School of Agriculture, Food and Rural Development

Opportunities & Challenges for the Development of Pulses Markets

Executive summary

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Pulses Health and Nutrition claims

Observational and controlled intervention studies show links between consumption of various pulses and changes in important physiological parameters, which could impact the health of the general population. Pulses may reduce cholesterol, support weight management via glycaemic responses and aid digestive health. However, the evidence directly evaluating effects of controlled consumption of individual pulse types in a free living environment on these markers is still very limited. Thus, there is not sufficient evidence to support a consumer-oriented health claim suitable for use in marketing of British pulses.

Two research strategies could be used to obtain the scientific foundation needed to apply for health claims for British pulses. One would be to assess the health benefits of one particular type of food, which is based on a British pulse, to gain a unique risk reduction health claim for this specific product. The second option for strategy, which is most relevant as a follow-up to the first option, would be to aim for a health claim for a pulse type more generically, as an ingredient in a variety of products, which would enable different companies to use the health claim for any food that contained a sufficiently high percentage of this pulse.

Opportunities for future health claims are listed below in rank of feasibility.

1) Impact upon blood cholesterol/fat, which is approved as a biomarker that can be linked to reduced risk of cardiovascular disease
2) Digestive health (faecal weight, transit time and intestinal comfort)
3) Glycaemic control (less variable blood sugar levels)
4) Support for weight loss

In either case it is important to include:

1) Consumer research to assess consumer understanding and interest in health claims, including target groups, for one product or a range of products.
2) Design and implementation of an intervention trial of appropriate size and quality to form the basis for a health claim dossier.

Environmental benefits of pulse production

Adding pulses to a crop rotation provides a positive impact on the environment, primarily because of legumes' role in fixating nitrogen. Pulses may also improve the health of the subsequent crop reducing the exposure to some crop-specific pests and diseases. If the scale of these benefits is known, the input of fertilisers and pesticides can be reduced accordingly. While there is no published research explicitly valuing the economic benefits of introducing pulses in a rotation and in agriculture more generally, there is clear awareness of the potential benefits originating from moving to a more sustainable agriculture, where pulses can play an important role in reducing the external costs.

There are still significant knowledge gaps in our environmental benefits of leguminous and pulse production, leading to the following opportunities for future research:

- There is a need to better understand the role of legume roots in building soil structure and fertility. The benefits of grain legumes to subsequent crops may be dependent on leaving roots behind. Developing pulses that can serve multiple functions i.e. not only as a harvestable crop, but also as a soil builder may be a way to increase interest in this crop.

- Another research opportunity is to understand the role of pulses in pest suppression.

- The impact of pulses in rotation on biodiversity is still not well understood. This requires farming systems research and novel modelling approaches.

- Then we need social science research to unveil the barriers to farmers incorporating pulses in crop rotations. What type of incentives do market and policy provide farmers to reward those using sustainable farming practices?

- What is the economic value of adding pulses to crop rotations? What are the areas of the ecosystem that will benefit more from this change in agricultural practices?

Pulse market trends

There are four key lessons emerging from the analysis of pulse consumer and marketing trends:

1. The majority of British consumers have reduced the consumption of pulses, particularly in their traditional forms of marketing (canned or frozen). However a range of new pulse based products has been successfully introduced in the market.

2. There seem to be opportunities to develop novel pulse based products and target them at a growing market demand for healthy and sustainable foods.

3. Marketing research companies have identified three categories of consumers willing to increase the consumption of pulse-based products, these are: consumers with food related diseases or conditions; flexitarian and ethnic cuisine consumers; Vegetarian and vegans.

4. Finally, we could not find any recent study evaluating British consumers' attitudes to pulses and pulse based products benefits and barriers to adoption.

This summary of findings lead to the following research needs:

1. Investigate which are the food science and food technological challenges to successfully increase the use of British pulses in the snack, breakfast cereal and bakery new product categories.

2. The pulses industry may need to identify a more attractive and recognizable generic term or name for pulses.

3. At a pre-competitive level, the industry could conduct qualitative studies to understand consumer's levels of knowledge of product as well as what are optimal communication and education strategies to promote pulses to different consumer groups.

4. The industry may consider how to change the position of pulses in the NHS Eatwell plate and determine how it would affect consumers' attitudes, preferences and valuation of pulses.

5. Industry association and individual businesses need to determine the size, location and market value of the emerging health conscious, flexitarian, and vegetarian consumer market segments.

6. Both individual business and industry bodies will need to assess what pulse based products match the preferences of the different consumer segments identified in point 5 above

7. Given the increasing importance of the food service sector, another need for future research is to determine what are the drivers and barriers to increase the use of pulses or pulse based products in the catering and hospitality industry.

SCHOOL OF AGRICULTURE, FOOD AND RURAL DEVELOPMENT

Environmental benefits of pulse production

Report on the sustainability value of pulse production prepared for PGRO

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1. Introduction

Ecosystem services are benefits that society derives from ecosystem functions. While originally conceived by ecologists to describe direct and indirect benefits humans derived from nature, the concept of ecosystem services is increasingly used to describe anthropogenically altered systems, e.g. agroecosystems (Birkhofer et al., 2015). Robertson et al. (2014) identified five categories of ecosystem services that could be delivered by an agroecosystem. These were: provision of food, fibre and fuel, pest control through biocontrol, water purification, climate stabilisation, and soil fertility. It is expected that the incorporation of more pulses into crop rotations in the UK will have a positive effect on delivery of many ecosystem services which are outlined below:

2. Provision of food and fuel

The primary service provided by agroecosystems is, by definition, the provision of food, fibre and fuel. Diversification of the cropping system through the inclusion of pulses should therefore result in a diversified range of products produced at the landscape-scale and increased economic resilience of the local farming system. Impacts of this diversification on diets nationally, and on the agricultural economy are discussed in more detail elsewhere in this report. In the remainder of this section the impacts of pulses in crop rotations on other key ecosystem services will be discussed.

2.1 Soil fertility

The most common explanation for enhanced productivity of other crops in the pulse rotation is the provision of "free" N fixed by legumes to subsequent crops in the rotation (Shah, Shah, Peoples, Schwenke, & Herridge, 2003). While this is true of legumes grown as green manures, the evidence for improved supply of N from grain legumes is inconclusive. Much of the N_2 fixed by grain legumes is usually removed at harvest in high-protein seed and the net residual contributions of fixed N to agricultural soils after the harvest of a legume grain may be relatively small. This was demonstrated in a study in Canada where they showed that faba bean grown for seed returned 28-40 kg N ha^{-1} in its residues compared to 113-128 kg N ha^{-1} when it was grown solely as a green manure (St Luce et al., 2016). However, there was still a positive impact of the faba bean seed crop on the N supply to the subsequent crop, compared to a preceding crop of wheat or canola. The same was true of preceding crops of lentils and field peas. Similar results were obtained by Jensen et al. (2004) who studied N uptake in winter barley that followed a leguminous crop of lupins or peas and found uptake was 18–27 kg N ha^{-1} higher than when the winter barley followed oats. For the lupins this was attributed to N supply from decomposing roots. In unfertilised treatments subsequent crops in the rotation yielded higher than when not preceded by a legume, demonstrating a yield benefit even from this relatively small N input.

Higher amounts of N transfer to subsequent crops has been reported. Research in Australia (Rochester, Peoples, Hulugalle, Gault, & Constable, 2001) showed that faba bean fixed 135±244 kg N ha^{-1} and soybean 453±488 kg N ha^{-1} and that they each contributed up to 155 and 280 kg fixed N ha^{-1} respectively to the soil after seed harvest. This resulted in a reduction in N fertiliser requirements for the following cotton crop of 89 kg N ha^{-1} when the previous crop was a grain legume, and 127 kg N ha^{-1} when it was a green-manure legume. Reductions of N fertiliser needs of this magnitude could represent a significant reduction in production costs for cereal farmers.

In contrast a European study on the impacts of peas and pea/barley intercrops on N dynamics showed no effects of preceding crops of grain legumes on post-harvest soil mineral N content or the yield of a subsequent crop of wheat (Hauggaard-Nielsen et al., 2009). Similarly, a US study found no difference in yield of maize grown in monoculture compared to a two-year maize-soybean rotation, suggesting that in a rotation this "close" there is no added benefit from the grain legume (Riedell, Pikul, Jaradat, & Schumacher, 2009).

In the UK grain legumes are assumed to have moderate potential to supply N to subsequent crops as reflected in the industry's fertiliser N recommendations (RB209; Defra 2010) . Pulses or vegetable legumes are not included in the category of "high N vegetables" when describing previous crops. Instead, previous crops of peas and beans are categorized as slightly better than cereals or sugar beet, but not as good as many types of vegetables (e.g. leafy, nitrogen-rich brassica crops).

Aside from N effects, P cycling in agricultural soils may be improved by including pulses and vegetable legumes in the rotation. P that is "fixed" in insoluble chemical forms may be dissolved by organic acids such as malate and citrate that are exuded from legume roots (Richardson, Hocking, Simpson, & George, 2009), and made available to subsequent crops. This was demonstrated in a pot study where wheat was grown after a variety of legumes (lupin, field pea, faba bean) and uptake of P by the wheat was 30-50% higher when grown after legumes than when grown after wheat (Nuruzzaman, Lambers, Bolland, & Veneklaas, 2005).

2.1.1. Soil structure

Rotating pulses and vegetable legumes may also improve soil structure. Rochester et al. (2001) reported improvements in soil structure in Australian systems with penetrometer resistance lowest when the preceding crop had been faba bean, followed by lablab and field pea. Resistance following wheat, cotton and soybean was higher. Improvements in soil structure may be facilitated by tap-rooted legumes which can break up compacted soil layers aiding in drainage and aeration (Peoples et al., 2009). This benefit may make legumes an important component of rotations where minimum tillage practices are used. Min till practices are most effective when they are part of a systems approach to crop management that includes diversified crop rotations, e.g. those that include legumes (Pittelkow et al., 2014).

2.1.2 Enhanced soil biology

Numerous other benefits to soil biology are reported by Peoples et al. (2009) including reducing the survival of pathogenic nematodes, encouraging mycorrhizal associations and stimulating soil organisms like earthworms. Activity of beneficial plant growth promoting rhizobacteria (PGPR) may also be enhanced by legumes. Recent new evidence is emerging that so-called "inefficient" strains of rhizobia that do not have an effective hydrogenase uptake enzyme system (HUP^-) may "leak" H_2 gas into the soil environment where it is used as an energy source by soil microorganisms capable of oxidising it (for full details see the review by Golding and Dong 2010) . Therefore, including legumes in rotations that host HUP^- rhizobia may have beneficial effects on subsequent crops through promoting populations of PGPR.

2.2 Climate stabilisation

Pulses contribute to climate stabilisation services primarily by reducing the demand for N fertiliser at the rotational scale. The inclusion of pulses in the crop rotation not only benefits subsequent crops by improving soil fertility, but also eliminates the need for N fertiliser in the year of pulse production. This reduces indirect emissions from N fertiliser production during the pulse year. When comparing a typical 3 year arable rotation in the UK (winter wheat-winter barley-oilseed rape), with one that includes pulses, e.g. winter wheat-winter barley-field beans, N fertiliser needs will be approximately one-third less. Since manufacture and distribution of N fertiliser results in emissions of GHG equivalent to 2.86 kg CO_2 per kg N (Kustermann, Kainz, & Hulsbergen, 2008), this could be equivalent to a reduction in emissions of 400-600 kg CO_2e per ha depending on the N fertiliser rate used for the crop replaced by the pulse. This was illustrated in a modelling study by Field et al. (2015) who estimated that the global warming potential of a model farm that was included in a winter wheat-oilseed rape-faba bean rotation would be significantly lower (by up to 100 t CO_2e) than a model farm that included a winter wheat-winter wheat-oilseed rape rotation. This reduction was attributed to reduced emissions from manufacture of N fertiliser in the rotation that included faba beans.

2.3 Energy use

Linked to its impacts on climate stabilisation, the use of legumes can reduce demands on energy. Just as the legume phase of the rotation reduces GHG emissions due to N fertiliser manufacture, it also reduces energy use. This was shown in a study in Switzerland where production of faba bean or field pea crops used 25% less energy than oilseed rape and 36% less energy than wheat and barley on a per hectare basis (E. S. Jensen et al., 2012). Considering the whole rotation, Kirkegaard et al. (2008) found that fossil energy use was 12-30% lower when a legume was included in the rotation compared to rotations without legumes. This is not just due to reductions in N fertiliser use in legume rotations, but can also be attributed to a reduced need for pesticides due to the diversification of the rotation and the consequent reduced energy footprint from pesticides when legumes are used, as discussed in the next section.

2.4 Pest control and disease suppression

Not all the benefits from pulses in rotation can be attributed to N supply. In fact, it has been estimated that 75% of the rotation benefit of legumes is accounted for by other factors (Bullock, 1992). Reducing the inoculum load in the soil for certain soil-borne diseases is one way that a diversified rotation including pulses and vegetable legumes can improve productivity. Cereals following legumes may require up to 25% less fungicide and herbicide application than when they follow a cereal, saving up to €31 ha^{-1} (Von Richthofen et al., 2006). Last year's world record breaking wheat crop in north Northumberland was grown following a crop of spring beans (http://www.fwi.co.uk/arable/northumberland-grower-breaks-world-wheat-yield-record/) which may have contributed to the low disease pressure recorded in the field.

2.5 Landscape biodiversity benefits

Any crop which results in a more diversified crop rotation can enhance landscape biodiversity both in space and in time. This can benefit farmland birds as illustrated in a study by the Royal Society for the Protection of Birds where a biodiversity index (a composite population index based on the relative numbers of 19 farmland birds) increased by 165% over the 13 years since a legume-based rotation was introduced to a farm in Cambridgeshire (Field et al., 2015). Similarly, invertebrate diversity would also be expected to increase with more landscape-scale diversity (Zander et al., 2016).

2. ECONOMIC EVALUATION OF THE BENEFITS FROM THE USE OF PULSES ON ECOSYSTEM QUALITY

The previous sections identified a number of areas where the introduction of pulses in agriculture, particularly in rotation with other crops, can increase the environmental quality of ecosystems. These environmental benefits increase the quality of the environment to the advantage of the whole society, preserving species of plants and animals for the present and for the future (Pearce, Markandya, & Barbier, 1989). However, these benefits tend to be generally non-monetary: farmers engaging in activities that preserve the environment often might incur additional direct or indirect costs (e.g. from losses in yields, or to purchase more expensive phytochemical with low environmental impact), but these costs almost always do not yield any monetary return. These benefits are often referred to a "non-market value" because the market does not reward the additional costs with an additional profit (Drake, 1992). As discussed in the previous section, the introduction of pulses has an important potential to increase the sustainability of agricultural systems, and the resulting environmental benefits might not lead to an economic incentive because:

a. Environmental benefits are public goods: benefits are for all, and it is often impossible to prevent people to enjoy them because they are not contributing to its maintenance. For instance, a beautiful landscape is available to all, independently the number of interested people, and without restrictions.
b. An improved sustainability leads to clear external benefits: for instance, an improved ecosystem improves the quality of groundwater, and reduces the occurrence of diseases brought from water across society also in locations very distant from where the farmer leaves, without recognition to those who contribute to the improvement.

Non-market benefits from are typical of market failure: the market does not reflect the full social costs or benefits of a good or service. These market failures typically characterise natural resources and environmental goods, and also characterise the environmental impacts of intensive agricultural practices (Tilman, Cassman, Matson, Naylor, & Polasky, 2002). Note that besides the environmental benefits mentioned so far, sustainable agroecosystems also have a positive impact in preserving communities and developing skills, local culture, and local knowledge (J. Pretty, 2008).

These non-market benefit can be quantified in order, for instance, to determine public spending decisions that reward behaviours that protect the environment (e.g. subsidies), or to account for the natural capital of a country. Economic valuation methods have been used in several areas of research to measure their costs and benefits of non-market goods to society.

2.1 A brief definition and taxonomy of values

The term "value" refers to the importance an individual give to a good or service. In an economic sense, value refers to the amount of income an individual is willing to give up in order to obtain a certain benefit. Individuals may benefit in more than one way from an improved ecosystem, and the total economic value reflects all the different type of social interests. While the taxonomy of values can be complex, this section focuses on three key types of values relevant to environmental economics:

1. **Use value:** the benefit derived from the actual use of a good/service. The obvious example comes from the marketplace: a person who likes pulses pays to be able to eat them. However, a consumer may derive direct use value from a beautiful agricultural landscape or biodiversity when hiking or fishing. Individuals may also benefit from a landscape or biodiversity without getting close to it (e.g. by watching a TV program), or by directly using goods that are produced *because of* the high environmental quality, e.g. honey; this is called **Indirect use value**.
2. **Option value:** people value goods or services for having the option to use them at some point in the future. For instance, a person living in a city may not benefit from environmental preservation at present, but may value preservation activities because he plans to retire in a rural environment. This option value may not be personal: individuals may value the ability of future generations to have access to environmental spaces, and have a **bequest value**.
3. **Non-use ("passive use") value:** value not associated with actual or optional use of a good or service. Individuals may value a good or service on the basis of the mere knowledge that it exists, even if they know they will never use it. For example, a person might value the protection of a certain landscape or an endangered bird in a remote area of the UK without expecting (or wanting) to go there.

Without going into the details of the estimation, the studies below report values that measure the total economic value, including both use and non-use value (Drake, 1992; Hanley, Schläpfer, & Spurgeon, 2003).

2.2 The economic value of more sustainable agricultural systems

Unsustainable agricultural systems cause significant external costs to society. For instance, they may lead to ground water contamination, making it unsuitable for human consumption; or reduce the amount of biodiversity, for instance reducing the bee population. These costs are external because they are not usually integrated into the economy (e.g. they are not included in the price of agricultural goods). Importantly, these costs can occur sometimes in a relatively distant local and time frame from when the polluting started. Often the impact is mainly felt in groups that are peripheral to society (e.g. rural communities; or urban poor) and responsibilities are difficult to establish. A shift more sustainable agricultural system can lead to a reduction in the external environmental and health costs imposed by agriculture on society.

In a recent review of the sustainable agriculture literature Pretty (2008) show that sustainable practices: increase agricultural yields by an average 79% across the a wide range of agricultural systems and crop types (geometric mean: 64%); often (60% of the studies) reduce pesticide use without losing yields; and increase in carbon sequestration by an average of 0.35 tC/(ha yr).

Given the complexity of measuring sustainability and to identify all the external costs of unsustainable agricultural systems, there are not many studies comprehensively estimating the potential benefits of more sustainable agricultural practices. Pretty et al. (2000) find that the annual total external costs of UK agriculture is in the order of £2,343 M (a value that could reach £3907 M). This value is sizeable: incorporating these external costs would increase the costs to farms by £208/ha of arable and permanent pasture. In the UK, the costs refer to the contamination of drinking water (over £210 M/year), greenhouse gas emissions (£1113 M/year), damage to the soil (just short of

£100 M/year), losses in biodiversity and landscape (circa £130 M/year), and damages to human health (£777 M/year).

Similar estimates for the US (Tegtmeier & Duffy, 2004) identifies total annual external costs from agriculture to sit between $5.7 to $16.9 billion (£3.3 to £9.7 billion), a value that would add $29.44 to $95.68 (£16.87 to £54.82) per cropland hectare. They indicate that the largest impact comes from crop production ($4969 to $16,151 M/year), followed by livestock production ($714 to $739 M/year). Notably, these values refer to conservative estimates of externalities: they tend to primarily focus on external costs that cause a financial loss in the economy, therefore excluding those areas where the external costs do not have a market impact (e.g. losses in the birds population). As a result, these values can be a mild as well as a severe underestimate of the actual total negative external costs associated to agriculture, despite originating from very thorough and high-quality research.

2.3 The economic value of using pulses on rotations.

There are only a limited number of studies estimating the external costs of agriculture and we could not find any studies assessing the economic benefits of pulses on rotations. The closest recent work on the addition of pulses in crop rotations we could find is Gan et al. (2015) who show that the addition of pulses leads to an:

- increase in the moisture of the soil;
- increase in nitrogen available in the soil;
- increase in crop production by 36%;
- increases the amount of protein in cereals by 51%; and increased the efficiency of nitrogen fertilizer use by 33%.

Despite these benefits, which can improve cereal productivity whilst reducing the needs for nitrogen fertilization, which may decrease global warming and environmental pollution, most farmers don't seem interested in integrate pulses in agricultural production. This failure in itself causes possibly large external costs to the environment, by causing an unnecessary overconsumption of fertilisers and chemicals that reduce the environmental quality of soils and ecosystems.

Magrini et al. (2016) show this situation was caused by favourable economic conditions of cereal markets and to an increase in low-priced imported pulses (mainly soybeans), which in turn discouraged pulses production in continental Europe. This market-driven situation resulted in the evolution of crop systems based on stimulating production by using agrochemicals to keep costs down, rather than focusing on more sustainable alternatives.

A consequence of the Magrini et al (2016) study is a need to more clearly understand economic incentives to increase the use of pulses in rotations, ensuring markets and trade policies reward those using more sustainable practices. Also there is a need to more systematically assess the external benefits earned from shifting to a system that adds pulses in agricultural systems that rotate crops.

3. CONCLUSIONS

This report briefly summarised key knowledge on the beneficial impact of adding pulses to rotation on the environment. Because of their role in fixating nitrogen, pulses can be an extremely important part of a sustainable agriculture because they can increase the nitrogen content of soils without impacting the need for chemical supplementation. The

first part of this report highlights these benefits. A second part advances this point, quantifying the economic benefits. While there is no research explicitly valuing the benefit of pulses in rotation and in agriculture more generally from an economic standpoint, there is clear awareness of the potential benefits originating from moving to a more sustainable agriculture. Pulses can play an important role in reducing the external costs of agriculture, therefore

4. Research needs

- There is a need to better understand the role of legume roots in building soil structure and fertility. With grain legumes, N benefits to the subsequent crop may be dependent on the roots that are left behind. This means that the size of the root system and its N content could be important as well as the yield of the pulse. Developing pulses that can serve multiple functions i.e. not only as a harvestable crop, but also as a soil builder providing N to the next crop and also improving soil structure in min till rotations, may be a way to increase interest in this crop.
- More research on the role of pulses in rotations in pest suppression is needed. At what stage of the rotation is a pulse most effective in suppressing soil borne diseases? What factors determine this effectiveness?
- The impact of pulses in rotation on biodiversity is still not well understood. The scale that the diversity needs to be at is not yet understood i.e. what is the optimum field size and diversity of annual crops in a landscape for optimum diversity? This requires farming systems research and modelling approaches.
- What are the barriers to farmers incorporating pulses in crop rotations? What type of incentives do market and policy provide farmers to reward those using sustainable farming practices?
- What is the economic value of adding pulses to crops rotation? What are the areas of the ecosystem that will benefit more from this change in agricultural practices?

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SCHOOL OF AGRICULTURE, FOOD AND RURAL DEVELOPMENT

Pulses Health and Nutrition claims

Report identifying existing and potential use of nutrition and health claims in pulse based products prepared for N8 Industry Innovation Forum

Anthony Watson & Kirsten Brandt

4/3/2017

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1.0 British Pulses

Staple British pulse crops can be divided into three main categories; combining peas, winter beans and spring beans (PGRO 2016). Table 1 contains the pulse varieties recommended by the PGRO (http://www.pgro.org/index.php/agronomy-guides-publications/recommended-lists-2016, 2016) and their average nutritional content. It must be noted that there are no reliable sources of the nutritional composition of British grown pulses. The data represented are therefore collected from multi-national sources.

2.0 What are Nutrition and Health Claims?

Due to the 2016 EU referendum result, it is unclear how claims on foods products sold in the UK will be governed in the future. This document will focus upon the current legislation set out by the European Union with the expectation that similar principles will be used after the UK leaves the EU.

Since 2006, the European Union has regulated the use of nutrition and health claims for foods (Regulation (EC) No 1924/2006 (foods, 2007). These regulations lay down harmonised EU-wide rules for the use of health or nutritional claims on foodstuffs based on scientific consensus or new evidence. The key objective of this Regulation is to ensure that any claim made on a food label in the EU is clear and substantiated by generally agreed scientific standards. Three types of claim exist, nutrition claims; comparative claims and health claims (Efsa Panel on Dietetic Products and Allergies, 2011).

- Nutrition claims refer to statements which directly refer to a food or group of foods. “High in fibre”, “low in salt”, “low in saturated fat”.

- Comparative claims can be made between foods of the same category, taking into consideration a range of foods of that category. The difference in the quantity of a nutrient and/or the energy value shall be stated and the comparison shall relate to the same quantity of food.

- Health claims are statements which relate to a relationship between food and health. Health claims can be split into three main categories:

    - Functional health claims (Article 13 claims) - Referring to the growth and development of normal functions within the body.

    - Risk reduction claims (article 14(1)(a) claims) – Referring to claims which describe the ability of a food to reduce the risk of developing a certain disease

    - Claims referring to a child`s development (Article 14 (1)(b)

- The health claim must however not “Attribute to any foodstuff the property of treating or curing a human disease, or referring to such properties” (Article 7 (3) of Regulation 1169/2011). For this reason research into pulses should not focus on the treatment of a specific illness.

Table 1. British pulse varieties and their nutritional composition.

Pulse variations	**Variety**	**Nutritional content /100g cooked weight**																														Source
		Energy (Kcal)	(gram)	(g)	ed fat (g)	ted fat (g)	Trans fat (g)	Carbohydrates (g)	Sugar (g)	Protein (g)	(g)	Vitamin A (IU)	(mg)	Vitamin D	(mg)	(mcg)	Thiamin (mg)	(mg)	Niacin (mg)	(mg)	Folate (mcg)	(mcg)	Calcium (mg)	Iron (mg)	(mg)	(mg)	(mg)	Sodium (mg)	Zinc (mg)	Copper (mg)	(mg)	(mcg)	Fluoride (mg)	
Combining peas	White peas / Navy beans	140	0.6	0.1	0.5	0.1	0	26	0.4	8	11	0	0.9	0	0	0.6	0.2	0.1	0.6	0.1	140	0	69	2.4	53	144	389	0	1	0.2	0.5	2.9	2.2	U.S. Department of Agriculture, Agricultural Research Service. 2008. USDA National Nutrient Database for Standard Reference, Release 21. Nutrient Data Laboratory Home Page, http://www.ars.usda.gov/ba/bhnrc/ndl

	Maple peas	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
	Marrow fat peas (canned)	87	0.8	0.1	-	-	-	13.8	0.9	6.9	5	-	Trace	0	0.3	-	0.1	0.04	1.5	0.1	11	-	26	1.5	22	100	160	160	0.7	0.04	0.20	trace	-	Composition of foods integrated dataset (CoFID). Public Health England.
Spring beans and Winter beans	Pale (green) hilums	141	6	1	3	1.2	0	11	-	12	4	156	17	0	0	0	0.3	0.2	1.3	0.1	111	-	154	2.5	6	158	539	14	0.9	0.1	0.5	1.4	0	U.S. Department of Agriculture, Agricultural Research Service. 2008. USDA National Nutrient Database for Standard Reference, Release 21. Nutrient Data Laboratory Home Page, http://www.ars.usda.gov/ba/bhnrc/ndl

	Black hilums	99	5	0.8	-	-	-	7	1	9	6	412	0	-	-	-	-	-	-	-	-	-	65.9	2.2	-	-	-	24.7	-	-	-	-	-	U.S. Department of Agriculture, Agricultural Research Service. 2008. USDA National Nutrient Database for Standard Reference, Release 21. Nutrient Data Laboratory Home Page, http://www.ars.usda.gov/ba/bhnrc/ndl

Pulse list taken from (http://www.pgro.org/index.php/agronomy-guides-publications/recommended-lists-2016, 2016) '--' indicates that no reliable nutritional information is available.

2.1 Current health claims

Currently, there are no accepted health claims on EU the register of nutrition and health claims relating to any Pulse species, product, or food as a whole; nor are there any currently under review.

2.2 Current nutrient claims

As outlined in table 1, pulses are a source of protein, carbohydrates, soluble and insoluble fibre, vitamins and are low in fat. Within the Eat Well Guide published by the Food Standard Agency (FSA), pulses are represented in the protein section, along with other more conventional sources of protein such as; meat, eggs and fish. The FSA recommendation is to "eat more beans and pulses" with no advice of serving size or frequency.

There are several recognised nutrition claims which can be used to market Pulses as healthy types of food. Table 2 below lists the current nutrient claims, which can apply to British pulses, either on their own or in a food formulation. These nutrient claims can be used for the products that they apply to, including as part of a campaign based on generally recognised nutritional benefits of British pulses as ingredients in a range of foods.

Table 2. Current ESFA approved nutritional claims which can be used to market UK grown pulses.

Claim	**Conditions**	**Pulse claim can be used against in cooked form**
Claims applicable to pulses (almost) irrespective of processing		
Source of fibre	Product contains at least 3g of fibre per 100g or at least 1.5g of fibre per 100kcal	White peas, Marrowfat peas, pale hilum, dark hilum
High fibre	Product contains at least 6g of fibre per 100g or at least 3g of fibre per 100kcal	White peas, dark hilum
Source of protein	At least 12% of the energy value of the food is provided by protein	White peas, Marrowfat peas, pale hilum, dark hilum
High in protein	At least 20% of the energy value of the food is provided by protein	White peas, Marrowfat peas, pale hilum, dark hilum
Claims applicable to pulses if processed accordingly (with no or little addition of fat/salt)		
Foods low in fat	Product contains no more than – 3g of fat per 100g for solids or 1.5g of fat per 100ml for liquids	White peas, Marrowfat peas

Foods with a low or reduced content of saturated fatty acids	The sum of saturated fatty acids and trans-fatty acids in the product does not exceed 1.5g per 100g for solids or 0.75g per 100ml for liquids and in either case, the sum of saturated fatty acids and trans-fatty acids must not provide more than 10% of energy	White peas, Marrowfat peas, pale hilum, dark hilum
Foods with a low or reduced content of sodium	Product contains no more than 0.12g of sodium, or 0.3g of salt, per 100g or per 100ml	White peas, pale hilum, dark hilum
Foods very low in sodium/salt	Product contains no more than 0.04g of sodium, or 0.1g of salt, per 100g or per 100ml	White peas, pale hilum, dark hilum

2.3 Example product using nutrition claims

Products are currently on sale in the UK which are marketed based on the nutrient content of pulses. These products have a competitive advantage in the growing market of health foods when compared to other products which are not marketed in such a way. For example, a major manufacturer is Calbee UK who currently market YUSHOi Snapea rice sticks which are made from 74% British green peas. These pea snacks are marketed as "high in fibre*" and "a source of protein". Calbee UK have seen exceptional growth in profits since their launch with a turnover of £750,000 in year 1 and £5.7 million in year two. Growth is projected to hit £60m in year 5 indicating a great potential, which may be applicable for other pulse based products.

3.0 Potential future health claims

Other than the above standardised health messages allowed by EFSA, there are no specific public health messages pertaining to the consumption of pulses in the UK (EU). The literature, however, contains evidence to support health benefits of pulse consumption. Several likely health benefits are highlighted in the scientific literature, which demonstrate that individual health claims may be substantiated with further research.

3.1 Cardiovascular disease

Pulses contain nutritional constituents that could prevent the onset of cardiovascular disease. These include soluble fibre, folate and phytochemicals, of which dietary fibre has received the most attention. A recent systematic review and meta-analysis of dietary fibre intake and risk of cardiovascular disease (Threapleton et al., 2013), concluded that "total dietary fibre; insoluble type fibre; and fibre from cereal, fruit, or vegetable sources are associated with a lower risk of CVD and coronary heart disease (CHD) in healthy populations". The meta-analysis, which included pulses and legumes in the assessment of 'vegetables', describes a significant reduction in CHD and CVD risk with increasing soluble and insoluble fibre intake from 'vegetables'. There

was a significantly lower risk of CHD and CVD associated with greater intakes of 'vegetable' fibre, up to intakes about 6 g/day for CHD or 10 g/day for CVD. Overall, a reduced risk of 9% was seen for both CVD and CHD with every additional 7 g/day of total fibre consumed. In relation to pulses, this would relate to a serving of approximately 80g of Navy beans per day.

In 2010 the Agriculture and Agri-Food Canada commissioned a review of the scientific literature with the aim to better understand the relationship between pulses and cardiovascular disease risk factors (a summary of this report can be requested from www.agr.gc.ca/food-regulatory-issues). The systematic review highlighted a highly consistent effects of whole pulse consumption upon LDL cholesterol levels (lower) but not HDL or triglycerides, resulting in a moderate association between pulse consumption and changes in blood cholesterol. The review, however, does not differentiate between pulse types and contains mostly pulses such as chickpeas or various types of beans that are not grown in the UK or "mixed pulses" of which only a portion are relevant to the UK industry.

Of the 12 papers included in the meta-analysis, only 1 paper, on field beans, assesses pulses relevant for UK production (Fruhbeck et al., 1997). In this study, 4 groups of 10 men consumed either 90 g bean flour (cooked or raw) or 90 g of control powder (potato + milk powder) per day for 30 days. In the groups receiving the field bean flour, changes in cholesterol composition during this period reduced the LDL/HDL ratio by 0.7 unit and the TC/HDL ratio by 1.0. These differences are similar to what in another study corresponded to between 50% and 200% reductions in the risk of cardiovascular incidents such as heart attacks (Manickam et al., 2011).

3.2 Blood sugar management and weight loss

The control of blood glucose is essential for the treatment and prevention of diabetes. Pulses contain carbohydrates which are low on the GI index. For example Navy beans have a GI index of 30 (glucose = 100). This is considerably lower when compared to food such as wholemeal bread (GI of 77). This means that carbohydrates are more slowly released, which in turn reduces the insulin and glucose spikes associated with consuming carbohydrates. Studies with other types of food indicate that low GI foods often can help with the management and prevention of metabolic diseases such as diabetes mellitus and aid satiety.

A recent review of 9 intervention trials reported an average 31% increase in subjective satiety when meals containing pulses were compared to control meals (Li et al., 2014). However it must be noted that calorie intake during a subsequent meal was not affected. A 2016 review of 21 randomised controlled trials which investigated the effect of exchanging whole dietary pulses for other dietary components for >3 weeks upon body weight of adults reported an overall weight loss (<1kg) even when this was not part of a weight loss programme (Kim et al., 2016). It was concluded that this weight loss could be supported by the satiating nature of pulses brought about by their high fibre and protein content and low GI rating. However only four of the published studies tested the use of pulses as an aid to weight loss under appropriately controlled conditions, and all 4 of these trials investigated a diet of mixed pulses, therefore, while constituting important supporting evidence, they cannot directly be used to justify a health claim for the species grown in Britain.

In terms of glucose regulation, in diabetic patients, consuming 1 cup of legumes and pulses per day as part of a low GI diet improved both glycaemic control and reduced calculated CHD risk score to a greater extent than a low GI diet supplemented with wheat as a source of high soluble

fibre (Jenkins et al., 2012). In healthy adults, the low GI of pulses lowers glucose levels after consumption when compared to consuming a standard test meal. The glycaemic response after consuming pulses has been shown to be dependent upon the pulse type, other foods in the meal and subsequent meals (Mollard et al., 2011). Isolated pea protein and isolated pea protein combined with hull fibre can also reduce blood glucose levels, although still with no influence upon satiety as measured by second meal calorie intake (Mollard et al., 2014).

3.3 Gut health

Pulses contain high levels of non-digestible carbohydrates which reach the lower colon (Mussatto and Mancilha, 2007), constituents which retain their functionality after cooking (McCleary and Rossiter, 2004). These non-digestible carbohydrates have been shown to increase stool volume and normalise transit time in adults with a slow transit time (>48h) (de Vries et al., 2016). They influence gut microbiota (Mussatto and Mancilha, 2007) which may be a mechanism for some of the previously mentioned effects. Consumption of pulses has also been correlated with a reduced risk of colorectal cancers (Cassidy et al., 1994). Reduced transit time, more frequent bowel movements, increased faecal bulk, or softer stools, may be considered by the EFSA as beneficial physiological effects, provided they do not become so extreme that they result in diarrhoea.

Fractions of pulses (4g of pea hull fibre per day for six weeks) have been shown to significantly increase bowel movement frequency and faecal weight in in elderly care home residents with low stool frequency (Dahl et al., 2003). 100g of dry weight green peas, chickpeas and lentils (added to daily diet as a freeze dried powder) per day for 28 days had no effect upon frequency or flatulence in healthy males with normal bowel habits when compared to potato (Veenstra et al., 2010). Potentially indicating a normalising effect of consuming pulse fibre upon bowel function. This data also indicates that bowel habits of otherwise healthy adults would not be negatively affected by adding pulses to a normal diet, making approval of a health claim more feasible.

4.0 Summary

Literature from observational and controlled intervention studies show links between consuming various pulses and the modulation of important physiological parameters which could impact the health of the general population. Data suggests that pulses may reduce cholesterol, support weight management via glycaemic responses and aid digestive health. However data directly evaluating effects of controlled consumption of individual pulse types in a free living environment on these markers are still very limited, and not sufficient to obtain a consumer-oriented health claim suitable for use in marketing of British pulses. Although there is some evidence to support each of these health benefits, it is still necessary to establish required and sufficient portion sizes and consumption schedules, and this needs to be done for each pulse type since the data are not sufficient to quantify differences among them. Future health claims are listed below in rank of feasibility.

1) Impact upon blood cholesterol/fat, which is approved as a biomarker that can be linked to reduced risk of cardiovascular disease

2) Digestive health (faecal weight, transit time and intestinal comfort)

3) Glycaemic control (less variable blood sugar levels)

4) Support for weight loss

5.0 Future research

For a health claim to be accepted by the EFSA, the food must have reliable data which provides evidence of a nutritional or physiological benefit to consumers (Article 5 of Regulation 1924/2006). A specific health claim usually covers only one well-defined food (the one that has been investigated), unless there is evidence that the studied effect can be generalised across several foods, for example if it can be shown to be caused by a specific constituent, which is present in several foods. Due to this, initially one pulse must be chosen to be investigated.

There are thus two research strategies which could be used to attain the scientific foundation needed to apply for health claims for British pulses. One would be to assess the health benefits of one particular type of food, which is based on a single British pulse to gain a unique risk reduction health claim for this specific product. The second option for strategy would be to aim for a health claim for a pulse type more generically, as an ingredient in a variety of products, which would enable different companies to use the health claim for any food that contained a sufficiently high percentage of this pulse.

In either case it is important to include:

1) Consumer research to assess consumer understanding and interest in health claims, including target groups, for one product or a range of products.

2) Design and implementation of an intervention trial of appropriate size and quality to form the basis for a health claim dossier.

It would be feasible (and is our recommendation) to start with the first strategy (one specific product), which can then be used as part of the second strategy, which would require tests of other products employing the same ingredient. A controlled nutritional intervention trial should be undertaken which assesses the impact of one pulse based product upon the relevant health outcomes. Based on the existing science, benefits are likely to be identified for blood cholesterol, bowel comfort, glycaemic response and weight loss. It is important that the research includes:

a. Dosing and consumption schedule that the conditions of use for future health claim messages can be based on.

b. A measurement of timescale – How long it takes for the positive effects to be found

c. The use of only one chosen British pulse based food

A nutritional intervention of this type would cost circa £400,000 and take approximately 2 years to complete from the planning to delivery. Almost all the costs are related to organising and implementing the intervention, the costs are not much lower if only fewer outcomes were tested.

A between subjects trial as outlined in figure 1 would be the most appropriate for this type of intervention as it would allow for an intervention period of 12 weeks or more without issues with compliance. Of the 4 main themes set out in section 3.4, the intervention trials should be set out into 2 projects. The first would assess the impact of consuming pulses upon cardiovascular and digestive health and the second would assesses the impact of consuming pulses upon weight loss and blood glucose regulation. This is because weight loss trials need to incorporate a weight loss strategy, such as calorie restriction, in all treatment groups; a factor which may impact markers of cardiovascular health.

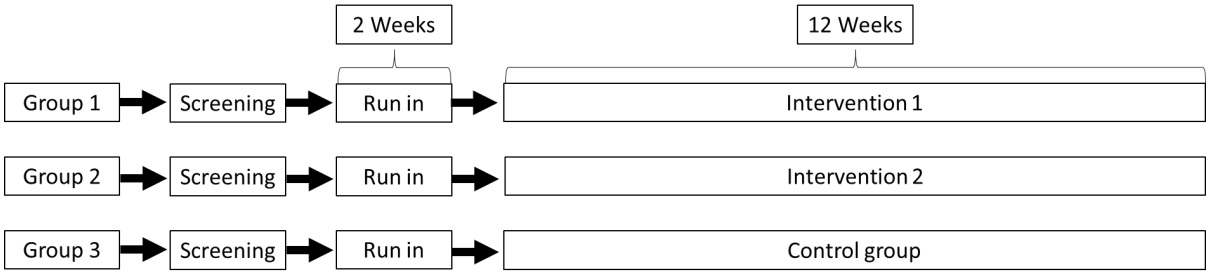

Figure 1. Between subjects design trial to investigate the physiological impacts of consuming pulse based foods.

These data, along with technical data defining the tested food and a systematic review of all published data considered relevant for the health claim would then form a dossier which could be submitted to the NDA panel of the European Food Standards Authority or the appropriate corresponding UK body if the UK establishes a separate national health claim system which has become operational at this time.

Once this process is in progress or completed, it would be relevant to carry out a technical review of which other products could be manufactured using a high proportion of pulses, followed by research as needed to provide missing data. Data from these trials and research projects can then be used to assess the physiological effects of a range of products containing pulses or pulse derivatives; for example pea flour added to bread.

5.1 Further options for research

To complement such relatively large human intervention trials, further options to conduct research include MPhil, MRres and PhD projects. MRes projects would be smaller than those discussed in section 4.0 and would generally be an inexpensive way of producing pilot data for a proof of concept, most suitably focused on consumer acceptance of products and ingredients. This could however also encompass formulation of new ready to eat foods or small pilot human intervention trials.

PhD projects could be used to collect considerable amounts of data, including multiple medium sized human intervention trials. This process is however often rather lengthy, taking at least 3 years for the project to be completed and data interpretation finalised. The cost of a PhD studentship is approximately £32000 per year for three years plus trial running and consumable costs.

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SCHOOL OF AGRICULTURE, FOOD AND RURAL DEVELOPMENT

Pulse market trends

Report on consumer and market trends prepared for PGRO

Diogo Souza Monteiro, Ya Wen Cheng, Elena Benedetti & Luca Panzone

4/3/2017

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1. Introduction

The consumption of dry, frozen and canned pulses has been declining in the UK in the last few decades but particularly since the turn of the millennium. However, in the last three years there has been a renewed interested and demand for pulses as ingredients in new products categories. A number of opportunities are arising for pulse producers willing to work with food processors developing products to meet an increasing demand for healthier products. Also, pulse base products have a market in the emerging segments of the population concerned with products that are free from lactose or gluten, vegetarians, vegans and flexitarians as well as those with health and environment protection concerns.

Pulses are rich in protein, fiber and vitamins. Also these products have the potential to substitute imported carbohydrate and protein rich ingredients used by the British food processing industry. Moreover, recent studies have demonstrated their health and nutritional value of pulse based products[1]. The wide variety of pulses makes these products versatile and able to play a key role in healthier and more sustainable diets. Their diversity also enables their incorporation in a wide range of uses, such as main dishes, snacks, soups or even deserts.

However, to successfully substitute current ingredients used in the food industry with UK-based pulses there need to be studies on the technological and economic conditions of using British pulses as ingredients. Also, one of our main findings is that consumers seem have limited recognition and a poor image of pulses. Thus, consumer acceptance is a key challenge for the successful development of British Pulses markets. This will require cooperation and coordination of efforts among the different agents in this industry in order to reap the potential rewards for British industry and society from increasing pulse consumption.

This report presents the findings of desk research describing the current and past consumption patterns of different protein sources. It has three main goals: firstly to provide an overview of traditional pulses (i.e., fresh, frozen, canned) and emergent pulse based markets. Secondly it is to identify opportunities for the UK pulse industry. Third is to identify needs for research to support the sustained growth of pulse markets.

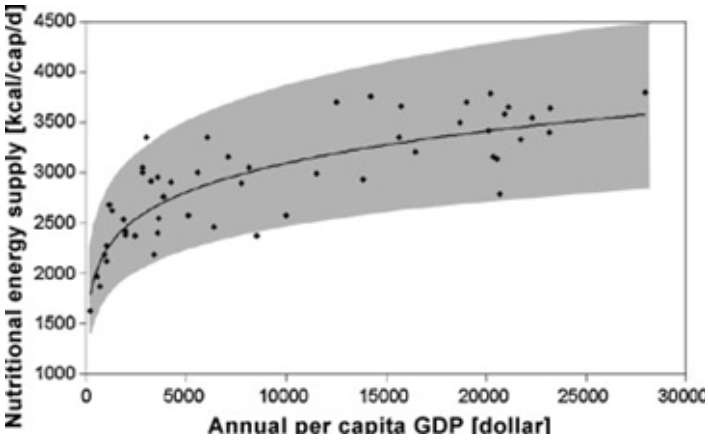
2. Global and British Protein and Pulses Consumption Trends

In most regions of the world there has been an increase in purchasing power, causing a demand for more food (Latham, 2000). Fogel & Helmchen (2002) found that economic development lead to shifts in food consumption patterns, claiming that income growth led to both demand for *more quantities* but also more *variety* of food. In other words increases in incomes not only raise quantities demanded but also diet diversification. Examining FAO balance sheet data Gerbens Leenes, Nonhebel and Krol (2010) show there is a positive correlation between income and increases in food supply and varying food composition. This relation can be seen in figure 1, which shows how the total

[1] See the report titled identification of health and nutrition claims to market British Pulses.

energy from food nutrients changes with levels of income. What the figure shows is that the daily energy requirements for healthy living are met has soon as countries have a US$5000 annual gross domestic income per capita. However, the growth of demand for energy increases at a decreasing rate with increases in GDP. What this suggests is that with higher incomes consumers shift the composition of their diets.

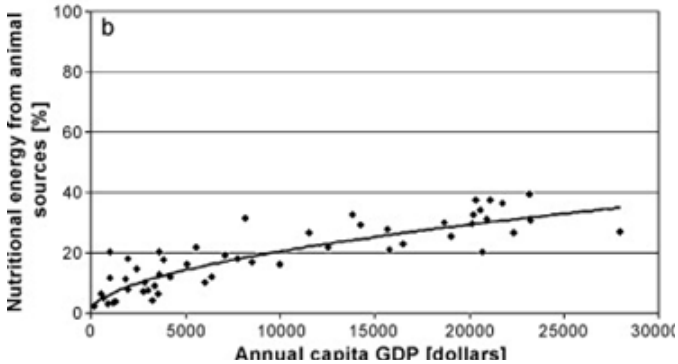
Figure 1: Relating total energy from food supplied with level of Gross Domestic product (GDP)



Source: Gerbens-Leenes, P., Nonhebel, S. and Krol, M. (2010)

Further evidence to this observation is shown in Figure 2, where it can be seen that in high-income countries a larger proportion of nutritional energy comes from consumption of animal products. However, it is interesting to observe that recently high income consumer segments in the richest countries in world are reducing their meat consumption (Jobse-van Putten, 1995; DEFRA, 2015). This general pattern for developed and high income per capita countries, such as the UK, may open interesting prospects for nutritional balanced products such as pulses. To further examine this global trend the next section explores recent trend in sources of protein in British diets.

Figure 2 Proportion of energy from animal level of Gross Domestic product (GDP)



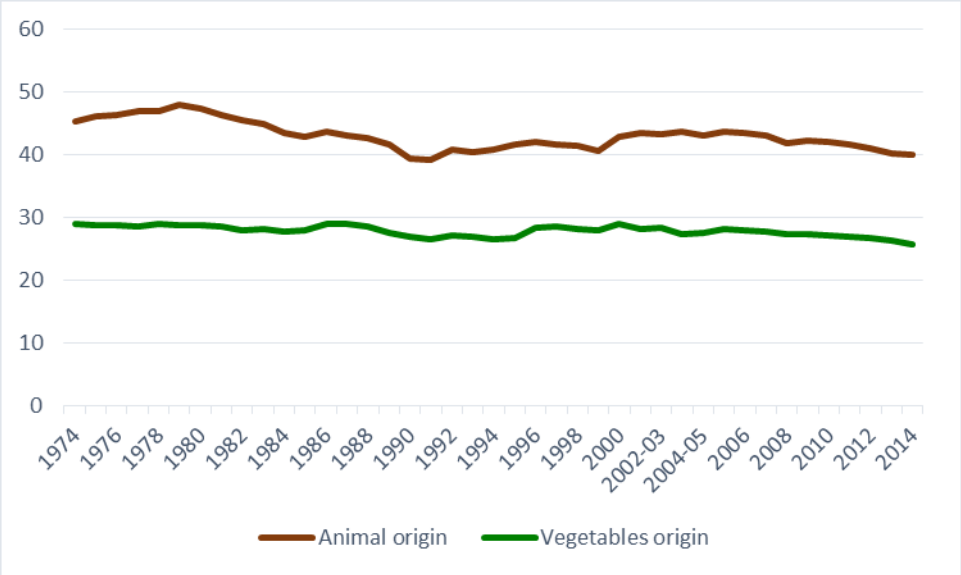
Source: Gerbens-Leenes, P., Nonhebel, S. and Krol, M. (2010)

2.1 Protein consumption in the UK, 1974-2014

Protein consumption in the UK has been relatively stable in the past 40 years. The National Health Service (NHS) recommends each person consumes between 75-80g of protein a day. However, this guidance is not specific about the sources of proteins. Figure 3 below shows a breakdown of protein source in British diets. In line with the

global trends for sources of energy in food shown in figure 2, it is clear that in the UK more protein is consumed from animal products than from vegetables. It is also worth noticing that in the last 40 years, the consumption of protein has been rather stable, as would be expected in a high income country.

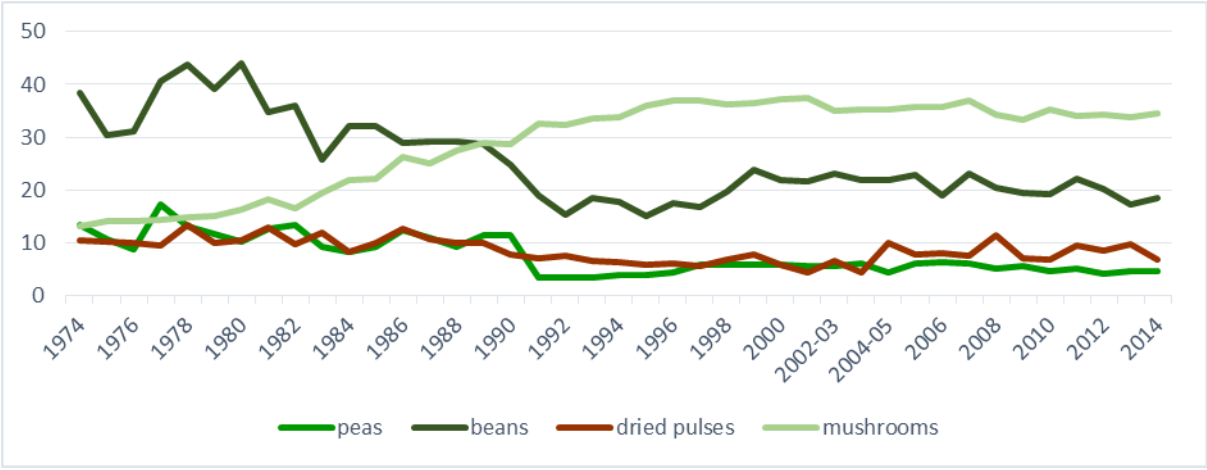
Fig. 3: Sources of protein in British households diets, 1974 and 2014, g/person/day.



Source: DEFRA 2015

Focusing now on the vegetable protein sources, Figure 4 shows a substantial degree of substitution across pulse products. Specifically the consumption of beans declined fairly steadily over the last 40 years. While peas and dried pulses consumption also declined, they had a smaller drop in consumption than beans and primarily this occurred between 1990 and 1993. It is worth noting that in the same period there has been a steady increase in the consumption of mushrooms.

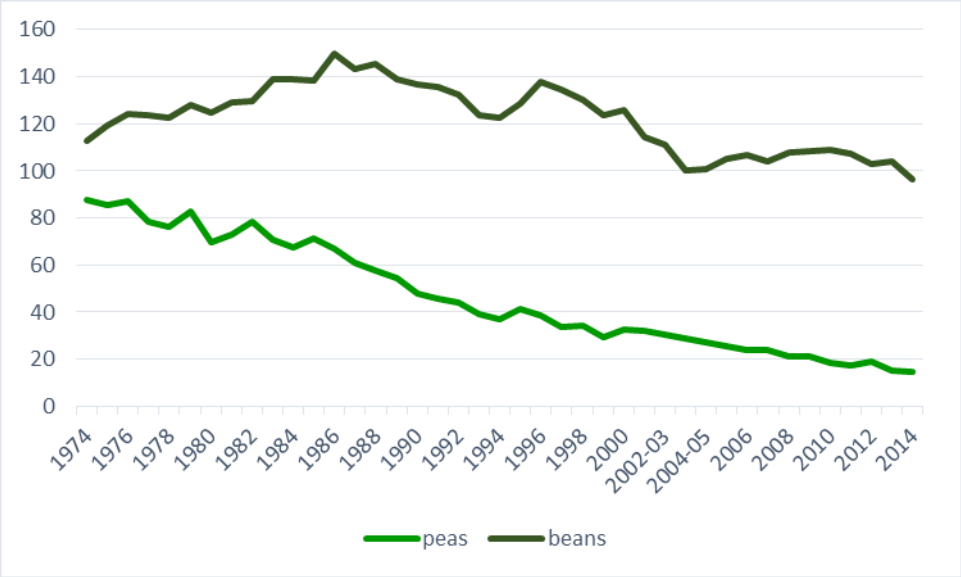
Fig. 4: Trends in consumption of vegetable protein sources 1974-2014, g/person/day.



Source: DEFRA 2015

To finalize this first general overview of the pulses markets, we focus our attention on two pulses markets trends: the canned and frozen market. Figure 5, reports trends on the canned market comparing beans with peas. What the figure clearly shows is that, contrary to what was observed in figure 4, the decline in consumption of canned peas has been sharper than that of beans in the last 40 years. Given that most canned peas come from marrow flat peas, this trend explains why producers have seen their incomes decline.

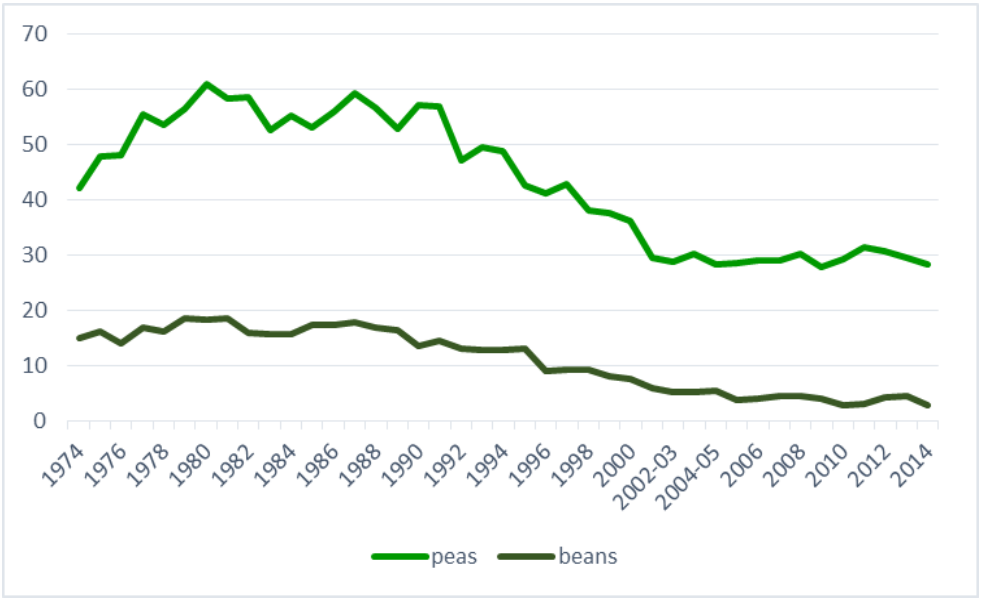
Fig. 5: Trend in consumption of canned pulses 1974-2014, g/person/day.



Source: DEFRA 2015

Turning to trends in consumption of frozen legumes, Figure 6 shows a much wider variation of consumption of peas than that of beans. The consumption of frozen beans is declining and this category seems to be disappearing. However, the market of frozen peas had a period of expansion in the 70s, sharp decline in the 90s and has been fairly stable over the last 15 years.

Fig. 6: Trend in consumption of frozen legumes 1974-2014, g/person/day.



Source: DEFRA 2015

From this preliminary analysis of broad global and British trends in the consumption of vegetable proteins and pulses we can take the following lessons:

1. While in high income countries' most protein consumption comes from animal sources, there has been a decline in meat consumption particularly in high income segments.
2. In the UK, the consumption of pulses has declined over the last 40 years, but this decline has not been equal across all pulses products.
3. While the consumption of peas and beans has declined in both canned and frozen markets, the combined reduction of pea consumption is higher than that of beans.
4. Interestingly, there seems to shift in the way pulses are preferred. So consumers seem to prefer buy canned beans and frozen peas. What these finds suggest is that there are different market segments for these products worth further research.
5. The family food survey suggests that frozen beans and canned pea markets are slowly disappearing.

3. The UK pulses market:

As we saw in the previous section the outlook for the pulses market in the United Kingdom has been rather negative in the last 40 years. However, not all pulses are equal, has some products have performed better than others. Moreover, as we will show below, there are exciting new trends in the market using pulses in creative ways that have a significant growth potential. Furthermore there are a number of alternative ways in which to segment the market that offer good opportunities for market expansion.

To complement the general information provide above, it is important to understand where pulses are mainly sold, as this gives us guidance on which marketing channels offer more potential for market expansion. The trends on distribution of pulse products are taken from Euromonitor (2016) and shown on table 1 below. The data gives two important insights: first most pulses are still consumed at home and thus, quite naturally, the retail channel dominates pulses sales. However, the second message is that the consumption on food service and institutional sectors (hospitals, schools and care homes) has been increasing. This follows a trend observed across food categories, where the increasingly demand for convenience is driving a growth in food service such that on average people are consuming as much away from home as they are doing at home.

Table 1: Sales of pulses by marketing channel (% of Total Volume)

	2010	2011	2012	2013	2014	2015
Retail	89.0	88.0	87.5	87.0	86.5	86.7
Foodservice	10.6	11.4	12.0	12.2	12.5	12.3
Institutional	0.4	0.6	0.5	0.8	1.0	1.0
Total	100.0	100.0	100.0	100.0	100.0	100.0

Source: Euromonitor 2016

It is also worth investigating what types of differentiation are happening on pulse markets and how they are evolving. Table 2 sheds light into these opportunities. The table reports the evolution of sales between 2012 and 2015 in pulses using organic or fair trade labels.

Table 2: Use of environmental and human rights labels in pulse products (% Total Volume)

	2012	2013	2014	2015
Fair trade	1.0	1.0	1.0	1.0
Organic	13.7	14.6	15.6	15.9
Organic/ Fair trade	0.3	0.3	0.4	0.5
Conventional	85.0	84.0	83.0	82.6
Total	100.0	100.0	100.0	100.0

Source: Euromonitor 2016

The table clearly shows that there is a growing, while marginal, interest in pulse products valued with an environmental or human rights labels. Suggesting there is a willing audience and market to purchase such products.

In short, while the general outlook of traditional pulses markets has not been very good, there are clear signs of a renewed interest in these products and opportunities for market development on food service and institutional marketing channels as well as potential to develop markets of products with environmental and health and wellbeing labels. There is however a clear threat from more competitive international competitors that have been able to capture some market-share.

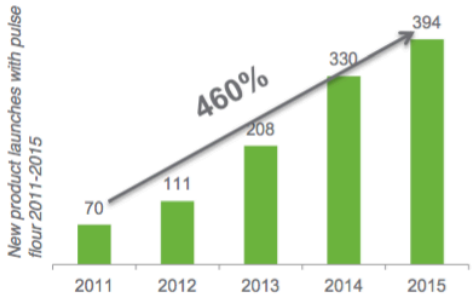
3.1 Innovation in pulses markets

This section reviews recent market research reports covering recent products launched in the market as well as consumer segments that have the potential to increase pulse consumption in their diets.

3.1.1. New products in the UK market

The previous section has shown how the traditional use of pulses market has been stable or slowly declining. By contrast this section shows an exciting market emerging using pulses as key ingredient in a range of product uses. This diversification of uses is mainly driven by the Canadian pulses industry and, in a sense, emulates the expansion of the use of soybeans promoted by the US industry over the last three decades. According to an Ingredion[2] analysis based on the Mintel GNPD[3] database and reported on figure 1, there has been a 460% growth in the number of products using pulse flour in the past 5 years. Regarding the product categories where there has been a large incorporation of pulses. Table 3 below shows that snacks, bakery products, processed meat, fish and egg products and sides dishes respectively with 289, 204, 202 and 126 dominate the trends in new pulse based products launched between 2011 and 2015.

Figure 1: Trends in new Pulse based products launches



Source: Mintel 2015

Table 3: Leading categories using pulses as ingredients

Top 10 category (2011-2015)

	Category	Number of launches
1.	Snacks	289
2.	Bakery	204
3.	Processed Fish, Meat & Egg Products	202
4.	Side Dishes	126
5.	Soup	80
6.	Meals & Meal Centers	69
7.	Sauces & Seasonings	59
8.	Desserts & Ice Cream	29
9.	Savoury Spreads	14
10.	Chocolate Confectionery	13

Source: Mintel, 2015

[2] Ingredion is a leading global Fortune 500 ingredients solutions company serving both the food and pharmaceutical industries and is listed in the New York stock exchange (NYSE: INGR). Among its products are sweeteners, starches, nutrition ingredients and biomaterials. They also have a range of pulse based ingredients such as pulse based flours.

[3] The Mintel Global New Products Database records new packaged foods across all categories launched annually in a given national market.

An example of the type of opportunities that are emerging is an Ingredion egg white substitute that can be used in food service and industrial pasta products. The advantage of using pulse protein as an egg white replacer in pasta is that it enables the retention of the structure and colour of the product along with aroma and flavour for a much lower cost. This type of replacement can be particularly attractive to consumers with egg allergies. Another example of a product developed my Ingredion is VITESSENCETM Pulse 3600 Protein, which is a faba bean product concentrate highly nutritious protein concentrate and certified gluten-free. Finally, HOMECRAFT® Pulse flour, another innovation by Ingredion, was developed for the health and clean label market segment. This product has been used in snacks sector, namely as a new ingredient for gluten and high protein snack applications as well as on bakery products and breakfast cereals.

Along with Ingredion range of products there are a range of other smaller companies developing a range of products increasingly available on supermarkets shelves in the UK and Germany. In the United Kingdom, Cofresh Snack Food Quinoa Chips have been sold since in May 2015. This new product is tailored specifically to the vegan, vegetarian or kosher consumers. It contains the following ingredients: quinoa flour (29%), corn flour, rice flour, corn starch, lentil flour, pea flour, rapeseed oil, sugar and salt.

The supermarkets have not been oblivious to this trend and have been developing products for their private label health and wellbeing ranges. An example are two products introduced by Waitrose in September 2015, namely the Waitrose Crisp & Spacy Lightly Dusted Cod which includes lentil flour and Waitrose Chicken & Pesto Wrap launched in UK in December 2015 containing pea protein and claiming to be gluten-free. Sainsbury's launched its meat free quarter pounders in January 2014 which are based on peas. This product has been promoted as high protein and vegetarian product for the vegetarian and vegan markets. Morrisons also launched the Wholefoods range featuring pulses, beans, dried fruits, seeds and nuts used on its healthy and free-from product ranges. NuMe, Morrisons' healthy eating range, with 300 products launched in the Spring 2012, offers foods with lower calorie, salt and fat levels (Mintel 2014). ASDA launched Souper in the soup category that includes four-strong high-protein "fully loaded" soups and was launched in the Spring 2015. The Souper range supplied in a highly renewable packaging and locked for freshness. It also is easy to carry, store, open, and quick to prepare, thus easy to take along when travelling (Mintel 2016).

In brief:

- A number of international and domestic food innovation companies are developing pulse based ingredients as substitutes for meat products
- Supermarkets are developing health and wellbeing as well as vegan and vegetarian product ranges based on pulses
- Marketing intelligence reports find that for these products to have wider acceptance, the taste needs to be improved.
- It is not clear to what extent these new pulse based products incorporate British pulses.

3.2 Emerging pulse consumer segments

The emergence of new pulse based products reflects a shift on consumer preferences and demand for products that align with concerns over health and wellbeing. The consumer of traditional pulse users is well understood and confirmed in a recent study by Kantar Demographics suggesting that 60.6% of the UK canned pea shoppers falls within the C2DE social classes with 42.8% of them earning under £20K and another 41.2% earning between £20-£60K annually. Of these canned peas shopper 80% have no children. Furthermore, 75.5% of these shoppers are over 45 years old, dominating consumption by the older generation with 26.3% of households being empty nesters and 28.9% of them retired (The Food and Environment Research Agency (FERA), n.d.). However, the marketing research reports we accessed **did not clearly indicate the socio-economic profiles of these consumers nor the size of the consumer segments** purchasing these novel pulse based products. Still, the reports and studies we examined suggest there are three main groups of consumers with renewed interest in consuming pulses: 1) consumers with a food related disease; 2) vegetarian and vegans; 3) flexitarians and ethnic consumers. We further describe these groups below.

3.2.1. Consumers with food related diseases

This first large segment comprises consumers with a health related food disease. In this group are included the celiac, the diabetes and those with lactose, gluten or egg intolerance. It is not clear how large this segment is but reports we accessed suggest they can be up to 12% of the market. For example, the Mintel Private Label Food Consumer and non-alcoholic drink report 2015, finds that respectively 11% and 12% of British households reported they had at least one member with a dairy or a gluten allergy.

This is a considerable marketing opportunity for pulse flour, meals and other products in the 'free from' sector. There should be a greater role for more dedicated marketing to these consumers. The Grocer published a research in November 2014 reporting that over three quarters of the female shoppers would like to see more gluten free products in store.

A number of tangible new product development (NPD) opportunities in the free-from category could increase frequency of usage and purchase among existing user. One third (34%) of the existing users would like to see more supermarket own-label varieties of free-from food. This agreement rises among lower earners, the less financially secure and also the lower socio-economic groups, suggesting that a stronger emphasis on value would help the sector to recruit new and more frequent users (Mintel, 2013).

People suffering from diabetes must control their glycaemia, i.e. their blood glucose concentration. Among the numerous starchy foods available, beans, and pulses in general, present the lowest glycemic index, which makes them a valuable source of energy for diabetic people.

3.2.2. Flexitarians and Ethnic consumers

Flexitarians are an emerging group of consumers that can be characterized either by: 1) those that are transitioning from omnivorous to vegetarian diets; 2), vegetarians that occasionally eat meet; or 3) any consumer that is reducing animal products in their diet.

Mona Rademacher the Ingredion's Wholesome & Bakery division marketing manager in Europe was quoted by FoodNavigator, saying that a growing cohort of flexitarian consumers are looking for alternatives to animal-derived protein sources. Thus this is a key target market to develop products based on pulses.

A Euromonitor Passport (2016) report on Fresh Food in the United Kingdom suggests the health and wellness trend looks set to continue for the future, particularly gaining momentum among the younger generation. This is likely to result in further growth in demand for fruit, vegetables, nuts, pulses and other products offering suitability for a variety of applications and everyday consumption moments, such as inclusion in vegetarian dinners or on-the-go snacks (Euromonitor, 2016).

Assuming the flexitarian consumers' segment includes the growing number of people in the younger and over 45 age group that express concerns over their long term health and wellbeing, this segment is likely the most relevant for the develop of growing market for British pulse based products. However, the characteristics, purchase power and consumption preferences of this group are yet to be fully understood as they have been only broadly defined my market research companies such as Mintel.

Ethnic cuisines enjoy mainstream demand in the UK, with only 12% of the adults having never visited or ordered takeaways from ethnic restaurants or outlets. Chinese (56%) and Indian (42%) stand out as the most visited ethnic food outlets (Mintel 2010; Mintel 2013). An additional contributing factor is the increasing willingness of British householders to cook Turkish, Indian and other cuisine, which use pulses as staple ingredients (Euromonitor, 2016). This report finds that three in five adults (62%) enjoy eating foreign food, and 45% of them reported being interested in other cultures, according to the same report, due to factors such as foreign travel and the rising availability and promotion of ethnic foods that has gained support and interest.

Meanwhile, Mintel's Ethnic Cuisine published in March 2009, shows that only 6% of the UK adults had not eaten ethnic foods at home in six months. The consumption of ethnic cuisine within this period was reported to be twice a week or more by 8% of the UK adults, with men ranging from 25 to 44-year-olds, social grade ABs and households earning more than £50,000 per year being the most likely frequent users (Meat-free and Free-from Foods - UK - September 2013, 2013).

3.2.3. Vegetarians and vegans

In a recent report Euromonitor (2016) suggests that raising health awareness and vegetarianism will contribute to the growth of demand for products containing pulses' protein content. Vegetarian consumer groups have been advising their associates on how to substitute meat products, i.e. animal proteins, by plant protein sources (Leterme, 2002). Given pulses high protein content they are a primary ingredient of a vegetarian diet together with nuts and some seeds. In fact, in the food guide pyramid for vegetarian meal planning, pulses, nuts and seeds replace the meat and fish products (Messina & Burke, 1997; Vegetarian Society UK, 2001a).

Moreover pulses are presented as protein sources that are cholesterol-free, virtually devoid of fat and are good sources of dietary fibres, carbohydrates, calcium and iron (Mangels, 2001a,b; Vegetarian Resource Group, 2001; Vegetarian Society UK, 2001b).

Although the Vegetarian Resource Group mentions a possible deficit in methionine for grain legumes if consumed in extreme quantity, it considers that other protein sources eaten throughout the day will easily balance the diet (Mangels, 2001a).

The following points summarize the information in this section:

1. While most pulses are still consumed at home, there is potential for considerable growth on the food service market channel, particularly business catering for schools, hospitals and restaurants.
2. There is evidence of potential growth for products marketed using sustainability related labels, namely organic and fair trade
3. A number of novel products have emerged in the market to meet the demand of three emerging consumer segments:
    a. Consumer with food related diseases or conditions
    b. Flexiterian and ethnic cuisine consumers
    c. Vegetarian and vegans
4. Future research is needed to understand how to best match products with the main consumer groups identified

4. Perception of benefits and barriers to pulse consumption

The perceived health benefits and barriers to dietary change have been examined in a number of studies (Balch, Loughrey,Weinberg, Lurie, & Eisner, 1997; Cox, Anderson, Lean, & Mela, 1998; Lloyd, Paisley, & Mela, 1995). The perceived benefits of eating fruits and vegetables include staying healthy, weight control, and feeling more energetic (Balch et al., 1997).

4.1 Perceived benefits of pulse consumption

A Global consumer survey conducted by Canadean in 2015 finds that pulses are perceived as the second heathiest vegetable source of protein, however in the United States and Canada more than half of the respondents were unfamiliar with the term "pulses".

In the UK there aren't any recent studies in the public domain examining consumer's attitudes and perceptions of pulses and pulse products. However, a study conducted by Lea et al (2005) in Australia may give some insight on health perceptions of these products. Regarding legumes (the study was not specific on pulses) the study found they were considered tasty, stored well and, particularly the canned ones, where considered convenient. Importantly, this study asked which promotion tactics would more likely increase vegetable consumption. Respondents suggested that highlighting health benefits, increase knowledge and skills on product use, communicate their convenience, taste and visual appeal as well as making it "cool" and modern would are key to a successful communication campaign.

The other benefits that consumer have indicated as perceived benefits of pulse consumption are their nutritional quality, functional properties and its low cost. Understanding food choice is important because the information provided by marketers and health professionals needs to be pertinent to the experiential and cognitive schemas

of consumers. Clearly, understanding how consumer learn and are made aware of product is key and increases the likelihood of knowledge assimilation and behavioral change (Worsley & Scott, 2000).

4.2 Perceived barriers to pulse consumption

Along with the benefits, Lea et al (2005) found the participants in their study had the following barriers to eat more pulses and legumes:

- taste,
- flatulence, and
- limited knowledge on how to best prepare pulses**.**

In a Euromonitor (2005) report on fresh food consumption trends in Western Europe, pulses are found to have a **poor image** as they are mostly seen as a source of food in low-income economies, due to its low cost and ease of storage.

Convenience is also a main perceived barrier to pulses consumption. It is useful to distinguish between two inconveniences, namely usage and availability. Most consumer living in urban areas in developed societies are time pressured and are demanding for convenience in food preparation. Therefore products are fairly quick to prepare tend to be preferred. Even consumers who are committed to healthy eating and regularly cook are unlikely to soak pulses and boil them before they can prepare their favorite dishes every single day. The success of dried foods, such as pasta and rice, lies on how easily and quickly they can be prepared. This contrast with the rather labor intensive preparation of dried pulses, which along with their unattractive packaging undermines their health and wellness credentials (Euromonitor, 2008).

Regarding availability, the issue in here is how easy it is for consumers to find pulse based products where they shop or eat away from home. The lack of availability of pulse based dishes in restaurants menus is an important barrier to their choice. Similarly, the fact that pulses and pulse based product are not easy to find in supermarket shelves, constitutes a barrier to consumers that might be otherwise tempted to choose these products.

Finally, consumers expressed concern over certain legumes anti-nutrient proprieties, despite having health-promoting agents and that will sometimes influence their means of processing and eventually taste and consumer food acceptance (Vaz Patto et al., 2014). For some consumers the anti-nutritional content of legumes reduce their biological value, as their presence is undesirable for humans and animals when these products are consumed raw. For example, faba bean contain tannins, vicine, convicine, and 2 glycosides related to favism. Favism causes strong stomach hemorrhaging. Table 4 below summarizes the perceived drivers and barriers to pulse consumption.

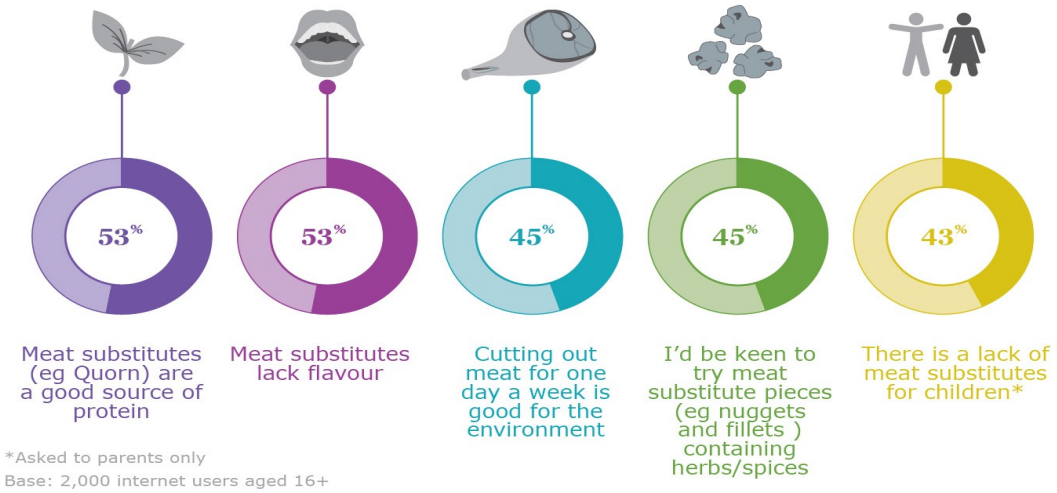
Table 4: Perceived drivers and barriers of pulse consumption

Perceived Benefits	Perceived barriers
Healthiness	Image and recognition
Nutritional quality	Convenience of usage or preparation
Value (low cost)	Availability (how easy is it to find in shops)
Weight control and satiety	Anti-nutrients and flatulence

4.3. Challenges of motivating consumption of pulses

One of the emerging opportunities for the developing of pulses markets is the increasing demand for meat substitutes. Since meat is a main source of protein, there is a clear opportunity to cater for consumer groups that are searching for alternative protein sources. However, consumers searching for meat substitutes consider these products to have low sensory appeal (Hoek et al., 2011b), a point supported by business research in the UK (figure 1) (Mintel, 2013a). Meat substitute products are appreciated more when the product is in a meal (e.g. with rice) rather than served on its own (Hoek et al., 2013). Research indicates that the consumption of meat substitutes increases the more these products resemble meat, in quality as well as in terms of cooking methods (Schösler, Boer and Boersema, 2012; Hoek et al., 2011a). In this respect, shifting consumer choices along a hierarchy of meat alternatives could be a more successful way to progressively introduce meat substitutes in diets (Sadler, 2004). Instead, acceptance of meat substitutes can be increased by introducing meat-free convenience foods (Schösler, Boer and Boersema, 2012), which simplifies use for consumers who have no knowledge of how to cook these products.

Figure 1: Consumer attitudes towards vegetarian and meat free products 2013



Source: Mintel (2013)

Finally, some consumers may have concerns over the technologies used to process pulses. In their qualitative study in Australia, Lea et al. (2005) found that participants were worried over processing of plant foods, particularly in terms of added chemicals and other additives that might reduce levels of vitamins and minerals as well as affect taste. For example, canned legumes were considered not as tasty and healthy as dried legumes prepared at home. The key lessons from this section of the report are:

- Pulse are perceived as nutritional rich, affordable and having good health proprieties
- There are barriers to increase consumption and these are: they are consider a cheap protein source, they are inconvenient to prepare and to find in shops and they can cause inconveniences due to their anti-nutrient components
- Poor sensory experience, lack of knowledge and poor communication of benefits and uses of pulses has been hindering further acceptance of these products as meat substitutes

5. Potential for use of pulse in new product lines

A number of recent pulse based products were introduced in the market ranging a wide number of food categories. There is a vibrant and dynamic market where both established players and small and medium enterprises are introducing a growing number of pulse based products. Many options exist for the inclusion of grain legumes in innovative food preparation with increased nutritional value and specific functional attributes (Vaz Patto et al., 2014). Examples include the fortification of foods such as breads, pastries, curd-like products, imitation milks, soups, pasta, noodles, meat or canned products (Boye et al., 2010)

5.1. Breakfast cereals

Breakfast bars are the biggest growing product category in the breakfast food industry. Pulses can be treated to remove any beany flavours and then softened for easy eating and added to cereals or bakery products. Due to their high protein content, peas and lentils could be added to breakfast cereals in the same way as soy is already being used. Furthermore, pulses can be combined with cereals and other vegetables (nuts or dried fruits) to improved nutrition value, taste, texture and overall balance (Singh & Singh, 1992).

Interest in the use of pulses and their constituents in breakfast foods formulation is growing in many developed countries. Factors contributing to this include their reported nutritional and health benefits, changes in consumer preferences, increasing demand for variety or balance, change in demographics (age, racial diversity), rise in the incidence of food allergies and ongoing research on production and processing technologies. The production of these products uses extrusion technology which has become one of the primary techniques for processing food products (Boye et al., 2010).

5.2. Soups

Pulses are frequently used in the preparation of soups and the market for ready-to-serve soups is an attractive sector for innovation. Given the excellent functional properties and potential functions of pulses they can be used both as main ingredients, additives, binders, emulsifiers, thickening or gelling agents in innovative soups.

Innovations in thermal processing in glass jars or cans and infrared drying and other forms of secondary processing can lead to new soups based on pulses (Cenkowski et al., 1989; Vandenberg, 2009). European and North American consumers are generally more familiar with thermally processed pulse products in ready-to-eat forms such as soup and side dishes.

5.3. Snacks

Manufacturers and consumers no longer see potato as the only crispy snack option and are diversifying snacking to include vegetables, pulses and grains. Consumers are drawn to process packaged high protein options, such as snack foods made from pulses, as would be expected in a heavily convenience-oriented market like the UK (Baroke, 2016). The use of pulses in snacks has a number of advantages such as high fiber and protein content. Also reduced fat and reduced salt crisps, associated with weight management are losing their appeal, at the expense of natural or naturally-perceived variants that subtly communicate their health benefits (Hosafci, 2015).

An opportunity for crisp-style snack brands to embrace this interest in protein by responding to the 18% of users who claim they'd be interested in buying non-potatoes or grain-based crisps, such as those made from pulses (Mintel, 2014).

Other food and snack preparations are also made from pigeon peas. Value-added, nutritious snacks with reduced levels of flatulence factors and higher contents of dietary fiber can be fabricated successfully by extrusion processing of formulations based on lentil, dry pea, or chickpea, and represent good alternatives to traditional cereal-based snacks. Also, the commercialization of value-added, pulse-based snacks would increase pulse consumption (Berrios et al., 2010).

5.4. Ready meals

Retailers are increasing the use of pulses on their ready meals product ranges, however they are not doing much in-store advertising to promote the inclusion of these options on cost-effective healthy meals solutions. Retailers could also locate recipe cards next to healthier produce; with recipes showing how healthy products can be easily turned into healthy meals that are more cost-effective than ready-meals and other branded frozen foods.

The dried ready meals category declined by almost 5% in Western Europe and more than 1% globally. There are some healthy brand extensions, such as Uncle Ben's Express Wholegrain Rice with Mediterranean Vegetables (from Mars), available in the UK, but overall things are looking a bit bleak and faced a decline. However, as the Mintel (2015) report cited above suggested the use of pulses on non-dried ready meals is increasing.

However, the potential size and characteristic of consumer segments purchasing pulse based ready meals is yet to be fully examined.

5.5. Drinks

There is a rapid expanding market of milk alternatives and soya milk has become a mainstream alternative to milk. While there have been tests using other pulses, such as lentils and peas, in the production of milk alternatives (Swanson et al 1990), there hasn't been any successful market launch so far. This maybe because there are

rheological and flavor challenges to overcome (Boye et al 2010). Also, a study recently conducted by the James Hutton Institute successfully created a range of beers and spirits from fava bean flour (Walker et al 2016).

This part of the report identified some additional food categories where there is potential for future pulse based product development. In short:

- There is good potential to use pulses in breakfast cereals and baking industry, however little is known on the characteristics of pulses currently produced in the UK to be incorporate in product formulations
- The snack industry is already making extensive use of pulses in their new products and some of the products already use UK pulses in their formulations
- The soups and ready eat meals are already using and have the potential to incorporate more pulses, however it is not clear whether these categories clear growth potential

6 Summary

Our analysis of the academic, national statistics and marketing intelligence sources reveals that there is an ongoing change occurring in pulses markets. The first key lesson of this report is that consumers have limited understanding of what pulses are and what are their benefits. This translates in the decline of traditional ways of selling these products. So it is imperative to understand how to best reposition this product category to make it appealing to consumers.

While the term pulse and traditional ways of marketing peas and beans (the bulk of British pulse production) does not seem to resonate with most consumers a range of new pulse based products have been successfully introduced in the market. So a second key lesson is that the industry needs to quickly be able to work with food manufacturers in the development of British pulses based new products.

A third key lesson is that marketing research companies have identified three categories of consumers willing to increase the consumption of pulse based products these are: Consumers with food related diseases or conditions; Flexiterian and ethnic cuisine consumers; Vegetarian and vegans. However it is not clear what are the size and socio-economic characteristics of these segments.

Finally, we could not find any recent study evaluating British consumers' attitudes to pulses and pulse based products benefits and barriers to adoption. We did find studies in Canada and Australia, suggesting that these products are perceived as healthy, tasty and good value for money. However, they are seen as inconvenient to buy and prepare, have a poor image and are perceived to have anti-nutrients and lead to flatulence.

7 Research needs

Along this report we highlighted deficits in information that require future research. Below we indicate a number of issues that we believe would need to be investigated to fully assess the future of pulse markets:

1. Identify a more attractive and recognizable generic term or name for pulses.
2. Conduct qualitative studies to understand consumer's levels of knowledge of product as well as what are the communication and education strategies to promote pulses.
3. Determine in what food group do consumers' place pulses. This is because pulses are currently placed along with meats and other main protein food group rather than fruits and vegetables.
4. Determined the size, location and market value of the emerging health conscious, flexitarian, and vegetarian consumer segments.
5. Assess what products best match the three main consumer segments identified above.
6. Determine alternative (and optimal) communication strategies to improve knowledge and demand for novel pulse based products.
7. Investigate what pulse based products taste profiles are acceptable to mainstream consumers.
8. Investigate which are the food science and food technological challenges to successfully increase the use of British pulses in the snack, breakfast cereal and bakery new product categories.

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