Summary

Livestock have been identified as significant contributors to the emission of greenhouse gases (GHG), and policies adopted by some authorities have discriminated against them for this reason as the UK seeks to meet the targets of the Kyoto Agreement. Analysis of available data shows that, while some livestock production systems can be implicated, grazing livestock in the UK on non-intensive systems of production make a negligible contribution to GHG emissions. On the contrary, native breeds of livestock contribute positively to society in many ways. Their local adaptation is realised beneficially on pastureland which sequesters carbon and in conservation grazing where there are associated benefits for biodiversity, and they have an obvious cultural value through their association with history and heritage. Therefore, the focus of GHG policy should be on agricultural processes that use fossil fuels and contribute to deforestation and ploughing up of pasture, rather than on livestock which utilize non-intensive grazing.

Key words

Grazing livestock, greenhouse gases, native breeds.

Introduction

In March 2006 Defra and the devolved authorities published “Climate Change, The UK Programme 2006” which showed that progress in the UK was ahead of the requirements of the Kyoto Protocol (i.e. to reduce emissions of greenhouse gases by 12.5 per cent below 1990 levels by 2008-12), and promised to set a “more challenging domestic target to reduce carbon dioxide emissions by 20 per cent below 1990 levels by 2010” (Defra, 2006). GHG emissions in the UK in 1990 totalled 209.9 million tonnes of carbon dioxide equivalent (MtC), and had fallen to 178.9 MtC in 2004. The strongest attention was directed towards carbon dioxide (CO$_2$), where power generation was the main factor, and its contribution decreased by 16% to 152.5 MtC, but greater reductions were achieved with methane (CH$_4$) (down 50% to 12.5 MtC) and nitrous oxide (N$_2$O) (down 40.4% to 11.1 MtC) where the main factors were landfill sites and agricultural soils respectively.

The attention of policy-makers, when considering reductions of GHG emissions, focuses on the Intergovernmental Panel on Climate Change (IPCC) inventory and the international and domestic targets that have been set. In this context it was noted in 2002 (figures taken from 2000 inventory and based on CO$_2$ equivalents) that “CH$_4$ and N$_2$O each currently contribute 7-8% of GHG emissions to the UK inventory, as compared with CO$_2$ which contributes some 85%” (ADAS, 2003). However, it has been determined that all sources of GHG should be subject to reduction targets, and more recently CH$_4$ has come under closer scrutiny, although it contributed only 12% of total GHG emissions in 1990 and emissions (excluding those from natural sources) have fallen by 53% since then.

The land-use sector (including agriculture and livestock) is implicated as a causal factor, although it generated only 7% of all GHG in 2004 (Defra, 2006). It is not significant with regard to CO$_2$ emissions, but plays a bigger role with the minor gases. “Recent assessments (DETR, 1998) indicate that almost half of UK N$_2$O emissions and around 25% of UK CH$_4$ emissions are from agriculture, forestry and land-use practices” (IGER, 2001). By 2010 it is
projected that agriculture will account for 40% of methane emissions, and that livestock enteric fermentation will be a major contributor.

A News Release by FAO on 29 November 2006, commenting on a report by Henning Steinfeld from the FAO Livestock Information and Policy Branch, ‘Livestock’s Long Shadow – Environmental Issues and Options’, (Steinfeld, 2006), made a pointed attack on livestock. “Livestock are one of the most significant contributors to today’s most serious environmental problems. Urgent action is required to remedy the situation.” Closer scrutiny of the argument reveals regional differences, and it is noted that developing countries account for nearly two-thirds of CH$_4$ emissions.

However, although it then becomes clear that much of the argument is directed towards overgrazing and deforestation in the developing world, it has influenced thinking in the UK. The theme has been reflected in the proposal by Camden Council to cut meat and dairy products from canteen menus in the belief that it will reduce carbon emissions, and in the Scottish Government 2008 policy document ‘Climate Change and Scottish Agriculture’ (ACCSG, 2008), which advocates fewer livestock, switching to non ruminant stock, and replacing Scotland’s native cattle with larger, faster maturing breeds.

Responses to date from the livestock industry appear to have been sought primarily from representatives of intensive livestock production systems. The Radio 4 programme ‘Costing the Earth’ on 8 May 2008 solicited the opinion of Peter Bradnock of the British Poultry Council who said: “Organic poultry meat has about 45% more global warming potential than indoor-reared poultry meat.” The voice of the non-intensive livestock industry has not been heard. Although factory-reared chickens may convert grain to meat more efficiently, account must be taken of the large carbon demand of intensive livestock in all species to produce the grain they eat and to maintain the infrastructure and environment they require.

**Discussion**

Although a significant body of scientific opinion continues to oppose policies to combat global warming, the majority accepts the need to reduce the emission of GHG. The role of livestock in this process is recognised, but the evidence on the issue is confused and has not been considered in sufficient depth or with an adequate consideration of associated factors, some of which may be socio-economic rather than purely commercial. For example, native breeds have an obvious heritage value, and their local adaptation is utilised beneficially in conservation grazing where the associated impact on biodiversity has been linked to sustainable productivity and to reduced carbon emissions (Flombaum and Sala, 2008).

The close link to biodiversity was defined in a report from OECD: “Over (and under) grazing practices, loss of mixed farming systems and semi-natural farmed habitats (e.g. grasslands), drainage, moor burning, and pollution are the main pressures from agriculture on biodiversity” (OECD, 2008).

Defra has accepted that other factors should be taken into account. “Some of the potential options may however be inappropriate: they may not always be compatible with the Government’s wider goals for sustainable agriculture, may not be cost effective, have unacceptable animal welfare implications, or may risk additional environmental impacts involved in growing a high resource input alternative, for example maize instead of grass based feed.” (Defra 2006). Similarly, a Scottish expert group recognised that: “On the basis that market conditions might be expected to reflect society’s relative demand for food products as against the value it places on the impact of climate change, there is not a robust case for any unilateral policy intervention that attempts to control stock numbers” (ACCSG, 2008).

“Livestock can bring significant benefits to the UK’s landscape and biodiversity through helping to manage the land by appropriate grazing practices... For some land where arable crops are not appropriate, livestock farming is an option which also has potential for net environmental gains through managing the landscape and protecting biodiversity” (Cabinet Office, 2008).
Carbon in the air is fixed in the short term C-cycle into leafy pasture plants, consumed by grazing animals and then released back into the air. There is no net increase in the atmospheric carbon from this process, and a relatively stable situation existed until the Industrial Revolution. It is the act of taking fixed sources of carbon (e.g. trees and fossil fuels) and adding them to the atmospheric carbon pool that has increased atmospheric concentration (Table 1) and is driving climate change. Energy generation, industrial development, intensification of agriculture, and disturbance of soils in the post-Industrial Revolution era are major factors. Soils are the largest carbon reservoir of the terrestrial cycle, and the disturbance of forest, woodland and pasture can make a significant impact on the carbon balance (Rice, 1999). Estimated emissions of CO₂ equivalent in Scotland in 2005 attributed more than 70% to losses from land converted to cropland and from agricultural soils. Therefore, the focus should be on agricultural processes that use fossil fuels and contribute to deforestation and ploughing up of pasture, rather than on livestock digestive processes.

Table 1: Global atmospheric concentration (ppm unless otherwise specified), rate of concentration change (ppb/year) and atmospheric lifetime (years) of selected greenhouse gases

<table>
<thead>
<tr>
<th>Atmospheric Variable</th>
<th>CO₂</th>
<th>CH₄</th>
<th>N₂O</th>
<th>SF₆</th>
<th>CF₄</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-industrial</td>
<td>278</td>
<td>0.700</td>
<td>0.270</td>
<td>0</td>
<td>40</td>
</tr>
<tr>
<td>Atmospheric concentration (1998)</td>
<td>365</td>
<td>1.745</td>
<td>0.314</td>
<td>4.2</td>
<td>80</td>
</tr>
<tr>
<td>Rate of concentration change</td>
<td>1.5</td>
<td>0.007</td>
<td>0.0008</td>
<td>0.24</td>
<td>1.0</td>
</tr>
<tr>
<td>Atmospheric Lifetime</td>
<td>50-200</td>
<td>12</td>
<td>114</td>
<td>3,200</td>
<td>&gt;50,000</td>
</tr>
</tbody>
</table>

Source: IPCC (2001); taken from Greenhouse Gases and Global Warming Potential Values (2002), US Environmental Protection Agency

It is essential that all sides of the question are analysed critically before disseminating simplistic deductions which can be misunderstood by an audience ignorant of the full picture. For example, CH₄ levels have halved since 1970 (Figure 1) and CH₄ is a minor contributor compared with CO₂. The relative contribution to global warming over the next 100 years of current emissions of greenhouse gases is CH₄ 24% and CO₂ 63%. The GHG have different characteristics. Although the global warming potential (GWP) of CH₄ is 21 times that of CO₂ (and N₂O is 310 times that of CO₂), its atmospheric lifetime is only 12 years compared with 50-200 years for CO₂ and 114 years for N₂O (Table 1). To put the question of CH₄ and livestock in perspective, CH₄ contributes less than 10% of GHG emissions to the UK inventory (ADAS, 2003), and CH₄ emissions from enteric fermentation from all livestock in the UK in 2006 contributed one-third of the total CH₄ emissions excluding those from natural sources (Defra statistics from NAEI Netcen estimates). Thus the contribution of non-intensive grazing livestock in the UK is negligible.

Non-intensive livestock production

The argument concerning carbon emissions from livestock on non-intensive grazing (i.e. long leys, permanent pasture, uplands and conservation grazing) is related mainly to their longer production cycle, therefore emitting more CH₄ during their lifetime. However, it should be noted that in Scotland, where non-intensive grazing livestock comprise a relatively large proportion of the livestock industry, GHG emissions (CO₂ equivalent) from beef cattle and sheep are only 16.3% of the total from farming (ACCSG 2008), which is a lower proportion than in areas of more intensive livestock.

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Reducing the length of the production cycle is a possible route to reduction of emissions, provided that it does not involve ancillary activities which negate the benefit. Research at the Rowett Institute in Aberdeen “...into developing a feed additive for ruminants that inhibits methane formation and improves feed efficiency... have shown that up to 70 per cent inhibition of methane formation can be achieved... also gives rise to an improved feed efficiency of 10 per cent...". This is valuable research, but it considers only one aspect and is too narrow.

Attention should be directed also to issues such as the C-cycle of CH$_4$ (i.e. the net increase in atmospheric CH$_4$ as opposed to emissions from the animal), the efficiency of native adapted breeds in the conversion of plant fibre, and the results of grazing livestock on upland or permanent pasture. In 2005 the total UK CO$_2$ equivalents emissions from all livestock were 17.4 Mt, while the removals by grassland were 7.9 Mt (Table 2). Accurate allocations of these data to intensive and non-intensive grazing livestock are not available, but non-intensive livestock comprise around one-third of the total ruminant population (GLU equivalents) and graze 89% of the total grassland area on agricultural holdings, so that such systems are estimated to achieve a net GHG removal. The value of pasture in this context must not be undervalued. For example, when land use changes from native forest to arable cropping carbon losses are 42%, but when the change is from pasture to cropping the losses are 59%. Soil C stocks increase after land use changes from native forest to pasture (+ 8%), confirming that pasture holds more carbon than native forest.

Methane
The research and reports submitted at this point deal inadequately with non-intensive grazing livestock, and most conclusions and recommendations are based on studies of intensive livestock. The ADAS report of 2003 stated: “This is considered in the context of three areas of mitigation strategy which are highlighted for policy development for N$_2$O - - - and CH$_4$ (improved longevity and lifetime performance of dairy cows; improved lactation performance; and dietary manipulation)” (ADAS 2003). The focus on dairy cattle continued: “...the following areas of CH$_4$ mitigation deserve particular consideration as a basis for Defra’s policy development... 1) Improved longevity and lifetime performance in dairy cows. Dairy production accounts for some 75 % of CH$_4$ emissions from UK agriculture and provides a major target for mitigation policies. 2) Improved lactation performance. 3) Dietary manipulation. There is substantial scope to mitigate CH$_4$ emissions through the manipulation of diet.”
of cows’ diets”, although it was noted mitigation from the latter point would not influence the IPCC inventory (ADAS, 2003).

Table 2: GHG emissions and removals (Mt CO$_2$e) 2005 (Dore et al, 2007)

A conclusion reached in the same report appears to ignore these factors. It states that: “From a biological standpoint the simplest and most effective way to reduce CH$_4$ emissions is to intensify livestock production - to produce the same amount of livestock-product from fewer animals in shorter time and to reduce the low-productivity use of sheep and cattle in landscape management” (ADAS, 2003).

No substantive evidence is produced to support the recommendation to “reduce the low-productivity use of sheep and cattle in landscape management”, and the report admits that “…almost unavoidably, the UK’s livestock policies are multi-objective and, where appropriate, policies of reducing the intensity of livestock production may be favoured” (ADAS, 2003).

Another report states: “Initial model outputs demonstrate that total agricultural CH$_4$ emissions could potentially be reduced by 17.3% (maximum feasible reduction), while emissions from the dairy, non-dairy and pig sectors could be reduced by 22%, 11% and 7%, respectively. Such reductions would have a cumulative cost of £700 billion, far in excess of the sector’s contribution to GDP… The most cost-effective and acceptable options for reducing emissions of CH$_4$ are high technology digestion of pig wastes and reducing cattle numbers in order to reduce quantities of excretal waste” (IGER, 2001). This places the emphasis clearly on the problems of slurry associated with intensive livestock.

The balance between intensive and non-intensive systems of production is summarised: “Intensive agriculture can have negative impacts on biodiversity, but land management for agriculture also sustains habitats that protect biodiversity and landscapes” (Cabinet Office, 2008)

The use of pasture for non-intensive grazing livestock, including the need to graze designated habitats in an ecologically sensitive way, is fundamental to the assessment of the carbon footprint of this sector of the livestock industry. “So I feel we can be clear that it is this excess production of CH$_4$ (i.e. relative to pre-industrial levels) that is doing the damage and must recognize that it stems ultimately from the use of fossil fuels to produce the chemicals
that drive most modern farming systems. If we miss this distinction we could end up throwing the baby out with the bathwater. The baby in this instance is conservation grazing, which, being based on a high fibre diet might be most implicated in any methane critique." (Grayson, 2008). GHG emissions from livestock enteric fermentation in the UK have remained constant (Figure 1) and thus other causal factors must be sought to solve the problems.

The net additions of carbon to the atmosphere are relatively small, and are derived mainly from burning fossil fuel and changes in land use. In the UK, livestock are a minor contributor, and the “respiration of livestock makes up only a very small part of the net release of carbon that can be attributed to the livestock sector” (Steinfeld 2006). Burning fossil fuels and changes in land use in the UK are associated with intensive livestock production, and have very limited relevance for non-intensive livestock which have low energy requirements for feed, fertiliser, fuel, electricity or infrastructure. A study in Minnesota concluded that “at least half the CO$_2$ emissions of the two dominant commodities and CO$_2$ sources in Minnesota (maize and soya bean) can be attributed to the intensive livestock sector... emissions in extensive systems sourcing their feed mainly from natural grasslands or crop residues can be expected to be low or even negligible...” (Steinfeld 2006).

The logical conclusion of these assessments is that adapted livestock on non-intensive grazing are net contributors to the sequestration of carbon, and their use should be encouraged.

**Nitrous Oxide**

The situation is clearer with regard to N$_2$O which has a global warming potential 310 times that of carbon dioxide over a 100-year time horizon. The main source of emissions in the UK is agricultural soils largely because of the use of inorganic N fertilizer for cultivated crops and intensive grazing livestock. “Clear evidence that fertiliser practice (form, timing) affects N$_2$O emission has been obtained, - - - best available information (Final Report of Defra project NT1843 Mixed farming system desk study: impact of management on losses to water and air. ADAS/University of Edinburgh) suggests that the averaged N$_2$/N$_2$O ratio of emission products is around 11. Thus, in addition to being the major pathway for N$_2$O emission, denitrification may represent a significant loss of fertiliser N” (ADAS). In Scotland the “Agri-environment schemes such as the Rural Stewardship Scheme (RSS) include a number of measures which will contribute to a reduction in emissions by encouraging more extensive land use practices” (Defra 2006). Non-intensive grazing livestock require lower levels of inorganic N fertilizer, their manure is spread more regularly and efficiently and, as Defra noted, “faeces deposited whilst grazing, or stored as farmyard manure decompose aerobically and produce little methane” (Defra statistics from NAEI Netcen estimates).

There is agreement that the major nitrogen (N) inputs into agricultural systems in the UK occur via N fertilisers, animal feeds and slurry management (IGER, 2001), none of which are associated with non-intensive grazing animals, but ambiguity persists in recommendations: “A comprehensive review of potential management strategies for reducing N$_2$O emissions from agriculture identified four target areas - fertiliser practice, general agronomy, manure/slurry management and systematic changes... Reducing animal numbers and improving fertiliser efficiency were the most cost-effective options” (IGER, 2001). The general recommendation to reduce animal numbers fails to distinguish between different categories of livestock, and non-intensive grazing animals are included in the generalisation.

**Conclusions**

Non-intensive grazing livestock in the UK make a valuable contribution to biodiversity and quality of life. Native breeds have local adaptation which gives them particular value on natural grassland and in conservation grazing. They yield products of high quality, and are an integral component of the heritage of the UK.

The contribution of non-intensive grazing livestock to GHG emissions is small, and they utilise land which sequesters C, so that overall they are net contributors to carbon sequestration. The negative light in which they have been shown results from lack of evidence or from misinterpretation in some quarters of an FAO report. Systems of livestock production in the
UK should not be coloured by the effect on GHG emissions of deforestation and overgrazing in the developing world.

Native breeds of cattle and sheep in the UK are an asset which offer many benefits. The discrimination against them expressed in recent policy documents is not justified, and there is a need for policy review. In particular, there should be support for the sustainable and ecologically beneficial exploitation of the native adaptation of livestock on land which is not suitable for arable cropping, or which is important for amenity objectives.

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