

Associations between cow behaviour at pasture, weather conditions and day length

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Abstract

Pasture grazing of cattle increases economic performance and is regarded as beneficial for cows' health but weather may affect animal behaviour. The study reported here assessed associations between behaviour and weather. Ten spring-calving dairy cows were monitored during spring (63 d), summer (13 d) and autumn (13 d). Cow behaviour was recorded using the noseband sensor and pedometer-based RumiWatchSystem (Itin + Hoch GmbH, Liestal, Switzerland). Weather conditions were measured continuously using an on-farm weather station. When day length exceeded 15 h d⁻¹, cows were observed grazing longer. Rumination time was highest when mean air temperature ranged between 7.5 and 12.5 °C. Rainfall was associated with reduced lying time and increased standing time. Walking time was lower when day length was less than 12 h d⁻¹. No significant associations with wind speed were detected. Overall, moderate associations between weather and behaviour were observed.

Keywords: weather, behaviour, pasture, grazing time, rumination time, linear mixed models

Introduction

Consumers perceive grazing as more natural than indoor systems and grazing animals have greater freedom to express natural behaviours such as exploration (Spooner *et al.*, 2014). Evidence suggests that access to pasture can improve cow health. However, cows' preference for pasture appears to be dependent on weather conditions. Cows have been shown to prefer barns to pasture when temperatures are particularly high (von Keyserlingk *et al.*, 2009). This study assesses the associations between prevailing weather and behaviour of dairy cows at pasture on a fulltime basis.

Materials and methods

The experiment was carried out at Teagasc Moorepark Research Centre, Fermoy, Co. Cork, Ireland across three time periods in 2016. A weather station (less than 1.5 km from the farm) monitored weather during the experiment. Cow behaviour was monitored using the RumiWatchSystem (Itin + Hoch GmbH, Liestal, Switzerland) consisting of a pedometer and a noseband sensor. Eighty nine days of observations occurred during early (63 d), mid (13 d) and late (13 d) lactation. Due to farm management reasons and other ongoing experiments, cows included in the study grazed in groups of 15 animals (early lactation), 105 animals (mid-lactation) and 100 cows (late lactation). Ten cows were observed at any one time. Individual milk yields (kg) were recorded daily at each milking (Dairymaster, Causeway, Co. Kerry, Ireland). Pre-grazing sward height was measured daily with a rising plate meter (diameter 355 mm and 3.2 kg m⁻²; Jenquip, Fielding, New Zealand).

Statistical analysis was performed using R (R Core Team, 2017). Descriptive statistics and density plots have been used to evaluate distributions of all continuous variables. A linear mixed model for repeated measures ('lme4' package of R; Bates *et al.*, 2008) was built for eight response variables to evaluate the effects of weather, day length and other covariates. Fixed explanatory factors included in initial models were temperature, rainfall, wind-speed and day length. Fixed effects included in the final models were

selected based on Akaike Information Criterion (AIC) using a back-fitting procedure (Tremblay and Ransijn, 2015). The model with the lowest AIC was considered the best and final model.

Results and discussion

Due to the non-normal distribution of weather and day length data, values originally recorded on continuous scales have been transformed into three level factors aiming to include at least 100 observations in each factor (Table 1). Five models for five dependent variables were developed (Table 2). Cows grazed longer with longer day length. Grazing time was significantly higher when day length was > 15 h ($631.3 \pm 14.9 \text{ min day}^{-1}$) compared to 12 - 15 h ($585.5 \pm 15.2 \text{ min day}^{-1}$; $P = 0.001$) and < 12 h ($576.8 \pm 17.0 \text{ min day}^{-1}$; $P < 0.001$). Each 1 cm increase in pre-grazing grass height resulted in a reduction of 7.4 min day^{-1} in grazing time ($P = 0.001$).

Grazing time increased $1.45 \text{ min day}^{-1}$ for each kg day^{-1} of milk yield ($P = 0.042$). Rumination time was 422.1 ± 14.6 , 457.0 ± 15.0 and $419.8 \pm 23.3 \text{ min day}^{-1}$ in the classes of temperature < 7.5, 7.5 - 12.5 and > 12.5 °C, respectively. Significant differences were found between temperature classes < 7.5 and 7.5 -

Table 1. Descriptive weather statistics, discretization criteria and the number of observations in each level of the resulting factors.

Item	Continuous				Categorical		
	Min	Max	Mean	SD	Cut-points	N	%
Temperature (°C)	4.10	19.59	10.53	3.93	< 7.5 °C	189	25.0
					$\geq 7.5 \text{ °C} < 12.5$	340	44.9
					$\geq 12.5 \text{ °C}$	228	30.1
Rainfall (mm d ⁻¹)	0.00	21.00	1.40	3.32	< 0.1 mm d ⁻¹	388	51.3
					$\geq 0.1 \text{ mm d}^{-1} < 2.5$	239	31.6
					$\geq 2.5 \text{ mm day}^{-1}$	130	17.2
Wind speed (m s ⁻¹)	1.07	5.21	2.74	0.98	< 2.0 m s ⁻¹	204	26.9
					$\geq 2.0 \text{ m s}^{-1} < 4.0$	445	58.8
					$\geq 4.0 \text{ m s}^{-1}$	108	14.3
Day length (h)	9.66	16.33	13.92	2.09	< 12 h	137	18.1
					$\geq 12 \text{ h} < 15$	310	41.0
					$\geq 15 \text{ h}$	310	41.0

Table 2. Descriptive statistics for behaviour outcome variables investigated and corresponding fixed effects retained in final models.

	Grazing time	Rumination time	Lying time	Standing time	Walking time
Mean (min day ⁻¹)	596.6	488.9	579.5	773.5	89.8
SD (min day ⁻¹)	77.1	69.5	146.5	135.6	23.7
Rainfall (mm day ⁻¹)			***	***	
Temperature (°C)		***			
Day length (h)	***				***
Supplementation (kg)		***			
Group dimension			**		***
Pre-grazing grass height	***				
Days in milk (d)		***	***	***	
Milk yield (kg)	*	***			

* $P < 0.05$, ** $P < 0.01$, *** $P < 0.001$; variables assessed but not retained in any of the five final models: wind speed, herbage allowance, parity and breed; time = m day⁻¹.

12.5 °C ($P = 0.014$), and 7.5 - 12.5 °C and > 12.5 °C ($P = 0.030$). Rumination time was not significantly different between the classes < 7.5 and > 12.5 °C.

Concentrate supplementation was associated with significantly reduced rumination time (504.1 ± 10.8 vs 361.8 ± 32.0 min day⁻¹; $P < 0.001$). Rumination increased by 0.75 min day⁻¹ for each day of Days in Milk (DIM) ($P < 0.001$) and by 2.58 min day⁻¹ for each kg day⁻¹ of milk yield ($P < 0.001$). Lying time decreased with increasing rainfall. Cows lay down for significantly longer times on dry days (582.9 ± 19.3 min day⁻¹) than when rainfall was 0.1 - 2.5 mm day⁻¹ (536.8 ± 20.1 min day⁻¹; $P = 0.041$) and > 2.5 mm day⁻¹ (478.4 ± 24.3 min day⁻¹; $P < 0.001$). A significant difference was also found between the classes of rainfall 0.1 - 2.5 and > 2.5 mm day⁻¹ ($P = 0.048$). Lying time was significantly shorter in a big group (473.7 ± 29.9 min) than in a small group (591.7 ± 20.2 min; $P = 0.003$), with a difference of almost 2 h d⁻¹. Lying time also increased with DIM.

In summary, rainfall and day length were both associated with two out of five behaviour measures assessed. Temperature was associated with only one variable, rumination time. No significant effects of wind speed were found. The generally modest effects are likely to be due to the mild weather during the observation periods. This is particularly true of rainfall (daily mean 1.4 mm day⁻¹).

Conclusion

Cow behaviour was associated with weather during the observation periods. Rainfall, in particular, was associated with increased standing time and reduced lying time as well as rumination. This could have implications for production and lameness prevalences.

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