Revealing the Opportunities For Growing Peas and Beans in the UK

BY

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1 EXECUTIVE SUMMARY ~ THE BENEFITS AND THE FUTURE FOCUS

This study has explored the UK pea and bean industry focussing chiefly on cultivation and markets. It has identified the main commercial opportunities and the wider economic potential. To realise the potential for the UK economy the sector must take action to overcome the existing barriers. The report makes recommendations and defines actions in support of this objective. The key points of the report are as follows:

Current position

- The production and consumption of peas and beans contributes to the Government objectives of improved human health, reduced environmental impact and economic return through export.
- The UK is one of the top three bean exporters globally and a leading exporter of marrowfat peas. UK peas and beans command international market share through quality, traceability, and associated good service.
- For UK dried-pulse exports, the average value is high at £400 per tonne.
- In 2012 only 157,000 hectares of UK farm land was committed to the cultivation of peas and beans.
- Excellent, but limited, research has improved the performance of UK pea and bean production in the last decade.

Opportunities

- Global markets are growing; exports to Japan have increased from the UK by 250% in 5 years.
- Pea and bean exports could grow strongly over the coming 5 years if properly supported, adding value to the entire UK economy.
- A rise in UK production would help build markets in animal feed compounding, fish food, exporting higher value foods and drive new product innovation in added-value food manufacturing for sports nutrition and health food markets.
- Existing markets could sustain a doubling in the size and value of the UK pea and bean industry in the coming five years.
- Pulses offer growers an opportunity to raise profits, and manage farm resources in a more sustainable way. Yields can increase and better quality can be preserved.
- The inclusion of a pulse crop in the rotation provides the only opportunity to fulfil the Ecological Focus Area (Greening) requirements of the revised Common Agricultural Policy whilst also gaining a profit on the area by maintaining land in production.
- The excellent UK research base has the capability to improve yield and quality traits to meet production and market needs.

Barriers

- The area of UK peas and beans cultivated has been in decline since 2001, decreasing the incentives for commercial investment and research in the crops.
- The UK supply chain is fragmented. There is a need for greater communications to build confidence and connectivity throughout the supply chain.

- The true economic value, markets and commercial benefits of production and processing have been poorly communicated throughout the supply chain.
- UK consumers remain largely unaware of the health benefits of including pulses within their diets. Many farmers have insufficient knowledge of optimal cultivation and storage practices to ensure the maximum value return from peas and beans.

Recommendations and actions

1. UK Statistics – To ensure clarity in the marketplace, there is an urgent requirement that pea and bean production statistics, market prices, and supply and demand information be made public through official annual reporting.
2. Knowledge transfer – Farmers need support through a coordinated approach to the communication of the economic and environmental benefits, shared best practice in cultivation and storage, pest and disease monitoring and management to increase UK pea and bean production. For example, clearer guidance on the benefits of nitrogen fixation is necessary.
3. Consumer dialogue – A concerted effort to inform the consumer of the benefits of eating pulses should be coupled with continued marketing to reposition peas and beans in the marketplace.
4. Research and development - Agricultural research into peas and beans should continue to be strongly supported; research needs and priorities should be identified and coordinated through the Pulse Crop Genetic Improvement Network.

If these four recommendations are pursued with vigour over the next five years, the UK industry will double in size, be aligned to respond to EU CAP reforms and deliver combined health, environmental and economic gains that will be felt at the farm level and throughout the food supply chain.

2 THE OPPORTUNITIES THAT PULSES OFFER

SUMMARY OF CHAPTER 2

The UK pulse area peaked in 2001 at 319,000 hectares and has been in decline since then reaching a low point in 2012 of 157,000 hectares.

It matters because pulses help to achieve a fleet of Government objectives, including economic, environmental and health policies.

Yet the falling area has led to a decline in investment in pulse research causing pulse knowledge to be refreshed insufficiently quickly. This represents a market failure that needs to be addressed.

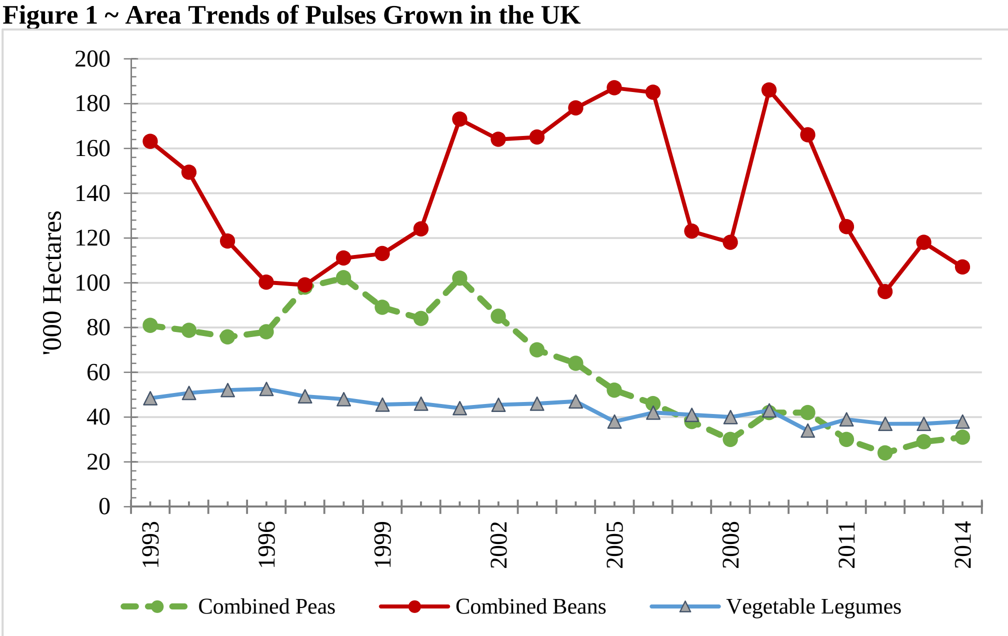
2.1 DEFINITIONS

Pulses are edible dry mature seeds of leguminous crops, excluding those harvested for fresh products which are classified as vegetables[1]. In the UK, pulses are almost solely peas and beans. Freshly harvested peas and beans have also been included in this study as they are leguminous and therefore relevant to incorporate. For the purposes of this report, the bulk of the study is focussed on dry pulses but with reference to the fresh produce sector where relevant.

2.2 WHAT HAS HAPPENED TO PULSE AREAS?

According to published statistics, the area of all pulses including vining peas grown in the UK peaked in 2001, at 319,000 hectares. It has since been in gradual decline with the 2014 harvest area falling to its second lowest in 20 years at 176,000 hectares. Combinable pulses in 2014 at 138,000 hectares were half their recorded area in 2001 (275,000 hectares). Combinable peas have suffered the greatest decline in percentage terms with a 70% fall in area despite a modest recovery since 2012.

Figure 1 ~ Area Trends of Pulses Grown in the UK



Source: Defra

[1] Food & Agriculture Organisation (FAO).

Figure 1 demonstrates the cropped area trends in combinable peas, beans and vined (fresh) pulses. It is clear that, whilst the pea area has been in long term decline since 2001, there has been a shorter but still 50% reduction of combined bean area since 2009. The long term trend of vegetable legumes is very gradual but also in decline. The highest pulse area in the UK in the last 20 years was roughly 80% higher than the 2014 harvest.

2.3 WHY IT MATTERS

The presence of a healthy and vibrant pulse industry in the UK makes considerable contributions towards several policy objectives covering economic, environmental and health issues:

- Pulses are economically valuable, contributing to farm profitability, the food supply chain and the national balance of payments through exports.
- Pulses contribute substantially to farming objectives, including the sustainable intensification expectation as explained by John Beddington[2].
- Beans are insect pollinated so are positive for insect numbers, and therefore the wildlife population.
- Pulses do not require organic nitrogen fertiliser; they help reduce greenhouse gas emissions from agriculture and are a low carbon source of protein.
- Pulses make a contribution to food self-sufficiency.
- Pulses make substantial contribution towards a healthier population.
- Pulses are good for weight loss as they are low in fat and digest very slowly.

This is a non-exhaustive list but serves to highlight to the reader how versatile pulses are in their contribution to so many parts of society.

Yet, published yield data are estimated, crop area information is unclear and there is no public record of pea or bean prices in the UK. People in the industry therefore have little reliable information with which to make decisions. The declining area has led to reduced investment in research and development. Pulses now cover a relatively small proportion of UK arable land so there is limited justification for commercial organisations to invest in research on pulses. The knowledge of pulses is therefore not being refreshed, and the technology is not being replaced as fast as it is for other crops. According to official estimates, pulse yields have not increased for 30 years (refer to Figure 14 on page 34), so the competitiveness of pulses to the farmer is diminishing further, making them yet less attractive to cultivate. The number of pulse seed breeders in Europe has fallen from about 30 to around 10 in 10 years[3]. Agrochemical manufacturers spend millions of pounds[4] creating new plant protection products and this cost is rising. These firms are therefore increasingly unlikely to invest in creating a new product solely to treat a crop that covers only a few thousand hectares.

Pulses used to be fed extensively to livestock in the UK. However, the crop size is now too small to supply feed compounders reliably throughout the year. It is more cost effective for processors to use other comparable feedstock, often imported, that *can* be guaranteed rather than change recipes frequently.

[2] (Beddington, 2011).
[3] From discussion with Peter Smith of Wherry's.
[4] (Phillips McDougall, 2013).

This represents a market failure which can be corrected by intervention. If the cultivation, processing and consumption of domestic pulses is so useful in so many policy areas, making positive contributions to so many parts of society, there must be a case to regenerate the industry.

2.4 OBJECTIVES OF THIS STUDY

What catalytic interventions are required to generate a buoyant UK pulse industry? How can the link between production and market be reinforced so the opportunities listed above are re-captured? This study tackles the economic angle of this question.

The world changes daily and this paper does not suggest it will return to how it was 14 years ago but history provides great lessons from which to learn about the future. It is fair to set recent historic performance as an ambition to which the pulse industry might aspire. This study examines why the area fell and more importantly what can be done to return the pulse area back to its levels in 2001. What tools and information would the pulse sector need to gain to achieve this aspirational goal? The pulse industry cannot be measured simply by the area of land it covers; indeed, yield increases might lead to a decline in area. It is the value of the sector that is important. Yet the total value of the pulse industry will be led primarily by market movements, so the success of the sector could be better measured by the total tonnages being produced and successfully marketed.

The paper examines the global and UK marketplaces, where the business has changed over the years and, more importantly, where the opportunities to rebuild it are and how this might be achieved. It then examines the farm, and what tools growers need to rekindle their commitment to pulse farming. There is a section that examines the way crop statistics are identified and how this might be improved.

2.5 HEALTH BENEFITS

This report does not explore the health benefits of pulses in detail but does make reference to their benefits in diets being slow to digest, low in fat and well balanced in protein and carbohydrate with a high level of fibre. There are several papers recording these benefits of pulses, which explain how they are central to the Mediterranean and Scandinavian diets, both populations of which have a high longevity. There is also ample evidence that pulses help to reduce blood cholesterol and attenuate blood glucose, key factors in avoiding diabetes and cardiovascular disease. Vaz Patto *et al*[5] in 2014 provide an excellent summary of the health benefits of pulses including their broad provision of vitamins and minerals, antioxidant and high fibre properties. Dahl *et al*[6] also explore the contribution of pulses to healthiness, considering the biochemical characteristics they exhibit, necessary for healthy diets.

2.6 ENVIRONMENTAL CREDENTIALS

As with the health benefits, this study makes little mention of the benefits of peas and beans on the environment or the drive towards the reduction of greenhouse gasses. However it explores how pulses not only require no nitrogen fertiliser but also provide some residual nitrogen for the following crop. Growing pulses reduces greenhouse gas emissions and Canfield *et al* explain how pulses even in simple rotations can ‘decrease nitrogen

[5] (Vaz Patto, et al., 2014).
[6] (Dahl, et al., 2012).

use substantially, by adding soil nitrogen otherwise provided by synthetic fertilisers'[7]. This is particularly important as synthetic nitrogen fertiliser manufacture is the largest single contributor to greenhouse gas (GHG) emissions in agriculture, accounting for up to 40% of emissions[8]. Zero Carbon Britain[9], published in 2010, recognised the benefits that pulses play to the sustainable intensification of agriculture as 'essential'. The contribution of pulses to sustainable farming is multiple, including adding organic matter to the soil, generating nitrogen fertiliser naturally, generating high levels of good quality protein as an alternative to animal protein (with inherently less efficient production). The paper projects the UK with a proportion of livestock in 2050 being replaced by high protein pulses such as peas and beans. This is echoed by a paper published by the WWF and World Climate Research Network; 'How low can we go?'[10]

These benefits, coupled with the spring planting or later harvesting nature of peas and beans, can raise the efficiency of all sorts of aspects of a farm business beyond solely nitrogen fixation. Wherever a farm business becomes more efficient, it means it uses fewer resources to achieve the same output, thereby being environmentally beneficial too. Evidence[11] suggests that pulses in the rotation encourage wildlife on a farm, measured with the 'bellwether' proxy of bird numbers. (If bird numbers are rising, it is considered that other life is likely to be increasing as well.)

The European Parliament noted[12] the environmental benefits of pulses in its new agricultural policy reform and also recognised that their cultivation in Europe would offset the imbalance of vegetable proteins imported into the EU, where 70% of vegetable protein is imported.

2.7 Stakeholders of this Study

This report is written with the following audience in mind:

1. Government and policy makers
2. Those responsible for allocating research grants and influencing research objectives

Other stakeholders with interest in the findings include:

3. The pulse trade, processors and manufacturers and other commercial organisations involved in pulses including farmers.

[7] (Canfield, et al., 2010).
[8] (Carlton, et al., 2012).
[9] (The Centre of Alternative Technology, 2010).
[10] (Audsley, et al., 2009).
[11] (Henderson, 2011).
[12] (European Parliament; Directorate General for Internal Policies, 2013).

3 THE UK PULSE INDUSTRY

SUMMARY OF CHAPTER 3

The UK grows three main types of dry harvested pea; marrowfat, blues and yellow peas. Marrowfats are largely used to make mushy peas but also exported at high value; blues are primarily micronized for the pet food industry and also incorporated into winter foods like soups and stews. Yellows cover a minimal area in the UK.

Beans are categorised simply as winter and spring varieties. The better quality beans are exported, largely to Egypt and poorer quality beans are used as livestock feed.

Fresh peas and beans are also an important component of the UK pulse crop; they are tightly managed by the frozen pea companies.

There are other niche pulses including soybeans and lupins but these are not covered in detail in this report

3.1 PEAS

There are three main types of combinable peas grown in the UK as follows:

- *Marrowfat peas* are spring sown and consumed in the UK and abroad as canned products (mushy peas), snack foods or as ingredients in processed foodstuffs. Marrowfat peas are typically the premium pea product, grown to a supply contract at considerable premiums over feed quality.
- *Large Blue peas* (also known as *greens)* are the most popular dried pea type grown in the UK for canning markets and fried and roasted snack foods. They are largely micronized (roasted, cracked and rolled) for pet foods for small rabbit-like pets and also inclusion in dog foods. These peas are also used as ingredients in soups, stews and other such (winter) foods.
- *Yellow peas (*also known as *whites)* are grown for a variety of purposes including splitting, whole processing and even milling for ethnic food processing in the UK. They are a very niche crop in the UK covering about a thousand hectares having fallen in recent years. However they are the most widely produced pulse in the world.

There are also other pea varieties which are specialised for specific end-uses and therefore grown in small quantities; these include *maple peas* and *capucijner peas*. The complexities of the varietal differences coupled with the fresh and dried harvesting methods makes the uses of peas enormously varied. Furthermore, various quality samples are used for different purposes and channelled through different markets and other specifications. There is no published information on how much of each pea type is produced, but on the basis that there is about 30,000 hectares in total in an average year, traders' consensus is roughly as follows:

Table 1 ~ Combinable Pea Crop Tonnage Estimate in an Average Year

	Area (Ha)	Yield t/ha	Tonnage
Total Marrowfats	6,000	3.5	21,000
Total Blues	22,000	3.5	77,000
Total Yellows	2,000	3.5	7,000
Total Peas	**30,000**	**3.5**	**105,000**

Estimates accumulated from several traders' opinions

There are now only about 500 to 600 combinable pea growers in the UK. Their average area will be about 50 hectares each. Note that, in the list of pea uses, livestock feed is not included. Peas make a healthy animal food and can make up to 30% of mature pig rations[13], but peas are more valuable than that and only a small proportion of peas (that have failed other quality tests or have been rejected from the cleaning process) end up being fed to livestock in the UK, probably about 15 to 20% when cleanings are included.

Vining peas are grown under dedicated contracts, as part of a highly integrated supply chain. Their production is closely managed between the grower and the processor. Often, the grower is a dedicated vining pea growing operation that rents land at premium rates for single years solely for vining pea production. Growers are usually arranged in cooperatives that supply sole processors. The tonnage produced is carefully regulated because an oversupply would flood a relatively fixed marketplace. The harvesting is managed by the processor, and top grade samples are processed and frozen within two and a half hours of harvesting (so-called '150 minute peas'). In the UK there are 20 fresh pea producing groups, a fall from 80 only 18 years ago although the area has not fallen by as much. In 2014, 141,052 tonnes of fresh peas were harvested in the UK, from 31,986 hectares[14]. The UK is well suited to growing fresh peas and beans and is the number one pea vining country in Europe.

3.2 Beans

Field beans or faba beans (*Vicia faba*) are divided simply into spring and winter beans. The differentiation in the marketplace between winter and spring beans is not as clear-cut as it is for pea types. The bulk of UK beans is either exported for human consumption or used for domestic animal feed.

Exported beans go to Arabic states, primarily Egypt but also other North African countries. One of the Arabic staple foods is a dish called *ful medames*, the other is *falafel*, and both use faba beans as their staple ingredient. Most spring beans are grown for export whole, whilst winter beans are often polished, split and also exported, their larger size and flatter oval shape compared with their spring counterparts making them more suited to splitting.

Few people eat faba beans in the UK, because their taste does not match the palate of the UK consumer. Instead, those beans that are not exported are generally used for animal feed. This is in the region of 200,000 to 300,000 tonnes (half to three quarters of the crop), depending on how many have been produced and how many have been exported. They make an excellent animal feed and, like peas, can comprise a significant proportion of (non-ruminant) concentrate ration. However as a proportion of all animal feed, very few are used in UK animal feed manufacture mostly because the continuity of supply cannot be guaranteed. If more were produced, the feed industry would be keen to use them. Winter beans are more likely to be used for animal feed simply as they command a slightly lower premium than spring crops. Of those that are used in the UK, the majority are 'extruded' and blended 50:50 with oilseed rape meal. This is then used as an ingredient in pig and poultry feed. There is no accurate knowledge on how many beans are fed directly on farm. There is also no published information on how much spring and winter beans are produced, but on the basis that there is about 150,000 hectares in total in an average year (a very variable figure); traders' consensus is roughly as follows:

[13] BEPA Feed Industry Newsletter 2014.
[14] British Growers' Association.

Table **2** ~ Combinable Bean Crop Tonnage Estimate	Area (Ha)	Yield t/ha	Tonnage
Spring Beans	90,000	3.6	324,000
Winter Beans	60,000	3.6	216,000
Total Beans	**150,000**	**3.6**	**540,000**
Estimates accumulated from several traders' opinions			

The proportion of spring beans has been rising in the last 4 years according to agronomists and traders, largely because the premium is slightly higher and the yield is now comparable to winter varieties. The gross margin is therefore better for spring beans than winter along with the benefits of spring cropping.

3.3 OTHER PULSES

Other pulses are grown in the UK that cover a small area and account for minimal tonnage and proportion of the industry. Soybean is the most cultivated legume in the world. UK cultivation has declined from its peak at 2,000 hectares to little more than a hundred hectares. The introduction of these beans into the Greening regulations (refer to section 7.7 on page 51) in the 2015 Common Agricultural Policy reforms may change this slightly. One issue raised in this report is the inability of pulses to offer a reliable supply of feedstock to animal feed compounders in the UK. This is where home grown soybeans are very strong, as their incorporation simply offsets the imports of beans from overseas.

Lupins too are pulses. This crop is not measured by Defra or recorded in official statistics making it a 'hidden' crop. However, it apparently accounts for as much as 2,500 hectares of farmland[15]. It is largely grown by livestock farmers in northern areas such as Cumbria where maize does not grow well. It is rich in high quality protein for livestock feed and grown for silage or dry feeding to cattle. Again, its incorporation as a crop qualifying in the Greening regulations for Ecological Focus Areas could be useful for the crop.

[15] Soya UK.

4 EXPORT AND HOME MARKET OPPORTUNITIES

SUMMARY OF CHAPTER 4

There are multiple opportunities to add value to the supply chain and new markets are opening up for UK pulses.

The EU imports the majority of its vegetable protein feed for its livestock. Pulses might be able to supply some of this marketplace if production increased. The fish farming is growing and pulses fit well in this sector. This could be a large growth area in the coming decade.

UK-grown peas and beans are favoured in the fresh and dried pulse marketplace globally because of the high quality, assurances and service that come with them. There is opportunity to grow export markets because of these added-value traits.

Pulses are also free from gluten and are not nuts or peanuts so circumvent many people's allergies and preferences to avoid certain foodstuffs. They therefore make great snacks as well as vegetables in a full meal.

Mushy peas are linked closely to fish and chips. Consumption of dried pulses in the UK is static. Britons like baked beans but these are not faba beans and are not grown in the UK. This could be changed with careful marketing.

Pulses are digested slowly, increasing satiety. They can therefore help reduce food consumption as well as offering other health benefits.

How can we generate enough demand for the pulse crop size to double? If another 600,000 tonnes of peas and beans were grown, there would be a feed market to supply. Whilst it might have an impact on price, the opportunities to add value through exports or processing outlets are numerous.

4.1 PROTEIN AVAILABILITY

Peas and beans make an excellent, high protein component of a pig or poultry ration. Throughout the EU, 70% of proteins fed to animals are imported, mostly soybean or soymeal[16]. Most of this is from genetically modified (GM) varieties. EU legislation prohibits the import of unauthorised varieties of GM crops on the basis that they are not cleared as safe for human or livestock consumption by the European Food Standards Agency (EFSA). (For more background on this, refer to Appendix section 9.4 on page 62). Segregated EU-authorised varieties are becoming increasingly scarce as other importing regions, China in particular, are less concerned about GM varieties and authorised varieties are dearer to produce. It is possible that, within 10 years, the cost of sourcing such authorised varieties will exceed the cost of home grown protein.

Pulses could be incorporated into livestock rations, particularly pig and poultry as already described. Most compounders don't use pulses because of lack of continuity of supply. Evidence (for example from the Green Pig Project[17]) confirms that if a compounder was guaranteed a year-round supply of beans or peas, they could be included in the rations. Another recent study confirmed that feeding pea and faba bean in pig (grower and

[16] (USDA GAIN Report E60050, 2011), (APRODEV, 2011).
[17] http://www.bpex.org/R-and-D/R-and-D/GreenPig.aspx.

finisher) diets up to 30% soybean meal replacement had no detrimental effect on the carcass quality or weight[18]. The Green Pig (LK0682) project has shown that soybean meal can be replaced entirely by peas or beans in nutrient-balanced pig diets[19].

Clearly the price would have to be right, and so feed compounders would purchase pulses at a lower price and specification to food manufacturers. Farmers would be inclined to grow for this market if they could grow a higher yield for feed than for human consumption or at lower cost. A recent report from Reading University[20] suggests that a policy to replace imported (soybean) protein with pulse protein to feed livestock would be economically and environmentally detrimental, the main reason being it would displace wheat and other crop production area from the UK. This is accepted although this paper also identifies the opportunity for farming and the soil of raising the proportion of pulses in the rotation which could indirectly raise output of other crops per hectare. If pulse area (and yield) increased, some might be used as livestock feed, which might indirectly offset imported vegetable pulses.

4.2 Quality Impact

Sweetness and tenderness are the most critical factors for the consumption of fresh peas according to a report prepared as part of the QDiPS LINK project[21]. This has led vining pea processors to harvest earlier to capture high quality, with specific varietal preferences and at smaller sizes. The race for the sweetest and most tender pea is on. It is also noted that a consequential rise in pea consumption has a negative impact on the consumption of other (competing) vegetable classes. This point is strongly reinforced by branded manufacturers in both the tinned mushy pea and the frozen vining pea sectors.

Continued work on improving pulse flavour and evenness of texture when cooking will help create opportunities for new products and growth in existing marketplaces.

4.3 Pea Exports to Japan and Elsewhere

Exports to Japan have increased from the UK by 250% in 5 years. If this trend continues, it could justify the cultivation of another 1,500 hectares of marrowfats by 2020. It is a small but high valued area. India and China are both major growth areas for pulse trade. Whilst the majority of their imports are bulk peas, their middle and upper classes are increasingly demanding added value goods which might provide opportunities for long distance freight from high value marrowfat peas like ours.

Japan, the premium value export market for peas from the UK, prefers UK supplies to others because of our unmatched level of traceability through the UK Farm Assurance scheme (The Red Tractor scheme) and processors' standards of accreditation (British Retail Consortium). It is understood that other countries closer to home (Belgium) also purchase UK pulses for the same assurance guarantees. This is clearly an asset to build on as it represents a unique selling point. The UK guarantees of quality and provenance have earned it a valuable export outlet. The opportunities here are considerable whilst the quality of pulses are being met.

[18] (Smith, et al., 2013).
[19] (Houdijk, 2012).
[20] (Jones, et al., 2014).
[21] http://www.pcgin.org/QDiPS/index.htm.

4.4 Bean Exports

Future demand for UK exported beans clearly remains in Egypt. If forecasts of a decline of French beans prove correct, this could leave opportunities for the UK market to grow. A 50% decline of French exports shared between the UK and Australia could leave as much as another 50,000 tonnes of exports for the UK to trade, equivalent to 12,500 hectares. Agriculture needs to respond to supply the tonnage to capture such opportunities.

4.5 Whole-Crop Animal Feed

Before engines became commonplace, beans were grown in large quantities to feed horses and ox that acted as vehicles. The area of pulses grown therefore fell considerably when cars and tractors replaced animals[22]. Through insufficient investment in plant breeding though, the crop failed to adapt to modern farming techniques. However, research is being undertaken to use faba bean whole crop as forage for livestock to add protein to their diet[23]. If this became viable, it would open an entirely new sector of users.

Pulses are difficult to ensile and require additives to protect the proteins, but they offer highly digestible protein in the ration[24]. This is a knowledge transfer and technical challenge to incorporate higher protein into silage, but it is likely from reports cited above that this is only ever likely to be a niche use.

4.6 Fish Food

Decorticated bean is not only highly nutritious fish food but acts as a binding agent that retains its properties in water. Pulse proteins do not break down in salt water, another important trait for fish food. Bean skins have too much fibre so need to be removed.

The pressure on the food industry to prepare to feed ten billion people by 2050[25] means that the next food revolution could easily be the 'Blue Revolution': food from fish. Fish farming has the capacity to balloon to accommodate the burgeoning requirements of the growing population over the coming 20 to 30 years, and decorticated pulses as described already are a high quality food for fish.

The UK currently supplies a relatively small but growing fish food industry, in both Scotland and Scandinavia. Currently, about 20,000 tonnes is used but it is possible that this could increase exponentially in the coming decade. Decorticating pulses removes a considerable proportion of weight from the commodity. The skins are low value by-products compared with the cotyledon. Work on producing thinner skins has been undertaken but so far without success. There are opportunities here to improve the bean for supplying the fish industry.

4.7 Free From…

Pulses as a high protein, gluten-free food category fit neatly into many modern families' consumption habits, but are not eaten in any quantity in the UK. Milled pulse flour can be incorporated into breads to provide more protein, flavour or simply remove gluten. There is a considerable marketing opportunity here for pulse flour,

[22] (Cubero, 2011).
[23] (Mihailovic, 2014).
[24] (O'Kiely & Fitzgerald, n.d.).
[25] As forecast by the UN http://esa.un.org/wpp/documentation/pdf/wpp2012_press_release.pdf.

meals and other products in the 'free from' sector. There is a greater role for more dedicated marketing to consumers for an organisation like the British Edible Pulses Association (BEPA).

Research published in the Grocer in November 2014[26] reports that three quarters of female shoppers would like to see more gluten free goods on sale. Research commissioned by Almondy, a cake manufacturer, found 25% of shoppers to be gluten intolerant or avoided gluten for lifestyle reasons and the main age category likely to purchase gluten free products is the 18 to 34 category, exactly the age group that is not purchasing many pulse products. Another (arguably more independent) survey published in October 2014 by YouGov[27] found over half 'free-from' buyers have no intolerances or allergies at all.

4.8 The UK Pea Consumer

The consumption of canned peas is dominated by the older generation (three quarters of shoppers are over 45) and the less affluent (43% of shoppers earn less than £20,000 per year). A third of all mushy peas are consumed in either Yorkshire or Lancashire[28]. The consumption of mushy peas is also closely aligned with the 'nation's favourite' take-away, fish and chips. The total consumption of dried pulses is static in the UK.

Other food sectors have found themselves in this situation and have tried to attract the health-minded young consumer with snacks and so on. The prune industry for example, has repositioned their product offer from large bags of prunes in the baking section (purchasing of which was dominated by older ladies for baking) to snack packets for lunchboxes for families and very healthy foods for athletes and fitness enthusiasts[29]. There is *considerable* opportunity for the pulse industry to develop these markets backed by some of the recent research that has been undertaken to demonstrate how healthy the products are for people of all ages. Lessons can be taken from other sectors including the UK-based Californian prune marketing experts. Indeed, in Canada, new products including 'Megabite', a snack bar made from pulses and dried fruit, have been created from pulse flour. There is much innovation and new product development that could benefit from the incorporation of pulses.

4.9 Bean Consumption

The British do not really like faba beans, but they love baked beans. They are traditionally made with navy beans not produced in the UK. However a small pulse trading company called Hodmedod's (http://hodmedods.co.uk/) based in Norfolk produces baked beans made from faba beans. UK grown and baked faba beans is a different product to imported baked navy beans, and moving consumer expectation is a challenge for businesses like this, although the market is becoming gradually more curious about such 'novel' yet traditional home grown food. Hodmedod's also makes other products such as dried snacks out of pulses too.

Encouraging small businesses with big ideas to develop, through supported marketing or business development, might not only help grow the entire pulse sector but also foster greater entrepreneurialism in the UK.

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[26] http://www.thegrocer.co.uk/stores/consumer-trends/almondy-survey-shows-high-demand-for-free-from-foods/373558.article.
[27] http://www.thegrocer.co.uk/stores/consumer-trends/most-free-from-buyers-are-free-from-allergies-or-intolerances/372477.article.
[28] Kantar - Demographics, 52 w/e 18 August, 2013.
[29] Californian Prune Board, EU Marketing Association, Mark Dorman.

4.10 Inward Investment

A major Japanese investment in Deeside, near Chester, by a company called Calbee[30] has recently been confirmed. As the export trade to Japan is considered the highest value business and the highest quality, such a business coming into the UK pulse sector from abroad will present a considerable opportunity to the UK. It would be welcomed as both an opportunity to work more closely with the Japanese food industry, but also to expand the UK high value pulse marketplace.

Exports of a basic commodity are not necessarily the best outcome for a country. If the low value commodity is processed in the UK giving it higher value, and then exported, it will return far greater revenue to the country. It might then be exported as a different product but everybody gains additional value.

4.11 UK Snack Food Entrepreneur

The specific example above is just one growth opportunity, as is Hodmedod's. It does demonstrate the opportunity for new business growth. Other entrepreneurial snack-food operators might see a gap in the marketplace (or indeed create one) to develop high quality, high value snacks using pulses. If this idea gets off the ground and grows to only a few thousand tonnes, it would be a high value chain in the pulse sector. Small companies, such as Humdinger Foods Limited in Hull, have been building a range of products based on pulses which are now sold in many of the major retailers.

4.12 Controlling Obesity

Research has shown[31] that peas and beans are digested more slowly into the human digestive system than other sources of energy. The foods break-down more slowly, keeping people feeling 'full' longer after a meal. This means that pulses keep appetite sated longer so food is not craved for longer periods. This is a great opportunity as a dieting food.

Pulse consumption in Muslim states actually rises during Ramadan despite it being the month of fasting. In fact Muslims cannot eat during daylight hours so consume food before dawn that will 'keep them going all day' until dusk when they can eat again. They know that pulses will help them achieve this better than other foods.

Do dieters know this? This is a considerable marketing opportunity. Several surveys report the high number of people in the UK dieting at any time. One such survey[32] suggests more than one in four adults at any time is trying to lose weight. This survey doesn't account for how hard they are trying, but eating pulses is an easy way to make a difference.

4.13 Alternative Pulses

The number of minor pulses available that could enter the UK on a larger scale is high. Brief mention has been made of soybeans (generally classed as an oilseed legume, rather than a pulse) and lupins, but others are also potential crops. Each presents a possible economic opening for the pulse sector but, with the high quality commodities we already produce in reasonable volume and have the logistics and expertise to develop, it seems

[30] https://www.calbee.co.jp/english/world/#uk.

[31] (Sievenpiper, 2014).

[32] http://news.bbc.co.uk/1/hi/health/3454099.stm.

unlikely that devoting resources to building a brand new supply chain would be the best use of much invested money or time. Nevertheless, some creative entrepreneurs may well develop new opportunities from such crops in the future and the supply and support chains need to remain aware of changing circumstances in the sector.

5 PUBLISHED DATA FOR UK PULSES

SUMMARY OF CHAPTER 5

Good quality market and price information are necessary to assist investment and trading decisions thus allowing the addition of value to the sector.

Crop area figures require better analysis and explanation, especially the allocation of dried peas and beans between feed and human consumption categories.

Yield data is not highly trusted by industry. More time spent researching yields would be helpful, all the information gathered by Defra at harvest would also be useful if it was published. Pea and bean supply and demand information should be circulated by Defra. Not all the data collected is currently shared.

No pulse prices are formally collected in the UK. Doing so would probably present the greatest and lowest cost opportunity for improving the market operation and increasing the value of pulses at farm level.

> *"Market information is useful for all sorts of reasons. It underpins price movements, explains trends and allows us to plan our annual production. Currently we struggle as the figures for peas and beans are poor; the best information we can source is from traders which has a commercial bias."*
>
> *Quote from major UK fresh vegetable buyer and processor.*

Pricing of contracts for the vegetable buyer quoted above occurs with a minimum 6-month lead time, meaning that market supply and demand information is crucial to achieve the right price. Good quality information would facilitate better market planning by the grower, the merchant, processor and branded manufacturer. It would add value to the industry by providing confidence to commercial decision-making, helping to build custom both nationally and compete for export business.

5.1 CROP AREA FIGURES

Every year, Defra publishes data regarding the areas of the pulse crops (peas, beans and fresh vining pulses). They are published in the results of the June Survey of Agriculture[33], the Agriculture in the UK annual report[34] and the Basic Horticultural Statistics[35]. These are all highly regarded publications each of which carries a high readership.

The June Survey of Agriculture data is charted in Figure 1 on page 3. It identifies 118,000 hectares of combined field beans and 29,000 hectares of combined peas were grown in 2013 with another 37,000 hectares of fresh peas and beans. The June survey of Agriculture covers all agricultural land area.

[33] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/364157/structure-jun2013prov-UK-16oct14.pdf.
[34] https://www.gov.uk/government/collections/agriculture-in-the-united-kingdom.
[35] https://www.gov.uk/government/statistics/basic-horticultural-statistics.

Table 3 ~ Agriculture in the UK, Pulse Areas

	Harvest Year		
'000 hectares	**2011**	**2012**	**2013**
Agriculture in the UK Figures			
Peas and Beans Harvested Dry			
Peas for harvesting dry	12	11	13
Field Beans	125	96	118

Table 3 shows the pulse area data from Defra's Agriculture in the UK 2013 publication. It has the same figures for beans as the June survey, but only 45% of the areas for peas. In the footnotes referring to peas it explains: "*The figures presented here cover only that part of the crop which is harvested dry (about 80 to 90% of total production) and used for stockfeed. The remainder is included in UK Fresh Vegetables*". From the analysis in this paper, and comments from its contributors, it is clear that the animal feed-pea market is only about 20% of all UK dry harvested peas, and that is cleanings from processed peas and poor specification samples. No pea area is planted for the feed market. Dry beans are in the same table. A greater percentage of beans is being used as animal feed but no estimate of uses is made.

Figure 2 ~ British Horticultural Statistics, Legume Areas

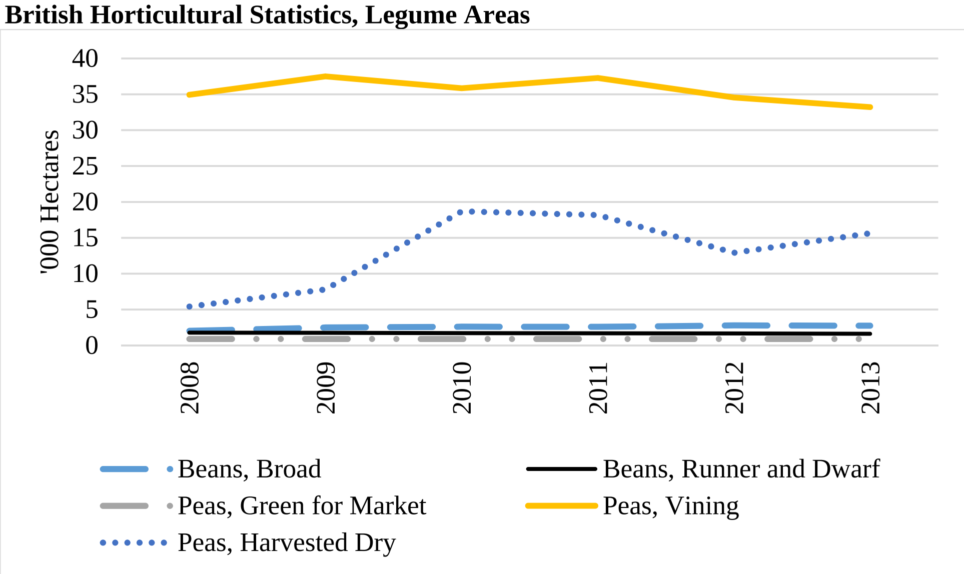


Figure 2 shows the UK legume area as described in the British Horticultural Statistics (BHS). This accounts for the rest of the pulses and legumes grown in the UK. These are figures taken from a separate survey so there will be statistical differences and therefore may not be expected to correlate perfectly but, as Table 4 demonstrates, the correlation between the two is good.

Table 4 ~ Correlation of June Survey with BHS and AUK Area figures

	Harvest Year		
'000 hectares	**2011**	**2012**	**2013**
Total of AUK and BHS Figures			
Total Peas	68	59	63
Total Beans	129	100	122
Total Pulses	**198**	**160**	**185**
Total June Survey Pulse Area	**194**	**157**	**184**

As an example, the total pea area in 2011 in Table 4 of 68,000 hectares is comprised of 12,000 hectares of dry peas for stockfeed as shown in Agriculture in the UK (Table 3), plus 900 hectares of green peas for market, 37,300 hectares of vining peas and 18,200 hectares of dry harvested peas all shown in the British Horticultural Statistics (Figure 2).

The estimate of area grown for feed came from a historic conversation between Defra and the PGRO, and hasn't been updated for some years. Speaking with the Pea Viners Association operated from the British Growers Association, the figures they keep on the cropped areas are accurate and precise. These figures could be easily shared. The biggest issue with cropped area is the misleading 'information' on how much pea (and bean) area is cultivated for feed. Defra should reassess what information it is trying to show in its Agriculture in the UK publication.

5.2 Yield Data

With the first autumn publication of June survey cropped area figures, Defra publishes its assessments of combinable crop yields each year. This includes cereals and oilseeds but not pulses. These data are based on a non-statistical 'survey' of agronomists and other experts in the combinable crop sector. It is undertaken throughout harvest-time by ADAS. The reports submitted to Defra include assessments of yield of pulses. At the end of harvest, often in late September, ADAS submits a 'final' report of estimated yields including yields for peas, winter beans and spring beans. For 2014, the yield estimates were:

- Peas 4.0 t/ha with a range of 2.5 to 5.5 t/ha
- Winter beans 4.3 t/ha with a range of 2.3 to 7.0 t/ha
- Spring beans 3.4 t/ha with a range of 2.0 to 6.8 t/ha

These figures are not published at the time; the earliest pulse yield figures that Defra publishes are in Agriculture in the UK, published in June the following year, after the crop is sold. Even then a single overall bean yield is given rather than for spring and winter beans separately. Generating a single yield from two crops suggests that Defra also has a crop area figure for the division between winter and spring beans. Again this is not published. As can be seen, these figures are not secrets, but are simply not used. Published pea and bean yields of recent years are as follows:

Table 5 ~ Published UK Pea and Bean Yields by Defra

Yield t/Ha	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**Average**
Peas	3.8	3.6	3.5	4.1	2.4	3.7	**3.5**
Beans	4.5	3.7	3.5	3.4	3.3	3.2	**3.6**

It is notable from the above how large the range of yields in the pulses can be. This, coupled with the very small crop areas for pulses, increases the difficulties in arriving at reliable and statistically robust yield data. ADAS agrees the yield figures are estimates as they don't have large resources from Defra to undertake extensive surveys to find the yields of small-scale minor crops.

ADAS collects the pulse yield data through conversation with ten agronomists (one in each Government Office Region). Each of them has contacts in their regions of whom they ask opinions. The results are then stratified according to the amount of pulses in each region. It appears then that a single commentator will be responsible for all the pulses in the North West, which in 2010 was 214 hectares, and a single one for the Eastern region which accounted for 16,476 hectares. In fact 75% of the English crop was produced in three areas so 75% of the crop yield estimate came from just three individuals. Whilst these individuals make their best estimates and ask contacts for opinions in the area, it is a very scant assessment for a national crop yield estimate, albeit one of small area.

The British Growers Association has a list of all fresh pea farmers, their hectarage of pulses grown and, crucially, their total weight supplied to their processors to the nearest kilogramme, as this is how the contracts are agreed and paid.

5.3 PULSE CROP SIZE

The crop sizes are compiled, simply by multiplying the area and the estimated yields together. Errors in the yield or crop areas will be multiplied in this calculation. The level of acceptable error depends on the uses of the figures. Traders, who need reliable information about the crop-size in order to know how much of a crop to sell, barely use Defra data, as it is not sufficiently timely or accurate, depending instead on their own figures. Others, possibly those putting data together for publications with little other commercial application, might find the Defra figures acceptable.

5.4 PULSE SUPPLY AND DEMAND INFORMATION

There is, according to Defra, a supply and demand balance sheet compiled for each crop; peas, spring and winter beans, but they are not available for examination. According to those involved, the 'home fed' line tends to be a balancing line between supply and demand. It might be right, but no work is done to confirm this.

In the course of this study, many sets of data and much consumption information have been generously provided by several contributors. However, these have not been published here in respect of the commercial sensitivity for each individual who shared it. It is noticeable though how different the figures are and, therefore, how wildly wrong some people must be!

Defra data on raw material usage in feed for Great Britain show that, for the year to September 2014, 45,700 tonnes of field beans and 24,300 tonnes of dry peas were used in the retail production of animal feed[36]. This represents 12% and 17% of the 2013 supply of beans and peas respectively. It does not make an assessment of how much is fed directly from the same farm to livestock. Experts[37] suggest the percentage sold as stockfeed is no more than 30% winter beans and 40% spring crops, mostly being UK produced pulses that missed the export human consumption quality criteria, but these percentages will vary considerably from year to year depending on availability and quality.

There is a demand for a clearer understanding of the supply and consumption of dry peas and beans in the UK, and, if Defra has the figures already compiled, it would be extremely useful for the industry if Defra would publish them.

[36] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/370937/animalfeed-statsnotice-06nov14.pdf.
[37] Experts include James Wallace, Pulse trader Dalmark Grain and Andy Bury, Pulse Trader Frontier.

5.5 PULSE PRICES

Before farmers consider cultivating a crop, they require an idea of the likely returns for planning and budgeting purposes. They will need guidance on likely yields and prices, but price information is sparse. Indeed, the only publically available information on pulse prices is that which is published by the Farmers Weekly, listing feed beans, feed peas and, in a regional market price box, micronizing peas. It has no information regarding forward prices, historic data or other datasets that are publically kept. Being the only published figures, they are necessary, but insufficient. They come from a quote from a single (local) trader, which, whilst a useful start, may be biased to that part of the world and commercial position of the individual at the time. The Farmers Weekly does not quote prices for other pulses such as human consumption beans, in other words, the markets which a farmer is likely to target.

It is not just the farmer who requires such prices. Buyers also need them. Indeed, when branded manufacturers suffer price rises of their input commodities, they may try to pass the cost rises to the consumer. However this involves a price renegotiation with the retail sector, dominated by the supermarkets. They comment that negotiating a price rise with a major retailer without evidence is near to impossible. This example demonstrates just how important it is to have datasets of back dated pulse prices and this would add considerable value to the entire pulse sector.

5.6 PROPOSAL FOR PROCESSES TO IMPROVE STATISTICAL RECORDS

The biggest improvements that can be made to the published information discussed above are as follows:

The crop area information can be improved mostly by better layout and explanations.

- In its Agriculture in the UK, Defra should decide and clarify *what* it is trying to show. It would be easiest and most useful simply to publish *all* dried pulses in one section and *all* fresh peas and beans in another. Clearer footnotes would be advantageous.
- Defra would benefit from having regular conversations with the trade, visits or an annual meeting to discuss pulse crop figures with those who really understand them. This could be facilitated through PGRO or BEPA. It is clear from research undertaken in this project that most people in the trade would be happy for such a regular communication.

Recommendations particular to crop area are:

- Whilst it is recognised that information in Agriculture in the UK and the British Horticultural statistics are survey based, the *actual* figures for fresh peas and beans are available and should at least be compared whilst the British Growers Association is prepared to share data.
- Defra should publish separate figures on spring and winter beans if they are available, as there is a commercial value in the difference.
- The area information will become available with the implementation of crop area codes, necessary for the Basic Payment Scheme in 2015. It is hoped these data will be compiled nationally and made publically available.

Yield data could be improved substantially by the following:

- In the autumn publication of crop areas and initial combinable crop yield assessments, early assessments of pulse yields should be included. This will generate discussion and interest.
- Crop yield and range data should be made public as soon as practical and ideally with the other combinable crop data. Whilst some pulses are harvested late in the season, for them to be considered as a crop of equal importance to others, they should be treated in a similar manner.
- Defra could create a more accurate crop yield estimate.
  - Those who know yield information first are agronomists, grain traders and those who have agreed contract tonnages with growers and could be included in the yield assessment process.
  - Regular pulse growers could also be used as ‘bellwethers’, giving guidance on overall yield trends according to each season.
  - Survey information would help support the assessment of yield. It is recognised that this makes the assessment more expensive.
- Publishing the yield estimates for both spring and winter beans.

Total crop size information and the national crop supply and demand estimates would follow with yield and area data confirmation. These should be published as soon as available in line with other combinable crop supply and demand information.

Ex-farm spot and forward pulse prices need to be gathered in a disciplined and reliable format. Whilst it is not a mandatory process (supplying prices of cereals and oilseeds to the Home Grown Cereals Authority (HGCA) is a legal obligation of traders), most have acknowledged that if all others offered the prices they would too. It is a role that the PGRO should take the lead on. It is recognised the organisation does not have economists and price gatherers, so might struggle to undertake the task in-house. However, it is understood that the Home Grown Cereals Authority (HGCA) which is the most proficient at collecting combinable crop prices (ex-farm, delivered prices and freight prices) is prepared to undertake the price collection work on behalf of the pulse sector. It is not known what it would cost, but the conversation needs to be started. The data need to be gathered and held in a publically available place and this should start as soon as possible.

6 GLOBAL SUPPLY AND DEMAND

SUMMARY OF CHAPTER 6

Sustainable intensification of agriculture is required to feed the rising and increasingly wealthy world population in the future. Pulses will inevitably play a major role in this task and the UK must be ready to capitalise on it.

Globally, faba bean production is flat at 4 million tonnes and pea production has been in decline since 1987, reaching a level over the last decade of about 10 million tonnes per annum.

International trade creates a global price and opens opportunity for exporters. The UK is one of the three largest faba bean exporters in the world, sending beans chiefly to Egypt.

Whilst the UK is currently a net pea importer, pea exports from the UK are global, mostly of small volume but high value cargoes. The UK is a top marrowfat exporter.

6.1 DEMAND

The rise in global population and increasing consumption per capita presents considerable opportunities for pulses, arguably greater than for other combinable crops. Global population is rising at 1.2% per year[38]. The current population of 7.13 billion is predicted to rise to around 10 billion by 2050. Food consumption per capita is also rising as the world becomes wealthier so the overall impact on demand for food is even greater[39]. The demands placed on agriculture and the food supply chain to produce more food without increasing land use or other limiting resources will increase. As a result, food with a large area footprint (the area required for the growing commodity, including its breeding stock and feed stock) such as grain fed beef is likely to increase in price and become less consumed. Foods that require less space to produce and offer a healthy contribution to the human diet are likely to see rising demand.

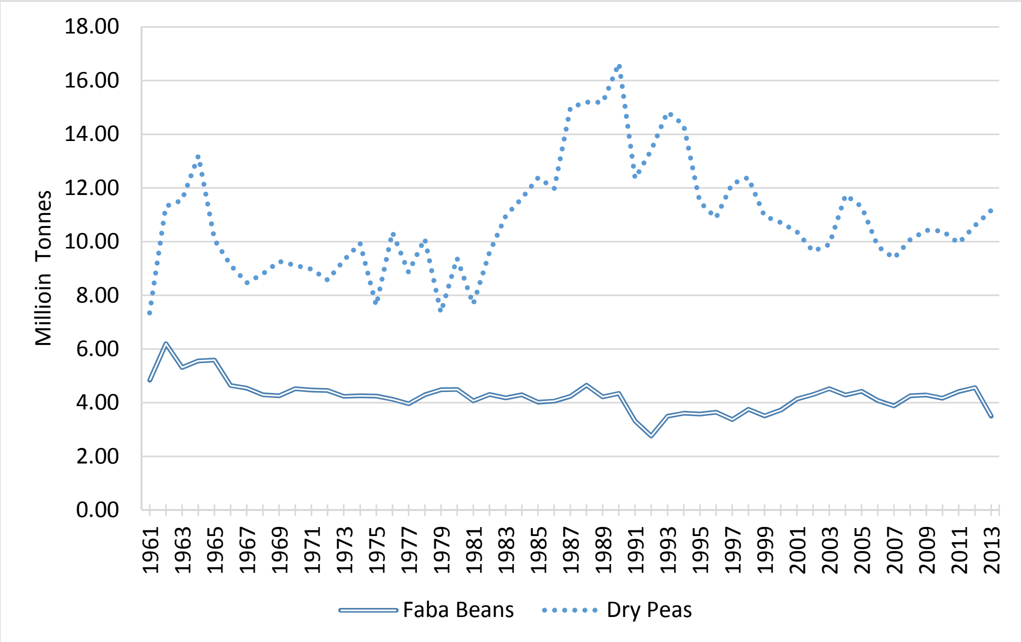
This presents opportunities for pulses. Pulse diversity means they can be grown in various climates and cooked in several ways. Dried pulses can be transported easily and stored for long periods, which helps make them staple foods of many cultures and climates. The United Nations has proclaimed that 2016 will be ‘International Year of Pulses’ in recognition of that sustainability. Pulses offer not only an opportunity to achieve ‘sustainable intensification’ of agriculture but also ‘sustainable extensification’ of consumption, a win on both counts.

6.2 PRODUCTION

The only freely and easily available data on global pulse production are from the FAO statistical bureau (FAOSTAT). These data are widely used because of their independence.

[38] http://www.worldbank.org/.
[39] (FAO, 2009).

Figure 3 ~ Global Dry Pea and Bean Production



Source: FAOSTAT

Figure 3 shows the production of combinable peas and faba beans for half a century. The combinable pea crop peaked in 1990, at nearly 17 million tonnes and declined to about 10 million tonnes since 2001. Production of beans has been far less erratic remaining steady at about 4 million tonnes for nearly 50 years. The consumption of beans per capita has therefore been falling as population has risen over this time.

6.3 TRADE

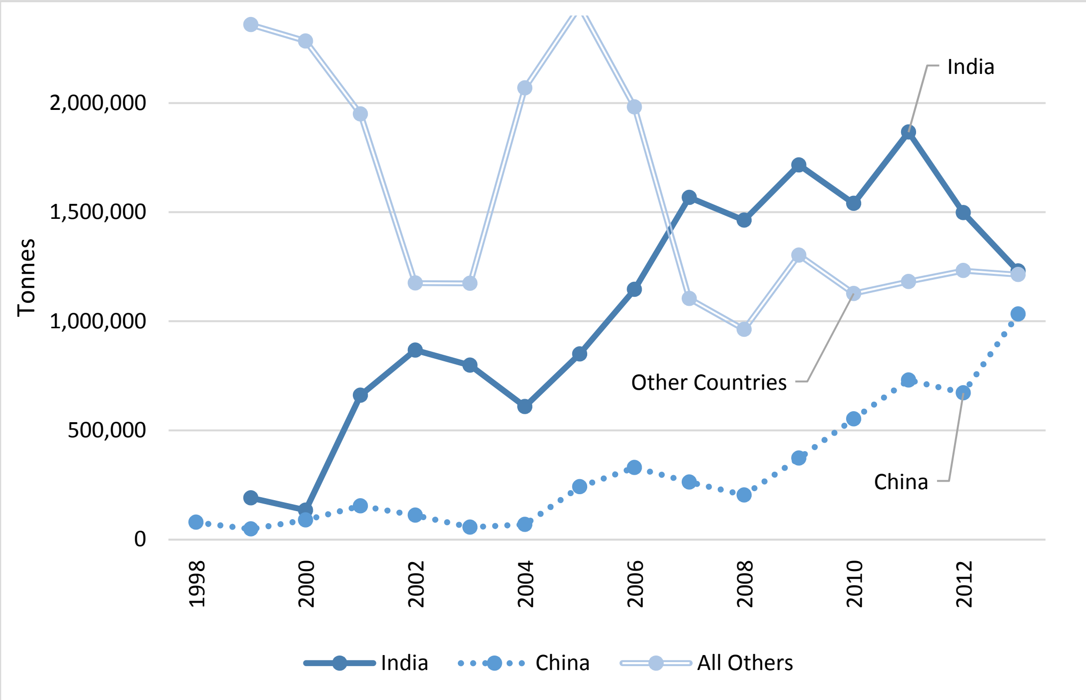
Of more importance than international production is the level of trade for each crop as consumption of domestic crops never impacts on the global marketplace and therefore present less of an opportunity (or threat) for the UK industry. These data are represented by the Global Trade Information Service[40]. It is recognised as the leading supplier of international merchandise trade data.

6.3.1 Peas

Figure 4 shows how India and China, the two largest countries by population and emerging economies of the world, now dominate pea imports. These are mostly yellow peas and predominantly from Canada. They each import as much as the rest of the world put together at over a million tonnes each per year. Almost no UK peas are exported to India but China has bought about 5,000 tonnes from the UK for each of the last two years.

[40] http://www.gtis.com/english/.

Figure 4 ~ The Main Global Combinable Pea Imports



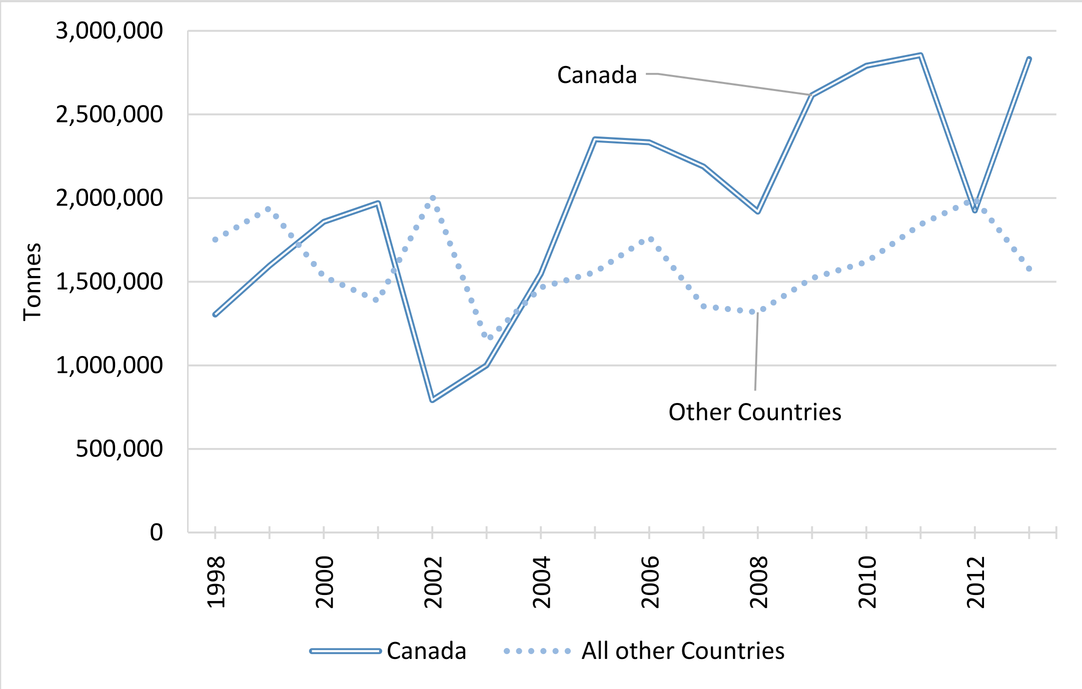
Source: Global Trade Information Service

In 2014 Canada produced 2.7 million tonnes of yellow peas out of a total Canadian pea crop of 3.5 million tonnes and exported 2.2 million tonnes of yellows out of total pea exports of 2.7 million. It can be seen that this accounts for about 75% of all global exports (Figure 5). In 2015, Canada plans to raise its production to nearly 4 million tonnes of peas, 3.3 million tonnes of which will be yellows[41], enough to supply the entire global trade in 2013. The Canadian pea industry is centred in Saskatchewan, far inland and difficult to export from, especially when the Great Lakes are frozen in winter. Exporting west across land to China is particularly expensive. However, this tonnage provides the critical mass to compete into bulk export markets. The considerable volume also means they can work on tighter margins which helps to win sales.

Whilst sustained growth could lead to new market opportunities, the UK is not in a position to compete in this bulk commodity marketplace at this time; its smaller production levels align itself more to smaller, added value business. Japan, a country that is 25th on the list of importers at only about 15,000 tonnes also purchases UK peas, especially high specification marrowfats. They sell at a high price for snack food products. Exports to Japan present valuable opportunities to the UK and, if other high quality and high value business can be generated for example from the top level exports to China, this could do the same.

[41] STAT Communications Ltd ~ Pulse Market Report.

Figure 5 ~ Global Pea Exports



Source: Global Trade Information Service

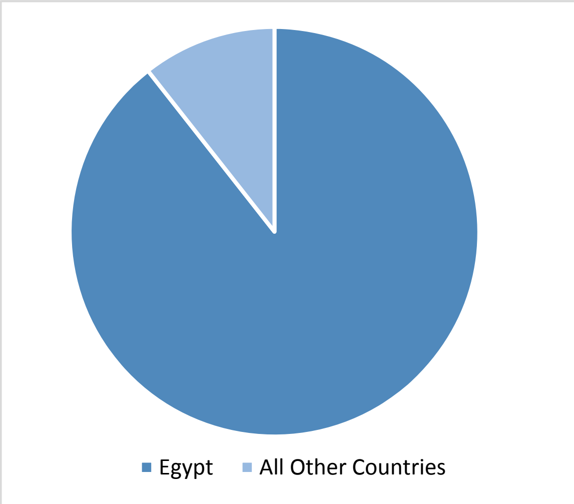
Marrowfat peas are a comparatively tiny market globally but important for the UK, being the largest producer, despite only growing in the region of 20,000 to 30,000 tonnes. A few are produced in France, and almost none elsewhere. This gives the UK market dominance of a very small and probably little known niche product. It is a slow process but building customers for marrowfats would give the UK a unique trade opportunity and some protection from the potentially very large yellow pea crop which could depress yellow pea prices next year. It appears that there is considerable potential to increase the amount of high value export sales of peas by maintaining a top quality crop, coupled with good quality service and smart marketing to keep the awareness of the UK pea high.

If more peas were available, it would be possible to increase the amount of high value exports of peas from the UK.

6.3.2 Beans

Global faba bean imports are dominated by Egypt; Figure 6 demonstrates just how much. This market has grown sharply since 2011, from less than 300,000 tonnes to in excess of half a million tonnes in 2013.

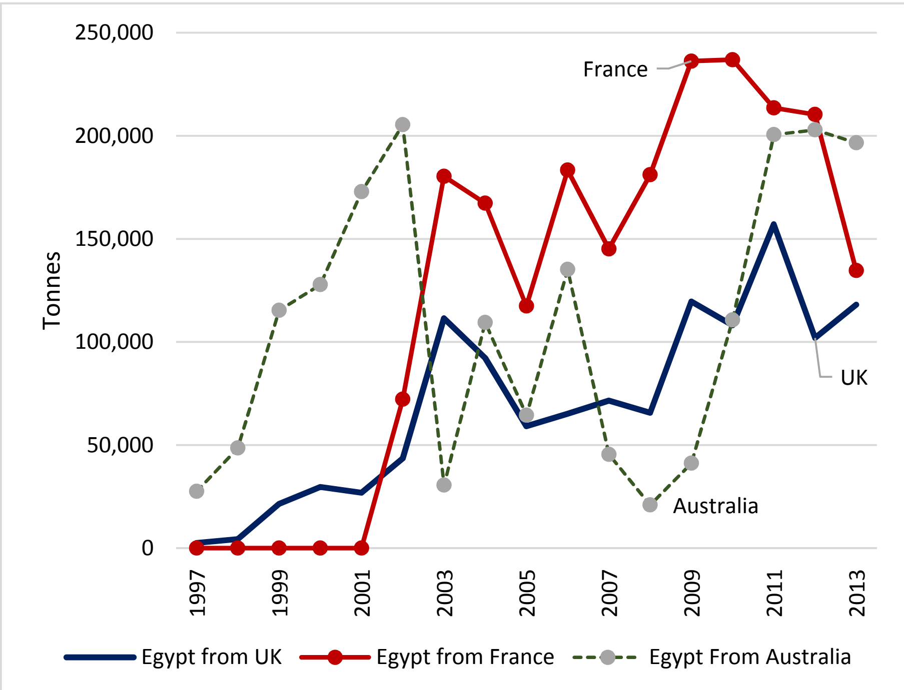
Figure 6 ~ Global Bean Imports



Source: Global Trade Information Service

It is clear from Figure 7 that the market is dominated by the UK, France and Australia. French trade to Egypt, whilst rapidly overtaking the UK in 2002 and remaining higher than UK exports since has been more erratic and, in 2013, collapsed by almost 50% whilst UK trade increased. Trade sources suggest that France might again have had fewer beans to export from the 2014 crop, possibly putting the UK into second place for Egyptian trade.

Figure 7 ~ Bean Exports to Egypt



Source: Global Trade Information Service

Whilst the UK's exports have overall been the lowest supplier out of the three, the UK has remained in most consistent growth. It is understood the UK bean is favoured over French and Australian beans because of its

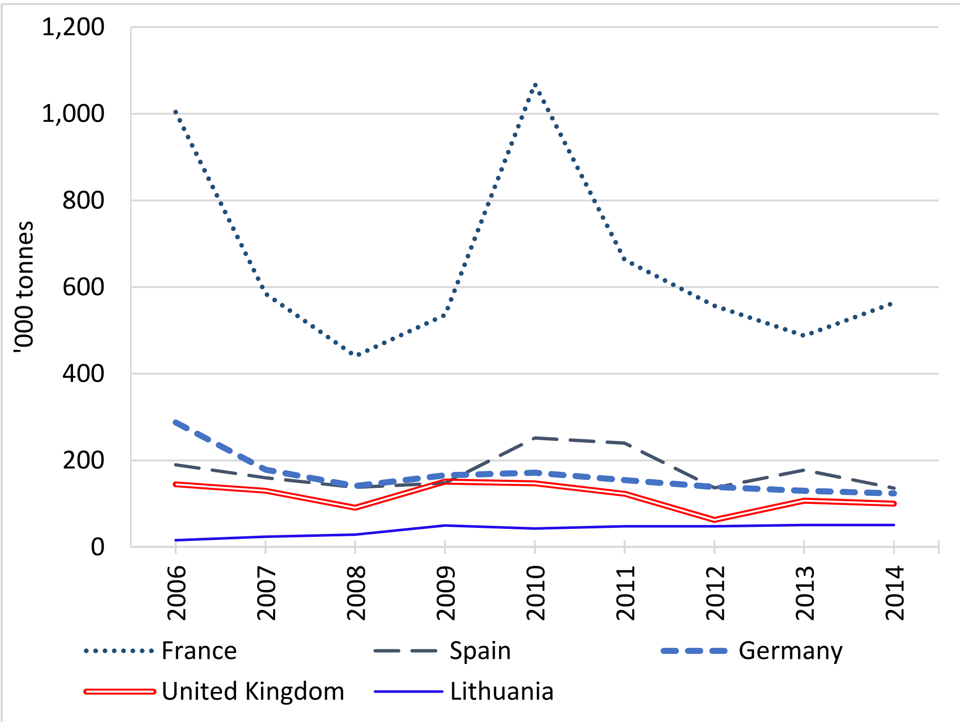
If more beans were available, more exports would be made.

quality assurance standards, the relationships built by the exporters and the associated service they receive with the commodity. We are now in a situation whereby exports to this market are made according to availability rather than demand. In other words, if more beans were available, more exports would be made.

6.3.3 EU Markets

The UK is the fourth largest combinable pea producer in the EU, but only produces 7% of output[42]. By far the most substantial producer, with over 40% of the output, is France. This is demonstrated in Figure 8 which shows the 5 largest producers. This chart shows how volatile pea production is even in France. This is reduced slightly when all countries' figures are combined, but the range over the 8 years is still large, changing from 2.2 million to 1.3 million tonnes, a 40% fall over the period.

Figure 8 ~ Production of Peas in the Top Five Pea Producing EU Member States



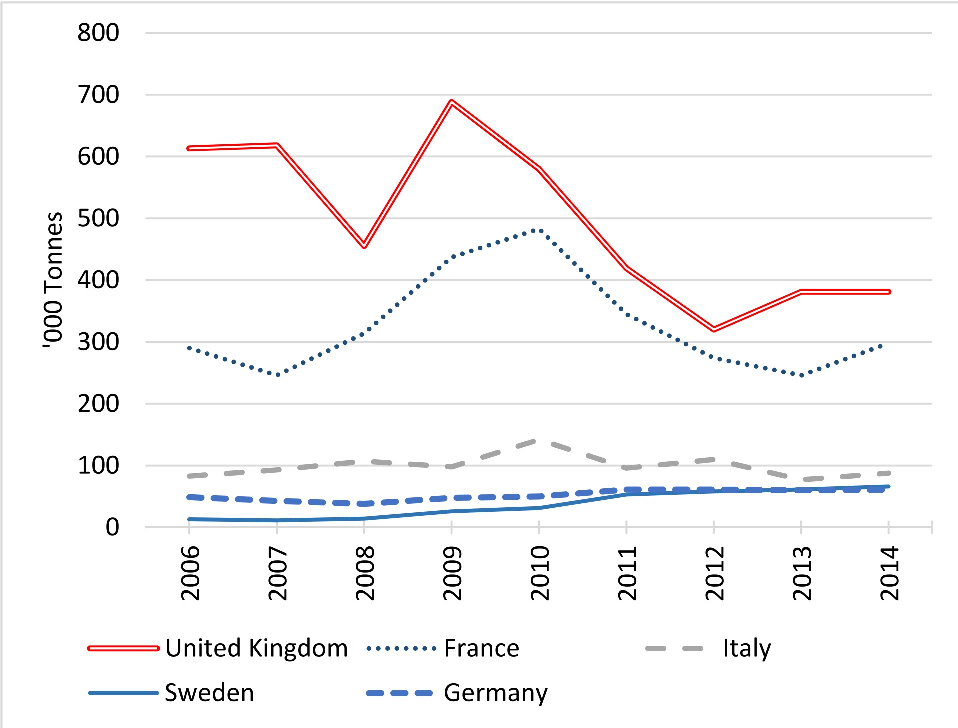
Source: Strategie Grains

Figure 9 shows that the UK is the leading producer of combinable beans and has consistently remained so over the entire period. In 2014, it is estimated that the UK accounted for about a third of all European bean production. However, only 8 years ago, the UK was responsible for half. This is not because production in other

[42] Information provided by Tallage, Provider of Strategie Grains.

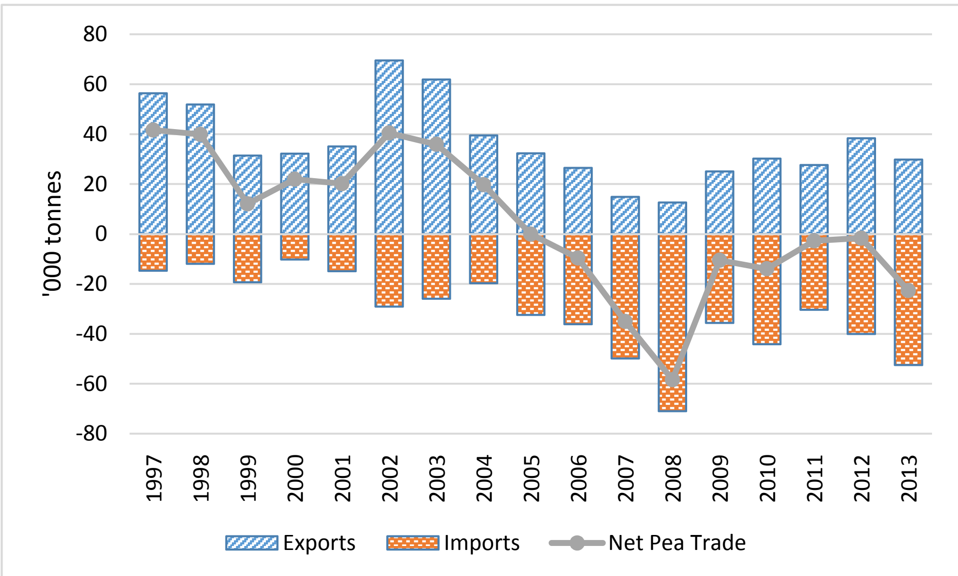
countries has increased, rather that UK production has fallen. Since 2010, the UK has held onto the top producer position by only a small margin over France as the chart demonstrates.

Figure 9 ~ Production of Faba Beans in the Top Five Faba Bean Producing EU Member States



Source: Strategie Grains

Figure 10 ~ UK Net Trade Statistics for Peas



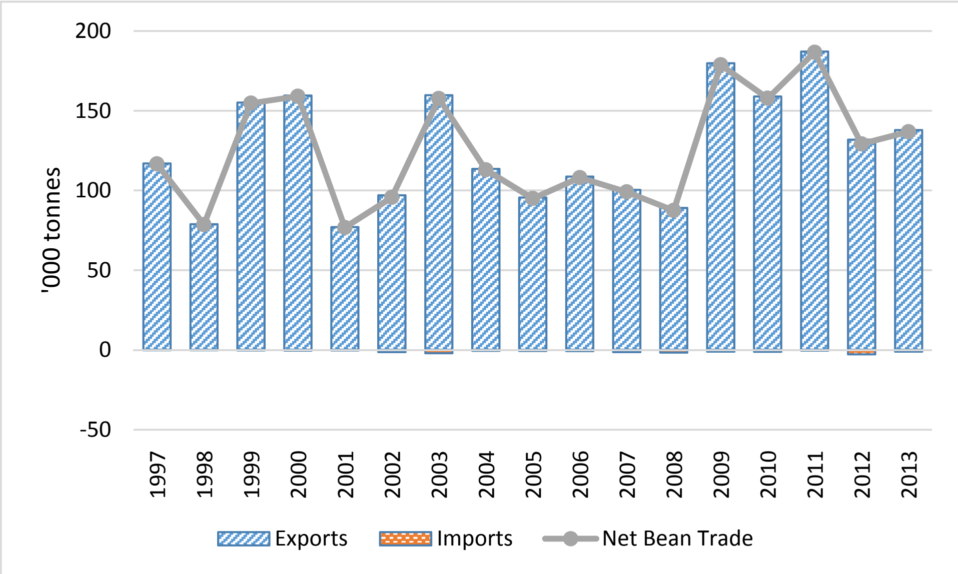
Source: Global Trade Information Service and Defra

Looking at the UK's traded figures for all types of dried peas (Figure 10), we see a gradual decline in trade position to the point that the UK has become a net importer since 2005 having had net exports of 40,000 tonnes in 2002. Imports in 2013 were dominated by Ukraine (19,604 tonnes), France (13,900 tonnes) and Canada

(5,115 tonnes). It is not clear what these imported peas were used for. The chief export destinations by tonnage in 2013 were China (5,100 tonnes), Japan (2,886 tonnes) and the US (2,609 tonnes) with Sudan and Malaysia close behind.

For beans (Figure 11), the overall trade trend is level to slightly increasing exports but with a high level of fluctuation from year to year. Imports of faba beans are negligible into the UK, partly because we produce a surplus to requirements, but also because there is a 3.2% import duty when importing from outside the EU.

Figure 11 ~ UK Net Trade Statistics for Beans[43]

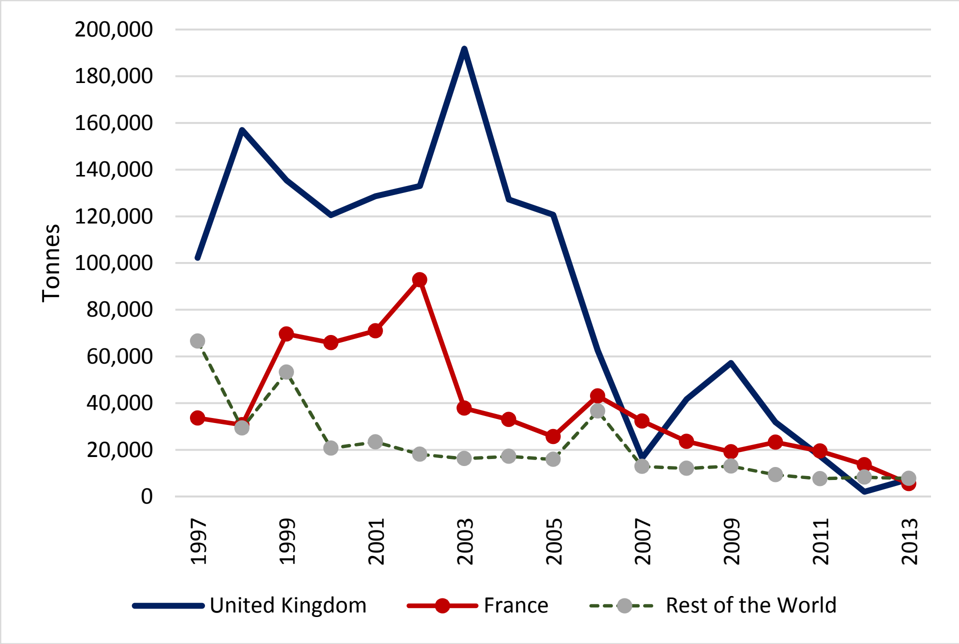


Source: Global Trade Information Service and Defra

Figure 12 demonstrates the area from which most UK exports have been lost: the Mediterranean. In fact, imports into Spain and Italy have plummeted from the whole world from almost 250,000 tonnes at the turn of the millennium to about 30,000 tonnes in 2013. This is not the UK losing trade opportunity to another exporter, rather a decline in the use of imported beans as an animal feed. Figure 24, on page 64, highlights how the price spread (difference) between feed beans and feed wheat for example has opened up in that period, therefore making beans less economical to use as an animal feed.

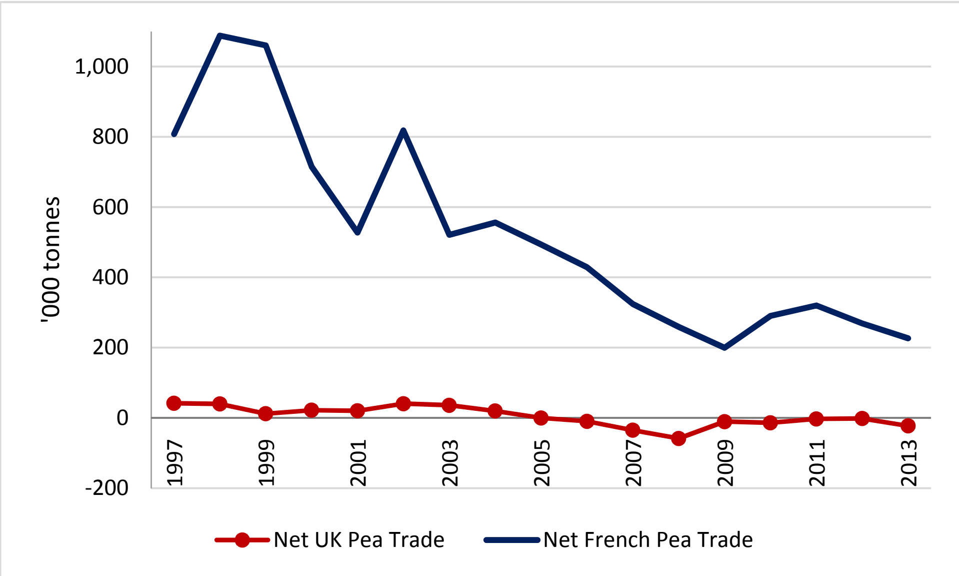
[43] Trade information in these charts is provided by the Global Trade Information Service.

Figure 12 ~ Bean Exports to Spain and Italy



Source: Global Trade Information Service

Figure 13 ~ UK and French Net Pea Exports



Source: Global Trade Information Service

Figure 13 demonstrates a similar pattern for peas. The UK has become a net importer but has never been a particularly high exporter, whereas the French, whilst still a net exporter, have reduced their volumes from over 800 thousand tonnes to about 200 thousand tonnes in eleven years.

6.3.4 Trade Summary

The old opportunities for feed pea and bean exports over the last decade have disappeared, as economics have changed. They may not return. Yet new outlets are appearing and mostly of potentially higher value. The gross UK dry pulse exports in 2013 totalled 168,000 tonnes and were sold at a total value of £67 million. This figure might be considered small compared with some other exports, for example wheat in a ‘normal’ year. However, for pulse exports, the average value per tonne was £400 (including all costs and service such as freight and insurance). This demonstrates the economic usefulness of pulses to all sectors of the supply chain that are prepared to give them the attention they deserve. Continued efforts to develop these markets could double them in five years’ time as is suggested in this paper.

6.4 PRICES

No individual decides the price of a commodity. The marketplace, determined as the relationship between demand and supply, does, both globally and locally. We can see that the decline of pulses is not solely affecting the UK, and that the UK pulse industry *does* respond to market signals that are set at a global level. The balance of supply and demand as a mechanism for setting price of a commodity is the route of market information communication between growers and consumers. This has a direct impact on production at farm level. It is within this setting that we are challenged with raising the competitiveness and therefore success of the UK pulse sector.

We cannot expect our intervention to change the market price, or the overall trade patterns, but to earn a greater percentage of export trades over our competitors or the higher quality business which would be highly valuable to all pulse sectors.

> *This year, a well grown pulse crop is one of the best gross margins on an arable farm.*

6.5 EX-FARM CONTRACTS AVAILABLE

Most peas and beans are traded in the open market, although there are some exceptions.

- *Marrowfat peas*. These are grown to contract with the seed supplied and the peas bought back by the same merchant. A limited supply of contracts available is keeping prices high for top quality samples. Demand for these peas is high compared with the tonnage being grown. With premiums as high as they are, many farmers would be keen to grow these on the open market, but the lack of seed availability prevents this. This is the only combined pulse crop where a farmer could reliably get a firm sale price at the point of drilling in 2014/15.
- *Large Blue peas* are generally sold in open market trades after harvest, once the tonnage and specification is known. Some forward contracts to purchase are made based on a feed price and premium for human consumption quality (normally of £15 to £20 per tonne).

- *Yellow peas.* Barely 7,000 tonnes are produced in the UK now, having halved since 2011 (refer to Table 1 on page 7), so no market will be available unless pre-ordered and grown to contract or sold as feed.
- *Feed beans* have some buyback contracts available over the winter after drilling, but this depends largely on the season. Some feed compounders buy tonnages forward (ahead of the delivery date) and a few merchants are prepared to take on a small tonnage at their own risk, although this will be comparatively small.
- *Human consumption beans* sold for export are traded throughout the year. However, farmers are only able to make sales for a new crop once some export sales have been made. This hampers the booking of feed sales too as most bean growers will be interested in higher value orders from exporters.

Demand for marrowfat peas is high compared with the tonnage being grown. With premiums as high as they are, many farmers would be keen to grow these on the open market, but the lack of seed availability prevents this.

7 GROWING AND MARKETING PULSES ON FARM

SUMMARY OF CHAPTER 7

Pulse yields have not increased since the 1980's and many growers lack some expertise to maximise their returns from peas and beans. Pulse yields are more variable than most other arable crops.

It is valuable for a grower to manage pulse crops for top quality, aiming to market them into human consumption marketplaces. There are several aspects that require good management to achieve this.

Currently the gross margin for pulses is very competitive with all other broadacre combinable crops.

Nitrogen fixation is possibly the greatest added value benefit of legumes for the farmer. It is insufficiently understood or quantified by the farming community as few people can explain how to measure or manage it.

Spring pulses, as well as other spring crops, can spread the farm rotations sufficiently to add value to other crop yields and also help farmers achieve more with fixed overheads such as labour and machinery.

The Common Agricultural Policy reform has encouraged the cultivation of pulses.

7.1 WHY DO FARMERS NOT GROW MANY PULSES?

Pulses are suitable crops for profitable cultivation in most parts of the UK. They fit into farmers' cropping plans for several reasons, but there are also several reasons why they have not recently been included as much as might be expected. A survey conducted of European farmers[44] cited the following reasons as the main obstacles:

- Lack of competitiveness of grain legumes to other break crops at gross margin level
- Low market price
- Insufficient yield and the risk of yield fluctuation
- Harvesting difficulties

Pulses do require a high level of agricultural expertise to grow successfully each year but evidence in this chapter also suggests there is too much farmer ignorance or lack of completed research which, if undertaken, would fill in knowledge gaps we have in the UK about growing the crops.

The ultimate factor restricting the cultivation of pulses on farm is the perceived return they offer the farmer, compared with the economics of their competitor crops. Competitors include particularly oilseed rape but also second wheat and barley. In order to influence the cropped area of pulses, farmers have to recognise that their farm profitability can rise by incorporating them in their rotations if they farm well. The forthcoming sections in this chapter examine the barriers for cultivation and the economic opportunities for the farmer.

7.2 YIELD

Maximising yield at lowest possible cost is essential in order to maximise profits from arable farming. Finding ways to raise the yield of pulse crops will improve their profitability and therefore area cultivated. Weather is clearly outside a farmer's control; this is accused of being a key influencer of pulse yield fluctuations on a

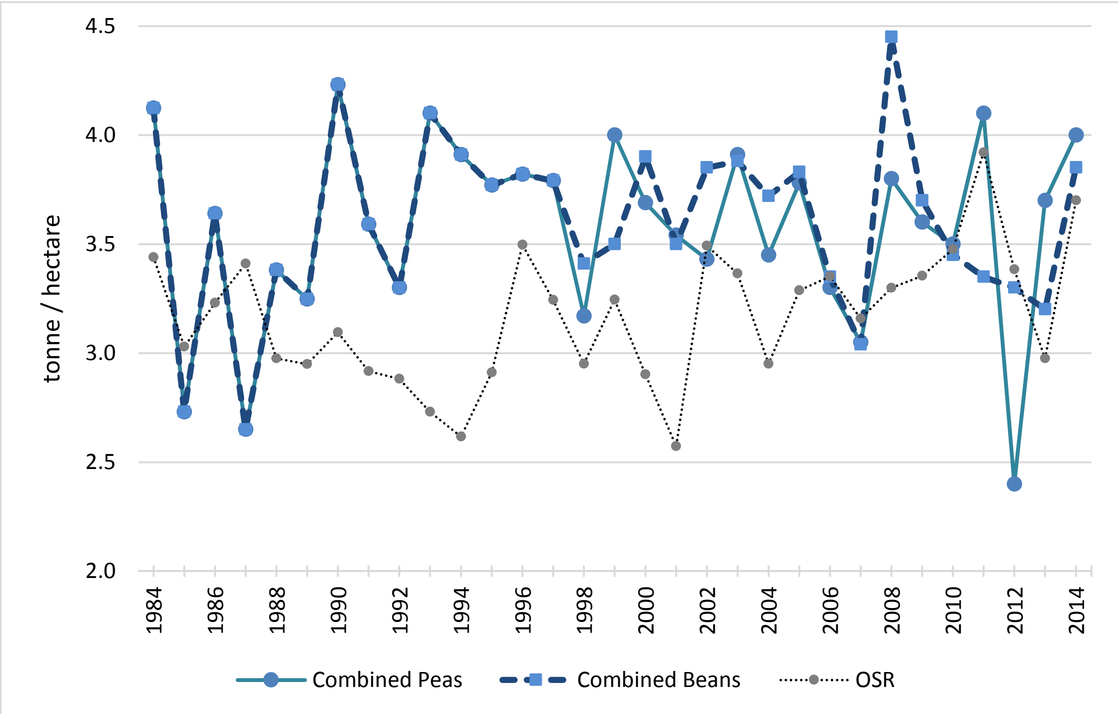
[44] (Williams, et al., 2014).

yearly basis and there is much truth in that. Yet, some growers reliably achieve substantially higher yields than others in neighbouring areas with similar soil and weather conditions. How do they manage it?

Based on Defra data, pulse yields, whilst variable from year to year, appear not to have improved for thirty years as demonstrated in Figure 14. The implication from this is that either plant potential through genetics or farmers' pulse-growing skills have not improved. It is noteworthy that the yield of oilseed rape has not sustainably risen either, possibly highlighting a more fundamental issue regarding combinable crop farming. With reference to the discussion on questionable data from Defra (section 5.2 on page 18), this chart demonstrates that, from 1984 to 1997, a single pulse yield was recorded instead of a figure for peas and beans separately.

Some growers reliably achieve substantially higher yields than others in neighbouring areas with similar soil and weather conditions. How do they manage it?

Figure 14 ~ Long Term Pulse (and OSR) Yield Trend



Source: Defra

Maximum yield and economically optimum yield are not the same but it is important to recognise theoretical 'maximum yield' so that growers can understand how much potential yield has been lost through limiting inputs such as seed bed preparation, weed control, soil minerals or any other restriction. There are several examples of beans achieving eight tonnes per hectare which suggests that we have a lot to learn[45]. When a grower averages, say, four tonnes per hectare, it is a useful exercise to identify where the other four tonnes were lost.

Agronomists, and other experts in pulse production, have explained that insufficient consideration into how to maximise the number of flower trusses, how to increase pea set numbers inside a pod, or how to keep the peas or beans growing in the pods, is given to each crop. One contributor suggested micronutrient requirement information for pulses is lacking. Most of these suggestions are without evidence. There is a considerable knowledge gap amongst growers on how to maximise pulse yield. Some of the research needed is identified here, but it is not possible in this report to identify all the science that might be relevant for the industry.

Some farmers have achieved eight tonnes per hectare of pulses, so when a grower averages, say, four tonnes per hectare, it is a useful exercise to identify where the other four tonnes were lost.

Growers are also concerned about the variation of yield, rather than it simply being too low. Table 6 demonstrates Defra's historical UK break crop yields for the eight years from 2006 to 2013. We note with caution the comments provided in section 5.2 on page 18 about yield uncertainty.

Table 6 ~ Historical Break Crop Yields

	2006	2007	2008	2009	2010	2011	2012	2013	2014	9-year Average	Standard Deviation
Combined Peas	3.30	3.05	3.80	3.60	3.50	4.10	2.40	3.70	4.00	3.49	0.52
Field Beans	3.35	3.04	4.45	3.70	3.45	3.35	3.30	3.20	3.85	3.52	0.43
Oilseed Rape	3.35	3.16	3.30	3.35	3.48	3.92	3.38	2.98	3.70	3.40	0.28
Linseed	1.35	1.59	1.82	1.95	1.64	1.95	1.50	1.80		1.70	0.22
Oats	5.99	5.50	5.80	5.77	5.52	5.62	5.14	5.46	6.09	5.65	0.29

Source: Agriculture in the UK

The analysis demonstrates that peas and beans do indeed have the greatest level of variation in crop yields compared with the average over this eight year period. However, it is pointed out[46] that the variation for crops covering smaller areas is likely to be greater. The variation on farm might be rather different to that on a national scale because of soil type, or weather issues in regions of the country. As a rule, the variation for smaller areas (per farm or even per field) is likely to be greater than yield variations over larger areas (regional or national) because of the averaging effect of larger areas.

Pulses are vulnerable crops. Their yield is affected by hot dry spells, standing water and they are not very competitive to weeds making it difficult to achieve consistently high returns. Nevertheless, there is an opportunity for better knowledge transfer to help growers consider all the factors that reduce yield and manage each of them accordingly because it is not just the weather factor. A report in a Canadian Pulse journal[47]

[45] Such as (Singh, et al., 2013).
[46] (Domoney, 2014).
[47] (Le-Feuvre, 2008).

explains how yield increases of up to 50% are achievable by placing properly managed bee hives in the bean fields during flowering; it's a simple management activity with highly valuable outcomes. This has also been extensively reported in Australia recently.

Fresh pea and bean yields have not risen either for many years. This information is known to be correct because of the contractual data collected by the British Growers Association. Whilst the varieties (of vining peas) have not changed much for many years, the processors are also increasingly keen to achieve more tender peas, meaning they are often harvested young, foregoing yield for tenderness. A dedicated, systematic programme of knowledge transfer on factors affecting yield could make a substantial difference to crop yields nationally.

A dedicated, systematic programme of knowledge transfer on factors affecting yield could make a substantial difference to crop yields nationally.

7.3 QUALITY ~ AFFECTING PRICE IN THE FIELD

Beyond marketing techniques, the key way a farmer adds value to a crop is by raising its quality to sell to higher value markets. This, as discussed, is important in the pulse sector as the price difference is often substantial. One contributor to this study suggested that the inputs for pulses are the same as for other combinable crops such as wheat, but where one requires more agrochemical, the other requires more management input. This is demonstrated in the speed a pulse crop can lose its value (or yield) if not correctly tended.

Some examples of quality issues that growers and the processors struggle with are listed below. It is not exhaustive but includes the major issues. Some are overcome by additives in processing or agrochemicals at production or preventable simply through exceptionally good farm management.

7.3.1 Bleaching at Harvest Time

The optimal harvesting window for peas is short. Bleaching (discolouration) in peas is caused by moisture and sunlight at pea maturity, two things difficult to avoid at that time. Different varieties bleach at different speeds. Peas should be harvested at about 18% moisture and dried slowly to 14 or 15% as required[48]. Bleached peas are worth much less as peas are used for colour in most processes. Missing the harvest by two days might lose a pea crop £50 per tonne, whereas leaving another crop by two days might affect its value, but probably by substantially less.

[48] (The Pulse Harvest Edition, 2013).

Table 7 ~ Value Loss by Missing Harvest Optimum by Two Days (Possible Scenario)

	Peas	Milling Wheat	Difference £/ha
Yield t/ha	5.0	9.0	
Premium Value £/t	£250	£160	
Lower quality value £/t	£200	£150	
Loss per hectare	£250	£90	£160

Source: Andersons. Demonstrative figures verified with trade source

Table 7 illustrates the possible quality loss of peas and bread wheat from missing the optimal harvest date by two days. If peas bleach, their price would fall this year by about £50 per tonne, although in previous years that fall has been as much as £100 per tonne, a potential loss on a high-yielding pea crop of as much as £500 per hectare from just missing the optimal harvest date by a weekend. Conversely, the loss of value of a high quality milling wheat is considered to be only a part of its potential premium and almost no loss for feed wheat. This demonstrates a basic economic assessment that many farmers miss at harvest time, possibly because they don't understand the technicalities of pea farming.

Some growers clearly do realise the importance of harvest timing, others will harvest good pea colours by chance rather than planning, and most growers do not achieve yields used in the example. Table 7 is therefore an extreme situation, not an average for all growers. Table 8 provides an estimate of what the 'average' gain might be per hectare and impact nationally, if the timing of harvest was improved for all growers. It uses the average UK pea yield (and wheat yield) and a smaller premium loss for the reasons already given to reach an uplift of £49 per hectare. Extrapolating this on a national scale gives a cost free uplift of pulse value of £1.4 million simply through improved knowledge exchange and better harvest planning. Over 7 years this gain would add up to £10 million.

Table 8 ~ Potential Value to UK by Improving Harvest Date

	Peas	Milling Wheat	Difference £/ha	UK 2013 Dry Pea Area Ha	Potential value gain £/year
Yield t/ha	3.5	8.0			
Premium Value £/t	£250	£160			
Lower quality value £/t	£220	£153			
Loss per hectare	£105	£56	£49	29,000	£1.42 million

Source: Andersons. Demonstrative figures verified with trade source

Simple details in farm management like this could make or save an arable farmer considerable amounts of additional value and create value for the UK. These techniques need to be made clear to farmers new to pulse farming, arable farm contractors who decide which fields to harvest and agronomists who have considerable influence on farm. The visual difference of just 2 days harvest is demonstrated by Figure 15. The PGRO has been explaining this difference to farmers recently using this image. More work like this would be rewarding.

Figure 15 ~ Visual Difference from Delaying Pea Harvest by Two Days

Source PGRO; Peas harvested 2 days apart with a £50/tonne difference in value.

7.3.2 Pea Crop Lodging and Netting

Collecting stones and soil can be a problem, especially if peas lodge (fall over) before harvest. Peas have contractual admixture levels, usually 1%, before deductions are taken. Stones can also damage the combine harvester. Several former growers have memories of pea crops collapsing from a light shower but there are now varieties available with improved standing ability, led by Campus, with an ‘8’ for ‘standing ability at harvest’ out of a possible 10 in the 2015 PGRO Recommended List[49].

Larger pea varieties tend to have better standing ability than a short stemmed variety because they have more lignin. The netting effect of (the semi-leafless varieties of) peas is also seen as a benefit here, as it holds the pea crops off the ground. This is not fully understood by some farmers who find the netting a barrier. Other growers have adapted their harvesting practices to accommodate pea netting by fitting side cutter bars to their combine.

7.3.3 Pea Moth

Pea moth holes are, for some processors, the biggest quality problem for peas. One pea processor for example has a standard of 0.3% holes (1 hole in 330 peas). Pea moth resistant varieties would be ideal, but it is a problem that can be minimised with timely pesticide use. This frustrates the processing sector because knowledge and technology is available to tackle the problem, although the window for applying the spray is tight and it varies, and inclement weather can obstruct application. This is why farmers are encouraged to use pheromone traps.

[49] http://www.pgro.org/images/site/news/nov-14/PGRO-RECOMMENDED-LISTS-2015.pdf.

7.3.4 Bean Bruchid Beetle

Consumers do not want to eat beetle larvae within their food even if it does them no harm. Furthermore, finding insect holes in food is unappetising. As most beans for human consumption are used either whole or simply split, meaning the shape of the crop remains intact, such holes are easily identified. Bruchid beetle is a common pest in UK bean crops, which leaves holes in the bean. A bean with a hole actually means the larva has eaten its way out and has left the bean. However, other 'hole-free' beans in the same sample might still have the larvae present. Bruchid beetle damage is a major loss of value to a grower. Whilst damaged beans can be separated after harvest, this is a very slow and expensive process, only worthwhile if the human consumption premium is high enough to justify it.

PGRO and Syngenta have worked closely on the bruchid beetle (Bruchid-Cast[50]), specifically regarding observing the life cycle and understanding the optimal conditions for beetles to lay eggs in flowers, which depends largely on moisture and temperature. They can only be controlled at this stage so observing timings is important. There is minimal problem in Scotland because of cooler conditions. France suffers from bruchid beetle in peas, but conditions in UK preclude this pest. Research is therefore also looking at earlier flowering bean crops to catch cooler conditions at the critical point.

7.3.5 Tannins in Bean Skin

Some have suggested that tannins in bean skins dictate an upper limit of bean incorporation in some animal feeds, including pig rations and fish diets, because of the meat taint caused and this is one reason why decorticating is deemed necessary in fish food. There is, however, empirical evidence to suggest this is not necessarily the case[51]. Tannin-free varieties have lower starch digestibility and higher protein digestibility[52] although these pieces of research are dated. Tannin-free beans have issues. Current varieties can be cross pollinated in the field, so the purity of tannin free status is low, especially when seed is home saved. There is no price premium and the yield is low. Skins are a lower nutritional value component of beans, so thinner skins, in favour of greater cotyledons, would be ideal. A thinner skin would reduce losses by weight, but so would a larger bean as the percentage of skin would decrease in either scenario. Research currently being undertaken under the *Beans4feeds* project is planning to determine the maximum inclusion levels in Atlantic salmon feed[53].

7.3.6 Value Lost from Failure to Meet Specifications

The supply chain is demanding. Its requirements will always be changing. Most critically, it is pointed out that processors' wish-lists are partially to facilitate their processing or simplify the production roles. Ultimately, the most important consideration is with regards to what 'stays in' the pulse. In other words, making new and novel discoveries and breeding resistance or yield traits would be fine, but only as long as they continue to meet the requirements of the consumer every time. In other words, flavour, taste, colour, healthiness and cost are what drive consumers to purchase. This puts this section into context.

[50] http://www3.syngenta.com/country/uk/en/AgronomyTools/Pages/BruchidCast.aspx.
[51] (Houdijk, 2012).
[52] (L Lacassagne, 1987) (Bond, 1976).
[53] http://www.beans4feeds.net/salmon.

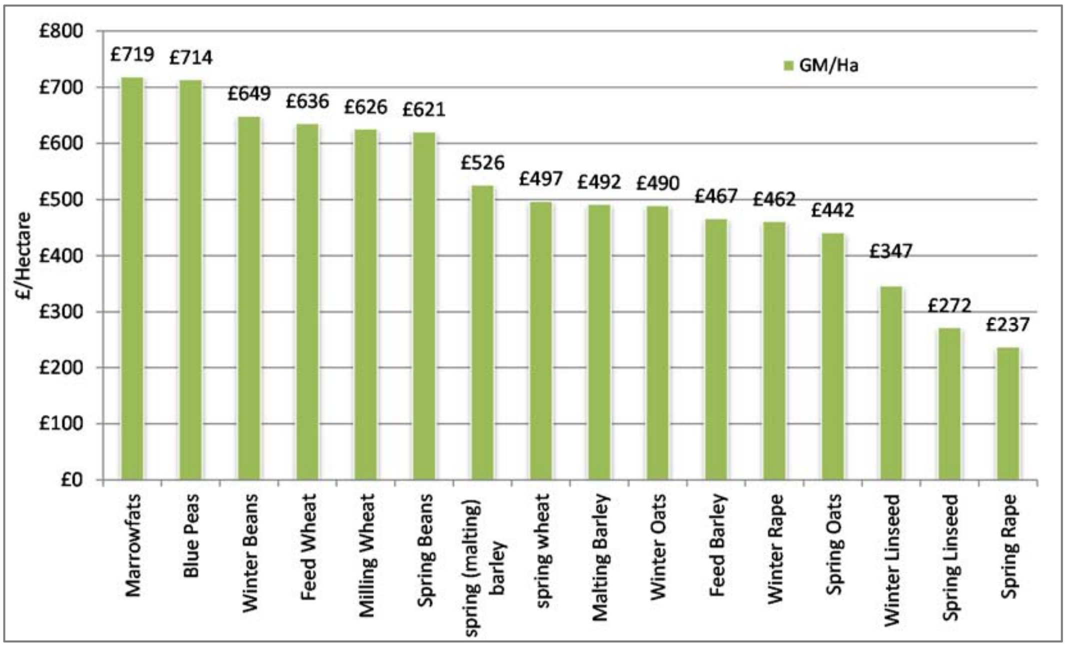
7.4 GROSS MARGIN

This section considers the gross margin and issues around it.

7.4.1 Gross Margin Economics

A gross margin is the financial schedule of an enterprise that shows the output less the costs that are directly attributable to it. It does not show the costs that would have been incurred if that crop was not grown. Gross margin is not profit as the overheads such as labour, machinery, rent and finance charges are not included. Importantly for pulses, the gross margin does not reflect the impact a crop has on subsequent crops such as raising nitrogen levels in soils for the benefit of following crops or the soil condition after harvest.

Figure 16 ~ Gross Margins of Various Combinable Crops for 2015



Source: John Nix Farm Management Pocketbook 2015

Figure 16 shows how competitive the pulse crops currently are against other combinable crops. Most years, they are not usually so high up the ranking, but pulse prices have risen relative to other combinable crops since 2012, making them more lucrative to growers. This is a considerable opportunity for farmers to profitably learn to grow what is a technically demanding crop. This price situation might not last in future years.

7.4.2 Agrochemicals

Pulse crops are not very competitive against other plants so are not good at supressing weed growth. Weed management is therefore particularly important. Being nitrogen fixing, they may fertilise other plants in the field although the nitrogen fixation does not develop until the crop is well established. Pre-emergence herbicides are the only effective control measure in pulses and their effectiveness varies depending on the seedbed (clod size and moisture levels) and weather conditions. Post-emergence options remain, but the chemistry available is relatively restricted and arguably less effective[54]. In other parts of the world, practices like 'crop-topping' is practised to remove ryegrass heads before viable seeds are formed[55]. In beans, yield loss near tramlines (brittle pods) from the passage of the sprayer can be a problem. Weed management is an important factor affecting yield and admixture although tools to manage it are sparse. It is one of the more testing challenges for the farm manager.

Effective control of weeds and diseases is paramount to ensure maximum yield in the crop and to ensure that weed seed is not returned to the soil. Changes to EU regulations regarding water quality, the banning of endocrine disruptors (regardless of their level of risk exposure) and the moratorium on neonicotinoids are coming together to remove a considerable number of agrochemical active ingredients from the available list[56]. Many have already been banned; several others are likely to disappear in the coming 4 years. As a result, the ability to control grass weeds in cereal, oilseed and pulse crops has become more challenging. This has contributed to an increase in weed populations in crops and the rise of herbicide resistant strains of weeds, particularly blackgrass. Several people interviewed as part of this study all identified the greatest potential loss to the pea and bean sector is likely to be *pendamethalin*, a pre- and post-emergence herbicide used to control a large range of grass and broadleaf weeds. Without this product, the pea and bean grower would struggle to cultivate a clean weed-free crop of pulses. There is currently no alternative herbicide in the research pipeline.

The inclusion of additional (spring) crops in the rotation allows a variety of chemicals from the different chemical groups to be used on the same weeds, thus reducing the risk of resistance to any particular active ingredient. Having a spread of crops in the rotation (particularly spring crops) also spreads the timing of agrochemical applications thereby avoiding spikes in water runoff (when all farmers in one catchment spray for a single pathogen at one time). Spring crops (and late drilled autumn crops to an extent) enable the use of non-selective herbicides over a longer period, increasing the effectiveness of weed control. Non-selective herbicides are much cheaper than in-crop agronomy which is becoming increasingly less effective. Over the decade to 2005, the cost of bringing a new active ingredient to market rose from $152 million to $256 million[57]. It is therefore increasingly unviable to create a new product specifically for a small-area crop such as pulses. Most agrochemicals used on fresh produce (including vining peas) are 'off label' or extensions of authorisation for minor use, referred to as 'EAMU'. Special arrangements allow pesticides already authorised for use on one crop to be used on similar crops without having to get another full authorisation. Agrochemicals used for dry pulses are increasingly coming into this category. It is not necessarily a problem, but licensing an EAMU involves a delay of 18 months to 4 years (depending on the residue tests required) meaning the product is used on other crops for several years first. An EAMU also comes at a cost which varies according to the number of residue tests required, normally from four to eight, each costing about £10,000[58]. The HDC is very involved in generating residue data for fresh produce and the PGRO has been undertaking similar work for dried pulses. It is thought that manufacturers are themselves unlikely to undertake this work on some crops for economic reasons.

[54] For example, *bentazone* is the only remaining post emergence herbicide available for broad leaved weed control in beans. *Nirvana* (*pendimethalin* and *imazamox*) is a residual herbicide which can be used on all combining and vining peas, plus winter and spring beans.
[55] (Meldrum, 2011).
[56] (King, 2014).
[57] (Phillips McDougall, 2013).
[58] Personal comment from agrochemical manufacturer.

7.4.3 Nitrogen Savings

Legumes have *Rhizobia* in their root nodules which fix atmospheric nitrogen. Several studies have quantified the amount fixed into soil, and how much is then available to the following cereal crop, and how much is then used by the subsequent crop, only some of which is discussed below. In its 2014 Agronomy Guide, the PGRO states that the amount available for the cereal crop following a pulse varies from 25kg to 50 kg per hectare of available additional nitrogen depending upon the amount of residual (biomass) and that the amount is greater with beans than peas but slower to mineralise from beans than peas[59]. However there is plenty of published work that offers various opinions and creates a confusing picture of what the figures are, how to calculate what the benefit is under various conditions, and how to manage this. Indeed, one contributor even suggested that a gradual decline in nitrogen fixing nodules over the last 25 years is reducing the nitrogen fixing benefit of pulses. Others have demonstrated that pea and bean weevils eat the nitrogen fixing nodules thereby reducing their impact. No published evidence has been found though to substantiate these comments. The large number of pea and bean types also complicates the research, all having different results.

A report[60], produced as part of a Defra project, cited various trials and studies that have estimated the amount of nitrogen fixed by a wide range of leguminous crops. For peas, the various information sources put the amount between 70 and over 200kg N/ha, whereas for beans the sources varied from 40 to 125kg N/ha. The report refers to trials in Germany with peas, where over a number of seasons the average amount left in the field was 202kg N/ha after harvest, 158kg of which was in the crop biomass (straw) and 44kg N/ha was as nitrate in the soil. The PGRO states that ADAS trials conducted from 1987 to 1990 indicated the nitrogen allowance after pulses relative to after wheat to be 70kg N/ha after spring beans, 40kg N/ha for winter beans and 50kg N/ha after peas. However, Canadian research quotes beans as the least efficient nitrogen fixers among legumes at 30-50kg N/ha[61]. The yield benefit of the wheat crop after pulses, rather than other break crops, was calculated at 840kg/ha (up to 10%), which was not necessarily all determined by the additional available nitrogen (PGRO Agronomy Guide). Similarly, Australian research suggests more than 50kg N/ha needs to be applied before wheat yields grown after wheat are matched by wheat grown after pulses in the absence of nitrogen fertiliser[62]. These data are supported by an HGCA study[63] by ADAS. A study carried out in Canada found that there was a disproportionately high increase in yield compared to that expected from the additional nitrogen uptake in wheat after pulses, meaning that non-nitrogen factors were also responsible for the greater wheat yield[64]. This is due to reductions in diseases and improvements to root growth, as well as the enhancement of growth of beneficial soil micro-organisms, none of which were quantified.

The ADAS work conducted for the HGCA shows protein concentrations in cereals are very similar when they follow other cereal crops in the rotation to those after break crops if given identical amounts of nitrogen fertiliser. It found that, if allowances were made for soil nitrogen residues, the grain protein content tended to be less not more after a break than after a cereal. However, Australian research found that, in some cases, no

[59] (PGRO, 2014).
[60] Defra funded (Cuttle, et al., 2003).
[61] (Akter, et al., 2014).
[62] (Pritchard, et al., 2005).
[63] (Sylvester-Bradley, 1993).
[64] (Arcand, et al., 2014).

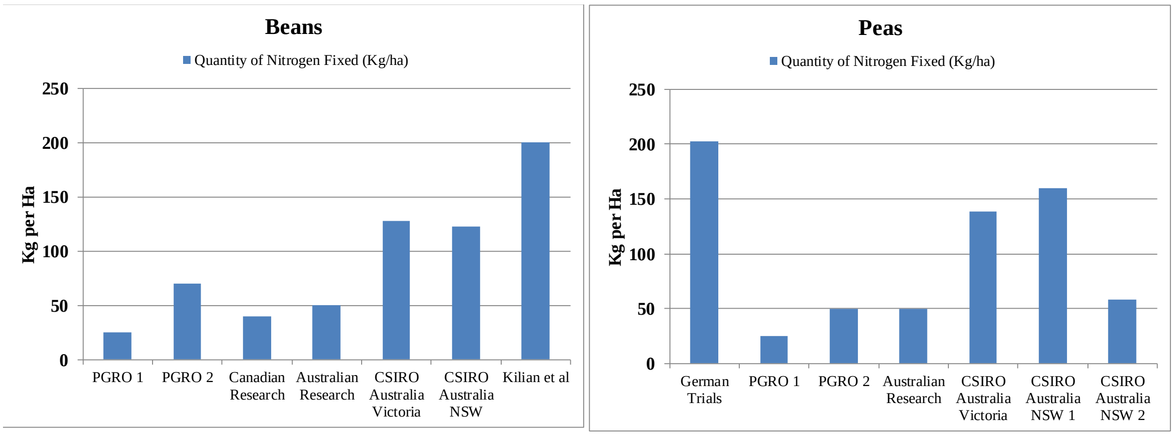
amount of fertiliser nitrogen applied to second wheat can raise grain protein to the level achieved from wheat after a pulse, indicating that pulses provide other benefits such as a more even supply of nitrogen over the growing season[65]. It found that as well as the yield benefit in a following wheat crop, a wheat crop after peas produced 1.9% extra protein compared with a second wheat crop. There could be further financial gains if growers opt to produce higher value milling wheats post pulses, in an attempt to attract higher premiums and or reduce the risk of failing to meet the milling specification required.

A report produced for the European Parliament's Committee on Agriculture and Rural Development[66] expressed the residual nitrogen left from a pulse crop combined with other pre-crop effects such as the reduction in root diseases for the following cereal crop as the 'fertiliser nitrogen equivalent'. From literature reviewed in this study, this was reported to be as high as 120kg N/ha. However, it highlighted that this beneficial effect is not always maximised because farmers do not take account of this when fertilising the following crop. A survey of agronomic experts, that was undertaken for the Legume Futures Project, demonstrated that the savings made in practice are significantly less than could be achieved, stating actual savings in farm practice to be nearer 20kgN/ha. It stated that many farmers treat legume-derived nitrogen as a bonus, rather than actively seeking to change the quantity they fertilise their crops, possibly through ignorance on how to use the benefit. As a result, the full potential benefits of the legume in the rotation, both economically and environmentally, are rarely achieved.

Nitrogen savings following pulses are significantly less than could be achieved, with savings on farm about 20kg N/ha. Many farmers treat legume-derived nitrogen as a bonus, rather than changing the quantity they fertilise their crops, possibly through ignorance on how to use the benefit. As a result, the full benefit of legumes in the rotation, both economically and environmentally, are rarely achieved.

[65] (Quinlan, 2008) and (Pritchard, et al., 2005).
[66] The Environmental Role of Protein Crops in the new Common Agricultural Policy, 2013.

Figure 17 ~ Results of N Fixation from a Selection of Research Documents



The paragraphs above demonstrate how muddled and confusing the message from research and science is to the grower. This is visualised in Figure 17 with various reputable organisations offering differing advice to the grower on how much nitrogen is generated by legumes. Furthermore, some reports discuss nitrogen fixation, others discuss residual nitrogen left in soil and others again consider the nitrogen taken up by the following crop. This is too confusing for non-academics to absorb.

Simple and clear messages of the effect of nitrogen fixation, and how to best manage it for a farmer's economic and environmental benefit, are needed.

Given the muddled and arguably conflicting evidence, to derive any value from this benefit, further work would be required to confirm the most appropriate figure to use to share with the farming community on the nitrogen fixing benefits of pulses or a simple method of nitrogen calculation. There needs to be simple and clear communication of the benefits arising from nitrogen fixation for farmers, enabling them to maximise the economic and environmental benefits.

The Economic Impact of Nitrogen Fixation

Despite the variations in evidence, assuming an average saving of 50kg N/ha, and assuming the nitrogen requirements of the following crop are satisfied solely by artificial fertiliser, then at current prices of £265/t for Ammonium Nitrate, this equates to a saving of £4.27 per tonne of the following crop of wheat[67] or £38.40 per hectare (at 9 tonnes per hectare). As a result, it is correct to attribute the value of the nitrogen fertiliser saving in the following cereal crop to the pulse gross margin, something that is not commonly done. This makes the economics of pulses more competitive to other break crops which do not fix nitrogen. This is illustrated in Table 9.

[67] All figures are taken from the ABC Book for 2015.

Table 9 ~ Gross Margin Comparisons Incorporating the Value of Fixed Nitrogen

£/ha	**OSR**	**Spring Beans**
Gross Margin *(ABC, Nov 2014)*	482	506
Value of 50kg N Fixed		38
Total Gross Margin	**462**	**544**

The nitrogen fertiliser saving in the following cereal crop should be attributed to the pulse gross margin, something that is not commonly done.

The benefit of reduced nitrogen fertiliser requirements when growing wheat after pulse crops compared with other break crops is widely but not well documented. Whilst the inclusion of this value in the gross margin is not mainstream it must be borne in mind as it is the performance of the whole farm which forms the basis for farm profitability, not one crop in isolation. As evidence of this confusion, Procam, a large national agronomy company in the UK, which tracks gross margin information on its farms, reports that nationally farmers tend to put *more* nitrogen fertiliser on wheat crops following legumes than wheat crops following oilseed rape. In 2013 for example, the average crop of wheat after beans received 210kg N/ha, whereas the average crop of wheat after oilseed rape received only 200kg N/ha bagged nitrogen. It is thought that farmers consider the residual bagged fertiliser unused after oilseed rape is greater than the available nitrogen generated by the leguminous rhizobia, or simply as they see the bagged fertiliser (and pay for it), it's residual value is more easily remembered. These data covered several tens of thousands of hectares[68]. If this is representative of the average UK farm practice, then the potential gain in savings nationwide is considerable.

Farmers tend to put more nitrogen fertiliser on wheat crops following legumes than wheat crops following oilseed rape.

As a crude summary of the previous sections, this document works on the basis that pulses save 50kg N/ha for the following crop rather than costing 10kg N/ha as the Procam data suggest. The loss is therefore 60kg N/ha. The current price of bagged nitrogen fertiliser (Ammonium Nitrate at 34.5% nitrogen) is £264/tonne[69] making 60kg/ha of unnecessary nitrogen application worth £45.91/ha. Spread across the entire UK pulse area of 176,000 hectares in 2014, this comes to a financial cost to the industry of £8.1 million. This demonstrates another relatively easy way to raise the efficiency of the farm system and increase competitiveness simply by making the knowledge of the benefits of pulses available to the farming community in a very clear and unequivocal manner.

[68] Personal Communication with Nick Myers, Technical manager of Procam.
[69] (Agro Business Consultants, 2014).

The most prominent and respected fertiliser guide in UK agriculture, RB209; The Fertiliser Manual, makes no quantitative reference to the benefits of pulses for subsequent crops. This summarises the silence on the subject. Editors of national costings books have been approached to include a value in their publications which should happen in 2015.

The most prominent and respected fertiliser guide in UK agriculture, RB209; The Fertiliser Manual, makes no reference to the quantitative benefits of pulses to subsequent crops.

Nitrogen Saving Conclusion

In summary of the above, the following actions are required to further realise the potential of pulse crops on farm:

1. Work to confidently quantify the amount of nitrogen fixed under various UK conditions
2. Knowledge transfer to farmers how to manage the rotation to maximise the nitrogen fixing benefit of legumes
3. Better accounting of nitrogen and other residues in farm management schedules
4. More research required to determine and quantify the non-nitrogen factors that contribute to increased wheat yields following pulse crops compared to other break crops, such as the impact of soil microbes.

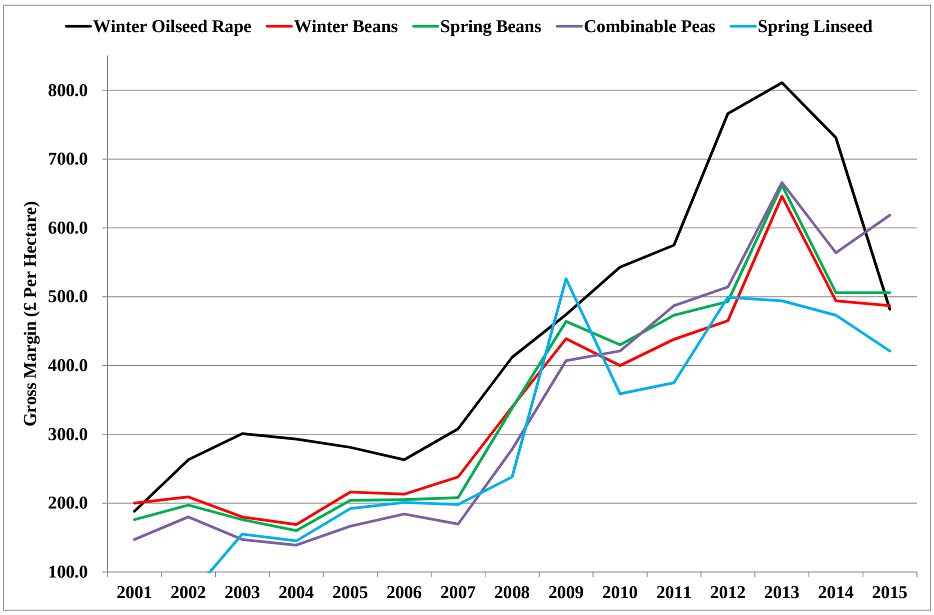
7.5 Gross Margin Analysis for Break Crops

The decision regarding cropping choice is determined by several factors including

- potential profit
- management requirement
- technical requirements
- resource availability, including soil type
- habit

Figure 18 compares the gross margin for six different break crops available to UK growers. This information has been taken from the Agricultural Budgeting and Costing book. It is a renowned publication within the industry and as a result the figures within the book are one of many factors that might influence a farmer's cropping decision. It demonstrates the gross margin for winter and spring beans has been approximately £100 per hectare below winter oilseed rape over this 15-year series. It also shows the gross margin from spring beans has moved ahead of winter beans in recent years. The margin of oilseed rape over beans became more significant in the period 2010 to 2014 on the back of higher oilseed prices.

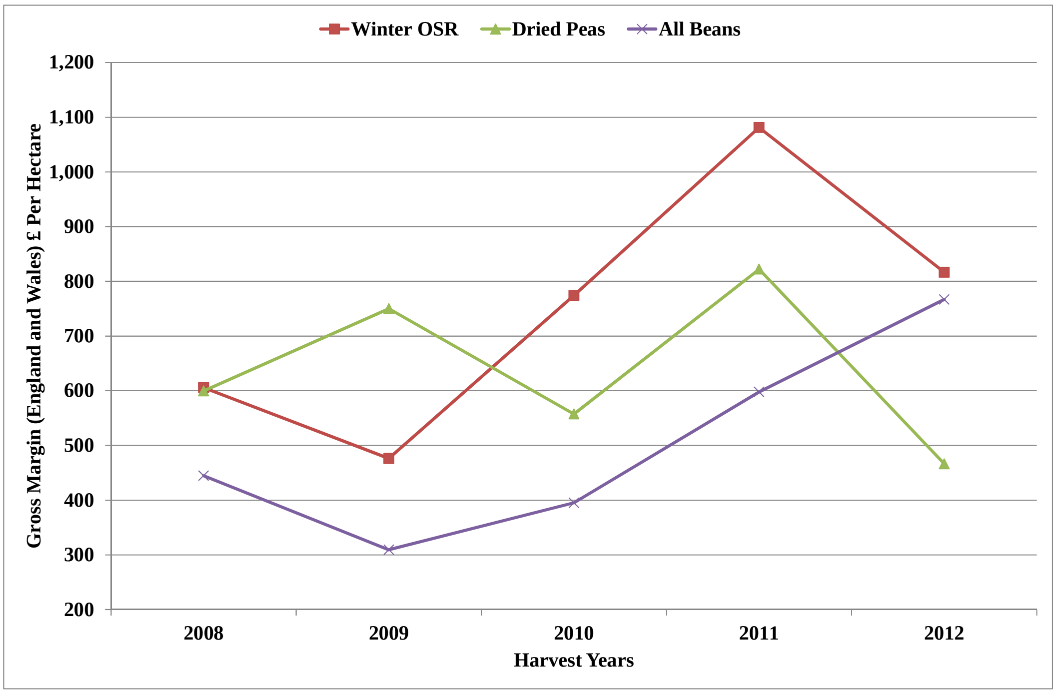
Figure 18 ~ Break Crop Gross Margin Comparisons £/Hectare



Source: Agricultural Budgeting and Costing book

The Farm Business Survey (England and Wales) (FBS) data in Figure 19 compares the gross margins for winter oilseed rape, all beans and combinable peas for the five years 2008 - 2012. It is notable that whilst the FBS shows actual data, it is rather out of date, the most recent data available being 2 years old. There is more volatility between years in the FBS than the ABC because the former captures actual results influenced by weather and actual sale prices, rather than budgeted yields (which inevitably assume 'averages'). However, for all three crops, the average gross margins in the ABC book are lower than those in the FBS data, the most significant difference being those for oilseed rape and peas. The point to draw from the above chart is that selecting a crop solely for maximum gross margin is difficult as prices cannot be easily predicted. They should be selected on a more holistic basis on how they fit into the farm structure and match the farm resources.

Figure 19 ~ Farm Business Survey Gross Margin Comparisons



Source: Farm Business Survey, 2014

As already discussed, Procam keeps gross margin details of its clients. In 2013, peas had the second highest gross margin after wheat. Whilst assumptions were made about the output prices and levels of claims, the information is useful as a guide of crop financial performance. Beans did not perform as well as can be seen in Table 10.

Table 10 ~ Gross Margin Results from Procam's 2013 Client Performance Data

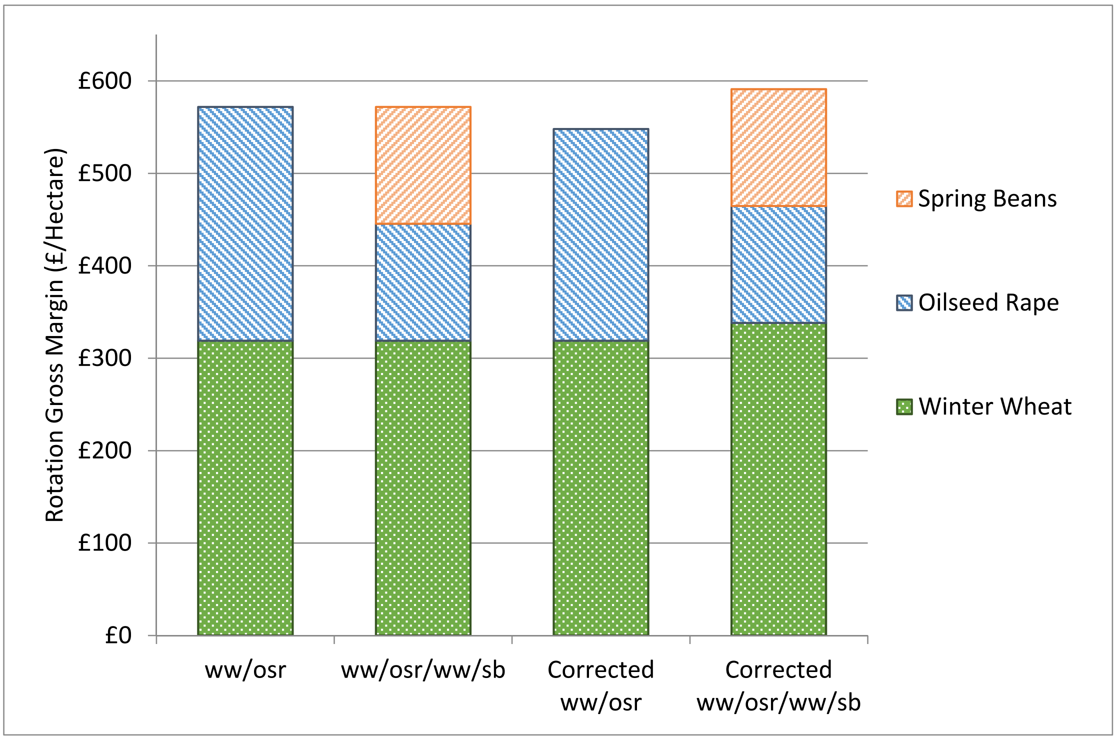
	Average		**Top 25%**	
Crop	**Gross Margin £/Ha**	**Yield T/Ha**	**Gross Margin £/Ha**	**Yield T/Ha**
Wheat	911	8.2	1,200	9.7
Peas	694	3.7	1,140	4.4
Oilseed Rape	520	3.27	909	4.3
Spring Beans	455	3.7	713	4.84

Source: Procam

In 2013, a major national agronomist firm noted that pea gross margins outstripped oilseed rape.

Figure 20 demonstrates the whole farm gross margins from two rotations, taking account of changes in other crops as a result of interactions with the rotation. The first is the two-year winter wheat and oilseed rape rotation, the second replaces oilseed rape one year with spring beans thereby becoming a 4-year rotation of wheat, oilseed rape, wheat and spring beans.

Figure 20 ~ Whole Farm Gross Margin Comparisons



Source: Agricultural Budgeting and Costing Book, November 2014 (79th Edition) and Andersons

For comparative purposes the gross margins of the beans and oilseed rape have been put at the same value in 'normal' conditions and are shown in the left two columns. However, in the right hand two columns, the inclusion of the pulse provides 50kg N/ha to the following wheat crop saving £38.40 per hectare on the wheat and the oilseed rape in the 2-crop rotation loses 5% of yield as its rotation is too short (this is an estimate). This calculation suggests that, in this situation, a gain of £43 per hectare over the entire rotation is achieved and is summarised in Table 11. This demonstrates the benefits of using pulses to increase the size of an arable rotation.

Table 11 ~ Changes to Gross Margins when Pulses Introduced

£/Ha	ww/osr	ww/osr/ww/sb	Corrected ww/osr	Corrected ww/osr/ww/sb	Difference
Winter Wheat	£319	£319	£319	£338	
Oilseed Rape	£253	£127	£229	£127	
Spring Beans		£127		£127	
Total	£572	£572	£548	£591	£43

7.6 Farm Overhead Costs / Structures

Above the benefits to the soil health and the following crop, pulses can also add advantage to the overhead structure of the farm. Fixed costs are those that are not directly linked to each unit of production and therefore vary independently of the hectarage cultivated or crop tonnage produced. They are categorised as:

- labour
- machinery

- administration and property
- rent and finance.

Cultivating a range of crops that require operations at different times of the year means resources can be used more fully and therefore costs reduced. Pulses provide this opportunity for winter wheat and winter oilseed rape based rotations but are not exclusive options to achieve maximum use of overheads. Farm modelling has been undertaken, as detailed in section 9.10 in the Appendices. These are summarised here.

Table 12 ~ Benefits of Adding Spring Beans into a Wheat and Rape Rotation

	£/Ha
Unmeasured Gross Margin Benefits (Table 13)	£43
Labour	£12
Machinery	£11
Finance	£3
Total	**69**

These figures are theoretical, and would only be realised in full if the farm operated at highly efficient levels. For example, many farms like a level of mechanisation above that which they need in most years to allow them to operate faster in tight operating windows if weather conditions dictate. If, by changing from a 3-crop to a 4-crop rotation, the farmer was to remove some labour, then the labour saving benefits would be achieved and so on. It should also be remembered that most of the benefits in Table 12, excepting the gross margin benefits attributed to beans, could also be achieved by cultivating other spring crops such as linseed. In other words, the benefits are achieved by cropping spring crops rather than pulses. Overall improved profitability of the Loam Farm model adopting a 3-crop rotation (over 4 years) instead of four shows a marked difference (Table 13), especially in a year when profitability is already depressed from low commodity prices.

Table 13 ~ Profit and Loss of Loam Farm Model with Two Rotations

£ Per Hectare	**WW/OSR**	**WW/OSR/WW/SB**
Crop Output	1,012	1,001
Variable Costs	464	410
Gross Margin	**£548**	**£591**
Labour	141	129
Power and Machinery	279	268
Property and Admin	86	86
Rent & Finance	246	243
Total Fixed Costs	752	726
Margin from Production	**-£204**	**-£135**
Single Payment & ELS	217	217
Business Surplus	**£13**	**£82**
Total Business Surplus	**7,800**	**49,320**

Source: The Andersons Centre

7.7 COMMON AGRICULTURAL POLICY

Reforms to the EU Common Agricultural Policy (CAP) were implemented on 1st January 2015. Amongst other changes, the amount of money from subsidy is going to fall from previous levels. Andersons' projections suggest the decline will be about 15% in current terms from 2013 to 2019. This pressure on profitability will necessitate changes to business practises, which could in many cases place greater emphasis on the benefits of pulse crops in rotations, especially if farmers are given the clear financial facts. Specifically though, the implementation of 'Greening' could offer support to pulses.

Under the new CAP policy, 30% of a farmer's Basic Payment is allocated to 'Greening', a set of new rules farmers have to comply with. 'Greening' is a set of environmental rules with three parts:

1. Retention of Permanent Pasture (at a national level)
2. Crop Diversification Rules on arable land
3. Ecological Focus Areas on arable land

Parts 2 and 3 support the cropping of pulses. Under the Crop Diversification requirements a farm with between 10 and 30 hectares of arable land must have two crops in the rotation and a farm with over 30 hectares of arable land must have at least three crops in the rotation. There are many farms where a grower has had to include an additional crop in the rotation for harvest 2015. Many are growing or considering a pulse crop to augment their rotation to the minimum crop number. This is unlikely to be large tracts of arable land that are converted to a new crop in the first instance but, for those who grow pulses as the third crop, it will help them to learn more about growing and marketing pulses and possibly increase their appeal in future years.

Ecological Focus Areas (EFA) can be thought of as 'environmental set-aside'. Five per cent of a claimant's arable land has to go into in EFA. There are various options that a farm could choose to utilise as its EFA:

1. Fallow land
2. Landscape features - hedgerows
3. Buffer strips next to watercourses
4. Green cover – over-wintered green cover/seed mixtures
5. Nitrogen fixing crops – beans, peas, lupins, soya, for example

There are specific management rules, conversion factors and weightings, according to their environmental value, allocated to each EFA option. The option for nitrogen fixing crops results from a European focus on improving habitat for, and increasing populations of pollinating insects, and reducing the European protein deficit. One hectare of nitrogen fixing crop contributes 0.7 ha of EFA. Clearly the presence of other landscape features, the financial impact of fallowing land, and the 'fit' of other crops on the farm will determine whether or not a particular business considers pulses under the nitrogen fixing crop option. Those businesses with pulses already in the rotation will be able to satisfy their EFA requirements easily, whereas some others will grow pulses as a way to meet the new EFA Greening requirement.

Nitrogen-fixing crops within the EFA can be grown in England without any additional management regulations. However, in Scotland, there are additional regulations including field margins from 2016. Growers will also have to grow two varieties of pulses to claim EFA from them. This regulation could jeopardise any potential uplift the policy might offer the pulse sector, depending on how it is implemented.

The introduction of a pulse into a previously non-pulse rotation would help achieve both aspects of the Greening regulations that affect arable land in one management decision and without the need to fallow land, something that is inherently costly as it generates no revenue. Seed sales statistics and evidence from seed merchants suggested an increased focus on pulses for autumn 2014/spring 2015 at least in part as an initial reaction to the legislation. The HGCA Early Bird cropping survey, which surveys over 260,000 ha of arable land across England and Scotland, indicated in November 2014 that intended plantings of peas and beans for harvest 2015 were 24% greater than that for harvest 2014. Clearly these results are tentative and could well be an initial reaction by growers to new complex legislation, but inevitably the policy has re-focused growers on the potential of pulse crops.

This is another opportunity for the pulse industry to press home the importance of taking good care of a pulse crop, spending time making sure the conditions are right and thereby harvesting a high, clean yield. It could also be seen as a threat: if farmers grow pulses because they feel they have to, rather than through their own decision, they might not be motivated to manage them well and then be disappointed with the results.

7.8 Organic Pulse Production

One might be excused for thinking that legumes comprise an essential part of the organic farmer's arable rotation. It might then surprise that the amount of organic pulses grown in the UK is very small, with most organic farmers having moved away from pulses. Pulses, being nitrogen fixing, actually fertilise the plants around them once they are established. This accelerates weed problems within organic crops. At the same time, lacking the vigour to fight weeds off, they are often out-competed. Pulse cultivation also has a relatively high dependence on agrochemical technology when fighting diseases like *chocolate spot*, which can halve a bean crop yield if not treated. The organic sector, like the conventional, suffers from high variation of pulse yield and, with insufficient prices or premiums over conventional prices, have been growing fewer and fewer.

Some organic growers report positive benefits from growing wheat and bean mixtures, harvesting all at the same time and separating the grain. It is a concept that could potentially benefit all growers but one which to date has had no significant research in the UK[70]. However, there is currently no market in the UK for organic human consumption beans. Any produced are therefore used as animal feed.

The feedback from the organic sector of UK agriculture is that a more robust plant with fungal resistance and greater vigour to resist weed infestations would help them reconsider the crop at current economic levels.

7.9 Break Crop or Critical Part of Rotation?

Pulses are considered a break crop and a minority one, compared with oilseed rape. The term 'break crop' is, for most growers, a tool with which to return to wheat. 'Break' sounds almost second best and some growers are guilty of treating their non-wheat crops in this way. Several commentators including agronomists agree that many growers have not in the past considered pulses with the same attention to detail as first wheats. It is maybe not surprising then that results have been less than ideal.

[70] Personal communication, Roger Vickers PGRO.

7.10 THE KNOWLEDGE GAP

Pulses are historically best suited to small-medium farms, those that have the resources to give ample attention to a relatively small crop area to ensure high quality. Storage on large farms tends to be large, warehouse style flooring for example and oilseed has featured highly, but its economics is falling now. Yet some of the best arable growers are very large farms who have embraced pulses as part of their long term rotation and have committed their enterprise to their efficient and effective production which demonstrates their versatility. Pulses are a viable crop for the future and the industry should focus on ensuring it is viable for large scale professional farmers of the future.

8 CONCLUSIONS ~ REPAIRING THE MARKET FAILURE

The UK pea and bean industry has been in decline for several years. This has reduced the incentive of commercial organisations to reinvest in the sector, thereby reducing the growers' interest in it further. Also, the public sector, despite the considerable policy benefits that peas and beans offer to Government, has not been investing as much resource in them as other crops. This too, has accelerated the decline of production. A 'chicken and egg' scenario has been created between cropped area of peas and beans and the potential return it offers interested parties. This is a market failure that can be repaired relatively easily.

Without action, the pea and bean industry could fall further into decline. The new markets it has generated supplying the fish food industry, high value exports to Japan and elsewhere and continued growth in trade to Egypt and the added value processing sector in the UK could be put into jeopardy if nothing changes.

Alternatively, with strong and decisive support, the opportunities discussed in this report could flourish and grow quickly in the coming years to add considerable value to several parts of the food industry, encourage healthier eating and support more sustainable farming practices.

The pulse industry has many opportunities to grow. The changes to agricultural policy, the price premium pulses currently command over other combinables and the forthcoming International Year of Pulses 2016 could all boost the sector, but these are short-term factors. They should be used to lever greater impact from more investment in the research and development of new varieties, new management techniques and other technologies on how to grow and store peas and beans effectively.

Government and policy setters who see the opportunities that pulses present to support so many policy objectives must plan for success and prepare for growth. The infrastructure and research should be put in place in preparation for a growing and more successful pulse supply chain. Without it, growth will surely be stifled. Reliable market information, trustworthy crop area and yield data are a necessary minimum.

Improved knowledge transfer to the grower and the consumer is the best tool to capture the opportunities within the pulse sector.

There is so much information available from the UK and global sources about pulses and how to grow them that this study cannot cover it all. Yet so much is not reaching the relevant decision-maker. It appears this is so in particular with regard to the primary producer and the end-consumer. Improved knowledge transfer to the grower and the consumer is the best tool to capture the opportunities within the pulse sector.

Clearer knowledge and guidance on the benefits of nitrogen fixation is necessary for the industry. An understanding of how to measure it and what factors affect it are necessary so a grower can calculate the fixation that occurs each year in each field. If this required additional research, it should be done.

Better yield, crop area and therefore production figures by Defra on pulses would push the sector forward considerably as would an ongoing record of pulse prices.

Notwithstanding the good work undertaken by the PGRO, BEPA and other bodies, there is an opportunity for considerably clearer knowledge exchange at farm level, for example which soil types are suitable for pulses, and guidance on the amount of nitrogen fixation. This can then be easily documented for example in agricultural costings books. Progress is being made, and the current Optibean work (Technology Strategy Board/Innovate UK-funded project) will also facilitate this, but more is needed.

The end-consumer has so many choices and so much information to absorb that unclear messages will be missed. The pulse industry needs to send out unmistakable messages on the tastiness and health benefits to the consumer. This, coupled with the slowly rising innovation of pulse-based foods, may raise the hitherto flat consumption trend of pulses in the UK.

The opportunities for the sector are multiple and affect all links of the supply chain. There is a role for Innovate UK, the BBSRC, Defra Statistics, as well as industry bodies and farmers to turn around the market failure that has been allowed to happen until now.

The following section identifies the specific conclusions from this report.

8.1 Specific Requirements for Repairing the Market Failure

To enhance grower profitability:

- Knowledge exchange to farmers on how to achieve high yields of pest free pulses can be improved. Issues like how to benefit from bee hives in the field, improved timing of bruchid beetle and pea moth insecticides, harvest timing of peas and correct seed bed preparation are good examples that are not fully understood by all growers.
- A clear agreement on the best way to communicate the benefits of nitrogen capture to growers should be established. Either a fixed estimated figure for all areas or rather a simple calculator tool such as a sliding scale is suggested. This must then be clearly explained to the farming community.
- Better appreciation by growers of the whole farm benefits of pulses, especially beyond the gross margin, would support rotational decision making.
- RB209, the Fertiliser Guide, needs updating with a section included on how leguminous crops add nitrogen to soils and how they should be managed to maximise the benefit of their nitrogen fixing properties and savings generated.
- There is work to do simply to dispel myths and out of date knowledge, for example, to promote newer varieties. New growing advice on the current Recommended List needs reiterating particularly to the agronomy sector, the most influential source of advice to arable farmers.
- A re-evaluation of the suitability of combine harvesting equipment for pulses to ensure that netted pea plants and tall woody bean stalks are suitably catered for at harvest time.
- Support with pulse storage, either on-farm or off-farm, to manage the slow-drying and quality separation issues would be valuable.

The above will build the understanding of the value of pulses to the grower and help to improve the consistency and robustness of pulse production.

To assist the budgeting, marketing and supply chain economics of pulses:

- Price information needs to be collected and be publically available in a structured and robust manner. The PGRO should tackle this in the first instance and approach the HGCA for guidance or to work with them to help do this.
- Harvest yield estimates of pulses should be published by Defra at the same time as those of other combinable crops early in the autumn and greater attention needs to be given to achieving more reliable yield estimates.
- Crop area information needs to be better explained by Defra, particularly the split between feed and food crops.
- A broader demonstration of the market opportunities for pulses would help growers identify their markets and grow them to meet set specifications, build farm profits and support UK added-value exports.
- A greater profile of the environmental, sustainable and health benefits should be built for pulses, not just for academic research, but to demonstrate to consumers and importantly policy makers how useful they are to supporting so many policy objectives.

These points would raise the awareness of new and growing markets for pulses and build the grower and customer base necessary to secure larger and new markets for pulses. Concerning research objectives:

- Targeted breeding remains necessary for:
  - Seed quality traits to achieve unique selling points of attraction for top markets, both domestic and export
  - Improving resistance to disease & pests
  - Crucially focussing on retaining or improving the benefits to the consumer including taste, texture, health-promoting and colour traits
- Programmes like the Pulse Crop Genetic Improvement Network (PCGIN funded by Defra) should continue to be supported to build on dialogue and knowledge exchange to integrate the pulse crop supply chain closer together.
- Work on genetic improvement of target traits should continue in order to improve quality and ensure sustainable performance.
- Research is required to create an accurate and precise calculator to assess the amount of nitrogen fixed by a pulse crop and how much is available for the following crop.
- An assessment to help growers quantify the whole farm benefits of spring crops in a rotation, including machinery and labour savings.

If these recommendations are implemented, there is every reason to expect the growth of a strong and vibrant pulse industry in the UK to see it double in size in five years or less. The pulse sector is an agricultural one with potential to create substantial value by making relatively low cost but very important changes.

9 APPENDICES

9.1 ACKNOWLEDGEMENTS

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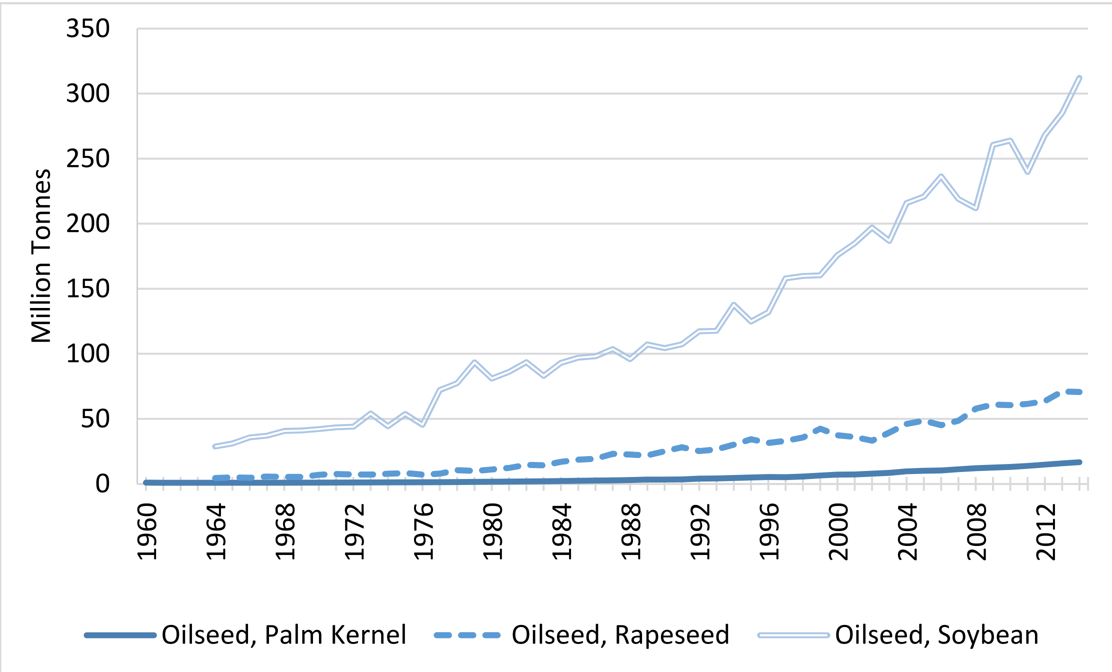
9.3 Why Pulse Areas Have Fallen

9.3.1 Changes in Global Commodity Demand

The world is always changing. Its food requirements move each year, based on population, consumption habits and policies. Over the last decade, the demand for vegetable oils and seed meals rose quickly. The growth of the Chinese pig industry (which is now as big as that of the rest of the world[71]) has led to a surge of soybean demand, both to feed the pigs and also to cook the pigs in the oil. Also, the EU has developed a biofuel policy requiring a minimum inclusion rate of biofuels into road transport fuel. Total oilseed rape consumption in the EU has more than doubled between 1999/2000 and 2013/14[72] and now over 50% of oilseed rape oil used in the EU is used to manufacture biodiesel. This leaves the seed meal, a high protein competitor of feed pulses.

There are two implications of this. Firstly, market forces mean that the amount of palm oil is globally now on the rise. Palm is the only oilseed that has no meal as a co-product. This is gradually replacing oilseed rape and thereby creating new demand for meals or other proteins although, as Figure 21 shows, this growth is from a very low base. The chart also demonstrates the exponential growth of the oilseed sector globally since the 1980's but especially in the last decade. Secondly, the EU biofuel regulation is legally binding until 2020, whereupon it could potentially end. Lobbying has already begun and EU policy-makers have already changed their pro-biofuels position into a very neutral one. After 2020, the supply of rape meal might fall substantially as the demand for oilseed rape could decrease sharply, potentially leaving a large gap for animal feed that feed pulses could fill.

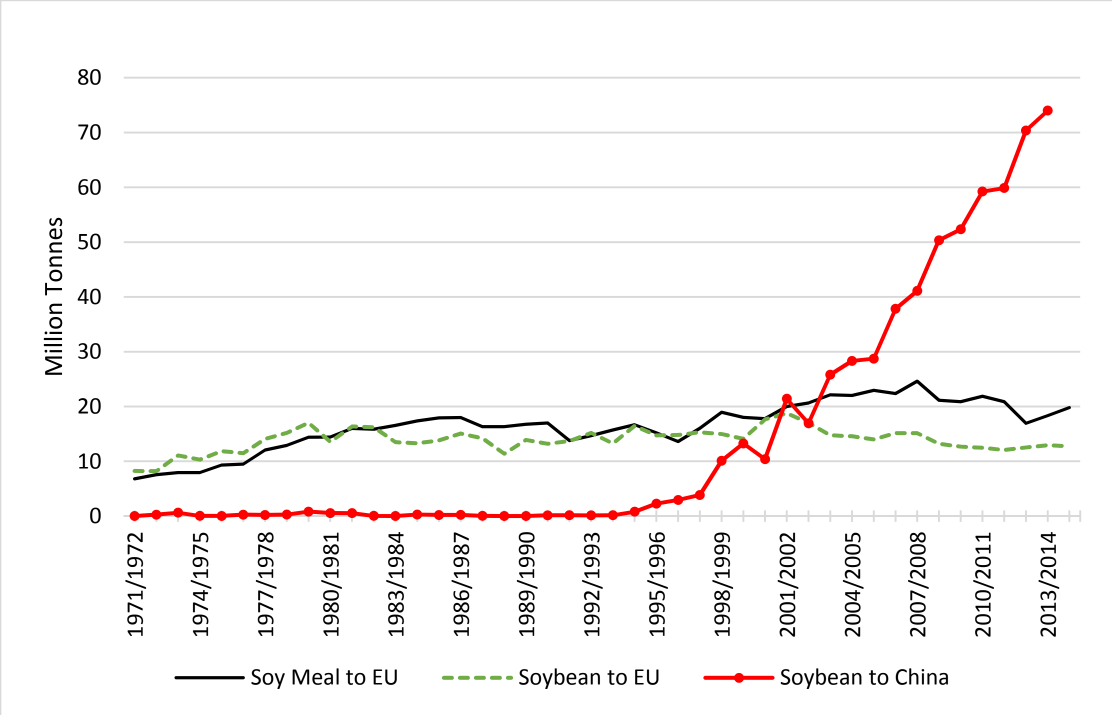
Figure 21 ~ Global Production of Major Oilseeds



Source: USDA Foreign Agricultural Service

[71] USDA data.
[72] Figures supplied by The US Foreign Agricultural Service http://apps.fas.usda.gov/.

Figure 22 ~ Global Imports of Soya Commodities



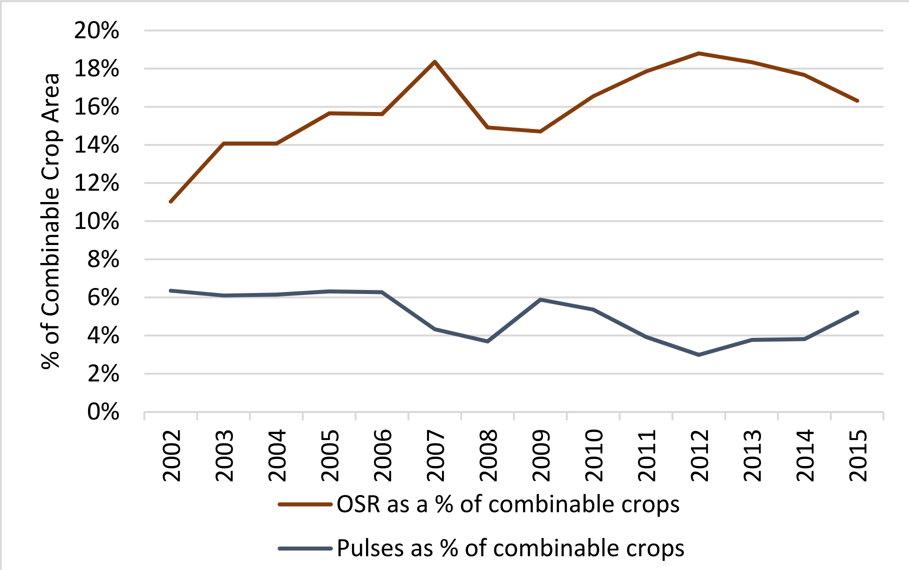
Source: USDA Foreign Agricultural Service

Figure 22 demonstrates the top 2 importers of soybean and soymeal in the world; the EU and China. It is clear how dominant the Chinese market is and has been since policy change took place in the late 1990's to import soybean. Soybean is a legume and contains about 18 to 21% oil and 36 to 40% protein. Whilst classified as an oil crop, it is more of a protein crop.

9.3.2 Competing Crops

The fall of pulse area in the UK is almost 'mirror-reflected' by the increase of oilseed rape (OSR) area since 2002 as Figure 23 demonstrates. It is a reflection of how effective the UK farmer is at responding to global market signals.

Figure 23 ~ Combinable Pulse and OSR Area as Percentages of UK Combinable Cropland



Source: Defra data

The rise of demand of oilseeds is reflected in all regions where free market economics have been allowed to influence the marketplace. Not only have OSR cropped areas increased, but also large agrochemical firms have invested large sums into novel innovations in oilseeds. The launch of hybrid varieties of oilseed rape is an example, evidence of seed breeding programmes and developments include Clearfield, a non-GM innovation for growing crops including oilseed rape by BASF[73]. This technology is only just entering the pulse sector (in lentils)[74].

Anaerobic digestion plants have also been built in considerable number over the last decade throughout the UK. Most of them are using maize in relatively large quantities as feedstocks. Many were not designed to use energy crops as feedstock but operators have found insufficient alternative feedstocks. The outcome of this is to push up the rent for land on a local basis on which to grow maize, outcompeting some other crops. This might have had a small effect on pulse areas.

9.4 EU POLICY ON GENETICALLY MODIFIED CROPS

No genetically modified organism (GMO) can be marketed in the EU, for any commercial purpose including use as animal feed or human food, without prior authorisation under EU legislation (EC Regulation 1829/2003[75]). This authorisation is granted under guidance from the European Food Safety Authority (EFSA). Once a GM crop has this authorisation, it can be legally imported for commercial use to supply the animal feed or human food supply chain. It is deemed safe by EFSA at this point.

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[73] http://www.agricentre.basf.co.uk/agroportal/uk/media/marketing_pages/clearfield/BASF_CL_Best_practice_1204.pdf.

[74] https://agro.basf.ca/lentils/.

[75] http://ec.europa.eu/food/food/animalnutrition/labelling/Reg_1829_2003_en.pdf.

In order for a GM crop variety to be legally cultivated in the EU, it has to pass another authorisation (Directive 2001/18[76]), known as 'The Deliberate Release Directive'. In the UK, the seed variety then either needs to become registered on the UK National List of approved crops, or, if it has been cultivated in another Member State successfully, is placed on the '**Common Catalogue'**. This is a pan-EU list of crops that are legally allowed to be cultivated in any part of the EU. From this point there is no legal restriction stopping anybody from growing it in the UK. If anyone wants to grow it, there is no legal requirement to register it or apply for permission to cultivate it. It can be treated as if it is any other variety regardless of crop type. The only regulation would be at the point of crop marketing; the supply chain would need to know so that its GM status could be included on the product label.

The EU takes longer than other countries or regions of the world to authorise GM varieties; it undertakes more tests with limited resources. This has therefore created a considerable 'backlog' of strains for EFSA to trial that have already been approved for cultivation (as well as use) in other countries outside the EU. This misalignment of authorisations is referred to as '**asynchronous authorisation**'. There are several varieties being produced in other countries that cannot yet be imported into the EU.

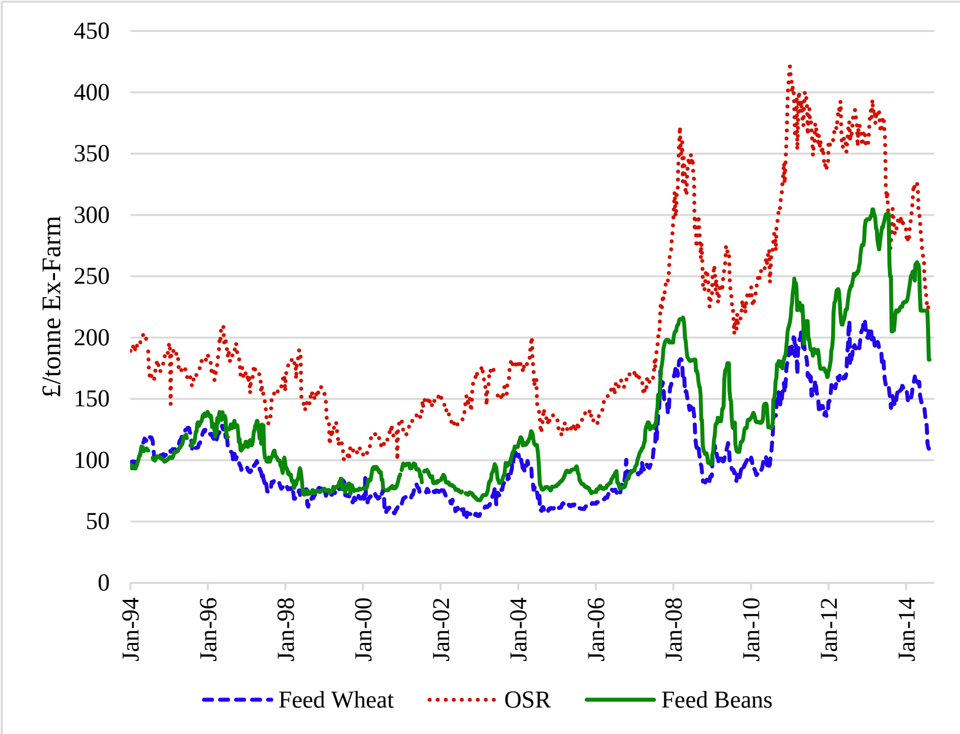
The GM industry started in the US in 1996 (commercially) and the first imports of GM materials into the EU were from there. In 2008, the US first authorised varieties for cultivation with more than one GM trait (so called '**stacked traits'**). They have very rapidly been adopted by the US farming community and are now grown throughout the US. However, they have not yet been authorised for use in the EU. There is no segregation of these varieties in the US which effectively makes almost the entire US soybean crop and US soya meal unauthorised for use in the EU. There is as yet no test for 'stacked traits'. GM tests can identify single traits but not confirm whether they are from the same GM 'event' (plant). This matters when calculating the proportion of GM material in a batch. EFSA has recently (May 2011) established a new set of guidelines and methodologies to assess the health risks of food and feed derived from these products. These take into account the increasing complexity of these plants[77].

[76] http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2001:106:0001:0038:EN:PDF.

[77] Refer to www.efsa.europa.eu/en/efsajournal/doc/2150.pdf and www.efsa.europa.eu/en/efsajournal/doc/2149.pdf.

9.5 PRICE RELATIONSHIPS WITH OTHER COMBINABLE CROPS

Figure 24 ~ UK Prices of Feed Beans, Feed Wheat and Oilseed Rape



Source: Farmers Weekly and HGCA ~ Spot Ex-Farm Prices

Figure 24 provides a long-term perspective of how three combinable crop prices have moved in 20 years. It demonstrates feed wheat, oilseed rape and feed beans. The volatility of the marketplace and the interaction between the crops can be observed. The three crops shown are produced for separate marketplaces, feed wheat, oilseed rape mainly for its oil and the beans largely for their protein. The relationship between the prices is primarily a reflection that each crop is competing with the other for cultivation land.

Figure 24 also demonstrates how the prices of all combinable commodities rose sharply in the autumn of 2007, roughly doubling. As oilseed rape price was the highest, its doubling meant substantially more income per hectare for this crop was achieved than most others. The rise of bean price relative to wheat and oilseed rape can clearly be observed. Feed bean prices were almost equal to feed wheat values in July 2010 but the spread between the two crop values increased from about May 2012. This year, a well grown pulse crop is one of the best gross margins on an arable farm. This is demonstrated in Figure 16 on page 40.

Whilst the consumption of oilseeds continues to rise, the high prices achievable in recent years has prompted more growers around the world to increase their oilseed hectarage, whether soybean, oilseed rape or palm. The last two harvests have had no serious weather issues and so production has exceeded demand. Prices hit a plateau and have since come down. Cereals too (led by maize and wheat) have experienced high yields and for 2013 and 2014 harvests, exceeded the annual global demand leading to a rise in global stock levels. This has placed downward pressure on price as ample stocks mean that buyers can acquire their requirements easily. The price of pulses has risen relative to other crop prices, partly as global demand has remained firm, but also, as the quality of UK pulses has been good in the last two seasons, meaning the level of exports as human consumption pulses has remained brisk. This has kept the market 'tight' for those sold into the domestic marketplace.

9.6 Risk Management

Commodities, especially agricultural ones, are notoriously price volatile. Food is price inelastic meaning its consumption is not so responsive to its price. Indeed, the price of foods (especially 'staples' like pulses) needs to move a long way to make a small impact on consumption patterns.

Volatile price movements have implications for growers, processors, manufacturers and traders. If they buy or sell something and then its value moves, profit can be lost very rapidly. In most commodities like wheat, futures markets exist where the financial risk of buying a grain can be offset by selling the same tonnage of 'futures' contracts. As the physical market changes, the 'derivative'[78] market also moves, negating any loss (or gain) to the holder of the goods. This means that business looking to trade wheat can do so many months before the delivery date, providing security of purchase and a fixed margin without price exposure.

There is no futures market anywhere in the world for pulses other than soybeans. There simply are not enough of them so there is nothing available for forward buyers to offset their risk of purchases. This means that the tools and contracts available for the sale and purchase of pulses is substantially more primitive than for other commodities such as wheat. It also means farmers cannot sell pulses as far ahead of harvest. Some traders and some buyers take a risk on the market, providing limited options into which growers might sell. This is not going to change as the volume traded is not enough (globally) to warrant a futures market in pulses. The nearest equivalent would be soybeans or soymeal.

[78] A derivative market is 'derived' from a physical market.

9.7 GROSS MARGIN EXAMPLES

Below are typical examples of bean and pea gross margins for UK growers for 2015.

Table 14 ~ Bean Gross Margin Schedules for harvest 2015

Winter Beans

Production level	Low	Average	High
Yield: tonnes per ha (tons per acre)	3.0 (1.2)	4.0 (1.6)	5.0 (2.0)
	£	£	£
Output	660 (267)	880 (356)	1,100 (446)
Variable Costs:			
Seed……………………………………		80 (32)	
Fertiliser………………………………		40 (16)	
Sprays…………………………………		111 (45)	
Total Variable Costs		231 (94)	
Gross Margin per ha (acre)	**429** (174)	**649** (263)	**869** (352)

Spring Beans

Production level	Low	Average	High
Yield: tonnes per ha (tons per acre)	2.8 (1.1)	3.7 (1.5)	4.6 (1.9)
	£	£	£
Output	644 (261)	851 (345)	1,058 (428)
Variable Costs:			
Seed……………………………………		84 (34)	
Fertiliser………………………………		37 (15)	
Sprays…………………………………		109 (44)	
Total Variable Costs		230 (93)	
Gross Margin per ha (acre)	**414** (168)	**621** (252)	**828** (335)

Source: John Nix Farm Management Pocketbook 2015

Table 15 ~ Pea Gross Margin Schedules for harvest 2015

Blue Peas

Production level	Low	Average	High
Yield: tonnes per ha (tons per acre)	3.0 (1.2)	3.75 (1.5)	5.0 (2.0)
	£	£	£
Output	780 (316)	975 (395)	1,300 (527)
Variable Costs:			
Seed…………………………………		99 (40)	
Fertiliser………………………………		38 (15)	
Sprays…………………………………		124 (50)	
Total Variable Costs		261 (106)	
Gross Margin per ha (acre)	**519** (210)	**714** (289)	**1,039** (421)

Marrowfats

Production level	Low	Average	High
Yield: tonnes per ha (tons per acre)	2.7 (1.1)	3.40 (1.4)	4.5 (1.8)
	£	£	£
Output	891 (361)	1,122 (454)	1,485 (601)
Variable Costs:			
Seed…………………………………		191 (77)	
Fertiliser………………………………		34 (14)	
Sprays…………………………………		178 (72)	
Total Variable Costs		403 (163)	
Gross Margin per ha (acre)	**488** (198)	**719** (291)	**1,082** (438)

Source: John Nix Farm Management Pocketbook 2015

Table 14 and Table 15 show the gross margins budgeted by the John Nix Farm Management Pocketbook for combinable peas and beans. They are for a typical farm for 2015 harvest. All figures inevitably vary from farm to farm. Prices could be different by harvest time too but these figures have been compiled using expert advice[79].

9.8 AGROCHEMICAL COSTS

Peas and beans are a relatively low user of agrochemicals compared with other combinable crops. Table 16 demonstrates the comparative expenditures for the major combinable crops budgeted for 2015 harvest on a 'typical' farm with low weed infestation. It shows that, other than for spring oats, the beans and blue peas are the lowest of them all. This keeps the working capital cost down and the gross margin up. Marrowfat peas cost more because the level of quality required is higher in marrowfats. Artificial desiccation not only ensures consistency of ripeness, but also manages weeds prior to harvest.

[79] Output support from Dalmark Grain and Frontier, fertiliser RB209, Sprays Frontier agronomy and seed Dalton Seed.

Table 16 ~ Typical Agrochemical Use (excluding seed treatments) 2015

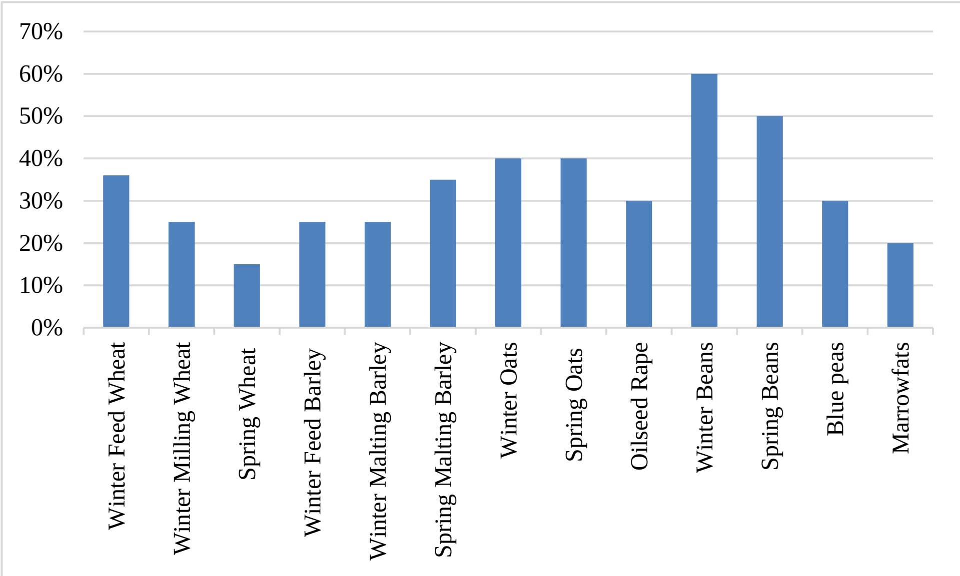
£/ha	Herb-icides	Fung-icides	Insect-icides	PGR*	Other	Total Ag-chemical	*Rank*
Feed Wheat	95	110	7	16	5	233	*14*
Milling Wheat	95	115	7	16	8	241	*15*
Second Wheat	105	115	7	16	5	248	*16*
Spring Wheat	60	50	7	16	5	138	*6*
Red Wheat	66	90	7	16	27	206	*13*
Feed Barley	75	75	7	16	5	178	*9*
W. Malting Barley	75	75	7	16	5	178	*9*
S. Malting Barley	60	50	7	16	5	138	*6*
Winter Oats	55	42	7	16	5	125	*5*
Spring Oats	35	32	7	8	5	87	*1*
Winter Rape	90	70	7	16	13	196	*12*
Spring Rape	70	50	7	16	13	156	*8*
Winter Beans	50	45	7	0	9	111	***3***
Spring Beans	50	40	10	0	9	109	***2***
Blue Peas	55	50	10	0	9	124	***4***
Marrowfats	65	88	10	0	15	178	***9***

** PGR = Plant Growth Regulators*
Source: John Nix Farm Management Pocketbook 2015

9.8.1 Home Saved Seed

A common practice amongst combinable crop farmers is to save a proportion of crop from one harvest in order to plant it as seed the following year. This practice saves the expense of buying in more seed from an agricultural merchant. The ex-farm price of a combined crop is considerably lower than the price to buy a similar amount of seed. However, home saved seed is not always tested for purity, cleanliness, health or germination, and after several years of cross pollination its varietal purity becomes diluted in some species, potentially reducing its yield and specific traits for which the variety is bred. (We note here that peas are self-pollinated so are not affected by this.) Often, home saved seeds are not cleaned or dressed with seed dressings as would be standard from a seed merchant. The sum of the various factors above explain that, whilst the saving of home produced seed can save money, it introduces quality and yield risks into the crop. Whilst the risks can be minimised with careful testing and so on, the financial saving is often not as great as the initial figures indicate. The estimates of home saved seeds in the UK are as shown in Figure 25. These are made in consultation with several seed merchants and agronomists. It can be seen that bean crops have the highest proportion planted with home saved seeds.

Figure 25 ~ Proportion of Crop Planted with Home Saved Seeds



Source: Estimates used in the John Nix Pocketbook, compiled by discussion with seed merchants and agronomists.

9.8.2 Seed Multiplication Rate

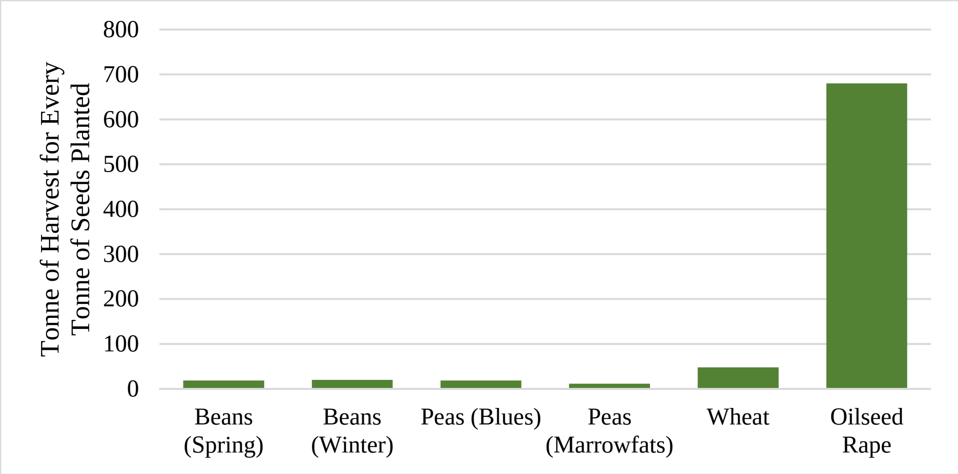
Pulse seeds multiply slowly. This means that, for the seed planted, a relatively small amount of crop is returned compared with other combinable crops. Table 17 and Figure 26 demonstrate the expected yield of pulses per tonne of seed planted compared with an average yielding crop of wheat, and the same for oilseed rape. Wheat returns about 2.5 to 4 times more seed than pulses whereas oilseed rape returns 35 to 60 times more. This is important particularly regarding the speed of multiplication of new varieties to ensure sufficient for retail sales.

This means the trade requires more time to prepare a new variety for market, but also needs to retain a higher proportion of an annual harvest to return to the farmer as seed each year. This is particularly critical in a year when yield and quality are poor. For example, if yields fall and quality is poor, then the ratios can fall substantially more. This reduces the speed at which crop areas can increase from one year to the next, and also slows the rate of plant breeding.

Table 17 ~ Rate of Multiplication from Seed to Crop

Crop	Seed Rate Kg/Ha	Harvest Yield t/Ha	Ratio
Beans (Spring)	200	3.70	18.5
Beans (Winter)	200	4.00	20
Peas	200	3.75	18.75
Wheat	175	8.40	48
Oilseed Rape	5	3.40	680

Figure 26~ Tonne of Harvest for Every Tonne of Seeds Planted



The last two seasons have seen a shortage of seed for some sectors of the UK pulse industry, particularly marrowfat peas, despite it being a closely managed market. (Most marrowfat peas are grown under contract.) A low yield coupled with a poor quality in some areas which reduced the proportion of samples that could be used meant that it has taken longer to multiply pulses up for resale than planned. This has led to a tight supply of marrowfat peas this and last season. It is thought that next season might also be restricted.

9.9 WHAT IS A ROTATION AND WHAT IS IT FOR?

A rotation is the order in which crops are grown on a farm. Farmers use rotations to maximise the long-term productivity of the soil and therefore profitability of the farm. Most crops cannot be grown on the same land in consecutive years without significant loss of yield or quality because of build-up of disease. Wheat, for example, suffers from *Take-all*, a soil borne disease that takes a season without wheat to clear from the soil. Other crops such as potatoes cannot be grown on the same land for up to 6-7 years. Most crops benefit from a rotational change for this reason. Also, there are virulent weeds that are difficult to remove from some crops so a change of crop facilitates their removal. For example, grass weeds are difficult to remove from grass based crops (cereals). Spring crops allow far more opportunity than winter cropping for land and pest management by cultivations and herbicide treatments ahead of drilling, simply as the land remains fallow for much longer when spring crops are used.

To maximise profitability, cereals farmers typically focus their rotation on maximising the area of 1st wheat crops[80] minimising the build-up of *Take-all*. As a result, break-crops are grown (such as pulses or oilseeds), thereby creating a rotation based around the (historically) most profitable wheat crop.

A 'break-crop' is identified in the UK as one that 'breaks' the continuous cultivation of wheat. They can also break the sequence of other crops. However by definition and the way the combinable crop farmer has historically treated the break crops, these are perceived to be second best in the rotation and are often farmed in a manner of secondary importance. There is ample evidence at The Andersons Centre that this is happening amongst many farmers.

[80] A 'first wheat' is one that is grown on land that was not growing wheat the previous growing season.

Take-all in second and subsequent consecutive wheat crops can reduce yields significantly depending upon seed treatments and drilling dates. As a result, break crops are required. However, reliance on one particular break-crop also creates its own soil borne disease problems. For example, a field heavily infested with clubroot from growing oilseed rape too frequently can reduce yield by over 50%, with HGCA trials demonstrating a yield loss of 0.03t/ha per 1% of plants infected. It is recommended that oilseed rape does not return to the same land for *5* years to ensure good yields are maintained[81]. For those arable farmers who produce root crops, their main focus will often be on maximising the number of root crops in the rotation e.g. potatoes or sugar beet. However, similarly soil borne pests/diseases which significantly affect yield can develop from growing root crops too close together in a rotation.

9.10 DETAILS OF LOAM FARM MODELLING WORK

The section here details how the figures calculating the benefit of an additional crop in a simple wheat and oilseed rape rotation are derived.

Some farm modelling has been conducted to quantify the benefit of including pulses within a wheat and oilseed rape rotation. For this exercise, Andersons' Loam Farm model has been used. Loam Farm is a notional 600 hectare *(1,480 acre)* combinable crop farm in the Eastern Counties which has been run on a real-life basis for over 20 years. It runs a simple rotation of feed wheat, winter oilseed rape, winter milling wheat and spring beans. There is a working proprietor plus one full-time man and harvest casuals. The analysis quantifies the changes required if the business replaced its spring beans with oilseed rape. The main assumptions are summarised as follows:

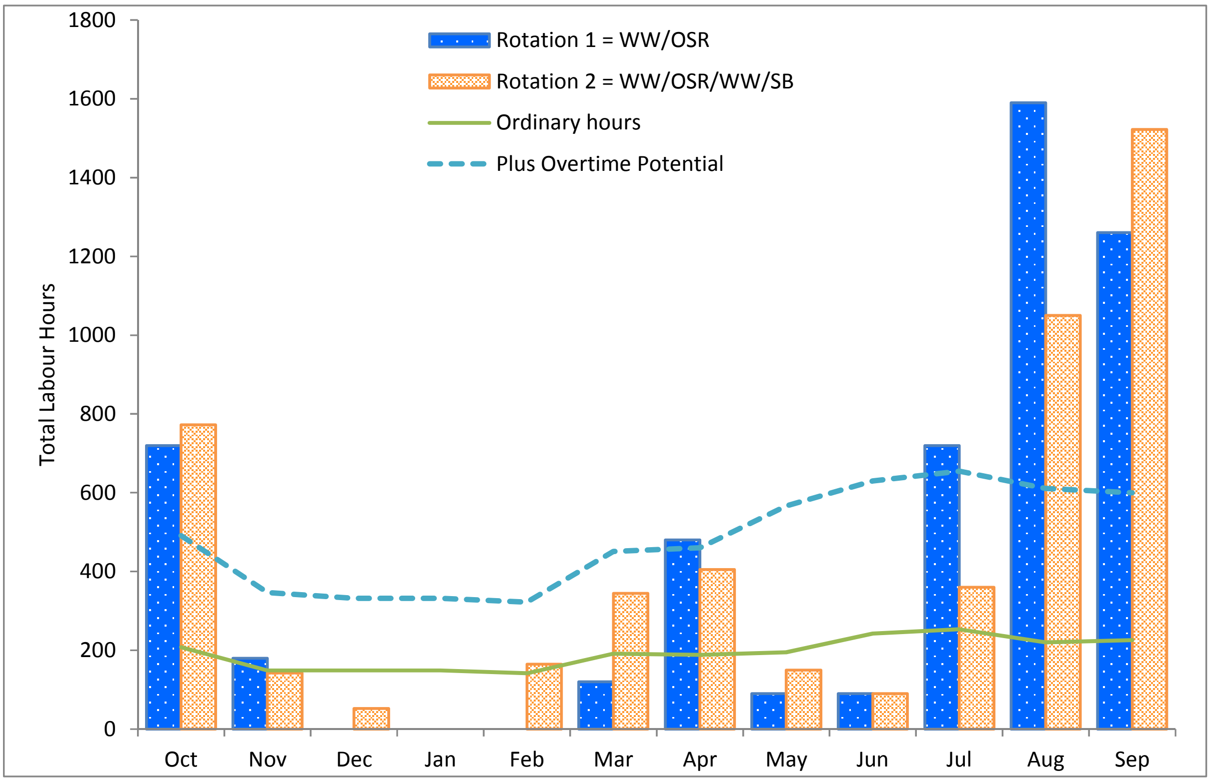
1. The model has been adapted to use gross margins from the ABC book for data consistency with other references to gross margins in this report.
2. Rotation 1 is WW/OSR and Rotation 2 is WW/OSR/WW/S Beans
3. Variable costs:-
    a. Insertion of the spring beans adds 10% to the yield of the following wheat (so a 5% wheat yield increase over the whole farm)
    b. OSR yields fall 5% in the 2-crop rotation because the rotational gap with the previous OSR is too short.
    c. Variable costs are included as per the ABC costing book

9.10.1 Labour

Figure 27 demonstrates the difference of labour requirements of the two rotations on Loam farm, one winter wheat and oilseed rape rotation, the other with spring beans making a 4-year rotation. It does not have many staff, so much work at peak times is undertaken in overtime or with casual labour. The chart demonstrates the possible full time and overtime hours in each month of the year. Labour requirement bars that rise above the solid line mean overtime is required in that month, and those bars that exceed the blue dashed line indicate a requirement for casual labour to help out with work peaks.

[81] HGCA, Managing Club Root in Oilseed Rape.

Figure 27 ~ Labour Requirement Comparisons by Rotation plus Labour Profile



Source: Labour Profile, John Nix Farm Management Pocketbook; farm details, Andersons Loam Farm.

Not only does rotation 2 (with the spring crop) have a flatter labour profile, but the total labour requirement is lower by 195 hours per year. In cost terms, this might not remove a permanent member of staff from the business, but there would inevitably be a reduction in over time. If full-time labour is utilised to its full this released staff could be deployed to other tasks at certain times of the year. If the cost of this time saved was a low skilled 'standard worker' according to the Agricultural Wages Act, including National Insurance and Employers Liability insurance would cost £7.44 per hour making a saving of £1,450. It is likely though that skilled tractor drivers earn more say a Grade 4 'craft worker' and taking a half of the time as overtime into account would cost £10.26 per hour, equivalent to over £2,000 saving in the year in opportunity cost. On top of this, the flatter profile means less overtime or temporary staff. A well-managed business will make use of the workers when work is not pushed, so this is difficult to value.

On this basis, Rotation 1, the 2-crop rotation, will require an additional 204 hours of overtime more than the 4-crop rotation, costing in the region of £14 per hour for a craft grade worker as suggested by the former Agricultural Wages Board, and making £2,800 per year. Also an additional 310 hours of harvest help will be required. If this comes at the same price, then this would cost £4,300 per year. Overall, if only the additional overtime and staffing requirements were costed in full, Rotation 1 could cost about £7,100 per year over Rotation 2.

9.10.2 Machinery

The short rotation in the example above will also require a greater machinery expenditure in order to complete work in tight time slots. The calculations are much the same as for labour, although complicated by the complexities of requiring various machines. Overall, on the basis that the labour demand is reduced by about 6% (in time), it is fair to assume the machinery will also be used by 6% less. The highest cost machinery would still be required so to reduce that to 4% would be reasonable. It might still be required on the farm, but could last longer. On this farm, the machinery cost is £166,000. A reduction of this by 4% potentially creates a saving of £6,500 per year.

For peas, there are sometimes additional harvesting costs. These are comprised of:

1. Lower work-rates – peas can be slower to harvest[82] than cereals especially if lodged[83]. For example, the National Association of Agricultural Contractors (NAAC) published charges for combining peas and beans are £3.50/acre (or 10%) greater than that for cereals (£34.75/acre for cereals and £38.25/acre for peas and beans (NAAC, Contracting Charges Guide for 2014/15)).
2. Wear and tear on the combine (and depreciation rates) can be greater if the crop is lodged due to the amount of soil and stones potentially entering the machine. This can wear and break knife sections and chopper blades. There is also the subsequent risk of break-downs and the risk of lifters entering the main elevator / drum which can cause serious machine damage and, crucially, delay further harvesting until the machine is repaired.
3. Lifters are required in most pea crops, even if not lodged heavily to ensure the pods are lifted away from the surface and enter the machine. Whilst most machines will have these available anyway for lodged cereals they will wear at a greater rate and could need replacing more frequently.

From experience with The Andersons Centre's own clients, harvesting work rates for beans are similar to cereals and can even be faster when they are weed free or pre-harvest glyphosate has been applied. This is due to a lower harvestable yield (although similar to oilseed rape), a larger seed that makes them easier to handle and less material passing through the machine than cereals and oilseed rape. It means the machine can sort out the crop more swiftly, particularly with the large seed size.

Drying and cleaning costs for field beans and peas can be high. With a large seed size, in-field drying can take longer than for cereals and OSR, plus also when mechanically dried, the heat must be lower than for cereals or OSR to prevent cracking / splitting of the outer coating of the seed. For beans in particular the harvest is later which can result in higher harvesting moistures due to the challenge of there being shorter days (often with less settled weather) in late August and September. The maximum drying temperatures for peas is 49 degrees Celsius (PGRO, 2014), whereas for cereals up to 65 degree Celsius can be used *(HGCA Source grain storage guide)*. It is also preferable not to use augers as the risk of damage is greater[84]. An additional crop in a rotation inevitably requires a new storage space. Some storage facilities may be less suitable, particularly if long storage periods are necessary.

[82] (Pritchard, et al., 2001).
[83] 'Lodging' of a combinable crop is when it has fallen over and needs to be picked up from the ground by the combine harvester.
[84] (Pritchard, et al., 2001).

9.10.3 Working Capital

The cost of funding the working capital required to grow a crop of oilseed rape (variable costs only) is approximately £5.50 per tonne (£18.70/ha) (assuming 5% per annum borrowing cost, over 12 months for seed and fertiliser worth £71.50/t and 8 months for most agrochemicals totalling £57.65/t), compared to £2.10 per tonne (£7.70/ha) for a spring bean crop (variable costs of £63/t over 8 months). Therefore, as well as the need to source less working capital to fund the growing crop and the lower cost of interest, there is also a cash flow benefit for the pulse crop as well because of the reduced time over which funds are required before being able to sell the crop after harvest. This assists businesses with limited collateral where securing additional overdraft facilities is difficult when additional funds are required, for example during periods of cash flow challenges (normally because of low market returns) or when expanding the business such as taking on additional land to farm (e.g. new tenancy).

9.11 AUTUMN AND WINTER CROPPING

Modern arable rotations are, and have been, dominated by autumn cropping in recent decades. Spring varieties, whether it be spring wheat, spring barley, spring oilseed rape or spring beans, on average have a lower yield potential than winter varieties. As a result winter varieties have been more popular because of their greater profit potential, because in most cases the lower yield from a spring crop cannot be off-set by the lower costs of growing the crop (for example, the rental cost is the same for both winter and spring crops). The autumn cropping trend has in extreme cases developed into an increasing focus on a two crop rotation of oilseed rape and winter wheat. This trend has developed from the higher gross margins that have been available from these relative to other crops, whilst also enabling the use of first wheat to be maximised in the rotation. However, these ‘close’ rotations have created problems on some farms. These include:

1. Increased weed burdens and resistance to herbicides, particularly the ability to control blackgrass[85] in wheat and oilseed rape
2. Increased disease pressure, e.g. clubroot in oilseed rape, with associated negative effects on yields. Evidence shows that a rotation gap of 5 years for oilseed rape lowers disease and raises yields[86].

In addition, short rotations create a higher risk business than an entity with a more diverse rotation due to the reliance upon few crops and market options. Factors such as soil type, seasonal weather conditions, herbicide resistance in weeds or disease problems can all mean changes are necessary to crop rotations. A longer rotation, incorporating a wider variety of crops, particularly when spring cropping is incorporated, can provide several benefits including:

[85] Blackgrass is a persistent weed in cereal crops. It is difficult to remove and has been developing considerable tolerance to herbicides. Resistant Blackgrass is therefore quickly becoming a major problem in mainstream UK arable farming.
[86] HGCA, Managing Clubroot in Oilseed Rape. TS110 Clubroot Topic Sheet 2011.

1. Greater ability to control weeds, with a variety of different herbicide choices, the use of stale seedbeds[87] and use of Roundup[88] prior to spring cereals.
2. Reduced presence of soil-borne diseases due to longer periods before the same crop returns to the same land e.g. clubroot in oilseed rape or *Take-all* in winter wheat.
3. Spread of peak workloads, therefore offering the potential to reduce overhead costs and improve timeliness of key operations such as sowing dates and spray timings.
4. More crops theoretically spread marketing and growing risks although this depends on the crops selected.

Although published information do not yet demonstrate this trend nationally, there is considerable anecdotal evidence that growers are recognising the benefits of wider rotations and the inclusion of spring cropping to address some of the issues above. Although not necessarily the sole reason, the high blackgrass burden in the 2013/14 crop has prompted many cereals producers to change their rotation. In terms of long-term sustainability, profitable farming is about responding to market opportunities whilst managing systems for long-term success, of which crop rotation forms a key part. Therefore, whilst there has been a lack of appreciation of the true potential of pulse crops historically, with these factors in mind, pulse crops now have a huge potential to become the break crop of choice in cereal rotations. Some of these factors are examined in more detail in the following sections.

There are currently 250 active ingredients approved for use in the UK, 87 of which have been identified as potentially under threat by various policies. Of the 87 active ingredients potentially threatened, 40 of these are highly likely to be lost or restricted in the short-to-medium term. These are comprised of 10 insecticides, 12 fungicides, 16 herbicides and 2 molluscicides[89]. The impact of this upon UK crop production would be significant with the following key effects identified:-

1. More difficult control of weeds, disease and pests.
2. Reliance upon fewer plant protection products, therefore increasing the risk and likelihood of resistance developing. This in turn makes chemical control even more challenging, less effective and expensive. There is already widespread evidence of resistance to certain Plant Protection Products or PPPs, particularly resistance by Blackgrass to the chemical Atlantis.
3. Yield reductions due to less effective control of disease, pests and weeds.

In time the cumulative result of the above effects will be a less competitive UK agricultural industry as a result of higher costs of production driven partly by reduced yields. This is likely to lead to a change in UK cropping patterns, with more focus on spring cropping, fallow and temporary grass as methods by which to control weeds primarily. Specifically for pulses, the two main impacts are identified as follows:-

[87] A 'stale seedbed' is a weed control technique where the seedbed is prepared some weeks ahead of drilling to encourage weeds to germinate, which can then be mechanically or chemically removed ahead of the crop drilling date.
[88] A non-specific herbicide.
[89] The Andersons Centre, 2014. The Effect of the Loss of Plant Protection Products on UK Agriculture and Horticulture and the Wider Economy.

1. Yield losses - less effective control of grass-weeds, broad-leaved weeds, downy mildew, Botrytis in peas and chocolate spot in beans.
2. Quality losses – less effective control of fungal diseases (as above) which can affect colour and stain, less effective control of pea moth and chocolate spot in beans.

The table below summarises potential future losses of active ingredients in relation to peas and beans.

Table 18 ~ Threat to Agro-Chemicals in Pulses

Pest/Disease/Weed Threat	Risk of Active Ingredient Loss	Yield Impact
Beans		
Grassweeds (including blackgrass)	Key loss would be pendimethalin. Also bentazone and carbetamide restricted by catchment	Low
Broadleaved weeds	Pendimethalin and linuron	Low
Fungal diseases	Chocolate spot control could be affected by loss of chlorothalonil and metconazole	Medium
Insects	No key losses – lambda-cyhalothrin and primicarb retained and bruchid beetle control retained.	None
Peas		
Grassweeds (including blackgrass) and Broadleaved weeds	Pendimethalin lost and bentazone restricted by catchment	Low
Fungal diseases	Downy mildew and Botrytis control affected by loss of chlorthalonil and metconazole	Medium
Insects	No key losses – lambda-cyhalothrin and primicarb retained.	None

Source: The Andersons Centre, 2014[90]

The current and future issues surrounding weed, disease and pest control are evident for all crop types in some form. It is difficult to distinguish any greater threat to one crop than to another. For example, The Andersons Centre's report identified the total potential yield loss for wheat at 12%, for OSR at 18%, and for peas and beans both at 15%. The key consideration / opportunity for pulses, therefore, are their ability to widen the cropping rotation and allow pre-crop control of weed populations with glyphosate which is limited when focused on autumn cropping.

In December 2013, EU wide restrictions were imposed on three Neonicotinoids, effectively preventing their use as a seed dressing on flowering crops and spring cereals. The use of the pesticides in seed treatments protects crops from insect attack for 6-8 weeks. Autumn 2014 was the first season where oilseed rape growers have not been able to use Neonicotinoids as a seed treatment to assist with the control of flea beetle in oilseed rape. Although at the time of writing it is not possible to accurately assess the impact this has had, it could be argued

[90] The Effect of the Loss of Plant Protection Products on UK Agriculture and Horticulture and the Wider Economy, 2014.

that the variability in yield and/or risk of growing oilseed rape is now greater than it has been historically. Reports from agronomists in certain areas, particularly in the South East, and figures from the National Farmers Union have indicated that oilseed rape establishment will be more challenging going forward and even in the relatively good conditions of autumn 2014 there have been crops written off or re-drilled because of flea beetle damage. Therefore, the farmer perception of pulse yield variability may actually be less of an influencing factor on farmers' crop choices if alternative break crops show similar variable yield trends.

9.12 Lengthening Rotations with Additional Crop Types

Many rotations in UK agriculture have become too short. The key point in this section is that a longer rotation, with more years between identical crops, is almost always good for the health of the soil and therefore the crop. Yields are higher when the crop is healthy and free from disease. This is a basic principle that can be obscured by economics; when oilseed prices are high for example, they have been cultivated as close as every other year. High wheat prices lead to higher levels of second and consecutive wheat with consequential lower yields. The same is true with pulses.

It is not necessarily the addition of a pulse into another rotation but the introduction of another crop type and often a spring planted one that can reduce many cultivation problems. However, there are some occasions when pulses are specifically beneficial to the following crop.

9.12.1 Plant Diseases

Oilseed rape crops are prone to a build-up of slugs (Crop Monitor). A wheat / oilseed rape rotation presents conditions for building up large numbers of slugs which feed on the high levels of organic matter left by the crop. This is particularly true where minimum tillage cultivation techniques are practised. With the growing pressure on water quality from the implementation of regulations from the Water Framework Directive[91] and the Drinking Water Directive[92], there is an emerging threat that molluscicides might not be available for many more seasons. Therefore, the lengthening of rotations helps reduce the risk of slug damage and cost of slug control in the rotation.

Field pea and faba bean are resistant to *P. neglectus (*a nematode that infects potatoes) and substantially reduce nematode numbers after only one crop[93], therefore being considerably beneficial to potato growers whose yields can be affected by the nematode[94].

9.13 Detail on Spreading Overheads

The focus on autumn cropping requires greater overhead costs as a result of larger machinery requirements due to the need to cultivate and sow the majority of the arable area in a short time window in the autumn. The autumn planting window is relatively tight, largely because of weather implications; establishment is necessary

[91] The Water Framework Directive is EU legislation that requires all rivers, lakes, ground and coastal water to reach good ecological and chemical status.
[92] The Drinking Water Directive sets quality standards for drinking water by way of various limits on the amount of pesticides and chemicals that are allowed to be present in drinking water.
[93] Producing Pulses in the Northern Agricultural Region, Chapter 6 Financial Benefits of Pulse Crops.
[94] Olthof, H A, Reproduction of Parasitism of Pratylenchus Neglectus on Potato, 1990.

before soil conditions become too wet and temperatures drop. As a result, winter cropping causes a labour peak in autumn (cultivations, seed-bed preparation and sowing). To manage this peak workload, large amounts of labour and machinery resources are required, necessitating a large amount of capital employed in equipment[95]. The inclusion of spring cropping in the rotation enables more cultivation and drilling to take place in the spring, thus reducing the autumn workload. This allows a business to either farm a given area with smaller (cheaper) equipment or grow without increasing the scale/output of its machinery fleet. Larger cultivation and drilling equipment requires higher horse power tractors, which cost more to purchase (greater depreciation charge and more capital employed), maintain and insure. Whether fuel consumption per hectare is greater will depend on whether that larger tractor can be effectively utilised for the rest of the year for other work which has lower horse power requirements. The amount of capital employed by the business per hectare is increased. Other work has also highlighted the benefit of reduced cultivations post pulses in terms of being able to create a seedbed for the following cereal crop more easily[96]. However, not all soil types are suited to late autumn or spring cultivations, especially with heavy machinery and establishing seedbeds in the spring on heavy clay soils can be a challenge in many years.

This spreading of workload also applies to autumn sown pulses e.g. winter beans, and at an extreme the inclusion of winter beans and spring bean crops would enable the most efficient use of cultivation and drilling machinery. A similar logic also applies to labour, as overtime is reduced (and/or less casual labour is required) and flatter labour profiles during the year can be achieved.

[95] Grain Legumes, No.45, 1st quarter 2006.
[96] Grain Legumes, No.45, 1st quarter 2006.