**MM30: Improved Animal Health – Cattle**
**MM48: Improved Animal Health – Sheep**

**Category**
Livestock management: Animal health

**Overview**
Endemic, production-limiting disease is a major constraint on efficient livestock production, both nationally and internationally, and will have an impact on the carbon footprint of livestock farming. UK systems are particularly vulnerable to endemic disease impacts because they are largely pasture-based. The emissions intensity of ruminant meat and milk production is sensitive to changes in key parameters, such as, maternal fertility rates, mortality rates, milk yield, growth rates and feed conversion ratios. All of these parameters are influenced by health status, so improving health status would be expected to lead to reductions in EI. However, there have been few empirical studies investigating the impact of any of the production diseases on GHG emissions intensity.

**Mitigation summary**

| **Effect on GHG categories*** | Rating | Notes |
|---|---|---|
| Enteric $CH_4$ | | |
| Manure $CH_4$ | | |
| Manure $N_2O$ | | |
| Soil $N_2O$: applied N | | |
| Soil $N_2O$: grazing | | |
| Energy $CO_2$: fieldwork | | |
| Energy $CO_2$: other | | |
| $CO_2$ liming and urea | | |
| $CO_2$ sequestration below ground | | |
| $CO_2$ sequestration above ground | | |
| Pre-farm emissions | | |
| Post-farm emissions | | |
| Substitution of higher C products | | |
| Production increases by more than the emissions | - | |
| | | |
| **Confidence in mitigation effect** | moderate | |
| **Cost-effectiveness**** | low-moderate | |
| **Confidence in cost-effectiveness** | moderate | |

*   ”-“ GHG reduction, “+”: GHG increase, “ ”: no significant effect
** low: =< £0/t$CO_2$e, moderate: £0/t$CO_2$e< >SCC, high: >SCC

**Related measures and potential synergies**

| **Measure** | **Impact on other measures** |
|---|---|
| Potential interactions with many measures depending on the specific disease and intervention. | |
| | |
| | |

**Inclusion in other marginal abatement cost curves**

| UK 2008 | UK 2010 | UK 2015 | Ireland 2012 | France 2013 | France 2019 |
|---|---|---|---|---|---|
| No | No | Yes | No | No | ? |

**What does the measure entail?**
Health can be improved through preventative controls (such as changing housing and management to reduce stress and exposure to pathogens, vaccination, improved screening and biosecurity, disease vector control) and curative treatments such as antiparasitics and antibiotics.

**Abatement rates and potentials in the 2015 MACC**
The impact of endemic disease is difficult to quantify, often relying on old data from experimental challenge studies, which do not reflect the natural presentation of many of these diseases. ADAS (2014) attempted to quantify the impact of the top cattle health 'conditions' on the carbon footprint of a litre of milk, and the reductions that could be made via veterinary and/or farm management interventions. The study concluded that a 50% movement from current health status to a healthy cattle population (assumed to be the maximum improvement achievable) would reduce emissions by 1436ktCO2e, or 6%. Eory et al. (2015) used a similar approach to quantify the effect of improving sheep health, and estimated that a 50% movement from current health status to a healthy sheep population would reduce emissions by 484ktCO2e/year by 2035.

Several studies have been undertaken since the 2015 MACC, which are briefly summarised below.

<u>UK cattle and sheep health: Skuce et al. (2016)</u>
Skuce et al. (2016) reviewed the evidence on prevalence and impact for 12 key ruminant diseases. They identified potential GHG emissions savings for all twelve diseases evaluated, while noting that some diseases are more tractable than others. They concluded that emissions intensity could be reduced through control measures relating to:

- milk yield and cow fertility rates (dairy systems)
- cow/ewe fertility and abortion rates
- calf/lamb mortality and growth rates (beef and sheep systems), and
- feed conversion ratios (all systems).

Three diseases, one from each the major livestock sectors, were considered more cost-effective and feasible to control: neosporosis (beef cattle), infectious bovine rhinotracheitis, IBR (dairy cattle) and parasitic gastroenteritis (sheep).

<u>Worms in sheep: Houdijk et al. (2017); Fox (2018)</u>
Houdijk et al. (2017) undertook experiments to determine the effect of parasitism on the EI of sheep, and found that infection with Teladorsagia increased calculated global warming potential per kg of lamb weight gain by 16%. Fox et al. (2018) also undertook experiments infecting sheep with Teladorsagia and found that infection led to a 33% increase in methane yield and a significant decrease in lamb growth rates, which led the authors to conclude that "there is potential for parasitism to have an extensive impact on GHG emissions".

<u>Worms in beef cattle: MacLeod and Skuce (2019)</u>
Gut worms are the most important gastrointestinal nematode parasites of grazing cattle, responsible for considerable sub-clinical disease and production loss. Bellet et al. (2016) undertook an abattoir study of prevalence and production impacts in England

and Wales of Ostertagia spp. (the study also recorded the effects of rumen fluke and liver fluke). Based on this data set, MacLeod and Skuce (2019) estimated that the growth rates of cattle with a high Ostertagia burden were about 10% lower than those with a low burden. This translates into a difference in EI of 3.9%, i.e. the high burden herd produced 3.9% more GHG for every kg of liveweight output. Assuming that the overall burden could be halved with appropriate treatment implies that the EI could be reduced by 2%.

<u>Liver fluke in beef cattle: Skuce et al. (2018)</u>
Skuce et al. (2018) investigated the impact of liver fluke infection on cattle productivity and associated greenhouse gas emissions intensity (EI) using abattoir data from NE Scotland from 2014-2016. The study focused on a cohort of 22,349 Charolais males from a total dataset of ~250,000 cattle. Liver fluke infection resulted in a statistically significant reduction in liveweight gain of 0.023kg/day and an extra 21 days to slaughter. As a result, the EI of meat from a herd with no fluke is approximately 1% lower than the same herd with fluke. The study only focused on one impact of fasciolosis (reduced growth rates) - other effects include changes in feed conversion ratio, mortality and fertility, milk yields and quality of output (e.g. carcass conformation and rates of liver condemnation), these will have an additive effect on GHG EI, so removing fluke may have a much greater impact on EI in practice.

<u>Lameness in dairy cattle: Chen et al. (2016); Mostert et al. (2018)</u>
Lameness can reduce dairy cow milk yield, thereby increasing the EI of the milk produced. Chen et al. (2016) calculated the effect of lameness on EI, using the impacts of lameness reported in a series of studies undertaken in Europe and North America. They estimated that lameness can lead to an increase in emissions intensity of 1-8% compared to a baseline scenario, depending on the prevalence of the disease. Mostert et al. (2018) investigated the effects of three types of foot lesions in Dutch dairy cattle: digital dermatitis (DD), white line disease (WLD), and sole ulcer (SU). They found that the impacts of these lesions on milk yield and calving interval led to an average increase in milk emissions intensity of 1.5%.

**Conclusion**
The studies undertaken since 2015 indicate that the abatement potentials given for improved cattle and sheep health in Eory et al. (2015) are achievable (while bearing in mind that studies with negative findings are less likely to be submitted for publication). Furthermore, they provide specific examples of how the abatement potential might be achieved, i.e. by reducing the incidence of gastrointestinal parasites, liver fluke and lameness.

**Cost-effectiveness**
The cost-effectiveness of improving health depends on:

- The cost of implementing the health measures.
- The changes in performance that arises from the health measures.
- The change in emissions and output (meat, milk and wool) that arise from the health measures.

These, in turn, are dependent on how the improvement is achieved, i.e. the specific health measures used, and the starting (physical and economic) performance of the flock or herd. As there are many possible combinations of health challenges and treatments, the cost-effectiveness of achieving mitigation via improved health is likely to vary considerably. Eory et al. (2015) estimated that improving cattle health could be achieved at an average of £-42/tCO2e, while the CE of improving sheep health would be £30/tCO2e, but noted that the CE was likely to be variable, and flocks/herds with below average health status are likely to provide scope for larger and more cost-effective reductions in GHG.

Cattle – likely to be low CE, moderate certainty
Sheep – moderate CE, moderate certainty

**Assumptions used in the MACC**
Abatement rates and cost-effectiveness assumptions used in the 2015 MACC.

**Ancillary effects**
Treating and preventing diseases tends to increase productivity and lead to reductions in the amount of feed consumed and the amount of volatile solids and nitrogen excreted per kg of output, which will in turn reduce the impacts (e.g. in terms of air quality, water quality and biodiversity) associated with feed production and manure management. Health can be improved through preventative controls (such as changing housing and management to reduce stress and exposure to pathogens, vaccination, improved screening and biosecurity, disease vector control) and curative treatments such as antiparasitics and antibiotics. The wider impacts of improving livestock health therefore depend on the specific species, system and, health challenge and control option. Eory et al. (2017) highlighted the following potential negative impacts that could arise:

- Water quality: Potential issues of aquatic ecotoxicity with some measures, e.g. synthetic pyrethroid dips (Beynon 2012)
- Biodiversity: Potential negative impacts via control of wild animal/plants and habitat alteration to reduce vector/pathogen populations (e.g. badger culling to reduce TB transmission or field drainage to reduce mud snail populations, which act as a vector for liver fluke). Further negative impacts of medication to dung invertebrates and indirect impacts further up the food chain. (SCOPS 2016; Adler et al. 2016).

Ancillary effects of the operation

| **Positive effects** | | **Source** |
|---|---|---|
| Off-farm GHG | Improvement in FCR leading to reduced feed demand | |
| Production | Improvements in animal performance | |
| Adaptation | None | |
| Environment | Improvements in animal performance could lead to reduction of non-GHG impacts, e.g. water and air quality | |
| **Negative effects** | | |
| Off-farm GHG | GHGs associated with treatment | |
| Production | No known effects | |
| Adaptation | None | |
| Environment | Potential impacts on water quality and biodiversity | Beynon (2012), SCOPS (2016); Adler et al. (2016). |

**Identified implementation challenges and barriers**

Potential barriers to uptake and key risks/uncertainties

| **Barrier to uptake** | **Source** |
|---|---|
| Resistance to treatments (e.g. antimicrobial, anthelminthic). | |
| Medicine residues in meat and milk, and associated withdrawal periods. | |
| Need for co-ordinated action to achieve effective treatment | |
| **Other key risks/uncertainties** | |
| | |

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