EBLEX

change in the air

The English Beef and Sheep Production Roadmap - Phase 1

"Livestock farmers understand the crucial role they have to play in producing more food with less impact and see themselves as a part of the solution to global problems that include climate change. This roadmap is an important starting point in realising this vision - understanding where we are, what we need to achieve and how we might do it."

Peter Kendall, President, National Farmers Union (NFU)

"Steady reduction in greenhouse gas emissions is going to be a requirement for all sectors of the UK economy, including agriculture. The beef and sheep industries are taking a lead with this environmental roadmap which demonstrates clearly that gains in efficiency and productivity can go hand-in-hand with environmental gains."

Ian Crute, Chief Scientist, Agriculture and Horticulture Development Board (AHDB)

"The meat industry takes its environmental responsibilities seriously, but what we have lacked to date is the means to demonstrate what we have all done and how we can improve. This first phase of the Roadmap is just the start of a journey towards demonstrating and delivering continuous environmental improvement."

Stephen Rossides, Director, British Meat Processors Association (BMPA)

"Over-hyped or not, climate change is an issue that is affecting every industry and one that cannot be ignored. This Roadmap is an important starting point, benchmarking where we are, what we might need to achieve and how we might do that in a cost-effective way."

Norman Bagley, Policy Director, Association of Independent Meat Suppliers (AIMS)

"GHG emissions from livestock production and how these can be reduced is one of the biggest challenges facing producers. This Roadmap is a starting point in assessing the current level of emissions and in sharing knowledge on ways to improve production in response to this. It demonstrates how the industry is working together to tackle the issues."

Peter Morris, Chief Executive, National Sheep Association (NSA)

"Retailers recognise the importance of whole supply chain solutions and are working closely with their beef and lamb producers to reduce their environmental impact. This report is an important step in recognising the improvements that can be made through adapting farming methods."

Andrew Opie, Food Policy Director, British Retail Consortium (BRC)

"The National Beef Association fully supports the Roadmap which sets out our priorities within the industry and focuses attention on what needs to be done. It is a huge step forwards in helping us work towards meeting the targets set by the Government in tackling GHG emissions."

Kim-Marie Haywood, Director, National Beef Association

Chairman's introduction

Climate change and the contribution that livestock production makes to it is one of the greatest challenges facing the agriculture sector today.

To ignore these challenges would be irresponsible, and yet to leap in with short-term policies and ill-conceived strategies would be equally remiss.

The UK Low Carbon Transition Plan requires English farmers to make and maintain a reduction in greenhouse gas (GHG) emissions to a level at least 11% lower than currently predicted by 2020. To do this, English farming needs a joined up approach, striving to achieve efficiency improvements across all interdependent sectors.

This document is a starting point for us, a stake in the ground from which we can move forward to address head-on how to reduce GHG emissions from livestock production, specifically beef and sheepmeat production.

It has been produced with input from key industry bodies and its aim is to share knowledge and research on changes producers can make to bring tangible reductions in emissions from their production systems. It is also a significant step in a wider process and will feed into other initiatives, including the GHG Action Plan, headed by the NFU, CLA and AIC, applicable to the whole of the agriculture sector.

This roadmap will naturally evolve and change, and we plan to update it annually. Phase One, which you are reading now, gives a snapshot of where we are today, highlighting the challenges in reducing GHGs, and benchmarking the current position. Phase Two will be published in 2010 and will include the role that processors play, as well as covering other enviromental issues like energy useage and biodiversity.

Tackling climate change is the responsibility of all industries. It will not be an easy journey for the livestock sector to navigate but it is one that is vital for English producers to address. I believe it will bring significant benefits, not just to our environment, but also to our economic performance and the future health of the industry.

John Cross
Chairman, EBLEX

Contents

1. Executive Summary

Introduction

The English Beef and Sheep Production Roadmap has been produced by a steering group of industry organisations led by EBLEX. The overall objective is to develop a strategy to guide beef and sheep producers towards actions that reduce the negative and promote the positive environmental impacts of their businesses.

Phase One of the Roadmap concentrates on one of the most important challenges facing the world today - mitigating the effects of climate change by reducing greenhouse gas (GHG) emissions and energy use.

It aims to establish realistic current performance benchmarks, based on the best available Life Cycle Analysis (LCA) modelling, and a practical strategy, to help meet the 2020 targets set for agriculture in the UK's Low Carbon Transition Plan against the background of other important environmental considerations.

Phase Two of the Roadmap - to be published in 2010 - will focus on the other significant environmental impacts of English beef and sheep production that must be taken into account alongside GHG emission reductions in improving the overall environmental balance of the industries. These include landscape management, carbon sequestration, nutrient management, water usage and quality, and environmental stewardship and biodiversity.

The Emissions Challenge

To meet the carbon budgets made legally binding in the 2008 Climate Change Act, the Government has published the UK Low Carbon Transition Plan. This sets out a comprehensive strategy to deliver national GHG emission reductions of 18% on estimated 2008 levels of 610 million tonnes carbon dioxide equivalent - Mt CO_2 eq - per year by 2020 (a reduction of over a third on 1990 levels).

As part of this plan, English farmers are required to continue reducing their annual GHG emissions. The immediate priority is for emissions from farming to be at least 11% lower than the 27 Mt CO_2 equivalent currently predicted for 2020 - a saving of some three million tonnes per year.

In planning to achieve the required savings, CO_2 equivalent emissions per kilogram of meat are taken as the key parameter in measuring real gains in the efficiency of livestock production, rather than merely reductions in stock numbers that would simply transfer production, and therefore, emissions elsewhere in the world.

Falling UK beef and sheep numbers driven by economic and structural factors in the next 10 years means that any reductions in GHG emissions per kg will inevitably deliver greater absolute savings for the environment.

English Beef and Sheep Production

The English beef and sheep production industries are large, complex and highly inter-dependent.

They represent the major proportion of the 2.9 million cattle and 16.7 million sheep slaughtered annually in the UK, supplying over 1.1 million tonnes of meat to the human food chain, with a farm gate value of nearly £3 billion.

Concentrated on 4.6 million hectares of land, the majority of which is only suited to grazing livestock, English beef and sheep production levels have been declining steadily over the past 10 years.

The productive health and well-being of both the beef and sheep production sectors fundamentally depends on maintaining the right balance between their key components and the other farm enterprises with which they are connected.

Beef suckler, dairy cow and ewe numbers are forecast to continue declining in the coming decade due to the decoupling of support payments, competition with more profitable enterprises, problems in securing labour, and fewer family successions.

This will result in a continued reduction in both beef and sheep slaughterings and domestic production levels.

Recent Progress

Steady improvements in beef and sheep production efficiency have taken place over the past decade, with 5% fewer prime animals required to produce each tonne of meat in 2008 than in 1998.

This, and the progressive reduction in both breeding and slaughter stock numbers over the past 10 years, has undoubtedly contributed to substantial reductions in GHG emissions recorded.

Livestock production in England is still viewed by some as having limited profitability. Any changes, therefore, which increase productivity and help to make an enterprise more profitable are to be welcomed. Reducing GHG emissions goes hand in hand with improving efficiencies, giving a win-win situation for producers.

Underpinning the recent efficiency improvements made in English beef and sheep production has been a series of industry-wide development and knowledge transfer initiatives. Most notable among these are the Estimated Breeding Value (EBV) schemes, the Beef and Sheep Better Returns Programmes (BRP), the Action for Profit (A4P) initiative, and the National Business Costings schemes.

Together with a number of other industry services, these initiatives provide a range of vehicles ideally placed to support environmental goals as part of a continued focus on increasing productive efficiency.

Current Emissions Position

Detailed modelling of current beef and lamb production systems using a Life Cycle Analysis approach has established national GHG emission and energy consumption benchmarks. These, in turn, have been used to calculate overall 2008 baselines for industry emissions and energy use against which to plan future reductions.

In 2008, 51% of prime carcase beef were derived from the dairy herd, 30% from hill and upland suckler herds and 19% from lowland suckler enterprises. The modelling suggests English beef production is currently generating a GWP100 of around 13.9 kg of CO_2 equivalent and is consuming just over 31 MJ of primary energy per kilogram of meat produced (Table 1).

Table 1: Current baseline environmental impact of English beef production and distribution of breeding cows in different production systems

Environmental impact		% cows in each system contributing to prime carcase beef		
GWP100 kg CO_2 eq/kg	Primary Energy* MJ/kg	Lowland Suckler Herds	Hill and Upland Suckler Herds	Dairy Herds
13.89	31.28	19%	30%	51%

* The CO_2 emissions implications of this are included within the GWP100 figure

This can be broken down into the benchmarks for practical improvement target-setting across the main production systems (Table 2).

Table 2: Current baseline environmental impacts for the main components of English beef production

Component System	Environmental Impact	
	GWP100 kg CO_2 eq/kg	Primary Energy * MJ/kg
Lowland suckler beef	17.12	35.18
Hill and upland suckler beef	16.98	33.38
Dairy beef	10.97	28.67

* The CO_2 emissions implications of this are included within the GWP100 figure

As well as tending to be more intensive, the considerable apparent advantage of dairy beef in these calculations primarily relates to the fact that calves are a by-product of milk production. Unlike suckler systems, in which all the requirements of the breeding herd as well as those of the slaughter animals are set against the meat produced, the dairy calculations attribute the vast majority of herd GHG emissions to milk production.

Based upon the stratification of the sheep industry into hill, upland and lowland systems in which 39%, 30% and 31% of the ewes respectively contribute to prime carcase lamb, the modelling indicates that English sheep production is currently generating around 14.6 kg of CO_2 equivalent GHG emissions and consuming 22 MJ of energy per kilogram of meat produced (Table 3).

Table 3: Current baseline environmental impact of English sheep production and distribution of breeding ewes in different production systems

Environmental impact		% ewes in each system contributing to prime carcase lamb		
GWP100 kg CO_2 eq/kg	Primary Energy* MJ/kg	Hill Flocks	Upland Flocks	Lowland Flocks
14.64	22.02	39%	30%	31%

* The CO_2 emissions implications of this are included within the GWP100 figure

This gives it a similar overall efficiency to beef production, with slightly higher levels of GHG emissions reflecting the industry's greater reliance on more extensive hill production, and lower levels of primary energy input and its lesser dependence on purchased feeds and fertiliser.

As in beef production, this overall baseline can be broken down into specific system benchmarks for planned emissions reduction (Table 4).

Table 4: Current baseline environmental impacts for the main components of English lamb production

Component System	Environmental Impact	
	GWP100 kg CO_2 eq/kg	Primary Energy * MJ/kg
Hill flocks	18.44	15.15
Upland flocks	13.82	23.69
Lowland flocks	12.62	23.68

* The CO_2 emissions implications of this are included within the GWP100 figure

The fundamental differences between more extensive and intensive production systems are particularly clear in this context. The poorer quality nutrition and longer production times of hill sheep mean very much higher GHG emissions per kilogram of lamb produced.

These calculations further highlight that Global Warming Potential tends to increase with extensification because more animals are required to produce each tonne of meat, and lower quality forages tend to generate higher methane emissions.

When assessing the environmental impact of different systems, it is vital to appreciate that hill beef and sheep, in particular, are converting and concentrating nutrients not suitable for human needs into valuable foodstuffs from difficult-to-exploit land resources.

Equally, their role in delivering environmental goods and services like biodiversity and landscape character, as well as enhancing the value of upland pastures as carbon sinks, needs to be taken into account.

Emissions Improvement Targets

To play its part in ensuring that English farming meets its UK Carbon Reduction Plan target, beef and sheep production individually need to reduce their annual GHG emissions by at least 11% by 2020.

On the basis of calculated current emissions levels - which include the CO_2 generated by primary energy use - this means reductions of around 1 kg CO_2 equivalent per kilogram of beef and sheepmeat respectively (Table 5).

Table 5: Annual Beef and Sheep GHG Emission Targets (GWP100 kg CO_2 eq/kg meat)

	2008 Baseline	2020 Target (-11%)
Beef	13.89	12.37
Sheep	14.64	13.03

Given the inter-connectedness of the various beef and sheep systems, these reductions have to be achieved across all the component systems rather than by any substantive change in focus. To do otherwise would risk upsetting the balance of the different livestock production systems which have developed over time as the best way of making the most of the natural resources available and other important environmental imperatives.

Under these circumstances, separate 11% reduction targets need to be established for each of the main system components (Tables 6 and 7).

Table 6: Annual Beef System GHG Emission Targets (GWP100 kg CO_2 eq/kg meat)

	2008 Baseline	2020 Target (-11%)
Lowland suckler beef	17.12	15.24
Hill and upland suckler beef	16.98	15.11
Dairy beef	10.97	9.76

Note: The total emissions savings of these components are reconciled to the overall industry target in Table 5 on the basis of the proportions of total beef production they represent.

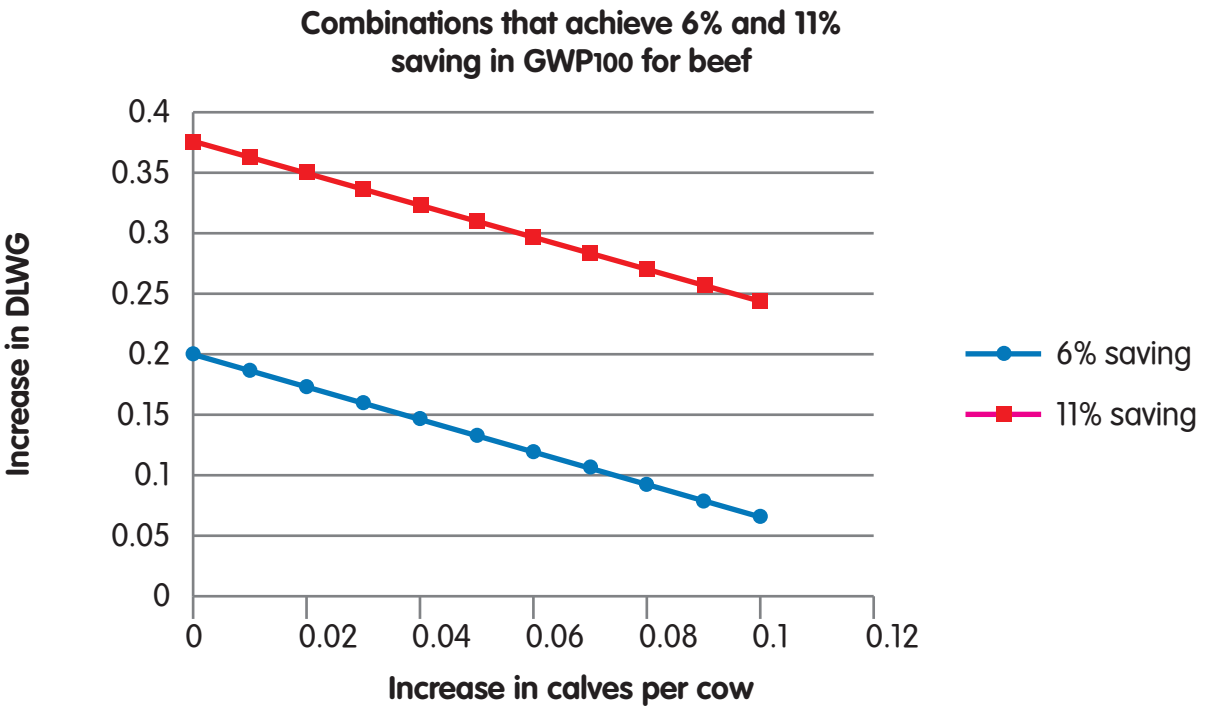
Table 7: Annual Sheep System GHG Emission Targets (GWP100 kg CO_2 eq/kg meat)

	2008 Baseline	2020 Target (-11%)
Hill flocks	18.44	16.41
Upland flocks	13.82	12.30
Lowland flocks	12.62	11.23

Note: The total emissions savings of these components are reconciled to the overall industry target in Table 5 on the basis of the proportions of total lamb production they represent.

Modelling shows the required 11% reduction in annual GHG emissions in beef production across the industry could be achieved through any number of combinations of feeding and fertility efficiency improvement (Figure 1).

Figure 1: Beef - combinations of herd efficiency improvements required to achieve a 11% saving in GWP100 by 2020

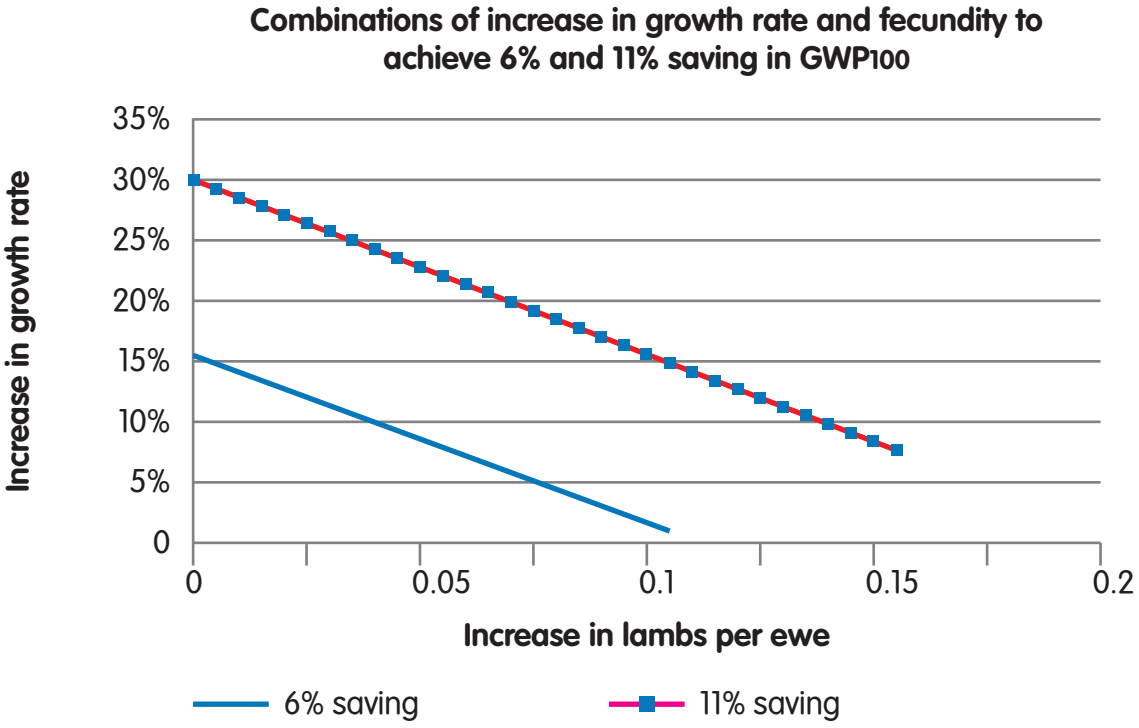


The "middle way" strategy to achieve 11% savings involves an increase in feeding efficiency (represented by daily liveweight gain) of 0.32 kg/day together with an increase of around 0.05 calves/cow/year by 2020. However, greater gains in fertility efficiency would decrease the level of feeding efficiency improvements necessary, and vice versa.

In the same way, the modelling shows the reduction in annual emissions by 2020 required to meet the 11% target in sheep production can be achieved by similar combinations of fertility and feeding efficiency improvements (Figure 2).

"Challenging though such improvements may be, the fact that they are all within the bounds of technical possibility indicates that the GHG emission reduction targets are achievable within the required timeframe."

Figure 2: Sheep- combinations of flock efficiency improvements to achieve the required 11% saving in GWP100 by 2020



In this case, the model reveals that to achieve the 11% target, a median improvement of 20% in daily liveweight gain coupled with 0.075 more lambs per ewe by 2020 is required.

Challenging though such improvements may be, the fact that they are all within the bounds of technical possibility indicates that the GHG emission reduction targets are achievable within the required timeframe.

Emissions Improvement Strategy

- Emissions reduction in English beef and sheep production needs to be based firmly on improving productive efficiency.

Assessment of realistic 10-year improvement possibilities for the key efficiency-increasing opportunities in both beef and sheep production through the Life Cycle Analysis model shows that improving the feeding efficiency of slaughter stock offers markedly greater emissions reduction benefits than improving either the fertility or longevity of breeding stock. Nevertheless, improvements in all these areas can make important contributions to the overall reduction.

- The three main areas of breeding, feeding and management all offer ample opportunities for improving feeding efficiency to the extent required.

- There is sufficient variation in performance traits of interest within the major breeds to mean that worthwhile improvement should be possible in key characteristics, like growth rate over the 10-year timeframe.
- Improvements are also possible through better forage utilisation, more productive pastures and more accurate rationing to reduce waste and optimise performance. Improving housing conditions and access to feed and water, as well as reducing clinical and sub-clinical levels of disease, offer further opportunities for greater efficiency.
- In the absence of reliable simple tools for measuring agricultural GHG emissions, existing industry data should be used as key proxies for performance monitoring, enhanced where feasible by specially instituted annual beef and sheep performance efficiency surveys.

Other Environmental Impacts

Emissions reduction needs to be undertaken with a full understanding of the other impacts - both positive and negative - of beef and sheep production on the environment.

Phase Two of this Roadmap will examine the environmental impact of beef and sheep production on the most significant of these areas in more detail. It will also attempt to establish the key inter-relationships between these factors so that the effects of particular production changes can be assessed on a broad environmental front.

11. Action Plan

To encourage sufficient progress in reducing GHG emissions across the English beef and sheep industries, a firm plan of action will be implemented from 2010 as part of EBLEX's established industry-wide programme to:

- Monitor performance at various levels
- Research improvement opportunities in a whole host of areas; and
- Transfer the knowledge gained in both as widely as possible.

Component	Action	Output	2008	2020 target
Performance Monitoring				
Beef GWP	Continue to run model with revised data and improved model as further information becomes available	Improved estimate of current performance against targets laid out in the transition plan	13.89 GWP_{100} kg CO_2 eq /kg meat	12.37 GWP_{100} kg CO_2 eq /kg meat
Lamb GWP	Continue to run model with revised data and improved model as further information becomes available	Improved estimate of current performance against targets laid out in the transition plan	14.64 GWP_{100} kg CO_2 eq /kg meat	13.03 GWP_{100} kg CO_2 eq /kg meat
Beef efficiency	Undertaking an annual assessment of the weight of carcase produced per day of age across GB beef production, bringing together BCMS age at slaughter data and carcase weights from EBLEX carcase classification reports.	An annual benchmark for the efficiency of beef output that can be tracked forward (and back) to provide the industry and producers with information on progress and targets against which to assess individual performance.	0.471 kg/d carcase wt (326 kg 692.51 days)	0.5 kg/d carcase wt
Beef fertility	Undertaking an annual assessment of calves produced per cow per year from BCMS and/or Defra census data, broken down at least by dairy or beef herd origin.	An annual benchmark for beef fertility that can be tracked forward (and back) to provide the industry and producers with information on progress and targets against which to assess individual performance.	Calving interval 413.5 days (88.27 calves per 100 cows)	Calving interval 392.4 days (95 calves per 100 cows)
Lamb efficiency	Undertaking an annual assessment of the weight of lamb carcase produced per ewe per year from Defra census data and AHDB's carcase classification reports.	An annual benchmark for lamb production efficiency that can be tracked forward (and back) to provide the industry and producers with information on progress and targets against which to assess individual performance.	17.31 kg lamb carcase per ewe (270335 tonnes 1,5616 K ewes)	18.00 kg lamb carcase per ewe

Ewe fertility	Undertake an annual assessment of ewe litter size from Defra census data.	An annual benchmark for lamb fertility that can be tracked forward (and back) to provide the industry and producers with information on progress and targets against which to assess individual performance.	118.2%	125.7% (plus 7.5 lambs per 100 ewes)
Beef and sheep unit performance	Extend the current costings scheme to include more herds and flocks for each production system to secure more accurate data on key aspects of physical performance.	Better benchmarks of more detailed performance measures across the range of production systems to track industry progress and provide targets for individual business performance assessment	284 beef 205 sheep	310 beef 260 sheep
Beef and sheep breeding progress	Undertake an annual evaluation of Signet Beefbreeder, ABRI breeds and Sheepbreeder genetic progress in key sire and maternal Estimated Breeding Values by breed.	An annual benchmark of the progress being made by beef and sheep breeders to track progress and highlight the potential for performance improvement currently available by using the best in breed.	5 year average to 2008 Suffolk 0.082 pts/year Texel 6.81 l pts/yr Limousin 0.91 BV/yr	5 year average to 2020 Suffolk 0.12 pts/year Texel 10.0 l pts/yr Limousin 1.1 BV/yr
National beef and sheep productivity	Establish an annual survey of the current productivity of beef and sheep systems, if feasible, involving a stratified sample representative of industries and utilising the sort of readily-available data pioneered in the EBLEX Snapshot tools.	An annual benchmark to anchor the detailed performance measures secured from the Beef and Sheep Costings scheme, allowing better assessments to be made of the productive efficiency of the national herd/flock and its components.	In progress	Annually update
Productive efficiency report	Publish an annual report of the productive efficiency of English beef and sheep, including data from the above monitoring tools and other information on breeding herd/flock sizes from the Defra census and carcase quality monitoring.	A single, high profile report setting out the state of the beef and sheep production industries, distributed and publicised widely, and utilised to establish the extent and specifics of efficiency improvements as well as highlighting areas of particular future improvement potential.	Beef report 2009 Sheep report 2008	Annually update

2. Introduction

The English Beef and Sheep Production Roadmap has been produced by EBLEX working closely with Defra, NFU, National Beef Association, National Sheep Association, British Meat Processors Association, Association of Independent Meat Suppliers and British Retail Consortium.

It is the second collaborative Roadmap developed by the food and farming industry as part of a determined Defra-led initiative to improve the environmental performance of the product groupings identified as having the greatest impact on the environment at both domestic and international level.

Within the food and drink sector - estimated to account for 20% to 30% of all European environmental impacts by the principal source of EU evidence (EIPRO) - milk and meat are considered to be in high environmental impact categories.

Following the publication of the Milk Roadmap by the Dairy Supply Chain Forum in 2008, this document represents the first step in better understanding the environmental impacts of two of country's most important meat industries, together with a structured plan to reduce those negative impacts.

It is designed to be developed and expanded through periodic review to provide an agreed strategy for the entire UK beef and sheepmeat supply chain to become progressively more sustainable in line with nationally and internationally agreed targets.

3. Objective and Scope

The overall objective of the English Beef and Sheep Production Roadmap is to develop a strategy to guide beef and sheep producers towards activities and actions that reduce the negative and promote the positive environmental impacts of their businesses.

Easily replicable in other parts of the United Kingdom, it is focused primarily on England - albeit based on more readily available UK industry data in most cases - and on production factors and activities up to, but not beyond, the farm gate.

While it is possible to confine initial production assessments to a single region, the extent to which meat transport, processing and retailing are integrated across the entire country makes it vital that environmental impacts further down the supply chain are assessed UK-wide rather than in separate regions.

Rather than seeking to address all the many and varied environmental impacts of beef and sheep production in a superficial way, this first part of the Roadmap concentrates on a significant and important challenge facing the world today - mitigating the effects of climate change by reducing greenhouse gas (GHG) emissions and energy use.

It aims to establish realistic current performance benchmarks based on the best available Life Cycle Analysis (LCA) modelling and a practical strategy to meet the 2020 GHG emission reduction targets set for agriculture in the UK's Low Carbon Transition Plan.

As such, it represents the beef and sheep production sector's response to the Transition Plan's challenge to agree a voluntary action plan for reducing emissions by Spring 2010.

Recognising the fundamental inter-connectedness of this emissions-reducing priority with other important environmental, social, and animal welfare as well as economic goals for the industries, this document charts the way ahead against the background of the following key considerations:

- Red meat is a valuable accessible source of energy, protein, vitamins and minerals in a balanced human diet, making a reliable and affordable supply that is vital for consumer health and well-being
- Fully 40% of agricultural land in England (60% in the UK as a whole) is only suitable for grass rather than arable, vegetable or fruit crop production
- Grassland is a carbon sink
- Beef and sheep producers constitute the bulk of UK farmers and their viability is essential to the sustainability of many rural communities
- Grazing livestock are essential to preserving the landscape, biodiversity and recreational value of the English landscape and in particular the hills and uplands
- Managed grasslands are increasingly valued for the range of other desirable environmental goods and services they provide - including carbon storage, water quality, flood prevention and tranquillity
- Measures to enhance the biodiversity and habitat value of open and enclosed grazing land are highly desirable even though they may conflict with the imperative of reducing GHG emissions
- As well as being vital for the management of some of the country's most valuable landscapes, grazed beef and sheep production systems are valued by the general public for their perceived animal health and welfare benefits.

The other significant environmental impacts of English beef and sheep production - including landscape management, carbon sequestration, nutrient management, water usage and quality, and environmental stewardship and biodiversity - will be addressed in Phase Two of this document, to be published in 2010.

Its value in promoting whole-industry sustainability will be further enhanced by co-operative development with appropriate organisations in Scotland, Wales and Northern Ireland, and by UK-wide contributions from the supply chain beyond the farm gate.

4. English Beef and Sheep Production

The English beef and sheep production industries are large, complex and highly inter-dependent, both with one another and with other farming enterprises.

A total of 2.9 million cattle and 16.7 million sheep were slaughtered in the UK in 2008, supplying 862,000 tonnes of beef and 326,000 tonnes of sheepmeat. At farm gate level, this was worth nearly £3 billion.

Of the 75,000 agricultural holdings recorded in England in the latest Defra census, nearly 46,000 (over 60%) are defined as grazing livestock, or hill and upland businesses. Most have a heavy, and in many cases near total, reliance on beef or sheep. Altogether, they employ just under 100,000 people - or over a quarter of the English farming workforce.

Excluding areas of cropping which support livestock enterprises, around 50% of the farmed land in England - approximately 4.6 million hectares - is devoted to grazing livestock production.

Of this, over 80% comprises permanent pasture or rough grazing which is only suitable for grass production, with the remaining 20% down to temporary grass - mainly in arable rotations.

The less productive the grassland, the more likely sheep are to dominate by virtue of their superior ability to utilise the poorest quality forages. In contrast, the highest quality permanent pasture and temporary grass tends to be used for dairying. Beef generally occupies the middle ground.

As a result, beef and sheep production tend to be concentrated in hill and upland areas of the country - predominantly in the north and west - with arable cropping dominating in the more fertile lowlands of southern and eastern England with dairy sandwiched in between.

Beef and sheep production in lowland areas primarily utilises poorer quality land unsuitable for arable cropping.

Current Beef Production Structure

Prime cattle provide 80% of the UK's current annual beef production reared as young bulls, steers or heifers slaughtered between 11 and 36 months of age.

These are produced by the 1.9 million dairy and 1.6 million suckler cows which make up the national cattle herd, the remaining 20% of production coming from breeding beef and dairy cows at the end of their productive lives.

The 12% decline in breeding cow numbers seen over the past 10 years has led to a progressive reduction in annual UK prime cattle slaughterings, from nearly 2.3 million to just over 2 million head.

At the same time, average carcase weights have increased steadily over the years to 326 kg, resulting in an annual production of around 700,000 tonnes of prime beef in 2008. This compares with 712,000 in 1998.

Approximately 50% of this beef is derived from dairy-bred calves - as a by-product of milk production - with 30% produced from beef suckler herds in the hills and uplands and around 20% from lowland beef suckler enterprises.

Dairy-bred beef calves, separated from their mothers at an early age, tend to be finished in lowland units at between 11 and 32 months of age, either intensively on cereal or by-product diets, or semi-intensively on rations based on grazed grass and conserved forage.

Beef-bred stock, on the other hand, are reared with their mothers until around six to nine months of age before being finished on a variety of forage and cereal-based systems at between 14 and 36 months of age.

While a growing number of large units specialise in finishing both dairy and beef-bred stock, most of the country's beef continues to be produced in mixed farming businesses. Here it is integrated with other animal or crop production enterprises to take maximum advantage of available grassland, buildings, straw and other arable by-products and labour resources. The use of manures for enhancing soil health is a good example of the advantages of mixed farming.

Beef production forms a significant component of many farming businesses, making specific environmental impacts - in straw and manure recycling as much as in GHG emissions - difficult to disentangle without sophisticated life cycle analysis.

In addition to the beef industry's continued reliance on dairy farming as a major source of prime stock, there has traditionally been a significant flow of young cross-bred females from dairy units to the beef breeding herd as replacement cows.

This flow has diminished in recent years with the more rapid decline in dairy cow numbers relative to suckler cows, the increasing trend to pure-bred dairy breeding and the growing influence of more extreme dairy genetics that are less well-suited to the needs of beef herds.

The fragmented structure of the English beef industry and its inter-dependence with dairying in particular is an important consideration in all efforts to improve its environmental as well as economic performance.

Current Sheep Production Structure

Like beef, the vast majority of UK sheepmeat comes from prime lambs, with under 20% of annual production being in the form of mutton from surplus breeding ewes.

Reflecting the 14% decline in breeding sheep over the past 10 years, just over 14 million prime lambs were slaughtered in 2008 against over 16 million in 1998.

UK lamb producers have progressively improved carcase weights in recent years through better breeding, feeding and management to a current average of around 19 kg.

This resulted in an annual prime lamb production of around 270,000 tonnes in 2008, compared to over 297,000 tonnes in 1998.

Although somewhat less well-integrated into other farming enterprises than beef production, the UK sheep industry maintains a unique stratified structure in which its three main components - each developed to meet the characteristics and needs of a distinct geographic production zone - are heavily integrated.

Forming the essential base of the industry are the 5.8 million hill ewes, comprising just under 40% of the current national flock. These hardy stock, grazing largely unenclosed hill pastures, produce around 20% of the annual prime lamb crop. Crossed with more productive but less hardy sire breeds they also generate around 1.5 million mules and other half-bred replacement ewes as the primary resource for upland flocks.

The 4.6 million mule and other half-bred ewes in the less harsh upland production zone (around 30% of national flock) are then crossed with terminal sires to produce around 30% of the prime lamb crop together with even more productive ewes as replacements for lowland flocks.

Finally, the lowland flocks with some 4.7 million mule and terminal sire times (x) half-bred ewes are crossed with different terminal sire breeds to produce the remaining 50% of the prime lamb crop.

Apart from making the best possible use of the wide range of production zones to produce both prime lambs and replacement ewes, this structure takes maximum advantage of the considerable hybrid vigour available through repeated cross-breeding.

Although less rigid than in the past, it further means that each component of the industry fundamentally depends on the others for its viability.

Different types of flocks are further integrated, both with one another and with other farming enterprises, in the lamb finishing side of the business.

The overwhelming majority of lowland and many upland lambs are marketed direct to slaughter from their birth flocks in the late summer and autumn. However, much of the hill and some of the upland lamb crop cannot be finished on the limited forage resources available to the flocks in which they were born. So a significant proportion are sold as store lambs in the autumn to farms in the lowlands, which have spare winter grazing capacity or better access to arable by-products, for finishing over the winter months.

Just as with beef, therefore, the productive health and well-being of the sheep industry depends upon maintaining the right balance of its key components, placing an additional constraint on improvement efforts.

Future Beef and Sheep Production Trends

All the forecasts suggest both the UK suckler and dairy herds will continue to decline in the coming decade due to a combination of factors. Foremost amongst these is the disincentive that decoupled support payments provide to keeping more stock than is strictly necessary - especially when many are net loss-makers. Other factors include competition with more profitable enterprises in the lowlands, major problems in securing labour, and fewer family successions.

This will result in a rate of fall in prime cattle numbers which is unlikely to be offset by sufficient increases in average carcase weight to prevent a continued reduction in overall domestic beef production. Especially so as 2008 saw the peak of adult cows and bulls re-entering the food chain in the wake of BSE, after which cow beef volumes can only decline.

Little investment by most suckler calf producers and many dairy herds in recent years as a result of poor prices, uncertainty over future price prospects, and the likelihood of higher feed and fuel costs, is compounding the problem, as is the heavy burden of regulation being imposed on herds.

It is highly likely that most suckler producers will rely on the Single Farm Payment (SFP) to stay in business in the coming few years, begging major questions over their medium-term future beyond 2013 when these payments are expected to progressively diminish.

In the same way, forecasting suggests the national sheep flock will reduce further in the coming few years. The rate of decline is, however, expected to slow as the impetus of the major industry restructuring prompted by CAP reform in 2005 falls away.

Sheepmeat prices are forecast to increase to offset some of the increased costs of production faced by producers, although this is unlikely to be sufficient to halt the breeding flock decline. And if consumer resistance prevents prices rising to the extent needed to relieve pressure on already negative margins, the flock may well decline at a faster rate than currently envisaged.

In any event, the decoupling of support payments will almost certainly result in producers concentrating their efforts on productivity improvement by retaining only their most productive ewes.

So the next decade will inevitably be characterised both by declining prime lamb and ewe and ram slaughterings, and sheepmeat volumes.

Indeed, in marked contrast to the recent past, the key challenge facing many hill and upland areas in the future is likely to be maintaining sufficient grazing animals to meet their landscape management objectives, rather than to prevent over-stocking.

5. Recent Progress

Also playing a valuable part in this reduction have been the primarily economic-driven improvements in beef and sheep production efficiency achieved over this time through better breeding and feed management.

With GHG emissions far more closely related to the number of animals than their individual productive ability, the environmental benefit of this improvement is clear in the fact that only 3.07 prime cattle were required to produce each tonne of beef in 2008 compared to 3.23 in 1998 - an efficiency gain of more than 5%.

Almost exactly the same scale of improvement is apparent in sheep production - 53.48 lambs being required to produce each tonne of sheepmeat in 2008 against 56.18 in 1998.

Relatively poor profitability, major industry restructuring and the switch in EU subsidies from headage payments to area-based support linked to environmental cross-compliance have together been responsible for much of the GHG emission-reducing decline in UK beef and sheep populations.

At the same time, the age at which prime cattle are slaughtered has decreased noticeably in recent years as the distorting effects of the original EU Beef Special Premium Scheme have faded. In taking advantage of the greater feed conversion efficiency of younger stock by finishing them at an earlier age, beef producers have made further progress in reducing their emissions, as well as other production costs.

Industry Improvement Programmes

Underpinning the efficiency improvements made in English beef and sheep production in recent years have been a series of industry-wide development and knowledge transfer initiatives.

The Estimated Breeding Value (EBV) schemes, organised by Signet Breeding Services and Breedplan UK with leading beef and sheep breeds, use detailed performance recording in breeders' flocks and complex computer calculations to predict the genetic merit that individual bulls or rams possess for a range of valuable characteristics. This provides increasingly

good genetic information to progressively replace 'by eye' sire purchasing judgements, ensuring the most rapid and consistent progress through breeding.

The focus on identifying stock with superior genetics for key sire traits, like growth rate and carcase quality, and maternal traits, like reproductive efficiency, provides a vital underpinning for improving the efficiency of commercial beef and sheep production.

When allied with the increasingly widespread use of AI in beef breeding and new technologies like Computer Tomography (CT) scanning in sheep breeding programmes, the expanding membership of the recording schemes that generate EBVs and the higher prices being paid for stock with higher EBVs is testament to their increasing value.

In the past year, a record of more than 17,000 cows from 16 breeds were officially Beefbreeder performance recorded in over 750 herds. Sheepbreeder recording also reached record levels of over 47,000 ewes from 31 breeds in 550-plus flocks.

Equally, the major bull and ram sales are reporting very much higher prices for top-ranked EBV stock. While sires with above average genetic merit in their breeds averaged just over £4,500/head at the spring 2009 bull sales in Carlisle, for instance, those in the top 1% fetched an average of well over £6,500.

Under the Defra-supported Better Returns Programme (BRP) banner, EBLEX has developed separate initiatives to spread best practice in beef and sheep production as widely as possible.

Involving extensive training events and easy-to-use information focused on the most important elements of breeding, feeding and management, these major knowledge transfer initiatives have engaged and helped producers across the country in thoroughly practical improvement efforts.

In the past two years, almost 400 separate BRP events have been run, including 170 in abattoirs addressing carcase issues and nearly 230 on a variety of production themes - many hosted by practising farmers.

The programme has also published a variety of advisory materials to help producers, including 20 detailed themed manuals on important topics like improving breeding, fertility, grassland management, carcase quality and 50 briefing documents on topical issues.

Well over 20,000 individual producers have so far signed-up to the BRP programme, suggesting a market penetration not far short of 50%.

In parallel to this, the EBLEX Action for Profit (A4P) Initiative has also built up a special internet-based library resource to help beef and sheep producers add value to their businesses by increasing returns and cutting costs.

Each of the 62 easy-to-read, single page A4P topic sheets produced to date concentrates on an area of production with particular improvement potential, summarises the best available technical and marketing understanding on the subject and provides key targets with practical checklist guidance on achieving them. These resources are electronically linked to sources of more detailed information and advice for those who wish to access them to provide information at a range of different levels.

National Business Costings Schemes are also run for beef and sheep enterprises on an annual basis to benchmark the physical and financial performance of a cross-section of beef and sheep enterprises.

Run by EBLEX - and the Meat and Livestock Commission before it - for more than 30 years, the costings are drawn from the actual cash accounts of a sample of self-selecting, co-operating farmers with a natural bias towards those keen on good record-keeping.

Over the years they have been developed to include more detailed analyses of both fixed and non-cash costs (including unpaid family labour, the rental value of owned land and interest on working capital) to give a more accurate picture of enterprise performance.

The schemes currently involve separate costings across more than 250 beef and nearly 200 sheep enterprises split into nine breeding, rearing and finishing categories. In each category - analysed into top third as well as average performers - the results have been presented in an annual Business Pointers report, communicated widely across the beef and sheep industries.

As well as providing an excellent record of the changing physical and financial performance of different components of the industries at farm level, the Business Costings Schemes give producers across the country reliable benchmarks against which to compare and monitor their own performance. EBLEX has also developed the "Snapshot" and "What if?" web-based tools to help livestock producers improve their enterprise cost control skills.

Together with a number of other EBLEX services - including detailed tracking and publication of auction market and abattoir returns, research into a range of economic and environmental improvement opportunities, and health and welfare reporting - these key improvement initiatives provide a range of vehicles ideally placed to support environmental goals as part of a continued focus on increasing productive efficiency; all the more so given their established reputation and value across the beef and sheep farming industries.

"Underpinning the efficiency improvements made in English beef and sheep production in recent years have been a series of industry-wide development and knowledge transfer initiatives."

6. The Emissions Challenge

To meet the carbon budgets made legally binding in the 2008 Climate Change Act, the Government has published the UK Low Carbon Transition Plan. This sets out a comprehensive strategy to deliver national GHG emission reductions of 18% on estimated 2008 levels of 610 Mt CO_2 equivalent per year by 2020 (a reduction of over a third on 1990 levels).

As part of this plan, English farmers are required to continue making reductions in their annual GHG emissions. The immediate priority is for emissions from farming to be at least 11% lower than the 27 Mt CO_2 equivalent currently predicted for 2020 - a saving of some three million tonnes per year.

Although this target is not broken down by individual agricultural sector, the plan highlights more efficient use of fertilisers and better management of livestock and manures as keys to its achievement.

At the same time, it emphasises the:

- Physical limits placed on emissions reduction by the complex natural cycles involved in ruminant livestock production
- Importance of not simply transferring emissions overseas by replacing domestic production with imports
- Need to meet other important environmental goals such as biodiversity and water quality maintenance and improvement.

There is broad scientific agreement that emissions should be measured in CO_2 equivalents. This is particularly important in agriculture where the main greenhouse gases are nitrous oxide (N2O) largely derived from nitrogen fertilisers and dietary nitrogen deposited through faeces and urine, and methane (CH4) from rumen fermentation, rather than CO_2 from the burning of fossil fuels for primary energy.

The CO_2 equivalent calculation takes into account that methane and nitrous oxide have 100 year Global Warming Potentials (GWP_{100}) that are 21 and 300 times that of carbon dioxide respectively.

To reflect the fact that cutting GHG emissions globally necessitates reductions through improving the efficiency of production rather than simply transferring emissions elsewhere in the world, all GWP measurements need to be made and improvement strategies developed on a strict per unit of output basis.

As well as ensuring real global savings rather than merely moving the problem elsewhere, of course, this approach is vital if the world is to meet its target of doubling food production by 2050 to meet the anticipated increase in demand.

In planning to achieve the required savings on current GHG emission levels in beef and sheep production, CO_2 equivalent emissions per kilogram of meat are taken as the key parameter.

Since the established trend of falling beef and sheep production driven by economic and structural factors is unlikely to halt - let alone be reversed - in the next 10 years, any reductions in GHG emissions per unit of output will deliver greater absolute production footprint savings for the environment.

7. Current Emissions Position

Current beef and lamb production systems in the UK have been modelled by a specialist team at Cranfield University using a Life Cycle Analysis (LCA) approach.

This has quantified the GHG emissions and energy consumptions of a comprehensive range of beef and lamb systems based upon all the inputs required to meet their production needs, calculated through a series of sub-models.

The primary energy requirements of various mixtures of grazed grass, conserved forage and concentrate feeds have, for instance, been apportioned to each system on the basis of daily live weight gains, length of life, time spent in housing, etc. Manure arisings have been calculated from intake and liveweight gains. And emissions of gases - including ammonia as well as CH4 and N2O - have been established using grazing, housing, enteric fermentation and manure management models (Appendix 1).

Further production systems employed to produce important inputs like barley grain and rapeseed meal have also been defined and the environmental burdens associated with them determined and taken into account.

These individual system components have then been used to establish national benchmarks for primary energy consumption and overall GHG emissions (including the CO_2 from the primary energy) for the main types of beef and sheep production regime.

Finally, the beef and sheep industries have both been modelled using Defra census, BCMS registration and slaughter and other available production data, together with EBLEX carcase classification results. This has enabled an overall 2008 baseline for industry emissions and energy use per kilogram of meat to be calculated against which to plan future reductions.

Beef Production Environmental Impact

Assuming 51% of prime carcase beef is derived from the dairy herd, 30% from hill and upland suckler herds and 19% from lowland suckler enterprises, the modelling suggests English beef production is currently generating a GWP_{100} of around 13.9 kg of CO_2 equivalent and is consuming just over 31 MJ of primary energy per kilogram of meat produced (Table 1).

Table 1: Current baseline environmental impact of English beef production and distribution of breeding cows in different production systems

Environmental Impact		% cows in each system contributing to prime carcase beef		
GWP100 kg CO_2 eq/kg	Primary Energy* MJ/kg	Lowland Suckler Herds	Hill and Upland Suckler Herds	Dairy Herds
13.89	31.28	19%	30%	51%

* The CO_2 emissions implications of this are included within the GWP100 figure

This can be broken down into the benchmarks for practical improvement target-setting across the main production systems (Table 2 and Appendix 2).

Table 2: Current baseline environmental impacts for the main components of English beef production

Component System	Environmental Impact	
	GWP100 kg CO_2 eq/kg	Primary Energy * MJ/kg
Lowland suckler beef	17.12	35.18
Hill and upland suckler beef	16.98	33.38
Dairy beef	10.97	28.67

* The CO_2 emissions implications of this are included within the GWP100 figure

Appendix 2 breaks these components down further into different production systems.

These calculations reveal that both the Global Warming Potential and primary energy use of beef systems tend to increase with extensification. This is because lower rates of growth mean more feed energy is used for maintenance. Carcase weights are similar but animals are older at slaughter.

Also significant in this context is the fact that the lower quality forages generally utilised in more extensive hill and upland production systems are less digestible and, because of changes in the rumen environment, more methane is produced. In simple terms, the fermentation produces more acetate than propionate which leads to more "spare" hydrogen which is converted to methane.

As well as tending to be more intensive, the considerable apparent advantage of dairy beef in these calculations primarily relates to the fact that calves are a by-product of milk production. Unlike suckler systems, in which all the requirements of the breeding herd as well as those of the slaughter animals are set against the meat produced, the dairy calculations attribute the vast majority of herd GHG emissions to milk production.

Sheep Production Environmental Impact

Based upon the stratification of the sheep industry into hill, upland and lowland systems in which 39%, 30% and 31% of the ewes respectively contribute to prime carcase lamb and taking into account the flow of breeding stock between the systems, the modelling indicates that English sheep production is currently generating around 14.6 kg of CO2 equivalent GHG emissions and consuming 22 MJ of energy per kilogram of meat produced (Table 3).

Table 3: Current baseline environmental impact of English sheep production and distribution of breeding ewes in different production systems

Environmental Impact		% ewes in each system contributing to prime carcase lamb		
GWP100 kg CO_2 eq/kg	Primary Energy* MJ/kg	Hill Flocks	Upland Flocks	Lowland Flocks
14.64	22.02	39%	30%	31%

* The CO_2 emissions implications of this are included within the GWP100 figure

This puts it at a similar overall level of environmental efficiency as beef production, with slightly higher levels of GHG emissions reflecting the industry's greater reliance on more extensive hill production, and lower levels of primary energy input and its lesser dependence on purchased feeds and fertiliser.

As in beef production, this overall baseline can be broken down into specific system benchmarks for planned emissions reduction (Table 4).

Table 4: Current baseline environmental impacts for the main components of English lamb production

Component System	Environmental Impact	
	GWP100 kg CO_2 eq/kg	Primary Energy * MJ/kg
Hill flocks	18.44	15.15
Upland flocks	13.82	23.69
Lowland flocks	12.62	23.68

* The CO_2 emissions implications of this are included within the GWP100 figure

The fundamental differences between more extensive and intensive production systems are particularly clear in this context.

The poorer quality nutrition and longer production times of hill sheep mean very much higher GHG emissions per kilogram of lamb produced, although primary energy consumption is considerably less by virtue of very much lower purchased feed and fertiliser inputs.

Most efficient in emission terms, although with higher levels of primary energy input, are lowland flocks with their very much higher quality forage availability.

When assessing the environmental impact of different sheep systems, it is vital to appreciate that, although generating relatively high GHG emissions, hill and upland flocks are converting and concentrating nutrients not suitable for human consumption into valuable foodstuffs from difficult-to-exploit land resources.

In this respect, they are more valuable than those either consuming grain that could be used for human food, or grass grown on land that could otherwise be cropped for human food production.

They are also, of course, essential resources in enabling the more intensive upland and lowland flocks, that generate lower emissions per kilogram of meat, to function.

Equally, as with hill and upland cattle, they play a hugely valuable role in delivering environmental goods and services like biodiversity and landscape as well as enhancing the value of upland pastures as carbon sinks.

8. Emissions Improvement Targets

To play its part in ensuring that English farming meets its UK Carbon Reduction Plan target, beef and sheep production individually need to reduce their annual GHG emissions by at least 11% by 2020.

On the basis of calculated current emissions levels - which include the CO_2 generated by primary energy use - this means reductions of around 1kg CO_2 equivalent per kilogram of beef and sheepmeat respectively (Table 5).

Table 5: Annual Beef and Sheep GHG Emission Targets (GWP100 kg CO_2 eq/kg meat)

	2008 Baseline	2020 Target (-11%)
Beef	13.89	12.37
Sheep	14.64	13.03

Given the inter-connectedness of the various beef and sheep systems and the additional positive environmental contributions of those more upland systems with the greatest Global Warming Potential, these reductions have to be achieved across all the component systems rather than by any substantive change in balance between systems.

To do otherwise would risk upsetting the balance of the livestock production systems which have developed over time as the best way of making the most of the natural resources available and other important environmental imperatives.

Under these circumstances, separate 11% reduction targets need to be established for each of the main system components (Tables 6 and 7).

Table 6: Annual Beef System GHG Emission Targets (GWP100 kg CO_2 eq/kg meat)

	2008 Baseline	2020 Target (-11%)
Lowland suckler beef	17.12	15.24
Hill and upland suckler beef	16.98	15.11
Dairy beef	10.97	9.76

Note: The total emissions savings of these components are reconciled to the overall industry target in Table 5 on the basis of the proportions of total beef production they represent.

Table 7: Annual Sheep System GHG Emission Targets (GWP100 kg CO_2 eq/kg meat)

	2008 Baseline	2020 Target (-11%)
Hill flocks	18.44	16.41
Upland flocks	13.82	12.30
Lowland flocks	12.62	11.23

Note: The total emissions savings of these components are reconciled to the overall industry target in Table 5 on the basis of the proportions of total lamb production they represent.

9. Emissions Improvement Strategy

Ruling out any radical change in the balance of the component systems as being unlikely to be practicable in the face of historic and structural constraints, the primary focus for achieving the required GHG emission reductions in English beef and sheep production has to be on improving the productive efficiency of each sub-system.

Since productive efficiency is so closely tied to economic viability in modern farming, this approach also has the benefit of offering significant financial advantages to all those involved, regardless of the level or type of their businesses or future rural support arrangements.

English producers now almost universally accept that continuing to improve the productive efficiency of their businesses is essential to their future well-being. So a strategy that delivers GHG emissions reduction while helping to secure their economic future will be far better received than environmental schemes requiring considerable amounts of time, effort and cost for little immediate value in the essential priority of business survival.

Efficiency Improvement Opportunities

Within both the beef and sheep industries, there are three main efficiency improvement opportunities available:

1. **Increasing the longevity of breeding stock**, so the costs of their non-productive rearing phase are spread over a greater weight of meat produced
2. **Increasing the fertility efficiency of breeding stock**, so they produce more slaughter stock and a greater weight of meat in their productive lives
3. **Increasing the feed efficiency of slaughter stock**, so they produce more meat per unit of input.

Assessment of improvement possibilities for these opportunities in both beef and sheep production through the Cranfield Life Cycle Analysis model suggests they all offer worthwhile GHG emission reduction benefits.

However, the extent of their relative value varies widely, with beef modelling showing that industry-wide increases in feeding efficiency through either genetic or nutritional improvement and fertility offer markedly greater benefits than improvements in longevity (Table 8).

Table 8: GHG Emission Savings from Beef Production Efficiency Improvements

Area	Change in physical performance	GWP100 Saving (kg CO_2 eq/kg meat)
Fertility Efficiency	+ 0.02 calves/cow/year	0.26
Longevity	+ 1 year productive life	0.07
Feeding Efficiency - genetic improvement	+ 5% lifetime growth rate	0.30
Feeding Efficiency - feed quality improvement	+ 5% forage energy density (ME)	0.31

The relative industry-wide value of fertility and feeding efficiency improvements is also highlighted through the sheep modelling (Table 9).

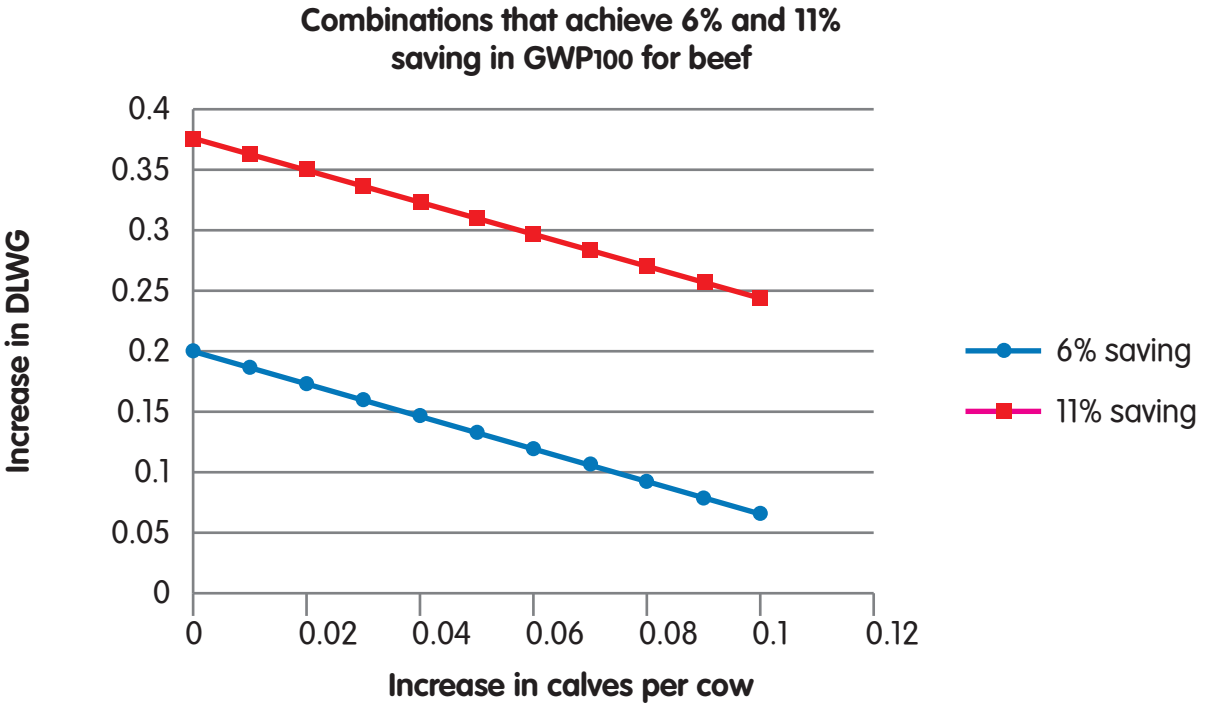
Table 9: GHG Emission Savings from Sheep Production Efficiency Improvements

Area	Change in physical performance	GWP100 Saving (kg CO_2 eq/kg meat)
Fertility Efficiency	+ 0.1 lamb per ewe	0.74
Feeding Efficiency - genetic improvement	+ 2% daily liveweight gain (DLWG)	0.18
Feeding Efficiency - feed quality improvement	+ 5% forage energy density (ME)	0.61

Efficiency Improvement Requirements

Further modelling shows the required 11% reduction in annual GHG emissions in beef production across the industry could be achieved through any number of combinations of feeding and fertility efficiency improvement (Figure 1).

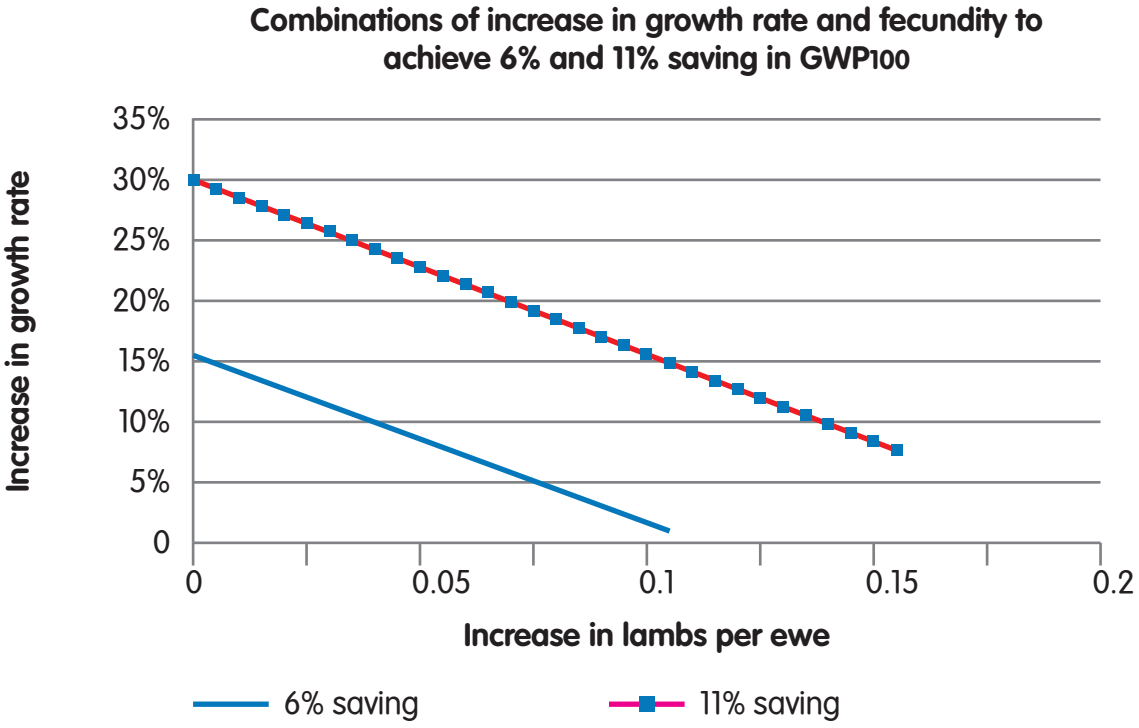
Figure 1: Beef - combinations of herd efficiency improvements required to achieve a 11% saving in GWP100 by 2020



The median strategy to achieve 11% savings involves an increase in feeding efficiency (represented by daily liveweight gain) of 0.32 kg/day together with an increase of around 0.05 calves/cow/year by 2020. However, greater gains in fertility efficiency would decrease the level of feeding efficiency improvements necessary and vice versa.

In the same way, the modelling shows the reduction in annual emissions by 2020 required to meet the 11% target in sheep production can be achieved by similar combinations of fertility and feeding efficiency improvements (Figure 2).

Figure 2: Sheep - combinations of flock efficiency improvements to achieve the required 11% saving in GWP100 by 2020



In this case, the model reveals to achieve the 11% target a median improvement of 20% in daily liveweight gain coupled with 0.075 more lambs per ewe by 2020 is required.

Challenging though such improvements may be, the fact that they are all within the bounds of technical possibility indicates that the GHG emission reduction targets are achievable within the required timeframe.

Achieving the Feeding Efficiency Improvements

The focus of industry-wide efforts to achieve the GHG emission reduction targets clearly needs to be on feeding efficiency more than anything else.

In this context, improvement activity must be concentrated on the three main areas of breeding, feeding and management.

Breeding more feed-efficient stock is a long-term process. However, the generation intervals of cattle and sheep mean worthwhile improvement should be possible by 2020.

The fact that well-managed breeding leads to permanent and cumulative gains makes it a particularly valuable underlying component in improvement efforts.

The range of EBVs for key characteristics like growth rate currently existing within the major beef and sheep breeds indicates there is considerable additional genetic merit already available for producers to utilise.

The current variation around the +26 kg average 400-day Growth EBV for Limousin beef sires, for instance, is from +2 kg in the bottom 10% of the breed to +49kg in the top 10%. Equally, the variation around the average +5.04 kg Growth to 21 Weeks EBV in Texel rams is from +3.01 kg to +7.97 kg.

The widespread use of AI - especially in the dairy industry - allows the maximum number of herds to use the very best genetic merit stock, enabling particularly rapid progress to be made through beef breeding. This helps to make up for the longer generation intervals of cattle compared to sheep.

In both cases, the rate of breeding progress is heavily dependent on the uptake of performance recording by breeders, and the utilisation of EBVs as a tool for sire and ram selection by commercial producers.

Recent Better Returns Programme training and support has done much to increase the momentum of EBV adoption and use across both industries. This needs to be maintained and built-on to ensure it makes a sufficient contribution to feeding efficiency improvement.

Feeding improvements, in contrast, can deliver far more rapid feeding efficiency progress. Both forage quantity and quality are important, with research showing major opportunities for producers to both utilise more of the forage they grow and make more from higher quality forages.

This is illustrated most dramatically in the calculated savings possible through the use of clover as opposed to merely grass species in beef and sheep production (Appendix 3).

Maize silage provides opportunities for lowland beef production systems to improve daily liveweight gains, as do pasture improvements. High sugar ryegrasses are known to improve output and the stock-carrying capacity of land. Greater inclusion of clover in swards delivers valuable gains in animal performance, as well as nitrogen efficiency. More effective grassland management can dramatically improve daily gains.

In addition, a variety of alternative forage crops provides useful opportunities to buffer grass growth at key times of the year. There is substantial potential to improve both forage conservation and rationing to reduce waste and optimise performance. And the increased feeding of co-products of human food production can deliver valuable efficiency gains as well as fulfilling a useful recycling role.

The latest EBLEX Business Costings (October 2009) show top third beef producers have feeding periods between 15% and 34% shorter than bottom third producers, whilst at the same time finishing younger cattle at heavier weights. Since feed conversion efficiency naturally reduces with age for all types of cattle, this underlines the opportunity immediately available for both financial and environmental improvement.

There is also much that can be done to reduce the deposition of excess subcutaneous fat in both beef and lambs as they near slaughter weight. As well as being a waste to the processor, this fat requires four times as much energy to produce than the lean meat the market wants.

While the opportunities for boosting efficiency through feeding are many and varied, it is important to appreciate that there may be other environmental constraints on the extent to which they can be achieved.

For instance, landscape conservation and biodiversity enhancement objectives will almost certainly limit the improvements possible in some hill and upland pastures and their management.

In management terms too, improving housing conditions, space and access to feed and water all provide opportunities for increasing daily liveweight gains.

Equally, there is much producers can do to both reduce mortality and prevent sub-clinical health conditions compromising feeding efficiency by keeping on top of important infectious diseases like scours and pneumonia, metabolic diseases like hypomagnesaemia and pregnancy toxaemia, and worm and liver fluke infestations.

Better health planning plays a key role in this respect, ensuring that predictable problems are prevented wherever possible and always treated effectively as soon as they first become apparent rather than dealt with on a traditional - and increasing costly - fire-fighting basis.

Improving biosecurity will further minimise the extent to which potential health problems are imported into herds and flocks.

Monitoring Progress

A major barrier to achieving the required improvements in GHG emissions from beef and sheep production lies in the lack of convenient ways of measuring environmental performance across such diverse and complicated industries. This has become all too evident during the construction of the complex model that has been required to estimate the current emissions baselines.

A tool that would allow an accurate assessment to be made of emissions performance at farm level would really help to drive through changes by enabling business managers to understand their current position and the effects of any changes they make.

In its absence for the foreseeable future, however, the fact that emissions performance is so closely allied to technical efficiency is extremely valuable - not least in encouraging producers to take improvement action for their own good as much as for that of the wider environment.

In this respect there is a considerable amount of existing industry data that can be used as a proxy for emissions performance improvement.

For the beef sector the most practical proxies are:

- Weight of carcase produced per day of age; and,
- Calves produced per cow per year.

In the same way for sheep, they are:

- Weight of carcase produced per ewe; and,
- Average litter size.

In addition, information on performance efficiency at individual farm level may usefully be secured to complement existing Business Costings data. This can be achieved through regular surveys collecting readily-available figures from stratified samples representative of all the main beef and sheep system components.

10. Other Environmental Impacts

While emissions reduction is clearly the most urgent priority, it needs to be undertaken with a full understanding of the other impacts - both positive and negative - of beef and sheep production on the environment.

This is vital if reductions in GHG emissions are not to compromise the achievement of other important environmental objectives, such as landscape management and biodiversity promotion.

It is also important in ensuring future beef and sheep production strategies take full advantage of mutually beneficial improvements, such as more efficient artificial fertiliser usage and water quality enhancement.

Landscape Management

Even though the relative indigestibility of their herbage creates GHG emission challenges, maintaining sufficient grazing livestock on the English hills and uplands is essential if their open character is to be maintained and the encroachment of bracken and woody scrub is to be avoided.

Beef and sheep production is important too in maintaining the traditional small hedge-bounded field structure that characterises much of northern and western England and has been so sadly depleted in many other lowland areas; a structure long recognised for its value in supporting wildlife both as a food resource and for safe movement.

Carbon Sequestration

Regular grazing of appropriately managed grassland and the steady return of nutrients to the soil in faeces and urine accelerates its natural cycle of growth and decay. This has been shown to improve the capture of CO_2 through photosynthesis and its incorporation into soil organic matter.

In this way grazed beef and sheep play a valuable role in increasing carbon capture and storage, especially in permanent pastures where lack of cultivation minimises carbon release through oxidation.

Fertiliser Use

Over the past 10 years, the annual British Survey of Fertiliser Practice shows overall nitrogen, phosphate and potash applications to grassland in England and Wales more than halving to 52 kg/ha, 7 kg/ha and 12 kg/ha respectively by 2008.

At the same time, beef and sheep production stands out as the lowest user of artificial fertilisers on grass. In 2008, for instance, grassland on grazing livestock farms received an average of just 34 kg/ha of N, 8 kg/ha of P2O5 and 10 kg/ha of K2O. This compares with 117 kg/ha, 16 kg/ha and 25 kg/ha recorded on dairy farms.

The progressive introduction of higher sugar ryegrasses, clovers and other more efficient forage species into grassland swards offers the opportunity to reduce this use of energy and potential pollutant even further. As does the better utilisation of farmyard manure.

Nutrient Management and Planning

The fact that 60% of livestock farmers out-winter their beef and sheep reduces the nutrient management and planning challenge they pose, especially when it comes to storing and applying manures produced from housed stock.

The challenge is further reduced by the widespread use of straw bedding in winter beef and sheep housing systems, leading the majority of animal waste to be produced as farmyard manure rather than slurry. Of course, this also provides a valuable way of processing and recycling the organic matter in straw.

Nevertheless, there remains the potential to make greater use of farmyard manure and minimise the risk it can pose to water and air quality by better planned applications.

Out-wintering of stock on forage crops or in open air corrals, which is proving more popular with some producers to reduce housing costs and improve animal health, also needs careful management to minimise pollution risk.

Water Usage and Quality

Water use is another area in which beef and sheep producers have significantly less of a challenge than more intensive livestock businesses. However, with over half of the 350-plus general livestock farmers participating in the 2006 NFU Water Survey reporting they were affected by that year's drought, there is considerable awareness of the need to maximise water use efficiency.

Water quality is perhaps a more significant concern for many grazing livestock farmers, especially those situated in important river catchments. Working closely with Natural England and other specialists, considerable work is already underway in improving river quality through catchment sensitive farming practices - including, most significantly, excluding livestock from access to key rivers.

Environmental Stewardship and Biodiversity

Latest figures from Natural England indicate that grazing livestock producers had around 30% of their agricultural area in Entry Level Stewardship by mid-2008.

Although this is significantly lower than the 50% of the entire agricultural area now covered by such schemes, it fails to account for the considerable area of land included in the agri-environment schemes such as Countryside Stewardship and Environmentally Sensitive Areas.

Evidence from particularly sensitive landscapes shows uptake of agri-environment schemes to be considerably higher than the simple ELS figures suggest. In one of the largest of England's Areas of Outstanding Natural Beauty - the Shropshire Hills - where beef and sheep production predominate, for instance, over 70% of the registered farmed area is currently managed under some form of agri-environment scheme.

With agri-environment support such a vital element in the incomes of so many hill and upland producers, in particular, Environmental Stewardship offers clear opportunities to extend wildlife and other conservation measures even further, especially through targeted uptake of the Higher Level Scheme.

Care must be taken, however, to ensure that stewardship activities like promoting less productive, species-rich pastures in the interests of biodiversity have the least possible conflict with the GHG emissions reduction.

These and other significant beef and sheep production environmental impacts will be addressed in more detail in Part II of this Roadmap, which will also attempt to establish the key inter-relationships between these factors so the effects of production changes can be assessed on the broadest possible environmental front.

11. Action Plan

To encourage sufficient progress in reducing GHG emissions across the English beef and sheep industries, a firm plan of action will be implemented from 2010 as part of EBLEX's established industry-wide programme to:

- Monitor performance at various levels
- Research improvement opportunities in a whole host of areas
- Transfer the knowledge gained in both as widely as possible.

Component	Action	Output	2008	2020 target
Performance Monitoring				
Beef efficiency	Undertake an annual assessment of the weight of carcase produced per day of age across GB beef production bringing together BCMS age at slaughter data and carcase weights from EBLEX carcase classification reports.	An annual benchmark for the efficiency of beef output that can be tracked forward (and back) to provide the industry and producers with information on progress and targets against which to assess individual performance.	0.471 kg / d carcase wt (326 kg 692.51 days)	0.5 kg/d carcase wt
Beef fertility	Undertake an annual assessment of calves produced per cow per year from BCMS and/or Defra census data, broken down at least by dairy or beef herd origin.	An annual benchmark for beef fertility that can be tracked forward (and back) to provide the industry and producers with information on progress and targets against which to assess individual performance.	Calving interval 413.5 days (88.27 calves per 100 cows)	Calving interval 392.4 days (95 calves per 100 cows)
Lamb efficiency	Undertake an annual assessment of the weight of lamb carcase produced per ewe per year from Defra census data and AHDBS carcase classification reports.	An annual benchmark for lamb production efficiency that can be tracked forward (and back) to provide the industry and producers with information on progress and targets against which to assess individual performance.	17.31 kg lamb carcase per ewe (270335 tonnes 1,5616 K ewes)	18.00 kg lamb carcase per ewe

Component	Action	Output	2008	2020 target
Performance Monitoring				
Ewe fertility	Undertake an annual assessment of ewe litter size from Defra census data.	An annual benchmark for lamb fertility that can be tracked forward (and back) to provide the industry and producers with information on progress and targets against which to assess individual performance.	118.2%	125.7% (plus 7.5 lambs per 100 ewes)
Beef and sheep unit performance	Extend the current costings scheme to include more herds and flocks for each production system to secure more accurate data on key aspects of physical performance.	Better benchmarks of more detailed performance measures across the range of production systems to track industry progress and provide targets for individual business performance assessment.	284 beef 205 sheep	310 beef 260 sheep
Beef and sheep breeding progress	Undertake an annual evaluation of Signet Beefbreeder, ABRI breeds and Sheepbreeder genetic progress in key sire and maternal Estimated Breeding Values by breed.	An annual benchmark of the progress being made by beef and sheep breeders to track progress and highlight the potential for performance improvement currently available by using the best in breed.	5 year average to 2008 Suffolk 0.082 pts/yr Texel 6.81 l pts/yr Limousin 0.91 BV/ yr	5 year average to 2020 Suffolk 0.12 pts/yr Texel 10.0 pts/yr Limousin 1.1 BV/ yr
National beef and sheep productivity	Establish an annual survey of the current productivity of beef and sheep systems, if feasible, involving a stratified sample representative of industries and utilising the sort of readily-available data pioneered in the EBLEX Snapshot tools.	An annual benchmark to anchor the detailed performance measures secured from the Beef and Sheep Costings scheme, allowing better assessments to be made of the productive efficiency of the national herd/flock and its components.	In progress	Annually update

Productive efficiency report	Publish an annual report of the productive efficiency of English beef and sheep, including data from the above monitoring tools and other information on breeding herd/flock sizes from the Defra census and carcase quality monitoring.	A single, high profile report setting out the state of the beef and sheep production industries, distributed and publicised widely, and utilised to establish the extent and specifics of efficiency improvements as well as highlighting areas of particular future improvement potential.	Beef report 2009 Sheep report 2008	Annually update

Performance Improvement Research and Development			**Reporting date**
Grass and clover breeding	Identify ways to improve the nutritive value of grasslands through the development and use of higher nitrogen efficiency and higher sugar and more water-efficient ryegrasses and clover varieties in improved sward combinations.	Recommendations for grassland productivity improvements through better variety selection and sward management.	Dec 2010
NIR manure analysis	Develop a rapid and reliable on-farm technique for measuring the nutrient composition of farmyard manures.	A tool giving producers more confidence in the manurial value of their farm waste, encouraging more complete and better planned utilisation.	April 2013
Dairy calf selection	Assess the performance differences of apparently different types of pure dairy bred bull calves reared and finished intensively for beef production.	Practical information on pure-bred dairy bull calf performance reared under commercial conditions to encourage better young calf management and uptake for beef rearing, so reducing the wastage of unnecessary surplus dairy bull calf disposal.	March 2010
Grassland monitoring	Demonstrate ways in which beef and sheep producers can improve their grassland utilisation through better grazing management based on regular monitoring of sward growth.	Recommendations for practical grazing management improvement using techniques developed in the dairy industry.	Dec 2010

Performance Improvement Research and Development			Reporting date
Maize grain beef finishing	Determine how best to use crimped grain maize in beef finishing in place of rolled barley to maximise performance through minimising digestive problems.	Recommendations for grain maize treatment and rationing as an alternative to barley finishing.	Aug 2010
Chicory utilisation	Examine the efficiency improvement benefits of including chicory in the diets of grazing cattle and lambs.	Recommendations on the best ways of making the most of the apparent benefits of chicory in increasing productive efficiency.	Sep 2012
High quality oats	Utilise the most promised varieties of high quality oats as a major cereal component in ruminant feeding to maintain performance while decreasing methane production.	Information on ways in which high oil oats can be used to improve the productive efficiency of commercial diets.	April 2014
Marker-assisted sheep breeding	Evaluate the effectiveness of various genetic markers for muscling in sheep breeds in commercial cross-breeding.	Information for breeders and producers on the value of employing existing genetic markers for muscling in UK systems.	Dec 2010
Faecal egg counts in sheep breeding	Investigate practical ways for utilising Faecal Egg Count (FEC) EBVs in selecting breeding stock for improved resistance to intestinal worms.	Practical recommendations encouraging breeders and producers to incorporate FEC EBVs in their breeding improvement programmes.	Dec 2019
Young bull promotion	Develop a national scheme with key beef breed societies to increase the selection and use of young bulls with superior EBVs for key performance traits in breeding and performance recording.	Promote more rapid genetic progress through reduced generation intervals and improved selection decisions while improving the accuracy of EBVs.	On going
Ram linkage programme	Increase the genetic linkages between flocks by increasing the use of rams with superior EBVs for key performance traits in breeding and performance recording,	Improve the confidence of the industry in EBVs across breeds and increasing the uptake of high merit rams to boost genetic progress.	On going

Performance Improvement Research and Development			Reporting date
Emissions model development	Improve the GHG emissions model to increase its precision and value in assessing emissions and planning improvement strategies.	Provide the beef and sheep industries with increasingly precise estimates of the extent of both current emissions to track improvements and the value of specific productivity gains in reducing them.	On going

Knowledge Transfer			Reporting date
Beef BRP	Extend the established BRP programme to a wider cross-section of herds and increasing participation in its events and activities focused on the breeding, nutrition, fertility and health, systems and costings improvements available to all beef producers.	Communicate the results of performance monitoring, R and D and other work in thoroughly practical ways that help beef breeding, rearing and finishing businesses make incremental improvements in their enterprises for progressively greater economic and environmental value.	On going
Sheep BRP	Extend the established BRP programme to a wider cross-section of flocks and increasing participation in its events and activities focused on the breeding, nutrition, fertility and health, systems and costings improvements available to all sheep producers.	Communicate the results of performance monitoring, R and D and other work in thoroughly practical ways that help sheep businesses across the stratified industry make incremental improvements in their enterprises for progressively greater economic and environmental value.	On going
Action for profit resource	Develop the focused Beef and Sheep Action for Profit Resource to underline the environmental as well as economic value of specific production system improvements.	Underline the extent to which important environmental improvement objectives can be achieved as part of economic improvement rather than requiring separate attention.	On going
Health tracking and advice	Regular tracking of important livestock health issues through NADIS, with timely seasonal advice for producers on avoiding or overcoming problems.	Help producers take positive action to minimise the effects of a range of diseases on productive efficiency.	On going

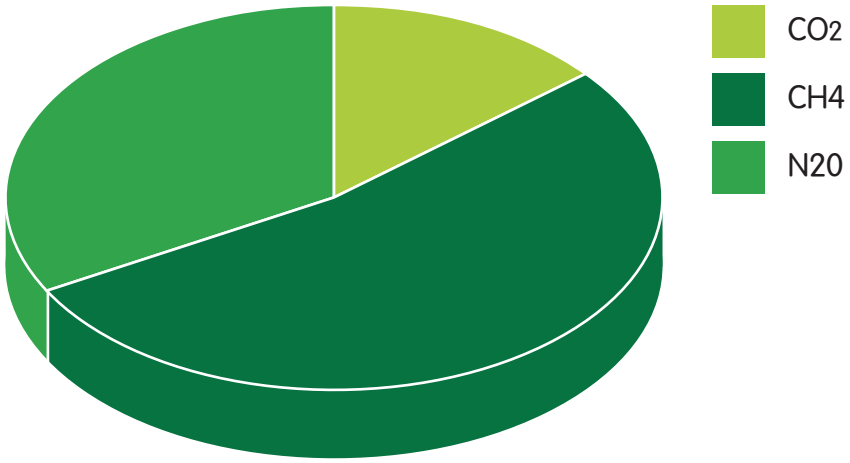
In addition to these activities, primarily focused at reducing GHG emissions through improvements in productive efficiency, Phase Two of this Roadmap will be produced in 2010 to assess the range of other important environmental impacts of English beef and sheep production and provide a comprehensive strategy to improve the industries' overall environmental balance, taking full account of the need to meet multiple objectives.

Key elements of this will include:

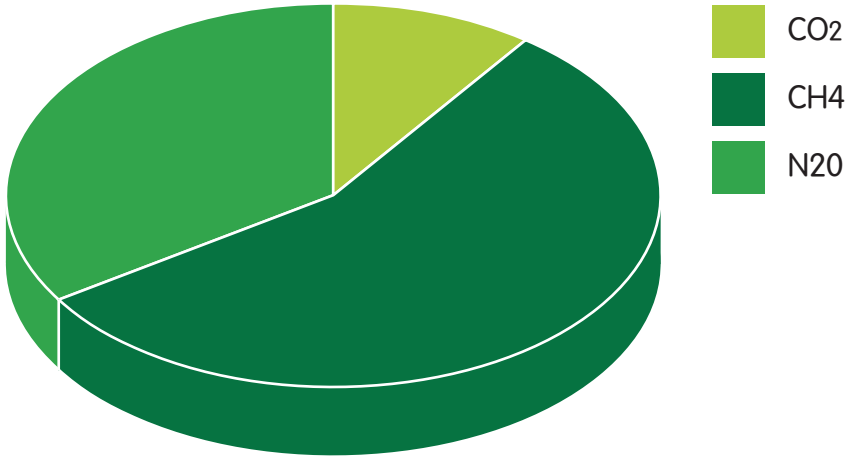
Content	Focus
Nutrient utilisation	Establishing current fertiliser usage and nutrient planning benchmarks for targeted improvement.
Carbon sequestration	Assessing the extent to which grazing livestock contribute to the value of land as a carbon sink and ways of improving it.
Water use and quality	Establishing an industry benchmark for water use, together with ways of minimising overall requirements and safeguarding water resource quality through catchment sensitive farming.
Landscape management	Defining levels of grazing livestock production essential to prevent degradation of hill and upland landscapes, in particular, and suggesting the best means of securing them.
Environmental schemes	Defining levels of grazing livestock production essential to prevent degradation of hill and upland landscapes, in particular, and suggesting the best means of securing them.

12. Appendices

Appendix 1a: Breakdown of the Global Warming Potential of UK beef production into the main greenhouse gases



Appendix 1b: Breakdown of Global Warming Potential of UK sheep production into the main greenhouse gases



Appendix 2: Current baseline environmental impacts for the main systems of English beef production

Component System	Environmental Impact	
	GWP100 kg CO_2 eq/kg	Primary Energy * MJ/kg
Lowland suckler beef (autumn-calving)	18.01	37.92
Lowland suckler beef (spring calving)	16.60	33.59
Upland suckler beef	17.32	33.10
Hill suckler beef	16.49	29.48
Suckler beef	**17.03**	**34.09**
Intensive dairy beef	10.12	29.99
Non-intensive dairy beef	11.46	28.08
	10.97	**28.67**

* The CO_2 emissions implications of this are included within the GWP100 figure

Appendix 3: The implications of clover use in sheep production on GWP100

The baseline data in the Life Cycle Analysis model assumes that lowland and upland grassland is fertilised. If it is assumed that grass clover swards account for all grassland, then the model determines that very little fertiliser is required by the systems. There is consequently a considerable saving in energy since a large portion of the presumed nutrient supply was in the form of artificial fertiliser. However there is still a large emission of nitrous oxide during the turnover of nitrogen in the soil created by the clover, which results in the overall GHG emission saving being rather less dramatic than the saving in energy.

Use of clover in sheep production systems

Component System	Environmental Impact	
	GWP100 kg CO_2 eq/kg	Primary Energy * MJ/kg
Baseline	14.64	22.02
Fertiliser with clover	13.36	14.99
No fertiliser with clover	13.14	14.05

* The CO_2 emissions implications of this are included within the GWP100 figure

Use of clover in beef production systems

Component System	Environmental Impact	
	GWP100 kg CO_2 eq/kg	Primary Energy * MJ/kg
Fertiliser with clover, grazing	13.89	30.58
Fertiliser with clover grazing and silage	13.83	30.33
No fertiliser with clover grazing	13.83	30.33
No fertiliser with clover grazing and silage	11.72	21.33

* The CO_2 emissions implications of this are included within the GWP100 figure

Glossary

ABRI - Agricultural Business Research Institute

BCMS - British Cattle Movement Service

CO_2 eq - Carbon Dioxide Equivalents

DLWG- Daily Live Weight gain

EBV - Estimated Breeding Value

ELS - Entry Level Stewardship

GHGs - Greenhouse Gasses

GWP - Global Warming Potential

GWP_{100} - Global Warming Potential, over 100 years

LCA - Life Cycle Analysis

MJ - Mega Joules (standard energy unit)

MT - Mega Tonnes

NADIS - National Animal Disease Information Service

NIR - Near Infra-Red

Notes

The English Beef and Sheep Production Roadmap - Phase 1

EBLEX is the organisation for beef and sheep producers in England. It aims to encourage better returns, stimulate profitable demand for quality beef and lamb, and champion the development of a sustainable industry.

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