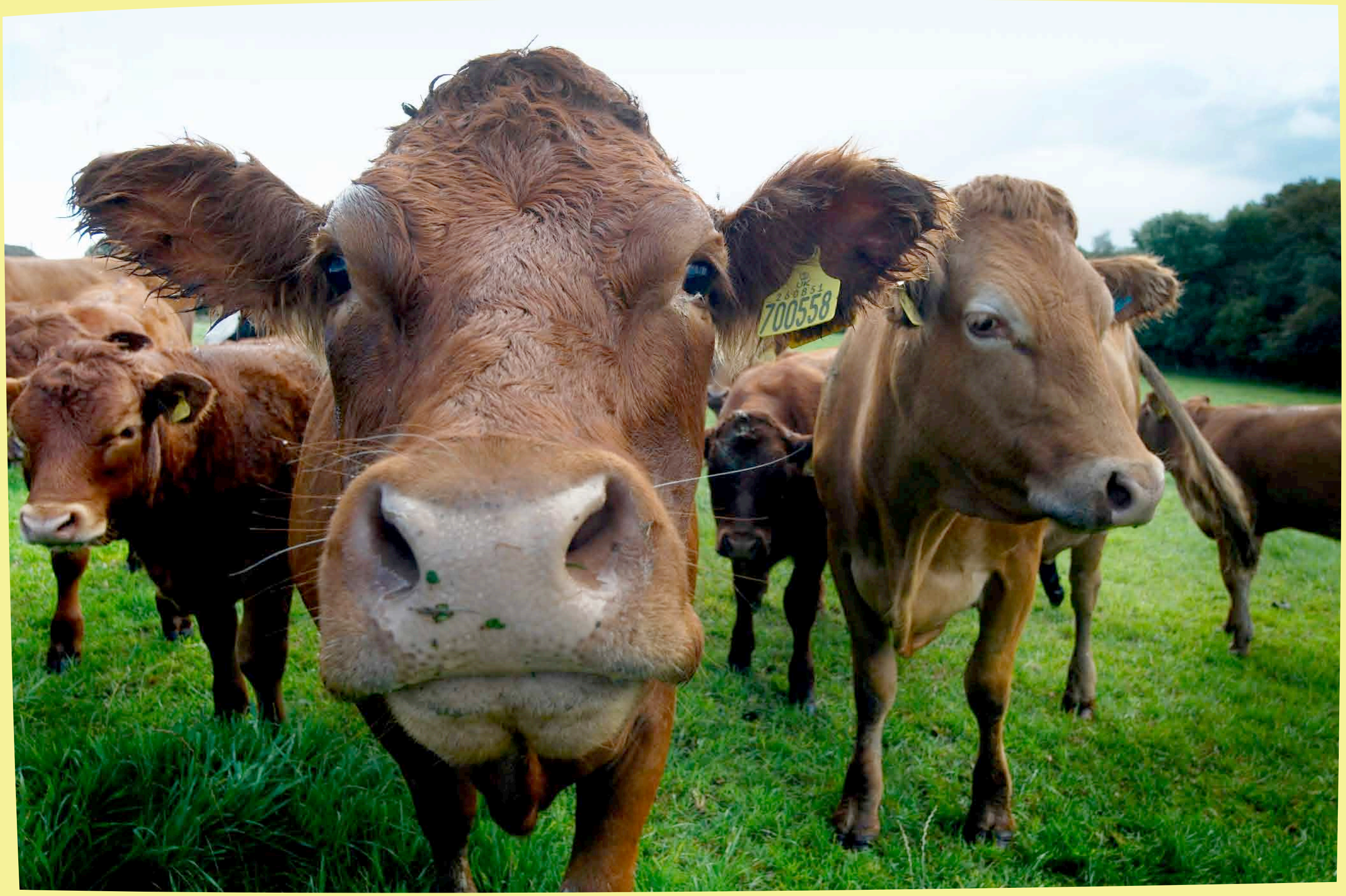
National Trust



What's your beef?

Introduction

What has beef to do with the National Trust?

We care for more than a quarter of a million hectares of land across England, Wales and Northern Ireland on behalf of the nation. This holding embraces some of our most spectacular countryside and includes farmland, woods and historic landscapes, as well as more than 1,100 kilometres of coastline.

We directly manage nearly 400 sites, amounting to some 20,000 hectares, while the remaining land is farmed by 1,500 agricultural tenants. A total of 160,000 hectares – 80% of the farmed area – is grazeable land, mostly located in upland areas. Cattle and sheep farming are at the heart of the management of this diverse estate. The future viability of livestock farming, in both economic and environmental terms, is therefore central to our agricultural and food interests.

Grazing land ranges from heath, moors and downland to more intensively managed agricultural swards and provides an important national resource, fulfilling a wide range of functions beyond the production of meat, milk and wool. These functions, described collectively as ecosystem services, include collecting and cycling water, storing carbon in vegetation and soils, supporting biodiversity, preserving a treasured landscape containing fascinating evidence of our past and providing accessible green space for people to enjoy.

The story does not end with land management. We operate more than 150 restaurants and tearooms, with an ambition to use fresh, seasonal ingredients produced as locally as possible by our tenants and other suppliers, including artisan food producers. It matters to us – and to our visitors – where our food comes from, how it was produced, its impact on the environment and the welfare of animals. Our approach to sustainable land management aims to help our farmers reduce their environmental footprint, protect the natural resources on which they depend, and add value to the food they produce.[1]

Most importantly, we aim to encourage and inspire people to reconnect with land – and what better way to do this than through food. We want to support the nation's newly rekindled interest in where food comes from, how it is produced and its environmental impacts. In the past few years we have created over 1,000 new public allotments on our land to encourage schools, communities and families to grow their own vegetables. However, producing a source of protein-rich food to complement those vegetables in a well-balanced meal is not easy for individuals. If we want *locally* sourced protein-rich food, our diet must of necessity include meat, dairy, fish or eggs.

This is where beef comes in. If there is any single food that typifies the British culinary tradition, it is beef, and its benefits extend far beyond its taste. But not all beef is created equal, and the way it is reared has a major impact on the environment and on its quality and nutritional value.

Cattle and sheep – unlike humans – can digest grasses and coarse plant foods and provide us with meat and dairy foods from grasslands. During the digestion of food by these ruminant animals large amounts of methane, a potent greenhouse gas, are produced. This is at the root of global concern about the impact of ruminant animals on the climate.

The current focus on climate change and the part agriculture has to play in mitigating greenhouse gas emissions is leading to suggestions that intensive production methods – where cattle are fed largely on cereals, producing less methane – should be preferred over more traditional livestock farming. Cattle and sheep are vital for the management of our grasslands, and for centuries have shaped the appearance of our much-loved countryside.

This brief report aims to raise awareness of these issues and inform how the National Trust approaches its land management and food procurement decisions in its catering operations, and its contribution to the wider debate on food security and climate change.

Background

The National Trust and land management

In the UK, more than two-thirds of our farmed area is grassland. Of this, nearly half is rough grazing or commons as opposed to agriculturally improved swards.[2] Grasslands cover a wide range of important habitat and landscape types as well as the usual pastures and meadows associated with agriculture. The National Vegetation Classification recognises 48 separate grassland types grouped by occurrence on acid, alkaline or neutral geology.[3] In altitude they range from montane communities and acid grass moorland in the uplands to lowland meadows, pastures, salt marsh and coastal dune systems.

The National Trust's approach to sustainable land management, embodied in 'Our Land – for ever for everyone' (2010), is founded on the principle that food security in the long term depends on environmental security and safeguarding the resources of soil, air, water and biodiversity upon which production depends. Using these resources wisely and efficiently is key to our ability to maintain production levels in the long term.

Intensification of production may be seen as the answer to meeting the food requirements of an increasing population, both domestically and globally. However, intensification of farming historically – such as the ploughing of grassland to produce crops and increased stocking in response to headage payments – has led to environmental damage including pollution of ground- and surface-water, soil degradation, reduced biodiversity and loss of carbon from land. This damage is easily caused and difficult and slow to repair. Any intensification that damages the resources required for production is counterproductive, and a focus on *optimising*, rather than maximising farming efficiency is a far more positive approach.

The climate and food security debates are inseparable, and there have been many calls to reduce meat consumption in order to cut emissions from livestock and divert arable food production to feeding people more directly. However, many agricultural grasslands and grass-based habitats are not suitable or capable of growing arable crops for direct human consumption. Grazing by livestock, therefore, is the only way to turn grass into human-edible food.

Beef production and the climate debate

Reduction of greenhouse gas (GHG) emissions from all types of farming is vital for the agriculture industry to play its part in achieving the government's ambitious targets under the Climate Change Act 2008 to cut GHG emissions by 80% of 1990 levels by 2050.

Many life cycle assessment (LCA) studies have reported on the GHG emissions from beef production and shown that intensive production methods, where cattle are fed a high proportion of cereal-based feed,

Background

have lower emissions than more extensive production where the diet is predominantly grass-based. As a consequence there is a widely held view that intensive methods are preferable with respect to GHG emissions in agriculture. However, we feel that a narrow LCA-based view of emissions ignores the wider aspects of sustainable land use. In particular, LCA methods that exclude land carbon sequestration ignore the huge potential for increasing carbon stocks in soils – to which the National Trust has committed in its approach to land management.

Grasslands provide ecosystem services

Beyond their vital role in meat production, grasslands and grass-based habitats fulfil a wide range of functions for society, now often referred to as ecosystem services.

WATER

A Water Resource Risk Assessment in 2006 overlaid more than 150 water-related data sets onto all National Trust properties in England and Wales. This produced a valuable database for land managers which revealed that 43% of the surface area of England and Wales drains through, or to the boundary of, National Trust land.

Water resource management is a universal issue – all grassland management depends on, and interacts with, water in some way and our ability to produce food, conserve wildlife and sustainably manage landscapes is influenced by the water resources at our disposal.

Grassland management in particular plays an important part in the management and protection of water resources. Care in the application of manures, fertilisers, herbicides and pesticides helps reduce pollution of watercourses and unwanted enrichment of freshwater habitats. Permanent and long-term grassland cover protects soils and, with appropriate management, prevents soil erosion and siltation of watercourses and standing water bodies.

An increase in the frequency and intensity of winter rainfall is predicted as a consequence of climate change. This has led the government to reconsider its approach to the management of flood risk. Hard-engineered solutions such as widening or deepening river channels to increase flows and contain floodwater have had adverse environmental impacts; they are expensive and, on their own, are not effective in the management of excess water in catchments. Greater emphasis is being placed on reducing surface run-off, encouraging infiltration to recharge groundwater, and generally slowing the passage of water through catchments. Grasslands have an important part to play in this approach and synergies have been identified between the creation and management of wetlands and washlands for flood control and increased biodiversity.

CARBON

Soils have a huge potential to store carbon. Globally, the Intergovernmental Panel on Climate Change (IPCC) estimates that nearly 90% of the potential for agriculture to cut greenhouse gas emissions lies in enhanced carbon storage in soils. A study of the National Trust's Wallington Estate in Northumberland in 2010 revealed that 95% of its carbon stocks were held in the soils, compared with 5% in vegetation, even though more than a quarter of the 5,500 ha estate is wooded.[4] Most variability of soil carbon at Wallington was related to individual farm management, which had more influence than soil type. This supports the National Trust's ambition to increase soil carbon by optimising land management, particularly on grasslands.

TABLE 1

Relative carbon content of soils under different land use and management regimes

Land management	*Total carbon in 0–30cm layer (t/ha)*
Highly productive pasture	63.6
Woodland	58.9
Low productivity pasture with moderate grazing	53.3
Reduced tillage arable	41.1
Over-grazed pasture	37.4
Direct drilling arable	35.7
Multiple tillage arable with tines	35.2
Multiple tillage arable with discs	31.7

Table 1 shows the relative carbon content of soils under different land uses in the UK.[5] This gives a useful

Background

indication for potential land use changes to increase soil carbon stocks. Woodlands and permanent pasture have the greatest potential to sequester carbon in soil, and in arable situations, reduced tillage performs this function better than multiple tillage methods.

Carbon in soil organic matter may take decades to accumulate,[6] but carbon losses that result from land use changes – such as ploughing of grasslands – can occur rapidly, negate any gains made, and are difficult to reverse.[7] For soil carbon gains to persist, land use and land management change must be long term. This aspect of carbon husbandry is important for land managers to appreciate when confronted with short-term opportunities to manage land for profit.

BIODIVERSITY

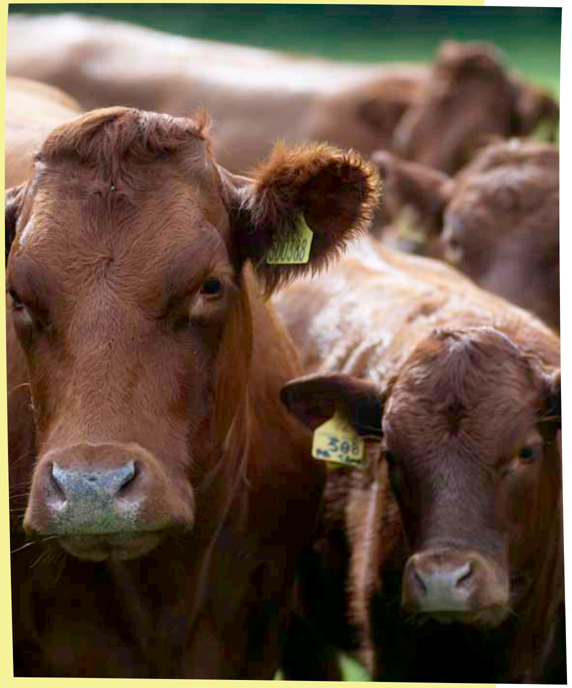
National Parks and Areas of Outstanding Natural Beauty are some of our most highly prized and protected landscapes. Predominantly they are pastoral in character and depend on agriculture and grazing animals to maintain their special qualities. To a large extent grasslands typify our green and pleasant land. The range of grassland types in the UK embodies many of our most important and specialised habitats including moorland, downland, wood pasture, herb-rich meadows and coastal marshes. Many are protected under UK or EU designations, which further signify the importance we attach to them as a nation.

ARCHAEOLOGY

The undisturbed soils of permanent pastures or inaccessible, steep or rocky grasslands protect the archaeological record of historic land use, settlement patterns and industrial activity. The care and management of archaeological monuments and features often requires the maintenance of permanent grass cover to prevent physical damage or mixing of soil layers by cultivation or afforestation. The protective cover of vegetation also reduces vulnerability of exposed soils to erosion through natural weathering or physical wear by people or animals.

ACCESSIBLE GREEN SPACE

Octavia Hill, one of the founders of the National Trust, observed as early as 1895 that 'the need of quiet, the need of air, the need of exercise, the sight of sky and of things growing seem human needs, are common to all men'. A growing body of research is now backing up her intuition with science. Physical exercise outdoors is known to generate positive health benefits on blood pressure, self-esteem and mood. For example, recent research from Essex University shows that as little as five minutes' 'green' exercise can have a significant impact on self-esteem.[8] It has also been suggested that increased access to a wide range of 'green' exercise activities could produce substantial economic and public health benefits.[9] Grasslands provide an accessible land type that meets the need for access to the countryside.



The National Trust research project

In 2010 we commissioned research to understand the sustainability of different beef production methods on National Trust land. This used life cycle assessment of different systems to assess carbon impacts, as well as an assessment of performance against other significant criteria, such as animal welfare and nutritional value of meat.

Beef production in the UK

In the UK, more than two million cattle were slaughtered in 2010, producing nearly 900,000 tons of beef. These animals were supplied in roughly equal proportions as bull calves or beef crosses from the dairy industry and from the 1.7 million strong national herd of suckler cows, spread across 60,000 farms.[10]

Calves from the suckler herd typically graze with their mothers for 6–10 months before being weaned. In contrast, calves from dairy cows are typically taken into the beef system at about a week old and bucket-fed on milk replacer for 5–6 weeks when they are weaned on to forage and concentrates.

After weaning, farmers adopt different strategies for fattening. These range from more extensive grazing-based systems, where animals may only be housed in winter, if at all, to more intensive systems where cattle are kept in buildings for most of the time and fed more concentrated, cereal-based diets.

Typically, extensive systems take between 22 and 24 months (or more) to get animals to slaughter weight and cereal-based systems can achieve earlier finishing at between 12 and 18 months. Most systems involve some degree of concentrate feeding to supplement grass from grazing or silage and hay. The proportion of concentrate feed in the diet and its type and source can have a significant influence on the overall greenhouse gas emissions attributable to the meat produced.

Greenhouse gas emissions

Globally, meat and dairy products account for around half the food-generated emissions and between 10% and 18% of human-related emissions overall.

Levels of meat consumption vary widely between different countries and cultures, ranging from an average of 5 kg per person per year in India to 123 kg per person per year in the USA. Global demand for livestock products is growing, particularly in developing countries, and by some estimates consumption of meat and milk is expected to increase by 50% by 2030 and to double by 2050. Although this often quoted figure may be too high and open to debate, a significant degree of growth seems inevitable.

It is widely considered that GHG emissions need to be reduced globally in order to avoid catastrophic climate change and at least 16 nations, including a number of major economies, have introduced legislation to cut emissions.[11] The UK government led the way and the Climate Change Act 2008 set legally binding targets to cut GHG emissions by 80% of 1990 levels by 2050.

The comprehensive body of published research on beef production and climate change has not yet produced a simple, clear set of guidelines for farmers and consumers. In particular, LCA methods are limited and do not provide an integrated view – this may have led to contradictory or confusing messages.

The National Trust project brief

The brief was to assess the cradle-to-farm-gate emissions of ten tenanted National Trust farms, selected as representing a cross section of different beef production systems. The analysis was carried out by Best Foot Forward and Laurence Gould Partnership, using the Publicly Available Specification guide PAS 2050, 'How to assess the carbon footprint of goods and services'. Additional scenarios were developed to explore the potentially mitigating effect of carbon sequestration by grassland and as a result of organic conversion. Carbon sequestration is currently excluded from PAS 2050 due to method and data uncertainties – although it is likely to be optional in future product footprinting standards.

The beef carbon footprint analysis was undertaken in accordance with PAS 2050 (British Standards Institute,

The National Trust research project

2009) using the E-CO_2 Project, Carbon Trust accredited, beef footprinting tool. The carbon accounting unit used by PAS 2050 is CO_2 equivalent per kg live weight of beef produced (kg CO_2e/kg LW), which incorporates the GHG potency of methane and nitrous oxide emissions.

Although PAS 2050 excludes carbon sequestration by soil and vegetation, estimates of potential mitigating scenarios were developed and presented separately using a methodology applied by other UK researchers.[12] The potential carbon sequestration benefits of converting to organic agriculture were also explored using methods outlined by the Soil Association.[6]

Finally, a comparison with other published life cycle studies was undertaken – including other UK studies and those examining US feedlot and Brazilian Cerrado production. Emissions from land use change scenarios were also considered in this part of the study.

The key questions were:

- What are the GHG emissions associated with beef systems typical of National Trust farms?
- How do they compare with UK farms in other studies?
- How do they compare with US feedlot and Brazilian Cerrado production?
- What happens if carbon sequestration is included in carbon accounting?

The sample farms

The selection of farms was intended to represent a range of beef enterprises typical of National Trust tenanted farms. The sample consisted of four organic, four extensive conventional and two semi-intensive conventional holdings, representing upland and lowland England, with one farm in North Wales. All the farms sold finished animals apart from two, one organic and one extensive, which sold their animals as 'stores' to be finished elsewhere.

Published LCA carbon figures for US feedlot[13] and Brazilian Cerrado beef[14] production were used for comparison with the National Trust farm results.

Findings

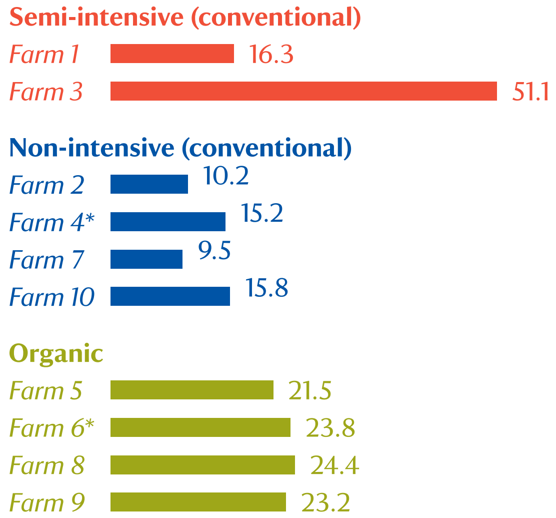
The headline results of the analysis are set out in Figure 1. Overall, the average carbon footprint for the eight farms that finished their own animals was 21.5 kg CO_2 equivalent per kg live weight of beef produced (kg CO_2e/kg LW). However, there was a wide range of performance within the small sample. The conventional farms ranged from 9.5 kg to 51.1 kg CO_2e/kg LW, while the organic farms averaged 23.2 kg CO_2e/kg LW, within a narrow range.

The figures from the National Trust farms are comparable with average figures produced by EBLEX in a study of 30 farms where averages for upland suckler beef and lowland suckler beef were 15.66 kg CO_2e/kg LW and 19.22 kg CO_2e/kg LW respectively.[15] The EBLEX results were also widely variable within each group.

The results from the sample farms suggest that GHG emissions from organic beef were slightly higher than conventional, with emissions from one conventional farm clearly much higher than all others.

FIGURE 1

Overall results (kg CO_2e/kg LW)



*Farms 4 and 6 do not finish their animals on the holding

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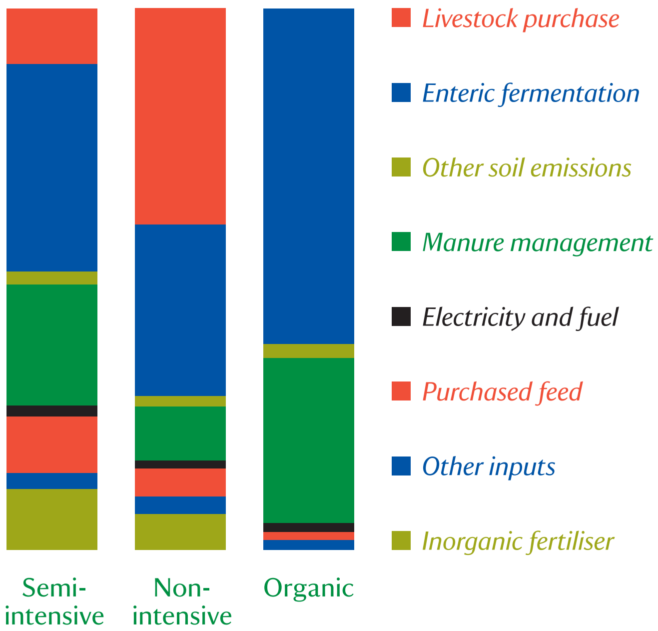
Figure 2 shows the proportions of the major emission sources for the farms:

- Methane emissions from cattle (enteric fermentation)
- Manure management
- Purchased feeds
- Manufacture and use of fertiliser (in the non-organic systems)
- Livestock purchase (rearing of bought-in animals)

FIGURE 2

Sources of main emissions (%)



This is in line with other beef LCA studies[12,14,15,16,17] of the carbon footprint of beef and points to aspects of the production where there may be greatest scope for emission reductions. Overall, conventional farms tended to have lower enteric fermentation and manure emissions, but a higher reliance on purchased feeds and inorganic fertilisers. Wide variability in beef carbon footprints has also been noted in other projects undertaken by E-CO_2 Project. This is a reflection of the diverse farm system characteristics, which affect final beef carbon intensity.

In this small study sample, the conventional non-intensive herds had the lowest carbon footprints. These herds were on farms that do not rely on significant quantities of energy-rich feeds or fertilisers and achieve higher beef output and reduced enteric emissions by utilising alternative feedstuffs. A good example of this is Farm 7, the best performing farm. It carries a conventional suckler herd on a mixed farm where cattle graze pasture but are also fed a moderate amount of additional feed e.g. potatoes and sugar beet pulp, which have low CO_2e values. Manures are also exported to the arable business, transferring the carbon burden to arable crops and making the beef enterprise appear more efficient.

Of the farms studied, Farm 3 and Farm 7 have the highest and lowest carbon footprint respectively. There are similarities between the two enterprises – they are of similar size and both 'conventionally' managed – but there are important differences:

- Live weight output
- Inorganic nitrogen application rates
- Manure management methods
- Lime application rates
- Herd structure – reflecting breed characteristics

TABLE 2

Comparison between Farm 3 and Farm 7

	Farm 3	*Farm 7*
Carbon footprint (kg CO_2e/kg LW)	51.1	9.5
Size of beef enterprise (hectares)	36	48
No. of suckler animals	39	37
No. of all beef livestock	106	82
Finished live weight (kg LW)	6,625	11,370
Livestock breeds	Charolais	Angus and Lincoln Red
Maturing age	Late	Early
Fertiliser use (kg of N)	5,600	1,523
Lime use	Yes	No
Manure management	Slurry	Heap and export to arable

The net effect of these differences results in Farm 3 being five times more carbon intensive per unit of production. Although both herds have a similar number of suckler cows, Farm 3 has a larger herd due to breed characteristics.

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This additional livestock 'overhead' contributes to higher emissions via a number of mechanisms:

- More enteric emissions
- More manure – and resultant management emissions
- More purchased feed requirements

The Charolais cattle of Farm 3 are late maturing and deliver a larger finished carcase weight compared to the native breed Aberdeen Angus and Lincoln Red cattle of Farm 7, but the additional slaughter weight did not appear to compensate for the extra six months' GHG emissions.

Carbon sequestration scenarios

Soil carbon sequestration is a mechanism with potential to 'offset' agricultural emissions – including those from livestock farming.[12] The subject is controversial because of interpretations of the degree of permanence of carbon storage, so the approach of this study was by way of two illustrative scenarios examining potential benefits.

The methods used were implemented in research by The Soil Association[6] and Bangor University for the Countryside Council for Wales.[12] The estimates of annual soil carbon sequestration occurring on beef enterprise permanent grassland and cropland are compared with the PAS 2050 output.

As soil carbon densities were not analysed on the farms, published research was used to develop two scenarios to explore the potential effect of carbon sequestration on the PAS 2050 footprint results:

A Grassland carbon sequestration on all farms. Permanent grassland sequesters carbon at a rate of 0.24tC/ha/year.[18] This assumption was used in a recent beef carbon footprint study for the Countryside Council for Wales.[12]

B Grassland and cropland carbon sequestration on organic farms. During conversion from conventional to organic agriculture, soil carbon levels improve at the following rates over 20 years: grassland: 0.42tC/ha/year; cropland: 0.55tC/ha/year.[6]

RESULTS

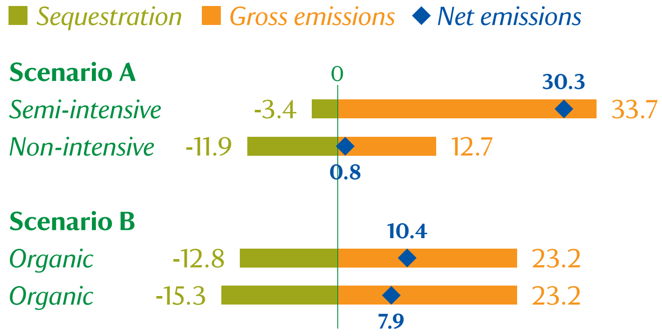
In Scenario A, grassland carbon sequestration reduced emissions per kg live weight by between 10% and 94%. On two farms the beef carbon footprint per kg live weight was net negative: these were upland farms with a significant amount of grassland/other carbon dense habitats. Farms with limited grassland and high dependence on bought feeds benefited less from this (e.g. semi-intensive Farms 1 and 3).

In Scenario B, three of the four farms had converted to organic agriculture within the past 20 years and so were 'eligible' for the carbon sequestration benefit (Farm 6 had always been farmed extensively and so was assumed to be in equilibrium in this scenario). The effects here were slightly greater than those seen in scenario A, reducing per kg LW emission by an average of 66%. Farm 9 had a negative footprint.

A summary of these results, by farm system, is presented in Figure 3. The non-intensive conventional herds performed well due to their mix of pasture and some better-quality feeds. The benefits seen in both scenarios may not accrue indefinitely – there is a potential limit to increased soil carbon levels, although this 'saturation' model has been challenged by some.[19]

FIGURE 3

Carbon sequestration scenarios (kg CO_2e/kg LW)



Scenario A: Gross emissions are the results of PAS 2050 compliant analysis. Sequestration relates to the annual sequestration occurring on grassland (at 0.24tC/ha/y). More intensive systems do not benefit as much as they have a small amount of grassland and rely more on purchased feeds.
Scenario B: Gross emissions are the results of PAS 2050 compliant analysis. Sequestration relates to annual grassland and cropland carbon gains associated with the conversion to arable agriculture over a 20 year period after changing to organic management.

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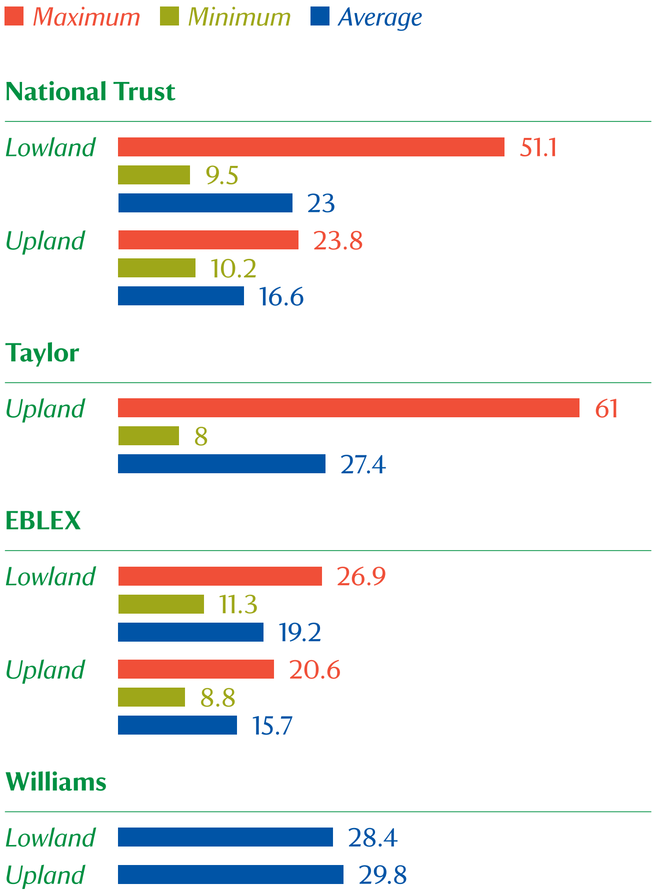
Comparison with other UK production

FIGURE 4

Study comparisons of beef footprint (kg CO_2e/kg LW)



The results of the National Trust beef footprints were compared with three other studies (see Figure 4):

- Taylor et al. (2010) – an analysis of 20 upland beef and lamb farms in Wales
- EBLEX (2010) – an analysis of 30 beef farms (including dairy beef) in England
- Williams (2006) – a top-down model of UK beef production, funded by Defra

The EBLEX work was carried out using the same foot-printing software as this study so should be the most comparable. The work by Taylor was PAS 2050 compliant so also should be reasonably comparable – although some method differences are likely, particularly accounting for complex livestock movements. The Williams work is the least comparable as it uses different soil nitrous oxide emission assumptions and does not account for soya-related land use change. Bearing this in mind, the results are reasonably consistent, showing footprints in the range of 15.7–29.8 kg CO_2e/kg LW.

Comparison with overseas beef production methods

The National Trust results were compared with systems used to produce meat imported into the UK. Two other systems were examined – USA feedlots and Brazilian grassland production from the Cerrado.

FEEDLOT BEEF

Feedlot beef are reared on pasture for 6 months and then weaned and acclimatised to trough feeding and a corn-based diet before moving to the feedlot. Animals are confined in pens each holding 100 or more and fed on a diet based on maize, silage and gluten feed, alfalfa hay and some soybean meal. They also receive antibiotics and hormone growth promoters routinely. The animals typically gain 1–2 kg per day and are sold at 12–14 months old.

CERRADO-REARED BEEF

The Cerrado is a vast tropical savannah covering about a fifth of Brazil. It is rated by the World Wide Fund for Nature as the most biologically rich savannah in the world. Much of the Cerrado has been agriculturally improved either by cultivation to grow crops such as soybeans for animal feed or cleared for grazing animals. Around 74% of Brazilian beef cattle for EU markets are sourced from the central Cerrado region.

The clearance of woody vegetation from the Cerrado results in a significant biomass carbon loss. Brazilian researchers estimate the carbon losses to be equivalent to 167t CO_2e/ha.[20] This massive carbon loss cannot be ignored for this type of production.

Figure 5 shows the relative scenario footprints of the US feedlot and Cerrado compared with the National Trust farms.

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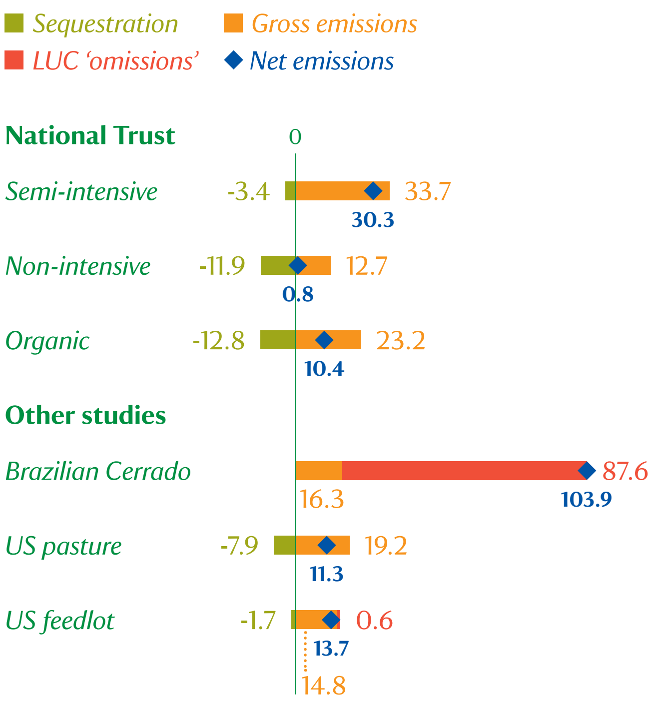
FIGURE 5

Scenario results (kg CO_2e/kg LW)

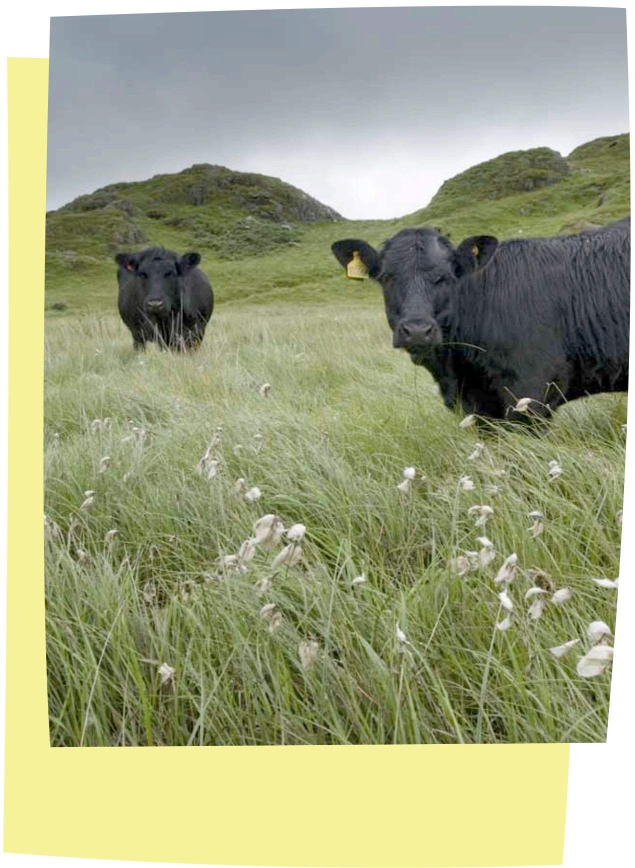


LUC 'omissions' are as estimated by National Trust research. Sequestration is carbon stored in soils through grassland management.

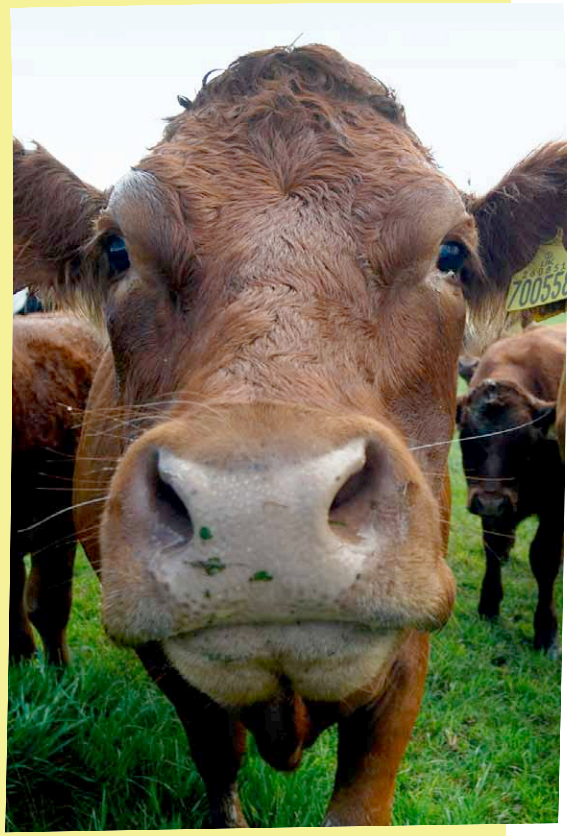
If the emissions associated with the Brazilian Cerrado are calculated using PAS 2050, it appears to be a reasonably carbon-efficient production system – on a par with the NT farm average. However, when recent land use change is accounted for, it has the worst carbon footprint by far. Even allowing for the uncertainties in this calculation, the conclusion is clear: it is a very carbon-intensive form of beef production.

Similarly, using emissions data alone, US feedlot production appeared to be relatively carbon-efficient compared with NT non-intensive and organic farms. This is largely because grain-fed cattle produce less methane, and have shorter life spans than grass-fed cattle.[17] However, when allowance is made for carbon sequestration, the UK and US pasture-based systems in the scenario performed better, in net carbon emissions, than the US feedlot.

The principal reason given for the lower GHG emissions of feedlot production is that digestion of grain by cattle produces less methane per kg of live weight produced. As enteric methane is the dominant emission in the beef life cycle, any reduction here normally outweighs the associated increase in feed carbon footprint.



Discussion



Benchmarking

Livestock production and in particular beef production has been brought into question in recent years as a result of concerns over its contribution to greenhouse gas emissions and potential effects on climate change. However, most of these concerns have not adequately considered the diversity of beef production systems, the land on which they operate, and their different environmental impacts and benefits.

This report set out to investigate the role of carbon footprinting in the assessment of a range of beef production systems, and to suggest what additional factors should be considered to properly assess wider environmental impacts.

The diverse beef systems in the UK include intensive cereal beef, silage beef, grass-finished beef, 18 month beef and 24–30 month beef. This report illustrated ten typical National Trust beef farms, and compared them to other studies in the UK. It also compared UK systems with more intensively reared feedlot systems in the USA and extensively reared beef from Brazil.

Our findings show that carbon emissions modelling using a current life cycle analysis protocol, while useful for benchmarking, provides an incomplete view of carbon efficiency. It is clear that variability of inputs and production systems do indeed have marked effects on CO_2e costs, as witnessed by a threefold difference in emissions across NT farms. However, the means of most data sets, including the National Trust farms, fall within a relatively narrow band between 10 and 25 kg CO_2e/kg LW.

When carbon sequestration associated with land management and carbon costs resulting from recent land use change are included in the model analysis, extensive beef production looks far more favourable compared to other systems and for non-intensive farms the modelled net effect approached carbon neutrality.

CARBON SEQUESTRATION IN SOILS

Current carbon accounting methods do not include carbon capture in their modelling for grassland, although there are plans to remedy this omission in the future with the development of a unified agriculture, forestry and other land use GHG inventory for the UK. However, we think that national inventory-based methods are a blunt tool.

In 2010, The National Trust and Durham University investigated land management for soil carbon at our Wallington Estate in Northumberland.[4] The results showed that soil carbon was influenced by many variables, the most influential of which was the management regime of individual farmers. We think, therefore, that farmers would benefit from employing readily available soil analyses to determine the carbon status of their own soils. Several motivated UK farmers who have analysed soil organic matter on their farms under grazing regimes are reporting carbon stock increases of between 3 and 5 tonnes/ha/year. This is an order of magnitude greater than modelling data currently available, and if widely confirmed would radically alter the current outlook on GHGs in UK agriculture. It follows that there is a need to obtain

Discussion

more data for soil organic matter and soil carbon changes under carbon-friendly management – in both grassland and arable farming. The National Trust will contribute by generating data from soils sampled under management changes in real farming conditions.

Maximum or optimum efficiency?

Beef production systems that generate less CO_2e per kg live weight gain are widely promoted as both more profitable and more environmentally friendly. As a consequence, attention has been focused on *maximising* feed conversion, with rapid growth to achieve early slaughter weights, supported by increased fertiliser input, cereal diet and imported feedstuffs. Our native breeds of cattle and related hybrids are well adapted to rough grazing, unlike Continental cattle. They mature slowly and produce smaller carcases – but if all the other benefits of extensive grassland meat production are considered, then lower output may be acceptable. Consequently we believe that more attention should be paid to *optimising* production, where lower efficiency is offset against related ecosystem protection.

Predictions of global population rise and changing dietary patterns anticipate that beef consumption will continue to rise. If this is the case, extra beef production will have to come from intensifying existing grassland use, advances in plant and animal breeding, and increasing use of cereals and grain legumes to feed cattle – regardless of GHG implications. We should also expect habitat loss to continue, especially in tropical regions. We consider that this way forward is unsustainable and undesirable for the land in our care. Grazing systems – as typified by many of our farms – are limited by the amount of grazing and conserved forage available from the farm itself, without much reliance on bought-in feed. Our advice to our grassland farmers will continue to be founded on the principle of land capability – this means we have to make informed judgements about changes in land use to ensure that optimum management regimes are adopted for the land in question.

Nutritional quality of grass-fed and grain-fed beef

It is widely accepted that meat plays an important part in a healthy balanced diet. It provides essential nutrients such as protein, omega-3 fatty acids, iron, zinc, selenium, and vitamins A, B, D and E. There is also evidence that some of these nutrients are more easily assimilated from meat than from other sources.[21]

The Department of Health recommends reducing saturated fats in our diet as these are associated with increased cholesterol levels, which increase the risk of heart attack and stroke. However, it also recommends increasing the intake of unsaturated fatty acids, particularly omega-3 polyunsaturated fatty acids, which are known to be beneficial in protecting against a number of heart and neurological diseases.

Analysis of meat from animals fed on grass consistently demonstrates significant benefits in the overall fatty acid profile and antioxidant content in comparison to grain-fed beef. Studies have shown that grass-finished cattle can produce loin of beef with about a third of the saturated fat of comparable cereal-fed beef, putting it on a par with skinless chicken breast.[22]

Meat from grass-finished cattle is found to be higher in beneficial omega-3 fatty acids, maintaining a favourable ratio between omega-3 and omega-6 fatty acids. It has also been shown that the level of omega-3 fatty acids in meat falls sharply if the livestock diet is switched from grass to cereals[23] – so intensive finishing on concentrates quickly negates the benefits of earlier pasture grazing.

Over the last 20 years, health benefits of conjugated linoleic acids (CLAs) have emerged. The indications are that CLAs, which occur naturally in small amounts in meat, play an important role in reducing cancers, hardening of the arteries and the onset of diabetes. It is clear that the typical human diet is deficient in CLAs, and grass-fed beef animals have been shown to produce 2 to 3 times more CLA than cattle fed on high-grain diets.[24]

The box overleaf summarises the nutritional benefits of grass-finished meat over animals finished on concentrates.[25]

Discussion

Health benefits of grass-finished beef

- Lower in total fat
- Lower in the saturated fat associated with heart disease
- Higher in beta carotene
- Higher in vitamin E
- Higher in the B vitamins thiamin and riboflavin
- Higher in the minerals calcium, magnesium and potassium
- Higher in total omega-3 fatty acids
- A healthier ratio of omega-6 to omega-3 fatty acids (1.65 vs 4.84)
- Higher in conjugated linoleic acid (CLA), a potential cancer fighter
- Higher in vaccenic acid (which is transformed into CLA)

Beef differentiation?

Consumers are currently given little information about the beef they buy, although this is changing. Retail marketing messages are starting to include origin, breed types, maturing time post slaughter (e.g. 21-day hung) – but there is rarely, if ever, a mention of the cattle's own diet. Most beef systems could claim that grass and conserved forage (silage, haylage and hay) forms part of the diet during the life of the animal, but this could obscure any dependence on cereals, soya or other feeds.

Until recently, there have been no standards to define grass-fed beef. The Pasture Fed Livestock Association was formed to do just that. Based on the American Grassfed Association, the PFLA has developed standards relevant to both conventional and organic systems that clearly establish a definition for permitted grass, forage and conserved feed and, importantly, prohibit grain feeding completely.

Conclusions

Our findings, based on modelled sequestration data, indicate that the GHG impact of extensive beef production is not as high as calculated by less complete models. This should be reassuring for less intensive farmers faced with the obligation to reduce GHG emissions – it is possible that extensive grassland may in fact be carbon neutral or positive.

When the true benefits to ecosystem services and human health are included, extensive livestock production on grassland is reaffirmed as the best use of this resource to produce food for people.

On the basis of the issues covered in this report, our stance on beef production is that we will maintain our wider view of sustainability, which embraces optimal agricultural production based on land capability, animal welfare, local food production, and the protection of ecosystem services. We will continue our commitment to GHG reduction by sharing expertise between farmers on carbon-friendly farming, and maintaining our commitment to protect existing carbon-rich soils wherever they occur on our land holding.

We will also continue to press for more formal and robust market mechanisms that reward farmers for the wider ecosystem benefits – including reduced GHG production – that extensive, grass-fed beef clearly brings. We need to future-proof all our farming, and a dash for maximised beef production in the face of increasing population demands risks long-term damage to the farmed and wider environment. Finding ways to make it pay for farmers to pursue extensive, grass-fed beef systems will become increasingly important.

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