time required to reach the desired mature weight (589 kg live weight) and the daily WF_B was increased by 36% and decreased by 24% relative to the base case with 90% and 110% baseline TDN values, respectively. The second sensitivity analysis of TDN, 1000 scenarios, showed that the feedlot stage had the most extensive daily WF_B variability than the cow-calf and stocker stages. The results of the third sensitivity analysis of forage and crop specific water demand indicated that production efficiency had a significant impact on the daily WF_B across all beef cattle phases and that the daily WF_B can be higher in cow-calf or stocker phases and lower in the feedlot phase in some circumstances. Precision data-driven simulations resulted in a WF_B that accounted for differences in individual cattle.

Conclusion

The causal loops identified in the current study provide a systems-level insight into the drivers of the WF_B within and across each major segment of the beef supply chain. PSM can help enhance the precision of WF_B estimations and provides an opportunity to understand further the dynamics that drive individual animal water efficiencies.

References

Menendez, H.M., Tedeschi, L.O., 2020. The characterization of the cow-calf, stocker and feedlot cattle industry water footprint to assess the impact of livestock water use sustainability. The Journal of Agricultural Science 158 (5), 416–430.

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76. Comparison of enteric methane emission of lactating dairy cattle using Tier 3 methodology for the UK and the Netherlands national GHG inventories

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Introduction

Production of methane by cattle as a result of microbial fermentation in the rumen and large intestine contributes to worldwide greenhouse gas (GHG) emissions. The UK national GHG inventory has historically relied heavily on the Intergovernmental Panel on Climate Change Tier 1 methodologies, which effectively use livestock numbers multiplied by a standard factor to estimate methane emissions. However, as part of the GHG Platform, the UK moved to Tier 2/3 methodologies to differentiate between standard practices and take account of mitigation strategies designed to reduce GHG emissions. Although the UK uses a country-specific Tier 3 equation for estimating methane emissions, it is an empirical relationship between dry matter intake (DMI) and methane emissions that cannot interpret changes in methane emission in response to changes in the nutritional composition of the diet. In contrast, the Netherlands inventory uses a dynamic mechanistic model for estimating methane emissions of dairy cows that has the potential to quantify management and nutritional mitigation strategies for reducing methane emissions. The suitability of the Netherlands Tier 3 methodology for use in the UK national GHG inventory was assessed using UK feed composition/intake and activity data for dairy cattle as inputs for the model to predict changes in methane emission in response to changes in diet composition.

Material and methods

In the UK Tier 3 protocol, methane emissions of dairy cattle are estimated using a UK-specific relationship between daily enteric emission and feed DMI (Brown et al., 2021). The DMI of dairy cattle is determined using UK-specific energy balance equations (Thomas, 2004). The Netherlands Tier 3 protocol estimates enteric methane emission of dairy cows using a dynamic process-oriented mechanistic model based on a methodology that represents the dynamics of microbial activity in the rumen and hindgut, including the effects of the fermentation conditions in those compartments (Bannink et al., 2018). Access to a set of on-farm data from approximately 200 UK dairy farms was secured for use in this task that enabled the calculation of average feed ingredients and dietary nutrient composition of dairy cattle on-farm. The annualised data were averaged across UK financial years 2018/19 and 2019/20 and included herd size, total milk yield, average milk composition, body weight, calving pattern, main breed, and the area of land allocated to grassland and forage maize. The data were used to estimate methane emissions using the UK and the Netherlands Tier 3 protocols. In situ rumen degradation characteristics for protein, fibre, and starch in dietary components were equal to values adopted in The Netherlands inventory method.

Results and discussion

Summary of on-farm data and results for dietary ingredients and methane emission are shown in Table 1. The UK and Dutch methods ranked methane emissions from the different farm typologies in the same order, however, the UK inventory method resulted in higher estimates of enteric methane by dairy cattle compared to the Netherlands Tier 3 model by 9.4 kg/cow/yr, 1.6 g/kg DMI and 1.2 g/kg milk (a 7.4% difference). The lower predictions with the latter model can be explained by the relatively low proportion of roughages (50%) relative to concentrates and slightly increased fat content (1%) of UK diets compared to Dutch diets, as these are associated with lower enteric methane production.

Table 1
Summary description of on-farm data and average dietary ingredients, and methane emission estimated using the UK and The Netherlands Tier 3 protocols for dairy cattle using on-farm data.

Item	All farms	AYR/Aut	Spr/2B	Large BPS	Med BPS
Herd size (number of cows)	245	231	420	238	283
Milk yield (L sold/cow/yr)	8402	8478	7415	8737	6668
Milk fat (g/kg)	40.4	40.2	42.9	40.1	42.3
Milk protein (g/kg)	33.2	33.1	35.0	33.0	34.4
Body weight (kg)	636	640	593	643	602
Feed composition (g/kg DM)					
Concentrate	355	353	377	354	356
Fat	3	3	2	3	2
Maize gluten	35	36	29	35	39
Minerals	9	10	7	10	7
Rapeseed meal	16	16	17	16	17
Soyabean meal	11	11	7	11	7
Wheat	70	71	61	70	71
Maize silage	62	63	44	71	14
Grass silage	366	371	298	362	387
Grass herbage	72	66	157	67	99
DMI (kg/yr)	6176	6210	5735	6325	5403
UK Tier 3 dairy protocol					
CH_4 emission (kg/cow/yr)	130.0	130.6	123.1	132.4	117.8
CH_4 yield (g/kg DMI)	21.1	21.0	21.5	20.9	21.8
CH_4 intensity (g/kg milk)	15.5	15.4	16.6	15.2	17.7
The Netherlands Tier 3 dairy protocol					
CH_4 emission (kg/cow/yr)	120.3	120.7	114.5	122.4	109.0
CH_4 yield (g/kg DMI)	19.5	19.4	20.0	19.3	20.2
CH_4 intensity (g/kg milk)	14.3	14.2	15.4	14.0	16.3

All farms, all calving patterns and production systems; AYR/Aut, all year round and autumn block calving herds; Spr/2B, spring block and two block calving herds; Large BPS, large-sized breed production system; Med BPS, medium-sized breed production system; DMI, dry matter intake; CH_4, methane.

Conclusion and implications

The Netherlands Tier 3 model represents enteric fermentation in detail and can therefore describe variation caused by nutritional and animal factors, which will improve methane prediction accuracy. A major limitation of using the Netherlands Tier 3 approach in the UK is the availability of detailed data on diet composition and rumen degradation characteristics of feed substrates as inputs.

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References

Bannink, A., Spek, W.J., Dijkstra, J., Šebek, L.B.J., 2018. A Tier 3 method for enteric methane in dairy cows applied for faecal N digestibility in the ammonia inventory. Frontiers in Sustainable Food Systems 2, 66.

Brown, P., Cardenas, L., Choudrie, S., Del Vento, S., Karagianni, E., MacCarthy, J., Mullen, P., Passant, N., Richmond, B., Smith, H., Thistlethwaite, G., Thomson, A., Turtle, L., Wakeling, D., 2021. Report: UK Greenhouse Gas Inventory, 1990 to 2019: Annual Report for submission under the Framework Convention on Climate Change. Ricardo Energy & Environment, Didcot, UK.

Thomas, C., 2004. Feed into Milk: a new applied feeding system for dairy cows. Nottingham University Press, Nottingham, UK.

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77. Respiration rate as marker of heat stress in dairy sheep

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Introduction

Ewes are characterized by a remarkable adaptation to climate change (Sejian et al., 2017). The Mediterranean area is characterized, in general, by dry and hot summers and by wet and mild winters, with specific characteristics depending on the region (Ramón et al., 2016). During summer heat stress conditions are frequent, with high variations of daily temperatures (Sevi and Caroprese, 2012; Peana et al., 2017), that increase the internal heat production preventing to maintain thermal homeostasis (Sejian et al., 2017). One of the most important indicators of defensive dissipation mechanism of animals, particularly important in sheep (Brockway et al., 1965), is the respiratory rate, which acts to facilitate the dissipation of heat excess. The study aimed to define the different response to daily temperature variations (for more weeks consecutively) during summer and winter conditions in sheep housed indoor without forced cooling systems.