



Grassland resources for extensive farming systems in marginal lands: major drivers and future scenarios

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Animal activity and welfare of suckler cows grazing during hot and cold days on fen grassland in northeast Germany

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Abstract

In east Germany, the number of heat days ($>30^{\circ}\text{C}$) will be three to four times higher by the end of this century compared with 1961-1990. Such high temperatures are far above the temperature optimum for cattle and can cause depressions of health, fertility and performance. In a grazing experiment suckler cows were equipped with collars and ruminal transmitters, measuring the GPS position and different physiological data of the animals over the grazing season. Characteristics of animal behaviour were described and compared to the weather conditions. During hot days, the heart rate of the grazing cows increased. They decreased moving over the pasture and changed their activity rhythm. The cows were able to limit a temperature increase of the body surface and reduced the rumen temperature presumably by increasing their water consumption.

Keywords: heart rate, rumen temperature, water consumption, GPS collar, ruminal transmitter

Introduction

Gömann *et al.* (2015) prognosticate a triplication or a quadruplication of the number of heat days ($>30^{\circ}\text{C}$) for east Germany by the end of this century compared with 1961-1990. Cattle have a rather low temperature optimum and heat can lead to depressions of health, fertility and performance. For a better understanding of the interactions of weather, site conditions and animal performance on pastures we carried out a grazing experiment. The objective of this experiment was to measure and analyse behavioural and physiological data of grazing cows. This will be the basis for the optimization of pasture systems that ensure high animal husbandry efficiency and animal welfare with reference to climate change. The paper provides results of the initial experimental season.

Materials and methods

The grazing experiment was conducted at Paulinenaue, northeast Germany ($52^{\circ}68'\text{N}$, $12^{\circ}72'\text{E}$; 28.5-29.5 m a.s.l.; mean annual temperature 9.2°C ; mean annual precipitation 534 mm, Eutric Histosol) from June to September 2016. Two suckler cows of the herd were equipped with a GPS Plus Collar (Vectronic-aerospace, Berlin). Each device consists of a collar and a ruminal transmitter, measuring the positions by GPS to describe moving distances (MD) and velocity, locomotion activity on the X and Y axis accumulated over a sampling interval (LA), temperature in the reticulum (T_r), temperature of the body surface at the collar (T_c) as well as the heart rate (HR) and HR counting (HRc). HR data were filtered and only recorded when the animal rested and had very low LA (Signer *et al.* 2010). The activity and physiological data, GPS and the weather data were recorded in 3, 5 and 15 min intervals, respectively. The GPS and weather data were transformed by interpolation into 3-min intervals of the animal data. The data were evaluated for each cow during periods of each three cold and three hot days in June, August and September. A 'cold day' was characterized by maximum air temperatures (T_{max}) of about 15 to 20 $^{\circ}\text{C}$ (mean air temperature $T_{\text{mean}}=17.6^{\circ}\text{C}$) and a 'hot day' by T_{max} of about 25 to 35 $^{\circ}\text{C}$ ($T_{\text{mean}}=29.3^{\circ}\text{C}$). The daily comparison of the animal and weather data covered the time from 10:00 to 18:00 p.m.

Results and discussion

Animal data in the course of a cold day (22 Sept 2016) and a hot day (12 Sept 2016) are shown in Figure 1 as examples for cow No. 10. The cows adapted their behaviour. They reduced moving over the pasture and changed their activity rhythm on hot days.

The distribution of periods with high and low LA has completely changed on a hot day and is characterized by longer continuous rest periods compared with a cold day. But there was no significant difference in the average daily LA. In contrast to a cold day, very low velocities of the cow's movement were reported on a hot day, where the MD values significantly decreased (Table 1). Compared with the cold days, T_c increased significantly by about 10 °C, but did not exceed a difference of about 3 °C to T_{mean} .

In contrast to a cold day, periods of very slow rebound of T_r , e.g. between 14:20 and 15:20 h, were reported as well as a significant decrease of T_r on a hot day. The remarkably slow rebound of T_r was only found when the position of the cows was very close to the watering point.

When the cows grazed during hot days, their heart rate increased significantly (Table 2). In comparison with the cold days, less HRc were registered during the hot days, indicating greater difficulties for the cows to come to rest.

Table 1. Average animal temperatures and behavioural data on cold and hot days (significant differences cold vs hot days are indicated by different letters; $P < 0.05$).

Cow	Cold days				Hot days			
	T_r (°C)	T_c (°C)	LA (%)	MD (m)	T_r (°C)	T_c (°C)	LA (%)	MD (m)
7	36.30a	21.81a	47.33a	2,005a	36.09a	31.71b	51.11a	1,771a
10	36.38a	21.26a	44.75a	2,148a	33.84b	31.66b	43.01a	1,968a
Average	36.34a	21.55a	46.11a	2,073a	34.96b	31.69b	47.06a	1,870b

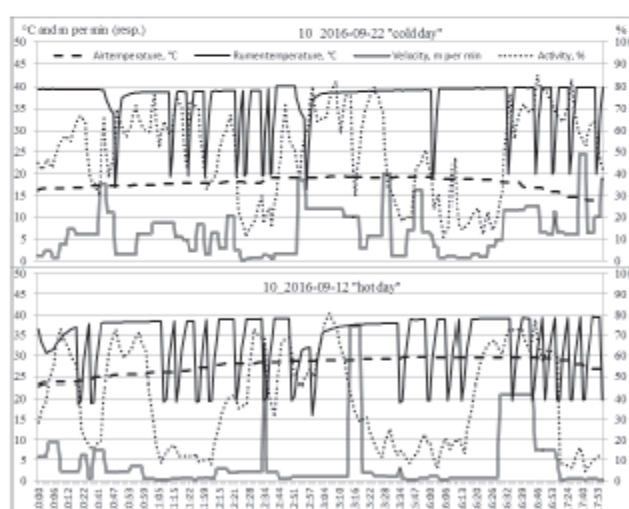


Figure 1. Course of various parameters of cow no. 10 on a cold and a hot day.

Table 2. Heart rate (HR) numbers and HR counting during cold vs hot days (significant differences cold vs hot days are indicated by different letters; $P < 0.05$).

Cow	Cold days		Hot days	
	HR (min^{-1})	HRc (n)	HR (min^{-1})	HRc (n)
7	64.20a	10.89a	66.85b	12.78a
10	62.45a	24.22a	64.72a	16.00a
Average	63.33a	18.00a	65.78b	14.00a

Conclusions

By changing their behaviour during grazing, our suckler cows were able to adapt to high temperatures. Although we did not measure it directly, we assume that particularly high water consumption was the precondition for that result. This underlines the importance of an adequate water management on pastures in our region. The summer months of 2016 were comparatively cool and each of the heat periods lasted for only three days and was preceded and followed by cooler periods. If such heat periods last longer, as is not uncommon for our region, a larger heat stress could be expected. The reported data on the hot and cold days showed a similar reaction of the two cows to the different temperature situations. But particularly in terms of HR and HRc, there are some differences between cows. Therefore, the study should be extended over longer heat periods, involving larger samples of cows.

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