Automated feeding of sheep 2: Feeding behaviour influences the methane emissions of sheep offered restricted diets

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Under extensive grazing conditions, there are periods of the year where sheep consume feed at levels which do not meet their maintenance requirements; therefore, it is important to understand the impact that less than maintenance feeding has on methane (CH_4) yield (Goopy *et al*. 2020). Total CH_4 production (g/day) decreases with reduced DMI, however the opposite may be true for CH_4 yield (g CH_4/kg DMI) which has been observed to increase with lower DMI in sheep (Hammond *et al*. 2013). Measuring CH_4 emissions using short term approaches is complicated due to diurnal changes in CH_4 emissions and feeding behaviour, which may be influenced by method of feeding. Sheep offered restricted feed amounts using an automated feeding system alter their feeding behaviour to consume more meals in the early morning after daily allowances were reset (Behrendt *et al*. 2020). It is likely this change in feeding behaviour may impact CH_4 emissions.

This experiment investigated the effect of restricted feeding on feeding behaviour (DMI and time since last meal), CH_4 emissions and yield in Maternal Composite sheep. An automated feeding system (Muir *et al*. 2020) was used to restrict DMI to 40, 60, 80, 100, 140 and 180% of estimated maintenance requirements of Maternal Composite ewes (n= 126) for 41 days. All feeding events were recorded using 2 automated feeders and 18 ewes per pen. Methane was measured over 45 minutes using portable accumulation chambers (PAC) on day 30 and 31 of restricted feeding. Measurements of feeding behaviour were subjected to ANOVA with pen as the block. Methane emissions and yield were subjected to an analysis of covariance with time since last meal as a covariate. Variates were transformed where residuals were not normally distributed. The relationship between CH_4 emissions, DMI and time since last meal were examined by REML.

As anticipated by the experimental design, sheep offered a lower level of feed consumed less feed daily ($P<0.001$) and less feed ($P<0.001$) in the 24 hours prior to PAC measurement (Table 1). Feeding level affected the time since last meal prior to PAC measurement ($P<0.01$). Methane emissions increased with level of feeding ($P<0.001$), while CH_4 yield (g/kg DMI) decreased ($P<0.01$). Time since last meal was a significant covariate ($P<0.001$) affecting both CH_4 emissions and yield. Dry matter intake in the 24 hours prior to PAC measurement explained 37.5% of the observed variance in CH_4 emissions ($P<0.001$). Time since last meal explained 40.5% of the observed variance in CH_4 emissions ($P<0.001$). When combined, both parameters explained 58.7% of the variance in CH_4 emissions.

Table 1. Dry matter intake (DMI), feeding behaviour and methane emissions of Maternal Composite ewes offered 40, 60, 80, 100, 140 and 180 % of estimated maintenance requirements

	Estimated Maintenance Requirements							
	40%	60%	80%	100%	140%	180%	*P*-value	l.s.d
DMI (kg /day)	0.456	0.649	0.745	0.930	1.266	1.461	<0.001	0.0821
DMI 24 hours (kg)	0.385	0.655	0.821	0.973	1.379	1.809	<0.001	0.2974
Time since last meal (min)[A]	5.81 (333)	5.24 (189)	5.53 (252)	5.39 (219)	5.02 (151)	4.60 (100)	0.006	0.637
CH_4 (g/day) [B]	2.74 (15.5)	3.08 (21.7)	3.23 (25.2)	3.17 (23.9)	3.52 (33.7)	3.43 (30.9)	<0.001	0.240
CH_4 Yield (g/kg DMI 24 hr.) [B]	3.69 (40.2)	3.58 (35.9)	3.44 (31.1)	3.34 (28.2)	3.38 (29.3)	3.05 (21.1)	0.001	0.288

[A]Variate was log transformed for analysis. Back-transformed values are provided in parentheses. [B]Variate was log transformed for analysis of covariance conducted with time since last meal as a covariate ($P<0.001$). Back-transformed values are provided in parentheses.

Methane emissions were affected not only by daily DMI, but also time since last meal. Methane yield increased substantially at low levels of DMI. Adjusting for the effect of time since last meal may improve the precision of CH_4 measurements when using PACs.

References

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