**Application** Variation in greenhouse gas emissions (GHGe) across UK beef and sheep production systems may highlight opportunities for cutting carbon footprints of ruminant livestock.

**Introduction** The sustainability of ruminant livestock systems is under considerable scrutiny given the contributions of methane and other greenhouse gases to climate change. Although data relating to GHGe from beef and sheep systems are widely reported, these data are either based on global averages that are not specific to or characteristic of UK systems; or are dated, both in terms of farm performance and GHGe calculation methodology. Reducing GHGe from UK beef and sheep production therefore relies on a trifurcate approach: 1) establish the baseline, 2) quantify the impacts of specific management practices and systems, and 3) evoke behavioural change such that producers adopt new practices and/or improve existing operations. On-farm practices account for up to 90% of the GHGe from beef and lamb production from farm to fork, therefore meat processors have an obvious interest in encouraging mitigation measures to reduce their Scope III emissions. As the largest beef and lamb processor in the UK, ABP Foods therefore initiated the PRISM2030 programme to enhance the sustainability (GHGe plus wider environmental, economic and social metrics) of their suppliers.

The objective of this study was to quantify a baseline for GHGe from UK beef and sheep operations (as represented by 352 farms nationwide) and to identify the range of key performance indicators (KPI) associated with these operations.

**Materials and Methods** A total of 352 beef and/or sheep farms were identified and recruited into the PRISM2030 programme. All farms supplied beef cattle, lambs or both into ABP’s British (300 farms) or Northern Irish (52 farms) red meat supply chain and were recruited through recommendations from livestock buyers, posts on social media and in email newsletters, or word of mouth from farmers in the programme. Farms were assessed against the demographics of the ABP red meat supply chain to ensure that there was a wide spread of flock or herd sizes, enterprise types, locations and elevations across the sample population. Farm consultants visited each farm, collecting data with which to populate the Agrecalc (https://www.agrecalc.com/) farm carbon calculator to quantify on-farm GHGe. Farms that had an additional beef or sheep enterprise on farm that did not supply ABP, or that had insufficient sales to calculate accurate GHGe were excluded from the analysis. The GHGe data from the resulting sample populations (332 beef and 200 sheep enterprises) were used to calculate overall and sector-specific baselines within which to compare data. Statistical analyses on the GHGe data were executed using a single-factor ANOVA followed by f-tests and t-tests to determine differences between variance and means.

**Results** Data relating to KPI are summarised in Table 1. Lowland suckler cattle herds within the population were bigger, had heavier cows and a younger age at first calving, although calving percentages were similar between lowland and upland/hill enterprises. Suckler breeder-finisher cattle were slaughtered earlier, but with lower slaughter weights and DLWG compared to cattle reared on finishing units. Crossbred and early-lambing ewe flocks had increased lambing % and slaughter weights but lower flock sizes compared to late lambing or hill flocks.

The overall mean GHGe intensities from UK beef and sheep production were 26.7 kg CO2e/kg dwt and 23.47 kg CO2e/kg dwt, respectively. However, mean GHGe intensity varied considerably between beef enterprise types. Suckler enterprises had significantly higher GHGe intensities compared to finisher enterprises (P<0.001), ranging from, 22.6 kg CO2e/kg dwt for dairy-bred finishers to 32.9 kg CO2e/kg dwt for upland and hill suckler-finishers (Table 2). Similar trends were exhibited by ewe flocks compared to store lamb enterprises, with store lamb enterprises having a significantly lower (P<0.01) GHGe intensity than crossbred, hill or late-lambing flocks; but a similar GHGe intensity to early-lambing ewe flocks (Table 2).

**Table 1. Key performance indicators from 332 beef and 200 sheep enterprises across the UK1**

|  |  |  |  |
| --- | --- | --- | --- |
| **Suckler Cattle** | **Cow liveweight (kg)** | **Age at first calving (mo)** | **Calving %** |
| Lowland2 | 667 (61.2) | 27.0 (3.97) | 95.4 (6.49) |
| Upland and hill3  | 636 (57.3) | 28.9 (4.43) | 95.4 (6.75) |
|  |  |  |  |
| **Finishers** | **DWLG (kg/d)** | **Age at slaughter (mo)** | **Slaughter weight (kg)** |
| Lowland2 | 1.10 (0.23) | 20.1 (4.11) | 621 (62.4) |
| Upland and hill3 | 1.01 (0.22) | 20.5 (4.76) | 624 (80.2) |
| Beef-bred | 1.19 (0.30) | 22.2 (3.12) | 659 (54.3) |
| Dairy-bred | 1.05 (0.27) | 22.2 (3.88) | 608 (65.0) |
|  |  |  |  |
| **Sheep** | **Ewe numbers (head)** | **Lambing %** | **Slaughter weight (kg)** |
| Crossbred flock | 453 (495) | 169 (21.7) | 66.9 (11.0) |
| Hill flock  | 554 (444) | 146 (19.8) | 56.3 (8.60) |
| Early flock | 410 (319) | 162 (22.7) | 67.4 (10.6) |
| Late flock | 573 (503) | 147 (24.3) | 62.3 (13.9) |
| Store lambs | - | - | 58.3 (14.8) |

1 Means followed by standard deviation in brackets

2 Lowland suckler-finisher enterprises

3 Upland suckler-finisher enterprises

**Table 2. Greenhouse gas emission intensities from UK beef and sheep enterprises1**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Beef enterprise**  | **Lowland Suckler** | **Upland/hill suckler** | **Beef-bred finisher** | **Dairy-bred finisher** |
| **GHGe** **(kg CO2e/kg dwt)** | 30.5a (10.0) | 32.9a (13.9) | 24.0b (13.9) | 22.6b (8.03) |
|  |  |  |  |  |  |
| **Sheep enterprise** | **Crossbred flock** | **Hill flock** | **Early-lambing**  | **Late-lambing**  | **Store lambs** |
| **GHGe** **(kg CO2e/kg dwt)** | 27.1c (12.6) | 24.3c,d (12.6) | 20.4d (7.08) | 24.1c (10.1) | 19.6d (10.6) |

1 Means followed by standard deviation in brackets

a,b Means with different super-scripts are significantly different (P<0.001)

c,d Means with different super-scripts are significantly different (P<0.01)

**Conclusions** The increased GHGe intensities from suckler-finisher enterprises compared to beef- or dairy-bred finishers; and for store lamb enterprises compared to most types of ewe flock were not unexpected given that both suckler-finishers and ewe flocks maintain a breeding population in addition to finishing cattle. However, further research is required to elucidate which beef and sheep KPI have the greatest influence upon and therefore mitigation potential for GHGe intensities.