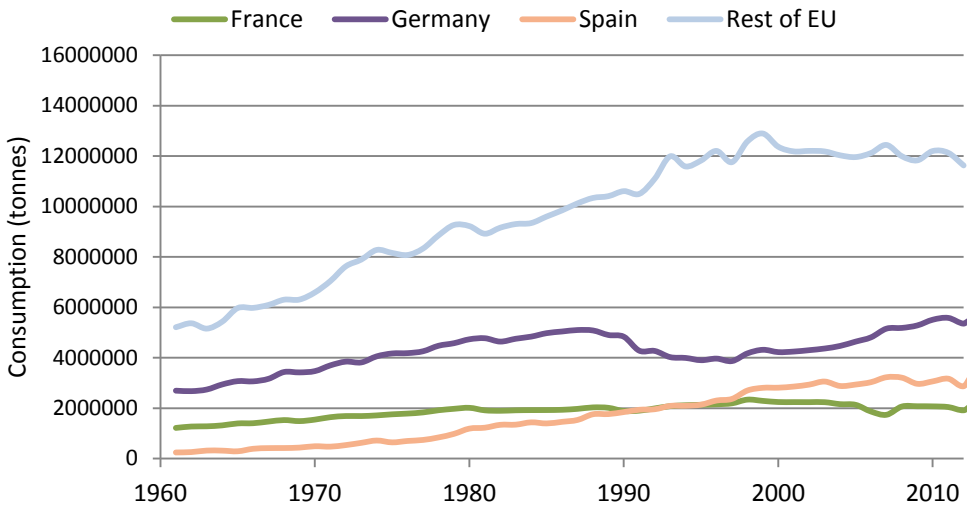


Figure 35. EU-28 pork consumption in tonnes.

Poultry

Poultry (chicken, turkey and duck) as of 2014 accounts for roughly 6% of agricultural output of the EU (Marquer et al., 2014). Figure 36 demonstrates that this sector has seen widespread growth, increasing from under 1 million tonnes in 1961 to over 5 million in 2012 in the EU-28 (excluding France, Spain and the UK). This increase in production has been largely constant, with only minor slow-downs during the 1980s, followed by a sharp rise in the 1990s and another slow down at the turn of the millennium before increasing again to 5.2 million tonnes in 2012. The three major producers of poultry, up to 2012, were France, Spain and the UK, with Spain and the UK seeing production increase relatively unchecked from the 1960s onwards. France however, saw production more than double to 1.36 million tonnes in 1997, before cascading down to 819,383 tonnes in 2006.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 635727.

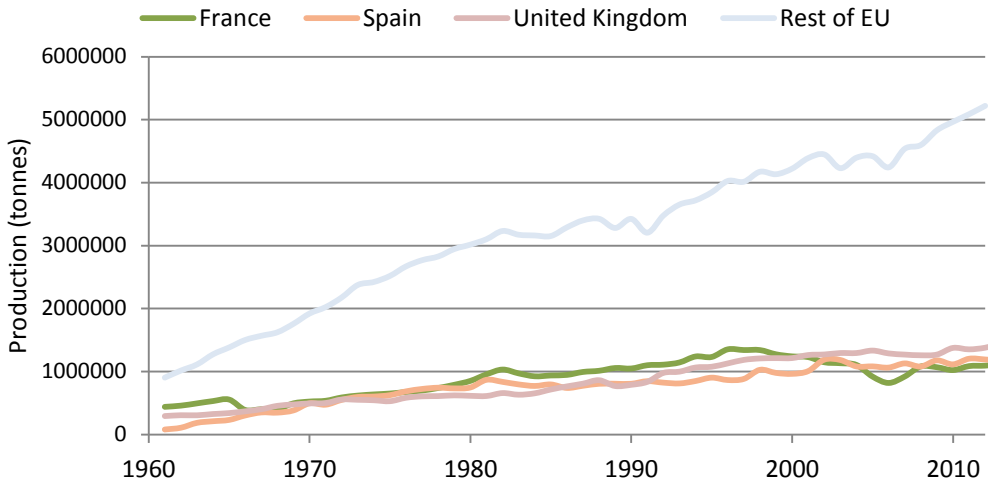


Figure 36. EU-28 poultry production in tonnes.

Much like the previous meat examples, poultry consumption (Figure 37) has followed a similar pattern to that of production; in fact up to 2012 production in France was higher than consumption, suggesting exports or other uses. The other EU-28 countries show a similar pattern, with production outstripping consumption, whilst the UK apparently consumes more than it produces. In considering actual growth of consumption, poultry appears to show no sign of a reduction, unlike pork and beef. Across the principal producers of poultry and the other EU-28 countries, consumption appears to be in the ascendancy across EU-28 countries.

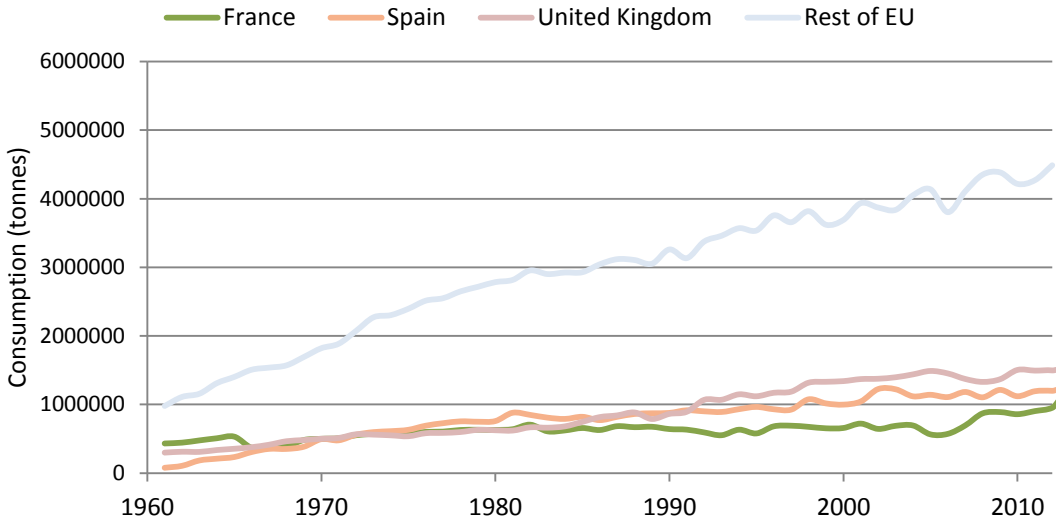


Figure 37. EU-28 poultry consumption in tonnes.

Milk (Whole)

Across Europe milk production gradually increased from the 1960s-1980s, whilst remaining relatively stable since the early 1990s onwards. Marquer (2015) suggests that the implementation of milk quotas as part of the CAP, helped to keep production stable, whilst capping production from 1984 onwards. From Figure 38 there is clear evidence of this in both Germany (purple) and France (green), the principal producers of milk, producing roughly half of EU-28 production. These countries saw increases in production to a mid 1980s

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 635727.

peak before reducing and then stabilising from the early 1990s onwards, with the other EU-28 countries combined demonstrating a similar pattern. However, more recent trends suggest that production has begun to increase following a decline in some countries, with the 2009 introduction of annual milk quotas increasing by 1% in preparation for their removal in 2015 (Marquer, 2015).

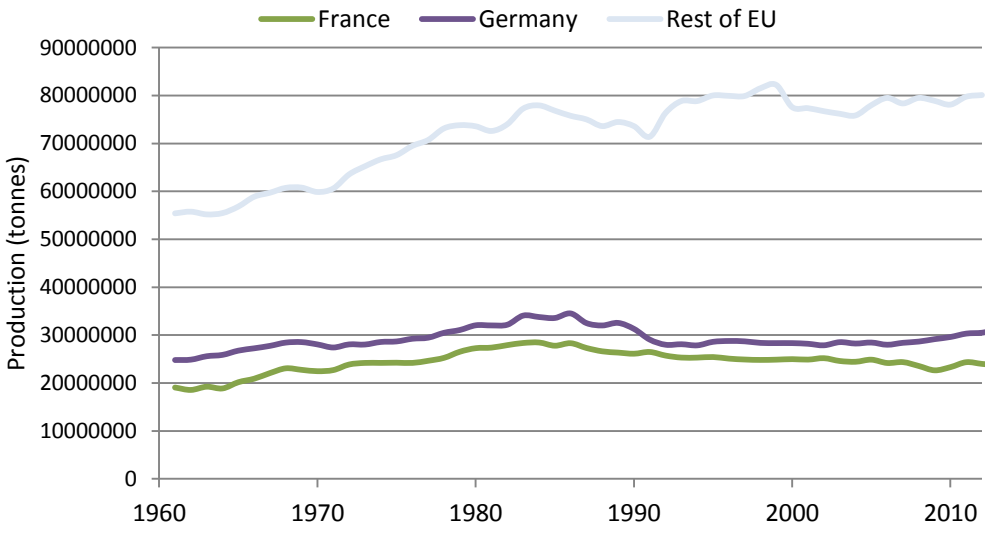


Figure 38. EU-28 whole cow milk production in tonnes

Much like that of meat consumption and production patterns, the patterns of milk consumption are almost identical to that of production. Once again, this suggests the apparently self-sufficient nature of Europe's milk market, with Europe producing a surplus of milk and other dairy products, which are increasingly exported globally (European Commission, 2016e). However, considering the perishable nature of whole milk, and the trends demonstrated in Figures Figure 38 and Figure 39, exports of milk are minimal in comparison with European based consumption. The trends of consumption have largely mirrored production, even during the considerable declines following the implementation of quotas in the 1980s (Marquer, 2015). From Figure 39, it can be inferred that across the EU-28 countries, including the biggest producers, consumption is relatively stable and has been since the turn of the millennium.

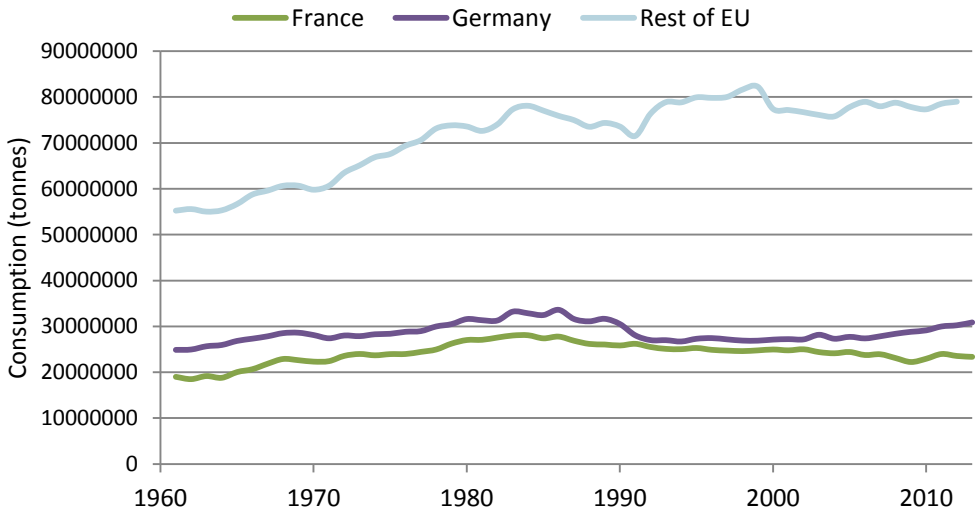


Figure 39. EU-28 whole cow milk consumption in tonnes.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 635727.

5.2.3 Overview

To provide a brief overview of the analysis previously performed, Table 3 has been included to offer a quick reference point of recent trends across the EU-28 nations for the products included within this analysis.

Table 3. Overview of the trend analysis performed for the PROTEIN2FOOD and other important protein crops.

Product	Production	Consumption
Lentil	↑	↑
Chickpea	↓	↑
Faba Bean	↑	↓
Buckwheat	↑	↑
Lupin	↓	N.D
Quinoa	N.D	↑
Amaranth	N.D	N.D
Soya	↑	↓
Beef	↓	↓
Pork	-	-
Poultry	↑	↑
Whole Milk	-	-

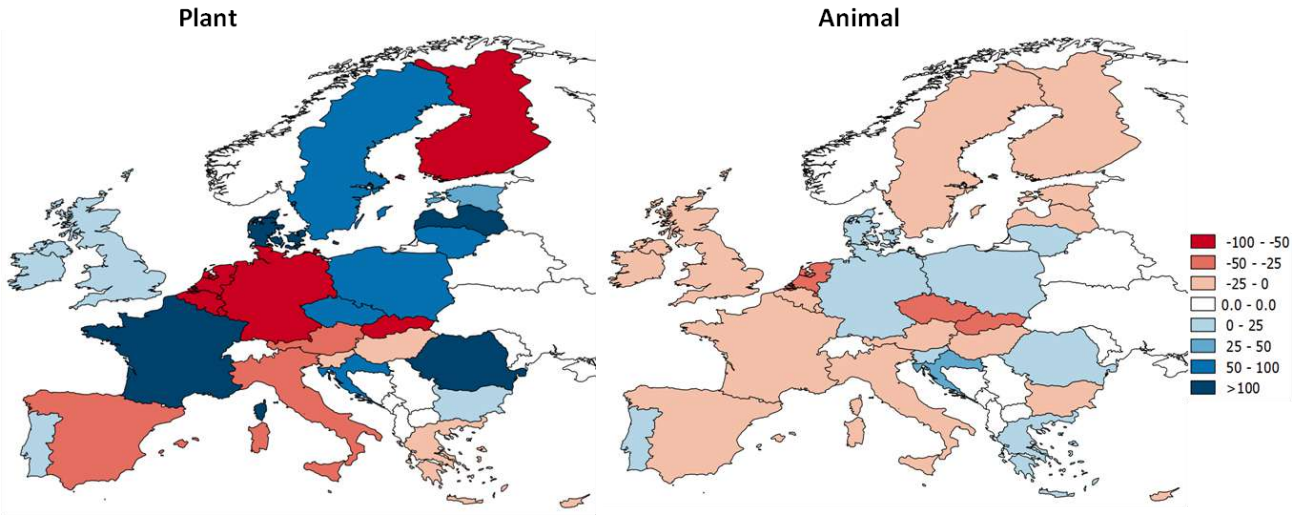
Note: Table demonstrates recent trends (2000 onwards) for both production and consumption of each crop, across EU-28 countries. ↑ represents increases, ↓ decreases, - no change and N.D no data.

5.3 Analysis of production and consumption patterns across EU countries

From the analysis of consumption and production of protein products across EU-28, it is evident that a number of temporal patterns exist. However, it is difficult to interpret geographic (country based) patterns from the previous analysis. The literature (de Boer et al. 2006; Westhoek et al. 2011) suggest a number of geographic patterns in both animal and plant based protein product production and consumption across Europe. De Boer et al (2006) highlighted a north-south divide in sources of dietary proteins across Europe, with southern European countries deriving greater proportions of their protein supply from plant, rather animal sources. To identify whether a geographical divide is still evident, or if other geographic patterns exist, and whether temporal patterns can be identified across Europe the following analysis has been developed. Figure 40 highlights the percentage change in per capita consumption of animal and plant proteins from 1993 to 2012, developed as a combination of all PROTEIN2FOOD crops and animal products into two respective groups.

Although a north- south pattern is not apparent, there appears to be a heterogeneous pattern of protein consumption across Europe. Firstly, it is noticeable that the extent of change is most extreme in plant proteins, as evident by the intensity of the colours in Figure 40 with bluer colours representing a positive change in per capita consumption and redder colours a negative change. For example France sees a 124% increase in plant protein consumption, whilst Germany sees 49% reduction, whilst in animal consumption the Netherlands sees a 31% reduction and Croatia increases by 42%.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 635727.



Note: Percentage changes based upon average per capita consumption data for the years 1993-1997 and 2008-2012.

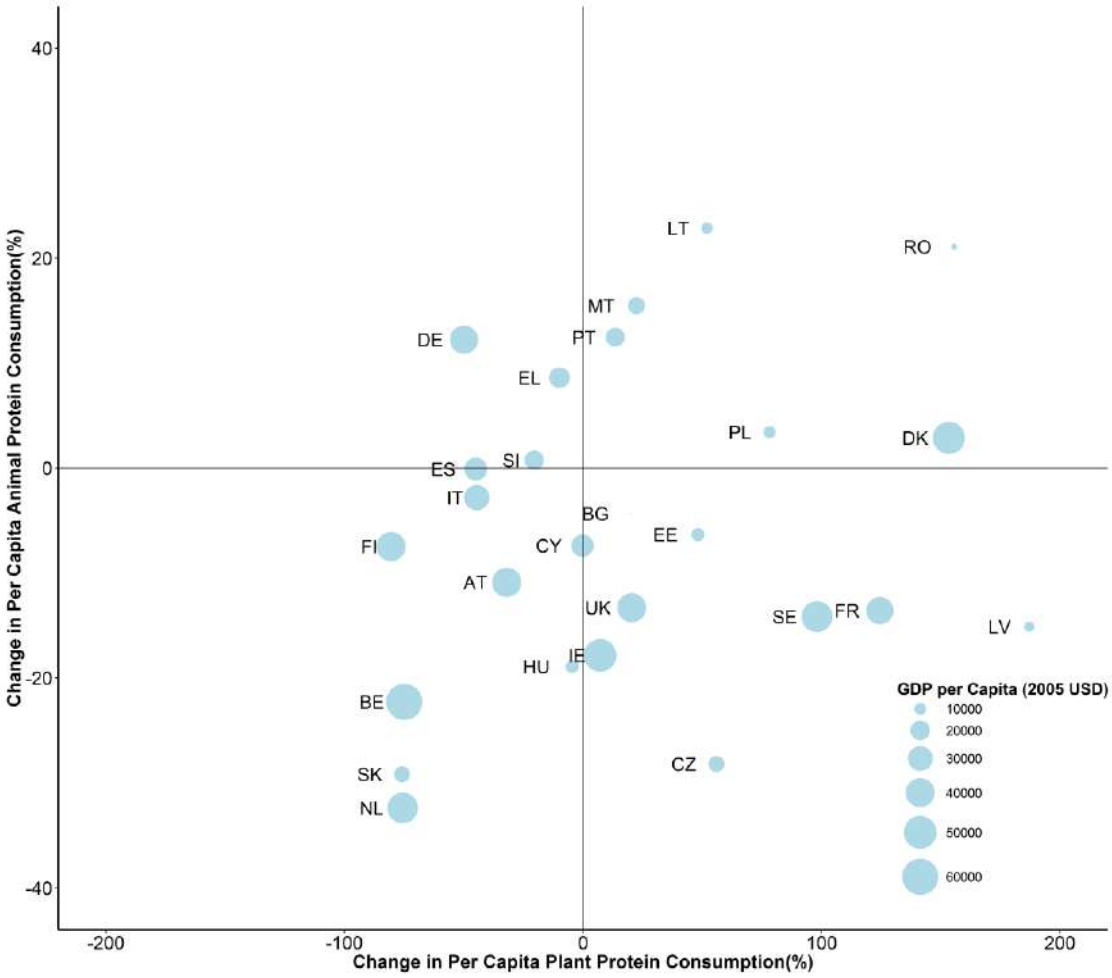
Figure 40. Change in EU-28 animal and plant based protein consumption from 1993-2012.

Figure 40 further suggests that countries traditionally reliant upon a diet rich in plant based protein consumption (the Mediterranean diet) have seen substantial changes, with Spain, Italy and Greece all seeing reductions in both plant and animal protein consumption since 1993. In contrast, countries such as the UK and France show contrary patterns, increasing consumption of plant-based proteins. Such increases in richer countries such as France, UK and Denmark may suggest the increased awareness of the benefits of the consumption of such products (Patterson et al 2009; Zare et al 2012).

Figure 40 suggests an east-west, rather than north-south divide. This is perhaps not surprising if consideration is made of the results of Rivers Cole & McCoskey (2013) and Vranken (2014), where relatively wealthier nations reach an inflexion point and begin to reduce meat consumption. Most, but not all western European countries follow this pattern, with relatively wealthier countries generally reducing animal product consumption (France, Spain, Italy, the UK, Austria, Sweden, Finland, the Netherlands and Belgium). Other factors, including health concerns (van Wezemael et al. 2010; Kearney 2010; Westhoek 2011; Drewnowski 2011) and increased choice (Cavadini et al. 2000; Duffey & Popkin 2007) may have further driven reduction, beyond solely economic. Less wealthy countries were seen to increase their consumption (Poland, Estonia, Romania, Bulgaria and Croatia) following the Kuznet's curve, but seemingly not having yet reached the income inflexion point, where reduced consumption would be expected. Such increases in consumption may also be associated with urbanisation, where movement towards cities has repeatedly been cited as a driver behind higher consumption of meat and movement away from traditional diets (Kearney, 2010; European Commission, 2015a). However, there are two notable exceptions, Germany (12%) and Denmark (3%), both of which have increased per capita consumption, perhaps suggesting the importance of meat within their culture or that other socio-economic, such as meat price may be driving such consumption changes due to reduced costs associated with meat consumption.

To further illustrate this analysis, Figures 41 and 42 were produced, placing EU-28 countries within four quadrants, according to relative changes (from 1993-2012) in plant and animal protein consumption (Figure 41), and relative changes in plant and animal protein product production (Figure 42). From these figures a clearer perspective of changes in both consumption and production can be observed, whilst also offering the potential of country groupings, based upon their inherent characteristics.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 635727.



Note: Percentage changes based upon average data from the years 1993-1997 and 2008-2012, scale of points are proportional to average GDP per Capita (constant 2005 USD) between the years 2008-2012.

Figure 41. Changes in European animal and plant based proteins consumption.

In considering the potential benefits (Springmann et al., 2016) of dietary shifts in European countries, moving towards plant based protein dependent diets, at the expense of animal based proteins; the lower right hand quadrant is where countries would ideally be located. This quadrant represents countries with increasing consumption of plant based proteins, whilst reducing animal protein consumption. In contrast, the upper left demonstrates countries moving towards greater consumption of animal based proteins at the expense of plant proteins. In general, from the above figure there is an apparent clustering towards the lower right, rather than the upper left, despite a number of countries located in the upper left quadrant. This may suggest that during the 20 year period from 1993 onwards, EU-28 may be shifting towards notable dietary changes; importantly this shift to the bottom right appears to be fairly heterogeneous, with considerable diversity in countries located there. This heterogeneity is particularly evident within the lower right quadrant, with a cross section of countries, big/ small, rich/ poor and eastern/ western. This may suggest that movement into this more 'desirable' quadrant may be more complicated than just merely considering, wealth, size or geographic location. From considering the size of the points for each country (Figure 41), representing GDP/capita, it is quite clear that both relatively poor and relatively rich countries are moving towards increased consumption of plants proteins, at the expense of meat.

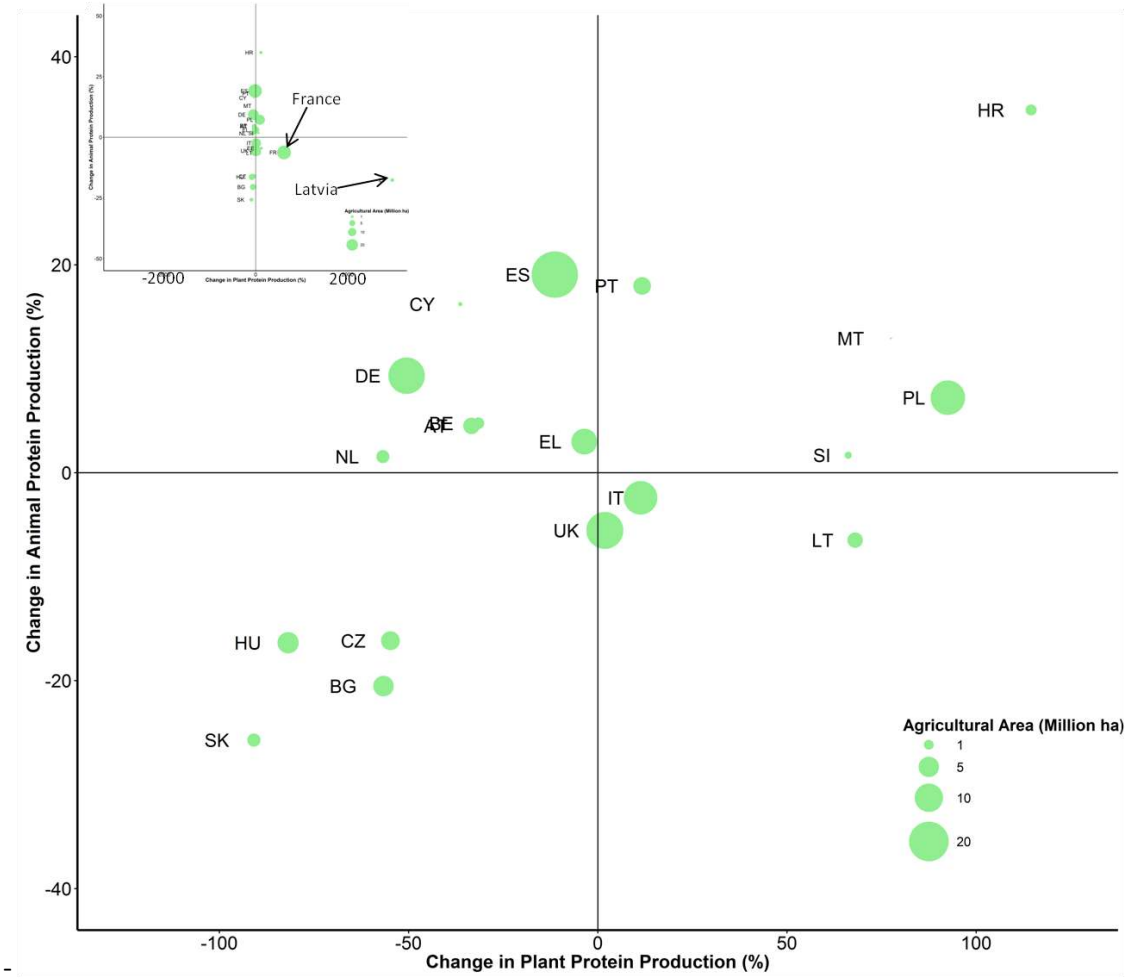
This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 635727.

The findings of Rivers Cole & McCoskey (2013) and Vranken (2014) would suggest that the majority of relatively wealthier countries should be in the lower quadrants; due to wealth induced reductions in meat consumption- this suggestion is largely followed. However, a number of countries (Germany and Denmark) buck this trend and are found in the upper two quadrants (increased meat consumption). Interestingly, countries such as the Netherlands, Belgium/ Luxembourg, Italy and Austria have seen reductions in both animal and plant proteins, offering a curious pattern of consumption, which may suggest that in these countries dietary changes, are moving local diets to heavier reliance on other pulses or to cereals as a means of getting their dietary protein.

Finally, that so few countries are located in the upper left quadrant (3) and so many in the lower right (7) is encouraging if we consider the understood benefits of moving from high animal protein diets to high plant protein diets (Allen et al., 2008; Cassidy et al., 2013; Bouvard et al., 2015 ; Springmann et al 2016). This may demonstrate a considerable shift in the European over the past two decades, with the apparent decline in meat consumption an especially important shift. Perhaps more importantly, that the diversity of those countries in the lower right is so great, could also be considered a positive and it may demonstrate that future trends and dietary shifts away from meat to other sources of dietary protein may be not be entirely reliant upon the richer, north-western European countries to drive a continental wide shift.

Figure 42 has been developed to offer an insight into the patterns of production, demonstrating the relative changes from 1993-2012, whilst also highlighting the scale of agricultural activities in each country (size of points). This figure offers an insight into just how important, in terms of scale, the shifts of production of both meat and plant proteins across Europe are considering the area dedicated to these products.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 635727.



Note: Percentage changes based upon average data from the years 1993-1997 and 2008-2012, scale of points are proportional to average agricultural area between the years 2008-2012. A zoomed out view of the figure is included in the upper-left to highlight France and Latvia and demonstrate the scale of change in these countries.

Figure 42 Change in European animal and plant based proteins production

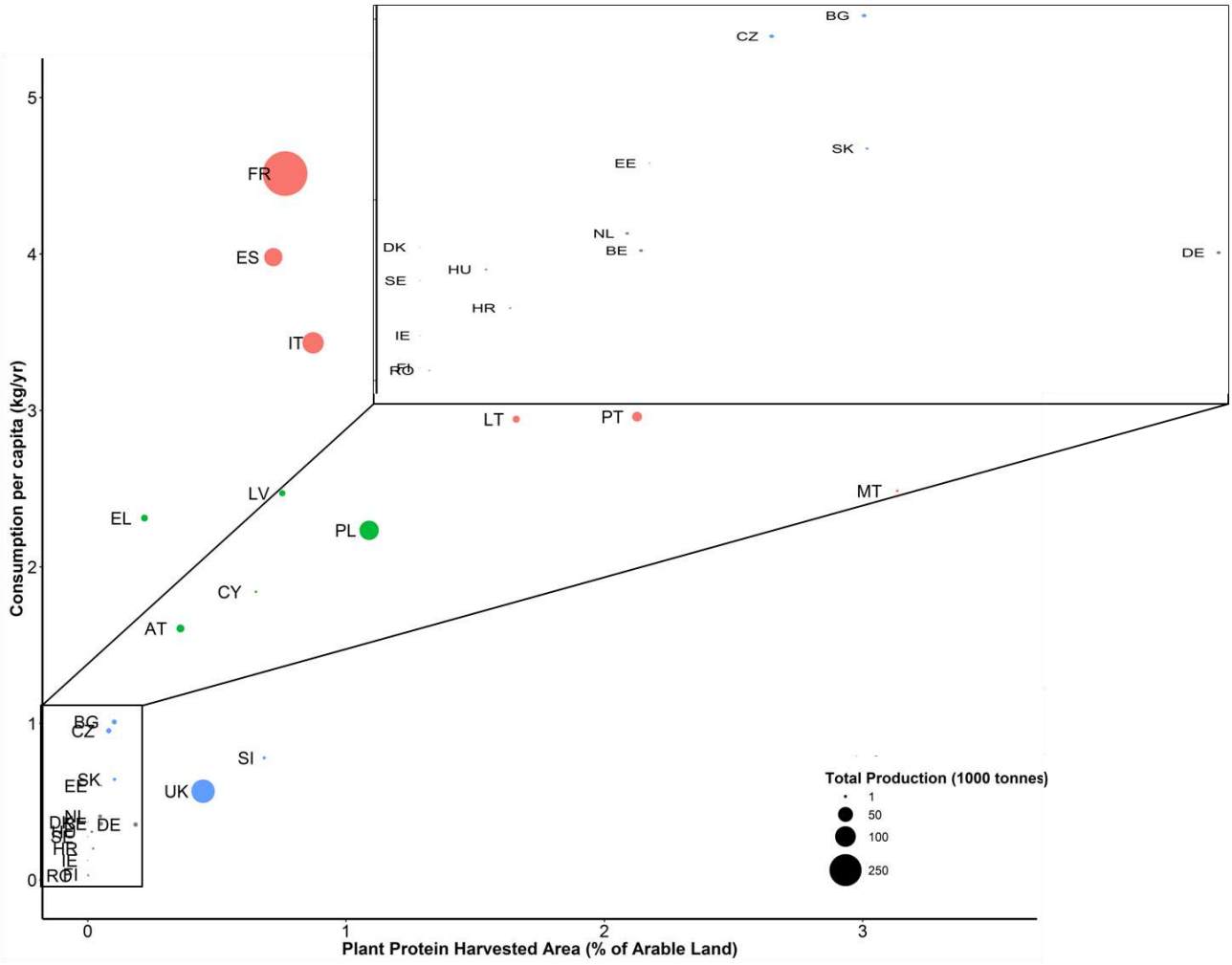
Similarly to the previous figure, the lower-right quadrant represents the idealised location for European countries to be located, or at least moving towards. This quadrant represents greater production of protein crops, whilst reducing production of animal based products. However, unlike Figure 41 most countries appear to be congregated around the upper left or central points, with pockets of countries in the lower left and upper right. Like the previous figure, the results of production demonstrate a certain level of heterogeneity, but also pockets of homogeneity. For example, countries seeing both reduced animal product production and plant protein production (lower left quadrant) appear to be largely eastern European. Whereas, those countries in the upper left, appear to be largely heterogeneous with countries including Spain, Germany, Greece and Cyprus.

Those countries in the lower right (Italy, the UK and Latvia) demonstrate not only heterogeneity but also the importance of scale. Despite the UK and Italy being important agricultural nations within Europe, this is offset by Spain, Europe´s second largest agricultural nation in terms of agricultural area and Germany a significantly important county too. It is notable that the potential benefits of those countries in the lower right may be offset, not only in terms of the scale of change, with Germany and Spain reducing considerably more their plant production that the UK and Italy are increasing theirs, but also in the increase in animal production which is higher in these countries than the reductions in the UK and Italy. Further, and perhaps more concerning is that such high reductions in plant protein production in Spain may be considerably

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 635727.

more important than they are beneficial in the UK and Italy at the EU scale, purely based upon the scale of agricultural activities, and the proportion of these activities within each country.

Figure 43 shows an aggregated value for the per capita consumption of the PROTEIN2FOOD crops across EU-28 countries, together with the importance of these crops to national agriculture, considered via proportions of arable land dedicated to this aggregate and finally the scale of this production. Further, based upon those characteristics (per capita consumption and harvested area as a proportion of arable land) of each country we developed country groupings through cluster analysis.



Note: Developed from average values for period 2008-2012, with colours representing clusters developed from cluster analysis. Size of the points represents total production of all PROTEIN2FOOD crops across EU-28 countries.

Figure 43. Area dedicated to plant protein harvest and per capita consumption in EU-28 countries.

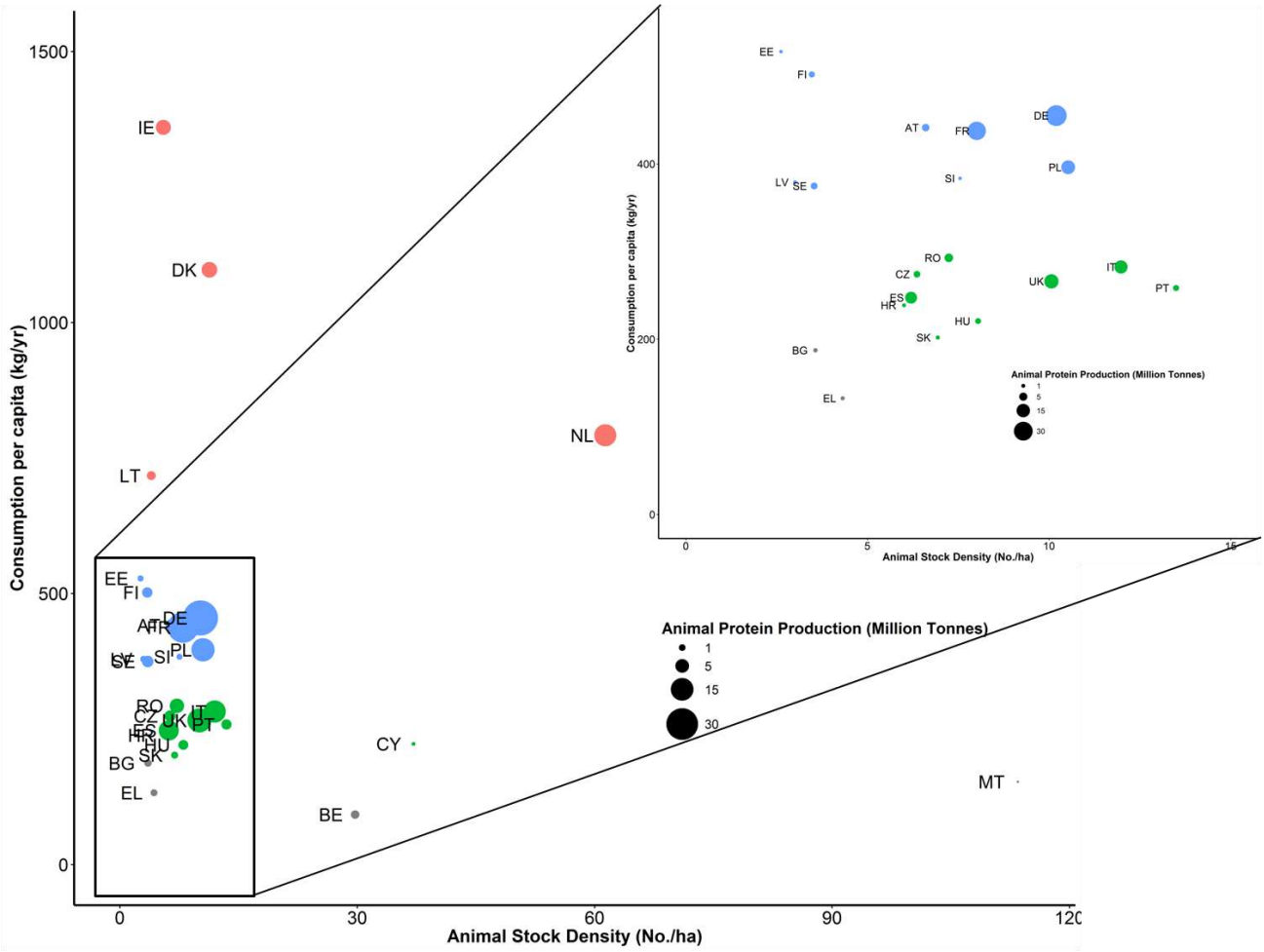
From Figure 43 a novel perspective of these crops is offered, not only is it evident the importance of these crops to Mediterranean diets with France, Spain, Italy, Portugal and Malta having high levels of consumption, and thus found in the same cluster (red), but the considerable variability in the importance of these crops to agriculture. These crops consist of over 3% of the total harvested area of Maltese agriculture, whilst in Spain and France they account for less than 1% but the scale of this production is order of magnitudes larger in France and Spain. Further, what can also be extracted from this figure is not

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 635727.

only the limited importance of these crops in general to European agriculture, but the sheer dominance of France, Spain, Italy and to a lesser extent the UK and Poland in producing these crops.

The consumption of these crops across the Mediterranean demonstrates despite some declines the continued importance of these crops to Mediterranean agriculture, cuisine and diets. However, as previously demonstrated despite the comparatively high levels of consumption, production in many countries and for many crops has reduced considerably over recent decades, which may suggest the impacts of the agronomic and economic barriers of production (LMC International 2009; Voison et al 2014).

Finally, the cluster analysis developed from the production of animal based products and their per capita consumption (Figure 44) demonstrates a huge difference in scale of consumption, with Belgium/ Luxembourg consuming the least per capita (<92kg/year), whilst Ireland consumes the most (1360kg/yr/person). From the use of cluster analysis, four clusters were characterised, with the first (blue) containing France and Germany which can be characterised by high production and relatively moderate per capita consumption (~400kg/yr).



Developed from average values for period 2008-2012, with colours representing clusters developed from cluster analysis. The sizes of points are related to total animal protein production as an average of 2008-2012 values.

Figure 44. Animal stocking densities (stocks/ agricultural area) and per capita consumption in EU-28 countries.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 635727.

The cluster analysis demonstrated in Figure 44 was based upon consumption per capita and stocking densities. The red cluster, containing Denmark, Ireland, the Netherlands and Lithuania can be characterised as having high consumption and variable stocking densities. The second cluster (blue), containing both Germany and France are the two most populous nations in Europe, therefore may be expected to have the highest production, as evidenced by the size of their points and that they are found together in the blue cluster. This cluster can be characterised by moderate consumption and low stocking densities. In the third cluster (green) a range of countries including the UK, Italy, Portugal and the Czech Republic can be characterised by both low stocking densities and low per capita consumption. The final cluster (grey) can be characterised as low consumption and highly variable stocking densities with Malta being the extreme within over 90 heads per hectare of agricultural land.

6. Econometric assessment of protein products production and consumption in Europe

Considering the analysis presented in the previous chapter, in this section we apply econometric assessment techniques to identify significant explanatory variables for protein product production and consumption in the EU. Once relevant models are specified, we will consider the future with the aim of identifying the prospects for protein production and consumption in the near future.

6.1 Methods applied

Given the focus of the PROTEIN2FOOD project on certain protein-rich crops and on the potential shift from animal protein to plant protein, the analysis presented in this section focuses on the assessment of production and consumption of selected crops and animal-based protein products. Due to data availability (number of observations across countries and time) the products analysed include, in the case of crops only the leguminous crops lentil, chickpea and beans. The analysis of animal protein products focuses solely on meat consumption and production including cattle, pigs and poultry.

The focus on these products is with the double purpose of (i) identifying significant explanatory variables, i.e. demonstrating the significance level of previously identified variables (such as GDP, health awareness or CAP interventions), and (ii) modelling consumption and production of the protein products under study. For this, different econometric model estimations have been tested, following a three-step process:

1. Selection of dependent variables
2. Selection of potential explanatory (independent) variables
3. Model testing and selection of the most adequate model estimation

Dependent variables within these models are legume and meat consumption and production, thus we estimated four general models: two models for legumes, one for consumption and the other for production, with two further models estimated for meat; consumption and production. To eliminate the effect of country size and population on consumption and production, we used relative variables describing, in the case of consumption models per capita consumption of legumes and meat, and in the case of production the share of arable land devoted to legume cultivation, and the density of livestock per country (num. of stocks per agricultural area). The variables considered are listed below:

- **Legume consumption per capita**: Per capita consumption of legumes, calculated as the sum of lentil, chickpea and broad beans consumption (tonnes per capita).
- **Legume production (absolute)**: Legume production in absolute terms, calculated as the sum of lentil, chickpea and broad beans production (tonnes).

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 635727.

- **Legume production (relative)**: An estimate of legume production in relative terms, calculated as the sum of the arable land devoted to lentil, chickpea and broad beans production (ha).
- **Animal protein consumption per capita**: Per capita consumption of meat, calculated as the sum of cattle, pig and poultry consumption (tonnes).
- **Animal protein production (absolute)**: Meat production in absolute terms, calculated as the sum of cattle, pig and poultry meat production (tonnes).
- **Animal protein production (relative)**: An estimate of meat production in relative terms (density), calculated as the sum of the cattle, pig and poultry stock number, divided by the agricultural land (No./ha).

The selection of potential explanatory variables that drive consumption and production is based on the analysis presented in the previous sections, and is supported by an extensive literature review. The relevant variables considered within the analysis of production and consumption are described below:

- **Gross Domestic Product per capita**: GDP per capita (PPP, constant 2010 international $).
- **Producer prices:** Producer prices of different crops considered (lentils, chickpeas, broad beans, soy and wheat) and meat (cattle, pigs and poultry) (constant 2004-2006 int. dollars/tonne).
- **Livestock yields**: Cattle and pig yield/ carcass weight (tonnes/animal).
- **Agricultural area**: Agricultural area of the country (ha).
- **Arable Land:** arable land in country (ha)
- **Population > 65 years:** Percentage of total population above 65 years (%)
- **Rural population:** Rural population as share of total population (%)
- **CAP period**: Categorical variable created to specify the CAP period in force.
- **Mediterranean region**: Dummy variable created to identify the Mediterranean countries where legumes are part of the traditional 'Mediterranean Diet'.

The tested models are panel data models estimated using different estimators (ordinary or generalized least squares) and also considering *fixed effects*, that account for those relevant variables which are invariant across time, including a country's features such as culture and tradition.

The general structure of the estimated models is as follows:

$$Y_{i,t} = \beta \cdot X_{i,t} + \propto_i + u_{i,t}$$

Where $Y_{i,t}$ is the dependent variable (consumption/production of legumes or meat) defined by country and year, $X_{i,t}$ is the vector of selected independent variables, β is the vector of coefficients for the independent variables, α_i is the unknown intercept for each entity (the effect of each country characteristics) and $u_{i,t}$ is the error term.

The spatial coverage of the models include all EU 28 countries, while the time period considered covers a 32 year period from 1980 to 2012[8]. Data sources and main variable definition are described in section 3 of this document.

[8] Those models including price variables are defined for the 22 year period 1991-2012 due to data limitations.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 635727.

6.2 Results of the econometric assessment

The results presented in this section correspond to the best fitted models for each variable under analysis. For each of the four dependent variables under study (legume and meat production and consumption), more than one model is presented, reflecting model estimation and considering regular panel data models or fixed effects panel data models. In all cases, results show that the variance of the explained variables is determined to a great extent by country-specific characteristics (e.g. culture and tradition). The socio-economic or market variables included in the analysis are capable of explaining around 50% of the variance (in some case even only 40%) of the modelled variables. In fact, the fixed effects models that consider countries' specificities show very high R^2 values, which is to say they are able to explain a much higher percentage of variation of the dependent variables. Results for each specific model are explained below.

6.2.1 Legume production

Table 4 highlights the results obtained from each panel model analysed for legume production. For each model, independent variables are specified with their β coefficients, significance level, and standard errors (in brackets).

Two models have been selected: a regular panel data model and fixed effects panel data model. In both, prices have been regressed using a lag. In this case we introduced dummy variables to try to capture two different effects: (i) the effect of the CAP programming period, and (ii) the geographical effect of the Mediterranean region as the main producing region for the legumes considered.
The dummy variables that specify the CAP period are:

- CAP_period 1: Initial years (from 1980 to 1991)
- CAP_period 2: MacSharry Reform (from 1992 to 1999)
- CAP_period 3: Agenda 2000 (from 2000 to 2004)
- CAP_period 4: 2003 Reform CAP implementation (from 2005 to 2009)
- CAP_period 5: Health check CAP reform (from 2010 to 2012)

Results of the analysis of legume production show that the main drivers are prices (lentils and chickpeas). In model 1 the price of lentils is highly significant showing that the higher the price the greater the land share devoted to legume production. When fixed effects are considered the price of chickpea also becomes significant, although the significance level of both lentil and chickpea prices is lower than in the model without fixed effects. A similar issue is observed with respect to the CAP period: significance is higher in the model without fixed effects. In both models, it seems that the successive reforms of the CAP have discouraged the production of legumes, despite specific payments for these crops. This may be explained by the relatively greater support given to the production of other crops (crops with higher yields when CAP payments were coupled). This may further support suggestions that production barriers continue to inhibit production (Von Richthofen et al. 2006; LMC International 2009; Voison et al 2014; Cernay et al 2015), despite the implementation of subsidies. The dummy variable for the Mediterranean region becomes highly significant in model 1 showing that Mediterranean countries show a higher production of this type of crop.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 635727.

Table 4. Comparison of legume production models.

Legume Production (share of arable land)	Panel Model	Panel Model with fixed effects
	Model 1	Model 2
Lentil Price t-1	-.0001177*** (.0000216)	-.000074* (.0000394)
Chickpea Price t-1		.0001042** (.000043)
CAP period 3 *(dummy)*	-.0434218** (.0186797)	-.0001248 (.0471811)
CAP period 4 *(dummy)*	-.0520575** (.0206815)	-.0996468* (.0545378)
CAP period 5 *(dummy)*	-.0206802 (.0236605)	-.0886589 (.0737875)
Mediterranean region *(dummy)*	.5805875*** (.0352186)	
R^2 (adj.)	**0.5657**	**0.8132**

* p<0.1; ** p<0.05; *** p<0.01

6.2.2 Legume consumption

Table 5 shows the results obtained from each panel model analysed for legume consumption. For each model, independent variables are specified with their β coefficients, significance level, and standard errors (in brackets).

Table 5. Comparison of legume consumption models.

Legume Consumption (per capita)	Panel Model	Panel Model with fixed effects
	Model 1	Model 2
GDP per capita	-2.73e-05*** (5.72e-06)	-1.49e-04 *** (2.29e-05)
Legume production (absolute)	2.09e-05*** (2.59e-06)	2.98e-05 *** (4.16e-06)
Mediterranean region (dummy)	1.2925*** (.4644)	
Lentil Price		-1.68e-04 (1.51e-04)
Chickpea Price		4.49e-04** (1.43e-04)
R^2 (adj.)	**0.4062**	**0.9265**

* p<0.1; ** p<0.05; *** p<0.01

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 635727.

In this case, legume consumption is according to the model's estimations dependent on GDP per capita, showing that the higher the GDP per capita the lower the consumption of legumes. This supports the general findings of dietary shifts, that as people become increasingly wealthy they move away from plant proteins towards animal proteins (Kastner et al., 2012; Vranken et al., 2014).

Legume production appears as a highly significant variable, the greater the legume production the greater its consumption. This could be explained by the fact that when production is high prices tend to decrease, and therefore this could incentivise the demand for legumes. Also, this can represent the geographical patterns widely commented in this report, concerning the tradition of legume production and consumption in certain areas of Europe such as the Mediterranean (Mediterranean diet). This fact is also supported by the high significance level of the dummy variable for the Mediterranean region.

In the case of the fixed effects panel data model, the price of chickpea appears as well as a significant variable.

6.2.3 Meat production

Table 6 shows the results obtained from each panel model analysed for animal protein production. For each model, independent variables are specified with their β coefficients, significance level, and standard errors (in brackets).

In the case of meat production, the models estimated show different behaviour compared to those of the legumes. In this case, the panel data model without fixed effects show an R^2=0.51. This means that more than 50% of the variance of meat production can be explained by market variables and socio-economic development. However, when introducing the consideration of fixed effects across countries the model estimation of the variance of meat production (R^2) is not as high as in the legume models. This means that in the case of meat production, country specificities such as cultural values are not such determinants.

In model 1 (without fixed effects), GDP per capita emerges as a highly significant variable. In this case the variable is the squared GDP per capita and the coefficient has a negative sign. This would represent an inverted parabolic relation between both variables, showing that as GDP increases meat production grows as well until a certain level of GDP is reached and meat production reverses its trend. This shows behaviour similar to that identified within the literature with respect to meat consumption (Rivers Cole & McCoskey, 2013; Vranken et al., 2014).

With respect to prices, both models show high significance of soy price. As soy is such a key ingredient to livestock feed, it is perhaps unsurprising that the two models reflect it as a variable that triggers the reduction of meat production. Meet prices are also significant variables in both models, while livestock yields are significant only in model 1 (without considering country effects).

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 635727.

Table 6. Comparison of animal protein production models.

Meat Production (stock density)	Panel Model	Panel Model with fixed effects
	Model 1	Model 2
GDP per capita		5.11e-08 (3.50e-08)
Squared GDP per capita	-2.27e-12*** (4.30e-13)	
Soy Price	-.0000109*** (1.45e-06)	-3.80e-06 *** (1.48e-06)
Cattle Price	1.98e-06*** (1.90e-07)	
Cattle Price t-1		8.02e-09 (2.68e-07)
Pig Price	-4.89e-07 (4.11e-07)	
Pig Price t-1		6.64e-07 ** (3.46e-07)
Cattle Yield	.0219035*** (.0044348)	
Pig Yield	-.0586596** (.0116293)	
R^2 (adj.)	**0.5128**	**0.7355**
* p<0.1; ** p<0.05; *** p<0.01		

6.2.4 Meat consumption

Table 7 shows the results obtained from each panel model analysed for animal protein consumption. For each model, independent variables are specified with their β coefficients, significance level, and standard errors (in brackets).

The model estimation for meat consumption shows that country effects, e.g. geographical and socio-cultural aspects, are determinant for consumption of meat than in other cases. In this case, model 1 (without fixed effects) only captures 40% of the variance of the dependent variable. However, when we consider the country fixed effects, R^2 increases up to 95%.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 635727.

Table 7. Comparison of animal protein consumption models.

Meat Consumption (per capita)	Panel Model	Panel Model with fixed effects
	Model 1	Model 2
GDP per capita	3.85e-03*** (2.74e-04)	6.91e-04*** (1.91e-04)
Meat production (absolute)	4.55e-06** (1.28e-06)	1.89e-05*** (2.60e-06)
Cattle Price	-.0168*** (2.9e-03)	-2.56e-03* (.0013)
Pig Price	.0151*** (4.99e-03)	-1.81e-03 (.0020)
Population > 65	-6.721*** (0.929)	-1.637** (.7706)
Rural Population	.4039* (0.225)	.7064 (.6935)
R^2 (adj.)	**0.4152**	**0.9502**

* p<0.1; ** p<0.05; *** p<0.01

The variables identified as significant are, in model 1, GDP per capita, meat production, cattle and pig price, population share over 65 years old, and share of rural population. The model shows that that higher GDP and greater meat production result in higher meat consumption. On the other hand, higher beef prices result in lower consumption, supporting the literature (Marquer et al., 2014). At the same time this model indicates, as supported by the literature (Spiller & Schulze, 2010; European Commission, 2015a), that an ageing population results in lower meat consumption. With a lower level of significance, the model shows that a higher share of rural population is linked with higher meat consumption, which is not entirely consistent with literature (Kearney, 2010). However, the sign of the coefficients may be distorted by the presence and sign of other variables. In the case of model 2 (with country fixed effects) the significant variables are the GDP per capita, meat production, price of cattle and the population share over 65 years old. The model shows similar effects of these variables as in model 1, as explained before, there is a positive relation between GDP and meat consumption. This model also shows that meat consumption increases as country's meat production increases and as the price of meat decreases. Finally, the model reflects also the negative impact of ageing population in meat consumption.

6.3 Future prospects for protein product production and consumption in Europe

As stated in previous sections of this document, production and consumption patterns are governed by an array of variables. Econometric model assessments confirm that some of these variables are easy to measure, such as prices or demand, but many others such as those related with social and cultural values and with policy and institutions, are difficult to measure and to project into the future. This is an important obstacle for modelling consumption and production patterns and especially in making projections of future trends and developments. Moreover, the changing environment of scientific and policy developments make it difficult to make assumptions on future prospects. Further, European and increasingly global consumers are considering the origin of production and processing of the food products they purchase. This consumer awareness of production and trade ethics (social responsibility), along with increasing health and quality concerns, is pushing the diversification of protein demand and also of protein supply, including the

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 635727.

development of new products. These factors increase uncertainty on the future of animal and vegetal protein consumption and production.

In general terms, protein crop production in Europe is expected to increase by 40% during the next 10 years (European Commission, 2015b). This production increase is mainly driven by a favourable political and socio-economic environment, but this increase in production is expected to stem from increased demand for high protein animal feed products (European Commission, 2015b). However, it will continue to represent a limited share of the European arable land (European Commission, 2015b).

According to the European Commission (2015b), European animal protein production is projected to increase slightly in the near future, driven by pig and poultry, with beef production expected to reduce to 7.6 million tonnes by 2025. However, the production of pig and poultry meat is expected to increase by 2% and 4% respectively (European Commission, 2015b). Regarding animal protein consumption, world total meat consumption is expected to increase by 15% in the next 10 years (European Commission 2015b). According to the same document, European per capita meat consumption will pick up in 2016 and then gradually fall back to 2008 consumption levels (66.7 kg per person) by 2025.

6.3.1 Plant protein

Globally, several factors suggest that positive trends in production of protein crops in the future. Pulses can be economically interesting crops for developing countries, as they may be less risky and more stable, than other niche crops (CBI, 2015a). Regarding developed countries, there are several factors that may encourage legume production in the short term such as the recent increases in prices paid to farmers (FAO, 2016), and favourable policies aimed towards nitrogen fixing crops, with the capacity of pulses to fix nitrogen making useful within rotational crop patterns (CBI, 2015a).

Concerning consumption, an improved perception of legumes' nutritional properties and health benefits (Patterson et al., 2009; Zare et al., 2012) together with increased concerns with respect to meat consumption may be responsible for recent increased consumption of lentils. Further, relatively low consumer prices may have contributed to an increase of consumption within European countries, which may account for the recent upturn in consumption as highlighted within this document.

Lupin, a native and under cultivated European crop could become a good alternative to soy, given its high content and quality of protein. Recent data show European lupin production (60% of area located in Poland according to the European Commission, 2015b) is steadily declining, mainly because of low productivity, low prices and policies favouring imports of soy (Lucas et al., 2015). Current concerns about Europe's increasing dependence on imported protein sources, as well as environmental advantages, have set the focus again upon lupin and other legume crops (Lucas et al., 2015).

In the near future, grain demand will continue to increase, driven mainly by grains used in livestock feed (maize, soy, etc.). According to CBI (2015a) demand will also increase for "pseudo-cereals" (quinoa, amaranth, buckwheat…), as such, markets are expanding and new products being developed. As the demand for high protein-gluten-free cereals across the EU increases, the prospects of amaranth demand appear positive (CBI, 2015b). However, the available trade and production statistics do not provide a robust basis for amaranth consumption estimation. According to CBI (2015b), Germany is the largest European importer of amaranth seeds, but this commodity is becoming increasingly popular in other EU markets such as the UK, the Netherlands, Sweden and France. As with other protein crops, the amaranth market has expanded mainly due to the organic sector; however, amaranth is increasingly becoming available in conventional retail stores (CBI, 2015b). The same study states that amaranth may compete with many

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 635727.

other cheaper substitute grains such as wheat, barley or rye, but provides added value to these common grains.

Soya consumption is expected to continue growing, due to its importance as a constituent of many animal feeds (CBI, 2015c).

The increasing trend of demand for quinoa is expected to continue, mainly due to its nutritional properties, along with an array of research initiatives attempting to develop varieties adequate for EU production conditions (CBI, 2015c), with EU countries already producing modest amounts of quinoa (2,000 tons in 2014, CBI 2015c). Due to its nutritional profile and the increasing awareness of consumers about its health properties, quinoa consumption is expected to keep showing positive trends in the future. However, the market is expected to stabilise, with the rise of more quinoa producers and subsequent drop in prices (CBI, 2015c). The demand for quinoa will persist as quinoa also can become a good alternative as a gluten-free grain, and many food products are expected to be developed from quinoa as main ingredient. Current demand of quinoa in Europe has been driven by the organic sector, but since quinoa is becoming a popular product in the coming years it may enjoy opportunities in also in the conventional market (CBI, 2015c).

6.3.2 Animal protein

Total meat production in the EU is expected to increase slightly in the near future (up to 46.5 million tons by 2025), driven mainly by moderate increases in pork and poultry production (2% and 4% respectively) despite the downward trend of beef production (down to 7.6 million tons by 2025) (European Commission, 2015b). Although some increases are expected in production, European total meat consumption is expected to decrease from 68 to 66.5 kg/capita by 2025 (European Commission, 2015b). This would support our results which suggest that EU-28 per capita meat consumption appears to have begun to reduce. This reduction will be most significant within the EU-15 (European Commission, 2015b), due to social concerns over animal welfare and climate change, potentially coupled with the fact that the European population is getting older, and ageing is a factor that negatively affects the consumption of meat (Spiller & Schulze, 2010). This decreasing trend in total meat consumption in Europe, contrasts with the global trend which is expected to increase moderately, also driven by pork and poultry (Kearney, 2010).

Beef consumption and production are expected to decrease across Europe in the near future (European Commission, 2015b). Whereas by 2025, pork production is expected to increase by 2% and per capita consumption may follow opposite trends in EU-15 and EU-N13: Pig meat consumption is expected to fall in the EU-15 down to 31.1 kg per capita while in the EU-N13 it will gradually increase up to 34.9 kg per capita, particularly in Poland and Romania (European Commission, 2015b). Limited increases in pork production may be influenced by environmental and social concerns along with regulations on manure management (European Commission, 2015b). Poultry on the other hand is expected to see production grow by 4%, to 14.1 million tons by 2025 (European Commission, 2015b), and per capita consumption to increase by 3.4% to 22.8kg/capita by 2025 (European Commission, 2015b). The expected growth in poultry production and consumption may be due to the considerable advantages it has over other meats including; lower prices for consumers, lower production costs and investment, favorable meat to feed ratios (OECD/FAO, 2015), short time of breeding and better nutritional image (European Commission, 2015b). Further, this growth on poultry production will be stronger in the EU-N13, particularly due to productivity increases in Hungary, Poland and Romania (European Commission, 2015b).

Dairy products global consumption and production is expected to grow by 1.9% per year (European Commission, 2015b). According to the European Commission (2015b), milk supply in Europe is expected to increase by 0.8% a year, in response to an increasing global demand and sustained domestic consumption. In addition, as a result of the removal of the quota system of the CAP, some Member Countries may

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 635727.

experience a boost in their production previously constrained. However, this supply expansion could moderate after a few years driven by common market factors such as competition, moderate milk prices or production costs (European Commission, 2015b). In addition, it is worth mentioning that some improvements in yields are expected within this sector. Yields are expected to improve by 1.4% a year, resulting in annual milk yields of 8,400 kg/cow by 2025 in the EU-15, and by 2.5% a year to 6,460 kg/cow in the EU-N13 (European Commission, 2015b). In both cases, the number of dairy cows is projected to decrease, more acutely in the EU-N13.

While milk consumption has risen in many developing countries (particularly in Asia), consumption is expected to decline in Europe and the USA (Kearney, 2010) as consumers replace cow milk with non-dairy products (European Commission, 2015b). Total fresh dairy product consumption (milk including UHT, yoghurt, quark and fresh cream) is expected to decrease by 2kg/capita by 2025. Regarding butter and cheese, both production and consumption are expected to grow steadily up to 2025 (European Commission, 2015b). Butter production is projected to increase by around 12%, reaching 2.6 million tons by 2025, whilst consumption will increase at a lower rate of 9% to 4.6 kg/capita (European Commission, 2015b). Cheese production across the EU is expected to increase to 11.2 million tons by 2025, while consumption is expected to increase from 13 to 16 kg/capita by 2025. These estimated increases in per capita cheese consumption are expected to be driven by shifts in consumer preferences and health/nutrition awareness (European Commission, 2015b).

According to the above analysis, most future changes both in production and consumption of protein products across Europe are driven not only by economic or political conditions but also by increasing environmental, health and social concerns of consumers. There are suggestions from our analysis that long-term declines in production and consumption of protein crops in Europe are being arrested and that increases may be expected in the coming years. However, the future evolution of protein crops may rely on the development of new food products with vegetal protein ingredients, along with the information provided to consumers relative to nutritional and environmental advantages of protein crop consumption. Concerning animal protein consumption, meat and dairy products show different trends in Europe, with cheese and butter increasing, stabilising total meat consumption and decreasing per capita meat consumption.

Table 8 summarises the literature-based future prospects analysed within this section, for the main protein sources and substitutes in Europe.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 635727.

Table 8. Future prospects of production and consumption of protein products in Europe

	Product	Production	Consumption
Protein Crops	Lentil	↑	↑
	Chickpea	N.D.	↑
	Faba Bean	↑	↓
	Buckwheat	↑	↑
	Lupin	↑	N.D
	Quinoa	↑	↑
	Amaranth	N.D	↑
	Soya	↑	↑
	Average European trend	**↑**	**↑**
Animal Protein	Beef	↓	↓
	Pork	↑	↓
	Poultry	↑	↑
	Whole Milk	↑	↓
	Butter	↑	↑
	Cheese	↑	↑
	Average European trend	**↑**	**↓**

7. Conclusions and Final Remarks

Global shifts in dietary patterns towards animal-based protein consumption have raised global environmental concerns due to their importance in driving deforestation, biodiversity loss, climate change and also their impacts on human health. As a consequence, a number of global and European policy and science policy initiatives are being developed to raise awareness on the impacts of animal-protein consumption and to incentivise the consumption of plant proteins. Among these, the EU project PROTEIN2FOOD aims to develop innovative protein-rich food crops that contribute to human health and environmental sustainability. The success of these novel food crops depends on consumer acceptance, profitability and convenience from the point of view of the producer. In line with this, understanding market trends and conditions for protein products in Europe is crucial.

The analysis presented in this report demonstrates that PROTEIN2FOOD crops have seen considerable changes in both production and consumption over the past half century. These changes have been observed globally, continentally and across EU-28 countries, with per capita consumption of these crops reducing globally, and within historically important consuming continents like Asia and Europe since 1961. However, there are clear suggestions that consumption and production of these crops has recently increased globally and across multiple continents.

Across EU-28 countries, much like at other scales, some protein crops have seen recent increases in production and consumption. However, most EU-28 countries saw production of such crops largely decline over recent decades. Elements including support offered by the CAP to other crops, variable yields and low prices may have limited expansion of cultivation in recent decades (Von Richthofen et al. 2006; LMC International 2009; Voison et al 2014; Cernay et al 2015). However, recent changes to the CAP may have arrested these trends. The analysis of per capita consumption of the protein crops analysed within PROTEIN2FOOD has demonstrated wide-scale declines since the 1960s. However, much like production, we

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 635727.

have shown that in some countries and with certain crops that consumption has begun to increase recently.

Beyond PROTEIN2FOOD crops, global and continental analysis of production and consumption of meat (beef, pork and poultry) demonstrated that global per capita meat consumption almost doubled since 1961, with recent increases being especially acute in Asia and Africa. Our analysis supports Marquer et al. (2014) at the global scale, with the suggestion that consumers are moving away from beef towards pork and poultry. This movement away from beef, towards poultry and pork was also identified at the EU-28 scale. With the respect to the continental analysis, the pattern identified in EU-28 countries appears consistent with more developed continents (the Americas, Oceania and Europe), where consumption of beef and pork appears to be stabilising or decreasing, whilst poultry consumption increases.

Additionally, we have shown that within EU-28 countries growth in production is more intense for animal proteins, compared to plant proteins. This increase in production of animal protein products may simply be correlated to increased populations in each country, as we have largely demonstrated that per capita consumption of meat is in general across EU-28 countries reducing or stabilising.

The results of our production pattern analysis across the EU-28 demonstrated that in recent decades only a few countries witnessed increased plant protein production, whilst also seeing reductions in animal protein production. This point may further demonstrate the importance of PROTEIN2FOOD and other initiatives in driving a shift towards greater plant protein production and reducing animal protein production, based upon the development of plant-based alternatives to animal protein. Further, that so few countries saw such changes may be concerning considering the negative consequences of animal protein production (e.g. climate change, biodiversity loss), and may highlight the potential for more localised production of plant proteins to improve the long-term sustainability of consumption, considering that demand for many protein crops in EU-28 countries is apparently satiated through imports.

Analysis of consumption trends demonstrated shifts in per capita consumption in both animal and plant proteins across Europe. The analysis highlighted geographic patterns that largely support previous analyses (de Boer et al. 2006; Westhoek et al 2011), with the importance of PROTEIN2FOOD crops largely concentrated in southern European countries, with the notable exception of buckwheat. The importance of animal proteins on the contrary, are more concentrated in northern European diets as evidenced from this analysis, whilst still important in southern Europe, per capita consumption in northern countries is generally higher.

However, we highlighted recent trends that are suggestive of a gradual shift in dietary consumption of the herein analysed protein products. These shifts are especially evident in animal protein consumption, with reductions notable across wealthier countries during the 20 years since 1993- potentially supporting Vranken et al (2014). In terms of these potential dietary shifts, there does not appear to be a definitive classification for countries (i.e. wealthier/ poorer, northern/southern European). The results from this analysis are more heterogeneous, but the identified shift towards greater per capita consumption of plant based proteins and reductions in animal based proteins may be coming in wealthier, northern countries (UK, Sweden, France and Ireland). However, there are exceptions (Bulgaria, Latvia, Czech Republic, Estonia and Cyprus) suggesting this is not a shift solely based in northern Europe. This may be encouraging for Europe, and an EU-wide shift in consumption patterns towards greater plant protein consumption.

The econometric assessment used to identify significant explanatory variables for protein product production and consumption across the EU demonstrated that variance of the explained variables is determined to a great extent by country-specific characteristics (e.g. socio-cultural context). The socio-economic or market variables included in the analysis are capable of explaining around 50% of the variance (in some case even only 40%) of the modelled variables. In particular, the models identified the importance

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 635727.

of prices in explaining plant and animal protein production, with GDP per capita also found to be important in explaining meat production. The importance of geographic differences, repeatedly mentioned in this document was identified as a potential explanatory variable of plant protein consumption, whilst socio-economic variables including; GDP/capita, price and demographics were identified in explaining meat consumption patterns.

Analysis of future trends suggested that protein crop production in Europe is expected to increase over the coming decade. These increases are suggested to be driven by favourable political and socio-economic environments, but this increase in production is expected to stem mostly from increased demand for high protein animal feed products. European animal protein production is projected to increase slightly in the near future, driven by pig and poultry, with beef production expected to reduce, whilst European per capita consumption is expected to gradually reduce into the future.

Finally, the relevance of socio-economic and policy contexts are clearly important in driving production and consumption of protein products. However, it should be reiterated that as we have repeatedly demonstrated there are also geographical factors that may further drive patterns for protein crop production and consumption- determined by culture, traditions concerning production and dietary choices. In this regard, food and health policies in Europe must account for this issue and should raise awareness on the health and environmental benefits of shifting diets and production towards plant-based protein. At the same time, the results and conclusions presented in this report evidence the need to develop attractive new protein products that take into account consumer preferences as well as producer needs, and highlight the importance of projects such as PROTEIN2FOOD and the clear necessity for its implementation and success.

8. Delays and difficulties

The final delivery of this deliverable has been delayed by a number days due to a combination of factors. Following an amendment to the Grant Agreement of the project, signed by the Commission in month 16, the delivery date of D4.1 was brought forward from month 20 to month 18. As this document relies upon the input from different partners within the project, this change in the deadlines limited the time for coordination, exchange and reception of required inputs. This has resulted in a one-week delay with respect to the amended deadline.

All SMEs involved in T4.1 have contributed to this deliverable, except CyberColloids which is not strictly an end user of protein products. CyberColloids work in PROTEIN2FOOD focuses on the analysis of the potential functionality of different new crop-based proteins as ingredients in food application research. As this work is not directly related to task 4.1, the contribution of CyberColloids to WP4 will be greatest in task 4.3 devoted to the multi-criteria assessment of protein production lines, projected at a later stage in the project.

9. Impact and dissemination activities

The analysis herein provided offers a contemporary analysis of the historical global, continental and EU-28 trends of protein products' production and consumption. It has also offered an up-to-date contextualisation of EU-28 trends within European policy and socio-economic landscapes. This work can be used as a foundation for further work within work package and the project in general, and could potentially form the basis of a future scientific publication.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 635727.

10. References

Allen, N.E., Key, T.J., Appleby, P.N., Travis, R.C., Roddam, A.W., Tjønneland, A., Johnsen, N.F., Overvad, K., Linseisen, J., Rohrmann, S., Boeing, H., Pischon, T., Bueno-de-Mesquita, H.B., Kiemeney, L., Tagliabue, G., Palli, D., Vineis, P., Tumino, R., Trichopoulou, A., Kassapa, C., Trichopoulos, D., Ardanaz, E., Larrañaga, N., Tormo, M.-J., González, C.A., Quirós, J.R., Sánchez, M.-J., Bingham, S., Khaw, K-T., Manjer, J., Berglund, G., Stattin, P., Hallmans, G., Slimani, N., Ferrari, P., Rinaldi, S. and Riboli, E. (2008). Animal foods, protein, calcium and prostate cancer risk: the European Prospective Investigation into Cancer and Nutrition. British Journal of Cancer. 98: 1574–81.DOI:10.1038/sj.bjc.6604331

Alvarez-Jubete, L., Arendt, E.K., Gallagher, E. (2010). Nutritive value of pseudo-cereals and their increasing use as functional gluten-free ingredient. Trends in Food Science and Technology. 60:240- 257. DOI: 10.1016/j.tifs.2009.10.014

Bailey, R., Froggatt, A. and Wellesley, L. (2014). Livestock-Climate Change´s Forgotten Sector. Global Public Opinion on Meat and Dairy Consumption. Chatham House Research Paper. Available at: https://www.chathamhouse.org/sites/files/chathamhouse/field/field_document/20141203LivestockClimateChangeBaileyFroggattWellesley.pdf

Bertheau, Y. and Davison, J. (2011). Soybean in the European Union, Status and Perspective, Recent Trends for Enhancing the Diversity and Quality of Soybean Products, Prof. Dora Krezhova (Ed.), ISBN: 978- 953-307-533-4, InTech, Available from: http://www.intechopen.com/books/recent-trends-for-enhancing-thediversity-and-quality-of-soybean-products/soybean-in-the-european-union-status-and-perspective

Bouvard, V., Loomis, D., Guyton, K.Z., Grosse, Y., El Ghissassi, F., Benbrahim-Tallaa, L., Guha, N., Mattock, H. and Straif, K. (2015), Carcinogenicity of consumption of red and processed meat. The Lancet Oncology. 16:1599-1600. DOI:10.1016/S1470-2045(15)00444-1

Cassidy, E.S., West, P.C., Gerber, J.S. and Foley, J.A. (2013). Redefining agricultural yields: from tonnes to people nourished per hectare. Environmental Research Letters. 8: 034015. DOI:10.1088/1748-9326/8/3/034015.

Cavadini, C., Siega-Riz, A.M. and Popkin, B.M. (2000). US adolescent food intake trends from 1965-1996. Archives of Disease in Children. 83:18- 24. DOI:10.1136/adc.83.1.18

CBI (Centre for the Promotion of Imports from developing countries).(2015a). Dutch Ministry of Foreign Affairs. ” Trends: Grains and pulses in Europe”. October 2015. Available at: https://www.cbi.eu/sites/default/files/market_information/researches/trends-europe-grains-pulses-2015.pdf Accessed: August 2016.

CBI (Centre for the Promotion of Imports from developing countries). (2015b). Dutch Ministry of Foreign Affairs. ” Factsheet: Amaranth grains in Europe”. December 2015. Available at: https://www.cbi.eu/sites/default/files/market_information/researches/product-factsheet-europe-amarath-grains-pulses-2015.pdf Accessed: August 2016.

CBI (Centre for the Promotion of Imports from developing countries). (2015c). Dutch Ministry of Foreign Affairs. ” Factsheet: Quinoa in Europe”. December 2015. Available at: https://www.cbi.eu/sites/default/files/market_information/researches/product-factsheet-europe-quinoa-grains-pulses-2015.pdf Accessed: August 2016.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 635727.

Cernay, C., Ben-Ari, T., Pelzer, E., Meynard, J-M. and Makowski, D. (2015). Estimating variability in grain legume yields across Europe and the Americas. Nature. 5:11171. DOI:10.1038/srep11171

de Boer, J., Helms, M. and Aiking, H. (2006). Protein consumption and sustainability: Diet diversity in EU-15. Ecological Economics. 59:267- 274. DOI:10.1016/j.ecolecon.2005.10.011

De Schutter, O. (2011). Agroecology and the Right to Food. Report presented at the 16th Session of the United Nations Human Rights Council [A/HRC/16/49].

Drewnowski, A. (2011). The contribution of milk and milk products to micronutrient density and affordability of the U.S diet. Journal of the American College of Nutrition. 422S-428S.

Duffey, K. and Popkin, B. M.(2007) Shifts in patterns and consumption of beverages between 1965 and 2002. Obesity, 15, 2739 –2747. DOI:10.1038/oby.2007.326.

European Commission (2009). Council Regulation (EC) No 73/2009 of 19 January 2009 establishing common rules for direct support schemes for farmers under the common agricultural policy and establishing certain support schemes for farmers, amending Regulations (EC) No 1290/2005, (EC) No 247/2006, (EC) No 378/2007 and repealing Regulation (EC) No 1782/2003.

European Commission (2013a). Overview of CAP Reform 2014-2020. Agricultural Policy Perspectives Brief. Available at: http://ec.europa.eu/agriculture/policy-perspectives/policy-briefs/05_en.pdf. Last accessed: 29 March 2016.

European Commission (2013b). European Commission Memo: CAP Reform- an explanation of the main elements. Available at: http://europa.eu/rapid/press-release_MEMO-13-621_en.htm. Last accessed: 25 May 2016.

European Commission (2015a). World food consumption patterns – trends and drivers. *Agricultural Market Briefs, No. 6*. Available at: http://ec.europa.eu/agriculture/markets-and-prices/market-briefs/pdf/06_en.pdf . Last Accessed: July 2016

European Commission (2015b). EU Agricultural Outlook 2015-2025. Available at: http://ec.europa.eu/agriculture/markets-and-prices/medium-term-outlook/2015/fullrep_en.pdf Last Accessed: July 2016

European Commission (2016a). The 1992 reform ("MacSharry reform"). Agriculture and Rural Development. Available at: http://ec.europa.eu/agriculture/cap-history/1992-reform/index_en.htm. Last Accessed: 04 June 2016

European Commission (2016b). Agenda 2000. Agriculture and Rural Development. Available at: http://ec.europa.eu/agriculture/cap-history/agenda-2000/index_en.htm. Last Accessed: 04 June 2016

European Commission (2016c). The 2003 reform. Agriculture and Rural Development. Available at: http://ec.europa.eu/agriculture/cap-history/2003-reform/index_en.htm. Last Accessed: 03 June 2016

European Commission (2016d). The 2008 CAP "Health Check". Agriculture and Rural Development. Available at: http://ec.europa.eu/agriculture/cap-history/health-check/index_en.htm. Last accessed: 01 June 2016.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 635727.

European Commission (2016e). Milk Market Situation. Milk Market Observatory. Available at: http://ec.europa.eu/agriculture/milk-market-observatory/pdf/market-situation-presentation_en.pdf. Last Accessed: 02 June 2016

European Parliament (2013). The environmental role of protein crops in the new Common Agricultural Policy. Directorate General for Internal Policies: Policy Department. Available at: http://www.europarl.europa.eu/RegData/etudes/etudes/join/2013/495856/IPOL-AGRI_ET(2013)495856_EN.pdf. Last accessed: 27 February 2016.

FAO (2013a). 2013 Food Balance Sheets for 42 selected countries. Available at: http://faostat3.fao.org/download/FB/FBS/E. Last accessed 14 July 2016.

FAO (2013b). Tendencias y Perspectivas del Comercio de la Quinua. Available at: http://www.fao.org/3/a-i3583s.pdf. Last accessed: 14 April 2016.

FAO(2016). FAOStat. Available at: http://faostat3.fao.org/download/Q/QL/E. Last Accessed: 15 May 2016.

Gelder, J.Wv., Kammeraat, K., and Kroes, H. (2008). Soy consumption for feed and fuel in the European Union. A research paper prepared for Milieudefensie (Friends of the Earth Netherlands), 22 p.

Godfray, H.C.J., Beddington, J.R., Crute, I.R., Haddad, L., Lawrence, D., Muir, J.F., Pretty, J., Robinson, S., Thomas, S.M. and Toulmin, C. (2010). Food Security: The Challenge of Feeding 9 Billion People. 327:812-818. DOI:10.1126/science.1185383.

Guida-Johnson, B., Zuleta, G.A (2013) Land-use land-cover change and ecosystem loss in the Espinal ecoregion, Argentina. Agr Ecosyst Environ 181:31-40. doi:10.1016/j.agee.2013.09.002

Holasova, M., Fledlerova, V., Smrcinova, H., Orsak, M., Lachman, J., Vavreinova, S. (2002). Buckwheat- the source of antioxidant activity in functional foods. Food Research International. 35:207- 211. DOI:10.106/S0963-9969(01)00185-5

Kastner, T.M., Ibarrola-Rivas, M.J., Koch, W., Nonhebel, S. (2012). Global changes in diets and the consequences for land requirements for food. PNAS. 109: 6868–6872. DOI: 10.1073/pnas.1117054109

Kearney, J. (2010). Food consumption trends and drivers. Philosophical Transactions of the Royal Society B. 365: 2793-2807. DOI:10.1098/rstb.2010.0149.

LMC International (2009). Evaluation of measures applied under the Common Agricultural Policy to the protein crop sector. Available at:. http://ec.europa.eu/agriculture/eval/reports/protein_crops. Last accessed 29 May 2016.

Lucas, M. M., Stoddard, F. L., Annicchiarico, P., Frías, J., Martinez-Villaluenga, C., Sussmann, Duranti, M., Seger, A., Zander, P.M., & Pueyo, J. J. (2015). The future of lupin as a protein crop in Europe. *Frontiers in plant science, 6:705.* DOI: 10.3389/fpls.2015.00705

Machovina, B., Feeley, K.J., Ripple, W.J. (2015). Biodiversity conservation: The key is reducing meat consumption. Science of the Total Environment. 536:419-431.DOI:10.1016/j.scitotenv.2015.07.022

MAGRAMA (Spanish Ministry of Agriculture, Food and Environment) (2013). Programa Nacional Para La Calidad De Las Legumbres Superficies Determinada. Campaña 2013/ 2014. Available at:

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 635727.

https://www.fega.es/sites/default/files/imported/PwfGcp/imagenes/es/LEGUMBRES_Superficies_determinadas_2013-2014_tcm5-42089.pdf. Last accessed 15 July 2016.

MAGRAMA (Spanish Ministry of Agriculture, Food and Environment) (2015). Informe sobre el primer año de aplicación para el clima y el medio ambiente (GREENING). Available at : http://www.fega.es/sites/default/files/INFORME_BALANCE_PRIMER_ANNO_APLICACION_GREENING.pdf. Last Accessed 12 April 2016

Marquer, P., Rabade, T. and Forti, R. (2014). Meat Production Statistics. Eurostat Statistics Explained. Available at: http://ec.europa.eu/eurostat/statistics-explained/index.php/Meat_production_statistics#Beef_and_veal_.28bovine_meat.29. Last Accessed 01 June 2016

Marquer, P. (2015). Milk and milk products – 30 years of quotas. Eurostat Statistics Explained. Available at: http://ec.europa.eu/eurostat/statistics-explained/index.php/Milk_and_milk_products_-_30_years_of_quotas. Last Accessed 02 June 2016

OECD (2014), Agricultural Policy Monitoring and Evaluation 2014: OECD Countries, OECD Publishing. http://dx.doi.org/10.1787/agr_pol-2014-en

OECD/Food and Agriculture Organization of the United Nations (2015). OECD-FAO Agricultural Outlook 2015-2024. DOI: 10.1787/agr_outlook-2015-en

Patterson, C.A., Maskus, H., Dupasquier, C. (2009). Pulse crops for health. Cereal Foods World. 54:108- 112. DOI:10.1094/CFW-54-3-0108

Prentice, A.C. (2014). Dairy products in global public health. The American Journal of Clinical Nutrition. 99:1212S-1216S. DOI:10.3945/ajcn.113.073437

Radics, L. and Mikóházi, D. (2010). Principles of Common Buckwheat Production. The European Journal of Plant Science and Biotechnology. 4 (Special Issue 1):57- 63.

Rivers Cole, J., McCoskey, S. (2013). Does global meat consumption follow an environmental Kuznets curve? Sustainability Science, Practice, & Policy. 9: 26–36.DOI:

Sans, P. and Combris, P. (2015). World meat consumption patterns : An overview of the last fifty years (1961-2011). Meat Science. 109:106- 111. DOI:101.1016/jmeatsci.2015.05.012

Schneider, A.V. (2002). Overview of the market and consumption of pulses in Europe. British Journal of Nutrition. 88:S243-S250. DOI:10.1079/BJN2002713

Spiller, A. & Schulze, B. (2010). Meat consumption: What will Europe be eating in 20 years). A*grifuture, Summer/10.* Available at: http://www.agrifuture.com/fileadmin/agrifuture/binary/summer10/af_0210_18-21.pdf Last Accessed: August 2016.

Springmann, M., Godfray, H.C.J., Rayner, M., Scarborough, P. (2016). Analysis and valuation of the health and climate change cobenefits of dietary change. PNAS. 113:4146-4151. DOI:10.1073/onas.1523119113

Stoddard, F.L. (2013). The case studies of participant expertise in Legume Futures. Legume Futures Report 1.2. Available from www.legumefutures.de

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 635727.

Tilman, D., Balzer, C., Hill, J and Befort, B.L. (2011). Global food demand and the sustainable intensification of agriculture. PNAS. 108: 20260–20264. DOI: 10.1073/pnas.1116437108

Tscharntke, T., Clough, Y., Wanger, T.C., Jackson, L., Motzke, I., Perfecto, I., Vandermeer, J. and Whitbread, A. (2012). Global Food Security, Biodiversity Conservation and the Future of Agricultural Intensification. Biological Conservation. 151: 53–59. DOI:10.1016/j.biocon.2012.01.068

Van Wezemael, L., Verbeke, W., Kügler, J.O., de Barcellos, M.D. and Grunert, K.G. (2010). European consumers and beef safety: Perceptions, expectations and uncertainty reduction strategies. Food Control. 21:835- 844. DOI:10.1016/j.foodcont.2009.11.010

Voison, A.S., Guéguen, J., Huyghe, C., Jeuffroy, M.H., Magrini, M.B., Menard, J.M., Mougel, C., Pellerin, S. and Pelzer, E. (2014). Legumes for feed, food, biomaterials and bioenergy in Europe: a review. Agronomy. 34:361- 360. DOI:10.1007s/s13593-013-0189-y

Von Richthofen, J.S., Pahl, H., Bouttet, D., Casta, P., Cartrysse, C., Charles, R. and Lafarga, A. (2006). What do European farmers think about grain legumes? Grain Legumes. 45:14- 15.

Vranken, L., Avermaete, T., Petalios, D. and Mathijs E (2014). Curbing global meat consumption:Emerging evidence of a second nutrition transition. Environmental Science & Policy 39: 95–106. http://dx.doi.org/10.1016/j.envsci.2014.02.009.

Westhoek, H., Rood, T., van den Berg, M., Janse, J., Nijdam, D., Reudink, M. and Stehfest, E. (2011). The Protein Puzzle, The Hague: PBL Netherlands Environmental Assessment Agency

Zare, F., Champagne, C.P., Simpson, B.K., Orsat, V. and Boye, J.I. (2012). Effect of the addition of pulse ingredients to milk on acid production by probiotic and yoghurt starter cultures. Food Science and Technology. 45:155- 160. DOI:10.1016/j.lwt.2011.08.012.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 635727.

11. Annexes

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 635727.

11.1 Annex 1: Market Database

Table 9. Lentil database year 2012.

Country	Variable												
	Arable Land (1000 ha)	Area Harvested (1000 ha)	Proportion of Arable Land (%)	Production (1000 tonnes)	Yield (tonne/ha)	Import Quantity (1000 tonnes)	Import Value (1000 US$)	Export Quantity (1000 tonnes)	Export Value (1000 US$)	Producer Prices Annual (USD/tonne)	Domestic Consumption (1000 tonnes)	Gross Production Value (constant 2004-2006 million US$)	Population (1000 persons)
Austria	1355,1					1,464	1931	0,17	318		1,294		8464
Belgium-Luxembourg						8,478	0	6,464	0		2,014		11584
Belgium	802					8,405	8089	6,462	6319		1,943		11060
Luxembourg	62,56					0,073	178	0,002	8		0,071		524
Bulgaria	3317	1,411	0,04253844	1,73	1,2261	5,018	3580	0,564	422	620,39	6,184	0,75	7278
Croatia	906,4	0,011	0,00121359	0,022	2	0,323	435	0,001	2		0,344	0,04	4307
Cyprus	85,3	0,025	0,02930832	0,011	0,44	1,281	1315	0,088	136	1744,87	1,204	0,02	1129
Czech Republic	3157		0			6,97	5884	1,329	1638		5,641		10660
Denmark	2418		0			0,716	1016	0,122	254		0,594		5598
Estonia	621					0,03	65	0	0		0,03		1150
Finland	2249,1					0,172	432	0,003	8		0,169		5408
France	18283,49	15,065	0,08239674	25,195	1,6724	25,457	24965	2,229	4726		48,423		63937
Germany	11834					26,974	26111	2,619	4538		24,355		82800
Greece	2540	2,35	0,09251969	3	1,2766	12,411	11602	0,974	995	1928,14	14,437	5,22	11125
Hungary	4397	0,025	0,00056857	0,02	0,8	2,838	2444	0,296	316	1520,94	2,562	0,01	9976
Ireland	1170					0,165	294	0	0		0,165		4576
Italy	7118	2,629	0,03693453	1,842	0,76	29,653	26229	1,537	2004		29,958	2,44	60885

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 635727.

Country	Variable												
	Arable Land (1000 ha)	Area Harvested (1000 ha)	Proportion of Arable Land (%)	Production (1000 tonnes)	Yield (tonne/ha)	Import Quantity (1000 tonnes)	Import Value (1000 US$)	Export Quantity (1000 tonnes)	Export Value (1000 US$)	Producer Prices Annual (USD/tonne)	Domestic Consumption (1000 tonnes)	Gross Production Value (constant 2004-2006 million US$)	Population (1000 persons)
Latvia	1178					0,072	134	0,006	25		0,066		2060
Lithuania	2260,5					0,107	160	0,029	49		0,078		3028
Malta	9					0,064	66	0	0		0,064		428
Netherlands	1011					8,479	8366	2,528	4159		5,951		16714
Poland	10925					1,889	1784	0,108	218		1,781		38211
Portugal	1122					0,857	716	0,906	1144		-0,049		10604
Romania	8798					0,345	283	0	0		0,345		21755
Slovakia	1392,3	0,608	0,04366875	0,477	0,7845	2,482	2421	0,893	1932	885,26	2,066	0,29	5446
Slovenia	171,7					0,056	109	0	0		0,056		2068
Spain	12570	36,298	0,28876691	15,046	0,4145	49,906	45226	2,1	2772	1019,1	62,852	9,15	46755
Sweden	2599					1,579	2100	0,24	524		1,339		9511
United Kingdom	6212					22,854	22638	2,248	4349		20,606		63030
Argentina	39754	1,9	0,00477939	2,4	1,2632	0,039	39	8,422	5767		-5,983	0,69	42095,22
Bolivia	4353					1,44	785	0	0		1,44		10496
Brazil	72607					13,446	10106	0,006	12		13,44		198656
Chile	1336,98	1,013	0,07576778	0,718	0,788	18,014	14143	0,001	1		18,731	0,43	17388,44
Colombia	1578	4	0,25348542	1,25	0,3125	60,254	46166	0,085	85		61,419		46881,02
Ecuador	1147,9	3	0,26134681	2,2	0,7333	15,834	12125	0,007	10	1027,9	18,027	1,72	15492
Peru	4150	3,953	0,09525301	3,74	0,946117	39,121	34378	0,011	13	1000	42,85	2,06	29988
Ethiopia	15346	123,718	0,80619054	151,5	1,224559	10,265	7186	0,002	1	532,6	161,763		173475
Uganda	6900					0,721	911	0,928	469		-0,207		36346

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 635727.

Table 10. Chickpea database year 2012.

Continent	Country	Variable												
		Arable Land (1000 ha)	Area Harvested (1000 ha)	Proportion of Arable Land (%)	Production (1000 tonnes)	Yield (tonne/ha)	Import Quantity (1000 tonnes)	Import Value (1000 US$)	Export Quantity (1000 tonnes)	Export Value (1000 US$)	Producer Prices Annual (USD/tonne)	Domestic Consumption (1000 tonnes)	Gross Production Value (constant 2004-2006 million US$)	Population (1000 persons)
Europe	Austria	1355,1					0,461	799	0,092	145		0,369		8464
	Belgium-Luxembourg						2493	3451	1193	1902		1,3		11584
	Belgium	802					2459	3387	1192	1899		1267		11060
	Luxembourg	62,56					0,034	64	0,001	3		0,033		524
	Bulgaria	3317	1411	0,04	1,73	12261	0,183	178	0,935	773		0,978		7278
	Croatia	906,4					0,147	260	0	0		0,147		4307
	Cyprus	85,3	0,083	0,1	0,278	33494	0,325	525	0,001	2	3224,36	0,602	0,38	1129
	Czech Republic	3157					0,598	742	0,137	263		0,461		10660
	Denmark	2418					0,702	1161	0,028	64		0,674		5598
	Estonia	621					0,002	4	0			0,002		1150
	Finland	2249,1					0,062	141	0,001	4		0,061		5408
	France	18283,49					5424	7488	1682	1293		3742		63937
	Germany	11834					5,07	6826	0,829	1477		4241		82800
	Greece	2540	1,5	0,06	2,3	15333	4,34	6645	0,179	444	2544,27	6461	3,69	11125
	Hungary	4397	0	0			0,121	228	0	0		0,121		9976
	Ireland	1170					0,066	130	0	0		0,066		4576

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 635727.

Continent	Country	Variable												
		Arable Land (1000 ha)	Area Harvested (1000 ha)	Proportion of Arable Land (%)	Production (1000 tonnes)	Yield (tonne/ha)	Import Quantity (1000 tonnes)	Import Value (1000 US$)	Export Quantity (1000 tonnes)	Export Value (1000 US$)	Producer Prices Annual (USD/tonne)	Domestic Consumption (1000 tonnes)	Gross Production Value (constant 2004-2006 million US$)	Population (1000 persons)
	Italy	7118	7928	0,11	11219	14151	23649	29293	2,14	2563		32728	9,29	60885
	Latvia	1178					1721	554	1699	512		0,022		2060
	Lithuania	2260,5					0,003	10	0	0		0,003		3028
	Malta	9					0,033	37	0	0		0,033		428
	Netherlands	1011					3218	3664	0,758	1292		2,46		16714
	Poland	10925					0,296	356	0,007	16		0,289		38211
	Portugal	1122	1159	0,1	0,634	0,547	13626	16689	1969	2862		12291	0,72	10604
	Romania	8798	0,165	0	0,161	0,9758	0,437	387	0,001	1		0,597		21755
	Slovakia	1392,3	0,3	0,02	0,2	0,6667	0,16	224	0,016	22		0,344		5446
	Slovenia	171,7					0,06	107	0	0		0,06		2068
	Spain	12570	34,6	0,28	21,9	0,6329	55335	75208	3228	4943	838,72	74007	14,9	46755
	Sweden	2599					1298	1971	0,047	115		1251		9511
	United Kingdom	6212					36841	37870	1568	3113		35273		63030
America	Argentina	39754	48	0,12	52	1833	0,093	100	85864	83518		-33771		42095,22
	Bolivia	4353	0,85818	0,02	0,65685	0,765396	0	0	0	0	79,5	0,65685	0,05	10496
	Brazil	72607					7327	9474	0,005	17		7322		198656
	Chile	1336,98	1334	0,1	1074	0,851	4439	4679	0	0		5513	0,44	17388,44

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 635727.

Continent	Country	Variable												
		Arable Land (1000 ha)	Area Harvested (1000 ha)	Proportion of Arable Land (%)	Production (1000 tonnes)	Yield (tonne/ha)	Import Quantity (1000 tonnes)	Import Value (1000 US$)	Export Quantity (1000 tonnes)	Export Value (1000 US$)	Producer Prices Annual (USD/tonne)	Domestic Consumption (1000 tonnes)	Gross Production Value (constant 2004-2006 million US$)	Population (1000 persons)
	Colombia	1578	0,068	0	0,054	0,7941	12656	15748	0	0		12,71		46881,02
	Ecuador	1147,9					0,639	929	0	0		0,639		15492
	Peru	4150	2404	0,06	2801	1165141	2387	3717	0	0	1397,7	5188	2,16	29988
Africa	Ethiopia	15346	239512	1,56	409733	171699	0,001	7	74006	54894		335728		173475
	Uganda	6900	8	0,12	5	0,625	0,011	7	0	0		5011		36346

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 635727.

Table 11. Faba Beans database year 2012.

Continent	Country	Variable												
		Arable Land (1000 ha)	Area Harvested (1000 ha)	Proportion of Arable Land (%)	Production (1000 tonnes)	Yield (tonne/ha)	Import Quantity (1000 tonnes)	Import Value (1000 US$)	Export Quantity (1000 tonnes)	Export Value (1000 US$)	Producer Prices Annual (USD/tonne)	Domestic Consumption (1000 tonnes)	Gross Production Value (constant 2004-2006 million US$)	Population (1000 persons)
Europe	Austria	1355,1	6852	0,51	15991	23338	0,901	755	0,868	547		16024	4,29	8464
	Belgium-Luxembourg				0		1117	583	0,124	110		0,993		11584
	Belgium	802	0,468	0,06	2418	51646	1,06	566	0,124	110		3354		11060
	Luxembourg	62,56	0,031	0,05	0,081	26129	0,057	17	0	0		0,138		524
	Bulgaria	3317	0,004	0	0		0	2	0	0		0		7278
	Croatia	906,4			0		0,013	43	0	0				4307
	Cyprus	85,3	0,47	0,55	0,291	0,6191	0,184	273	0,034	67	1055,13	0,441	0,21	1129
	Czech Republic	3157	1,5	0,05	2	13333	0,002	6	0,684	420		1318		10660
	Denmark	2418					3372	1322	0,428	299		2944		5598
	Estonia	621					0	0	0	0				1150
	Finland	2249,1					0,002	10	0,136	114				5408
	France	18283,49	60,34	0,33	2012	0,212	7493	5067	273444	114247		-263939		63937
	Germany	11834	0,9	0,01	2,6	28889	3707	2306	3255	1823		3052		82800
	Greece	2540	0,9	0,04	2,6	28889	1799	1848	0,125	94		4274		11125
	Hungary	4397	0,144	0	0,163	11319	0	0	0,002	3		0,161		9976
	Ireland	1170					0,46	250	0	0				4576
	Italy	7118	46,13	0,65	95996	2,81	14411	9681	3881	2558		106526	55,33	60885
	Latvia	1178					0,167	246	0,174	76				2060
	Lithuania	2260,5	1,4	0,06	2,7	19286	0,25	121	1707	721		1243		3028

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 635727.

Continent	Country	Variable												
		Arable Land (1000 ha)	Area Harvested (1000 ha)	Proportion of Arable Land (%)	Production (1000 tonnes)	Yield (tonne/ha)	Import Quantity (1000 tonnes)	Import Value (1000 US$)	Export Quantity (1000 tonnes)	Export Value (1000 US$)	Producer Prices Annual (USD/tonne)	Domestic Consumption (1000 tonnes)	Gross Production Value (constant 2004-2006 million US$)	Population (1000 persons)
	Malta	9	0,25	2,78	0,7	2,8	0,175	131	0	0		0,875		428
	Netherlands	1011	0,512	0,05	2	3963	1045	546	0,873	624		2172		16714
	Poland	10925	0,19	0	0,26	13684	0,03	61	0,143	102		0,147		38211
	Portugal	1122	22	1,96	18,5	0,849	3039	1462	0,023	49		21516	17,4	10604
	Romania	8798					0,025	19	0	0				21755
	Slovakia	1392,3	0,291	0,02	0,489	1684	0,015	19	0,001	2	271,41	0,503	0,09	5446
	Slovenia	171,7	0	0	0		0,004	19	0,006	18		-0,002		2068
	Spain	12570	24,6	0,2	25,9	1528	9539	6231	2,45	2669	397,18	32989	6,91	46755
	Sweden	2599					0,194	239	2249	769				9511
	United Kingdom	6212	19	0,31	94		2713	2139	131881	66976		-35168		63030
America	Argentina	39754	1,8	0	16	88889	0,044	20	0	0		16044		42095,22
	Bolivia	4353	13,5	0,31	13	0,963	0	0	1295	2167		11705		10496
	Brazil	72607	20969	0,03	5032	0,24	0,005	5	0	0		5037	2,24	198656
	Chile	1336,98	2127	0,16	8395	39466	0,016	38	0	0		8411		17388,44
	Colombia	1578	2127	0,13	8395	39466	0,016	84	0	0				46881,02
	Ecuador	1147,9	13287	1,16	2238	0,1684	2003	2119	0,006	18	954,48	4235	1,48	15492
	Peru	4150	55838	1,35	73698	13199	0	1	1598	3054	542,55	72,1	22,05	29988
Africa	Ethiopia	15346	574061	3,74	943964	16444	0,011	16	33454	23543	400	910521		173475
	Uganda	6900			0		0,063	46	0,132	45				36346

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 635727.

Table 12. Lupin database year 2012.

Continent	Country	Variable												
		Arable Land (1000 ha)	Area Harvested (1000 ha)	Proportion of Arable Land (%)	Production (1000 tonnes)	Yield (tonne/ha)	Import Quantity (1000 tonnes)	Import Value (1000 US$)	Export Quantity (1000 tonnes)	Export Value (1000 US$)	Producer Prices Annual (USD/tonne)	Domestic Consumption (1000 tonnes)	Gross Production Value (constant 2004-2006 million US$)	Population (1000 persons)
Europe	Austria	1355,1	0,098	0,01	0,185	18878						0,185		8464
	Belgium-Luxembourg													11584
	Belgium	802												11060
	Luxembourg	62,56												524
	Bulgaria	3317												7278
	Croatia	906,4												4307
	Cyprus	85,3												1129
	Czech Republic	3157												10660
	Denmark	2418												5598
	Estonia	621												1150
	Finland	2249,1												5408
	France	18283,49	2553	0,01	6197	24273						6197		63937
	Germany	11834	17,9	0,15	31,5							31,5	3,64	82800
	Greece	2540	0	0	0							0		11125
	Hungary	4397	0,054	0	0,032	0,5926						0,032	0,01	9976
	Ireland	1170												4576
	Italy	7118	5	0,07	6	1,2						6	1,59	60885

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 635727.

Continent	Country	Variable												
		Arable Land (1000 ha)	Area Harvested (1000 ha)	Proportion of Arable Land (%)	Production (1000 tonnes)	Yield (tonne/ha)	Import Quantity (1000 tonnes)	Import Value (1000 US$)	Export Quantity (1000 tonnes)	Export Value (1000 US$)	Producer Prices Annual (USD/tonne)	Domestic Consumption (1000 tonnes)	Gross Production Value (constant 2004-2006 million US$)	Population (1000 persons)
	Latvia	1178	0	0	0	1						0		2060
	Lithuania	2260,5	5,1	0,23	5,1	1					364,66	5,1	1,47	3028
	Malta	9												428
	Netherlands	1011												16714
	Poland	10925	49221	0,45	77799	1586					276,92	77799	13,57	38211
	Portugal	1122												10604
	Romania	8798												21755
	Slovakia	1392,3	0,08	0,01	0,16	2						0,16		5446
	Slovenia	171,7												2068
	Spain	12570	6,7	0,05	2,8	0,4179						2,8	0,66	46755
	Sweden	2599												9511
	United Kingdom	6212												63030
America	Argentina	39754	0,11	0	0,16	14545						0,16		42095,22
	Bolivia	4353												10496
	Brazil	72607												198656
	Chile	1336,98	21467	1,61	38949	18144						38949	5,15	17388,44
	Colombia	1578												46881,02
	Ecuador	1147,9	4,5	0,39	1,7	0,3778						1,7		15492
	Peru	4150											4,26	29988
Africa	Ethiopia	15346												173475
	Uganda	6900												36346

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 635727.

Table 13. Quinoa database year 2012.

Continent	Country	Variable												
		Arable Land (1000 ha)	Area Harvested (1000 ha)	Proportion of Arable Land (%)	Production (1000 tonnes)	Yield (tonne/ha)	Import Quantity (1000 tonnes)	Import Value (1000 US$)	Export Quantity (1000 tonnes)	Export Value (1000 US$)	Producer Prices Annual (USD/tonne)	Domestic Consumption (1000 tonnes)	Gross Production Value (constant 2004-2006 million US$)	Population (1000 persons)
Europe	Austria	1355,1					0,0271	89,32				0,0271		8464
	Belgium-Luxembourg						0	0						11584
	Belgium	802					0,042	117236				0,042		11060
	Luxembourg	62,56					0	0						524
	Bulgaria	3317					0	0				0		7278
	Croatia	906,4					0,0043	15688				0,0043		4307
	Cyprus	85,3					0	0						1129
	Czech Republic	3157					0					0		10660
	Denmark	2418					0,079	231769				0,079		5598
	Estonia	621					0					0		1150
	Finland	2249,1					0,022397	120483				0,022397		5408
	France	18283,49					3011893	10021553				3011893		63937
	Germany	11834					0,249675	893472				0,249675		82800
	Greece	2540					0	0						11125
	Hungary	4397					0	0						9976
	Ireland	1170					0,025616	135,89				0,025616		4576

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 635727.

Continent	Country	Variable												
		Arable Land (1000 ha)	Area Harvested (1000 ha)	Proportion of Arable Land (%)	Production (1000 tonnes)	Yield (tonne/ha)	Import Quantity (1000 tonnes)	Import Value (1000 US$)	Export Quantity (1000 tonnes)	Export Value (1000 US$)	Producer Prices Annual (USD/tonne)	Domestic Consumption (1000 tonnes)	Gross Production Value (constant 2004-2006 million US$)	Population (1000 persons)
	Italy	7118					0,315298	944013				0,315298		60885
	Latvia	1178					0	0						2060
	Lithuania	2260,5					0	0						3028
	Malta	9					0							428
	Netherlands	1011					1279504	3935518				1279504		16714
	Poland	10925					0,004301	15638				0,004301		38211
	Portugal	1122					0							10604
	Romania	8798					0	0						21755
	Slovakia	1392,3					0							5446
	Slovenia	171,7					0,009359	38371				0,009359		2068
	Spain	12570					0,111832	316285				0,111832		46755
	Sweden	2599					0,164089	520802				0,164089		9511
	United Kingdom	6212					0,478561	1374036				0,478561		63030
America	Argentina	39754					0							42095,22
	Bolivia	4353	68495	1,57	45782	0,668399	0		1984257	6555723	1373,3	25939424	20,64	10496

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 635727.

Continent	Country	Variable												
		Arable Land (1000 ha)	Area Harvested (1000 ha)	Proportion of Arable Land (%)	Production (1000 tonnes)	Yield (tonne/ha)	Import Quantity (1000 tonnes)	Import Value (1000 US$)	Export Quantity (1000 tonnes)	Export Value (1000 US$)	Producer Prices Annual (USD/tonne)	Domestic Consumption (1000 tonnes)	Gross Production Value (constant 2004-2006 million US$)	Population (1000 persons)
	Brazil	72607					0							198656
	Chile	1336,98					0							17388,44
	Colombia	1578					0							46881,02
	Ecuador	1147,9	1,25	0,11	0,8	0,64	0		0,368488	1006064		0,431512	0,57	15492
	Peru	4150	38498	0,93	44213	1148449	0		6488296	19349782	1469,7	37724704	14,91	29988
Africa	Ethiopia	15346												173475
	Uganda	6900												36346

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 635727.

Table 14 Wheat database year 2012.

Continent	Country	Variable												
		Arable Land (1000 ha)	Area Harvested (1000 ha)	Proportion of Arable Land (%)	Production (1000 tonnes)	Yield (tonne/ha)	Import Quantity (1000 tonnes)	Import Value (1000 US$)	Export Quantity (1000 tonnes)	Export Value (1000 US$)	Producer Prices Annual (USD/tonne)	Domestic Consumption (1000 tonnes)	Gross Production Value (constant 2004-2006 million US$)	Population (1000 persons)
Europe	Austria	1355,1	308,2	22,74	1275498	41385	512434	151210	587833	205418	270,51	1200099	146	8464
	Belgium-Luxembourg													11584
	Belgium	802											247,25	11060
	Luxembourg	62,56											11,85	524
	Bulgaria	3317	1185007	35,73	4455104	37596	21644	8468	2452535	717449	265,79	2024213	540,77	7278
	Croatia	906,4	186949	20,63	999681	53473	1149	575	394215	115007	238,49	606615	157,25	4307
	Cyprus	85,3	8,55	10,02	22923	26811	101487	35801	0,01	8	325,64	124,4	4,18	1129
	Czech Republic	3157	815381	25,83	3518896	43156	62919	21161	1521103	425388	247,03	2060712	474,21	10660
	Denmark	2418	614,1	25,4	4525,1	73687	370639	121244	653005	194075	266,32	4242734	635,56	5598
	Estonia	621	124,3	20,02	484,7	38994	12707	4572	251253	76871	291,86	246154	65,15	1150
	Finland	2249,1	227,3	10,11	887,1	39028	10094	4622	214182	61029	260,26	683012	124,38	5408
	France	18283,49	5303,3	29,01	40300,8	75992	284858	98376	1646902	504063 4	284,57	24116636	5225,93	63937
	Germany	11834	3056,7	25,83	22409,3	73312	3534904	1080675	6993096	222404 4	283,33	18951108	3113,97	82800
	Greece	2540	688991	27,13	1837072	26663	888,87	290451	337504	121612	298,64	2388438	273,15	11125
	Hungary	4397	1070,02	24,34	4010,99	37485	65,09	19497	1324686	384636	268,66	2751394	428,51	9976
	Ireland	1170	98	8,38	708	72245	304772	97411	50881	15359	282,82	961891	98,71	4576
	Italy	7118	1853637	26,04	7654248	41293	6108562	2045797	256616	109230	329,36	13506194	1461,44	60885

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 635727.

Continent	Country	Variable												
		Arable Land (1000 ha)	Area Harvested (1000 ha)	Proportion of Arable Land (%)	Production (1000 tonnes)	Yield (tonne/ha)	Import Quantity (1000 tonnes)	Import Value (1000 US$)	Export Quantity (1000 tonnes)	Export Value (1000 US$)	Producer Prices Annual (USD/tonne)	Domestic Consumption (1000 tonnes)	Gross Production Value (constant 2004-2006 million US$)	Population (1000 persons)
	Latvia	1178	352,4	29,92	1539,8	43695	251,37	84246	1489974	465188	270,91	301196	192,56	2060
	Lithuania	2260,5	627	27,74	2998,9	47829	160446	46158	1680302	561524	273,43	1479044	390,9	3028
	Malta	9	2,8	31,11	16	57143	60399	20960	41662	14790		34737	9,15	428
	Netherlands	1011	151625	15	1302002	8587	3689624	1076623	528889	165981	287,19	4462737	178,02	16714
	Poland	10925	2077,2	19,01	8607,6	41438	735149	200837	1060554	331161	275,38	8282195	1112,62	38211
	Portugal	1122	54,8	4,88	59	10766	1389895	440235	44759	14301	332,05	1404136	9,65	10604
	Romania	8798	1992,18	22,64	5297748	26593	531876	152466	2314889	699123	263,01	3514735	731,49	21755
	Slovakia	1392,3	388147	27,88	1275302	32856	84381	39376	296793	166641	263,33	1062,89	166,02	5446
	Slovenia	171,7	34586	20,14	188065	54376					250,77	188065	26,12	2068
	Spain	12570	1758,9	13,99	4650,3	26439	5467687	1686649	283463	117084	317,82	9834524	815,15	46755
	Sweden	2599	367	14,12	2289,3	62379	288061	87110	343039	113987	280,65	2234322	301,2	9511
	United Kingdom	6212	1992	32,07	13261	66571	1784946	640059	1503413	425351	306,35	13542533	1943,52	63030
America	Argentina	39754	3019403	7,6	8024995	26578	0,018	40	11461359	2937805	160,44	-3436346	856,96	42095,22
	Bolivia	4353	158019	3,63	145151	0,9186	95762	25764	0	0	305,11	240913	30,45	10496
	Brazil	72607	1912711	2,63	4418388	2,31	6580434	1757056	2404896	619050	232,95	8593926	647,1	198656
	Chile	1336,98	245231	18,34	1213101	49468	910962	282690	0,011	15	327,03	2124052	233,05	17388,44

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 635727.

Continent	Country	Variable												
		Arable Land (1000 ha)	Area Harvested (1000 ha)	Proportion of Arable Land (%)	Production (1000 tonnes)	Yield (tonne/ha)	Import Quantity (1000 tonnes)	Import Value (1000 US$)	Export Quantity (1000 tonnes)	Export Value (1000 US$)	Producer Prices Annual (USD/tonne)	Domestic Consumption (1000 tonnes)	Gross Production Value (constant 2004-2006 million US$)	Population (1000 persons)
	Colombia	1578	5916	0,37	8,99	15196	1499607	503582	0	0	495,46	1508597	2,07	46881,02
	Ecuador	1147,9	9318	0,81	7,45	0,7995	565268	203139	0	0	453,49	572718	1,5	15492
	Peru	4150	151915	3,66	226218	14891	1696622	570877	0,12	200	500	1922,72	46,81	29988
Africa	Ethiopia	15346	1627647	10,61	3434706	21102	1639039	539244	70865	36345	298,53	5002,88	698,91	173475
	Uganda	6900	14	0,2	20	14286	536199	209940	3138	1150		553061		36346

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 635727.

Table 15. Soy database year 2012.

Continent	Country	Variable												
		Arable Land (1000 ha)	Area Harvested (1000 ha)	Proportion of Arable Land (%)	Production (1000 tonnes)	Yield (tonne/ha)	Import Quantity (1000 tonnes)	Import Value (1000 US$)	Export Quantity (1000 tonnes)	Export Value (1000 US$)	Producer Prices Annual (USD/tonne)	Domestic Consumption (1000 tonnes)	Gross Production Value (constant 2004-2006 million US$)	Population (1000 persons)
Europe	Austria	1355,1	37126	2,74	104143	28051	100951	58897	69359	50937	598,72	135735	25,04	8464
	Belgium-Luxembourg													11584
	Belgium	802												11060
	Luxembourg	62,56												524
	Bulgaria	3317	0,248	0,01	0,196	7903	0,624	349	0,051	27	647,37	0,769	0,05	7278
	Croatia	906,4	54109	5,97	96718	17875	1568	1144	56538	35160	604,23	41748	25,31	4307
	Cyprus	85,3					0,002	5	0	0		0,002		1129
	Czech Republic	3157	5742	0,18	13149	22900	29924	15884	7627	4751		35446		10660
	Denmark	2418					88,54	54262	0,215	249		88325		5598
	Estonia	621					2777	1473	2739	2054		0,038		1150
	Finland	2249,1					6776	4507	0	0		6776		5408
	France	18283,49	37367	0,2	103935	27815	647673	400254	38418	27543	594,55	713,19	27,45	63937
	Germany	11834	0	0	0		3447342	1986305	41886	21653		3405456		82800
	Greece	2540	0,286	0,01	0,744	26014	282789	163360	0,042	43		283491		11125
	Hungary	4397	40,91	0,93	67,73	16556	27502	16309	52127	29389	576,36	43105		9976
	Ireland	1170					10942	5450	1188	853		9754		4576
	Italy	7118	152993	2,15	422,13	27591	1207329	656287	51177	41257		1578282	97,18	60885

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 635727.

Continent	Country	Variable												
		Arable Land (1000 ha)	Area Harvested (1000 ha)	Proportion of Arable Land (%)	Production (1000 tonnes)	Yield (tonne/ha)	Import Quantity (1000 tonnes)	Import Value (1000 US$)	Export Quantity (1000 tonnes)	Export Value (1000 US$)	Producer Prices Annual (USD/tonne)	Domestic Consumption (1000 tonnes)	Gross Production Value (constant 2004-2006 million US$)	Population (1000 persons)
	Latvia	1178					17927	9601	7541	3974		10386		2060
	Lithuania	2260,5					3826	1976	0,018	17		3808		3028
	Malta	9					1032	743	0	0		1032		428
	Netherlands	1011					2822559	1593719	1614195	986051		1208364		16714
	Poland	10925	0,855	0,01	1,46	17076						1,46		38211
	Portugal	1122					610627	358150	23098	12997		587529		10604
	Romania	8798	77927	0,89	104,33	13388	63325	38330	89,51	53718	494,22	78145	22,99	21755
	Slovakia	1392,3	21889	1,57	41832	19111	24824	19239	24,27	29894	548,46	42386	11,65	5446
	Slovenia	171,7	0,14	0,08	0,343	24500	205717	116750	198903	111834	512,18	7157	0,08	2068
	Spain	12570	0,5	0	1,2	24000	3313,17	1908936	16455	8426	565,77	3297915		46755
	Sweden	2599					14,74	13865	0,118	335		14622		9511
	United Kingdom	6212					803392	483785	1028	938		802364		63030
America	Argentina	39754	17577,32	44,22	40100196	22814	10114	3061	6158407	3191609	363,66	33951903	7236,37	42095,22
	Bolivia	4353	1292826	29,7	2661,91	20590	9838	7282	298,98	157912	314,61	2372768	353,09	10496
	Brazil	72607	24975258	34,4	65848857	26366	266464	152719	32468028	17248320	508,56	33647293	13589,53	198656
	Chile	1336,98	0	0	0		46,2	28434	6038	13432		40162		17388,44
	Colombia	1578	32521	2,06	86634	26639	285254	171276	0,244	354	668,69	371644	31,34	46881,02

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 635727.

Continent	Country	Variable												
		Arable Land (1000 ha)	Area Harvested (1000 ha)	Proportion of Arable Land (%)	Production (1000 tonnes)	Yield (tonne/ha)	Import Quantity (1000 tonnes)	Import Value (1000 US$)	Export Quantity (1000 tonnes)	Export Value (1000 US$)	Producer Prices Annual (USD/tonne)	Domestic Consumption (1000 tonnes)	Gross Production Value (constant 2004-2006 million US$)	Population (1000 persons)
	Ecuador	1147,9	50	4,36	82	16400	0,218	314	0,102	56	582,69	82116	19,19	15492
	Peru	4150	1236	0,03	2251	18212	92628	51410	0,086	121	856,06	94793	0,75	29988
Africa	Ethiopia	15346	31855	0,21	63653	19982	0,364	407	4221	2660	890,96	59796	14,79	173475
	Uganda	6900	45995	0,67	23	5000	0,324	122	3165	1230		20159		36346

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 635727.

Table 16. Cattle database year 2012.

Continent	Country	Variable										
		Stocks (No.1000)	Production (1000 tonnes)	Yield/carcass weight (tonne/animal)	Import Quantity (1000 tonnes)	Import Value (1000 US$)	Export Quantity (1000 tonnes)	Export Value (1000 US$)	Producer Prices Annual (USD/tonne)	Domestic Consumption (1000 tonnes)	Gross Production Value (constant 2004-2006 million US$)	Population (1000 persons)
Europe	Austria	1976527	222156	0,3268	24177	103540	50317	253221	4923,08	196016	834,43	8464
	Belgium-Luxembourg											11584
	Belgium	2484272	262,28	0,3189	22105	82325	78948	434292		205437		11060
	Luxembourg	188473	8585	0,3581	3167	26342	0,592	3182	4807,69	11,16	54,21	524
	Bulgaria	557641	20377	0,1426	0,992	3729	0,235	1003	2688,34	21134	46,35	7278
	Croatia	452	28,3	0,1284	6297	26820	1026	6720	4839,44	33571	52,07	4307
	Cyprus	56924	5305	0,3174	0,37	2781	0,027	14	3819,23	5648	19,32	1129
	Czech Republic	1353685	66,06	0,2888	5837	27396	4416	19369	3544,72	67481	353,9	10660
	Denmark	1606826	126,7	0,2554	22849	117088	49625	213960	3900,5	99924	342,22	5598
	Estonia	246	12275	0,221	1321	5382	1159	5436	3277,83	12437	44,17	1150
	Finland	912768	81,18	0,3013	1766	6334	0,001	3	3602,56	82945	205,88	5408
	France	19005649	1496865	0,3023	123837	649336	208877	1132364	5125,12	1411825	8112,85	63937
	Germany	12477389	1146255	0,3137	153,05	720973	206989	1028178	4915,74	1092316	4538,79	82800
	Greece	685	74,9	0,2256	86273	426317	0,471	1647	4615,38	160702	311,46	11125
	Hungary	698	25394	0,259	1592	7613	12462	47187	4267,4	14524	105,49	9976
	Ireland	6754,1	495402	0,3339	5859	24315	45994	232964	5313,36	455267	1879,82	4576
	Italy	6251,9	957787	0,2809	266812	1556296	46,02	180248	5896,76	1178579	2893,37	60885
	Latvia	381	17312	0,1711	0,931	3108	8742	29171	2294,36	9501	30,42	2060
	Lithuania	752,4	40902	0,2324	0,346	1244	9041	35957		32207		3028
	Malta	15593	1111	0,2721	0,092	653	0,011	69	4103,01	1192	3,75	428
	Netherlands	3879,25	373531	0,1932	246526	994860	160261	928258		459796		16714

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 635727.

Continent	Country	Variable										
		Stocks (No.1000)	Production (1000 tonnes)	Yield/carcass weight (tonne/animal)	Import Quantity (1000 tonnes)	Import Value (1000 US$)	Export Quantity (1000 tonnes)	Export Value (1000 US$)	Producer Prices Annual (USD/tonne)	Domestic Consumption (1000 tonnes)	Gross Production Value (constant 2004-2006 million US$)	Population (1000 persons)
	Poland	5776767	382,9	0,2464	7276	20759	204879	803115		185297	1007,79	38211
	Portugal	1497,5	92988	0,2275	53934	257177	8084	29746		138838		10604
	Romania	1988939	114464	0,1619	2668	6883	3041	11613	3147,4	114091	357,91	21755
	Slovakia	463358	11721	0,2463	4414	20057	1633	10734	3740,13	14502	73,71	5446
	Slovenia	462,3	33089	0,286	4403	22372	2536	13555	4460,77	34956	128,4	2068
	Spain	5812,6	591319	0,2587	50052	272385	97382	466110	2960,51	543989	1068,73	46755
	Sweden	1500293	120,82	0,3091	12,82	71859	0,155	1070	2777	133485	247,97	9511
	United Kingdom	9900	885	0,3301	72457	298514	59212	213937		898245	3164,79	63030
America	Argentina	49865866	2594336	0,227	0,348	1301	0,357	1476		2594327		42095,22
	Bolivia	8620784	215125	0,1939	0	0	0	0		215125	194,82	10496
	Brazil	211279,08	9307	0,2315	6223	19879	7496	21797		9305727	13244,03	198656
	Chile	3750	197571	0,2592	1201	7576	0,285	1452	3473,59	198487	421,57	17388,44
	Colombia	23493795	854232	0,2071	0,002	12	1326	6134		852908	1798,6	46881,02
	Ecuador	5235,55	265	0,2038	0,006	68	0	0		265006		15492
	Peru	5660948	183799	0,1423	0,176	1216		0		183975	355,16	29988
Africa	Ethiopia	53990061	338,15	0,1073	0,003	17	0,004	15		338149		173475
	Uganda	12840637	191,28	0,15	0	1	0,001	4		191279		36346

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 635727.

Table 17. Pig database year 2012.

Continent	Country	Variable										
		Stocks (No.1000)	Production (1000 tonnes)	Yield/carcass weight (tonne/animal)	Import Quantity (1000 tonnes)	Import Value (1000 US$)	Export Quantity (1000 tonnes)	Export Value (1000 US$)	Producer Prices Annual (USD/tonne)	Domestic Consumption (1000 tonnes)	Gross Production Value (constant 2004-2006 million US$)	Population (1000 persons)
Europe	Austria	3004907	530262	0,0976	67006	172626	96003	287524	2192,31	501265	844,72	8464
	Belgium-Luxembourg											11584
	Belgium	6633613	1109,61	0,0949	64208	161596	579,97	1414888	2019,77	593848	1969,31	11060
	Luxembourg	90023	10608	0,0727	4625	14370	2517	5824		12716	17,39	524
	Bulgaria	608266	73159	0,0708	59718	147415	4017	7419	2863,84	128,86	185,82	7278
	Croatia	1182347	104,1	0,076	19986	59684	0,096	238		123,99		4307
	Cyprus	394706	51723	0,0794	2054	7333	2037	4698	2538,46	51,74	98,66	1129
	Czech Republic	1578827	249869	0,0879	128,67	356679	26722	70150	2133,34	351817	370,65	10660
	Denmark	12330879	1669	0,0857	16424	62474	745367	1803431	2130,56	940057	3041,37	5598
	Estonia	375,1	48831	0,0765	9,25	24119	5,18	13698	2334,64	52901	109,05	1150
	Finland	1290363	192,94	0,09	1622	7067	9331	25770	2089,74	185231	300,26	5408
	France	13759913	2161653	0,0886	150022	481202	393237	933388	1915,22	1918438	3281,83	63937
	Germany	28131,7	5474021	0,0938	837915	1864559	953126	2614206	1993,08	5358,81	7369,47	82800
	Greece	1099	100,87	0,0564	149792	400708	3828	5107	3525,64	246834	265,39	11125
	Hungary	3044	393712	0,0929	96862	278507	77818	209225	2105,2	412756	670,21	9976
	Ireland	1570,6	241493	0,0812	25027	89818	74242	195201		192278	722,82	4576
	Italy	9350,8	1650837	0,1234	779148	1958730	58397	138321		2371588		60885
	Latvia	375	35726	0,0772	23823	54545	2278	7372	1980,04	57271	68,77	2060
	Lithuania	790,3	79439	0,0832	43976	105304	3461	9264		119954		3028
	Malta	45209	5665	0,0825	1017	3612	0	0	2599,56	6682	11,09	428
	Netherlands	12233,65	1331731	0,093	189765	439979	632307	1660592		889189		16714

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 635727.

Continent	Country	Variable										
		Stocks (No.1000)	Production (1000 tonnes)	Yield/carcass weight (tonne/animal)	Import Quantity (1000 tonnes)	Import Value (1000 US$)	Export Quantity (1000 tonnes)	Export Value (1000 US$)	Producer Prices Annual (USD/tonne)	Domestic Consumption (1000 tonnes)	Gross Production Value (constant 2004-2006 million US$)	Population (1000 persons)
	Poland	11581298	1848,6	0,0897	475401	1194875	258467	618131	2159,44	2065534	2441,48	38211
	Portugal	1984	362436	0,0654	97491	281754	14071	43065	2376,92	445856	533,01	10604
	Romania	5363797	442942	0,0826	88426	184481	14007	28463	2485,55	517361	871,4	21755
	Slovakia	580393	67,19	0,0803	54157	209338	12456	69251	1948,72	108891	114,07	5446
	Slovenia	347,31	35607	0,093	30274	94269	2352	8277	2207,31	63529	56,16	2068
	Spain	25250,4	3466323	0,0833	61707	149465	656913	1809841	1729,36	2871117	6272,33	46755
	Sweden	1363364	232,97	0,0901	24968	112931	5268	14863	1678,06	252,67	328,6	9511
	United Kingdom	4481	825	0,0801	222796	650255	113995	213956		933801		63030
America	Argentina	3952,16	331	0,0867	0,644	1753	0	0		331644		42095,22
	Bolivia	2787973	89385	0,0596	0	0	0	0		89385	67,6	10496
	Brazil	38795902	3330	0,0918	0	4	83516	177200		3246484	3037,91	198656
	Chile	3325481	583671	0,098	11273	34559	54214	101850	1506,92	540,73	959,23	17388,44
	Colombia	5526599	238505	0,0801	1165	3216	0	0		239,67	435,12	46881,02
	Ecuador	1161932	205	0,0935	3463	7822	0	0		208463		15492
	Peru	2991012	121,2	0,0512	0,112	337	0,001	9		121311	163,65	29988
Africa	Ethiopia	32,5	1875	0,05	0,002	16	0	0		1877		173475
	Uganda	2439,1	115	0,06	0,011	60	0	0		115011		36346

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 635727.

Table 18. Poultry database year 2012.

Continent	Country	Variable										
		Stocks (No.1000)	Production (1000 tonnes)	Yield/carcass weight (tonne/animal)	Import Quantity (1000 tonnes)	Import Value (1000 US$)	Export Quantity (1000 tonnes)	Export Value (1000 US$)	Producer Prices Annual (USD/tonne)	Domestic Consumption (1000 tonnes)	Gross Production Value (constant 2004-2006 million US$)	Population (1000 persons)
Europe	Austria	16957	108,5	14091	85122	354373	47009	159974		146613		8464
	Belgium-Luxembourg											11584
	Belgium	36078	401745	12996	193531	488142	460807	1022498		134469		11060
	Luxembourg	113	0,239	13819	7252	38463	0,347	2416		7144		524
	Bulgaria	14627	85864	16729	93,56	176276	40692	155021		138732		7278
	Croatia	5142	27,2	0,951	15,25	39049	4,95	13088		37,5		4307
	Cyprus	3925	25297	20118	7737	21436	1177	725		31857	0,51	1129
	Czech Republic	20691	151291	14011	93,59	271596	27812	81859		217069		10660
	Denmark	14679	187895	1841	52346	180733	73412	171211		166829		5598
	Estonia	2171	16,53	16166	16218	31555	5493	11359		27255		1150
	Finland	6333	99,32	16551	4781	25111	12017	19927		92084		5408
	France	216087	1094036	13133	362945	1131594	504851	1275302		952,13		63937
	Germany	136308	903293	14385	488196	1574529	443317	1131708		948172		82800
	Greece	34692	127,2	16737	65827	162394	17925	18995		175102		11125
	Hungary	41377	253843	1823	30415	41939	169488	562105		114,77		9976
	Ireland	16590	88	10878	62297	258820	51705	106310		98592		4576
	Italy	165000	922352	17812	57996	160942	142,34	373323		838008		60885
	Latvia	4418	24,63	16188	23031	38761	8733	23050		38928		2060
	Lithuania	8921	79302	17387	26895	45682	34058	86208		72139		3028
	Malta	983	4244	16565	4421	13826	0,104	159		8561		428
	Netherlands	97016	888521	16591	372311	732412	966237	2371835		294595		16714

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 635727.

Continent	Country	Variable										
		Stocks (No.1000)	Production (1000 tonnes)	Yield/carcass weight (tonne/animal)	Import Quantity (1000 tonnes)	Import Value (1000 US$)	Export Quantity (1000 tonnes)	Export Value (1000 US$)	Producer Prices Annual (USD/tonne)	Domestic Consumption (1000 tonnes)	Gross Production Value (constant 2004-2006 million US$)	Population (1000 persons)
	Poland	129982	1411	18001	38702	47485	515446	1309154		934256		38211
	Portugal	48400	244,41	13642	45288	118326	16312	31827		273386		10604
	Romania	89692	351704	1553	96356	150766	77302	222548		370758		21755
	Slovakia	11251	63401	1601	32111	150951	31225	117940		64287		5446
	Slovenia	2265	54558	16964	14042	44471	17024	45971		51576		2068
	Spain	138860	1193931	16962	119055	337852	115451	240722		1197535		46755
	Sweden	8395	109,67	14273	41727	186598	10426	17839		140971		9511
	United Kingdom	155133	1379	15005	388391	1532905	271315	429557		1496076		63030
America	Argentina	110837	1903	25904	2695	7292	329124	528655		1576571		42095,22
	Bolivia	196108	376315	21322	0,465	855	1777	2132		375003		10496
	Brazil	1277369	11534972	21998	2217	6231	3657637	6948066		7879552		198656
	Chile	80002	566261	22252	69673	131387	100707	282667	2006,35	535227		17388,44
	Colombia	160000	1112246	1	8413	15705	0,902	673		1119757		46881,02
	Ecuador	140703	330	2129	0,859	2693	0,101	70		330758		15492
	Peru	137669	1171466	2035	27132	37365	2701	9916		1195897		29988
Africa	Ethiopia	50377	60,48	0,8	0,004	15	0	2		60484		173475
	Uganda	37572	63	1299	0,745	634	0,061	92		63684		36346

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 635727.

Table 19. Milk (whole cow) database year 2012

Continent	Country	Variable									
		Production (1000 tonnes)	Yield (tonne/ha)	Import Quantity (1000 tonnes)	Import Value (1000 US$)	Export Quantity (1000 tonnes)	Export Value (1000 US$)	Producer Prices Annual (USD/tonne)	Domestic Consumption (1000 tonnes)	Gross Production Value (constant 2004-2006 million US$)	Population (1000 persons)
Europe	Austria	3382076	64177	74987	44443	634776	332266	452,56	2822287	1249,64	8464
	Belgium-Luxembourg							384,01			11584
	Belgium	11238897	51249	0	0	5867	4623	348,11	11233,03	1048,72	11060
	Luxembourg	499731	27458	0,103	125	0,756	473	306,22	499078	111,98	524
	Bulgaria	1093034	35622	20824	14213	6796	4992	409,11	1107062	288,9	7278
	Croatia	785948	44204	81239	48297	23458	18815	423,93	843729	266,7	4307
	Cyprus	153	63226	3775	3028	0,166	321		156609	81,23	1129
	Czech Republic	2814,68	76333	68521	43468	692579	311314	398,21	2190622	941,37	10660
	Denmark	4995,02	85067	23256	13669	194325	124568	461,97	4823951	1914,09	5598
	Estonia	720718	74454	4628	2886	163439	65847	384,55	561907	220,94	1150
	Finland	2296694	80978	27002	16276	11735	11123	575,64	2311961	1009,16	5408
	France	23998422	65872	345,6	195033	780515	462919	428,3	23563507	8866,55	63937
	Germany	30506929	7,28	1617898	704858	1907,39	964858	410,26	30217437	10522,43	82800
	Greece	819,8	38273	78819	57318	0,666	610	577,95	897953	399,43	11125
	Hungary	1812849	71938	107595	59730	326173	146395	391,33	1594271	566,4	9976
	Ireland	5387,77	47228	286653	135923	125882	62962	381,28	5548541	1690,09	4576
	Italy	10579572	60283	1828777	933569	12554	11915	541,79	12395795	4879,65	60885
	Latvia	870633	52905	61726	28462	253677	97980	347,27	678682	234,66	2060
	Lithuania	1774529	53611	388191	154738	95418	48731	334,78	2067302	349,34	3028
	Malta	43,36	67539	3828	2976	0,02	9	628,21	47168	19,88	428
	Netherlands	11675448	75765	475769	257246	382003	193984	409,18	11769214	4239,79	16714

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 635727.

Continent	Country	Variable									
		Production (1000 tonnes)	Yield (tonne/ha)	Import Quantity (1000 tonnes)	Import Value (1000 US$)	Export Quantity (1000 tonnes)	Export Value (1000 US$)	Producer Prices Annual (USD/tonne)	Domestic Consumption (1000 tonnes)	Gross Production Value (constant 2004-2006 million US$)	Population (1000 persons)
	Poland	12667773	51891	109156	55674	228061	131193	368,62	12548868	3493,38	38211
	Portugal	1938	78462	155992	85104	251888	123833	410,26	1842104	754,42	10604
	Romania	4329713	37006	118631	64468	7539	5659	656,07	4440805	1693,51	21755
	Slovakia	973	62321	51,87	26876	179382	91195	357,44	845488	294,03	5446
	Slovenia	620943	56932					385	620943	205,61	2068
	Spain	6313014	76318	484553	223876	151394	105492	389,73	6646173	2382,79	46755
	Sweden	2901	83369	21643	36826	42132	20666	500,74	2880511	1120,08	9511
	United Kingdom	13843	7665	116008	83506	542,47	251335	431,75	13416538	4538,54	63030
America	Argentina	32304421	14166	12104	6595	0,024	31	447,44	32316501	1739,45	42095,22
	Bolivia	2650	2598	0,119	350	1006	973	399,82	2649113	59,81	10496
	Brazil	6482572	12117	0,687	484	0,104	116	420,62	6483155	6413,68	198656
	Chile	5675067	4401	0,129	132	4939	4914	423,66	5670257	575,29	17388,44
	Colombia	1798864	22194	0,584	391	5376	5051	404,07	1794072	1469,41	46881,02
	Ecuador	3804991	0,3552	0,103	165	0		490,96	3805094	1516,19	15492
	Peru	1207,5	0,35	1593	1254	9418	6758		1199675	449,52	29988
Africa	Ethiopia										173475
	Uganda										36346

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 635727.

Table 20. Butter (cow milk) database year 2012.

Continent	Country	Variable									
		Production (1000 tonnes)	Yield (tonne/ha)	Import Quantity (1000 tonnes)	Import Value (1000 US$)	Export Quantity (1000 tonnes)	Export Value (1000 US$)	Producer Prices Annual (USD/tonne)	Domestic Consumption (1000 tonnes)	Gross Production Value (constant 2004-2006 million US$)	Population (1000 persons)
Europe	Austria	35607		12181	55964	1907	9812		45881		8464
	Belgium-Luxembourg										11584
	Belgium	53315		0,002	10	17123	59277		36194		11060
	Luxembourg	1,19		0,059	141	0,702	3260		0,547		524
	Bulgaria	1133		5598	22339	0,929	2748		5802		7278
	Croatia	5,26		1541	6591	1548	7815		5253		4307
	Cyprus			1042	5619	0	0		1042		1129
	Czech Republic	42,24		19504	84016	4,24	16230		57504		10660
	Denmark	38,5		19849	82380	45,04	287113		13309		5598
	Estonia	4		1045	5012	1481	6565		3564		1150
	Finland	51,51		4466	20842	21086	116354		34,89		5408
	France	416,4		140503	565116	75893	295271		481,01		63937
	Germany	447509		118786	483144	103584	439946		462711		82800
	Greece	1		6897	28092	0,062	272		7835		11125
	Hungary	3578		5012	20912	0,775	2967		7815		9976
	Ireland	145		4913	16751	142765	552129		7148		4576
	Italy	100973		26984	116743	8396	31786		119561		60885
	Latvia	5646		2,1	9170	2,14	9607		5606		2060
	Lithuania	10647		1757	7903	5526	21852		6878		3028
	Malta			0,545	2653	0,029	131		0,516		428
	Netherlands	133286		76477	280306	160693	627612		49,07		16714

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 635727.

Continent	Country	Variable									
		Production (1000 tonnes)	Yield (tonne/ha)	Import Quantity (1000 tonnes)	Import Value (1000 US$)	Export Quantity (1000 tonnes)	Export Value (1000 US$)	Producer Prices Annual (USD/tonne)	Domestic Consumption (1000 tonnes)	Gross Production Value (constant 2004-2006 million US$)	Population (1000 persons)
	Poland	171637		8783	41026	30174	114369		150246		38211
	Portugal	28446		9074	37569	18276	67726		19244		10604
	Romania	7,8		4,64	16883	0,452	1439		11988		21755
	Slovakia	7,1		9615	39081	1969			14746		5446
	Slovenia	2602							2602		2068
	Spain	36,7		17166	73432	14,69	57257		39176		46755
	Sweden	36,77		15038	76681	2322	10558		49486		9511
	United Kingdom	145		114989	511191	38037	160855		221952		63030
America	Argentina	93,3		4878	18981	0,614	1752		97564		42095,22
	Bolivia	22,21		0,895	3567	2,89	9629		20215		10496
	Brazil	20,6		0,002	19	0	2		20602		198656
	Chile	23,56		0,032	213	0	0		23592		17388,44
	Colombia	2935		1048	5003	0	0		3983		46881,02
	Ecuador	2		0,014	58	0,021	170		1993		15492
	Peru	0,316		0,016	44	0,181	552		0,151		29988
Africa	Ethiopia										173475
	Uganda										36346

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 635727.

Table 21. Cheese (whole cow) database year 2012.

Continent	Country	Variable									
		Production (1000 tonnes)	Yield (tonne/ha)	Import Quantity (1000 tonnes)	Import Value (1000 US$)	Export Quantity (1000 tonnes)	Export Value (1000 US$)	Producer Prices Annual (USD/tonne)	Domestic Consumption (1000 tonnes)	Gross Production Value (constant 2004-2006 million US$)	Population (1000 persons)
Europe	Austria	165296		94417	483528	78485	417064		181228		8464
	Belgium-Luxembourg										11584
	Belgium	563943		0,505	3313	55,5	254933		508948		11060
	Luxembourg	0		0,69	3304	0	0		0,69		524
	Bulgaria	58945		12851	53111	22002	90372		49794		7278
	Croatia	31,6		11652	50262	1,78	8428		41472		4307
	Cyprus	1,3		9154	44548	10006	80312		0,448		1129
	Czech Republic	112,69		72736	299062	37424	174505		148002		10660
	Denmark	302,7		77656	293482	268399	1402915		111957		5598
	Estonia	42,6		3408	18154	18959	80782		27049		1150
	Finland	102236		58229	302146	31812	159289		128653		5408
	France	1773		247433	1349312	613142	3326502		1407291		63937
	Germany	1381,1		658194	3830537	1045981	4208264		993313		82800
	Greece	41		107672	487364	50578	351144		98094		11125
	Hungary	72215		33914	133255	11366	53402		94763		9976
	Ireland	185,5		48067	202255	183999	822409		49568		4576
	Italy	1203,76		444507	1928245	294525	2519367		1353742		60885
	Latvia	31433		16,27	61633	16204	65725		31499		2060
	Lithuania	52128		7752	33201	79732	350638		-19852		3028
	Malta			6038	30406	0,045	189		5993		428
	Netherlands	764161		220305	885991	702719	3492672		281747		16714

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 635727.

Continent	Country	Variable									
		Production (1000 tonnes)	Yield (tonne/ha)	Import Quantity (1000 tonnes)	Import Value (1000 US$)	Export Quantity (1000 tonnes)	Export Value (1000 US$)	Producer Prices Annual (USD/tonne)	Domestic Consumption (1000 tonnes)	Gross Production Value (constant 2004-2006 million US$)	Population (1000 persons)
	Poland	719		48123	210000	137245	552333		629878		38211
	Portugal	58583		31261	144310	10235	51374		79609		10604
	Romania	60		29355	107616	7255	27109		82,1		21755
	Slovakia	38,4		26689	126971	16668	87432		48421		5446
	Slovenia	17994							17994		2068
	Spain	112,8		219882	967912	53885	312448		278797		46755
	Sweden	101		92192	513233	17178	92989		176014		9511
	United Kingdom	390		390626	1741426	106975	553890		673651		63030
America	Argentina	42		13409	89740	0,876	4267		54533		42095,22
	Bolivia	82,31		17,93	80523	8256	39075		91984		10496
	Brazil	58,5		0,618	4767	0,322	1343		58796		198656
	Chile	97,5		0,168	974	0	382		97668		17388,44
	Colombia	17966		2458	12446	0,027	145		20397		46881,02
	Ecuador	6		0,087	449	0	2		6087		15492
	Peru	0		0,124	436	0,023	21		0,101		29988
Africa	Ethiopia										173475
	Uganda										36346

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 635727.

Table 22. Cream (fresh) database year 2012.

Continent	Country	Variable									
		Production (1000 tonnes)	Yield (tonne/ha)	Import Quantity (1000 tonnes)	Import Value (1000 US$)	Export Quantity (1000 tonnes)	Export Value (1000 US$)	Producer Prices Annual (USD/tonne)	Domestic Consumption (1000 tonnes)	Gross Production Value (constant 2004-2006 million US$)	Population (1000 persons)
Europe	Austria	64739		12,15	22409	13249	23780		63,64		8464
	Belgium-Luxembourg										11584
	Belgium	3,78		0	0	0	0		3,78		11060
	Luxembourg	0		0,33	846	0	0		0,33		524
	Bulgaria	0,075		0	0	0	0		0,075		7278
	Croatia										4307
	Cyprus	0		0,466	982	1421	3275		-0,955		1129
	Czech Republic	47		10431	21322	13705	27373		43726		10660
	Denmark	64,75		16,26	39353	25699	63587		55311		5598
	Estonia	6		3237	6368	4,52	10034		4717		1150
	Finland	41979		1198	2597	11603	30516		31574		5408
	France	397,43		147107	366530	281722	310692		262815		63937
	Germany	542,2		191178	360058	173489	347876		559889		82800
	Greece	4		24299	39290	0,437	891		27862		11125
	Hungary	61,25		7093	13863	0,659	1222		67684		9976
	Ireland	22		5556	19310	2698	9179		24858		4576
	Italy	117594		82854	169614	12283	18596		188165		60885
	Latvia	35,8		2,11	3746	2591	6245		35319		2060
	Lithuania	73,2		0,912	1576	46075	85042		28037		3028
	Malta	0		0,198	455	0	7		0,198		428
	Netherlands	50		76994	94208	117132	250115		9862		16714

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 635727.

Continent	Country	Variable									
		Production (1000 tonnes)	Yield (tonne/ha)	Import Quantity (1000 tonnes)	Import Value (1000 US$)	Export Quantity (1000 tonnes)	Export Value (1000 US$)	Producer Prices Annual (USD/tonne)	Domestic Consumption (1000 tonnes)	Gross Production Value (constant 2004-2006 million US$)	Population (1000 persons)
	Poland	300		14058	29892	50538	99017		263,52		38211
	Portugal	19		12,05	17842	12166	18827		18884		10604
	Romania	0		1129	2380	0,817	1732		0,312		21755
	Slovakia	18		5551	11720	17865	23444		5686		5446
	Slovenia	15,9		0		0			15,9		2068
	Spain	176		12584	26155	70,35	147269		118234		46755
	Sweden	110		23849	52058	1215	2936		132634		9511
	United Kingdom	36,5		31,35	73974	69484	143940		-1634		63030
America	Argentina	7,6		0,005	4	7344	18325		0,261		42095,22
	Bolivia	1,26		0	0	0	0		1,26		10496
	Brazil	0,9		0,06	135	0,128	385		0,832		198656
	Chile	2		0	0	2901	2673		-0,901		17388,44
	Colombia			2051	3087	0	0		2051		46881,02
	Ecuador			0,045	193	0			0,045		15492
	Peru			0,033	30	0,039	75		-0,006		29988
Africa	Ethiopia										173475
	Uganda										36346

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 635727.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 635727.