Economic Impact of Plant Breeding in the UK

Commissioned by the British Society of Plant Breeders

July 2010

Final Report

Donald.webb@dtz.com
DTZ
No. 1 Marsden Street
Manchester
M2 1HW
Tel: 0161 235 7639

Contents

Executive Summary

- DTZ was commissioned by BSPB to conduct an independent economic impact assessment of the work of its members.

- The aim is to highlight the benefits delivered to the UK economy through new plant varieties developed by plant breeders and to highlight that these benefits are delivered by the major UK breeders without public subsidy.

- The report considers impacts relating to key crops including wheat, barley and forage maize.

Wheat

- Three areas of impact are highlighted as follows:

- **Yield increase - the gross value of the yield increase since 1982 attributable to plant breeders is estimated to be £373 - £445 million per annum in 2010 prices.**

- **Import substitution and the UK milling industry -** Plant breeding has provided the varieties that have enabled home grown wheat used for milling to grow by 57% between 1982 and 2009, or 1.7 million tonnes. **This has helped to safeguard up to 750 UK milling jobs and £300 million of annual UK milling turnover.** By reducing imports, plant breeders have helped support **annual emissions reductions of 113,000 tonnes per annum of carbon dioxide and transport savings of £51 million per annum.**

- **UK branded bread market – worth £2.9 billion, plant breeders have supported the trend to use 100% British wheat.** Hovis has a 9% turnover growth target over the next 3 years worth £33 million or £10 million per year. Meeting this target will be dependent on strong promotion, product innovation and UK provenance claims which would not be possible without the efforts of plant breeders.

Barley

- By developing new higher yielding barley varieties **plant breeders have provided UK farmers with an additional £75.6 million per annum of malting barley.**

- The additional alcohol extracted from malting barley as a result of the efforts of plant breeders has created:

- **For distillers**, **an extra 17.8 - 66.8 million potential bottles with a retail value on the whisky export market of £129 - £483 million per annum.**

- **For brewers**, **a potential additional £148 million per annum of beer**. However, brewers simply buy less malt as the beer market is declining. **This saves them £3.9 million per annum on input costs**.

- Processibility – reductions in beta glucan content in barley have allowed significant productivity improvements worth **£105 million in reduced staff costs per annum to the brewing industry**.

- By developing low GN varieties, plant breeders have helped to safeguard one of the UK's largest whisky export markets – USA and Canada – from future regulatory change. These markets were **worth £466 million per annum in 2009.**

- The efforts of plant breeders have helped to safeguard the UK malting industry which exists in a highly competitive market with **UK turnover of £511 million per annum and employment of 2,000 FTEs (Full Time Equivalents).**

Forage Maize

- By developing new, early maturing, forage maize varieties, plant breeders have supported rapid growth in the UK area of forage maize as farmers have recognised, and adopted, the benefits.

- Results of independent research show a financial benefit of £0.52 per cow per day, equating to £80 per cow over the winter period.

- **On this basis plant breeders have supported provision of better rations worth £66 million per annum to the equivalent of 96% of UK intensive dairy herds.**

Conclusions

- By developing new, early maturing, forage maize varieties, plant breeders have supported rapid growth in the UK area of forage maize as farmers have recognised, and adopted, the benefits.

- The table below provides a summary which shows that the annual benefits are in the range £1 – 1.3 billion per annum with a further £1.3 billion of safeguarded economic activity.

Wheat	
Wheat yield at feed prices	373
Potential additional milling wheat premium	72
Transport cost savings	51
Hovis provenance claims	10
Barley	
Barley yield	76
Additional beer	148
Brewing processibility	105
Additional whisky	129-483
Forage maize	
Forage maize improved dairy productivity	66
Plus safeguarding:	
UK Maltsters	511
UK Millers	300
Key whisky markets	466

- **The gross return on investment for the UK economy can be seen to be 40 to 1** – a high return on investment which compares with a range from 5:1 for fundamental research to 15:1 for more applied research.

- This report has demonstrated that plant breeders have made a substantial contribution to UK agriculture, food and productivity. Importantly, plant breeders have much more of a contribution to make in supporting the UK in meeting food security, sustainability and climate change objectives. An agreed UK strategy for this contribution plus selective public sector investment in pre-breeding will help support and maximise that contribution in future.

1.0 Introduction

1.1 The British Society of Plant Breeders (BSPB) is the representative body for the UK plant breeding industry. It was formed in 1966 after the UK Plant Varieties & Seeds Act 1964 established a legal framework for collecting seed royalties on protected varieties.

1.2 DTZ was commissioned by BSPB to conduct an independent economic impact assessment of the work of its members. The aim is to highlight the benefits delivered to the UK economy through new plant varieties developed by plant breeders and to highlight that these benefits are delivered by the major UK breeders without public subsidy.

1.3 The report considers impacts relating to key crops including wheat, barley and forage maize. The period for review is over the past 20-30 years.

1.4 This report is structured as follows:

- **Section 2** provides background to the plant breeding industry
- **Section 3** outlines the market failures in plant breeding and the rationale for investment
- **Section 4** quantifies the economic value contributed by BSPB members as a result of their activities
- **Section 5** presents a summary and conclusions

2.0 Background to BSPB

2.1 The British Society of Plant Breeders Ltd is the representative body for the UK plant breeding industry. Formerly the Plant Royalty Bureau, BSPB was formed in 1966 after the UK Plant Varieties & Seeds Act 1964 established a legal framework for collecting seed royalties on protected crop varieties, through plant breeders' rights.

2.2 Acting on members' behalf, BSPB licenses, collects and distributes certified seed royalties and farm-saved seed payments on the following crops:

- Cereals,
- Oilseeds,
- Potatoes,
- Pulses and
- Herbage.

2.3 The Society aims to promote investment in future crop improvement by optimising the return to plant breeders on their intellectual property. BSPB is a not for profit organisation, funded by a retention on the royalties that it collects, plus membership and licence fees.

2.4 BSPB represents 55 members currently, comprising virtually 100% of public and private sector crop breeding activity in agricultural crops, vegetables and amenity grasses in the UK. The Society promotes members' interests on technical, regulatory and intellectual property matters at a national and international level. It is a member of the European Seed Association and the International Seed Federation. A list of BSPB members is appended to this report.

2.5 The dynamics of the industry are such that total income to breeders across all crops is relatively inelastic at around £40 million per year. Wheat is the UK's most important crop economically. The cost of running a competitive wheat breeding programme in the UK is £1-£1.5 million per annum while the total royalty income to breeders in the UK from wheat is £14-15 million. The total royalty income associated with the three crops considered within this report is around £25 million (wheat, barley and forage maize). The royalty income for wheat and barley comes form BSPB's royalty collection data; the royalty for forage maize is a breeding industry estimate as maize seed royalty is included within the seed price and not collected separately.

Plant breeding companies spend about a third of their income on R & D, a higher proportion than for most other industry sectors, even for example the pharmaceutical sector at 30%[1] and the UK average at 1.6%[2]. Plant breeding is a high risk industry; breeding companies need steady state investment but have variable income flow depending on their success in the market place at any time.

[1] Association of the British Pharmaceutical Industry
[2] BIS 2009 R&D Scoreboard

3.0 Rationale for Investment in Plant Breeding

3.1 Plant breeding is the science and business of developing and commercialising new and better varieties of crop plants with improved yields, disease resistances, agronomic characteristics and quality attributes. Through the introduction of new varieties, plant breeding delivers benefits to farmers, primary processors such as millers and maltsters, users further along the food chain and ultimately the public as consumers.

3.2 Plant breeding is widely recognised as one of the most important tools that exist to tackle problems of global food production, food security, new pests and diseases and the challenges of climate change. Many reports have highlighted this importance including:

- *The potential to increase the productivity of wheat and oilseed rape in the UK* – A report to the Chief Scientific Advisor January 2009
- *How to feed the world 2050: the technology challenge* – FAO September 2009
- *Reaping the benefits: science and the sustainable intensification of global agriculture* – The Royal Society October 2009
- *UK Cross Government food research and innovation strategy* – Government office for science January 2010

3.3 An in-depth survey of 600 farmers presented at the 2010 Oxford Farming Conference singled out plant breeding as the most important scientific development for future agricultural production[3].

3.4 Public funding supports extensive fundamental crop research in the UK, mainly through BBSRC, Defra and devolved governments. Many discoveries have been made that have fundamentally changed modern crop production. For example, the discovery of the gene controlling straw height in wheat was made at the Plant Breeding Institute and bred into modern wheat varieties by UK plant breeders.

3.5 However, there is a gap between the outputs from most of this fundamental research and the inputs that plant breeders need to bring forward commercially successful new varieties. This gap is too great for plant breeders to fund from their limited research budgets.

3.6 BSPB members include publically funded Institutes. However, the major UK breeders receive no public funding for their work in delivering new plant varieties to UK and international markets. They receive their return on investment through the royalties collected – the £25 million associated with the crops considered in this report as set out in Section 2.

3.7 However, as this report will highlight, BSPB members have delivered benefits to the UK over and above those that they are rewarded for commercially. Further, BSPB members could make a significant contribution to the challenges highlighted above if the gap between fundamental research and plant breeding can be closed.

[3] http://www.ofc.org.uk/index.php?option=com_content&task=view&id=43&Itemid=64

3.8 Market failure is when the market, by itself, has not and cannot be expected to deliver an efficient outcome from a social perspective. Government intervention can seek to redress this market failure. Figure 3.1 illustrates examples of the market failures in relation to plant breeding. Each type of failure is discussed in further detail below.

Figure 3.1 Potential Market Failures in relation to Plant Breeding

Type of market failure	Nature of market failure in relation to plant breeding
Provision of public goods	Breeders will allocate their resources to the most valuable uses. Public goods, such as food security, are benefits to all of society. There is no incentive for breeders to bear this extra cost alone, when the benefits are shared across society.
Externalities	Environmental externalities can occur through side effects of crop growing e.g. pesticide residue or fertiliser run off. New varieties might deliver reduced negative externalities but breeders will only deliver these if the market pays for them.
Information asymmetry	Within the supply chain, there is a need for clear communication from plant scientists, to plant breeders, growers, agronomists, processors, distributors, retailers and consumers. Lack of awareness of what is needed or what can be provided could lead to sub-optimal outcomes.

3.9 **Public Goods** - Many of the future challenges faced by plant breeders are about public goods, that is, providing social benefits that are large in comparison to their private benefits. Food security, adaptation to climate change and reduced environmental footprint are all examples of public goods that plant breeders can make a major contribution to.

3.10 However, plant breeders will only invest where they can generate adequate returns in a reasonable timescale. There may be a requirement for public sector investment to secure these public goods.

3.11 **Externalities** – New crop varieties can bring substantial positive externalities as well as scope for avoidance of negative externalities. As well as increased yield, positive externalities include reduced pesticide or fertiliser use, cost savings and reduced carbon dioxide emissions. Plant breeders can make major contributions here.

3.12 **Information asymmetry** - a final market failure is defined as:

"Information is needed for a market to operate efficiently. Buyers need to know the quality of the good or service to judge the value of the benefit it can provide. Sellers, lenders and investors need to know the reliability of a buyer, borrower or entrepreneur. This information must be available fully to both sides of the market, and where it is not, market failure may result. This is known as 'asymmetry of information'."[4]

3.13 Growers may be unaware of the full benefits that improved crops are bringing them. Whilst yield in Recommended List trials continues to increase by about 0.5% per annum, this has not been reflected in recent years in national yields on farm. There is a need for research in this area to understand why the genetic potential of new varieties is not always being realised on farm and to implement the findings to ensure that the benefits of breeding are seen on farm.

[4] *The Green Book – Appraisal and Evaluation in Central Government* HM Treasury, Crown copyright

3.14 BSPB has a significant role in this regard in explaining the benefits of new varieties to industry to persuade it that they are worth paying for.

3.15 There is also a need to close the gap between fundamental research outputs and the inputs that plant breeders need as the only route to market. Going forward, there is a strong rationale for public sector investment in R & D that has direct application in commercial plant breeding programmes in the UK. This investment should assist in delivery of public goods necessary to address food security, climate change effects and so on.

3.16 This report will show what breeders have been able to achieve with the commercial R & D budget available to them. The implications are that the advances in genetic gain and delivery of economic benefit to the UK could be much greater if public sector funding could be targeted towards pre-breeding in crops of major economic significance and the translational research needed to pull through the results of basic and strategic plant science into commercial plant breeding programmes that are the only route to market for this work.

4.0 Economic Impact of Plant Breeding

4.1 The main contribution of BSPB members is to provide new higher yielding varieties with better market and agronomic characteristics and/or resistance to common pests and diseases.

4.2 The main crops where BSPB has had an influence are set out in this section along with assessments of impact throughout the supply chain.

4.3 The crops considered in this report are wheat, barley and forage maize.

Wheat

4.4 Wheat is the largest cereal crop by area grown in the UK. Plant breeders have developed a stream of new wheat varieties with much higher yields, higher quality, greater resistance to pests and diseases and better suitability for end uses.

4.5 The economic impact of plant breeding on UK wheat is set out under the following headings:

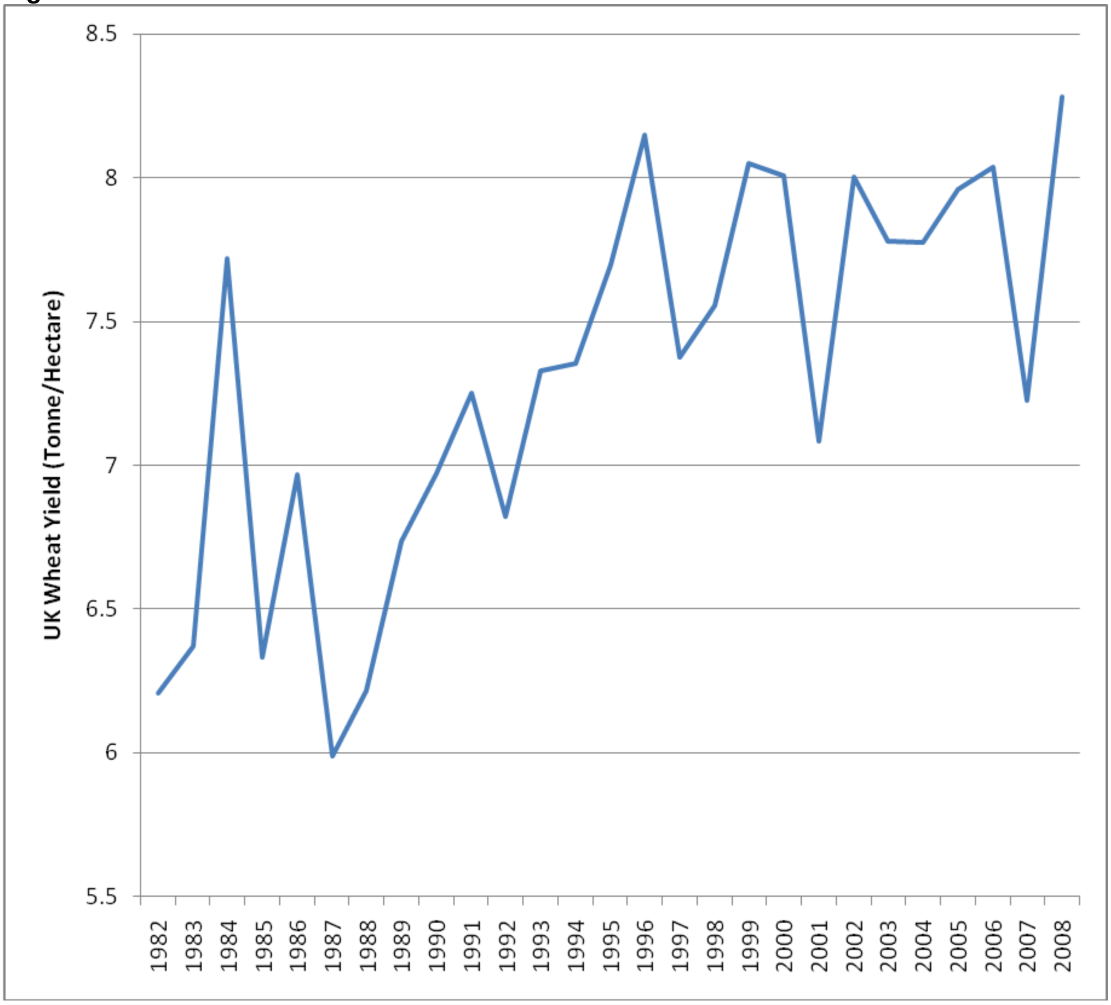
- Yield increase
- Import substitution and safeguarding the UK milling industry
- UK bread market

Yield Increase

4.6 In 2008 the UK produced 17.3 million tonnes of wheat, a 67% increase on the 1982 level of 10.3 million tonnes a year.

4.7 Much of the growth has been achieved through increased wheat yields - from 6.2 tonnes per hectare in 1982 to 8.3 tonnes per hectare in 2008 – an increase of 33% as shown in Figure 4.1.

Figure 4.1 UK Wheat Yield 1982-2008



Source: FAO

4.8 A report[5] by NIAB states that statistical analysis of trial yield data over the last 60 years found that while UK cereal yield increases prior to 1982 were due to a combination of factors, including plant breeding, agronomy and inputs, yield increases in winter wheat, spring barley and winter barley over the past 25 years have been almost exclusively due to improved varieties. Innovation in plant breeding accounts for around 90% of the increase in national average cereal yields from 1982.

4.9 Therefore a yield increase of 1.9 tonnes per hectare has been achieved as a result of plant breeding since 1982 (90% of the 2.1 tonnes per hectare increase).

4.10 The John Innes Centre (JIC) estimates that half of this increase in yield is due to semi-dwarfing benefits introduced to commercial varieties by plant breeders. Semi-dwarfing genes shorten the straw. This 'short straw' has a double benefit - more of the growth goes into the ears of wheat rather than the stalk and the standing crop does not lodge. The result is increased yield and reduced wastage from poor harvest conditions.

4.11 In 2008 the area harvested for wheat in the UK was 2.1 million hectares. Applying the wheat yield increase of 1.9 tonnes per hectare results in additional wheat production of 3.9 million

[5] A contemporary analysis of the contribution of breeding to crop improvement, NIAB, June 2009

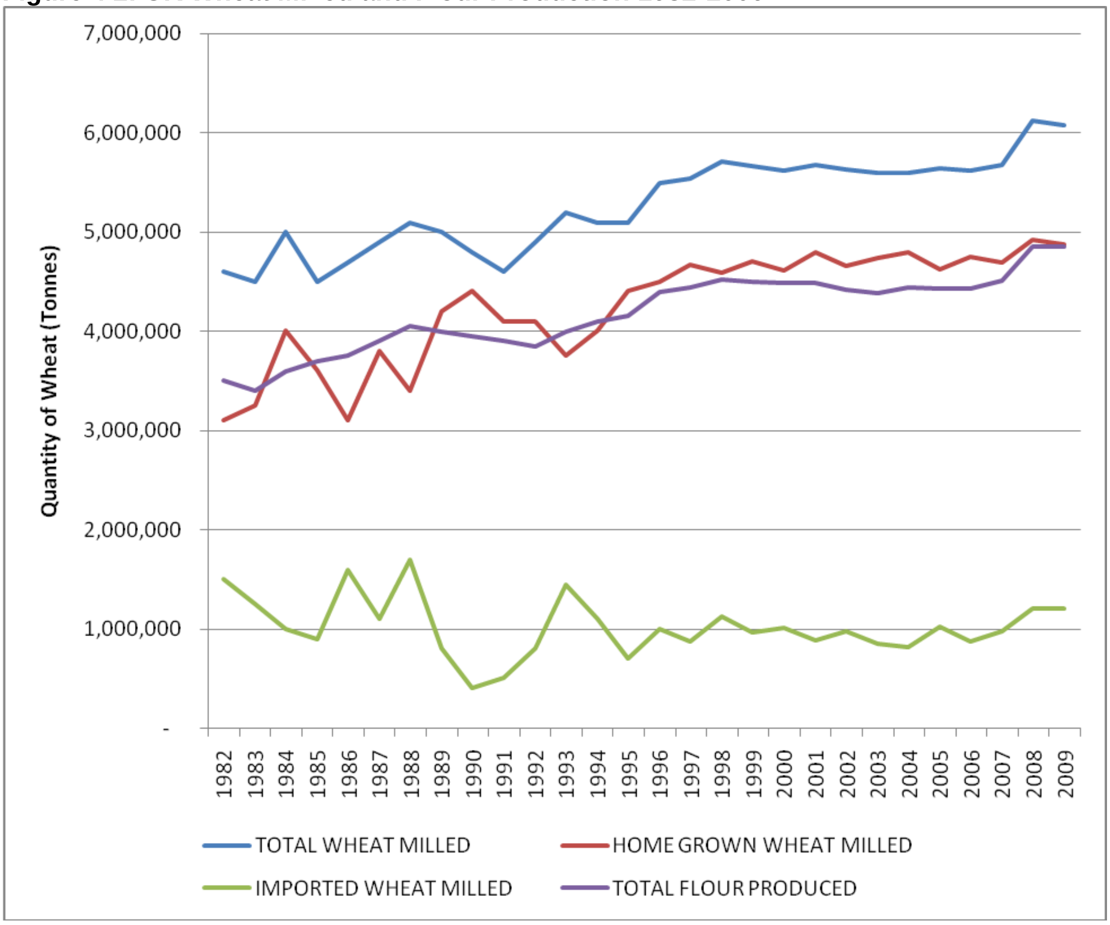
tonnes per annum compared with 1982. Using the range between average feed (£95.70 per tonne) and average bread making wheat price for 2010[6] (£114.5 per tonne), **the gross value of the yield increase in 2010 prices attributable to BSPB would be £373 million at feed prices or £445 million per annum at bread making prices**. The potential additional milling premium is therefore worth £72 million alone.

Import Substitution and Safeguarding the UK Milling Industry

4.12 Development of higher yielding varieties with better milling characteristics has allowed the UK to produce more of its own milling wheat, thus reducing the requirement for imported wheat from North America. Imports represent a loss of economic value to the UK economy as payments are made overseas. Retaining these payments within the UK creates local jobs and turnover.

4.13 This reduced dependence on imported wheat is illustrated in Figure 4.2. Between 1982 and 2008, the quantity of flour produced in the UK grew by 39% while the quantity of imported milling wheat fell by 20% stabilising at around 1 million tonnes per annum.

Figure 4.2: UK Wheat Milled and Flour Production 1982-2009



Source: defra

[6] defra

4.14 The development of higher yielding hard wheat varieties able to grow in the UK climate has allowed the UK milling industry to grow using home grown wheat. The milling industry is important to the UK economy as it employs 12,000 and has GVA (Gross Value Added) of £1.4 billion[7]. Of that total, nabim estimates that flour milling accounts for employment of 3,000 and turnover of £1.2 billion.

4.15 There are four factors that have contributed to flour milling industry growth and development over the period. These factors are:

- **Technological improvements** – millers and bakers have been able to invest in technological improvements that allow previously unusable wheat to be milled.
- **Capital investment** - millers have invested substantially in capital to reduce operating costs
- **Marketing and product development** – significant investment in these areas has ensured attractive products for the market.
- **Keeping raw material costs down** – wheat is the biggest cost for millers. Plant breeding has helped to ensure the UK produces wheat cost effectively.

4.16 Without these factors, it is likely that the UK milling industry would have declined in the face of imported flours from continental Europe or elsewhere. Plant breeding has, therefore, helped to safeguard the UK milling industry. Assuming equal weighting between the four factors above, plant breeding would be responsible for a quarter of the impact.

4.17 On this basis plant breeding has helped to safeguard up to 750 UK milling jobs and £300 million of annual UK milling turnover.

4.18 Plant breeding has provided the varieties that have enabled home grown wheat used for milling to grow by 57% between 1982 and 2009, or 1.7 million tonnes.

4.19 In the absence of new varieties, this volume of wheat could not have been produced in the UK so effectively, so imports would be more likely. Thus, growing within the UK also saves the cost of international shipping and associated carbon dioxide emissions.

4.20 Assuming shipping across the Atlantic from North America to west coast UK, the distance is approximately 3,300 miles[8]. The emissions from long distance shipping are c. 20g carbon dioxide per mile making the total emissions 66.5 kg per tonne of wheat imported from North America. Average shipping costs are around £30 per tonne[9].

[7] Source: Office for National Statistics, Annual Business Inquiry (ABI) 2008. Gross Value Added is a common measure of production efficiency and economic benefit. It broadly comprises staff salaries and profits generated in production.

[8] http://www.mapcrow.info

[9] http://www.openi.co.uk/h070821.htm based on average costs and conversion to UK£.

4.21 Based on 1.7 million tonnes of wheat, plant breeders have therefore helped reduce annual emissions by 113,000 tonnes carbon dioxide with a value of £2.8 million[10] per annum and transport cost savings of £51 million per annum.

UK bread market

4.22 The UK bread industry has annual sales of around £2.9 billion with the branded bread market worth £1.39 billion[11]. Three main bread manufacturers dominate the branded market:

- Warburtons have a 32% market share;
- Premier Foods (with brands such as Hovis) have a 26% market share; and
- Allied Bakeries (manufacturer of Kingsmill and Sunblest brands) have a 14% market share.

4.23 The market is highly competitive with a trend towards branded products associated with ‘family values’, ‘product integrity’, provenance, health and differentiation. As part of this trend, Hovis has announced in 2010 that its branded bread will be made from 100% British wheat. Whilst this includes some foreign wheat varieties grown in the UK, the bulk of this wheat is from varieties bred by UK plant breeders. Without the long term investment of UK plant breeders, it is unlikely that Hovis could make a 100% British wheat claim.

4.24 Warburtons sources about half of its wheat from the UK, the other half being imported. However, Warburtons is also helping to develop its own exclusive wheat varieties, testing new varieties submitted by breeders, so that it can reduce its reliance on imports and demonstrate the British provenance of its products.

4.25 Hovis has a 9% turnover growth target over the next 3 years worth £33 million. Meeting this target will be dependent on strong promotion, product innovation and UK provenance claims which would not be possible without the efforts of plant breeders.

Barley

4.26 Plant breeders have developed new barley varieties with a range of benefits as set out below. The economic impact of plant breeding on UK barley is set out under the following headings:

- Yield increase
- Additional alcohol
- Safeguarding the UK malting sector
- Other benefits

Yield Increase

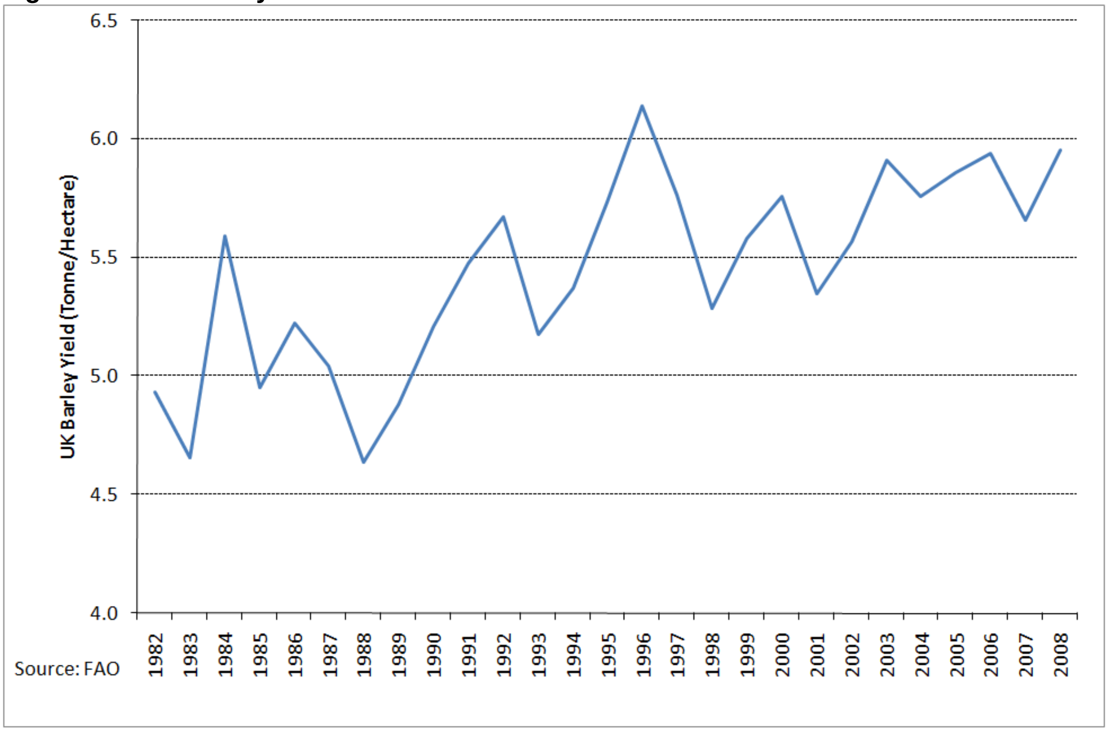
4.27 In 1982 barley production in the UK was 11.0 million tonnes, meaning that barley production

[10] DECC

[11] Premier Foods plc and the Federation of Bakers

has declined by 44% based on the 2008 production total of 6.1 million tonnes. However, despite the decline, barley yields have improved by 1.0 tonne per hectare between 1982 and 2008 (see Figure 4.3). There is strong demand for malting barley for the Scotch whisky industry and for brewing. Applying the 90% attribution identified by the NIAB research[12], an estimated yield increase of 0.9 tonnes per hectare has been achieved as a result of plant breeding since 1982.

Figure 4.3: UK Barley Yield 1982-2008



Source: FAO

4.28 In 2008 the area harvested for barley in the UK stood at 1.03 million hectares. Applying the barley yield increase of 0.9 tonnes per hectare, results in additional barley production of 950,000 tonnes. Using the average barley price for 2010[13] of £79.70 per tonne, **the gross value of the barley yield increase in 2010 prices attributable to plant breeders is £75.6 million per annum**.

Additional alcohol

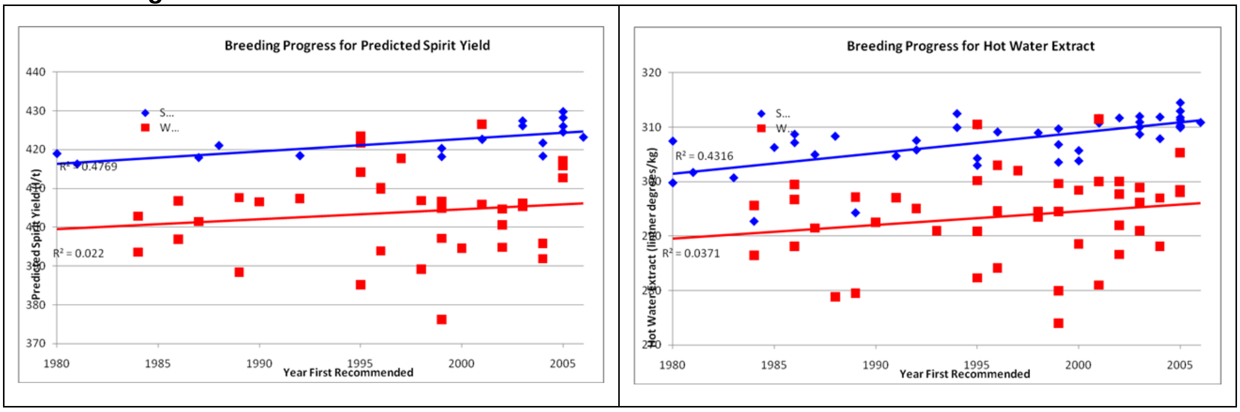
4.29 For malting barley there are a range of quality characteristics sought by the distilling and brewing industries. For distillers, predicted spirit yield is a key measure of how much alcohol will be produced from barley. For brewers, the key measure is hot water extract and this determines how much beer can ultimately be produced.

4.30 Plant breeders have delivered increases in these key measures for the benefit of industry.

[12] A contemporary analysis of the contribution of breeding to crop improvement, NIAB, June 2009
[13] defra

4.31 Independent research[14] has measured the benefits delivered since 1980 (Fig 4.4). Amongst recommended varieties, spirit yield from barley has improved from around 416 litres per tonne to 424 litres per tonne. Improvement in hot water extract since is 10 litre degrees per kg (302 to 312).

Figure 4.4: Improvements in Predicted Spirit Yield and Hot Water Extract from plant breeding



Source: SCRI and the AGOUEB Consortium

4.32 Whilst these increases appear fairly modest they have led to significant industry benefits as set out below.

4.33 UK maltsters use 1.7-1.9 million tonnes of malting barley per annum. The mid-point of 1.8 million tonnes has been used for the impact calculations. The yield of malting barley to malt is 82% giving 1.48m t of malt[15]

Figure 4.5: Impact assumptions for improvements in spirit yield and hot water extract from plant breeding

Whisky	Beer
48% of UK malt went for distilling in 2008 which makes 710,000 tonnes of malt at 82%. 1t of malt gives 424l of spirit which is 8l more per tonne of malt than in 1980. Based on 8l more per tonne and 710,000 tonnes equates to: - 5.6m extra litres of pure alcohol per annum - Evaporation loss of 2% of alcohol per year – take 5 years as the average equals 10% loss - 5 m extra litres of pure alcohol - Bottled at 40% - 2.5 times diluted gives 12.5 m litres - Normal bottle size is 70cl - Makes 17.8 m extra bottles available in	40% of UK malt went for brewing in 2008 which makes 592,000 tonnes of malt at 82% 1t of malt gives 312 litre degrees per kg which is 10 kg more per tonne of malt than in 1980 This improvement equates to 3.3% more beer by volume. - UK brewing industry turnover is estimated at £4.5 billion. A 3.3% increase would be worth £148 million in turnover to brewers. - However, the UK beer market is static or declining. - Therefore, the 3.3% improvement allows brewers to reduce their input costs while producing the same volume of beer. - 3.3% less malt equates to 19,600 tonnes

14 SCRI and the AGOUEB Consortium

15 Industry expert.

Whisky	Beer
2008 compared to 1980 based on 2008 figures - Average price on export market £7.28 (all whisky)	of malt @ £200 - a £3.9 million annual saving on input costs
Total value of additional whisky £129 million per annum	**Total value of additional potential beer £148 million per annum if market was growing.** **Savings in brewers input costs of £3.9 million.**

Source: Maltsters Association of Great Britain, SCRI and the AGOUEB Consortium, Scotch Whisky Association, Scotch Whisky Research Institute, Annual Business Inquiry, British Beer and Pub Association, industry experts and DTZ.

4.34 However, the Scotch Whisky Association highlights the fact that in the 1980s, the industry was largely using varieties with much lower spirit yield and that the real gain in spirit yield is probably at least 30 litres per tonne, or 3.75 times the SCRI figures.

4.35 On this basis, for distillers, the additional alcohol extracted from malting barley as a result of the efforts of plant breeders has created an extra 17.8 - 66.8 million potential bottles with a value on the whisky export market of £129 - £483 million per annum.

4.36 For brewers, the additional alcohol has a potential value of £148 million but brewers simply buy less malt saving £3.9 million on annual input costs. Margins are very low in the brewing sector so this still is a significant saving[16].

Safeguarding the UK malting sector

4.37 The efforts of plant breeders have helped to **safeguard the UK malting industry** by ensuring continual improvements in the quality of barley and thus the quality of malt. This in turn has kept malt prices down ensuring UK malt is competitive against imported malt. For example, this has ensured that UK malt producers can compete against the much larger French malting industry. Whilst maltsters have made significant capital investments in UK facilities, there is a real risk that without plant breeding improvements, the long term profitability of UK maltsters would have been lower than competitors abroad. The UK malting sector had a turnover of £511 million per annum and employed 2,000 people in 2008[17].

4.38 Advances made by plant breeders to boost domestic malt production have resulted in corresponding reductions in the volume of imported malt. This means that the UK avoids the associated freight costs. This is equivalent to an industry saving of £7.8 million per annum, based on 1.3 million tonnes of malt at a freight cost of £4 per tonne from France plus £2 per tonne loading[18].

4.39 By safeguarding UK malting, plant breeders have avoided carbon dioxide emissions on imported malt from France of 6,400 tonnes per annum with a value of £160,000 per annum.

[16] http://www.morningadvertiser.co.uk/news.ma/article/86354

[17] Office for National Statistics, Annual Business Inquiry (ABI) 2008

[18] HGCA cost of bulk grain transport and assuming malt would be the same.

This is based on a distance of 224 miles and 40g CO_2 per tonne of malt imported.

Other Benefits

4.40 By developing low GN varieties, plant breeders have helped to safeguard one of the UK's largest whisky export markets – USA and Canada – from future regulatory change. These markets were worth £417 million in 2008 and grew to £466 million in 2009.

4.41 By reducing beta glucan content in barley, improvements in processibility have been possible that have significantly improved brewing productivity as follows:

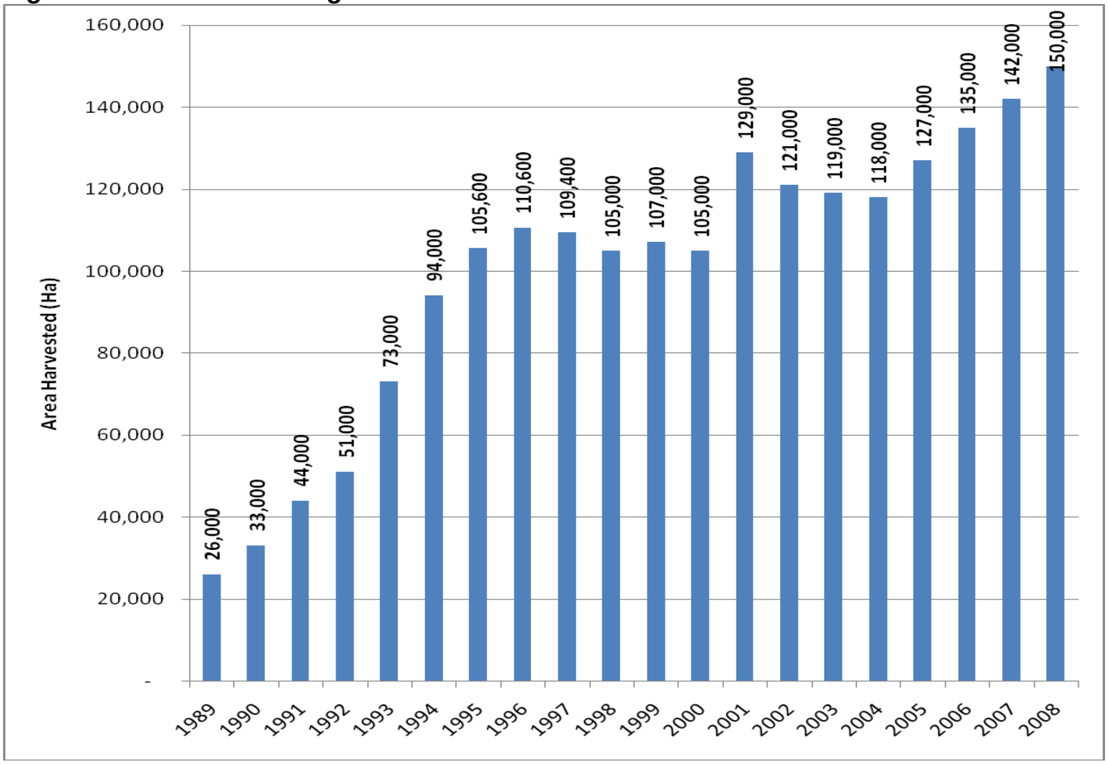
- Competition in the UK beer market has seen consolidation of brewing onto a small number of high throughput sites operating at nearly 100% capacity around the clock.
- These high efficiency gains have been made possible by investments in new equipment and through plant breeding improvements.
- Plant breeders have consistently reduced the beta glucan content in barley.
- High beta glucan content increases the viscosity of the mash in the brewing process and slows down the filtration process.
- A typical brewery might well achieve 10 brews per day now as opposed to 6 or 7 twenty years ago - an average productivity increase of 54%.
- Without lower beta glucan content, this productivity improvement would not have been possible. Assuming a quarter of the improvement is due to reduced beta glucan content, this equates to a productivity improvement of 13% due to plant breeders since 1990.
- Employment costs for the UK brewing industry were £706 million in 2008 according to the Annual Business Inquiry. Without the productivity improvements it is assumed that these employment costs would be higher at £811 million per annum.
- **Therefore, through reducing beta glucan levels in new varieties, plant breeders have supported the UK brewing industry with productivity savings of 13% since 1990. These savings are worth £105 million per annum** based on the industry staff costs of £706 million.

Forage Maize

4.42 Plant breeders have developed a range of early maturing, higher yielding forage maize varieties. These varieties have supported rapid growth in the UK area of forage maize as farmers have recognised, and adopted, the benefits. The popularity of maize is due to its high dry matter content and better nutritional quality in comparison to grass silage.

4.43 Historically the UK climate has restricted maize growing to the South East of England. New varieties have allowed forage maize to be grown further north. Figure 4.5 shows that between 1989 and 2008, the forage maize area has grown to 150,000 hectares, an increase of 136,000 hectares.

Figure 4.5: Growth in forage maize area harvested



Source: Limagrain

4.44 Adding maize to grass silage improves the gross margin per dairy cow. Research has compared diets of grass silage alone with maize silage in combination with grass silage (50:50 of forage dry matter)[19]. The following factors help to increase gross margin:

- **Higher ration intake** - the addition of maize silage improves dry matter intake by 3.8kg per day to 13.6kg relative to grass silage alone.
- **Lower production costs** - maize silage typically costs £73 per tonne of dry matter versus grass silage at £85 per tonne. The cost differential reflects the higher dry matter content of forage maize.
- **Higher milk yield –** forage maize has been found to deliver an increase in milk yield of 2.4kg per day, as well as increased protein and fat.

4.45 Forage maize uptake has grown fastest in intensive dairy herds where it can comprise up to 80% of the ration. More extensive units still rely more heavily on grass silage.

4.46 According to DairyCo, there are 5,100 holdings and 882,000 cows in the most intensive UK farms (those with more than 100 dairy cows). The area grown in 2008 (latest data) is 150,000 hectares. According to Agri-Food Biosciences Institute research, this area is enough to feed nearly 850,000 dairy cattle, or 96% of cows in UK intensive herds, as the following table shows.

[19] Agri-Food Biosciences Institute, Belfast

Table 4.6: Impact assumptions for forage maize

Area of forage maize grown (hectares 2008)	150,000
Yield per hectare (tonnes)	18
Total forage maize produced (tonnes 2008)	2,700,000
Convert to dry matter at 32% (tonnes)	864,000
Dry matter intake per cow per day (kg in a 50:50 ration)	6.8
Total DM intake per cow over winter (kg 150 days)	1,020
Cows fed over winter based on 864,000 tonnes	847,059

Source: Agri-Food Biosciences Institute data adapted by DTZ

4.47 The results of the research show a financial benefit of £0.52 per cow per day, equating to £80 per cow over the winter period.

4.48 On this basis, through new forage maize varieties, plant breeders have supported provision of better rations worth £66 million per annum to the equivalent of 96% of UK intensive dairy herds. These figures are based on the 2008 area while the actual area is growing each year.

5.0 Conclusions

5.1 Over a long period of time, plant breeders have made continual investment and incremental improvements to wheat, barley and forage maize. This work has been characterised by strong partnerships and communication throughout these supply chains. The total annual benefits associated with plant breeding for these three crops are substantial.

5.2 Figure 5.1 provides a summary which shows that the annual benefits are in the range **£1 – 1.3 billion per annum with a further £1.3 billion of safeguarded economic activity:**

Figure 5.1: Summary of impacts for three main crops

Wheat	
Wheat yield at feed price	373
Potential additional milling wheat premium	72
Transport cost savings	51
Hovis provenance claims	10
Barley	
Barley yield	76
Additional beer	148
Brewing processibility	105
Additional whisky	129-483
Forage maize	
Forage maize improved dairy productivity	66
Plus safeguarding:	
UK Maltsters	511
UK Millers	300
Key whisky markets	466

5.3 When the annual benefits are compared with the £25 million annual royalty income from the three crops under consideration, **the gross return on industry investment for the UK economy can be seen to be 40 to 1**.

5.4 Measuring the return on investment of any research is very challenging and complex. DTZ has previously conducted high level assessments of the return on investment from research covering both fundamental and applied research. Plant breeding is very much in the 'applied' category and close to market so the expected returns should be at the high end.

5.5 Other ratios found range from 5:1 for fundamental research to 15:1 for more applied research. Achieving 40:1 is, therefore, a high return on investment, and is achieved without any substantial public funding.

5.6 This report has demonstrated that plant breeders have made a substantial contribution to UK agriculture, food and productivity. Importantly, plant breeders have much more of a contribution to make in supporting the UK in meeting food security, sustainability and climate change objectives. An agreed UK strategy for this contribution plus selective public sector investment in pre-breeding will help support and maximise that contribution in future.

Appendix A

British Society of Plant Breeders Ltd - Members 2010

DTZ

APPENDIX A: BRITISH SOCIETY OF PLANT BREEDERS LTD - MEMBERS 2010

FULL MEMBERS - LARGE :

DLF Trifolium Ltd
Elsoms Seeds Ltd
Germinal Holdings Ltd (BSH)
KWS UK Ltd
Limagrain UK Limited
LS Plant Breeding
Monsanto (UK) Ltd
Syngenta Seeds UK Ltd
Saaten Union UK Ltd
RAGT

FULL MEMBERS - SMALL:

Cygnet Potato Breeders Ltd
Senova Ltd

ASSOCIATE MEMBERS - LARGE:

Agrico UK Ltd
Barenbrug (UK) Ltd
Branston Ltd.
Caussade Semences
Deutsche Saatveredelung AG (DSV)
Grainseed Ltd
Maribo Seed International ApS
Masstock Arable Ltd
Pioneer Hi-Bred (NE) Ltd
Rijk Zwaan UK Ltd

ASSOCIATED MEMBERS - SMALL:

AFBI
Advanced Technologies (Cambs) Ltd
Caithness Potato Breeders Ltd
Cope Seeds Ltd.
David Trethewey Seeds
Enza Zaden
Euro Grass Breeding GmbH & Co KG
Frontier Agriculture Ltd
Harlow Agricultural Merchants Ltd
Harper Adams
Huntseeds Ltd
HZPC Holland B.V.
IBERS
I G Pflanzenzucht GmbH
Irish Potato Marketing Ltd
JE & VM Dalton Ltd
John Ebbage Seeds Ltd
John Innes Centre
John Turner Seed Developments
Lion Seeds
Maïsadour Semences
Mike Pickford
Nunhems Seeds
Potato Innovations Ltd
PWB (Seeds) Ltd
Sakata UK Ltd
SCRI (Mylnefield Research Services)
Solana Agrarprodukte GmbH & Co KG
Top Green SAS
Tozer Seeds Ltd
TV Seeds
United Oilseeds
Wherry & Sons Ltd