The Value of Crop Protection

AN ASSESSMENT OF THE FULL BENEFITS FOR THE FOOD CHAIN AND LIVING STANDARDS

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Crop Protection Association
Dominic Dyer, CPA Chief Executive

It is increasingly recognised that access to agricultural innovation – including the most advanced plant breeding technologies and crop protection tools - will play a key role in boosting food production to meet the needs of a rapidly growing world population.

But modern, science-based agriculture is also the foundation for economic growth in the UK's farming, food processing and retail sectors, which together account for nearly 15 per cent of the nation's GDP and employ more than 3.7 million people.

This study is the first of its kind to quantify the economic benefits of crop protection, not only to maintain the quality, consistency and affordability of our food supply, but also to keep UK agriculture competitive and to safeguard jobs, growth and wealth creation within the rest of the food chain.

Sean Rickard’s central conclusion is that without effective crop protection tools to control the many pests and diseases which reduce yields and damage food quality, crop production would fall significantly and the nation’s food bill would increase by £70 billion.

Higher food prices would create pressures on disposable incomes with adverse effects for other sectors of the economy, while consumers would also suffer a reduction in the health benefits associated with a wide choice of affordable fresh fruit and vegetables.

Food for thought as European policy-makers preside over a regulatory environment in which spiralling development costs and restrictive new EU rules on pesticide approvals threaten the future availability of vital crop protection products to Europe’s farmers and growers.

George Freeman MP
Chair, All-Party Parliamentary Group on Science & Technology in Agriculture

Sean Rickard’s report is extremely timely in analysing the economic value of crop protection within the food production and supply chain. It coincides with the reinstatement of Defra’s primary economic remit under the new coalition Government, alongside a clear recognition that supporting a sustainable and profitable agricultural sector is Defra’s number one business objective.

Access to modern, science-based agricultural technologies and practices is vital, not only in tackling the global challenges of food security and climate change, but also in providing an essential platform for economic growth and trade.

Above all, this report highlights the role new technology - including innovative approaches to crop protection - has to play in maintaining the competitiveness of our food supply chain, in keeping the lid on food price inflation, and in safeguarding the quality and nutritional value of our food.

For policy-makers, the messages contained in the report serve as a stark reminder of our responsibility to ensure that the regulation of agricultural science and technology, at a national and international level, is truly proportionate and evidence-based. This is an important and timely piece of work.
Executive Summary

This report seeks to meet its objective firstly by demonstrating the importance of plant protection products to the type of modern, productive and competitive agricultural industry that has not only delivered a much higher quality of life but also will be necessary if the world is to meet the challenges of feeding its population in the coming years. Secondly, it attempts where possible, to put a monetary value on these benefits and in doing so highlights the enormous costs society would incur in the absence of synthetic plant protection products. These benefits and costs are separated into a number of specific sections.

Challenges to Global Food Production

The world’s population is growing and becoming more affluent. Rising demand for improved diets including more meat, dairy products, fresh fruit and vegetables calls for a supply response. But rising energy costs, emerging water constraints and climate change, combined with little scope for increasing the world’s agriculture area, threaten the agricultural industry’s ability to keep pace with demand. This challenge calls for a new Green Revolution in which higher productivity growth is secured by the application of science, technology and modern business practices. Synthetic plant protection products will be an essential part of the new revolution: productivity gains can be neither secured nor protected without them.

Underpinning the Food Chain

Food is the most basic of all necessities and it is impossible to think of a modern developed economy that cannot supply its population with a wide choice of high quality food at affordable prices. This report estimates that without plant protection products, food security in the UK, and by implication in the EU and in most countries across the world, would be severely reduced and the cost of food would rise substantially. In the UK the cost of food would rise by about 40 per cent, increasing food and drink expenditures by some £70 billion per year and raised to the level of the EU this implies additional food expenditures of some £750 billion. Not only would this place a burden on household budgets and result in a poorer diet for many but also this sum of money would be withdrawn from other sectors of the economy leading to a loss of businesses and employment. To put the effect of this withdrawal of expenditure in perspective it amounts to approximately double the annual cut in real terms in public expenditure recently announced by the UK government.
The Dynamic Contribution of Plant Protection

The foregoing demonstrates that the traditional, snap-shot approach of equating an industry's contribution to its gross value added is woefully inadequate when considering the total contribution of the plant protection industry. Without plant protection products crop yields would be about half their current levels with severe adverse implications for employment, efficiency and the profitability of farming and food businesses. But these business costs, along with the higher cost of food, do not fully capture the total contribution of plant protection products. The industry's contribution is quintessentially dynamic; it is a powerful catalyst for change and progress. The science of modern chemistry has proved a formidable force for economic prosperity and quality of life. From this perspective the longer term value of the existence of the plant protection industry is immeasurable; there can be little doubt that global development with all its benefits for reducing poverty and raising living standards would be slowed, if not thwarted if the world lacked the ability to adequately feed its population.

Downsizing the Farming Industry

Europe can boast some of the world's most efficient and advanced farming industries. The hallmark is high levels of productivity, in particular world beating crop yields and for a generation agricultural prices that have grown much more slowly than prices in general. Many factors contribute to this superior performance but in the absence of plant protection products the output of arable crops would be halved and production costs, notably labour costs, would rise as farmers sought to counteract the effects of the loss of these products.

Overall farm incomes would be reduced and inevitably a significant proportion of the 11 million people engaged in the EU agricultural industry would no longer be able to earn a living from farming. From the perspective of farming's customers, arable crop prices would rise, on average by at least 100 per cent, with severe knock-on effects for livestock farmers who depend on arable crops as feedstuffs. The output of livestock and livestock products would necessarily be severely cut back and prices for these products would rise on average by about a third.

Turning to the UK, the additional cost of agricultural output to its main customer, the giant food processing and manufacturing industry would be of the order of £12 billion but the cost to the industry's customers would be much greater as they turned to high priced imports in an attempt to make up the shortfall in supplies.

Without plant protection products... In the UK the cost of food would rise by about 40 per cent, increasing food and drink expenditures by some £70 billion per year.
Executive Summary (cont)

Damaging the Food Industry

The food processing and manufacturing industry is the largest manufacturing sector in the EU accounting for 13 per cent of manufacturing’s gross value added. Crucial to its efficiency and profitability is a secure and reasonably priced supply of good quality agricultural produce. But, as outlined above, without plant protection products its supply of raw materials from domestic farms would fall sharply and their prices would rise markedly. The industry would be forced to seek a much larger proportion of its inputs from overseas producers and at much inflated prices. Turning to the UK where food processing and manufacturing accounts for 14 per cent of manufacturing’s gross value added, the additional cost would be of the order of £40 billion, increasing by two thirds the industry’s total costs of procurement. Moreover, the much greater reliance on imports would not only substantially increase the volatility and reduce the security of their raw materials but also the industry’s competitiveness and economic sustainability would suffer a severe deterioration with knock on effects for enterprises and employment. The adverse effects would spread to product and process innovation. Most importantly, the industry would no longer be able to meet consumers’ demands for a secure and affordable supply of food products.

Lower Living Standards

Without plant protection products consumers would suffer more than higher food prices and a consequential deterioration in the affordability of food. In the UK the effect of the higher food and drink prices would be to add some £70 billion to annual household expenditure. But this increase of about 40 per cent on food and drink expenditure does not adequately capture the full value of plant protection products. There would be a loss of choice and a decline in the nation’s health and nutrition as households reduced consumption of expensive fresh fruit and vegetables. Pressures to grow crops on afforested land, on areas of high environmental value or outstanding beauty would grow reducing the opportunities a productive farming industry offers for rural leisure and recreation. Beyond farming there would be a cost in the form of the loss of social benefits that arise from the maintenance of the turf on sports fields and golf courses as well as the enjoyment afforded by well kempt domestic gardens. Finally, if households had to spend an additional £70 billion on food this would represent expenditure that was not available to support many other businesses and employment in other sectors of the economy. In short, a full accounting for the benefits of plant protection products would have to extend much wider than the higher cost of food.
Encouraging Invention and Innovation

Underlying the estimates of the benefits of plant protection products contained in this report is a sense of urgency. Innovations in crop protection science have a long cycle. Given the need to double world food production over the next 40-years it is crucial that the relevant research and development is encouraged and reinforced by EU and national policy. At the Rome Food Summit in June 2008, the UK led calls to create a Global Partnership for Agriculture and Food, with a commitment to double investment in agricultural research.

Currently legislation and official attitudes are more discouraging than positive. It is as though sight of the wider, critically important benefits arising from the development of new, more efficient and safer plant protection products has been lost in a wave of increased cost associated with regulation and compliance. The result has been a slowing down in the EU industry’s research activity and a lowering of the capacity in Europe to bring new plant protection products to the market compared to the United States.
PLANT PROTECTION PRODUCTS (PPPs) ARE AN INTEGRAL PART OF MODERN FARMING, SERVING TO PROTECT CROPS, VEGETABLES AND GRASS. THEY HAVE PROVED THE MOST ECONOMICALLY EFFICIENT MEANS OF CONTROLLING THE WEEDS, PESTS AND DISEASES THAT THREATEN AGRICULTURAL PRODUCTION.

The range and effectiveness of synthetic PPPs is now under pressure as a result of new EU legislation - 1107/09 /EC - and the implementation of the Water Framework Directive (WFD). It is therefore timely to consider the benefits that synthetic PPPs deliver, not only in contributing critically to the volume and quality of foodstuffs but also the wider benefits to the economy in terms of economic activity, employment and the advancement of knowledge.

A full assessment of the benefits of modern, synthetic PPPs must start upstream of farming with an appreciation that the PPP industry by means of its research activities is a major source of new knowledge that translates sooner or later into more effective, safer products. These benefits flow downstream to farming and beyond to food processors and manufacturers as well as retailers and finally consumers. The most obvious of these benefits is the security associated with a plentiful, stable and affordable supply of food. Less obvious are the nutritional and health benefits from produce that is free from blemishes and disease. And frequently overlooked are the wider benefits arising from the appearance of agricultural and garden flora that yield visual amenities and an enhanced quality of life. Rarely considered is the likely future contribution of PPPs to the development of bio-fuels and renewable plant based industrial materials that will play an important part in countering the effects of global warming and achieving sustainable industrial activities.

The approach taken in this report is to augment published national statistics with other publicly available information and relevant research to provide a more broadly based and balanced picture of the value of the crop protection industry not only to agriculture but also to the food chain in general and beyond to the quality of living. In this way it is hoped to provide an understanding that cannot be obtained from official statistics alone.

All sources are referenced in the endnotes to this report.
Terms of Reference

The terms of reference for this report are to set out the:

- importance of crop protection in meeting the global challenge of future food security;
- contribution of crop protection to a sustainable productive agricultural industry, in particular in making more efficient use of land, water and energy;
- value of plant protection in the UK to farming and the wider food chain and by implication the value in the EU;
- need for an effective plant protection strategy to be at the heart of the UK and EU food security policy;
- implications of an increasingly restrictive EU regulatory environment including the switch from risk-to-hazard-based assessment in the new EC Pesticide Authorisation Regulation;
- increasing costs of new product development in the EU Crop Protection Industry and the failure to keep pace with the loss of products; and
- the growing threat posed by pest and disease pressures against a background of climate change across Europe;

Report Structure

This report is separated into three sections. The first deals with growing concerns regarding the ability of the world’s agricultural industry to meet the rising demand for food over the next 30 to 40 years. This section provides an introduction for the second which seeks to quantify the total value of PPPs largely at the level of the UK but where data allows also for the EU. The total value goes beyond the lower food prices that result from the efficient production of food. The wider benefits include the discovery of new knowledge, the support of many thousands of jobs in the food chain and beyond, a major contribution to the health of the population through the provision of plentiful supplies of fresh fruit and vegetables and the release of land for recreation and visual amenity. In order to keep the assessment manageable the second section separates the economic contribution of synthetic PPPs to the UK and, by implication, the EU, into three discrete analyses: i) the direct benefit to the farming industry; ii) the indirect support to the giant food processing and manufacturing industry; and iii) the widespread gains to consumers and their living standards. The third section examines the importance of research and development for the plant protection industry and its products. It draws attention to the costs in terms of both funds and time, in developing new, more efficient crop protection products.
In 2007 the world’s attention was focussed on the global food crisis. Following a succession of short harvests, rapidly rising agricultural commodity prices generated food price inflation in developed nations, food shortages in developing nations and rising levels of hunger and malnutrition in the world’s poorest nations.

In response to the dramatic rise in the prices of grains, rice and dairy products, global agricultural production grew by 3.9 per cent in 2008. Most of this growth took place in developed countries and the Commonwealth of Independent States. Significantly, developing countries did not report above-trend growth, yet it is these countries that will be responsible for an increase of some 2.4 billion in the world’s population by 2050: see Figure 1.

Figure 1
Global Population Growth

Source: FAO
The International Grains Council’s preliminary figures for the 2009/10 harvest forecast a slight decline - less than one percent - in global grains production but its forecast for 2010/11 indicates a further decline of 2.5 percent resulting in total supply falling some 39 million tonnes less than consumption. Looking further ahead, the latest OECD-FAO ‘Agricultural Outlook’ while taking a generally hopeful view of the ability of the world to feed itself points out that ‘…land use in agriculture has actually grown very slowly for decades, falling in some regions and growing in others, primarily in developing countries. The best rainfed cropland is already being used, and expansion to other areas would incur higher input costs …. infringement on forested areas would obviously make considerably more land available for agriculture but would incur high social and environmental costs.’ Many experts are not so sanguine, for example a report by the authoritative Chatham House opens its analysis of food security with the words ‘….what we had thought of as abundant food supply is anything but. Western societies in particular, have tended to take their food supply for granted. The global system as currently operated will reach breaking point unless action is taken.’ And a follow-up Chatham House report, while noting the OECD-FAO’s outlook, points out that there is ‘…a real risk of a ‘food crunch’ at some point in the future.’ The Chatham House report identified seven major challenges facing global agricultural production in the coming years and these are summarised in Figure 2.

Figure 2
Seven Challenges to Global Food production

<table>
<thead>
<tr>
<th>ISSUE</th>
<th>CONCERNS</th>
<th>CHALLENGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Rapidly rising world population</td>
<td>Annual global per capita grain production has declined</td>
<td>Many developing countries are struggling to meet their population’s demand for food</td>
</tr>
<tr>
<td>2. Nutrition transition as per capita incomes rise</td>
<td>Global demand for meat and dairy products is rising</td>
<td>Continued upward pressure on world food and feed crop prices</td>
</tr>
<tr>
<td>3. The dependency of food production on energy</td>
<td>Energy prices have risen and are expected to rise further</td>
<td>Rising production costs plus increasing diversion of arable land from food to bio-fuels</td>
</tr>
<tr>
<td>4. Severe limits on the growth of agricultural land</td>
<td>The per capita area of cultivated agricultural land has declined</td>
<td>Future production increases will need to come from higher output per hectare of land</td>
</tr>
<tr>
<td>5. Global supply of water failing to match demand</td>
<td>Agriculture production heavily dependent on fresh water</td>
<td>Increased agricultural trade to compensate with the water embedded in food products</td>
</tr>
<tr>
<td>6. Stress of climate change on agricultural production</td>
<td>Identified as a cause of crop losses in recent years</td>
<td>Will contribute to the more rapid spread of crop and animal disease</td>
</tr>
<tr>
<td>7. Rural populations are declining as a proportion</td>
<td>Global harvests already dependent on migrant labour</td>
<td>Rising urban populations will become reliant on a reduced rural population for their food</td>
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</table>

Source: Chatham House
Chatham House is not alone in identifying a number of challenges that the global food system must overcome in the coming decades. All organisations with a track record in this area agree that the combination of rising populations and continued per capita income growth in developing countries will greatly increase global demand for food. Most experts put the increase at or near a doubling of demand by 2050. The UN expect the world’s population to rise by more than a third to 9.2 billion by 2050 and, as noted above, this increase will take place in developing countries where it might fairly be observed, agricultural industries lag behind the more advanced, highly efficient farms typical of North America and Western Europe.

But the growth of demand will owe more to development and its associated per capita income growth than population growth. Rapid development - China is the best exemplar - drives what the original Chatham House report describes as the *nutrition transition*. This is a feature of rising affluence which involves populations shifting away from traditional staples such as roots and tubers towards more meat and dairy products, as well as more refined and processed foods. In the 20 years prior to the global downturn in 2008, demand for meat in developing countries doubled. The FAO expects that demand for meat in developing countries will more than double over the next 40 years requiring associated increases in the production of grain for animal feeds of animal populations.

Increasing supply to meet this demand is a challenge heightened by a number of factors. The first is the constraint surrounding any increase in the world’s agricultural land area. Cultivated land per capita has declined worldwide; a process that is exacerbated by the spread of urbanisation in both developed and developing countries. Estimates vary but it seems that the area of productive arable land is likely to increase by just 5 per cent by 2050. Put another way today there is approximately 0.22 hectares of farmland per person but by 2050 this will have fallen to 0.17 per person. The logic is inescapable, the bulk of the future increase in production will have to come from greater output per hectare of land, ie higher yields.
Yields per hectare are positively related not only to natural resources such as good quality soil, adequate amounts of water and favourable climate conditions but also to the use of energy, fertilisers and crop protection products. The price of fertilisers is closely related to the price of energy and given that all forecasters expect energy prices to continue rising in the foreseeable future, farmers will be under pressure to ensure they maximise their efficient use of fertilisers. To complicate matters the global stresses on available fresh water are increasing. According to the Chatham House Report, overall usage currently stands at 54 per cent of the world’s freshwater supply but it goes on to point out that ‘... if per capita consumption rises across the globe at the rate seen within developed countries this could increase to 90 per cent by 2025’.

The rising cost of achieving higher yields together with the threats posed by climate change bring into sharper focus the contribution of synthetic PPPs. Agriculture is extremely vulnerable to climate change. Rising temperatures and changes in rainfall patterns have direct effects on crop yields, as well as indirect effects through changes in water availability. Higher temperatures reduce crop yields while encouraging weed and pest proliferation. It follows that in the coming years farmers will need to adapt to the consequences of climate change and this will involve a number of changes such as: sowing dates to avoid excessive heat stress in the summer; new crop varieties better suited to warmer temperatures and increased water stresses; as well as increasing use of conservation tillage. Crop protection will have a vital role to play in countering the effects of climate change and safeguarding crops, vegetables and grasses against the increased competition from weeds, animal pests, pathogens and viruses.
The main purpose of the original Chatham House report was to explore the implications of what it viewed as a growing threat to global food security. The report’s executive summary warned that ‘….. Over the next few decades, the global food system will come under renewed pressure ….. and if action is not taken, there is a real potential for demand growth to outstrip increases in global food production.’ And most significantly the report went on to state ‘….. the UK can no longer afford to take its food supply for granted’. A food system under pressure means higher food prices and one of the major challenges facing the world - arguably the most fundamental of challenges - is to be able to meet its growing demand for food at affordable prices. In developed countries such as the UK and EU, higher food prices create pressures on disposable incomes with adverse effects for other sectors of the economy. In developing countries higher food prices will threaten the pace of development and in the world’s poorest countries they will lead to hunger and malnutrition.

The growing threat to the world’s food system is echoed by the Royal Society whose investigation of these threats noted ‘….. It is now clear that global food insecurity is a chronic problem that is set to worsen …. Addressing [this problem] requires action on many fronts …... there is a need to build resilient global agricultural systems for the next 40 years … [and these systems] need to be underpinned by science and technology, as has been the case for the last 150 years’. In essence, the challenge is to greatly increase the productivity of agriculture but in a manner that is sustainable. That is, not only will farmers have to increase the output they get from each hectare of land but also they will have to achieve this by using less water and energy per unit of output.

In the view of the Royal Society the world needs a new Green Revolution involving scientific and technical advances that can deliver higher yielding plant and animal varieties that can reach their potential while reducing demands on the world’s resources. The Royal Society describes this as sustainable intensification. Key to the success of the first Green Revolution was improved crop management systems based on high-yielding crops whose potential was delivered with the aid of chemical fertilisers and synthetic PPPs. In response world food production more than doubled over the 40 years to 2000. One consequence of the success of the Green Revolution has been a trend in crop production towards a limited number of crop species and today three crops, wheat, maize and rice, are the primary sources for human nutrition worldwide and account for 40 per cent of global crop land.
More specialised agro-ecosystems are more vulnerable to weeds, pests and diseases and one influential study has estimated that the potential losses worldwide from pests varies from 50 per cent for wheat to more than 80 per cent for sugar beet. The same study concluded that ‘… the intensification of crop production necessary to meet the increasing demand [for food] through enhanced productivity per unit area might be impossible without a concomitant intensification of pest control.’

The value of synthetic PPPs can only properly be assessed when set against the challenges facing the world’s food system. The challenge is a global one, and will require developing countries to make a much enhanced contribution towards feeding themselves in the future. But realistically, developed nations including all members of the EU are going to have a major role to play in feeding the world and they will only be able to do this with the aid of continued advancement in the science and technologies associated with farming, together with freer trade policies. Put simply, the UK and EU food and farming industries will become increasingly important players in the global food industry and it is against this background that we need to place an assessment of the value of crop protection.

This brief overview has explained the importance of the efficient growth of agricultural productivity across the world if future populations are to be adequately fed. The message is very clear; synthetic PPPs will be an essential part of the agricultural systems that rise to the challenge. And although developing countries will need to contribute most to the increase in global food demand in the coming years, the world’s advanced agricultural industries will also have a vital role. In the first instance the EU and other developed regions of the world can improve their own food security and place less demands on the rest of the world by increasing agricultural production. The more successful they are in this respect the more they can contribute to the food needs of developing nations. To demonstrate the importance of synthetic PPPs in helping agricultural industries rise to the challenge of global food security we now turn to an economic analysis of the total value of synthetic PPPs.
Valuing the Benefits

THE STANDARD METHODOLOGY FOR ASSESSING THE BENEFIT THAT AN INDUSTRY DELIVERS IS BASED ON AN ESTIMATE OF ITS DIRECT ECONOMIC CONTRIBUTION USING THE CONCEPT OF GROSS VALUE ADDED (GVA).

In essence this is the difference between the value of sales plus output stocks less the value of intermediate inputs, ie the value of inputs purchased from other sectors of the economy. Viewed in another way, GVA comprises the value of wages and salaries, profits, and depreciation accounted for by an industry. This approach is set out in Figure 3 showing the composition of the UK food chain's GVA.

The data set out in Figure 3 are the most recently published and relate to the year 2008. In that year the UK agri-food sector (excluding fishing and fish farming) accounted for a total GVA of almost £85.6 billion or 6.7 per cent of national GVA. Some 3.7 million full and part-time jobs are created by the agri-food sector (including food retailing and catering) which in 2008 amounted to 12.6 per cent of total employment. The latest data show that consumers spent some £174 billion on food and drink and within this total, expenditure on food and non-alcoholic drinks accounted for £131.5 billion: a little more than 15 per cent of total consumers’ expenditure. If attention is confined to food consumed within the home the comparative figures are £81.7 billion and 9.4 per cent respectively.

Figure 3
The UK Food Chain

Source: Defra\textsuperscript{10} - figures relate to the year 2008
Not surprisingly the picture for the EU as a whole is very similar. In 2008 some 15 per cent of the EU’s GDP and 20 per cent of its employment was based on the production of food. There are some 11 million people engaged in agricultural production across the EU, 531,000 of whom are located in the UK. In 2008 EU consumers spent 12 per cent of their disposable personal income on food consumed in the home, to which must be added the 6 per cent that is spent on food consumed outside the home.

The approach set out in Figure 3 is perfectly acceptable if one is attempting a snapshot measure as to how much an individual industry contributes to a country’s GDP but it is grossly deficient if we are attempting to measure the full contribution that a vital industry such as agriculture makes to the quality of living. The positive benefits of agriculture go way beyond its direct contribution to the national economy, eg GVA and employment. These additional benefits are difficult to measure in the conventional sense of providing a numerical value but they are none the less of real value. To better understand the real or full contribution that a diverse, highly productive and competitive agricultural industry makes it is necessary to take into account the wider social and environmental benefits; for example, the value of a plentiful, stable and secure supply of blemish free, affordable food. For households it removes the stress associated with the fear of hunger and it ensures the ability to deliver a healthy and nutritious diet.

We can start our investigation of the total value delivered by synthetic PPPs with the simplified food chain set out in Figure 4. The figure reflects the reality that agricultural production lies at the heart of the food chain. Relative to the food chain’s needs, the lower the quantity of agricultural production from domestic suppliers the greater the volume of raw material that food processors and food manufacturers would need to import. But in fact in this situation the food processing and manufacturing sector would be very much smaller - thereby depriving the country of substantial employment and economic activity - as food retailers and caterers would source many of their food products directly from overseas suppliers. We can be confident that this would be the case as only food processors and manufacturers located alongside their sources of raw materials are likely to have direct dealings with farmers and are therefore in a better position to offer the security and transparency that is required in a modern food chain.

Thus, in addition to the loss of employment and economic activity, the country would suffer a serious deterioration in its trade balance with wider consequences for the economy. Our focus is PPPs and as will be demonstrated below in their absence both the supply and quality of agricultural produce would decline. It would not be possible to make up the shortfall with imports as across the world agricultural industries would be grappling with the same problems resulting in significantly reduced supplies and much higher food commodity prices. Thus, UK consumers along with their EU counterparts would be faced with the stress of much higher food prices and the problems associated with a less nutritious diet.
A modern, productive agricultural industry could not exist in the absence of sufficient and stable supplies of the key inputs shown in Figure 4. Indeed, modern agricultural systems are so integrated that the loss of any one of the key inputs would reduce the effectiveness of the others resulting in a substantial loss of agricultural productivity. This in turn would lower not only the efficiency of agriculture but also – as we will explore below - the efficiency of the food chain. Thus, the value of the economic activity involved in producing, for example, the fertilisers and PPPs needed by the agricultural industry is much greater than the measured GVA of their industries.

Again, the farming industry might be able to import sufficient quantities of the key inputs shown in Figure 4 and, indeed, both the UK and the EU agricultural industries import much of their energy needs. But, providing a country is capable of competitively producing the inputs required by its agricultural industry it is very much to the advantage of the country that it does so. Not only does domestic production generate employment and economic activity, but it also reduces pressure on the trade balance, improves the security of the nation’s food supply and creates opportunities to develop new knowledge in areas that are going to be vital to the world in meeting its future food demands.

An intuitive and practical way to assess the true value of synthetic PPPs is to estimate the impact on the food chain and more widely if the industry ceased to exist. That is, what would be the additional cost borne by farmers, food processors and manufacturers, retailers, consumers and the wider economy if the farming industry could no longer obtain synthetic PPPs? It would be disingenuous to claim that an estimate of the cost could be anything other than an approximation. Arguably, the process of calculating the costs, if transparent, is itself of greater value as it will reveal the scope of the total contribution. Such a calculation can only be made on the basis of many assumptions but if these are made clear it affords readers the opportunity to make their own judgement.
Crop Protection

We start our calculation with the PPP industry. In 2008, the UK crop protection industry accounted for some £60 million (7 per cent) of the £826 million GVA generated by the agricultural supply industries (see Figure 3). In 2009 the UK agricultural industry purchased £674 million worth of PPPs - approximately 6 per cent of its total expenditure on intermediate inputs. As can be seen from Figure 5, up to 1997 there was steady growth in the volume, value and unit price of PPPs. All three series then declined somewhat coinciding with a Common Agricultural Policy (CAP) that switched from encouraging production to a policy focussed on limiting production. It is significant that all three series recovered to their 1997 levels in 2009 following the dramatic rise in grain prices in 2008. The data shown are aggregated and therefore do not reveal variations between sectors. On a per hectare basis horticultural crops receive higher weights than arable crops and grasses receive relatively little. However, the area of arable crops at 4.5 million hectares is some 26 times the area of horticultural crops resulting in approximately 80 per cent of the total PPPs (by weight) being applied to arable crops and almost half to cereals.

If the synthetic PPP industry ceased to exist there would be a direct loss of £60 million GVA to the UK economy and by implication a loss of some £570 million to the EU economy where the value of PPP is estimated at £6.5 billion. In addition to the loss of GVA there would be a large loss of jobs across the EU - of the order of 75,000 - and the trade balance would suffer from the loss of exports of PPPs. In the absence of synthetic PPPs farmers would have to rely on measures such as rotations, variety selection and mechanical cultivations for crop protection. Organic PPPs would also be used, for example, Rotenone and Pyrethrin and production of these less efficient products would be expanded. That said, the supply of organic PPPs would only make up a small fraction of the volume of synthetic PPPs currently used. This follows because organic PPPs are significantly less effective than synthetic PPPs and many would not meet the exacting standards now in place for PPPs across the EU. But the loss of efficiency and competitiveness for businesses growing and storing agricultural produce would not be the only cost they would bear in the absence of synthetic PPPs.

Figure 5
Crop Protection Trends

Index
(2000=100)

Source: Defra
The PPP sector is an important part of the economically vital chemical industry whose EU sales currently exceed €500 billion. It is impossible to imagine a modern, productive economy without the contribution of the chemical industry. The synthetic PPPs sector, like the chemical industry of which it is part, is a powerful catalyst for change and progress. The science of modern chemistry has proven a formidable force for the economic prosperity and quality of life. On this basis the true value of the industry must include its future contribution; that is the new knowledge and innovation it would foster. The future economic value of the PPPs industry is potentially very large but impossible to measure with any precision. An indication of the potential value is provided by the PPPs sector’s contribution to the Green Revolution, a revolution that has improved the quality of life for the world’s population and saved countless millions from starvation and malnutrition. As set out in the first section, the world now needs a new Green Revolution and PPPs will, as recognised by the Royal Society, have an important future role in helping the world’s food industry meet the challenge of feeding a rising and increasingly affluent global population. The role of PPPs in protecting crop yields from biotic and abiotic stress, making them more resistant to disease and weeds as well as maximising the energy they draw from the sun and the water and moisture they receive will be vital if the world is to adequately feed its population. The value of synthetic PPPs when viewed from this dynamic perspective is very large indeed.
Farming

In 2009 some 534,000 people (farmers and farm workers) were engaged in UK agriculture; sales amounted to £21.5 billion and a GVA of £7.7 billion\(^\text{10}\). Comparable figures for the EU reveal some 11.2 million engaged in agriculture, sales of £326 billion and a GVA of £129 billion\(^\text{13}\). While these basic statistics reveal a large and significant industry, as shown in Figure 3 the agricultural industry’s output provides the bulk of the raw materials to support a food chain that in the UK culminates in annual sales of £174 billion.

Cereals - or more correctly grains - lie at the heart of agricultural production. In addition to providing the raw materials for bread, bakery goods, beer and spirits they also provide the bulk of feeds necessary for the production of meat and dairy products. More than 21 million tonnes of animal feeds are consumed by UK agriculture each year and feeds represent the largest item of expenditure recorded in the industry’s accounts. As cereals constitute a high proportion of animal feeds their price has a major influence on the production costs and profitability of meat and dairy production. In common with other EU agricultural industries the UK has greatly increased its production of cereals over the past 65 years from a cereals area that has been declining since the 1980s. This has been made possible by the growth of yields - see Figure 6 - a prime indicator of agricultural productivity. All other factors remaining equal the higher the level of productivity the lower the price of cereals and consequently the lower the price of cereal products, meats, dairy products and the cost of food in general.

As can be seen from Figure 6 the typical UK wheat farm now produces three times more per hectare than was the case in 1945 and while a significant proportion of the gains are due to better management, improved plant varieties and the application of fertiliser, the use of synthetic PPPs has both enabled and protected these gains. Despite the fact that the growth shown in Figure 6 reflects a number of integrated improvements it is instructive to compare the trend in the volume of PPPs utilised by UK farms with the growth of cereal yields. Figure 7 (next page) compares the two trends.

Figure 6
UK Wheat Yields

Yield (t/ha)

Source: Defra\(^\text{10}\)
Wheat accounts for some 40 per cent of the cereals area and it will be recalled that cereals account for almost 50 per cent of the volume of PPPs used. The figure shows a high correlation between the rate of yield growth and usage of PPPs which is not surprising given that much of the observed yield increase can be attributed to greater control of biotic stress rather than an increase in yield potential\(^{14}\). It would however, be incorrect to draw any definitive conclusions from Figure 7 as factors other than PPPs also influence the growth of yields; however the implied relationship does lend weight to the view that the increasing level of restrictions on PPPs has had an influence on the growth of cereal yields.

We now turn to an assessment of the situation if synthetic PPPs were no longer available to UK farmers. What follows is focussed on UK agriculture but the impact *mutatis mutandis* would be repeated across EU agricultural industries. It is widely accepted that crop yields would be significantly lower in the absence of synthetic PPPs. Research conducted over the past 20 years, mainly by Dr Erich-Christian Oerke and his colleagues at the University of Bonn in Germany, has shown that overall crop yields would be around half their current levels without the use of crop protection products\(^ {15}\). This conclusion is supported by other studies, whether in the form of modelling\(^ {16}\) or actual farm studies such as the 10 year study at Boarded Barns\(^ {17}\). The Boarded Barns study covered all aspects of conventional and organic farming and routinely found organic wheat yields to be about 50 per cent of conventional wheat yields. A more recent study by ADAS\(^ {17}\) suggests that the reduction in wheat yields - and implicitly cereal yields in general - would be greater, in excess of 60 per cent. This reduction would result more-or-less equally from the loss of synthetic herbicides and fungicides. The effectiveness of herbicides in controlling weeds would only partly be offset by increased ploughing and labour costs per hectare. And the loss of synthetic fungicides would be to force fungicide-free production techniques on the industry effectively bringing to an end modern cereals farming in the UK and by implication in Europe.
While cereals remain at the heart of agricultural production the loss of synthetic PPPs would adversely impact the yields of all arable crops, vegetables, fruit and grasses. For example, the same ADAS study raised the very serious threat to the potato crop if it was not possible to employ synthetic PPPs to counter disease. Potato blight continues to be a major threat to potato production and in the expert opinion of ADAS the loss of key substances for dealing with blight could result in yield reductions of up to 45 per cent which would be compounded by a higher rate of rot in storage. Fruit and vegetable yields, particularly brassicas, are extremely vulnerable to disease and pests and in the absence of synthetic PPPs yields could fall significantly more than 50 per cent. We will return to the health implications of this later.

We have, for the reasons set out previously, concentrated on the reduction in crop yields but the loss of synthetic PPPs would also have a direct impact on grasses. The loss of clover safe herbicides alongside broadleaved weed herbicides would significantly reduce the productivity of grass and the loss of synthetic fungicides would result in increased foliar disease in kale.

These examples of the loss of grassland productivity, together with the inevitable reduction in cereal based feed prices, would not only raise the costs of livestock and dairy production but also make unviable many of the farms that currently produce these products.
The major effect of the reduction in yields, which would take place across the EU, would be a substantial rise in the prices of agricultural products. It might seem that a good starting point would be current farm gate prices for organic produce - see Table 1. But recession and the fragile recovery have reduced demand for more expensive organic produce and consequently farm-gate organic price premiums have been reduced. Moreover, organic products have to compete with lower priced, conventionally produced products. Furthermore, the majority of organic crops are grown by specialist producers who might reasonably be expected to achieve higher yields than would be the case if they were grown more generally and incidentally is the reason why it is difficult to obtain a wider range of comparative data than set out in Table 1.

The data presented in Table 1 suggest an average increase in crop prices of at least 100 per cent would not be an unreasonable estimate. A rise of this order naturally raises the question as to whether the area growing crops would increase to make up the shortfall or whether customers would switch to imports to meet their needs. In reality the scope to increase the cropping area is limited. Currently the UK cereals area is slightly in excess of 3.1 million hectares compared to just over 4 million 25 years ago. In the interim a lot of agricultural land has been lost to development and in order to return to 4 million hectares - an increase of 29 per cent and a long way short of the 100 per cent necessary to offset a 50 per cent fall in yields - it would be necessary to take land from other crops, eg oilseeds and grasses. Moreover, with the doubling of cereal prices it is unlikely that land used for grazing would be so easily given up (of which more below) and the establishment of markets for other arable crops over the past quarter century combined with the fall in yields for these crops means that they would be competing with cereals for land.

If the scope to make up the shortfall by increasing the cereals area is severely constrained would imports be capable of meeting the UK’s demand for cereals? The straight answer is no. The EU would be suffering a similar fall in the output of crops and across the world grain production would be significantly lower. It follows that the prices of imports would rise sharply and to the extent that demand continued to outstrip supply so prices would be driven higher. At a global level some of the loss of yields would be offset by bringing more land into agricultural production but much of it at great cost to biodiversity and natural resources, eg deforestation. In short, not only would imports not be able to make up the shortfall, but the rise in global grain prices would, on the basis of past experience, more than double. We can therefore add the increase in the prices of imports to the reasons set out in introducing Table 1 as to why the rise in crop prices would be higher than 100 per cent.

Table 1
Comparative Conventional and Organic Yields and Prices

<table>
<thead>
<tr>
<th></th>
<th>CONVENTIONAL</th>
<th>ORGANIC</th>
<th>%DIFFERENCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>WINTER WHEAT</td>
<td>Yields (tonnes per ha) 8.2</td>
<td>4.35</td>
<td>−47.0</td>
</tr>
<tr>
<td></td>
<td>Prices (£ per tonne) 135.0</td>
<td>260.0</td>
<td>93.0</td>
</tr>
<tr>
<td>WINTER BEANS</td>
<td>Yields (tonnes per ha) 3.95</td>
<td>3.10</td>
<td>−22.0</td>
</tr>
<tr>
<td></td>
<td>Prices (£ per tonne) 130.0</td>
<td>275.0</td>
<td>112.0</td>
</tr>
<tr>
<td>WARE POTATOES</td>
<td>Yields (tonnes per ha) 47.0</td>
<td>25.0</td>
<td>−47.0</td>
</tr>
<tr>
<td></td>
<td>Prices (£ per tonne) 95.0</td>
<td>350.0</td>
<td>268.0</td>
</tr>
</tbody>
</table>

Source: ABC21
This conclusion is reinforced by three additional considerations. At the industry level the effect of lower yields will be compounded by a reduction in the area devoted to specific crops because in the absence of modern inputs to control weeds, fungus and disease land would need to be left fallow or sown to grasses and legumes. The fall in global production that this implies would be compounded by the loss on some farms of their entire crops to disease or pests and in any event output would be reduced by post-harvest losses because synthetic PPPs are the cheapest and most efficient protective strategy for stored crops. And finally, many farms in developed countries would find it impossible to recruit the labour they would need to control weeds in the absence of synthetic PPPs. In an era of greater controls on migrant labour, even with a rise of 100 per cent in crop prices, farms would struggle to recruit and pay for the increased labour they would need. In many cases it would not be profitable to continue farming. It is therefore reasonable to conclude that the supply of crops from domestic sources is likely to fall by more than the average 50 per cent fall in yields and consequently farm-gate prices for arable crops, fruit and vegetables would rise even further than indicated by Table 1.
Turning to meat and dairy prices, we would expect the average increase in farm-gate prices to be lower than the increase in cereal prices as feed costs only amount to a proportion of total costs on livestock farms. However, in addition to the higher prices of bought in feed, grazing livestock farms would suffer the higher costs associated with the loss of relatively cheap and efficient means of controlling the major weeds, pests and diseases that affect grass and forage crops. According to one study organically produced milk receives an average premium of 20 per cent while average farm-gate prices for organic beef and pork exceed conventional prices by 30 and 45 per cent respectively. These relative prices are given support by the data set out in Figure 8 which shows how farm-gate prices for meat moved following the rise in cereal prices in 2007.

Overall UK farm-gate prices for meat are now some 25 per cent higher than in 2006 but it does not follow that price increases of this order would be sufficient to offset the higher costs of purchased feedstuffs. As shown in Figure 8 the peak increase in cereal prices only lasted a few weeks, whereas it would be permanent under the scenario of no PPPs. Apart from the implied permanent doubling of feed costs, there would be additional costs for livestock and livestock product farms.

Currently the UK produces some 20 million tonnes of cereals, of which approximately half goes for animal feed. If we make the simplifying but not unreasonable assumption that cereal farmers would seek to sell to consumer markets rather than feed markets, livestock producers would be forced to import animal feeds to offset what would be a severe decline in availability from domestic sources.

But, as explained above imports would also be in short supply and priced accordingly. The UK currently has net-cereals exports of less than one million tonnes so up to nine million tonnes of cereals would need to be imported to make up the shortfall; that is imports of cereals would more than treble. It must be doubted if such a shortfall could be made up - remember both EU and global supplies would be lower - and consequently many livestock enterprises would need to downscale or cease production with the effect that livestock prices would increase to reflect the lower production. It is beyond the scope of this report to attempt a comprehensive estimate of the rise in the prices of livestock and livestock products but merely incorporating a 100 per cent rise in feed costs into livestock prices would raise them by more than 40 per cent.

On the basis of the foregoing it would be reasonable to conclude that in the
absence of synthetic PPPs farm-gate prices for arable crops, fruit and vegetables would be of the order of 100 per cent higher and the farm-gate prices of meat and dairy products would be around 50 per cent higher. This would represent - in the absence of any mark-up between the farm gate and first hand processors - an additional cost of some £12 billion per year, i.e. 66 per cent, to buyers of UK agricultural produce and there would be a pro rata increase for buyers of EU agricultural produce. But in fact this would be an underestimate of the additional costs because UK agriculture (and by implication EU agriculture) would be supplying a lower volume of output: at least a 50 per cent reduction for arable crops and a smaller but significant reduction for meat and meat products. We will return to this issue in the next section.

We have indicated above that in the absence of synthetic PPPs farm businesses would need to spend more on labour. But this raises another complication in an advanced economy. A major benefit of synthetic PPPs is the removal from farm systems of the ‘back-breaking’ drudgery associated with hand weeding. In this respect not only do synthetic PPPs contribute to a higher quality of life for farmers and their workforces, but they also counter what would otherwise be a shortage of farm workers willing to take on such jobs. We have observed above that in the absence of PPPs the shortage of labour would force many farms to cease production. We should now add that for surviving farms the quality of work would diminish and although difficult to quantify this represents another cost that would have to be borne in the absence of PPPs.

The foregoing has dealt with the farm-level economic costs associated with the absence of synthetic PPPs. But there would be wider, indirect costs if farmers did not have access to synthetic PPPs. Effective control of pests is a positive externality for other farmers, and reduced control at the farm level would impact farms across a wider area reducing output and incurring costs. A further indirect advantage of PPPs is the benefit that arises from greater protection and conservation on the countryside.

Higher yields, as noted above, in part the product of the efficient use of synthetic PPPs, reduce the pressures on farmers to cultivate un-cropped land delivering to society a greater benefit of biodiversity, woodlands and wild flower meadows than could be delivered by less productive farming. The opportunities afforded by herbicides to reduce mechanical cultivation on modern, larger scale farms have the much wider global benefit of reducing greenhouse gas emissions, as well as reducing the risk of soil erosion on sloping land and minimising moisture loss from soil surfaces. It is very difficult to put a monetary value on these benefits but this does not deny their existence nor their importance.
Food Processors and Manufacturers

As primary customers for the output of the farming industry, the efficiency and competitiveness of the giant food processing and manufacturing industry would be adversely affected in the absence of synthetic PPPs. We have demonstrated that the industry’s raw material prices would rise markedly: by some 66 per cent overall but more than 100 per cent for crops, vegetables and fruit. This would be compounded by the heightened risks associated with greater dependency on imports and more variable supplies - both in terms of volumes and quality. Greater instability in the supply of agricultural produce to food processors and manufacturers is an additional cost, impacting a wide range of activities from the writing of contracts to the raising of funds for investment and working capital.

The processing and manufacture of the agricultural sector’s output into food products and animal feeds constitutes the UK’s largest manufacturing sector, generating a turnover of some £74 billion and a GVA of £22.7 billion, amounting to 14 per cent of the UK’s manufacturing GVA. The industry directly employs 392,000 people and comprises 6,745 enterprises. As shown in Figure 3, the food processing and manufacturing industry is central to the UK food chain. It purchases three quarters of agriculture’s £19.9 billion of output and it exports products to the value of £13.2 billion. Indirectly the industry supports the vast majority of the 47,000 jobs in the sectors supplying its needs for non-agricultural inputs and distributing agricultural products - see Figure 3 - as well as the £2.3 billion GVA generated by these sectors. As in the UK, food processing and manufacture is the EU’s largest manufacturing sector accounting for: 12.9 per cent of the Union’s value added - ahead of the automobile and chemical sectors; 13.5 per cent of its employment - 4.4 million people, 310,000 businesses; and exports of €58.2 billion.

The size of the food processing and manufacturing sector has a strategic economic role that goes beyond the supply of food. In the UK, food processing and manufacture is particularly important to regional economies. For example, it represents 34 and 23 per cent of the manufacturing GVA in Northern Ireland and Scotland respectively and provides more than 20 per cent of manufacturing jobs in these regions, as well as more than 15 per cent in several other regions. This strength in regional employment is reinforced by a strong UK focus. Despite the trend over recent years for manufacturers to off-shore some of their activities, a recent survey of food processors and manufacturers revealed that two thirds retain over 75 per cent of their production and design functions in the UK and almost 80 per cent retain their R&D functions in the UK. Indeed, the sector is a core contributor to the R&D carried out by UK companies. According to the 2009 R&D Scoreboard, UK food producers and manufacturers spent £1.13 billion on R&D.

For food processors and manufacturers the main consequence of farmers being denied modern synthetic PPPs would be to greatly increase the costs and risks associated with its supply of raw materials. Support for the link between a rise in the price of cereals and food processors’ and manufacturers’ costs is set out in Figure 9. It shows a high correlation between the rise in the price of milling wheat in 2007 and the prices paid by food processors and manufacturers for their raw materials. Of course, food producers’ input prices reflect not only the prices of agricultural products and the increase was also influenced by rising oil prices and a fall in the value of sterling, but by far the biggest effect was the rise in agricultural prices.

The index of food processors’ and manufacturers’ input prices shown in Figure 9 includes both food and non-food inputs but as indicated above if attention is confined to agricultural produce then the permanent increase would be of the order of 66 per cent. As explained above, the effect of this increase would be to raise the costs to purchasers of UK agricultural produce by £13 billion of which some £10 billion would be borne by food processors and manufacturers. However, alongside this rise in costs buyers would face an overall reduction in excess of 50 per cent in the supply of arable crops, fruit and vegetables from domestic sources and a smaller, but significant decline in the supply of meat and dairy products.
In the UK and across the EU food processors and manufacturers would seek to replace the reduced supplies from domestic farms with imports, but this would be subject to availability and price. Since the world supply of grains would be significantly reduced in the absence of synthetic PPPs, prices of imports would respond accordingly. A reasonable assumption would be that the imported prices of agricultural produce would also rise by an average of two thirds.

Currently the UK imports some £20.9 billion of unprocessed and lightly processed products most, if not all, of which go to the food processing and manufacturing sector. If we apply an average price increase of 66 per cent to these imports the import bill would rise by about £14 billion but this assumes the same volumes would be imported. As explained above, the volume of cereal imports would need to double to make up the shortfall in domestic production and imports of other arable crops, meat and meat products would also need to rise sharply. That is, in addition to the effect of paying higher prices for current volumes of imported foodstuffs, food processors and manufacturers would also face the additional costs of purchasing increased volumes of imports that in turn would be subject to the higher prices outlined above. The higher prices of agricultural produce would be reflected in consumer prices and this would ensure that not all of the shortfall in domestic production would need to be made up as higher food prices - of which more below - would constrain overall food consumption.

If we assume the volume of imports of arable crops and vegetables rises by 75 per cent and meat and meat products by a third the total increase in food processors’ and manufacturers’ costs of agricultural produce would not be £14 billion but of the order of £25 billion. That is after taking into account the additional £10 billion paid to domestic producers, UK food processors and manufacturers would suffer an increase in raw material costs of some £35 billion and if we allow for wholesaling and distributors margins then the total increase would be at least £40 billion. To put this increase in perspective, UK food processors and manufacturers currently spend £52 billion on purchased inputs, so in round terms their input costs would rise by 75 per cent in the absence of PPPs.
The estimated rise of £40 billion in food processors’ and manufacturers’ costs would not be the only cost associated with the absence of PPPs. The much greater reliance on imports would represent a substantial increase in the volatility and insecurity of raw materials. Put simply, the efficiency and economic sustainability of UK food processing and manufacturing would suffer a severe deterioration with knock-on effects for enterprises and employment. Overall many enterprises, particularly smaller, medium-sized enterprises, would find the shortfall and additional cost of raw materials too great a burden and cease trading. This loss of businesses would impact on the sectors that supply food processors and manufacturers with their non-agricultural inputs and fixed capital, further increasing the loss of businesses and livelihoods. By applying the employment multiplier, for every two jobs lost in the food processing and manufacturing industry, another one would be lost elsewhere in the economy and as noted above there would be a disproportionate loss in the regions. This rise in costs and associated loss of employment and economic activity would be repeated across the EU but it is beyond the scope of this report to provide an estimate.

The higher costs of food production, the increased cost of imports and the loss of employment amount to a significant cost to society. We will take a closer look at the impact on society of these adverse effects in the next section but again we should not overlook a potential, additional cost going forward; namely, the effect of a decline in the economic performance of food processors and manufacturers. Figure 10 summarises these dynamic benefits. Profitable food processors and manufacturers, with access to a plentiful supply of good quality agricultural products, are in the best position to ensure for their customers a secure and affordable supply of food products, healthy choices, transparency and safety. A profitable industry is good for employment as well as pay and conditions. A key longer term benefit is the relationship between a profitable industry and expenditure on R&D. All industries rely on invention and innovation to maintain competitiveness as well as delivering to society higher value products. Figure 10 attempts to summarise these wider benefits, all of which would be threatened in the absence of PPPs.
Consumers
In the UK, household expenditure on food and non-alcoholic beverages accounts for some 10 per cent of total consumers’ expenditure; a little lower than the average of 14 per cent for the EU as a whole. In addition, consumers in both the UK and EU spend a further 5 per cent on meals outside the home. Figures 8 and 9 showed the effect of a 100 per cent rise in the price of cereals on the average price of meat and food processors’ and manufacturers’ input prices respectively. As would be expected, there would be a further knock-on effect to retail food prices as shown in Figure 11.

As can be seen in Figure 11, a 100 per cent rise in the price of cereals as it fed through the livestock sectors translated to retail food price inflation that peaked at almost 14 per cent in 2008 and over the period since 2006 has resulted in an overall increase in retail food prices of 25 per cent. Currently UK households spend some £174 billion on food and drink, and a 24 per cent increase in average prices would amount to an increase of £44 billion. Significant as this rise is, it represents a smaller increase than would arise in the absence of PPPs. We have estimated above that in the absence of synthetic PPPs some £40 billion would be added to food processors’ and manufactures’ costs.

But in addition retailers and caterers directly import £11 billion of foodstuffs and approximately 25 per cent of agricultural output is sold directly to retailers, caterers and consumers. The higher costs of direct imports and direct sales would add at least another £10 billion to food costs and after allowing for distributors’, caterers’ and retailers’ added values the total increase in the cost of food and drink at the level of consumers would be at least of the order of £70 billion. That is, the price of food and drinks for the average UK household would rise by 40 per cent and in broad terms this order of increase would be repeated across Europe.

Figure 11
Retail Food and Cereal Price Increases

Source: ONS and HGCA
The data set out in Figure 12 show that for three years after 2006, retail food prices rose at a faster rate than consumer prices in general. This relative increase was in marked contrast to previous years. Indeed, over the past quarter of a century the annual increase in retail food prices has been less than the annual increase in consumer prices generally. There are many reasons for this superior performance of retail food prices - not least the highly efficient food chain - but to a very large extent it is due to the decline in farm-gate prices. As ever there were a number of factors at work - including various reforms of the CAP - but the performance of farm-gate prices is due in large measure to the cost benefits of modern farming systems and as explained above, PPPs are central to the delivery of these benefits.

Figure 12 is important because it indicates the dynamic benefits of low food prices. If over the period shown agricultural prices had increased at the same rate as prices generally then the ability of households to reduce the proportion of their incomes devoted to food would have been constrained. The fact that food has become more affordable means that households have been able to direct expenditure to other sectors of the economy. This has had two significant benefits. First, it has created scope for new businesses and employment and second it has widened consumer choice and hence the standard of living.

**Figure 12**
**Relative Price Performance**

![Relative Price Performance Chart]

Index

- Retail food price index
- Consumer price index
- UK farm-gate cereal price

Source: Defra
These benefits have to a significant extent been made possible by PPPs. Another way of attempting to place in perspective the loss of value if PPPs did not exist is to compare the annual increase of some £70 billion in food costs with the UK Government’s recently announced spending cuts. In real terms the £70 billion is approximately double the annual effect of the government’s cuts.

We can think of the estimated £70 billion additional cost of food as representing part of the value - but as we shall see not the full value - of PPPs to the UK economy, and by implication this benefit can be pro rated for the EU. This sum represents the annual benefits of a modern, productive farming industry to the UK. Critics of such farming enterprises frequently claim that such systems produce food that is not as healthy as that produced by organic farming systems. However, a systematic review of the available published literature by six academics for the Food Standards Agency concluded ‘… There is currently no independent authoritative statement on differences in the putative health effects of organic and conventional produced foodstuffs.’ And in plain English the report went on to say ‘… there is currently no evidence of a health benefit from consuming organic compared to conventionally produced foodstuffs.’ It might further be observed that the lower prices associated with modern, productive farming mean that it is cheaper for a household to eat a healthy diet.

In 1990, the World Health Organization recommended that everyone consume at least five portions of fruit or vegetables per person per day due to their nutritional and health benefits. The advice has formed a central plank of public health campaigns in many developed countries and it has been officially promoted by the UK Government since 2003. The recommendation is based on population studies that have shown that people who eat a lot of fruit and vegetables may have a lower risk of chronic disease, such as heart disease and some cancers. Unhealthy diets or more precisely the illnesses they cause represent a significant proportion of the disease burden facing the NHS. A doubling of the price of fruit and vegetables in response to lower yields would reduce consumption of fruit and vegetables and it follows that this would result in a less nutritious and healthy diet. It is beyond the scope of this report to attempt to estimate the cost but the evidence supports the view that there would be a cost.
Another very real but very difficult to estimate cost would be the anxiety and loss of choice arising from a much reduced quantity and inferior quality of food. The absence of PPPs would also have wider effects on living standards. One would be some loss of countryside for leisure and recreation as farmers sought to bring into production additional land areas. Some £10 billion is spent by the UK population on rural leisure trips each year and once people reach their destination their main activity is walking. Most rural visits are to National Parks, such as the Lake District and Peak District. It is not clear how protected these parks would be if agricultural productivity declined as indicated in the absence of PPPs, but certainly open access land that is used particularly for walking would suffer some loss with knock-on adverse consequences for the leisure and recreation of many people.

A return to farming systems which exclude the use of PPPs would involve an increase in the cropped area of land and consequently a loss of wildlife habitats. The absence of PPPs would curtail minimal and zero tillage systems with their environmental benefits as farmers returned to ploughing in an attempt to control weeds mechanically, as a result damaging the soil and releasing carbon. Attempts to put monetary values on these benefits are beyond the scope of this report but they nevertheless represent real costs even if they can only be included in qualitative terms.

The value of PPPs for society goes wider than the health and environmental benefits already outlined. In an age of increasingly sedentary jobs, sport and recreation are very important for people’s physical and mental health. PPPs are used to maintain the turf on sports pitches, cricket grounds and golf courses and so help to bring secondary benefits of improved health and fitness, reduced stress, and greater quality of life. Similarly, the PPPs used in domestic gardens enable householders to maintain their plants - edible or ornamental - and protect them from pests and diseases. Gardening is the most popular leisure activity in the UK and PPPs help to facilitate a hugely popular pastime that provides fresh air and exercise for millions of people around the world, contributing to their health, fitness and quality of life.

Figure 13 attempts to summarise in qualitative terms the value to households that to a large extent are dependent on the availability of PPPs. The figure reflects the fact that the benefits are wider than the affordability of food.
Figure 13
Summarising the Benefits for Household

Affordability
- Low prices
- Efficient chain
- Science based
- High quality
- Nutritious diets
- Safety & assurance

Food security
- Adequate supply
- Competition
- New products
- Traceability
- Rural leisure
- Gardening & sport

Living standards
Choice & quality
The Contribution of Research and Development

THIS REPORT HAS ATTEMPTED TO PLACE IN PERSPECTIVE THE TRUE VALUE OF AN EFFICIENT AND DYNAMIC PLANT PROTECTION INDUSTRY. PART OF THIS ANALYSIS HAS BEEN TO DRAW ATTENTION TO THE DYNAMIC BENEFITS OF THE PPPS INDUSTRY; THAT IS, THE BENEFITS OF BRINGING NEW OR IMPROVED PRODUCTS TO MARKET AND THE DEVELOPMENT OF LOWER COST PRODUCTION PROCESSES.

The delivery of these dynamic benefits helps to ensure that the food chain remains efficient and competitive and thereby living standards and food security are protected and steadily improved. Put simply, research and innovation are the foundations of a competitive food industry and a better quality of life. This observation applies as much to the PPPs industry as it does to any other part of the food chain; indeed, as a science based sector it applies even more.

Research and innovation in the plant protection industry is driven by farming and the food chain's demand for greater efficiency, improved competitive performance and safer products. The process begins with the manufacturers of PPPs listening to the strategic needs of their customers and then seeking commercial solutions. The process can be encouraged by government policy and regulatory guidance, but it is a process that is primarily driven by the constantly evolving demands of the market. However, whether or not the process reaches a successful outcome with the delivery of products capable of commercially meeting the market's new demands is to a large extent determined by regulation. It should be a matter of growing concern, not only to the PPPs industry but also to the wider economy and society, that the delivery of new products better able to address emerging food production challenges is being frustrated by a combination of the growing cost of bringing new products to market and excessive regulation.

The search for new and improved products is guided by the need to ensure that PPPs meet modern safety and environmental standards. A new PPP has to meet all of the following criteria:

- high potency against a suitable spectrum of weeds, insects or fungi;
- high selectivity, allowing the compound to be applied at low rates and without affecting non-target organisms;
- chemical and metabolic stability, so that it survives in sunlight on the surface of a leaf, and then during translocation to its biochemical target within the plant, but without being so stable that it persists in the environment.

Before a new PPP can be registered (itself a cost) there are two lengthy and costly stages that a developer must go through: the costs of new discovery; and the costs of developing a commercial product. Research to discover new knowledge involves a number of increasingly complex stages to maximise the likelihood that the potential product meets the three criteria set out above. This costly research programme - normally conducted in the laboratory - holds no guarantee of success; namely, a potential product whose key attribute can be patented, exhibit good toxicological and environmental properties as well as good commercial prospects.

The development stage, again with no guarantee of success, is focussed on realising the commercial prospects. It is likely to involve the cost of building a pilot plant to produce suitable quantities of material for further biological and safety testing as well as guiding the most efficient manufacturing process. The development stage will involve large-scale field trials - the largest item of cost in the process - in order to test the efficacy of the potential product. Most importantly, although some preliminary safety testing will have been undertaken at the research stage, the development programme for a new crop protection product will include substantial toxicology and environmental testing to meet the statutory requirements of the regulatory bodies. A successful product has to generate sufficient profits not only to recoup the costs of its research, development and registration, but also to fund all the unsuccessful research.

The discovery, development and registration of a new product is an expensive process that can last 10 years and, over recent years, the costs have risen markedly. The rise in costs is in large measure due to a substantial rise in the costs associated with the development stage. One study having surveyed leading PPP companies put the increase in development costs between 2000 and 2005-8 at almost 85 per cent bringing the average total cost of the process to $256 million and drew particular attention to a 116 per cent rise in expenditure on field trials. According to the study the ‘...substantial rise in the costs of field trials ... [arises] ... from a need to increase efficacy data both for regulatory bodies and for companies as they set increasingly stringent commercial hurdles in the development process’.
As previously observed the PPP industry is an important contributor to the EU’s capacity for innovation via its research and development. Under-spending on such research could lead to an erosion of the benefits set out above that currently accrue to the EU’s population and indeed populations further afield. Regulation of PPPs in the EU has increased massively in recent years and there must now be the suspicion that the EU errs excessively on the side of caution. The increased cost of compliance with the regulations has created more difficult conditions for the EU PPP industry than is the case in the USA and other countries35.

We have argued above that PPPs lie at the very heart of a competitive food chain and thereby a better quality of life and in this section we have emphasised the importance of the development of new, more efficient PPPs if the world is to meet the challenge of feeding itself in the coming years. In contrast to many EU industries the PPP industry is characterised by high levels of investment in R&D, yet over the last few years, research activity has slowed down, lowering the capacity in Europe to bring new PPPs to the market compared to the United States, and a significant rise in the cost of registration. The development of new technologies is stymied by the belief that new technology necessarily entails new risks and that these new risks cannot be effectively mitigated or managed. From this perspective it would appear that EU crop protection policy has lost sight of the bigger picture. The new EU regulation 1107/09 that will enter fully into force in December 2013 has, as conceded by a senior European Commission official, resulted in a focus on existing products at the expense of the approval of new products over the past two years36.

It is not just 1107/09 that has created difficulties for the development and use of PPPs. The implementation of the Water Framework Directive (WFD) is likely to impact on a number of important crop protection products particularly herbicides. Restrictions and the enforced withdrawal of PPPs that have no close substitutes could make the control of blackgrass and other grass weeds almost impossible. A potential solution could be offered by the further expansion of R&D activities to develop innovative products that are more effective with lower impacts on the environment, but such a solution is compromised by the significant and rising cost of the investment required and the additional uncertainties imposed by the attitude of the relevant EU authorities.

A competitive and innovative PPP sector is not a given. It is the result of an integrated value chain starting with schools and universities, R&D, the manufacturing of base chemicals, intermediates, precursors, materials and consumer products, as well as the development of new applications. Europe must maintain a strong presence in each of the elements of this chain. If one part leaves Europe, the other parts will ultimately move elsewhere as well and innovation will die out. The domino effect along the supply chain will affect the development of new products and applications. In a context of rising energy prices and mounting concerns about the global climate, policymaking on energy and emissions is of particular importance to competitiveness. Climate change is a worldwide challenge and must be addressed on a global scale. The chemical industry is a major consumer of energy and, as a consequence, an emitter of greenhouse gases. But Europe’s chemical industry has a remarkable track record on energy efficiency, and innovative, climate-friendly, chemistry-led applications provide many of the required solutions. This is why any effective policy on energy and climate change must take the chemical industry’s unique role into account.
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