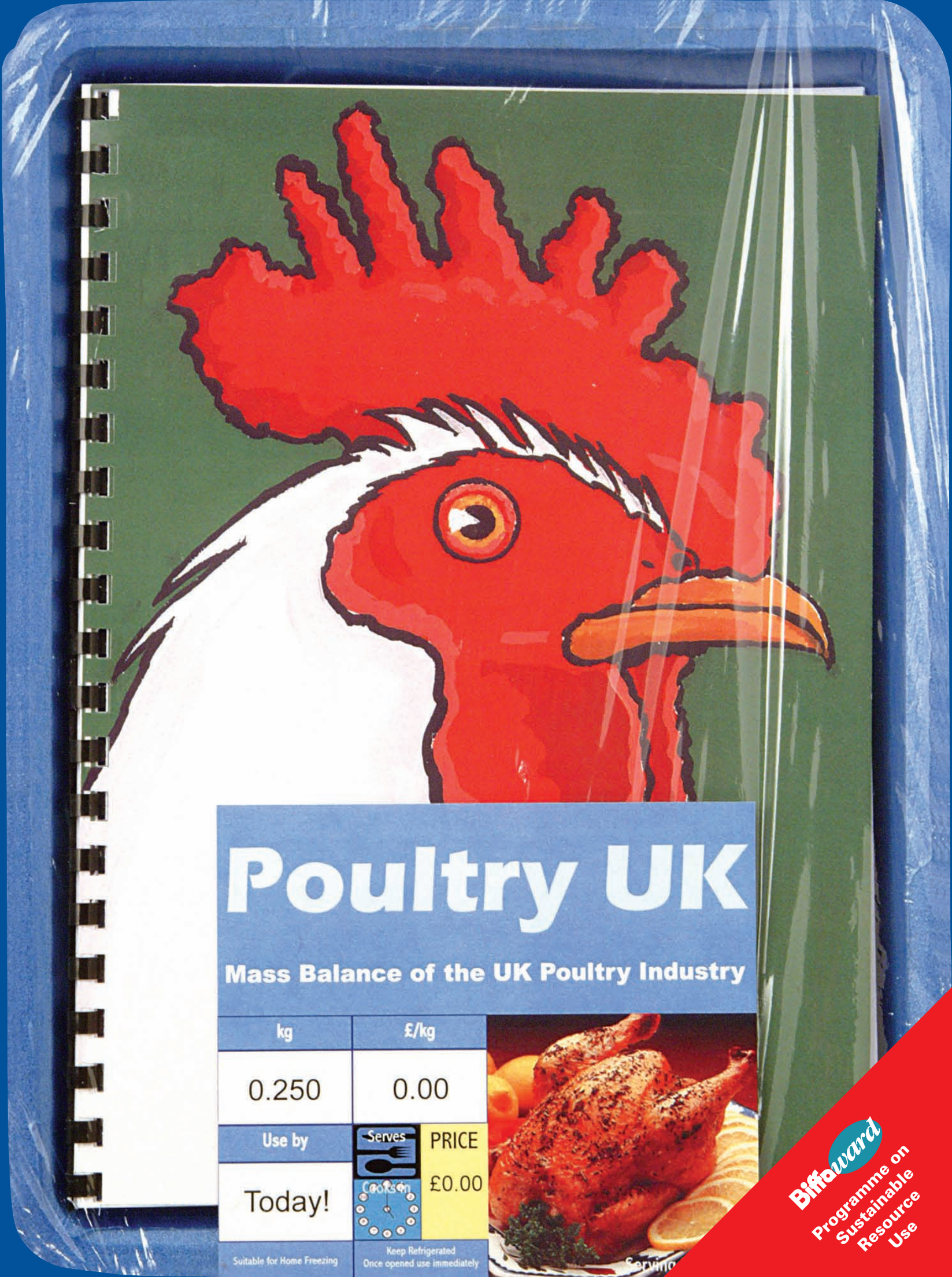

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Programme on
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Biffaward Programme on Sustainable Resource Use

Objectives

This report forms part of the Biffaward Programme on Sustainable Resource Use. The aim of this programme is to provide accessible, well researched information about the flows of different resources through the UK economy, based either singly, or on a combination of regions, material streams or industry sectors.

Background

Information about material resource flows through the UK economy is of fundamental importance to the cost-effective management of resource flows, especially at the stage when the resources become 'waste'.

In order to maximise the Programme's full potential, data will be generated and classified in ways that are both consistent with each other, and with the methodologies of the other generators of resource flow/waste management data. In addition to the projects having their own means of dissemination to their own constituencies, their data and information will be gathered together in a common format to facilitate policy making at corporate, regional and national levels.

Further information on the Programme is available at www.biffaward.org/studies.









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This report was prepared for Biffaward by

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Prior to publishing this report, a draft was issued to Biffaward, the British Poultry Council, the National Farmers Union and members of the Steering Group for review and comment. All comments and recommendations have been taken into account in producing this final report. Without the help and insight of the individuals concerned and the assistance of their companies in making them available, this report would not have been produced. Special thanks are due to the small group that consistently attended meetings and provided assistance and guidance throughout the life of the project.

All care has been taken to ensure the accuracy of the information presented in this report. All of the calculations, information and recommendations in this report have been compiled for the Biffaward Programme on Sustainable resource Use using data provided by independent contributors, and should not be regarded as definitive.

A. Introduction

This report forms part of Biffaward's Sustainable Resource Use Programme, the aim of which is to quantify the flows of primary resources through the UK environmental economy.

The programme will aid the effective management of primary resources by identifying the flows of those resources at material, regional or sectoral levels. The principal goal of this project is to identify opportunities to reduce waste by reduced use, recycling, re-use or recovery.

Within the Programme, data are generated in ways that are consistent between projects and are compatible with other sets of resource flow data. This will enable the information gathered to be made available in a common format to inform policy-makers at corporate, regional and national levels.

In return for providing data for the Programme, the UK Poultry Industry has been provided with an opportunity to establish benchmarks for environmental performance at a variety of levels throughout the supply chain.

The report is divided into four sections. Following this introduction, part B of the report follows the developing UK Poultrymeat industry from its early stages to the present day, looking at scale, structure and ownership of today's industry and the drivers affecting the sector; key legislation is referred to in sector B.5.

Section C covers the mass balance, which aims to quantify resources and energy flows within the sector in 2002. This sector covers feed production, all aspects of farming, processing and rendering, together with the linking transport requirements. The section goes on to use the data gathered for the mass balance to produce an ecological footprint, which provides an indication of natural resource consumption by the sector, and a set of benchmarks to help the industry learn lessons from the data gathered. Section C finishes with a summary of environmental, economic and social issues affecting the sector and anticipates change in these drivers.

The conclusions and recommendations look at ways in which the sector might improve its resource use and so increase competitiveness in the global marketplace.

The information gathered for this report encompasses the three major aspects of mainstream poultry production (chickens, turkeys and ducks), from the production of feed through the breeding and growing of the stock, to the production of jointed meat products and pet food ingredients.

The report will be disseminated throughout the poultry industry and will be made generally available for use in education and policy-making. The report is downloadable from www.racenvironment.co.uk.

It is intended that the project will:

- provide a sound basis for understanding the nature and scale of materials and resource flows through part of the UK agricultural sector; and
- enable the industry to identify any scope for changes in practice that facilitate more sustainable use of resources within the sector.

The study has been funded by Biffaward using landfill tax credits and contributions from members of the Poultry Industry that are acknowledged elsewhere in this report.

B. The UK Poultrymeat Industry

B.1 History

In 1950, the average citizen ate about 750 grams of chicken a year… Fifty years later, the average citizen ate that same quantity every fortnight.

Back in those post-war days there were plenty of chickens but few of them were for eating. Most families had chicken as a once-a-year treat at Christmas or Easter. The bird was, more often than not, a former laying bird: culled if she went broody, carefully steamed for 3 or 4 hours and then finished off as a 'roast' in the oven for an hour.

In the late '40's and early 50's there were birds reared specifically for the table by a relatively small number of farmers (many families had egg-layers….). Dorkings, Orpingtons and other table breeds had been developed in the previous century – these birds grew big and plump – an Orpington could be as big as 4.5 to 6.5 kg – but they grew slowly and were inefficient converters of feed; and that feed was rationed until the early '50's.

The old breeds were not prolific; very few clutches of seven or eight eggs a year would be reckoned a reasonable replacement rate. The system of poultry keeping was extensive – open-air, small flocks, no antibiotics – but nevertheless was prone to serious disease problems. In the years 1947 to 1958, Newcastle disease alone is believed to have killed 2% of the entire UK poultry flock. Leucosis cost a further 6% of the total income of all poultry producers.

In those early days, roast chicken was only for the well-connected, the well-to-do, or those with an accumulation of ration points.

Across the Atlantic, things were changing. Immediately after the War, U.S. companies commenced significant scientific breeding of both chicken and turkey table-bird strains.

By 1955 the new chicken hybrids – based on White Plymouth Rocks – were being taken up on a large scale by the nascent US broiler industry. "Broad-breasted", white-feathered turkeys were introduced to the USA farming scene at about the same time.

Although specialists in the UK began to breed similar chicken strains, none of these home-based breeds could ultimately compete with the U.S. breeding lines.

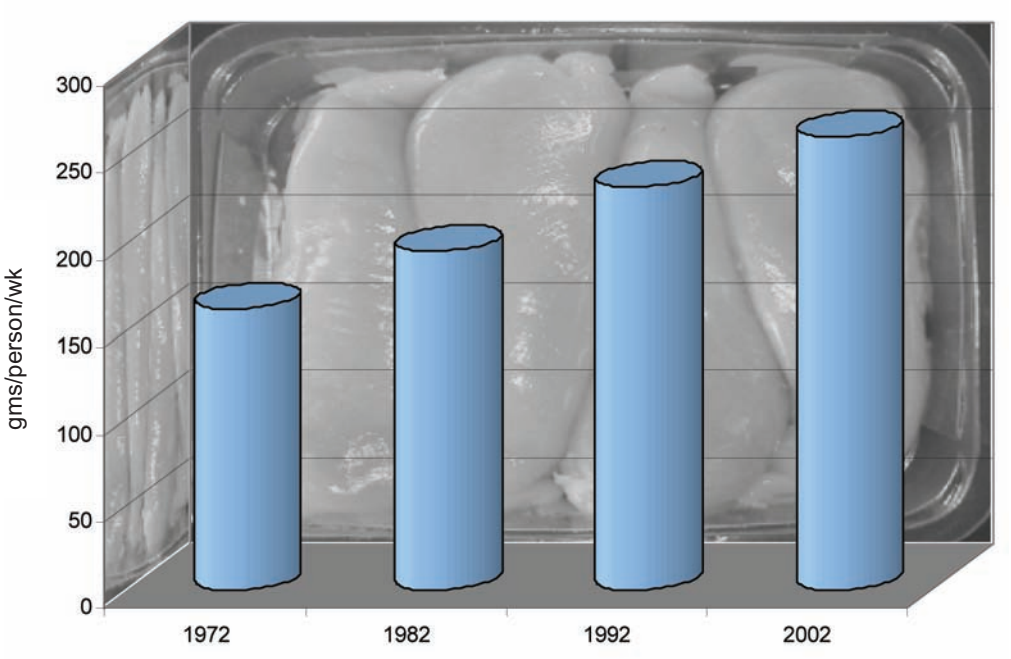


Fig B.1: Increase in chicken consumption over the past 30 years

The improvement in numbers of chicks hatched per parent female reflects significant improvements in fertility and hatching as well as the increasing longevity of parent birds.

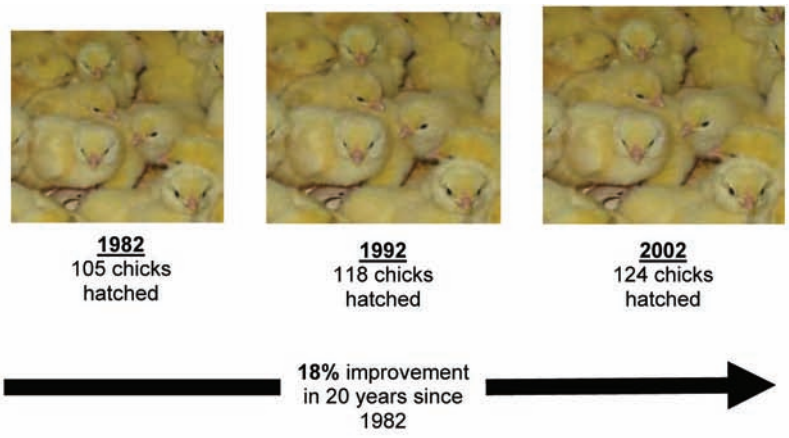
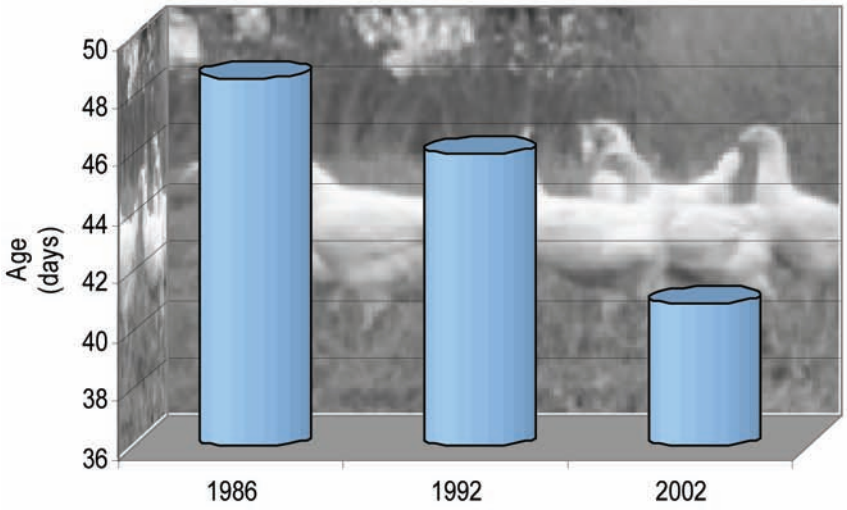


Figure B.2: Number of chicks hatched per parent female



As birds performance has improved, maturity is reached within about 40 days, enabling more flocks to be grown in a year.

Figure B.3: Decreasing Broiler Age

The first Ross lines appeared in 1956 and the Cobb grandparents arrived in Europe in 1959. British turkey companies – by contrast – had established successful commercial breeds by the early '60's and largely withstood US competition. British table ducklings also established their own niche.

Cherry Valley – established in 1957 – soon secured a significant place in the world market for ducks.

By the end of the decade, demand for poultry meat was rising rapidly. In 1960 consumption was five times higher than 10 years before (5.75 kg/year). The new hybrid chicken – just beginning to be termed 'broilers' in the UK – had the potential to meet the demand. Farming systems changed to realise the potential of the breeds and to meet the increasing market. Broilers were housed, were fed increasingly 'tailored' rations, environmental control was introduced, along with better health management – and the UK broiler industry was born.

Turkey and duck rearing systems paralleled those of broilers – became controlled indoor rearing with significant increases in production efficiency. The Christmas turkey became the norm and, increasingly, turkey figured on out-of-season menus. Duck, along with prawn cocktail and Black Forest Gateau, became an 'eating-out treat.'

B.1.1 A Changing Industry

The past thirty years has seen rapid change on many fronts in the UK poultry industry. The statistics shown in the charts in this section illustrate the main changes that have affected the industry.

The increase in consumption of table chickens reflects the increasing availability to a greater proportion of the population as the retail price of chicken fell and production rose in response to demand.

As the demand for chicken meat has increased, the industry has become more efficient, at all stages of production.

Initially, the growth in size of the national flock was achieved by both increasing the number of parent birds, and by improvements in breeder output. At the same time, improvements in genotypes, matched with refined diet formulations and improved environmental control, has led to an 16% improvement in the number of flocks that can be produced on any one farm in a year. All of these improvements are illustrated by the reduction in average flock age. Growing birds' performance has improved through the implementation of better management techniques.

The number of businesses operating hatcheries, providing day-old chicks for placement, has decreased over time due to a reduction in the number of birds grown by non-integrated companies and increased efficiency within the sector. Improvement in performance by a small number of companies has resulted in competition that has seen less-efficient companies leave the industry. As a result, the majority of hatcheries are now part of integrated businesses; only one major independent broiler hatchery continues to operate in the UK.

A move to larger growing units has been driven by a need to increase efficiency in terms of labour and investment payback. The main drawback with

The Feed Conversion Ratio (FCR) to similar finishing weights of broilers improves as birds have become bred for growth and better diets are developed, consequently the amount of feed used to produce a kilo of poultry meat falls.

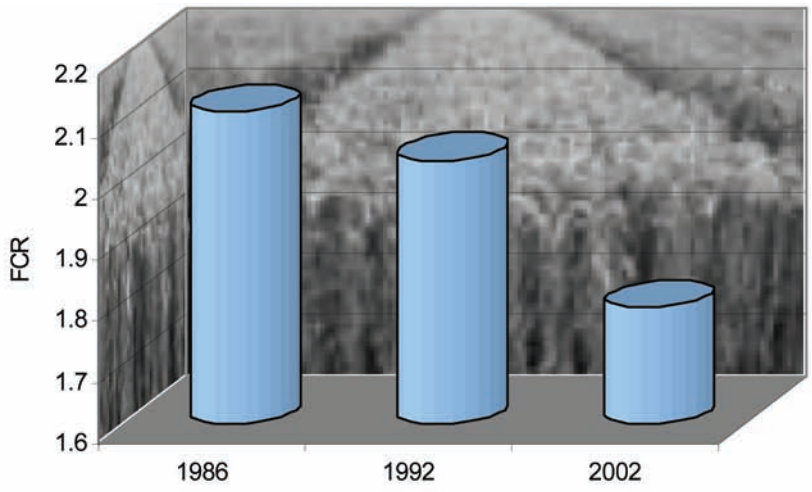
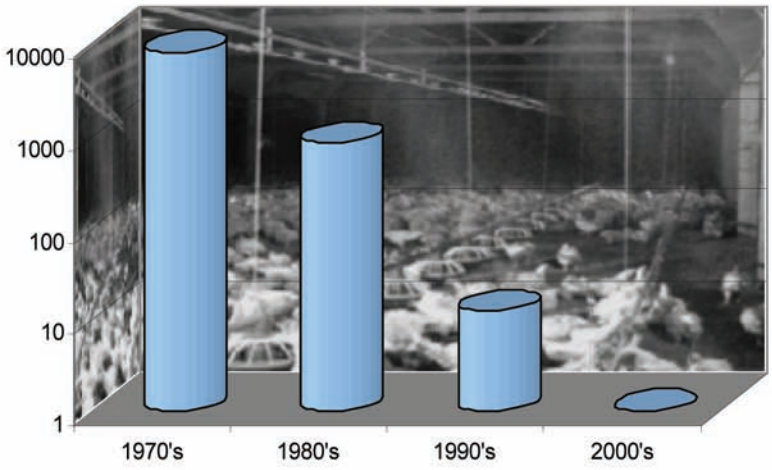


Figure B.4 Feed Conversion Ratio, 15% improvement in 20 years from 1982



Improvements in bio-security within the UK industry have resulted in a reduction in the number of disease outbreaks, as exemplified by the reduction in outbreaks of Newcastle Disease.

Figure B.5: Reduction in No. of Newcastle Disease cases over time

increasing unit size is greater vulnerability to outbreaks of diseases such as avian influenza, although risk of disease is much reduced by better biosecurity, vaccine development and breeding. The sizes and locations of units are generally limited by the perceived degree of impact of poultry production on the environment; for instance, new units are normally constructed well away from residential areas to avoid any loss of amenity that might arise from farms. The reduced number of companies operating in the sector has been reflected in substantial capital investment by individuals, in terms of new technology and take-overs of less-efficient or smaller businesses. The sector has also seen an increase in the amount of further processing of poultry meat, for instance into portions or ready meals. Biosecurity, arising in the main from the limited number of companies involved in production and strict import controls (Defra), provided the industry with stability in the early 2000s, when avian influenza hit the industry in mainland Europe, leaving the UK unaffected. The increase in UK poultry production has been accompanied by a 48% increase in imports in the 16 years since 1986. This is due to increasing demand from consumers for breast meat, both as portions and in added-value products. In order to balance demand for specific cuts, the UK exports a significant volume of leg and wing cuts to markets such as Eastern Europe.

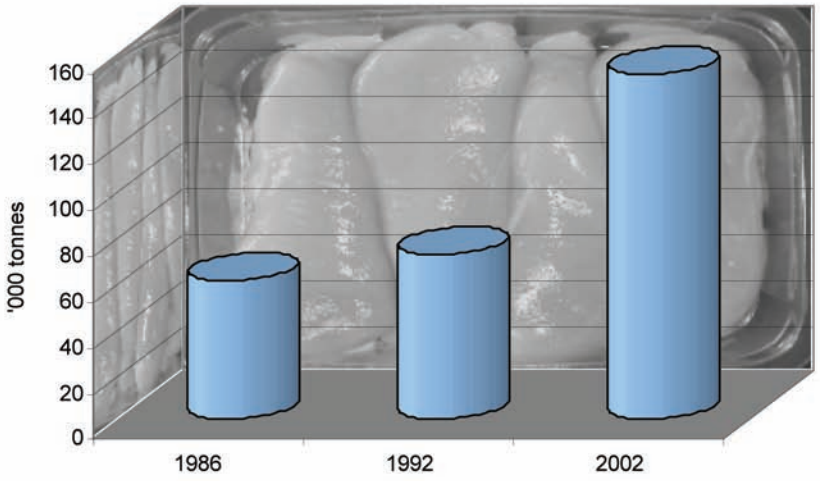


Figure B.6: Growth in imports of poultry meat to the UK

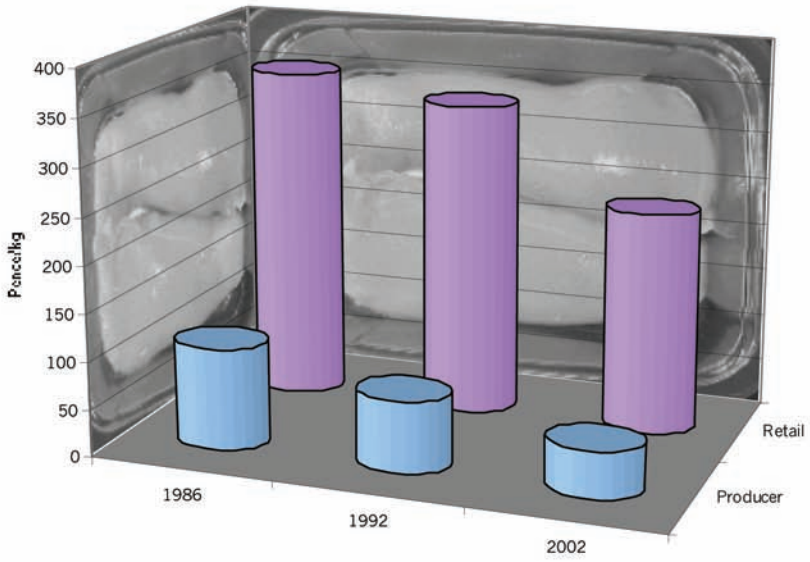


Figure B.7: Price per kg of poultry meat

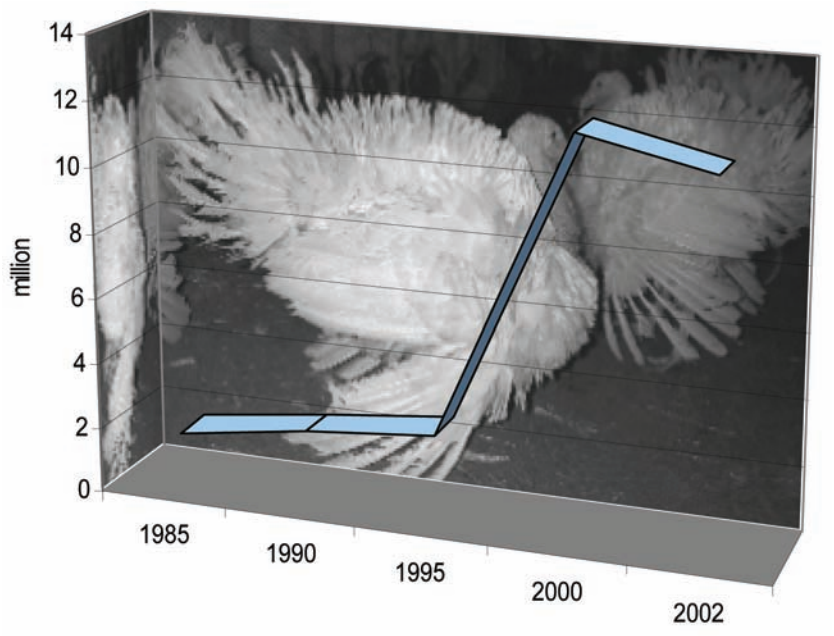


Figure B.8: The combined total of ducks, turkeys and geese in the UK

Taking inflation into account the real cost of broiler meat to the consumer fell by 34% in the 15 years following 1985, from 354 pence per kilo to 234 pence per kilo. This drop has been shadowed by a fall of 54% in prices paid to producers, from 108 pence to 48 pence per kilo liveweight; adjusted for inflation.

- increased number of birds
- improved bird performance
- increased capacity of units
- better biosecurity
- increase in further processing
- increase in imports
- price reductions

B.1.2 Turkeys & ducks

Turkeys and ducks are often considered together within reviews of the UK poultry industry. Whilst turkey meat is treated more as a commodity than duck, the two sectors have seen significant growth in the UK over the past ten years.

The sectors have seen a 625% increase in stock levels since 1985. Throughout this period, the number of whole birds produced for sale in both sectors has remained relatively stable. The increase in demand for turkey and duck meat, which the increased numbers satisfies, again seems to have been driven by consumer demand for added-value products, such as ready meals and cut portions. Over the two years 2000 – 2002, there has been a 7.5% decrease in UK stock. This is driven by the turkey sector and is due to an increase in the amount of imports of turkey meat, stimulated by lower production prices elsewhere in Europe. The volumes of turkey and duck meat production closely reflect the numbers of turkeys and duck in the UK.

The changes in the turkey market reflect the 98% increase in turkey production in the 15 years from 1985 and subsequent 9% decrease in the two years since 2000. Correspondingly, duck production has shown a steady increase of 167% in the fifteen years following 1985, consolidated by a 10% increase in the two years since 2000. The market prices for ducks and turkeys show fluctuations with time, although the general trends over the 17 years since 1985 are a 19% decrease in turkey price and a 6% increase in duck price.

B.1.3 Summary

The above statistics – though snapshots – serve to demonstrate the combination economic, social and environmental pressures under which the poultry industry has developed over the past thirty years and

continues to operate today. The challenge of ever-increasing demand for poultry meat has been met by gearing up the scale of production, in all parts of the sector. The key factors that enabled the industry to meet the demand were:

- the increased genetic potential of breeds; and
- the ability of growers to realise this potential through increased growth rates, reduced feed consumption and reduction of significant disease pandemics.

However, meeting the increased demand also had a down-side; poultry meat became a commodity. This in turn led to the prices producers were paid falling dramatically, paralleled by a significant fall in retail prices, though not as much as producer prices. EU and, increasingly, non-EU imports, out-competed home-grown supplies on price if not on standards.

The price pressure on the commodity necessitated structural changes throughout the industry. This led to ever-fewer and even larger production units throughout the chain and increasing integration: that is, control of the whole supply chain being in the hands of single companies, from feed mill to factory.

Even the dramatically increased efficiency of the industry over the past 20 years has not been enough to ensure a robust future. Over the period, public and regulatory demands for higher standards of welfare and food safety, added to the high ‘native’ costs of labour and raw feed materials, were exacerbated by increased competition due to fluctuating exchange rates and less stringent regulatory demands elsewhere in the world.

B.2 The Poultrymeat Industry Today

This section presents a summary overview of the UK industry as it is today. It addresses the drivers that have positioned the industry to date and those drivers that will impact on the industry in the future.

B.2.1 Structure and Scale

In the 5 years, 1997 – 2002, world broiler meat production increased by 28% to 46,097,000 tonnes; by 2002, the European Union accounted for 15% of world poultry meat production.

Within the EU, the UK is the second biggest producer of poultry meat with 17% of production; only France is larger with some 2.16 million tonnes produced annually.

However, poultry meat is a globally traded commodity, and both EU and UK production must be seen in this context. The UK produced 1,564,000 metric tonnes of poultry meat in 2001 – this is only a little higher than "minor World League" Mexico. The big players are now China (5,200,000 tonnes in 2001); Brazil at 6,580,000 tonnes and, out scaling all, the USA at almost 14,000,000 tonnes.

In 2002 24% of world poultry meat was "traded", Brazil alone exported as many tonnes of poultry meat as the

> Within the UK, the broiler industry is important both socially and economically. Poultry meat accounts for 43% of UK meat consumption and the poultry industry consumes almost one-fifth of the UK's annual wheat harvest.

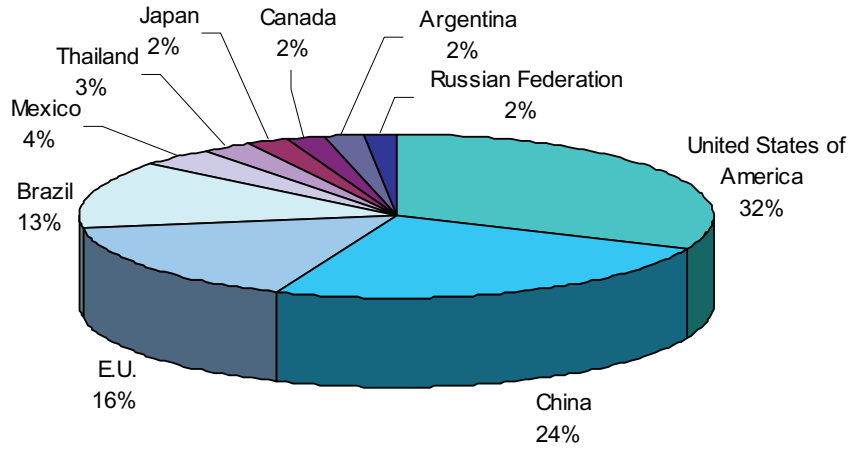


Figure B.2.1: World poultrymeat output (%)

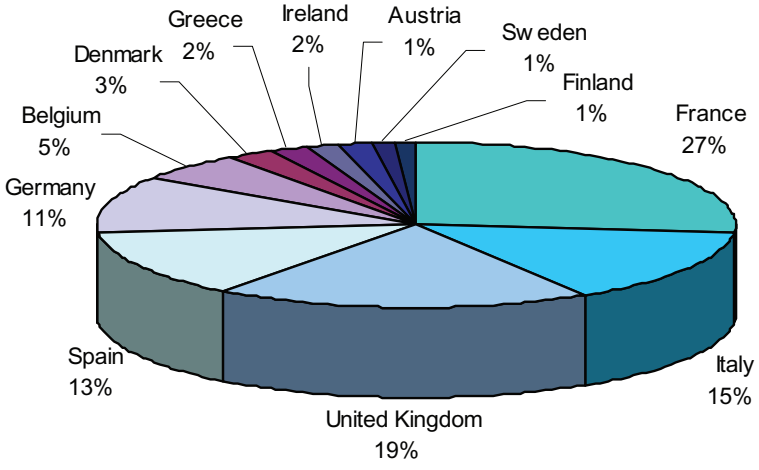


Figure B.2.2: EU poultrymeat output (%)

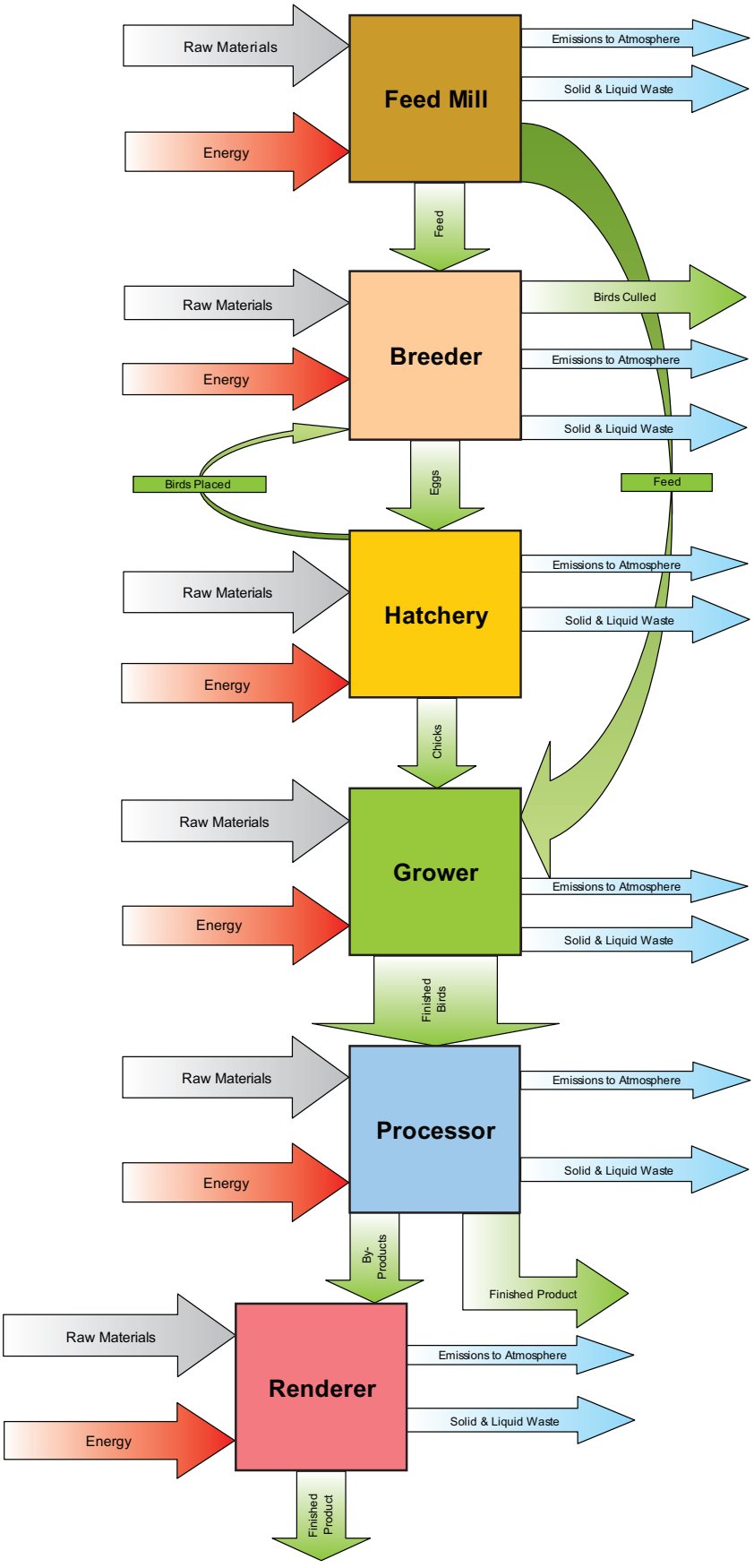


Figure B.2.3: The production chain

UK produced that year. The USA exported almost 3,000,000 tonnes. With the EU a net importer (1,320,00 tonnes in 2002), much of the tonnage traded globally was into Europe, including the UK. (160,000 tonnes net imports for 2002).

In the UK, the sector directly employs almost 60,000 people (full- and part-time) and probably double that number in related ancillary and supply sectors. In 2002, the retail market value of poultry meat was £2.8 billion – compared with £5.35 billion for all-meats sectors.

Turkey prices have also been largely geared to 'commodity meat' for some time. As with broilers, sales of added value products to supermarkets and the catering industry have increased dramatically over the last few years. The NFU estimates that, in 2002, over 9 million turkeys were imported into the UK. The number of turkey rearers has halved in 10 years, and prices have fallen by over 30%.

B.2.2 Segmentation & Integration

Most of the chicken meat consumed within the UK is from intensively-reared birds, grown to about 2.2 kg and slaughtered at an average of 40 days. Imports are derived from similar types of production systems.

The mainstream broiler industry is highly integrated. Some processor companies own or control all stages of production from supply of day-old chicks (usually owning at least some of the breeder capacity as well as hatchery facilities) through feedstuff manufacture and supply to delivery of finished product to the retailer customer.

There is a small, but growing, niche chicken sector. Supermarkets now offer Free Range broilers mainly derived from slower growing strains reared extensively but in other respects very similar to the conventional sector. There is also a very profitable sector covering the 'producer-marketeer' – sometimes organic, sometimes not – marketing 'traditional' table birds from the farm gate and farmers' markets at high premiums. Though this latter sector is insignificant in economic terms, it does have considerable potential 'educational' benefit. UK consumers are learning that British poultry should be recognised as a quality product when compared with much of the imports.

The structure of the turkey industry is basically similar to the broiler industry. The Traditional Farm Fresh (TFF) Christmas turkey sector is the equivalent 'niche', selling products at premium prices and usually comfortably profitable. The big integrators – Bernard Matthews, Sun Valley et al., face the same problems of being associated with a commodity product as broiler producers; constant price pressure and high levels of imports. TFF turkey production is largely free of these burdens.

The influence of the TFF sector should not be underestimated. In addition to its own consistent economic performance, the continuing market for UK breeds to meet this specialist market has helped UK turkey breeding succeed in competition with the US.

The majority of UK duck meat is derived from Cherry Valley stock or backyard birds. In 2002 10 million of the 20 million ducks slaughtered in the UK were Cherry Valley. A significant number of the others were 'branded' types, such as Breckland and Gressingham ducks, from Manor Farm Ducklings and Green Label Foods respectively. Unlike the broiler and turkey sectors, ducks do not face any significant threat from imports; rather, the UK duck industry has become a successful world exporter – though particularly of breeding stock and technology. Over a quarter of the 1.3 billion ducks reared in China annually are now Cherry Valley hybrids.

B.2.3 Production chain

60% of broiler chickens today are grown on farms owned directly by processors; the rest are grown by independent farmers almost all of whom are contracted to a processor. There is a relatively small (and unpredictable) 'free-market' in live birds, catering predominantly for the ethnic sector.

Whether the meat birds are 'conventional' broilers or a specialist product aimed at a niche market, the essentials of the production chain are similar.

> All commercial table chicken in the UK are hybrids, bred specifically for the purpose, with breeds constantly improved and updated by the breed companies.

More than 90% of UK parent stock breeding birds are sourced from two companies, the major players in the field operating worldwide. The breed companies usually rear the grandparent and elite stock, selling day-old broiler parents to be reared on to produce hatching eggs for the meat generation. Free Range and niche "traditional" are usually from specially bred slower growing strains.

About ten integrated specialist companies producing commercial hatching eggs, control 6.8 million broiler parent females in the UK. Rearing birds are moved at about 18 weeks to the broiler breeder laying farms where they produce broiler-hatching eggs to supply commercial day-old birds for meat production.

Broiler-breeder rearing is a specialist sector. Male and female breeders are normally from different strains; conventionally, male birds carry the performance genes (liveweight gain, carcase conformation etc) and the females the fecundity and livability. Like most farm animals, broiler breeders are feed restricted to acilitate health and reproduction. Considerable skill has to be exercised as the cocks and hens need different degrees of feed restriction. Bodyweight is constantly monitored and feed adjusted accordingly so that birds do not exceed optimal growth profiles as recommended by the breeding companies.

In most respects, broiler breeder housing is similar to broiler meat production. Stocking rates are less than for broilers, houses may be subdivided into pens, there are, of course, nest boxes, and feeders, which provide different rations for cock and hen birds. Light intensity tends to be higher and ventilation capacity appropriate for the number and size of chickens housed.

Hatching eggs are high value items and are treated as such both at the flock farm and the hatchery. Almost all eggs are hatched at hatcheries belonging, or contracted, to the integrated processors; and hatch only broilers. Of the four or five independent hatcheries left in the UK, most tend to cater for niche market producers and also hatch egg-layer strains as well as broilers.

In the mainstream sector, eggs are hatched (indeed, parent birds are placed) according to a schedule ‘working back’ from the processor’s need for continuity of supply of slaughter age birds. Chicks are delivered direct to the broiler growing farm by the hatchery’s own transport.

Feed is normally supplied from the processor’s own mill, however independent growers contracted to processors may have some freedom of action in choosing their supplier. This freedom, however, is in itself very restricted. Apart from wholly owned mills belonging to processors; there are only two major companies left manufacturing poultry rations in the UK. Due to the relatively small quantities of feed needed for independent and niche market growers there are many smaller, local mills also manufacturing small volumes of poultry feed.

90% of UK broilers are grown under the Assured Chicken Production scheme with regular audits: many supermarkets carry out additional audits of growing conditions on their suppliers' farms.

Slaughter age is factored in to the placement schedule. Most processors have their own catching teams and live bird transport though there are a few specialist catching /transport companies who deal with broilers as well as layers. Increasingly the designs of transport vehicles are intended to enhance bird welfare in transit and at loading/unloading.

Processing plants vary in size according to species and throughput, but are subject to appropriate regulations regarding animal health and hygiene. Birds are timed to arrive at the factory to minimise stress that might be caused by confinement and movement, and which may affect meat quality. Birds are usually allowed to rest before processing.

B.2.4 The Integrated Industry

Other than size, the major difference between the largest businesses in the sector and all of the others is the integrated nature of the operations. The largest companies are fully integrated with their own feed mills, hatcheries, farms and processing plants. This integration has been the result of diversification and acquisition within the sector. As processors have obtained more growing and processing capacity, they may have been able to take-over suppliers of such products as day olds and feed, especially since suppliers have often been vulnerable through reliance on a single customer. The Grampian Country Food Group, (owner of Grampian Country Chickens Ltd an active company in the broiler sector, is also active in the beef and pork sectors. Established in 1980, Grampian Country Chickens has expanded and integrated through acquisition as shown in the time line opposite.

In total, about ten companies in the UK are capable of processing more than 20,000 birds a day.

Today, as well as being fully-integrated in the UK, and like other integrators, Grampian also has overseas production capacity in Thailand. In 2000, the company made a profit of £12.9m on a turnover of £851m.

Many of the middle-sized companies, producing about 10 million birds a year each, are also more or less fully integrated, with their own feed mills, hatcheries, farms, processing and transport. In the case of Lloyd Maunder

1980 -	Grampian Country Chickens Ltd. Formed; Banff, North East Scotland
1982 -	Aberdeen factory acquired and Grampian Country Chickens (Bucksburn) Ltd established
1985 -	Acquired Mill of Brydock and formed Grampian Country Feeds Ltd
1988 -	Thorne Poultry acquired
1990 -	North Country Poultry acquired
1990 -	Vale Royal Hatchery acquired
1992 -	Established Grampian Coldstore and Distribution Centre at Thorne
1993 -	Acquired Cymru Country Chickens Ltd incorporating Cymru Country Feeds and associated rearing farms
1993 -	Established Strath of Brydock: a development of chicken growing units near Banff
1994 -	Mayhew Country Foods at Aberdare and Uckfield acquired
1996 -	Acquired Favor Parker Ltd; feed milling business in Norfolk
1996 -	Acquired Sovereign Food Group Ltd.; East Anglia
1998 -	Acquired Marshall Food Group; chicken processing business based in Mid Lothian
1999 -	Acquired Hamish Morison Ltd; the hatchery business in the Borders of Scotland
1999 -	Acquired SCATS Robertsbridge; feed mill in East Sussex
2001 -	Acquired Golden Foods International Co. Ltd; Chicken processing business based in Thailand

Table B.2.1 Poultry meat industry timeline

(which also has interests in beef, pork and lamb production), its own rendering plant.

All of the processors dealing with more than about 10 million birds a year are in close competition with each other because they depend to a significant degree on a limited number of supermarket contracts. Without the benefits of scale enjoyed by the largest businesses, competition to reduce prices might lead to under-investment in plant, creating potential for poorer environmental performance.

There are a further 30 – 40 smaller independent processors in the UK. Some are very small and are in the low throughput category of abattoir, defined by Defra as having a throughput of less than 150,000 birds a year.

B.2.5 Ownership of the Poultry Meat Industry

Of the large integrated companies, only Grampian Country Foods is a quoted UK company. Many of the other companies in the sector, unlike other industries of a similar scale, are still in the hands of family businesses: such as Boparan Holdings, Bernard Matthews, Faccenda Chicken and Lloyd Maunder.

Multi-national food businesses have had a relatively small role in the UK. In 1980, Cargill Inc. of Minnesota acquired the farmer-owned Sun Valley Poultry. The company has continued to grow in the UK and mainland Europe, but its name is now associated with poultry production in North America and South East Asia. More recently, in 1996, the Chicago-based OSI Group, the first supplier of beef patties to McDonald's, acquired the Northern Irish producer Moy Park, which has production facilities in France. OSI has subsequently acquired the integrated family firm of G W Padley and the smaller Dove Poultry, making it one of the largest UK poultry operators.

B.2.6 The Rendering Sub-Sector

A key part of food processing is the separation of meat and offal for human consumption from by-products. Products taken from birds suitable for human consumption can remain in the food chain. Carcases identified as unsuitable for human consumption are destroyed; the rendering sector takes most not qualifying for the consumer's plate. Renderers crush and grind by-products then heat them to reduce the moisture content and kill pathogens. Melted fat is separated from the solids (protein) by centrifuging. Solids are ground into powder such as meat and bonemeal.

End Products	Uses
Tallow:	
Grade 1	Edible fats after further refining
Grade 2	Pet food ingredient Toilet soap manufacture
Grade 4	Soap manufacture Industrial use Animal feed additive
Grade 6	Fatty chemicals
Meat and Bone Meal	Ingredient for compound animal feedstuffs and pet foods (not poultry feed)

Table B.2.2 End uses for rendering products

There are only five significant commercial poultry waste renderers in England and Wales, although some renderers of red meat do carry out a small amount of poultry rendering. By far the largest poultry waste processor is Prosper de Mulder Ltd and associated companies, with an estimated share of 81% of the market.

The bulk of the residues from poultry processing, after removal of meat and offal for human consumption, are in the form of animal waste. The range of waste taken includes feathers, heads, feet, fat and viscera; condemned carcases are not taken for inclusion in any of the edible products of rendering industry. This material is mainly acquired for processing in rendering plants from which poultry fat and meat and bone meal are derived. Some fresh material is taken by specialist plants for processing prior to inclusion in blends of slurry, which may or may not be cooked, used in canned pet food. The other operators are Wildriggs, Mid-Norfolk Proteins, Hughes' and Smith's. In addition, some poultry producers, such as Lloyd Maunder and Moy Park, do their own rendering.

B.3 Industry Drivers

A range of driving forces affects the broiler industry. For convenience, these have been classified as Economic and Market, Social, Environmental, Political, and Legislative drivers.

B.3.1 Economic and Market drivers

Globalisation of the industry is probably the most significant driver affecting the UK sector. Poultry meat is a global "commodity" – not easily differentiated from other competitive products. The main driving forces affecting businesses in this commodities market are:

- maintaining low cost production / reducing unit costs
- maximising economies of scale.
- matching production to demand.

The UK is not well placed to maintain "low cost production". The major international competitors (USA, Brazil and Thailand – possibly China in the near future) all have considerably lower feed costs. With feed accounting for about 75% of the cost of producing a slaughter-weight broiler/turkey, the UK's inability to produce certain feedstocks (proteins especially) and the relatively high costs of producing cereals in the EU will always allow the potential for successful non-EU competition.

UK labour costs are also high. Countries such as Brazil have mature industries with labour inputs not much greater than our own; but with much lower unit costs for labour and other inputs.

Thus, in 2001, UK costs to produce a kilo of poultry meat were €1.35: in Brazil the equivalent costs were €0.72. Inevitably, imports into the EU from Brazil have risen substantially over the last few years. Furthermore, our own major processors are 'exporting' the industry by acquiring or building production capacity in both non-EU countries and in recent accession states. Equally, US-based processors are establishing a presence in the UK through acquisition of UK companies.

In the UK, "economies of scale" continue to be made in the growing sub-sector, with fewer and fewer broiler farms each holding more and more birds and larger factories with faster line speeds. Such economies have probably gone almost as far as they can go, although the acquisition of Safeway by the Morrison Group may have some impact on the processing sub-sector of the industry as supply contracts are renegotiated on a national basis.

The UK cannot truly "match production to demand" in a commodity market, where price is the over-riding factor and demand is selective; the UK consumes more breast meat than legs and wings. Ultimately, the UK industry is likely to suffer unless the demand for product can shift from a desire for specific cuts of cheap chicken at any cost, to a balanced preference for high standard home-produced poultry meat.

B.3.2 Social drivers

Social drivers should work for the industry as well as against it.

It is well known that the UK consumer demands high quality, healthy, safe, welfare-friendly, environmentally sustainable poultry meat. Equally, it is also known that many consumers are rarely prepared to pay the cost of such a quality of product.

Nonetheless, the pressures on the EU and UK industries are to encourage ever-higher standards.

• Welfare

The EU – as a legislative whole – has higher standards of animal welfare than anywhere else in the world, the approved regime balances the needs of animals with the commercial interests of farming. Poultry production is covered by a raft of welfare regulations, including several specific to poultry (unlike other livestock sectors). Regulation increased with the introduction of the Broiler Directive. The whole cycle, from hatchery to rearing conditions, transport and slaughter are covered by both statutory regulations and "Codes of Recommendations", led by the European Convention for the Protection of Animals Kept for Farming Purposes and the Treaty on Improved Protection and Respect for the Welfare of Animals.

Outside the EU, animal welfare awareness is rapidly increasing in importance. The European Commission's Communication on animal welfare legislation relating to farmed animals in Third Countries and the implications for the EU, noted that neither Brazil nor Thailand – the major exporters of poultry meat to the EU – had even responded to the Commission's welfare questionnaire.

Within the EU itself, attitudes to welfare vary. The UK Government is often accused of "gold-plating" welfare

(and food safety) regulations. However accurate this opinion may be, it is certain that the UK has self-regulated successfully and is more scrupulous in implementing EU Directives and Regulations than many other EU countries.

For example, in the sister-sector of egg production, the UK is currently considering banning in 2012 enriched layer cages, which the EU will continue to allow. Meanwhile Austria, Belgium, Greece and Italy have been referred to the Court of Justice for failure to implement the 1999 Directive on minimum cage welfare standards. Foie Gras production, which is banned in the UK, is practiced widely in France and Belgium.

Despite the detailed regulations and voluntary standards covering welfare policed by DEFRA and the supermarket retailers, some sectors of the UK public have an increasing interest and a perception of the poultry industry which is less than favourable. If this perception is founded largely on ignorance, together with the successful lobbying of animals rights organisations concerned over industry developments, in the absence of a well–orchestrated campaign to make the public more aware of the high welfare standards applied in the UK, the industry must expect welfare pressures to continue, despite the fact European and national welfare measures should provide an effective response to the ethical lobby.

Future welfare and environmental performance within the industry is likely to be affected by social pressure to reduce stocking density in housing to low levels and consequently economic performance is likely to suffer. Research at the University of Oxford has shown that the stocking density per se, while important, is less so than other factors in the birds environment, such as temperature and humidity. Legislation that considers stocking density alone might not result in the desired improvements in animal welfare unless it is combined with good stockmanship and facilities designed for the task.

• Food safety

Food Safety issues closely parallel those concerning animal welfare. The EU has a raft of regulations with which imports may or may not comply (and often there is no system in place to check whether they do or not). Brazilian imports, for example, have been found to contain residues of nitrofurans (long banned in the EU) but an inspection of plants by the EU Food and Veterinary Office in 2003 confirmed for the third such visit that neither residue testing nor veterinary certification by the Brazilian competent authorities could be relied upon.

In the UK, competent implementation of food safety legislation and public pressure have tended to push the home industry ahead of other EU members. Growth promoters, including prophylactic use of antibiotics, were banned voluntarily in the UK as a result of public pressure. Some reintroduction of antibiotics has been necessary on welfare grounds due to the increased disease levels following the initial outright ban, though 80% of Assured Chicken Production broilers continue to be grown without their use.

B.3.3 Environmental

Integrated Pollution Prevention and Control (IPPC) and the Climate Change Levy (CCL) have, or will have, a considerable impact on the poultry industry, particularly the live bird sector.

All new or substantially changed farms with more than 40,000 birds must have a Pollution Prevention and Control (PPC) permit before starting up, and all existing poultry farms will have to be permitted by the end of 2007. In order to obtain a permit, units will have to demonstrate that they are using Best Available Techniques (BAT) to limit their effect on the environment.

Although many poultry units practice BAT – and thus costs for compliance activities should be modest – the fees and charges associated with IPPC represent a significant financial burden; permit applications are expected to cost £3,024 with an annual large farm subsistence fee of about £2,537.

The first milestones of the CCL Rebate Agreement have been met by almost all of the farms covered by the Agreement with an overall saving of over 67,000 carbon tonnes. However, subsequent milestones will be much harder to meet. It is almost certain that considerable redesign/rebuilding of existing poultry houses will be needed to comply, and it is doubtful that, in many cases, this will be an economic option.

B.3.4 Political drivers

Although government regulation operates on industry via economic and social mechanisms, political considerations often tend to distort ‘normal’ systems. The true free market in global poultry meat is constrained in many ways by both global and national politics.

The poultry industry is unsupported by the EU Common Agricultural Policy (CAP), being under the ‘light regime’

where the only support mechanisms are Trade Tariffs. However, as with welfare and food safety, different EU countries 'interpret the rules' according to internal political agenda. Thus, in 2003, the French Government announced that it would commit 9M to aid the restructuring of the French poultry industry.

The Tariffs themselves – though often only partly effective (for several years Third Country importers of frozen chicken breast meat to the EU were able to avoid paying the full tariff by lightly salting meat) – are now under threat through global politics in the form of the World Trade Organization (WTO).

In a pre-Doha round WTO meeting, Lord Whitty, DEFRA Parliamentary Secretary (Lords), confirmed that the UK Government wished to see import tariffs abolished as the Doha Ministerial Declaration subsequently implied. The European Commission is instead proposing "green box" compensation payments for EU producers who will be required to implement more stringent welfare regulations. There is no certainty that the WTO will accept "greenbox" or any other proposals based on welfare parameters.

Removal of tariffs without ongoing "greenbox" assistance will leave the UK industry even more vulnerable to imports from sources that do not operate to European / UK standards.

Current Statistics:	**2003**
Millions of broiler breeders placed in UK to June 2003	423 million
%change on same period in 2002	-1%
Millions of broiler chicks placed in EU to June 2003	2210.3 million
%change on same period 2002	+0.4%
Millions of broiler chicks placed in UK to June 2003	423.52 million
% change on same period 2002	+2.2%
'000 tonnes whole birds imported to UK to March 2003	11.86
%change on same period 2002	-4.5%
'000 tonnes cuts imported to UK to March 2003	73.49
%change on same period 2002	-3.7%
'000 tonnes broiler rations used in UK to March 2003	836.6

Table B.3.1 2003 poultry meat statistics

B.4 Legislation affecting poultry enterprises

There is an increasing amount of environmental legislation relevant to the poultry industry, with the prospect of more on the agenda. The following is not an exhaustive list and equivalent legislation exists in Scotland and Northern Ireland.

B.4.1 Climate Change Levy

The Finance Act (2000) Part II contains the legislative basis of the Climate Change Levy (CCL); it was announced in the Chancellor's 1999 March Budget. The levy is a tax on the use of energy in industry, commerce and the public sector, with offsetting cuts in employers' National Insurance contributions to encourage energy efficiency and the use of renewable energy sources. It was introduced by the government to help the UK meet its targets for reducing greenhouse gas emissions and is intended to promote energy efficiency, encourage employment opportunities and stimulate investment in new technologies.

The Government recognized the position of energy-intensive industries, such as intensive poultry farming and processing, the requirements of the IPPC regime, and the sector's exposure to international competition. Consequently, there was an 80% discount from the levy for those sectors that entered one of the 44 negotiated agreements for improving energy efficiency or reducing carbon emissions.

The British Poultry Council (BPC), formerly the British Poultry Meat Federation, is the CCL sector-representative for around 70 poultry meat processing facilities and six dedicated feed mills. The BPC represents around 700 poultry meat rearing units whilst the National Farmers Union (NFU), represents around 800 similar units. The majority of units in the sector operate under one of these two separate agreements.

At the end of the first target period of March 2003, all the sector associations in the Climate Change Agreements (CCA) submitted information to DEFRA on their energy performance in order to be re-certified for the next two years, under the terms of the Finance Act.

B.4.2 Pollution Prevention and Control Act 1999 and Pollution Prevention and Control (England) Regulations 1999

The Pollution Prevention and Control Act 1999 will eventually replace the EPA 1990, Part 1. The new Act will result in a coordinated system bringing together those installations currently under the IPC and LAPC regimes; along with new installations brought in by the EU Integrated Pollution Prevention and Control Directive. IPPC aims to provide protection for the environment by integrating the control of emissions to air, water and soil.

All poultry units falling under IPPC will require a permit to operate, the permits being based on the concept of Best Available Technique (BAT).

In order to demonstrate that BAT are being used operators must:

- ensure that procedures cause no significant level of pollution;
- take all preventative measures against pollution;

	Improvement in specific energy Consumption relative to base year position	Target (unadjusted for trading)	Facilities re-certified
Poultry meat processing	8.0%	6.4%	98%
Poultry meat rearing (BPC)	22.6%	5.1%	99%
Poultry meat rearing (NFU)	24.9%	4.3%	83%
All the facilities have been re-certified because they have met their individual targets outright, or through trading and/or product mix adjustment. Each CCA has further performance targets for the years 2004, 2006, 2008 and 2010.			

Table B.4.1 The results reported in the Climate Change Agreements (2003)

- minimize waste and dispose of it suitably;
- make efficient use of energy; and
- take effective measures against environmental accidents.

Guidance as to which techniques are BAT is compiled and coordinated for each sector by the European IPPC Bureau. The European Commission then publishes the information in the form of BAT reference documents, known as BREF notes.

B.4.3 Control of Substances Hazardous to Health (COSHH) Regulations 1999

The COSHH Regulations apply to all potentially harmful or hazardous substances, including wastes. The health risks to employees from exposure to substances considered hazardous must undergo a risk by employers and the exposure of employees to such substances prevented or controlled. Suitable and sufficient information and training must be provided plus routine exposure monitoring and health surveillance.

B.4.4 Environmental Protection Act 1990 (EPA 1990)

The EPA (1990) regulates the collection and disposal of waste and defines statutory nuisances. In relation to poultry production, the statutory nuisances sections are particularly relevant. A statutory nuisance is defined as including any dust, steam, smell or effluvia arising on industrial, trade or business premises and being prejudicial to health, or a nuisance. Local Authorities have powers to investigate complaints and can issue an Abatement Notice if a statutory nuisance exists.

The EPA 1990 Part I introduced a system of Integrated Pollution Control (IPC) in order 'to make provision for the improved control of pollution arising from certain industrial and other processes'. The IPC system provides a framework for pollution control by controlling the emissions to air, water and land from certain specified industrial processes in a single authorisation.

B.4.5 The Town and Country Planning (Environmental Impact Assessment) (England and Wales) Regulations 1999

The development projects that are required to undergo an environmental impact assessment are set out in the Town and Country Planning (Environmental Impact Assessment) (England and Wales) Regulations 1999 and the Environmental Assessment (Scotland) Regulations 1988 (as amended by the Environmental Impact Assessment (Scotland) Regulations 1999).

Units that are affected are defined in the Regulations as Schedule 1 developments, that is installations for the intensive rearing of poultry with more than 85,000 places for broilers or 60,000 places for hens, or Schedule 2 developments where the area of new floor space exceeds 500 square metres.

B.4.6 The Water Resources Act 1991

The Water Resources Act (WRA) is the principal legislation regulating water quality and quantity in England and Wales. Its aim is to prevent water pollution and it allows people to be prosecuted under the Act if they do pollute.

The Act prohibits causing or knowingly permitting the discharge or other entry of poisonous, noxious or polluting matters to controlled waters. 'Controlled Waters' include groundwater, lakes, ponds, rivers, streams and ditches. Businesses intending to discharge such substances, or trade or sewage effluent, directly to controlled waters, must obtain consent from the Environment Agency or risk prosecution. The licence details the conditions on the concentration limits, characteristics and volume of effluent permitted.

B.4.7 The Control of Pollution (Silage, Slurry and Agricultural Fuel Oil) Regulations 1991 (as amended)

The Control of Pollution Regulations specify the performance levels for installations used for the storage of silage, slurry and agricultural fuel oil; to minimize the risk of water pollution for keeping and handling these substances. Facilities that were in existence before 1 September 1991 are usually exempt from the rules, but the Environment Agency can require them to be improved under a Notice if there is a significant risk of pollution. New, substantially enlarged, or substantially reconstructed facilities must meet the standards set out in the Regulations.

B.4.8 The Protection of Water against Agricultural Nitrate Pollution (England and Wales) Regulations 1996 and the Action Programme for Nitrate Vulnerable Zones (England and Wales) Regulations 1998

The above Regulations follow from the EC Nitrates Directive (91/676/EEC), which was introduced amid environmental and health concerns over high levels of nitrate found in certain waters. The Directive aims to reduce nitrate pollution from agricultural sources, such as manure and fertiliser applications and could include some poultry operations. The Directive requires Nitrate Vulnerable Zones (NVZs) to be established in polluted catchments and for Action Programme measures to be implemented in those zones in order to reduce nitrate pollution. NVZs currently cover 47% of England, and are defined as those areas where the nitrate concentration in water exceeded, or was expected to exceed, the precautionary limit of 50mg/litre. For poultry enterprises, methods of compliance include controlling the rate and timing of manure applications and the adoption of appropriate means of storage of slurry and manure.

Regulations designating seven small NVZs in Northern Ireland came into force in June 2003 and introduced action programmes to reduce nitrate leaching.

B.4.9 Codes of Practice

MAFF Codes of Good Agricultural Practice for the Protection of Air, Water, and Soil 1998, also known as the Air, Water and Soil Codes respectively, and the Prevention of Environmental Pollution From Agricultural Activity 1997 (PEPFAA) provide practical guidance to help farmers and growers from prevent pollution to air and water and damage to soils. The Water Code receives statutory backing from the Water (Prevention of Pollution) (Code of Practice) Order 1998 (SI 1998/3084); as it relates to the pollution of controlled waters. Likewise, the PEPFAA Code has a statutory base under s.51 (1) of the Control of Pollution Act 1974; the PEPFAA Code primarily deals with preventing water pollution.

B.4.10 The Animal By-Products Regulations 2003

The Animal By-Products Regulations (ABPR) seek to prevent risk to humans and animals through the spread of disease from animal by-products by enforcing the EU Animal By-Products Regulation (EC 1774/2002). The regulation applies controls to the processing, disposal and marketing of animal by-products and processed animal by-products not intended for human consumption as soon as it is decided that material will not be used for human consumption, it is controlled by the order. The ABPR also addresses the placing of the market, export and transit of animal by-products and certain derivatives, and so affects waste disposal and animal feed industries, slaughter houses, tanneries, farmers, food processors, catering outlets and food retailers.

Of relevance to the poultry industry are controls shown on the following page:

- whole and part animal carcases (including blood) not intended for human consumption; and products of animal origin intended for feeding to livestock or for use in biogas or composting plants.
- The controls applied by the ABPR govern the disposal of wastes and uses of by-products, which are split into the three categories of:

  Category 1: high risk material that should be completely destroyed, for instance animals that are suspected or confirmed as having a TSE;

  Category 2: high risk material that might be used as a fertiliser, for instance diseased animals not covered in the first category, and material that is essentially not fit for human consumption;

  Category 3: material, whether or not it is fit for human consumption, that comes from the carcases of animals unaffected by any disease that might be communicable to humans or animals that are suitable for human consumption. This category includes; feathers, poultry blood, shells and hatchery by-products.

The ABPR is supported by guidance on specific types of treatment and their effective use, such as the guidance on treatment in approved composting or biogas plants.

Table B.4.2 The Animal By-Products controls which are relevant to the poultry meat industry

B.5 The future of the UK Poultry Industry

In the face of intense competition from overseas, the future of the UK Poultrymeat industry is far from certain.

Respondents from all sectors and levels of the industry have the same message – 'we're being faced with unfair competition on a Playing Field so far from level that we're in danger of sliding off it altogether…'

The UK poultry meat industry clearly believes that it almost certainly has the best product in the world. "Best" means consistency across the board, not only in quality of product – paramount though this may be – but also in food safety, animal welfare and environmental awareness. Nonetheless, the UK industry sees itself in apparently inexorable decline in supplying its own home markets.

The industry is quite prepared to compete in the global market. It accepts that this will always be tough – cost differentials, particularly on feedstuffs and labour costs – will always militate against the UK product. But most respondents reckon that their sub-sectors – their companies – can handle this. Being tough is something that the poultry industry has had to be; unlike the majority of agri-businesses in the UK, it receives no income from the CAP.

Despite this, the industry competes with third-country imports that have cost advantages and, at least sometimes, don't match the "social specifications" of hygiene, welfare etc, that are imposed upon home production.

Additionally, other EU countries that, theoretically, meet those same "social specifications" don't. Cultures vary across the community, and the UK tends to comply with the letter of regulation, not necessarily in the words of the implementing legislation but, most certainly, in the monitoring and policing of those regulations. Many of the respondents can cite examples – from their own experiences – where EU-wide regulations mean one thing this side of the Channel, and something else the other side. "And I don't mean Greece, Spain, Italy – but Germany, Holland, France…" (anonymous).

Inevitably, those that can are going with the tide. Processors 'outsource' and import poultry meat to supply to customers who aren't concerned about home produce so long as the price is right. Others have their own overseas production capacity. This is hard on the live bird sector, and those mills and hatcheries that supply farms, as well as those at other positions in the chain – the transport and catching firms, and the renderers. But processors who outsource or move production overseas are merely doing their best to survive by moving up the contours of the sloping playing field. This could be at the cost of high environmental and social performance for economic security.

Does it matter if the UK ends up exporting its poultry industry? Yes, it does. For the parochial interests of UK jobs, UK agriculture, UK balance of payments etc. Every chicken or turkey reared overseas, rather than in the UK, is at greater risk of being reared under relatively poorer welfare standards. Every kilo of imported meat is more likely to contain drug residues than UK meat. Furthermore, where the cost of inputs is a less over-riding factor than the UK, there is a tendency to greater profligacy of resources.

In the global landscape, sourcing UK poultry meat from home-grown sources would seem to be the best way of ensuring improved welfare birds, safer meat and efficient resource use.

What can the industry do to level the Playing Field? Probably only what it already does with some, but limited, success.

The industry lobbies Whitehall and Brussels in order to amend proposed regulations; but the adjustment of wording does not take into account different cultures of implementation.

The industry meets its customers' requirements – but compliance with audits and cooperation with marketing initiatives, doesn't change the tendency to buy primarily on price.

Labelling is adapted to enable the consumer to choose UK-produced food – but labels can cause confusion and Red Tractors are irrelevant to those who buy food because it can be microwaved in two minutes and is cheap.

Perhaps the industry must look to a future that encompasses a different kind of model altogether. The only significant problem for the Traditional Farm Fresh (TFF) sector is that of supplying sufficient product to meet the demand; it is a price leader, not a price follower, and its throughput grows slowly but steadily year on year. However, TFF is small; a niche market, mostly local, mostly seasonal and detached from the commodity market.

It may be possible for part of the mainstream industry to contemplate reversing direction. Unrolling, at least

partially, the trends towards economies of scale, ever-greater integration, the supplying of mass commodity to customers who are chiefly price driven. The environmental and economic effects of such a change are currently unquantifiable, but this exercise goes part of the way towards providing a tool that could help forecast impacts.

There may also be potential for marketing direct to the consumer – not via supermarkets, manufacturers and caterers. TFF does it – and country-of-origin labelling doesn't matter very much if the customer buys direct. The impact of such a change cannot currently be assessed, but it should have associated environmental benefits.

There may even be the opportunity of a more 'local loop' structure, sourcing such inputs as are UK produced, rearing, processing and marketing all in the same region and using nitrogen-rich wastes as fertilisers. A reversion to multiple small-scale capacity units can't be the answer for the whole industry, but it may be an answer for part of it.

In summary, the Poultrymeat sector is mature in terms of volume of production. In order to continue growing the sector must adapt a strategy where volume of production makes way for value of the end product.

And if not? Where does the industry go from here? If Global Warming is a reality then in a few years down the line, the UK could grow its own Soya…

C. The Mass Balance Model

C.1 Industry Sectors and the Supply Chain

This mass balance model aims to quantify the material resource and energy inputs to, and major waste outputs and emissions from the UK Poultry Industry in 2002.

The boundaries of the model, arrived at with the guidance of industry members, extend from the manufacture of poultry feed, using cereals and oilseeds, through the supply chain to whole chilled birds and portions, and output from rendering plants.

Further processing to add value to poultry products, by the production of ready meals and prepared portions for the catering trade has not been included in this part of the study.

Whilst the majority of inputs and outputs in the relevant sectors of the poultry meat supply chain are included in the study, the primary subjects of the study are energy and water usage; the two major resources flowing through the poultry supply chain.

The boundaries of the sectors making up the poultry meat supply chain are laid out below.

Feed Production

Of the raw material input to the feed milling sector, about 89% is of cereals, Soya and oilseeds or pulses. The remaining inputs provide oils and additional proteins, including vitamins, minerals and amino acids to balance the feed and optimise rations at each stage of bird development, plus packaging necessary for delivery of small-scale production. Meat and bone meal from cattle, or any other animal, is not fed to poultry in UK.

Feed compounding is a process based on blending, mixing, and the application of heat and pressure to produce a pelleted end product, which is readily eaten by birds and is easily handled and transported. The heat-based parts of the process normally use steam as the heat source; the means of raising steam vary between sites.

The majority of output from the sector is compound feed, which is delivered to the point of consumption in bulk, using road vehicles, which are accounted for elsewhere in the mass balance.

The secondary outputs from feed mills mainly consist of atmospheric emissions of steam and gases, foul water and waste packaging.

Farming

• The Chain

Poultry production is largely based on the use of selected hybrids of bird best suited to thrive in indoor production systems. Several generations of parent birds precede those birds that are used for meat production. The offspring of ‘Elite’ flocks make up the great-grandparent stock that produce fertilised eggs which are hatched to produce sufficient numbers of grandparent stock, to in turn produce the parents of the meat-producing generation.

Fertilised eggs from all generations are hatched in purpose-built hatcheries; chicks are then transported from here to the next stage of the production cycle.

Juvenile birds from the production stage are taken from their houses at between 37- and 43-days old and transported to a processing plant.

The principal inputs to the farming sector of the poultry industry are day old chicks, feed, water and bedding material. In addition energy is used for heat in the early stages of growth, ventilation at all stages but particularly during hot spells, and lighting throughout the stocking cycle. Chemicals are used for to clean down and disinfect housing, and veterinary medicines may be used in the event of the possibility of health being compromised.

The outputs from the sector are primarily birds for processing or old breeding birds, litter, which may be sent for burning in power stations or applied to agricultural land, and the carcases of birds that have died during the production cycle. In addition, wastes arise from cleaning and preparing the building at the end of each production cycle; including dirty water and packaging (from the supply of bedding material, which may be supplied on wooden pallets in plastic-wrapped bales).

• Breeding

Breeding birds are generally kept in similar conditions to other stages of the production cycle, but at lower stocking densities to allow for the provision of nesting boxes for laying and for sustainable litter conditions for longer cycle length. The birds reach sexual maturity at about 20 weeks and produce around 130 chicks during their 60-week productive life.

It is estimated that there are around seven million broiler-breeder birds producing fertilised eggs to be placed as day old chicks in the UK each year.

• Hatchery

Eggs laid by breeding birds are taken to hatcheries where they are incubated in carefully controlled conditions where temperature and humidity mimic conditions under a hen. Air is circulated in the incubators and eggs are turned regularly to ensure safe development of the embryos.

About 18 days after being placed in the incubators, the eggs are checked and infertile eggs and damaged embryos are removed. The remaining eggs are placed in hatchers and about three days later, broiler chicks emerge. Turkey poults hatch within very few hours of each other after 27 days.

Newly-hatched chicks are examined in the hatchery and may be sorted by sex, depending on rearing farm to grow separately to suit processing weight targets..

Hygiene to avoid infection is paramount in hatcheries and a great deal of attention is paid to cleanliness and disinfection.

Day-old chicks have a reserve of food (the yolk sack) that enables them to live healthily for more than 40 hours after hatching, during which time they are inspected and transported to rearing farms in reusable trays on dedicated temperature-controlled vehicles.

• Rearing

Poultry for meat production are reared on beds of chopped straw, wood shavings or chips or waste paper, in purpose-built houses holding up to 100,000 birds, on farms that may have several such houses. The type of floor in a house can have a significant effect on litter use, with up to 30% saving in modern houses, with concrete floors, over structures with earth floors.

Day old birds are placed in heated houses and roam and forage to the extent of the housing as they grow. As the birds' body weights increase, so does the amount of heat arising from the flock, supplementary heat inputs can then be withdrawn in all but the coldest weather. Fans are often used to augment natural ventilation throughout the growing cycle.

At the end of production cycles, birds are caught by trained staff and placed in reusable plastic modules for transport to a processing plant.

Transport

Transport is required between all stages of the supply chain, feed from mill to farm, eggs from laying farm to hatchery, day-old chicks from hatchery to laying and rearing farms and mature birds to processing.

When birds reach their target weight, which is normally between 1.8kg and 2.2 kg in broilers, 7kg and 20kg in female and 14kg and 40kg in male turkeys, and 3.2kg and 3.5kg in ducks, they are removed from the production site and are transported in specialised vehicles to a processing plant. In wet or cold conditions, the sides of the transporters will be closed to protect birds from the weather, but in hot weather the sides may be left open to allow air to pass through the containers and keep the birds cool.

Birds are inspected on arrival at the processing plant by a team monitored by the Meat Hygiene Service's veterinary supervisor, and are normally delivered to suit processing, which in turn is geared to suit the company's order book.

The main inputs to the transport sector of the industry are vehicles, fuel and tyres, the outputs being emissions from combustion, tyres, batteries and end-of-life vehicles.

Mortality during transport is low (less than 0.19% of the more than 850 million broiler birds that are transported each year).

Processing

Processing is the most complex sector of the poultry meat supply chain, the main input of which is live birds and output whole dressed birds, or jointed meat. The remaining inputs to the system are: energy, to light and power the plant; water for washing; disinfectants; and packaging. The secondary outputs are animal by-products, dirty washing water, packaging and emissions to atmosphere.

Following examination by a Poultry Meat Inspector (PMI) in the lairage, birds are hung onto the first section of the processing line. Birds are stunned, killed, and the carcases allowed to bleed before being dipped into scald tanks to loosen the feathers. For religious reasons, birds used for Halal and Shecita foods are not stunned before death. Subsequently the carcase moves along the primary line to plucking machines, using rubber fingers to remove all of the feathers. Blood is collected and taken for rendering. Feathers from the pluckers are transported by water in flumes and are

subsequently collected and taken for rendering for inclusion in feather meal or composting before disposal.

The carcase moves on to the eviscerating area, where first the head is removed normally followed by mechanical removal of the intestines and internal organs. The viscera are extracted separately and are grouped into items that might be sold with a whole bird or separately, items that may be used in the manufacture of pet food, and wastes for rendering. A PMI examines both the carcase and viscera for signs of ill health or damage in the birds before the carcase progresses to the next processing stage. Unsuitable carcases are condemned at this point.

Carcases are first washed and subsequently chilled to 4°C whilst moving on the processing line through a refrigerated chill room. Traditionally, carcases are allowed to mature for about twelve hours prior to cutting, but 'electronic' maturation now makes it possible to mature a carcase for cutting in a matter of minutes. The first stages of processing may vary from plant to plant, in smaller plants birds may be dry or wax plucked, and cooling may be by immersion in water rather than in air chillers.

The treatment of carcases also varies between species and processing plants, but carcases are generally weighed 'on the line' and whole carcases for the 'oven ready' market move on for trussing and packaging. Portioning of carcases is now common, and may be done by hand or by specially designed machines in the case of broilers, with portions being packed in trays for the retail market or bulked for the catering trade and further processing into ready meals or poultry meat products such as 'nuggets' or rolled joints.

Rendering and Pet Food

Waste animal material from processing plants is collected and sent for rendering and use in pet food manufacture; rendering may be used as a means to reduce volume prior to disposal or to produce ingredients for pet food. Such waste materials fall into one of two categories.

Meat and other body waste from poultry processing is classified as either Category 2 or Category 3 as defined in the EC Common Position Document No12/2002, dealing with animal by-products not intended for human consumption.

Category 3 material consists of parts of slaughtered animals that are fit for human consumption, but are not intended for human consumption, parts of slaughtered animals which are rejected as unfit for human consumption, but are not affected by any signs of diseases communicable to humans or animals and derive from carcases that are fit for human consumption. Feet, feathers and blood can also be classified as Category 3 materials.

Following appropriate processing, these materials are used in the manufacture of wet or dried pet foods, as well other animal feeds or some other, industrial use; or it can be applied to agricultural land. The Balance takes into account that proportion of the material flow which goes on to be rendered or processed into wet or dried pet food.

Category 2 material consists of manure and digestive tract contents, solid waste separated from waste water, birds that were dead on arrival at the plant, and veterinary condemnations.

These latter materials are not fit for consumption and are processed prior to use as a fuel or subject to restrictions, in compost, which may be applied to agricultural land as a fertiliser or soil-improver. These materials are either included in the waste stream from the processing sub-sector, or are accounted for as wastes from the rendering sector. Category 1 material is unlikely to arise from poultry processing.

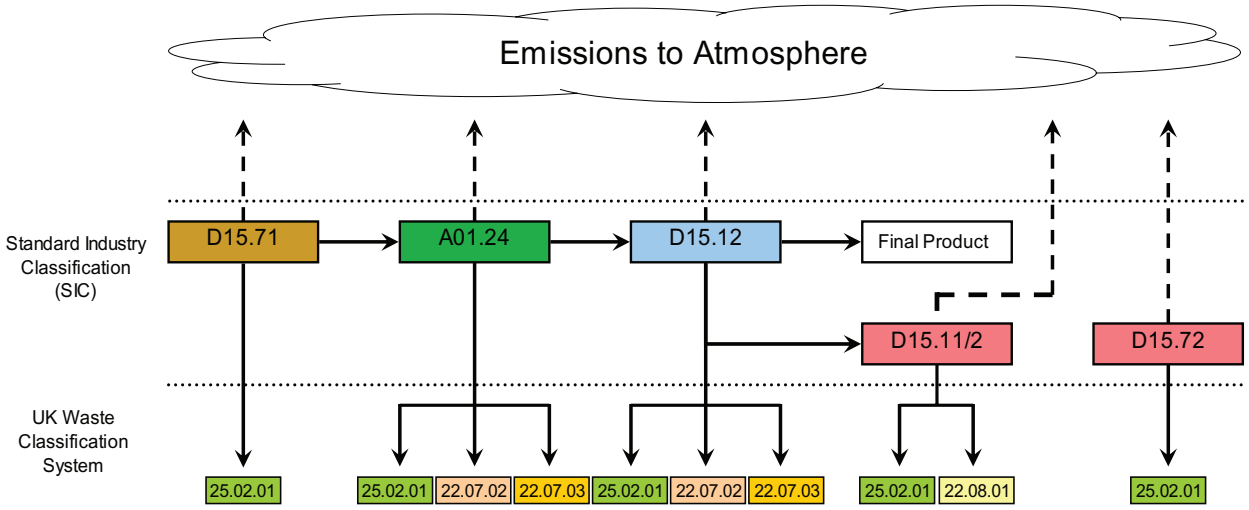


Figure C.1.1 Poultry industry SIC and UK Waste Classification System flow chart

The study deals with the following areas as defined by the Standard Industry Classifications (SIC):

A01.24	Farming of poultry
D15.11/2	Animal by-product processing
D15.12	Production and preserving of poultry meat
D15.71	Manufacture of prepared feed for farm animals
D15.72	Manufacture of prepared pet foods

Waste production is not classified within the SIC system, and in order to provide input to Mass Balance UK waste produced within the poultry industry has been classified within the following categories of the UK Waste Classification System:

22.07.00	**Animal matter**
22.07.01	Waste food – animal or mixed including – waste food that contains animal matter, canteen waste
22.07.02	Whole and/or part animals including – blood, skins, bones, dead animals
22.07.03	Excreta including – washing or processing liquors contaminated with blood or excrement
22.08.00	**Animal or vegetable fat, wax, grease**
22.08.01	Animal fats oils, waxes and/or grease including tallow
25.02.00	**Waste from biological processes other than sewage treatment or composting**
25.02.01	Wastes from biological treatment of effluents or wastes including – biological sludge from the treatment of effluents from the food industry, slaughtering excluding – sludge from physicochemical treatment, untreated settled solids.

Table C.1.2 Standard Industry Classifications codes and UK waste industry classification codes relevant to the poultry meat industry

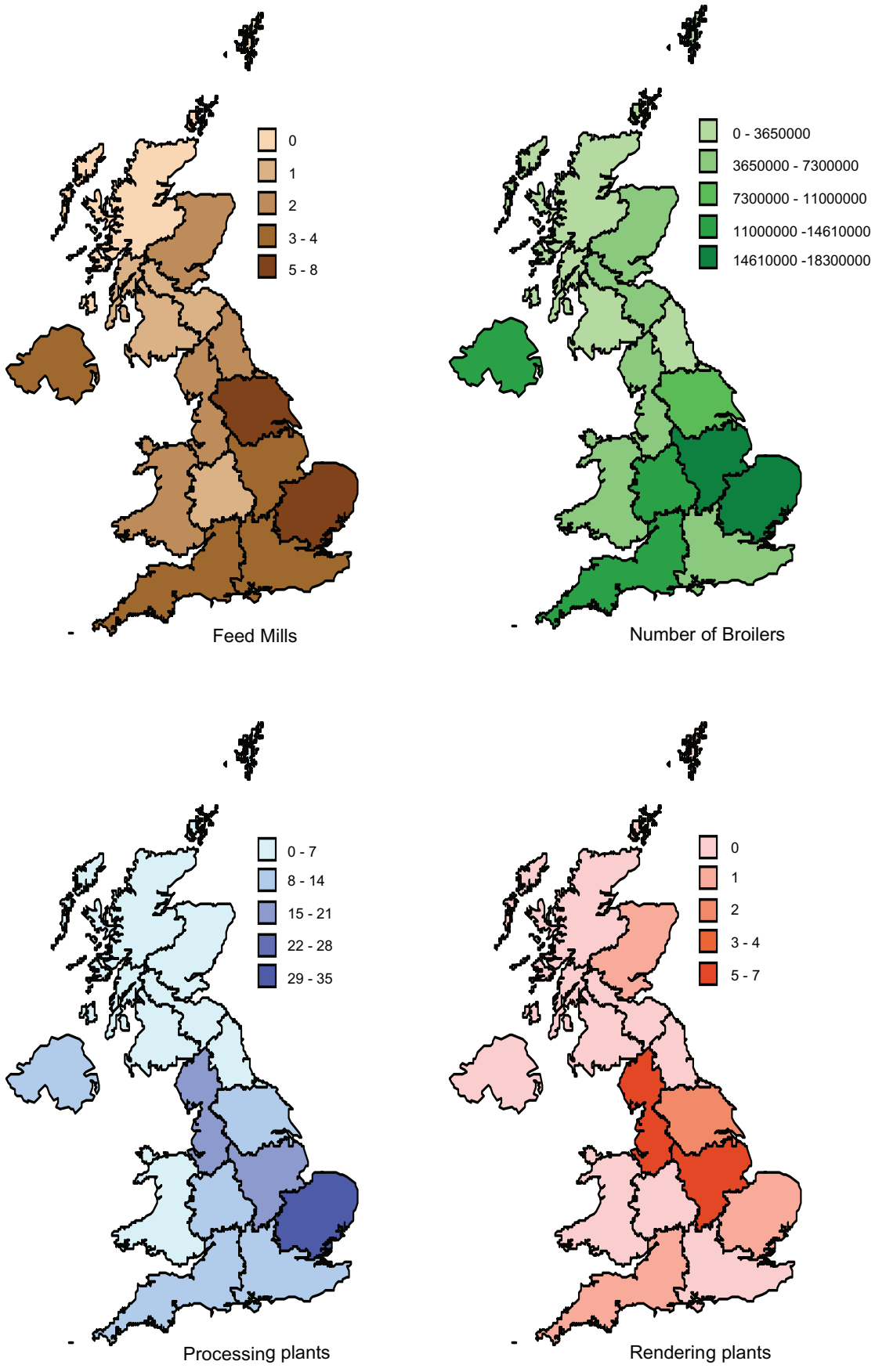


Figure C.1.2 Regional distribution of poultry meat production

C.1.2 Inputs, Outputs – the Balance

Whilst the primary aim of the study is to quantify the flows of carbon (in the form of energy and emissions) and water through the sector, in the course of gathering data, all significant materials flows have been quantified to enable the data to be used within the framework of Mass Balance UK.

The accounting period for the mass balance of the UK poultry industry is taken as January – December 2002, and the flows quantified by the project are as follows:

Initial Stock – for mass balance purposes, this report assumes that no finished product or raw materials existed within the sector at the beginning of the study period, or remains at its end. However, account is made of the number of birds existing on farms at the beginning and end of the period, the two values being the same, there having been no significant growth or contraction of the industry over the study period.

Imports – the quantities of materials brought into the sector from other sectors. The primary imports into the sector are the ingredients of feedstuffs, bedding, energy, water, packaging, process chemicals and medicines. No account is taken of the inputs required to produce or transport materials such as cereals, oils and packaging to production sites, the environmental costs of which are assumed to be associated with other sectors such as farming and packaging production.

Produced/extracted – no raw materials are extracted, or produced in the sector.

Exports – the primary exports from the sector are whole birds and portions that are either sent for retail sales or use in the catering sector. The bulk of exports are fresh chilled, but some account is made for the supply of frozen product for sale in either the home or export market. Environmental exports from the sector can be directly set against imports of feed, water and energy.

Embodied – the only material embodied in the sector is the packaging used to protect products in transit, on the supermarket shelf and in storage awaiting consumption.

Transformed – no materials are transformed by any of processes in the sector.

Recycled/recovered – some of the materials arising from the sector have been identified as being transferred for use in another sector. Some waste arisings in parts of the sector are taken for recycling, for instance paper and metals, or are recovered for other uses, for instance litter from farms can be used for power generation in specialist plants, or applied to land

Sub-sector	Surveyed Production	UK Production	Proportion of Sub-sector
Feed Mills	1,483,671 tonnes	3,823,662 tonnes	38.8%
Total Broilers	208,803,157 birds	808,000,000 birds	25.9%
Conventional Broilers	206,359,259 birds	No separate statistics available	
Free Range Farms	677,857 birds		
Organic Farms	189,069 birds		
Turkeys	10,228,430 birds	23,000,000 birds	44.5%
Ducks	1,997,032 birds	20,000,000 birds	10%
Processing	251,905 tonnes	1,533,000 tonnes	16.4%
Rendering	149,000 tonnes	tonnes/year	%
Pet Food	48,811 tonnes	tonnes/year	%

Table C.1.2 Proportion of poultry meat industry surveyed

as a fertiliser. Recycled and recovered material can be set directly against imports such as feed, bedding and packaging.

Disposal – the volume of material going for final disposal from the sector is relatively small, mainly comprising animal by-products that are unfit for human consumption, liquid effluents and some waste packaging materials.

Emissions – emissions from the sector are primarily to atmosphere and water, and include gaseous emissions from poultry housing, washing water discharged to sewer from several sub-sectors and steam, comprising waste heat and water, from feed production and final processing. Emissions can be set directly against imports of protein, water and energy. However, no quantitative data exist for many of the emissions from the sector, and estimates have been made using information from research in the UK and elsewhere in the EU.

C.1.3 Data Gathering

The initial sample for study was taken to be a group of larger, mainly integrated companies active in the sector. However, in order to ensure that smaller scale, and niche production could be accounted for in the final output, contacts were broadened to include a representative number of small-scale, free range and organic producers. Of the companies and individuals approached, few refused to participate in the project. It is estimated that the following proportions of the sub-sectors making up the industry responded by providing information for one or more of the sub-sector studies. It was originally anticipated that the response would be in excess of 50% for all sectors.

A series of seven questionnaires was mailed to relevant potential respondents in the sub-sectors and responses were made over a period of eight months. The sub-sectors were as follows: feed mills; hatcheries; growing farms (split in turn into breeding, laying and growing units); processing; rendering and pet food. A separate questionnaire was used to assess the impact of transport. The excessive time taken for responses to be made was primarily due to the complexity/unavailability of the data requested and change within companies.

The data gathered were input into a series of interactive MS Excel spreadsheets that allowed data to be verified as reasonable as it was recorded. Data quality queries where addressed as they arose and, where required, corrections made. The data were then manipulated to ease production of a range of benchmarks and the information required for the UK mass balance. The regional distribution of sub-sector activity within the poultry industry is shown in Figure C.1.2. The response to the request to complete the questionnaires was good, although a single, large integrated company failed to make any returns as promised at the outset of the project; this was due to internal restructuring during the period when the returns were required to be made.

Overall, the responses account for 221,028,619 birds produced in the study year, that is 26% of the UK's annual poultry production; and 251,473 tonnes of finished product, that is 16.4% of UK production. It is considered that this level of response makes the conclusions of the project relevant to the whole UK poultry industry.

In addition to 1,533,000 tonnes of home-produced meat processed in the UK, a further 354,000 tonnes were imported for further processing and 194,000 tonnes exported during the study period, a net supply of 1,693,000 tonnes. Imports of broiler meat have historically been derived mainly from Brazil and Thailand, but the accession states to the European Community, where energy and labour costs are lower than in UK, are likely to provide an increasing proportion of UK meat imports over the next few years.

The distribution of farm units throughout the UK cannot be inferred from the responses received because of the high proportion arising from integrated companies that either made a consolidated return or did not identify individual units by location. The distribution of poultry units in the UK shown in the maps on Page 31 is inferred from Defra data.

C.1.4 Data Validation

Data input into the spreadsheets for analysis were validated initially by comparison with industry standard performance data and subsequently with a rolling average of data input. Where significant differences were detected, the relevant respondent was contacted by telephone and the return discussed.

Many inconsistencies were identified in the course of data inputting, the main reasons for the differences were:

- misunderstanding of the questionnaire;
- use of the incorrect units;
- the production site being left 'fallow' for part of the study year;
- and mixed use of buildings unaccounted for in the questionnaire design. All inconsistencies were corrected using revised information submitted by respondents.

Much of the requested quantitative data was not readily available to all respondents and in some cases returns simply identified the method of sourcing/disposal. For the purposes of the mass balance, this information has been used with quantitative data to extrapolate the quantities of materials used/waste identified in returns onto national consumption/production.

C.2 Mass Balance Outputs

The acquisition of data for this mass balance was intended to make it possible to address all aspects of the sector and enable comparisons to be made between species in various sub-sectors. However, the variable quality of responses and low number of respondents in certain sectors has made it impossible to produce a comprehensive set of data as intended.

Where possible, the analysis of the mass balance in the sub-sectors laid out below includes data for all three species and a summary of the whole sub-sector. Where one or more sub-sectors or species are not presented, it is because either:

- there were insufficient data of adequate quality to make a valid assessment; or
- the sub-sector was so dominated by a single company or enterprise that the presentation of the data would breach confidentiality agreements made with contributors.

C.2.1 SIC D15.71 Manufacture of prepared feed for farm animals

This part of the sectoral mass balance consists only of data relating to the manufacture of poultry feed by the animal feed industry; it does not include home-produced feeds used on some smaller poultry farms or any feed for non-avian species. Mills producing poultry feed often specialise in production of both poultry and pig feeds, which are similar in constitution, both animals being monogastric. A small number of mills produce poultry feed alone. Estimates of inputs for poultry feed production were made where two feed types were produced at a single mill, and this is allowed for in the Mass Balance calculation. For the purpose of this exercise, no differentiation has been made between feeds manufactured for different species.

The total quantity of poultry feed produced in the United Kingdom in the study period was 3,823,662 tonnes, of this tonnage, 1,483,671 tonnes (39%) were identified by the respondents and input data provided. The results of

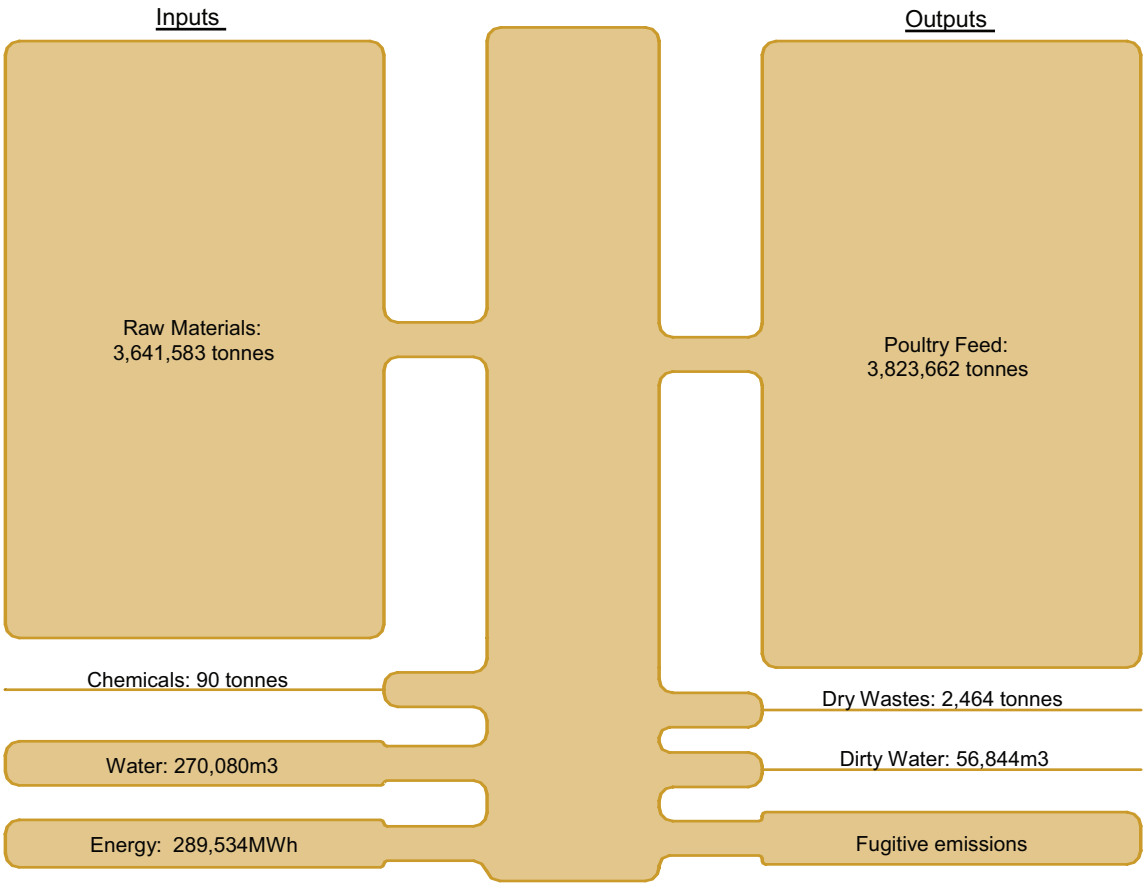


Figure C.2.1 Mass balance of the poultry feed sector

the survey have been extrapolated to provide the following estimated data for the sub sector and are shown below:

The balance of mass in the above table, excluding energy, shows an apparent imbalance of 28,783 tonnes (0.75% of total output). This small loss can be accounted for in: energy embedded in the finished product; water taken off-site in on-board truck washing systems; evaporation and steam lost to atmosphere during production and associated processes; and an underestimation of the volumes of dry wastes and dirty water arising from the process.

Of the total water input to the sub-sector, only 21% is accounted for as dirty water arising from production; this mainly arises from lorry washing, the balance being lost to atmosphere or embedded in the compound feed. Of the wastewater identified by respondents, 35% was applied directly to land and the remaining 65% either treated on site, or discharged to the public sewer.

The energy consumption per tonne of feed produced by the respondents was 75.722kWh, that is 289,534MWh for all feed produced. The breakdown of energy sources used in the production of poultry feed is shown in Figure C.2.2.

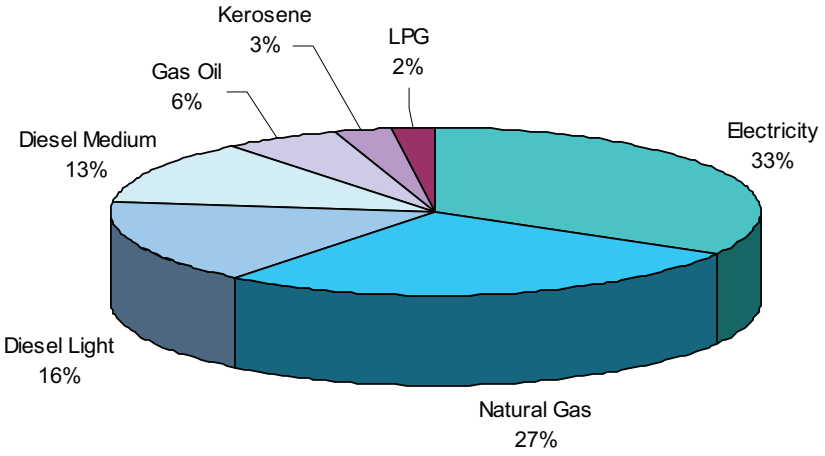


Figure C.2.2: Breakdown of energy sources used in the production of poultry feed

The sub-sector used about 0.0236 litres of chemicals per tonne of feed produced, mainly disinfectants, detergents and odour control agents.

The volume of solid waste produced per tonne of poultry feed was 0.00064 tonnes per tonne of feed produced. The majority of solid wastes produced arose from consumption associated with production; such as packaging and consumables. The inferred quantity of solid waste produced in the course of poultry feed manufacture was 2,464 tonnes. The chart below shows the breakdown of waste types produced and their fate in terms of disposal to landfill or recycling.

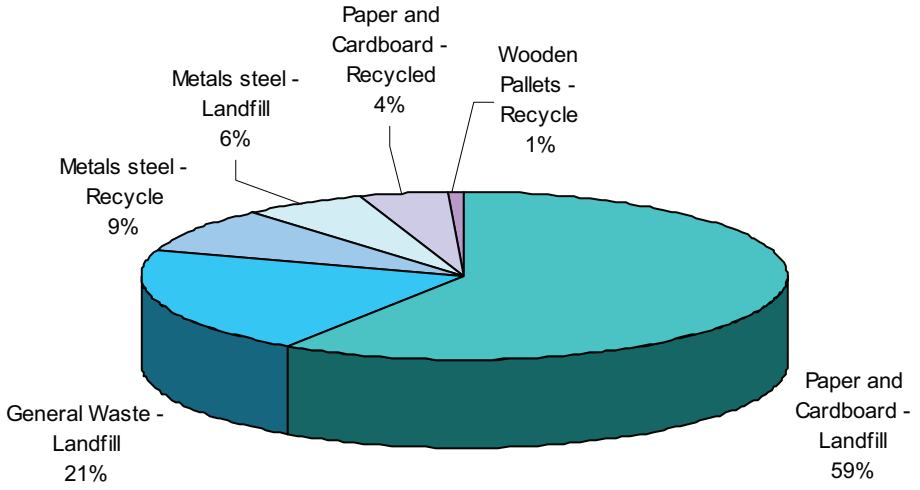


Figure C.2.3: Breakdown of the waste types arising from the feed sector

C.2.2 SIC A01.24 Farming of poultry

This section of the report uses data derived from the majority of UK production described under this SIC code. For the purposes of this project, the farming of poultry is taken to include the breeding, hatching and rearing of all birds, including elite, grandparent and parent generations, and the growing of the commercial broiler, turkey and duck flocks in the United Kingdom.

In order to provide comparisons between sub-sectors and species, where possible, poultry farming has been broken down into hatchery and breeding, and chicken-, turkey- and duck-growing sub-sectors. Where sufficient suitable data are available the latter three sectors have been analysed separately, using similar parameters. The number of birds surveyed was related to the total number for the period taken from Defra statistics and overall consumption and outputs for the UK sector inferred from that relationship.

In order to overcome the question of "which came first?", the statistics for hatcheries are addressed before those for breeding flocks.

• Hatcheries

The number of eggs set in the United Kingdom for poultry meat production during the study period was 1,081,880,000, and the number of chicks placed 817,880,000; a successful hatching for 75.6% of placings. The survey included duck hatcheries and identified 200,113,895 duck eggs being placed in the study period, that is 18.5% of the number identified by Defra, and 158,114,408 chicks produced for placing on farms, that is 19.33% of the Defra figure. The successful hatching rate for the survey population was 79.01%, that is 3.41% better than the Defra population.

The mass balance for the sub-sector has been calculated using the Defra statistics for the number of viable chicks produced, and subsequently placed, in the commercial broiler, broiler breeder and turkey sub-sectors.

The result of this balance shows a discrepancy of 398,282 tonnes more input than output, 42% of the total mass input excluding energy. The imbalance is most likely to be accounted for in the form of heat and water vapour exhausted from the hatchery in the course of

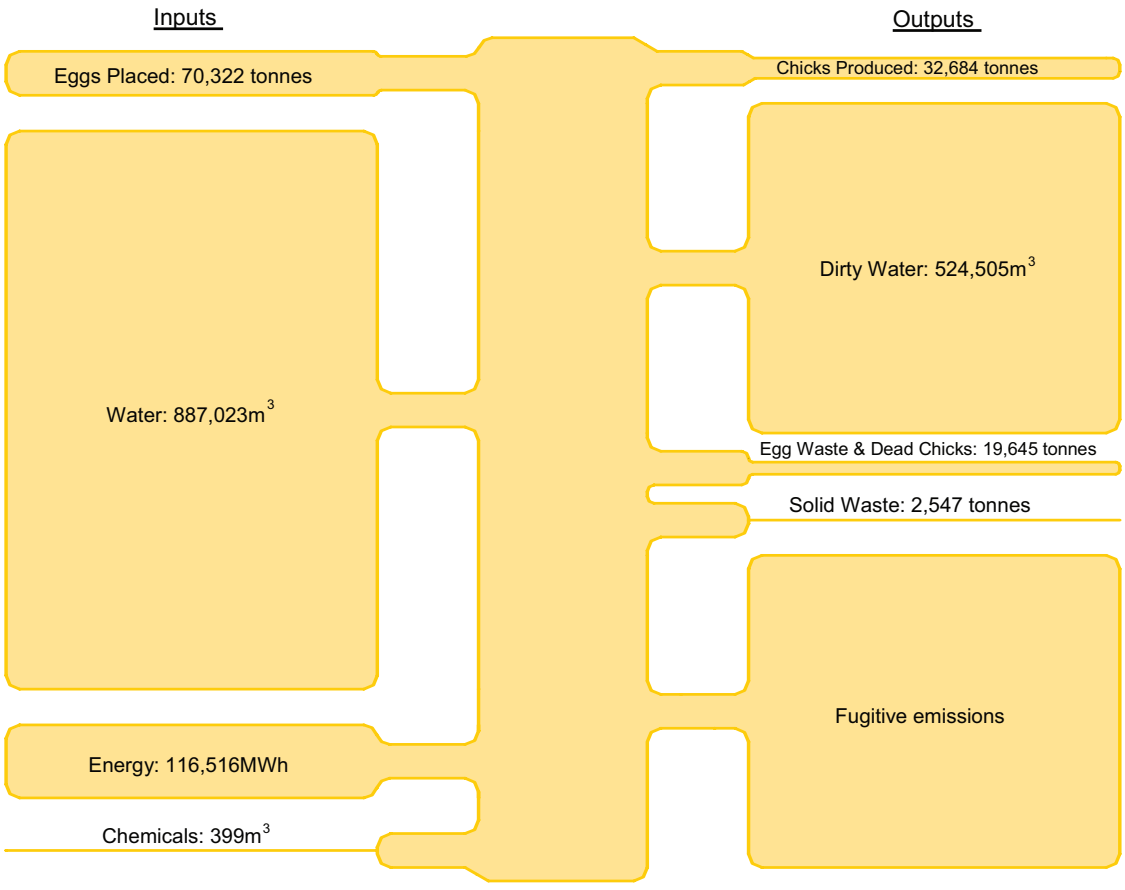


Figure C.2.4 Mass balance of the hatchery sector

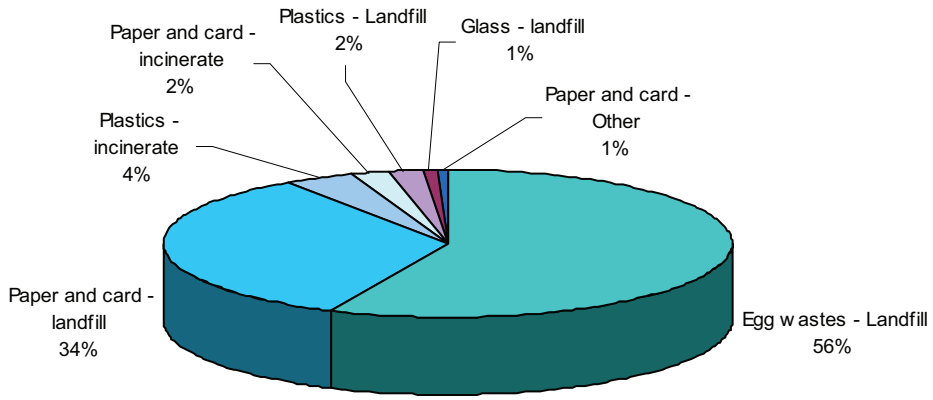


Figure C.2.5: Breakdown of the waste types arising from the hatchery sector

normal ventilation and during the routine cleaning down of buildings. Chicks also metabolise a significant amount of energy derived from the egg yolk between hatching and being placed on a farm.

The sources of energy used and wastes arising from the sector are shown in Figure C.2.5.

• The Breeding Flock

For the purposes of this report, the 'breeding' flock has been limited to broiler birds and split into three component parts, Breeding, Rearing and Laying, each of which has its own defining characteristics in terms of feeding regime, ages of stock and stocking density. Turkeys and ducks have been excluded from this section because of the relatively small number of companies involved in the sub-sector.

Birds culled from the breeding flock are used in meat production but are not accounted for elsewhere in the balance because of the difficulties in differentiating between birds culled from the broiler breeding and egg-

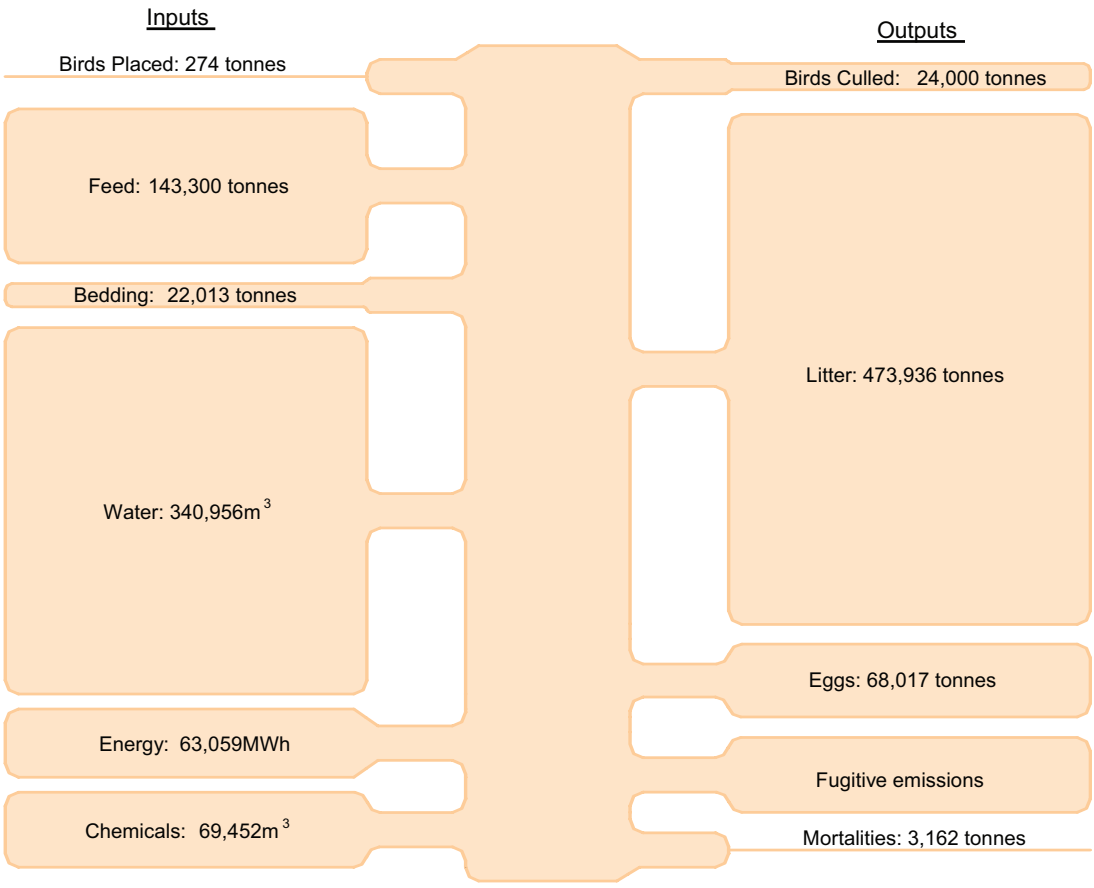


Figure C.2.6 Mass balance of the poultry breeding sector

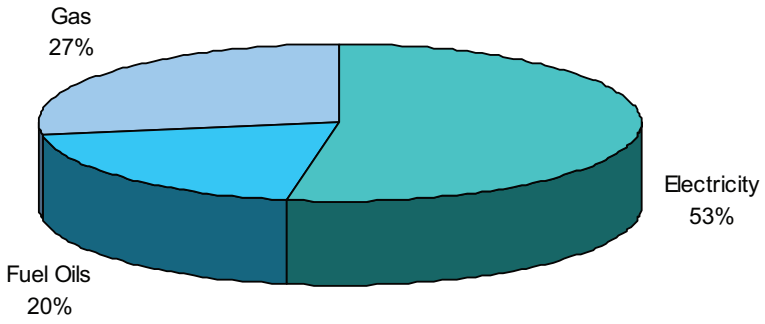


Figure C.2.7: Breakdown of the energy sources used in the breeding sector

production flocks, since they are shown as a single statistic.

The questionnaire returns indicated a level of mortality in the breeding flock 45% lower than that shown in the Defra statistics used to calculate the above balance.

The split between the sources of energy used in the sector are shown in the chart above.

• Broiler Growing

The number of broiler chicks placed in the UK during the study period, as identified by Defra was 817,110,000, including broiler breeders. The number of placements identified in the survey was 208,803,157 chicks, that is 25.6% of all placements in the UK. The number of birds identified by Defra as being produced, not including 'Dead on Arrivals' (DoA) or slaughterhouse rejects, was 832,560,000 birds. The output from this sub sector identified by the survey was net of mortality on the farm,

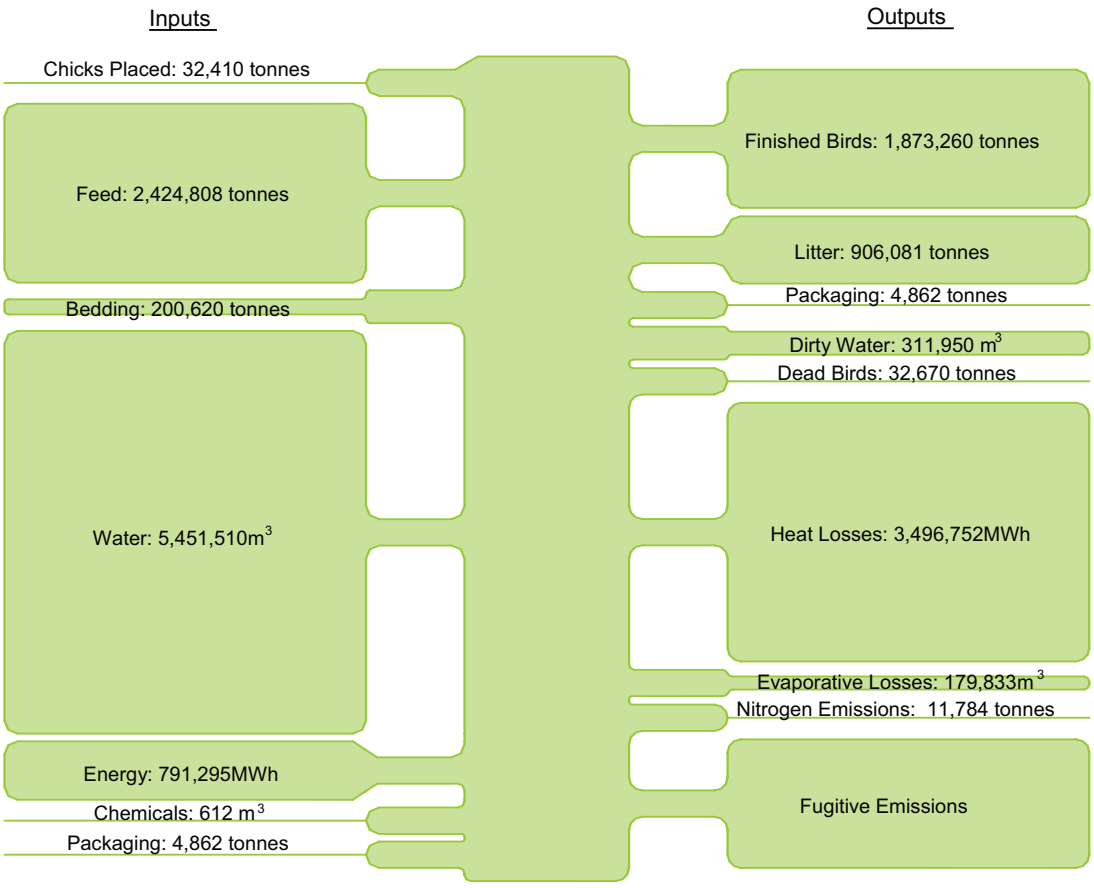


Figure C.2.8: Mass balance of the broiler growing sector

and included DoAs and slaughterhouse rejects, which are accounted for in the transport and processing sections of the Mass Balance respectively. In the absence of a direct comparison between Defra data and gathered data, calculations for this section of the Mass Balance are based on the number of chicks placed on UK broiler farms taken from Defra statistics.

Where lower numbers of placements were identified in any section of the questionnaire, adjustments were made so that a true 'consumption per chick placed' could be calculated.

The majority of the imbalance between inputs and outputs in this sub-sector are likely to be accountable as emissions of gases, heat and water vapour from the houses.

Energy use in the sub sector is divided between sources as shown in the chicken pie chart below. Generally, gas is used for the heating of houses at the beginning of the production cycle and electrical energy is used to drive ventilation fans for cooling and moisture removal towards the end of the production cycle. Fuel oils are generally used in the generation of electricity to power ventilation fans during power cuts, or provide power for additional ventilation fans during adverse (hot) weather conditions.

• Turkey Growing

The number of bird placements identified by Defra for the study period was 23,530,000; including female breeder poults. The production identified in the survey was 9,897,259 birds, that is 42% of UK output. Where lower numbers of birds were identified in any section of the questionnaire, adjustments were made so that a true 'consumption per bird' could be calculated.

The information gathered from the turkey sector is dominated by information returned by a single company. In view of the commercial confidentiality of the information contained in the returns, the use of data from this sector has been limited to the benchmarking of agreed parameters.

• Duck Growing

Defra keeps no separate data detailing the number of ducklings placed in the UK. Assuming an 80:20 split between ducks and geese in the UK population, the number slaughtered in the study period was 20,000,000, taken from the Defra returns for ducks and geese combined. The study received returns for 2,761,121 ducks slaughtered, that is 13.8% of UK production. The mass balance above extrapolates UK consumption and output values from information relating to the surveyed population.

Because of the predominantly outdoor nature of duck rearing, and the ducks' love of water, it is assumed that the volume of water used in this sub sector is either taken up by the birds or lost to the wider environment. This loss accounts for a substantial part of the imbalance between mass input and output, the bulk of the remainder being accounted for by gaseous losses to atmosphere.

• All Poultry Growing

The production of a mass balance for the overall UK Poultry Industry using data acquired from contributors would make it possible to infer performance for the turkey sector generally, and thus the performance of the farming activities of a single major producer. With this in mind, the mass balance of the farming sector has not been produced for publication in this document.

C.2.3 Transport of within the Poultry Sector

For the purposes of this report, transport within the sector includes all vehicle movements concerned with the movement of finished animal feed to farms, eggs

Bird Type	km per bird	Average live weight (kg)	km/kg live bird	km/kg fresh meat
Broiler	0.07	2.25	0.03	0.044
Turkey	0.43	13.52	0.03	0.038
Duck	0.09	3.872	0.02	0.032

Table C.2.1: Distance travelled per bird

from, and day old chicks to, farms, and commercial broilers from farm to processing plant. Vehicle movements associated with the administration of activities has not been included, although the data were collected.

The questionnaire sent to businesses related the distance travelled by vehicle types to sub-sectors, and this information has been extrapolated to arrive at the overall distances travelled within the sector. The data provided by respondents was accurate, but it is not known how representative the data are in relation to either individual sub sectors or the whole industry.

Table C.2.1 shows the number of HGV1 kilometres travelled per bird produced in the broiler, turkey and duck sectors, and relates that to the distance travelled per kilogram of live bird.

The figures show that despite the apparent imbalance between the distance travelled by individual turkeys and that travelled by ducks and chickens, the total distance travelled per kilogram of live bird is similar. Given that the eviscerated yield in each of the species is ducks 72%; broilers 70% and turkeys 82%, the distance travelled per kg of fresh turkey meat produced improves greatly in comparison with duck and broiler meat; this is due to the high eviscerated yield of turkeys.

The major waste product attributable to the transport subsector, other than lorry washing water, which is accounted for in the processing section of the balance, is mortality en route between farm and factory. Generally, this figure is taken to be in the region of 0.19%.

C.2.4 SIC D15.12 Production and preserving of poultry meat

This section covers the production and preserving of poultry meat as described in the SIC Code. That is, as the production of fresh, chilled or frozen chickens, turkeys, geese, or ducks, and the fresh or frozen fatty livers from ducks and geese and other offal from poultry generally.

This sector does not include the further processing of meat, or any of the above-mentioned products, which are classified under SIC Code D15.13 The production of sausages and pies, pate and pastes, and prepared

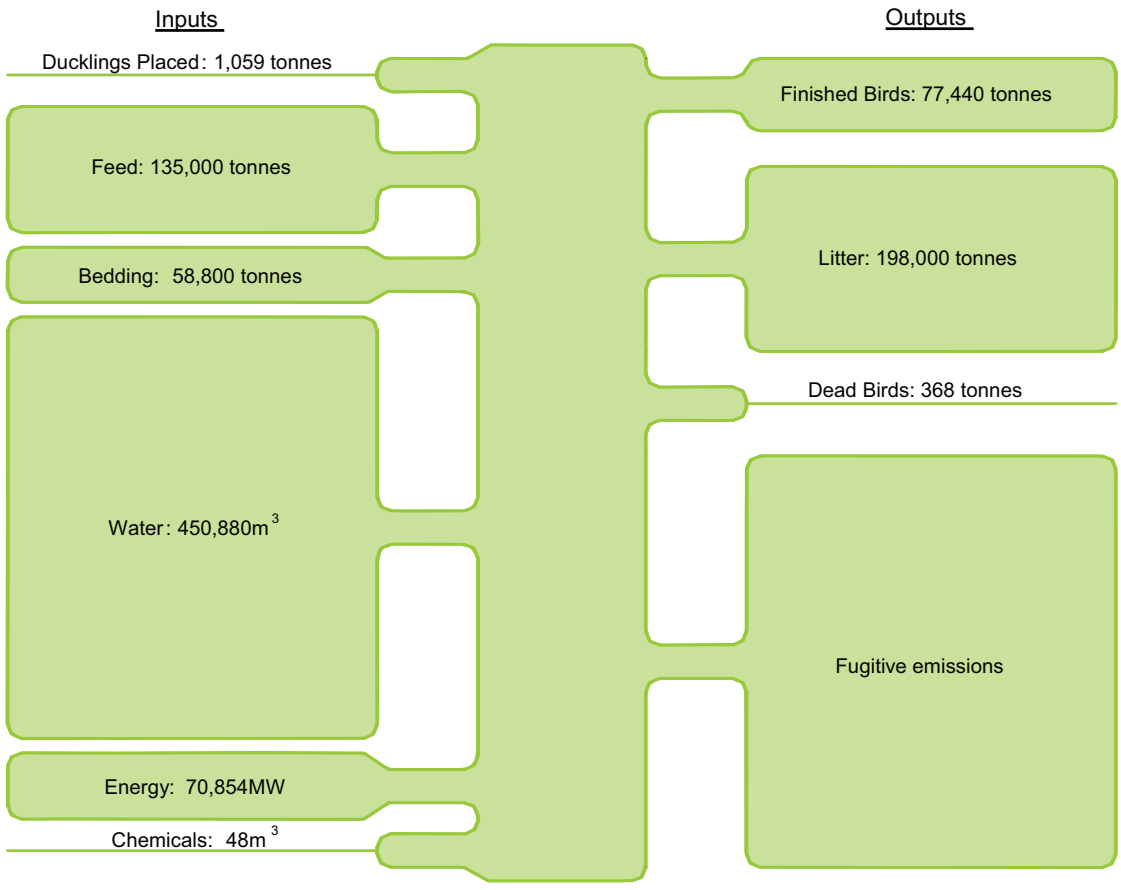


Figure C.2.9: Mass balance of the duck growing sector

meals, and preparations of meat, meat offal or blood. It does, however, include the meat used in these products.

The calculation of water usage and wastewater arisings during the production and processing of poultry meat was not straightforward. It was impossible to make any general conclusion regarding the volume of water used – or waste water arising – per tonne of meat produced. The reason for this was the wide range of input and output volumes per tonne of meat produced given in returns and the lack of any relationship between species or production volumes, and water in or waste out. Given the low level of confidence in many data returns, it was concluded that the value used in the Mass Balance calculation should be inferred only from accurate returns, which could be checked against standard values.

• Broilers

The Defra data for broiler slaughterings in 2002 shows a total of 832.56 million birds, producing a carcase weight of 1,202,170 tonnes, that is an overall eviscerated yield of 65% assuming an average live bird weight of 2.2kg. This statistic does not include birds that were rejected as unsuitable for human consumption post-slaughter; for the purposes of this project such birds are classed as 'Meat Wastes'.

For the purposes of this study, 'dry wastes' include: paper and card; plastics; glass and metal. 'Dry wastes' are solely derived from discarded packaging such as wrapping from deliveries of food containers and consumables' containers.

The materials influx of any food processing plant is dominated by water for washing and cleaning, energy for cooling meat and heating water, and chemicals for disinfection and for use in cooling plant.

Cooling is necessary initially to reduce carcase temperature to ease cutting and subsequently for conservation, as chilled or frozen whole birds or cuts. Meat that is subsequently used in the production of added value products is kept in cool storage until it is required for further processing.

Hot water is used for cleaning down and at various stages of production.

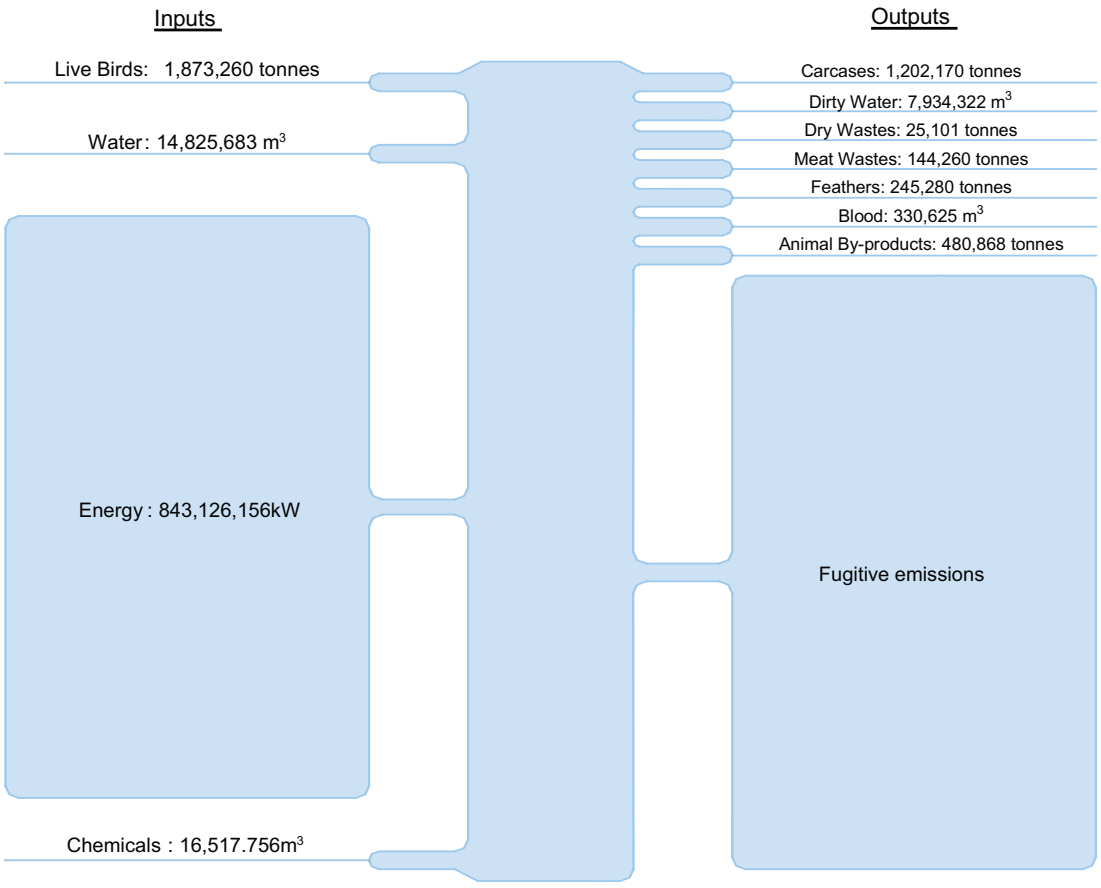


Figure C.2.10: Mass balance of the broiler processing sector

• Turkeys and Ducks

Due to the relatively low number of returns obtained from turkey and duck processors, the information relating to the turkey and duck processing sub-sectors have been combined for the purposes of this report.

During the survey period, Defra statistics show that 23,000,000 turkeys were slaughtered. There are no accurate figures for the number of ducks slaughtered in the period. It is considered that the major processors slaughtered in the region of 18,000,000 birds in the study year.

Wastes arising from the turkey and duck sectors are broadly similar to those from the broiler sector, with the exception of waste wax, a by-product of the plucking of ducks.

• All Poultry Processing

The fundamental mechanisms involved in the processing broilers, turkeys and ducks are common. The most significant difference is the cooling of turkeys prior to cutting, which is normally achieved by immersion in water, rather than by air chilling. This is due to the amount of time required to reduce a whole turkey carcase to cutting temperature.

The staged development of many poultrymeat-processing plants is also a common feature. As advances in technology and changes in environmental and welfare regulation have progressed, plants have been improved and adapted. This has resulted in very few truly integrated plants, capable of exploiting fully technology that might bring about savings in energy and other resource use.

The values underlying the above statistics have been input to Mass Balance UK.

The principal opportunities for significant reductions in the volumes of wastes arising from the sector lie in two areas. The recovery of low-grade waste heat from refrigeration plant for use in the pre-heating of water destined for steam raising and the use of water in washing-down food production areas. Whilst water reduction can usually be achieved through management measures, the integration of refrigeration and steam raising plant may require a significant amount of capital investment as well as redesign of plant layout.

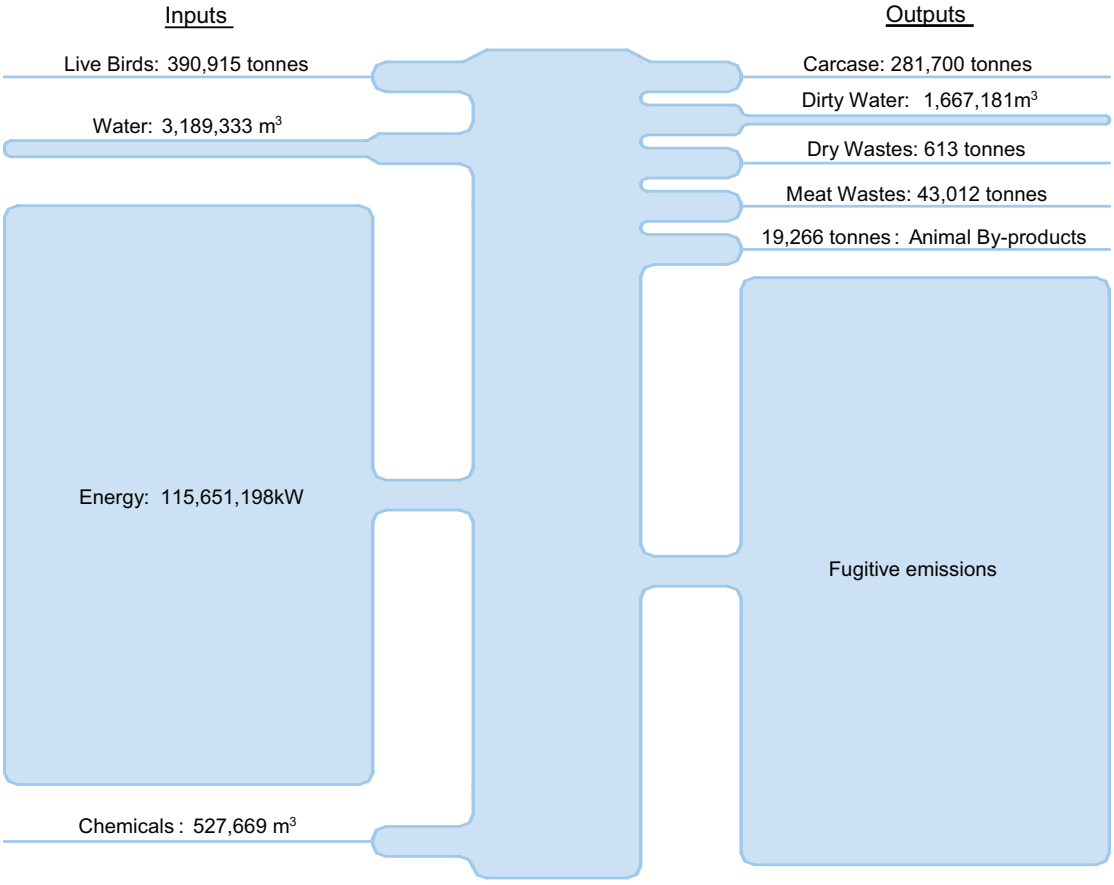


Figure C.2.11: Mass balance of the turkey and duck processing sector

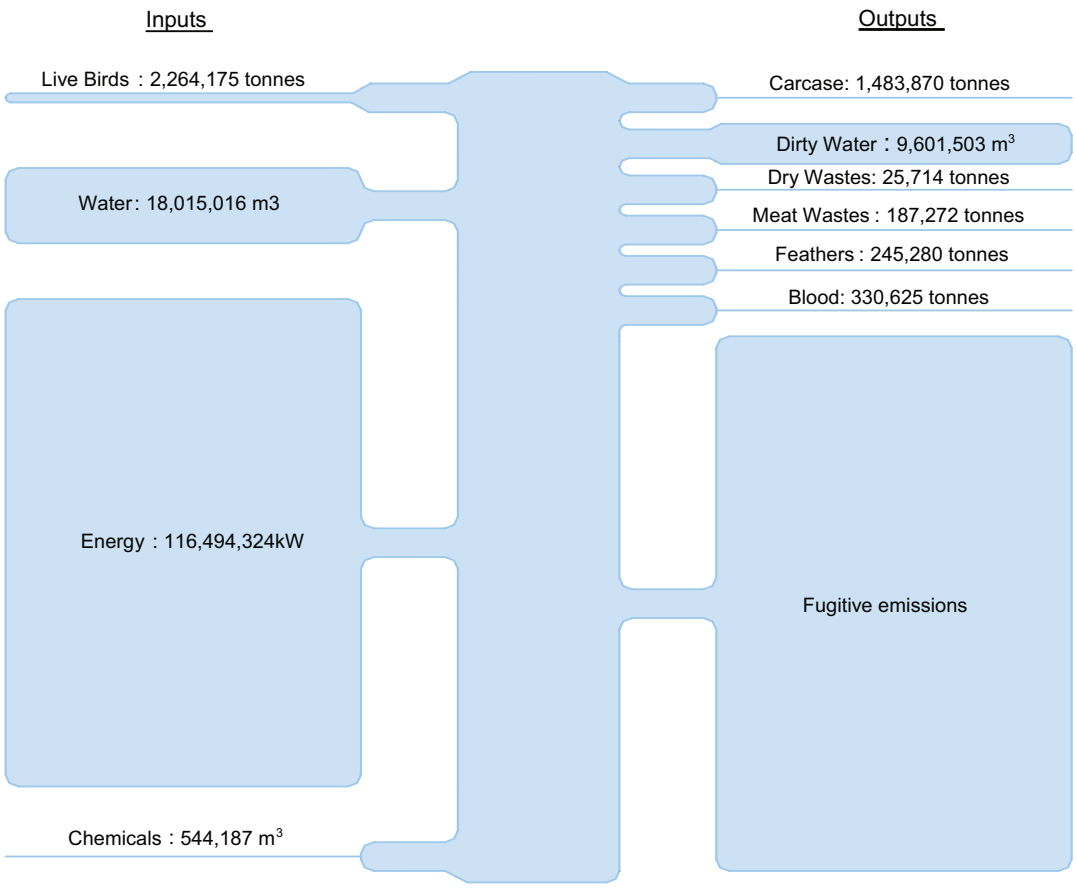


Figure C.2.12: Mass balance of the poultry processing sector

C.2.5 SIC D15.72 Manufacture of prepared pet foods

The part of this classification covered by this project is limited to the primary stages of pet food manufacture, producing chilled, fresh meats for canning, and rendered meals and poultry fat.

This sector of the industry is primarily concerned with what is left of a bird after meat and offal have been removed for human consumption.

There are 25 dedicated rendering plants across the UK, processing around 1.75 million tonnes of material per annum, about 35% of which is derived from the poultry sector.

The survey returns account for 259,000 tonnes of waste from the poultry sector. Based on the total number birds processed in the sector, it is assumed that the total volume of poultry-derived material processed in 2002 was about 631,000 tonnes, made up of waste from slaughter, blood, feathers and mortalities; the study accounts for about 41% of the UK throughput of poultry waste.

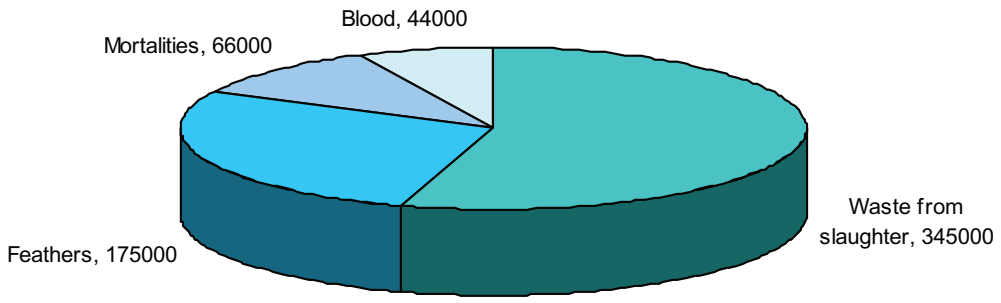


Figure C.2.13: Breakdown of raw materials rendered

Mortalities are made up of birds that were dead on arrival at the processing plant and those that were condemned as being unsuitable for human consumption at the processing plant. This material is normally rendered and the resulting high dry matter material sent for incineration.

Feathers and blood arising from poultry production have in the past have been used in the manufacture of feather and blood meal; which, in turn, has been a used as a component in animal feedstuffs. The use of blood and feather meal in animal feeds is now banned in Europe, Canada and the United States. Much of the rest of the world is considering the imposition of a similar ban in order to prevent the spread of *inter alia* avian flu; which can be transmitted in contaminated product. Blood and feather meal can still be used as a nitrogen source in feed used on fish farms. In the absence of a ready market for the material, the majority of meal produced from feathers and blood is incinerated.

The remaining material is waste from poultry fit for human consumption, and therefore suitable for inclusion in pet food. Material, such as heads feet and viscera, taken from carcases deemed fit for human consumption is mostly ground and chilled prior to inclusion in moist pet food. Other material, waste fat, some feathers, heads and viscera, is ground and cooked to destroy pathogens and reduce moisture. The component products (poultry fat and meal) are then separated and taken for further treatment based on end use. Depending on the source of the waste from which the fat and meal are derived, tallow and poultry fat are used in; animal foodstuffs and as an oil replacement in combustion. Meal is used in pet food manufacture and as a solid fuel replacement in power generation and cement manufacture.

The total amount of raw materials from the poultry sector rendered in the UK in 2002 was about 630,000 tonnes, made up of the fractions shown in the figure C.2.10.

The outputs from the sector generally relate directly to the volume input in the following approximate proportions: 11% poultry fat or tallow; 21% meal and 68% water vapour. The bulk of water vapour is

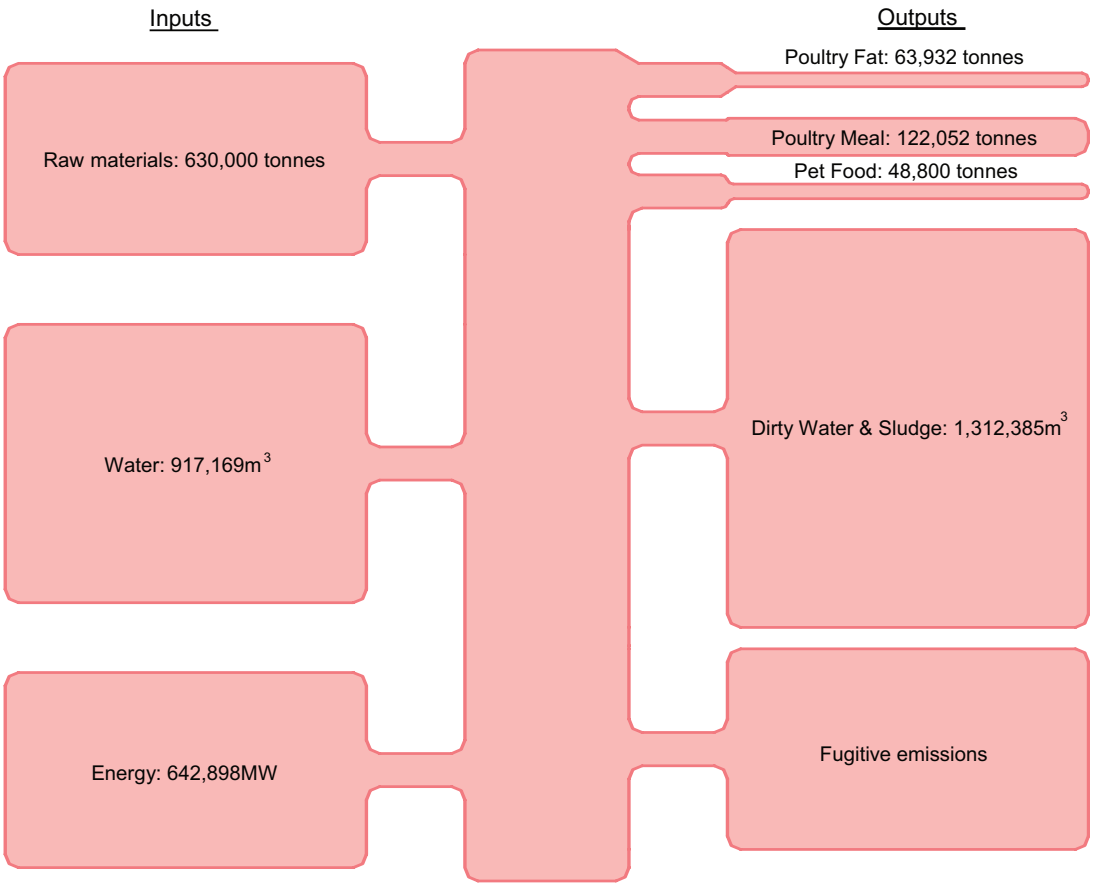


Figure C.2.14: Mass balance of the Poultrymeat rendering sector

condensed out and discharged to sewer or applied to land with any non-condensable vapour discharged to atmosphere via an odour control system.

Condensate from rendering contains a significant quantity of nitrogen, the major source of which is protein in blood and meat particles. Historically, this has been applied to agricultural land untreated, but since 2001 it has to be treated to discharge standards set out in the Rendering (Fluid Treatment) (England) Order 2001, before being applied to land or disposed of via sewer or watercourses.

The sludge fraction of the waste arising from rendering plants is also applied to land.

C.3 Ecological Footprint

C.3.1 Background

The ecological footprint of the UK poultry industry provides an indicator of the aggregated natural resource consumption of the sector in the same way as established indicators may represent various aspects of the financial sector.

The footprint accounts for use of renewable resources only, and the consequential demands placed on the environment. Non-renewable resources are only accounted for by their impact on, or use of renewable, productive biological capacity.

The footprint of the poultry industry is defined as "the area of land and sea that would be required to maintain current levels of consumption, using existing technology." Since many of the environmental impacts of production in the UK are outside the country, footprinting effectively re-allocates environmental pressures, first on the industry and subsequently down the supply chain to the consumer.

The footprint is measured in global hectares (gha), a standardised unit equivalent to a world-average productive hectare. Whilst no account is made for variation in productivity of land, such standardisation does permit global comparisons, between nations and regions, industries and companies.

The footprint includes land necessary to sequestrate carbon dioxide emissions from power generation and on-site fuel usage.

In 1999 the global average personal ecological footprint was 2.3gha, compared with a global capacity of 1.9gha. This value suggests that the human race is using more natural resources than can be sustained. The average personal ecological footprint in the UK in 2000 was 4.9gha, and in the south east of England 6.8gha; the average citizen of the United States has a footprint of 9.6gha.

C.3.2 Energy Use

Energy use by the sector is accounted for in the ecological footprint by direct land use plus the land required to reabsorb associated carbon emissions; referred to as 'energy land'. Potential for significant reductions in energy use in the sector have been identified and, if implemented, the relevant measures would result in a reduction in the sector's footprint.

The ecological footprint of energy use in the UK poultry industry is 0.25ha per tonne of poultry meat produced, that is a total of 300,542gha of energy land.

The use of energy in the sector is heavily weighted towards the ends of the supply chain, that is, feed production and processing, with electricity being the most common energy source. It should be noted that the feed production sub-sector uses energy for the generation of heat used in the production of compound feeds, whilst the processing sector uses energy for cooling of produce before it enters the further processing/retail/consumer sectors.

Significant savings could be made by reducing the amount of compound feed used on farms and by the recovery of waste heat from cooling produce, that is the integration of feed and final processing.

C.3.3 Water Use

A range of sources are used for water supply throughout the sector, and the level of treatment varies significantly between water used for washing down on farms to that used for washing down in food processing plants. The different sources of supply are accounted for in the main footprint, and on-site treatment is accounted for in the chemicals input to the footprint.

The consumption of water in the processing sector accounts for more than 97% of the total volume used in the industry, this is accounted for by the need for frequent cleaning of machinery and production space.

The water footprint for the UK broiler industry is 0.02gha of energy land per tonne of meat produced, or a total of 24,043ha. This takes no account of any mains leakage that may exist, and accounts for energy consumption in purification and transmission of raw water.

Any significant reduction in water usage in the sector is likely to be compromise either bird or human health, the greatest part of the consumption being used for the cleaning of bird housing and processing plants.

C.3.4 Feed Raw Materials

The principal ingredients of poultry feed used in the UK are shown in Figure C.3.1. The majority of inputs are from UK sources, other than Soya, which is mainly imported from the Americas. The 'growing' footprint of

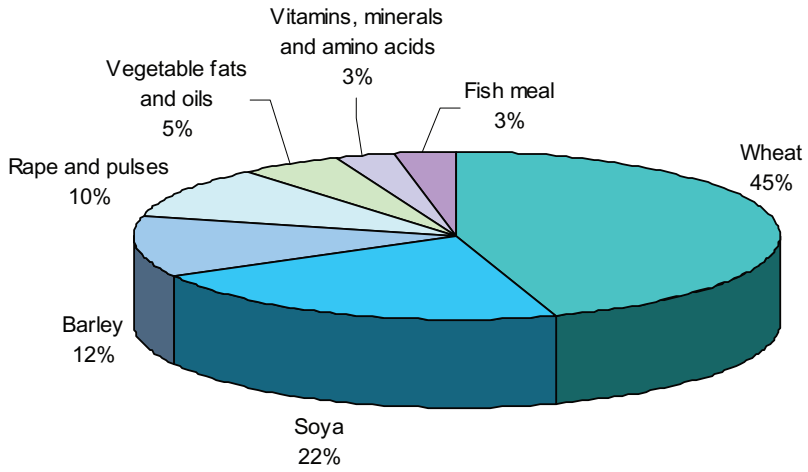


Figure C.3.1: Composition of broiler feed

the feed ingredients is 3.63gha/tonne, that is, the actual land area required to grow the crops; 16% of that area is outside the UK and a further 13% (0.47gha) is sea.

This part of the footprint can only be reduced by increased efficiency in production. Any such improvements, other than those associated with plant performance, are likely to be accompanied by increased consumption elsewhere, and may ultimately prove to be neutral or possibly negative in terms of global impact.

C.3.5 The Nitrogen Balance

The efficiency of conversion by poultry of vegetable protein contained in cereals, oilseeds and pulses to meat proteins is traditionally seen as one of the poultry industry's great strengths. Any industry footprint based on the use of imported and home-produced ingredients that have been grown using artificial fertilisers will include a significant impact from that area alone.

The poultry industry produces a significant quantity of nitrogenous waste in litter at the end of production cycles, and emits nitrogenous gases during production, subsequent storage and spreading of manure; none of these issues arise in traditional footprinting, because there is no direct use or reduction in use of land. The efficiency of nitrogen use in the disposal section of the material flow is disregarded by footprinting, with much recovered litter being burned for steam raising in connection with electricity generation rather than being used as a fertiliser in a more direct closed-loop recycling system.

In footprinting terms therefore, little account is made of the actual or potential recycling of nutrients within UK agriculture compared with the use of material for power generation. The increased recycling of nutrients to land, would serve to significantly reduce the industry's footprint by removing petroleum-based inputs and imports of phosphate.

C.3.6 The Footprint

The sum of the component parts detailed above, plus those items such as chemicals and internal transport, which are not included, gives an overall total ecological footprint of 4.68gha for each tonne of broiler meat produced in the UK.

This value may include some double counting, for instance, where energy is recovered from poultry litter or litter is used as a source of nutrients for growing crops. Whilst data from respondents to the survey suggests that 53% of their litter production is sent for use in energy from waste systems, further research suggests that the total amount is in fact in the region of 650,000 tonnes, that is 26% of poultry litter produced in the UK. The amount of energy produced from poultry litter is in the region of 1.32MW/tonne, a potential total of 1,197MW. In the context of the overall total energy requirement of the sector, this will not make a significant impact on its footprint. Two 12MWe and one 38.5MWe poultry litter fuelled stations are now generating in the UK; in the region of two-thirds of the disposal requirement of UK poultry production.

The bulk of the direct land usage of the UK broiler sector, which amounts to some 3.16gha/tonne of broiler meat produced, arises from the growing of food crops. The bulk of feed is produced inside the United Kingdom, occupying 2.58gha, and overseas Soya production

Sector	SEI REAP gha/tonne	Poultry UK gha/tonne	Proportion of SEI	Adjusted gha/tonne
Beef and Veal	5.18			8.49
Mutton and Lamb	3.51			5.76
Pork	3.73			6.11
Poultry	2.85	4.68	164%	

Table C.3.1 Comparison of the global footprint for meat industry sectors including adjusted SEI figures

occupies the balance of 0.58gha. These values include fertiliser inputs and the sequestration of emissions arising from cultivation activities.

Shipping from overseas and goods vehicle transport within UK account for a small proportion of the energy land-take, as does the production of chemicals, such as disinfectants and refrigerants, used in the sector.

C.3.7 Footprint Comparisons

Historically, no other agricultural/food sector has been surveyed for Resource Flows to the extent that this project has examined the poultry sector, however, comparable footprints have been produced for the Beef and Veal, Mutton and Lamb, Pork and Poultry sectors.

The results of these footprints, which are taken from the SEI Resources and Energy Programme, are laid out Table C.3.1 below. This shows a significant variation from the footprint derived from data from the current analysis.

The sector footprint derived from current data is 1.64 times greater than that calculated by SEI. The variation is most likely to be due to the comprehensive nature of the current study, and for the purposes of comparison Table C.3.1 also shows the adjusted footprints of the other sectors. This comparison should be viewed with caution because of the inherent differences between the sectors; for instance, a large proportion of UK-produced beef is reared on grass, thus removing the need for compound feed that is currently a basic requirement of broiler production.

C.4 Benchmarking the Sector

C.4.1 Why Benchmark?

"*Benchmarking is a performance measurement tool used in conjunction with improvement initiatives to measure comparative operating performance and identify Best Practice*" The Benchmarking Network.

Put simply, benchmarking involves an outward look at how others achieve their performance levels, together with an understanding of the processes that they use to achieve their performance level. Lessons learnt from benchmarking exercises, when used properly, lead to improved performance.

C.4.2 Using Benchmarking

To be effective, benchmarking should be an ongoing process, using regular comparisons to identify areas for improvement. The technique can be used at all levels of industry; in this exercise the relevant levels are enterprise and sector.

At the enterprise level, benchmarking can support management strategies to improve performance and competitiveness. The data arising from this project can be used to compare the performance of individual companies with industry performance, enabling the identification of areas of relative strength and weakness.

Companies may then work with one or more benchmarking partners to seek to identify how specific processes can be improved through understanding of how superior performance is achieved. This can help companies find innovative solutions in a culture where knowledge is shared and greater understanding of processes is achieved.

At the sector level, the techniques used in enterprise benchmarking are applied to the whole industry in which similar types of best practice are essential for compliance or competitiveness in a wider marketplace. The techniques provide a means of monitoring key performance indicators that impact on the ability of the sector to respond to changes in standards, and to identify best practice in relation to those factors.

		Energy (kWh)	Water (litre)	Nitrogen (tonne)
Feed Manufacture (per tonne)		75.722	70.634	0.034
Farming (breeding) (per chick)	Conventional Broilers	0.128	0.734	
Farming (growing) (per bird)	Conventional	1.013	6.982	
	Free Range	1.004	6.879	
	Organic	5.220	4.851	
Farming (per bird)	Turkeys	18.052	37.457	
	Ducks	3.543	21.984	
Processing (per tonne)	Broilers	701.337	1976.964	
	Turkeys	310.878	10948.440	
	Ducks	1060.291	14852.520	
Rendering (per tonne)		1020.474	1.456	

Table C.4.1 Resource consumption of the various poultry meat sectors

Effective benchmarking exercises are never one-offs; they should be part of an ongoing strategy for improvement, at whichever level they are carried out. It is also imperative that individual enterprises commit to benchmarking at all levels of the business, are prepared to accept criticism of performance and to provide the means to bring about improvement.

C.4.3 The Outputs

The data gathered could be used to establish a wide range of benchmarks, however, this report lays out only a few of the key indicators identified in the course of the project. The benchmark indicators extracted from the data can be found in table C.4.1 opposite.

Data providers have been provided with the above information directly related to their individual performance as given on the relevant return.

In addition to the benchmarking information shown above, the data gathered provide a useful picture of the range of practices employed in the industry; this information, when used with the benchmarking data may be used to identify best practice, particularly in the farming sector.

It is clear from the data that the majority of poultry farms use LPG as the primary heat source, whilst there is no alternative to electricity available for lighting and assisted ventilation. The meat production sector showed the greatest range of fuel types used, although fuels other than LPG and electricity only amounted to 6.4% of the total consumption, the bulk of that amount being accounted for by light diesel and kerosene, which were most likely used to fuel generators to satisfy additional demand for electricity for assisted ventilation during hot periods.

Energy recovery in the farming sector could be used in the later stages of a flocks life to provide heat for younger birds at an earlier stage of the growing cycle. This would require the entire building stock to be replaced.

The variation in electricity consumption between units also suggests that savings could be made by improvements in ventilation (reducing fan usage or power consumption) and a change from tungsten filamented bulbs to fluorescent lighting.

In the feed production sector, savings could be achieved by the use of combined heat and power plants (CHP), but only at significant capital cost. Less expensive savings could be made by reducing the degree of compounding employed in feed production.

In processing plants, the use of CHP would also result in savings, possibly with a payback period of as little as five years. Heat recovery would also provide savings, but primarily in new-built plants where it can be designed in before construction.

The amount of energy used for chilling could be reduced by about 30% by using localised chilling techniques, rather than chilling whole work rooms.

In most of the Poultrymeat sector, upgrading of existing equipment would result in significant savings, but the industry's unwillingness or inability to invest is not be overcome by the existing government action schemes.

C.5 Environmental Issues – Current and Future

The principal environmental issue of concern to the industry is the full implementation of the IPPC Directive, which was in mid-2004 for processing and is due in January 2007 for farms, by which time all qualifying sites will need a permit to operate. However, in addition to this legislative burden, the industry is faced with a raft of other issues that are likely to have an effect on its environmental performance. The economic and trading status of the sector, that has already been described, often make it difficult to invest significant capital sums in techniques and technologies that may show an immediate environmental benefit, but have a long-term financial payback. Therefore, the response of the industry to non-legislative environmental pressures is likely to be minimal, if it exists at all. Any policy changes likely to impose a financial burden on the sector will have to bear the limiting factors in mind so that UK production is not replaced by potentially less resource-efficient imports, that would satisfy demand at a lower cost.

C.5.1 Raw Materials

Relatively few different raw materials are used in the poultry sector; feed, bedding, water and energy are the most significant inputs and of these little is of direct environmental concern. Feed suppliers already face opposition to the use of GM ingredients in their products and fluctuating world commodity prices where non-GM ingredients are likely to carry an ever-increasing premium.

Whilst the poultry industry uses about 20% of UK wheat production, which is currently non-GM, in the region 22% of the poultry diet fed in the UK is imported Soya. The pressure on global producers to grow GM varieties of Soya is significant, and continuing insistence on the use of non-GM ingredients in the supply chain is likely to increase the cost of feed and consequently the UK-produced end product.

The consumption of feed can only be reduced through increased efficiency of birds, either by improved breeding, which may have social implications, or by more accurate targeting of protein in diets, through phased feeding or diet manipulation.

Phased feeding is the managed change of diet through the life of a flock, by changing the balance of ingredients to suit each growth stage of the birds. Practically, the diet cannot be changed more than two or three times during a crop cycle because of the economics of on-site feed storage and the number of feed deliveries required over a relatively short growing period; little improvement is likely to be seen in the near future.

The other main raw materials used in the sector are bedding for birds and water.

Bedding is mainly; sawdust/shavings and straw, although wood chippings are used in some areas. The proportion of use of each type is shown below.

None of the questionnaire returns showed use of wood chippings for bedding.

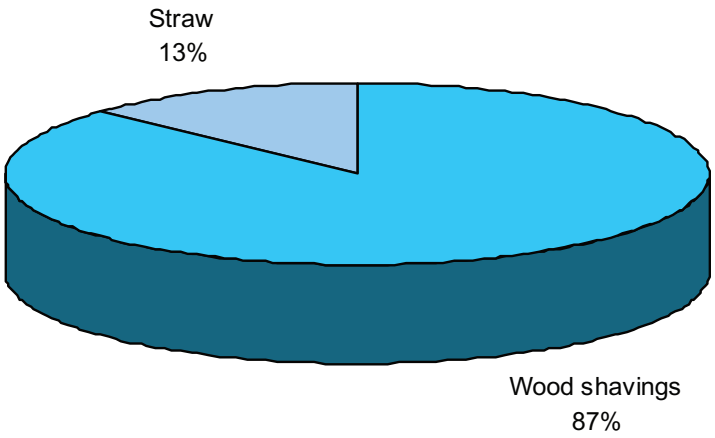


Figure C.5.1 Proportion of Bedding type used by all sectors of the poultry meat industry

Much of the sawdust and shavings used for bedding, and all of the wood chippings are produced directly from waste timber, either from timber-based industries, or directly from thinned trees. The use of such products ensures that carbon embedded in trees is either returned to the soil as organic matter in manure, or burnt in power stations and emitted to atmosphere as carbon dioxide.

In other producer countries such as Brazil and the United States, litter might be reused following composting in poultry buildings. In the UK, such re-use is not thought to be feasible because of low ambient temperatures. Low temperatures increase the time taken for composting to take place, and therefore the time taken to re-stock a house: The consequent reduction in productivity from a significant capital investment is unacceptable in the industry.

C.5.2 Products

The past ten years have seen a significant shift in the volume of poultry production from the fresh 'raw' product, to ready-prepared meals, the UK is becoming the primary European producer of ready meals, with increasing export markets in France, Germany and the Low Countries. The UK government is seeking to reduce energy use in the food chain and in particular the amount of energy used to prepare and store fresh ingredients and frozen products in households. The energy use associated with the use of fresh and frozen ingredients is significantly greater than that associated with part-cooked chilled further processed food, such as ready meals.

Social changes over the next decade are likely to result in an increase in the proportion of poultry meat sold as ready meals and an increasing demand for smaller portions as the number of single-person households increases, by up to 40% by 2011. The increased use of cook/chilled products is likely to have cause a slight reduction in the per capita consumption of energy in the UK, as less food is prepared from whole birds and jointed meat. Whilst in overall terms this will to some extent be offset by the increasing number of single-person households, the net benefit is likely to be significant. If some reduction is possible in this area, it is likely that government will ensure savings are made by exerting some kind of pressure.

C.5.3 Energy Sources and Consumption

The majority of the sector is tied into the Climate Change Levy, and so is under pressure to reduce energy consumption in all sectors.

• Feed Manufacture

Pelleted feeds, such as those in widespread use throughout the industry, require considerable amounts of energy to provide a carefully formulated, consistent product that optimises bird growth. It is possible to feed non-pelleted, non-compound feeds, using whole grain cereals and mashes to provide mineral and protein supplements.

The feeding of whole grains may also enable locally-produced grain to be used in diets, so reducing the amount of emissions from transport.

The energy use per tonne of feed produced, as identified by this study is 75kWh (MtP 150kWh tonne), compared with 50kWh/tonne of non-pelleted feed. Given a level of production of 3.8 million tonnes per annum, a change from pelleted to non-pelleted feed would result in a saving of 95 GWh per year.

• Farming

A significant amount of energy is used in the farming sector of the industry, first to keep housed birds warm and subsequently to cool them. No add-in technology is currently available to retain heat produced towards the end of the cropping cycle and use it to provide the necessary heat for the following crop, although heat could be transferred between houses. The amount of heat produced by a single chicken weighing 2kg can be as much as 7W; in a building containing 40,000 birds, this is equivalent to 0.28MW. On a site of 160,000 birds this equates to 1.12MW.

The necessary heat to sustain young birds is currently supplied using gas-fired heaters and excess heat later in the production cycle is extracted using powered ventilation. Full-scale trials using heat pumps installed in building floors and heat storage using underground water suggest that a 50% reduction in energy consumption would be possible at this stage.

Such an energy recovery system would serve to significantly reduce cost to the industry and the need to sequestrate carbon arising from power generation to satisfy demand to drive ventilation and combustion of gases to heat buildings. However, the capital costs associated with such changes, however small, may not be justifiable in a climate of uncertainty over the future of the UK poultry industry.

The study has identified that the use of fluorescent lighting in place of the existing incandescent bulbs, and more effective insulation, for heat loss in the early stages, and reduction of solar gain in the later stages of production.

It is accepted that the replacement of incandescent light bulbs with fluorescent lighting can give rise to significant savings in energy consumption, by up to 75%. A typical unit of 10,000 birds uses in the region of 1,600W of tungsten lighting, normally supplemented during brooding by additional fluorescent bulbs. Over a normal production cycle, the replacement of incandescent bulbs with fluorescent would give rise to a saving of about 37kWhe per tonne liveweight at 42 days. Given the assumption that 10% of UK broiler production has incandescent lighting, a saving of about 7GWh could easily be achieved.

On many broiler units it is common practice that heating and ventilation systems are run concurrently at some stages of production on many broiler units. This practice could be prevented through integration of heating and ventilation controls, with a consequent saving of several Gwhe per annum.

• Processing

The poultry industry is currently not faced with pressure to 'green' its energy use, that is to use wind or hydro-power sources, but if relatively low cost alternative energy sources could be found, such as a heat recovery system as described above or sustainable energy from waste plant with CHP, producers and processors would undoubtedly be interested; provided costs suited companies' capital expenditure programmes. Such energy sources may be incineration of poultry litter or of other rural wastes in plants located near production and processing sites.

Processing plants have high demands for both refrigeration and heating but the two systems are conventionally kept separate. Heating and cooling by process integration is an accepted technique, but is not widely adopted in industry. The technique involves the recovery of waste heat from cooling systems, connecting production processes to make both heat and cold available for use in production. For instance, process water might be pre-warmed using recovered heat from both refrigeration and flue gas condensate. Similarly, such low-level heat might be used for office heating using an underfloor system. Given a sufficiently high energy usage, it has been shown that the capital cost of this type of installation can be recovered within three years.

Silsoe Research Institute has carried out an investigation into the handling of poultry meat during processing in chill rooms, and has demonstrated an energy saving of about 30% by targeting the chilling of product rather than chilling entire work areas.

Banham Poultry already uses CHP and process integration of heating and cooling systems and is in the process of setting up a pyrolysis and gasification plant to treat by products from processing lines. The gases released during the process will be used for energy generation. The plant will handle up to 1,200 tonnes of material a week, reducing waste related truck movements by 95%. The only tangible waste from the process is fly ash, which amounts to 8% of the input volume.

It can be concluded that energy savings can be made at all stages of poultry production, but only if sufficient capital investment is available or the burden of regulation is overbearing. Given the current state of the UK poultry industry, it is unlikely that any significant capital investment will be made in existing installations, or that many new installations will be started. Government might be able to encourage an increase in investment by offering suitable tax incentives rather than by providing direct financial assistance for the carrying out of works.

C.5.4 Waste Generation

The environmental impacts due to waste arising from the majority of sites associated with poultry growing and processing are controlled by the incoming IPPC Regulations. IPPC requires that the operators of installations seek to use Best Available Techniques (BAT), which balance the costs to the operator against the benefit to the environment. Where there is a choice, the technique that results in the lowest overall emissions will be BAT, unless it is not an 'available technique'.

The key to effective BAT implementation is, however, the balancing of costs to the operator and advantages for the environment. Any technique may be rejected as BAT if the cost of its implementation outweighs its environmental benefits. This consideration of environmental economics is not an easy concept for the majority of IPPC applicants to grasp.

Any economic consideration should not take into account the lack of profitability of a particular business, or any other aspect of its financial position, the balance is simply between the cost of the installation and its

benefits. If the improvement in performance likely to arise from the implementation of BAT is small and its cost is significant, then a different standard should be applied to take account of this fact.

Correspondingly, any significant improvement in benefits as a result of the implementation of BAT has a high financial worth and is likely to justify greater costs. The correct interpretation of IPPC may well cause businesses to become unviable, and therefore fail, but in some cases the initial expenditure may well be recouped by improvements in performance or waste reduction.

The main wastes arising from the sector are

C.5.5 Re-use and Recycling

The nature of any food supply chain is such that opportunities for the re-use of items used in the food preparation sectors are minimal. Similarly, in the farming sector, the nature of consumption is such that no significant items of consumption are re-useable.

In the feed manufacturing sector, the main areas of wastage that have the potential for recovery and recycling are dust from manufactured feed, which, if suitable, can be and often is recycled into contemporary production, and steam condensate, the majority of which is embodied in the product, which can be returned to the system.

The farming sector has a single significant opportunity for recycling, that is the application of used litter to land for use as a fertiliser. Currently, the capacity exists for more than 50% of the broiler litter produced in the UK to be taken to purpose-built power stations for use in electricity generation.

If applied to land and incorporated into the soil for use by a growing crop, the emissions to atmosphere are likely to be in the region of 0.4kg/tonne of litter applied to land. In addition, a total emission of about 1000tonnes/annum carbon is returned to the soil organic matter bank. Approximately 14kg nitrogen/tonne of manure would be available to be taken up by the following growing crop, which may be fed to poultry or used as litter in poultry farms.

C.5.6 Atmospheric Emissions

Atmospheric emissions from the poultry industry are dominated by emissions from the farming sector, which are mainly nitrogen-based gases, predominantly ammonia. Ammonia arises directly from wastes excreted by poultry, and its emission from poultry housing is closely related to the rate of house ventilation. The amount of waste nitrogen in poultry excreta is directly related to the efficiency of digestion of the feed, which can be related to protein targeting in the feed, the flock's gut microflora, and feed dry matter.

Once excreted, the nitrogen in excreted urea is incorporated into other compounds: ammonia through mineralisation, nitrite and subsequently nitrate through nitrification; and organic nitrogen, fixed with carbon. The reduction of atmospheric emissions of nitrogen can only be achieved by immobilisation in organic nitrogen, or nitrification. The products of these two processes are locked into the poultry litter and can be taken up by growing plants, including crops. The reduction of atmospheric emissions relies on the maintenance of dry poultry litter in houses.

C.5.7 Water

Water as a resource is coming under increasing pressure, particularly in the south-east of England. The scope for reduction of in water consumption in the Poultrymeat sector, whether by recycling or change in practice, is limited.

Any future ban on the use of chlorine for the additional treatment of water in the sector may bring about a change in treatment to include ozone, which, together with additional filtration, might enable waste water from some operations to be reused.

In the absence of opportunities for recycling, the most significant saving that might be achieved in the sector would be by repairing broken distribution systems and turning off unnecessary taps.

C.5.8 The Future

The implementation of IPPC has the potential to significantly improve the overall environmental performance of the sector. Experience to date suggests that the licensing process is adequately establishing the baseline performance and encouraging the implementation of BAT. However, there is some doubt that the process allows a significantly holistic view of environmental performance within sub-sectors. This appears to be due to the splitting of sub-sectors into individual processes, each with its own set of impacts and BAT. Several participants in the project felt that this approach, which is relatively narrow when compared with techniques employed in Environmental Impact Assessment within the planning process, is likely to stand in the way of significant improvements in the overall environmental performance within the sector, particularly in terms of emissions to atmosphere arising from transport.

C.6 Economic, Market and Social Issues – Current and Future

C.6.1 Sustainability

External pressures toward the economic and social sustainability of the UK Poultry Industry are minimal, the economic sustainability of any industry being of little apparent consequence to the majority of outsiders. Socially, the industry recognises responsibilities in terms of providing employment in rural areas, in both production and processing sectors, and its duty to produce poultry meat to the highest standards of welfare and food safety. However, the impact of any closures of installations involved with the sector are unlikely to make national headlines. For instance, the takeover of G W Padley Poultry by the OSI Group made few headlines outside the trade press, the 'Wisbech Standard' and 'Grantham Today'.

C.6.2 Economic Pressures

The primary economic pressure facing the UK poultry industry is survival. The unsubsidised nature of the UK industry, together with poultry meat being a globally-traded commodity, leads to a reluctance to make investments that are either perceived as risky, or have a relatively long payback period. Any industry that feels that it is unable, for whatever reason, to make significant investment in its core business is unlikely to improve its environmental performance without external legislative or social pressure.

This situation has led the UK industry to become reactive and unwilling to commit to strategic plans that might lead to improvements in environmental performance. The greatest economic savings that can be made in a mature sector such as this are through economies of scale resulting from the acquisition of other, similar businesses. During the prolonged gestation of this report, we have seen the restructuring of the Grampian Country Foods' poultry business, and the takeover of G W Padley & Sons by OSI, the owners of Moy Park in Northern Ireland.

The sector faces continuing, sustained pressure to produce cheaper meat, which ultimately can only be satisfied by reduced costs of growing, feeding or processing, or by matching production exactly to demand.

The potential for savings that might arise from improved environmental performance and the constraints on implementation of measures are outlined in the body of the report, but the ability of the sector to match production to demand is limited by the extended lead times between the laying of an egg that eventually becomes the parent of a broiler bird and the point of supply of that bird, which is at least 120 days later. Inevitably, unforeseen fluctuations in demand have to be either satisfied by the importation of meat from abroad to satisfy demand, or by the freezing or placing on the export market at commodity prices of surplus production.

C.6.3 Social Pressures

The principal social pressures on the sector concern food safety and animal welfare. The animal welfare lobby, whilst strong, is faced with effectively needing to increase the standards set by the European Community. Those standards have been the subject of legal challenge and the ruling is that existing standards adequately balance the welfare needs of animals with the commercial interests of farming. Despite this ruling, the lack of uniformity between welfare standards achieved in the UK, the rest of the EU and the rest of the world remains a significant, largely unrecognised obstacle to the establishment of a level playing field for poultry production.

The industry also recognises its retailer customers as a significant driver of product specification. Retailer customers are also the principal specifiers of packaging and packaging systems that may require gas flushing of containers or new methods of presentation. Changes in packaging are significant consumers of materials and energy; and changes seldom lead to savings in either.

Product assurance schemes may be a useful way to encourage overall improvement in standards, and as retailers become engaged with the requirements of ISO14001, further pressure may come to bear on the sector.

C.6.4 Legislative Pressures

The poultry sector bears the burden of a wide range of legislative pressures, driven by environmental, social and health concerns.

• Forthcoming legislation: Controlled waste

Currently all wastes from premises used for agriculture are excluded from the definition of 'controlled waste' under Part II of the Environmental Protection Act 1990 and Regulation 1(3) of the Waste Management Licensing Regulations (WMLR) 1994. This means that they are not yet subject to the usual statutory controls on waste management – waste management licensing, duty of care etc.

The Regulations are expected to apply to agricultural waste from early 2006. Farmers will have to dispose of their waste by sending it to licensed sites or under an Environment Agency licence for on-farm disposal, or under a licensing exemption if they wish to recycle waste on-farm. The uncontrolled burning and burying of agricultural wastes on farms will be prohibited.

- When wastes from agricultural premises become controlled, those responsible for the waste must store, transfer, recycle and dispose of it safely in ways that protect the environment and human health.
- Proposals for amendments to the WMLR (1994)

In the June 2003 consultation paper 'Proposals for amendments to the WMLR (1994)' section 2.11 proposes that 'to help recovery, we propose to allow for the spreading of:

Blood and gut contents from poultry preparation plants as well as from abattoirs'

and continues in section 2.12 'manure and digestive tract contents which " the competent authority does not consider to present a risk of spreading any serious transmissible disease" may be spread to land without restriction. Defra is the competent authority in England and we intend to interpret "serious transmissible disease" to mean List OIE notifiable diseases where appropriate'. Responses are due by mid September 2003.

D. Conclusions and Recommendations

The UK Poultry industry has to survive in a highly competitive international marketplace. In order to succeed it is necessary that the sector takes advantage of every opportunity to reduce costs, improve product or gain a competitive edge in some other way, whether through high standards of welfare or environmental performance. The UK sector is at the forefront of world welfare standards, but there remains scope for improvement in environmental performance, which is likely to result in improvements in economic performance.

Feed

There is some potential for reduction in energy use during feed manufacture, and by production of a ration that would allow zero or minimal use of compounded feedstuffs on farms.

In production plants, environmental performance could be improved through the use of energy recovery and CHP, particularly on sites where energy and steam use is relatively high.

It is, however, unlikely that changes will be made to production systems unless integrated into a new plant or the substantial refurbishment of an existing site.

Breeding and Growing

There are many similarities between all of the farming sub-sectors.

In housed flocks, it would be possible to make substantial energy savings through the retention of heat between crops, although this may involve high capital cost or the compromise of animal health associated with multi-age stocking of sites.

Immediate savings could be realised through the use of low energy fluorescent light in housing.

The use of better insulation in older building stock would help to reduce the current need for both heating and cooling at different stages of the production cycle on many UK poultry farms.

Technology to enable the better use of manure from all poultry units as a fertiliser would encourage closed-loop recycling of nitrogen into feedstuffs for use in the sector via agricultural land.

Processing

The use of CHP in the processing sub-sector is relatively uncommon, considering the relatively great on-site requirements for energy, steam and cooling.The fuel source for CHP could come from agricultural by-products such as straw, bio-fuels grown on agricultural land or from waste products produced within the sector. The current practice of using poultry manure as a fuel should not be encouraged because of the loss of opportunity to utilize readily-available nitrogen as a fertiliser and sequestrate any carbon remaining in the manure within the soil profile. But in the absence of such recycling, energy recovery may be the best option.

None of the opportunities for improvement in environmental performance identified above are likely to happen without involvement of third parties. Processors of all sizes consider themselves to be in the business of poultry, not waste management or power generation. If changes are to be made, the most successful application is likely to be in new-build projects, not through the retrospective installation of technology in existing plants.

Rendering and Pet Food

The scope for reduction of environmental impact in the rendering and pet food sectors is limited by the relative simplicity of the process, but opportunities are most likely to arise from energy recovery in rendering plants and the use of relatively low value, dry products for combustion in on-site CHP plants, rather than such material being sent to landfill.

Overall

In summary, few improvements can be made in the environmental performance of the sector without significant capital investment. In the current world poultry market, it is unlikely that any such investment will be made in UK operations, in the absence of some form of encouragement. The UK poultry sector will continue to have a major role as a supplier of high quality food to the nation, but it is very likely that companies will increasingly move live bird production and primary processing to sites overseas, particularly for production of commodity meat for the inclusion in pre-prepared foods, if the differential costs of infrastructure development remain so heavily weighted against the UK.

Feed Mills

Inputs

Water (m^3/year)

Total Poultry Feed Produced (tonnes/year)	1,483,671
Total Water Supply m^3 for Poultry	104,798
Average water per tonne of feed	0.0706
Borehole	12,851
Mains	82,510
River	9,436

Energy (kWh/year)

Total Poultry Feed Produced (tonnes/year)	1,881,094
Total Energy	142,439,360
Energy per tonne of Poultry Feed	75.7216
Electricity	47,471,173
Diesel Light	22,729,368
Diesel Medium	18,079,720
Natural Gas	38,891,751
Biogas	3,616
LPG	3,038,240
Kerosene	4,228,902
Gas Oil	7,996,590

Chemicals (litres/year)

Total Poultry Feed Produced (tonnes/year)	1,050,615
Total Chemicals Used for Poultry Feed	24,760
Chemicals per tonne of Poultry Feed	0.0236
Detergent	15,578
Disinfectant	2,895
Other	6,287

Outputs

Dirty Water (m^3/year)

Total Poultry Feed Produced (tonnes/year)	912,388
Total Dirty Water for Poultry Feed	13,564
Dirty Water per tonne of Poultry Feed	0.0149
Land Application	4,800
Treatment	8,764

Packaging Waste (tonnes/year)

Total Poultry Feed Produced (tonnes/year)	1,050,615
Total Waste for Poultry Feed	677
Waste per tonne of Poultry Feed	0.0006
Paper and Cardboard - Landfill	398
Paper and Cardboard - Recycled	30
Metals steel - Landfill	40
Metals steel - Recycle	59
General Waste - Landfill	140
Wood - Landfill	4
Wooden Pallets - Recycle	6

Hatchery

Inputs

Water (m^3/year)	Broilers	All Poultry
Total Water	171,643	97,963
Chicks per Year	159,822,420	133,440,374
Total Chicks produced net of Mortality	158,114,558	131,985,474
Water per Chick	0.0011	0.0007
Water per Chick produced	0.0011	0.0007
Borehole	48,675	41,205
Mains	122,968	56,758
Energy (kWh/year)		
Total Energy	22,546,309	17,105,055
Chicks per Year	159,822,420	133,440,374
Total Chicks produced net of Mortality	158,114,558	131,985,474
Energy per Chick	0.1411	0.1282
Energy per Chick produced	0.1426	0.1296
Electricity	11,899,117	8,825,244
Diesel Light	370,481	61,800
Diesel Medium	1,893,488	1,893,488
Deisel Heavy	2,201,500	142,800
Natural Gas	5,249,323	5,249,323
LPG	932,400	932,400
Chemicals (litres/year)		
Total Chemicals	70,260	61,690
Chicks per Year	145,422,420	133,440,374
Total Chicks produced net of Mortality	143,868,436	131,985,474
Chemicals per Chick	0.0005	0.0005
Chemicals per Chick produced	0.0005	0.0005
Detergent	44,980	40,450
Disinfectant - Formalin	6,550	4,950
Disinfectant - Formaldehyde	3,850	3,200
Disinfectant - Other	14,880	13,090
Eggs		
Total Eggs Placed	168,645,400	201,113,895
Total Chicks Hatched	133,440,374	159,822,420
% Success	0.79	0.79

Outputs

Dirty Water (m^3/year)	Broilers	All Poultry
Total Dirty Water	73,286	84,406
Chicks per Year	122,012,501	132,913,779
Total Chicks produced net of Mortality	120,682,199	131,493,462
Dirty Water per Chick	0.0006	0.0006
Dirty Water per Chick produced	0.0006	0.0006
Soak Away	0	3,650
Treatment	56,052	63,522
Mains Sewer	17,234	17,234
Packaging Waste (kg/year)		
Total Packaging Waste	148,800	394
Chicks per Year	101,297,479	127,679,525
Total Chicks produced net of Mortality	100,193,033	126,315,142
Packaging Waste per Chick	0.0015	0.0031
Packaging Waste per Chick produced	0.0015	0.0031
Paper & Cardboard - Incinerate	2,000	9,500
Paper & Cardboard - Landfill	120,000	132,500
Paper & Cardboard - Other	0	2,000
Plastics - Incinerate	15,000	15,000
Plastics - Landfill	6,000	7,000
Glass - Landfill	3,800	3,800
Metals Aluminium - Landfill	1,000	1,000
Metals Steel - Landfill	1,000	1,000
Mortality		
Total Chicks	80,142,895	105,444,173
Average Mortality%	1.15	1.15
Dead Chicks	921,643	1,212,608
Dead - individual calculations	873,833	1,126,845
Actual %	1.09	1.07
Animal Waste Disposal (kg/year)		
Total Chicks	133,440,374	159,822,420
Total Chicks produced net of Mortality	131,905,810	157,984,462
Total Waste	3,199,300	3,801,300
Total waste per Chick	0.0240	0.0238
Total waste per Chick produced	0.0242	0.0240
Hatch Debris	1,715,000	1,990,000
Candling Clears	1,484,300	1,811,300
Disposal		
Landfill	2,829,300	3,431,300
Rendering	370,000	370,000

Growing

Inputs

Water (m^3/year)	Broilers	All Poultry
Total birds per year	207,263,644	219,476,891
Birds Produced net of Mortality	199,685,671	210,917,292
Total Water use by Poultry	1,456,754	1,857,926
Average per bird	0.0070	0.0085
Average per bird produced	0.0073	0.0088
Borehole	(no data)	(no data)
Mains		
River		
Abstraction		
Other		
Energy (kWh/year)		
Total birds per year	187960632	200989851
Birds Produced net of Mortality	181088415.4	193191458
Total Energy kWh	206559577	390432517
Average per Bird	1.0990	1.9425
Average per bird produced	1.1407	2.0210
Electricity	38,887,495	71,183,164
Diesel	13,972,104	15,029,327
Natural Gas	198,281	(no data)
LPG	153,501,697	304,021,745
Chemicals (litres/year)		
Total birds per year	199,052,392	212,093,729
Birds Produced net of Mortality	191,774,638	203,888,762
Total chemicals	160,541	185,008
Average per Bird	0.0008	0.0009
Average per bird produced	0.0008	0.0009
Disinfectant (litres/year)	95,295	109,309
Detergent (litres/year)	65,246	75,699
Stocking Area (m^2)		
Total birds per year	208,803,157	221,844,542
Total Area	1,837,768	2,822,942
Natural Ventilation	229,837	252,057
Controlled Ventilation	1,606,972	2,525,083
General Purpose	360	2,380
Pole Barn	600	43,329
Other	(no data)	92
Bedding (tones/year)		
Total birds per year	197,689,334	210,730,719
Birds Produced net of Mortality	190,461,417	202,575,584
Total Bedding	48,948	80,013
Average per bird	0.0002	0.0004
Average per bird produced	0.0003	0.0004
Straw	766	10,017
Wood Shavings	48,182	69,826
Feed (tonnes/year)		
Total birds per year	208,803,157	221,844,542
Birds Produced net of Mortality	201,168,896	213,283,064
Total Feed - tonnes	656,508	1,015,830
Average per bird	0.0031	0.0046
Average per bird produced	0.0033	0.0048
Pre-breeder crumb	1,726	1,972
Breeder Feed 1	14,519	18,019
Breeder Feed 2	12,009	28,857
Pre-starter	87	1,284
Starter crumb	32,141	34,913
Starter pellets	33,098	43,910
Grower	146,478	191,944
Finisher 1	198,232	261,813
Finisher 2	1,065	215,827
Withdrawal	209,747	209,867
Grain	7,406	7,424

Outputs

Litter Disposal (tonnes/year)	Broilers	All Poultry
Total Birds	179,575,199	192,616,584
Birds Produced net of Mortality	173,009,571	185,123,738
Total Litter	207,252	457,413
Average per bird	0.0012	0.0024
Average per bird produced	0.0012	0.0025
Direct to Land	50,916	201,076
Composting	46,336	46,337
Energy from Waste	110,000	210,000
Mortality		
Total Birds	199,149,334	212,190,719
Average Mortality %	4.85	4.46
Dead Birds	9,658,743	9,463,706
Dead - individual calculations	7,281,296	8,208,512
Dead weight - tonnes	9,174	9,174
Actual %	0.04	0.04
Incineration	765,782	785,439
Landfill	847,873	1,303,009
Composting	25	30
Rendering	4,404,051	4,854,615
Other	1,578	3,432
No means stated	1,261,987	1,261,987
Packaging Waste Produced (tonnes/year)		
Total Units Produced (t) (birds)	45,945,899	56,162,163
Average per bird produced	0.0109	0.0110
General Waste - Landfill	1	1
Paper and Cardboard - Landfill	251	256
Plastics - Landfill	220	220
Glass - Landfill	1	1
Metals - Landfill	1	1
Paper and Cardboard - Recycled		1
Plastics - Recycled	1	95
Metals - Recycled	(no data)	3
Paper & Cardboard - Incinerate	9	11
Plastics - Incinerate	1	1

Processing

Inputs

Water (m^3/year)	Broilers	All Poultry
Total water	1,125,828	2,514,528
Total tonnes produced	91,290	211,308
Water per tonne produced	12.3324	11.8998
Borehole	160,588	498,119
Mains	965,240	1,642,426
Other	(no data)	373,983
Process Washing Down		
Total tonnes produced	(no data)	88,307
Water used		95,714
Water per tonne produced		1.0839
Crate Washing		
Total tonnes Produced	25,779	114,086
Water used	5,390	50,445
Water per Tonne produced	0.2091	0.4422
Energy (kWh/year)		
Total energy	149,616,178	92,497,217
Total tonnes produced	251,473	131,887
Energy per tonne produced	595	701
Electricity	75,161,676	47,485,011
Diesel	27,344,214	16,263,585
Natural gas	43,546,315	25,734,394
LPG	3,563,973	3,014,227
Electricity used (kWh/year)		
Stunning	114,352	197,832
Crate washing/handling	688,480	857,720
Scalding	334,178	535,878
Plucking	1,080,872	1,538,732
Additional machinery	10,141,324	15,430,170
Chilling	13,809,206	23,491,066
Chemicals (litres/year)		
Total chemicals ltrs	1,812,121	2,050,606
Total wax tonnes	(no data)	62,555
Total liquid oxygen m^3		154,752
Total tonnes produced	131,887	251,905
Chemicals per tonne	13.7400	8.1404
Wax per tonne	(no data)	0.2483
Liquid oxygen per tonne	(no data)	0.6143
Detergent	153,855	294,092
Disinfectant	108,790	171,365
Refrigerants	5,756	9,810
Boiler	12,940	20,224
Effluent	1,528,080	1,546,110
Odour control	(no data)	2,105
Vehicle wash	2,700	6,900
Wax	(no data)	62,555
Liquid oxygen		154,752

Outputs

Dirty Water (m^3/yr)	Broilers	All Poultry
Total Dirty Water	765,676	1,370,461
Total Tonnes produced	66,376	167,429
Dirty Water per tonne produced	11.5354	8.1853
Land Application (m^3/yr)	(no data)	84,001
Soak Away		208
Treatment (m^3/yr)	765,676	1,281,574
Tanker	(no data)	1,246
Drain Cleaning etc		3,432
Packaging Waste (tonnes/year)		
Total Units Produced (t) (birds)	91,290	210,876
Average per bird produced	0.0209	0.011
General Waste - Landfill	750	750
Paper and Cardboard - Landfill	(no data)	283
Plastics - Landfill		106
Glass - Landfill		1.45
Metals - Landfill		4.5
Paper and Cardboard - Recycled	1,048	1,048
Plastics - Recycled	98	98
Metals - Recycled	10	10
Paper & Cardboard - Incinerate	(no data)	25
Animal outputs (tonnes/year)		
Total tonnage produced	131,887	251,905
Total Outputs	201,303	349,041
Outputs as % of tonnage produced	1.5263	1.3856
Meat	131,888	251,905
By-products	53,073	64,321
Waste	16,342	32,815
Feathers (tonnes/year)		
Total Feathers - tonnes	26,909	36,618
Total Tonnes produced	131,887	251,905
Feathers per Tonne	0.2040	0.1454
Incineration	(no data)	6,609
Landfill	14,774	16,591
Exported		1,263
Composted		195
Other	11,960	11,960
Blood (m^3/year)		
Total tonnes produced	131,887	251,473
Total Blood m^3	36,272	41,763
Blood per tonne produced	0.2750	0.1661
Landfill	(no data)	1,586
Landspreading	31,410	31,618
Rendering	2,002	5,699
Other	2,860	2,860
Wax (tonnes/year)		
Total tonnes produced	(no data)	12,314
Total Wax to Landfill		84
Wax per tonne produced		0.0068

Rendering

Inputs

Water (m^3/year)	
Total Water	216,997
Total Poultry material processed	149,054
Water per tonne	1.4558
Borehole	144,374
Mains	2,061
Abstraction	70,562
Water Usage	
Odour Control	15,068
Boiler	31,722
Energy (kWh/year)	
Total Energy	212,917,817
Total Poultry material processed	208,646
Energy per tonne	1,020
Electricity	9,947,906
Diesel light	2,709,003
Natural Gas	11,270,767
Tallow Fuel Oil	188,990,141
Energy used	
Total Poultry material processed	61,022
Mincing & Crushing	384,384
Pressing	906,048
Milling	377,520
Filtering	151,008
Odour Abatement	686,400
Chemicals (litres/year)	
Total Chemicals	415,797
Total Poultry material processed	208,646
Chemicals per tonne	1.9928
Detergent	4,950
Disinfectant	2,850
Boiler	147,037
Effluent Treatment	117,845
Odour Control	79,880
Vehicle Wash	61,625
Cooling Tower	1,610

Outputs

Dirty Water (m^3/year)	
Total Dirty Water	281,646
Total Poultry material processed	208,646
Dirty Water per tonne	1.3499
Tanker	6,006
Sewer	270,770
Effluent Sludge	4,870
Packaging (tonnes/year)	
Total Packaging	232
Total Poultry material processed	210,076
Packaging per tonne	0.0011
Paper	219
Plastics	8.6
Pallets	4.6
Waste (tonnes/year)	
Total Waste	14.1300
Total Poultry material processed	1,430
Waste per tonne	0.0099
Steel - recycled	0.54
Other - landfill	13.59
Filtered Waste	
Total Filtered Waste m^3	1,263
Total Poultry material processed	147,624
Filtered Waste (m^3/tonne)	0.0086

Completed Mass Balance Reports

Geographical

Isle of Wight

City Limits Report (London)

Mass Balance UK book

Mass Balance UK book 2

South East Report

Northern Ireland Report

Scotland Report

Wales Report

South West

Sector

Agricultural Report (Marcus Hodges)

Agricultural Waste Report (C-Tech)

Construction Report (Viridis)

BedZed Construction Report pt1

4sight – Rocks to Rubble – eco-region

Public Sector Report (Waste Watch

Solvent Waste in UK Furniture Manufacturing Industry

Exhibition Industry

Greening Britain's Schools

Publishing

Electricity Report

Foundry Report

UK Status Report on Waste from Electrical & Electronic Equipment (ICER)UK Status Report on Waste from Electrical & Electronic Equipment (ICER)

Mass Balance Study into Waste Arisings from the Food & Drink Processing Industries

National Health Service

Financial Sector

Newspaper Report

UK Paper & Board Industry

Ceramics Industry

Magazines Sector

Automotive

Poultry

Material

Carbon UK Report

UK Tyres Report (Viridis)

European Tyres Report (Viridis)

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Thermal Methods Report

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Large Scale Glass Manufacture

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Furniture Packaging Optimisation

Plastic Report

Sustainable Markets for Waste Glass from Fluorescent Tubes and Lamps

Paper

Material Flows of Iron, Steel and Aluminium

Civil Engineering Application of Tyres (Viridis)

Packaging Report

Glass

Transport Options for Waste in Scotland

Embodied Wood: The UK Mass Balance and Efficiency of Use

Nitrogen

Farm Packaging Waste

Mass Balance Reports To be completed

Geographical

Ecological Budget UK (WWF), regional series

North West

Material

Mass Balance & Scenario Analysis for UK Clothing & Textiles

Sector

Pigs

Ceramics

Schools

Tourism

See www.massbalance.org for downloadable copies of completed reports, if available.

Ingredients:

A Introduction

B The UK Poultrymeat Industry
History, The Poultry Meat Industry Today, Industry Drivers, Legislation affecting poultry enterprises, The future of the UK Poultry Industry

C The Mass Balance Model
Mass Balance Outputs, Ecological Footprint, Benchmarking the Sector, Environmental Issues – Current and Future, Economic and Social Issues – Current and Future

D Conclusions and Recommendations

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