

# Effects of heat stress and diet on milk production and feed and energy intake of Sarda ewes

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**ABSTRACT:** Ten Sarda dairy ewes (5<sup>th</sup>-6<sup>th</sup> month of lactation; 1995 ± 353 g/d of milk yield) were divided into two isoproductive groups and fed two different diets (high and low fiber) from May 20<sup>th</sup> to June 18<sup>th</sup> 2003, to evaluate diet effects on milk yield and intake. In addition, the relationships between meteorological conditions, measured during that unusually hot period, and milk yield and quality, dry matter intake, NDF or NDL were determined, to study animal responses to heat stress. Diet did not have any significant effect on the evaluated parameters. Milk yield was reduced by 20% (0.39 kg/d per head) as minimum temperatures changed from 9-12 °C to 18-21 °C. Similar milk yield reduction was observed as mean temperature-humidity index (THI) went from 60-65 to 72-75. As wind speed increased from 1.5-2.5 m/s to 2.5-4 m/s, milk yield increased by 10%. Milk composition was not affected by heat stress throughout the experiment except for milk somatic cell count, which was increased by high temperatures. Dry matter, fibre and net energy intake varied significantly during the trial, with consistent and marked decreases as heat load increased.

**Key words:** Sheep, Heat stress, Milk, Intake.

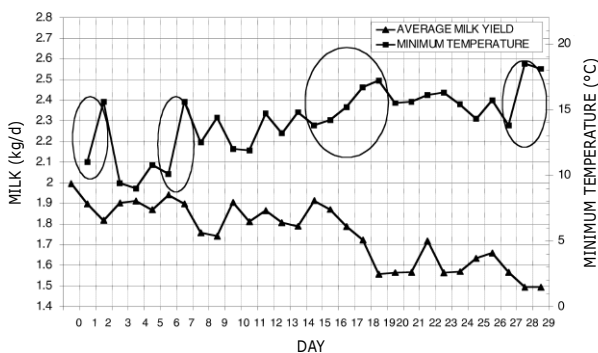
**INTRODUCTION** – In dairy cows, high temperatures and associated heat stress cause reduction of DM intake, milk yield and variations in milk composition. For this species, the meteorological conditions that determine heat stress have been quantitatively defined (Nardone *et al.*, 1992). Differently, the few studies conducted on lactating dairy ewes were not consistent in the threshold above which heat stress affected milk yield (Sevi *et al.* 2001; Finocchiaro *et al.*, 2005). Moreover, high dietary NDF concentration can affect milk yield during hot periods (Stott and Moody, 1960). For this reason, the main objective of this work was to study the effects of heat stress and diet on intake and milk production in Sarda dairy ewes, in order to better understand dairy sheep physiology and improve sheep farm management in Mediterranean conditions.

**MATERIAL AND METHODS** – The data of a nutritional experiment (Boe *et al.*, 2004), during which marked heat stress conditions occurred, were re-analysed accounting for environmental effects. Ten Sarda dairy ewes (5<sup>th</sup>-6<sup>th</sup> month of lactation; 1995 ± 353 g/d of milk yield) were kept in individual metabolic cages and fed *ad libitum* from May 8<sup>th</sup> to June 18<sup>th</sup> 2003. The cages were located inside a sheep barn, which was closed in three sides and protected from dominant winds, in Olmedo (Sassari, Italy). In the preliminary phase (May 8<sup>th</sup>-May 19<sup>th</sup>), the ewes were fed the same diet, while in the experimental phase (May 20<sup>th</sup>-June 18<sup>th</sup>) they were divided into two isoproductive groups and fed two different diets. Group A-NDF was fed a diet having a higher NDF concentration (49.4%, achieved by substituting cereal grains with soybean hulls and beet pulps) than that of group B-NDF (35.4%). Milk yield was monitored every 12 h and 24 h (daily), while milk quality and feed intake were checked daily considering the two milkings. Meteorological data were obtained from the station of Olmedo of the Agro-meteorological Service of Sardinia. Analysed meteorological factors were maximum, minimum and mean air temperature, maximum, minimum and mean air relative humidity, wind speed, mean and maximum temperature-humidity index (THI; Kliber, 1964), hours at various THI-threshold values, and some interactions among the meteorological factors. The CNCPS

Sheep (Cannas *et al.*, 2004) was used to calculate the energy balance of each ewe in two days of the experimental period: day 10 and day 20, respectively before and after a marked temperature increase and milk yield drop. Statistical analysis included the Pearson correlation between each of the meteorological factors and daily milk yield. In addition, ANOVA based on the Mixed SAS procedure (SAS, 2002) was carried out, after the formation of different class intervals for each meteorological variable, by using diet, meteorological factors and the interaction between diet and meteorological factors as fixed factors, milk yield during the preliminary phase as covariate, and ewe within treatment as random factor. For data measured every 12 h, milking time was also considered as fixed factor, while milk quality and feed intake were analysed using the already described model excluding the covariate. All meteorological data were divided into different class intervals. Finally, milk yield and feed intake data were submitted to a two-way ANOVA (factors: fiber level and time), in order to evaluate the effect of diet on them.

**RESULTS AND CONCLUSIONS** – The effects of fiber dietary levels on milk yield, main milk quality characteristics, DM intake and milk net energy were not significant. On the other hand, Sarda ewes were very sensitive to heat stress. In fact, the analysis of correlation demonstrated that milk yield and some meteorological factors, especially minimum temperature, were highly and inversely associated (Figure 1).

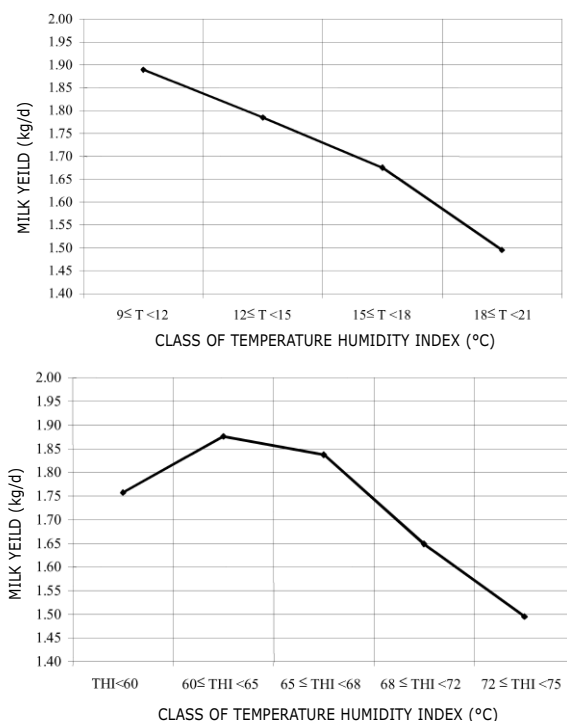
Figure 1. Evolution of minimum temperature and milk yield.



Significant and marked milk yield drops, up to 15% (about 0.30 kg/d per head) were observed when maximum and mean temperatures were higher than 21-24°C and 15-21°C, respectively. Milk yield was reduced by 20% (0.39 kg/d per head), as minimum temperatures changed from 9-12 °C to 18-21 °C (Figure 2). Wind speed positively influenced milk yield, with increases of 10% in milk yield, as wind speed increased from 1.5-2.5 m/s to 2.5-4 m/s, probably because of higher outflow of the hot-humid air of the barn. Mean air humidity also positively influenced milk yield, which showed up to 10% increase (0.18 kg/d per head) when relative humidity was higher than 45-55%. Milk yield slightly increased, as maximum air relative humidity increased from 75-85% on. Milk yield decreased by 20% (0.38 kg/d per head) as the mean THI passed from 60-65 to 72-75 (Figure 2). These marked effects of THI on milk yield, in a range of values that is not considered problematic for dairy cattle (Nardone *et al.*, 1992; Armstrong, 1994), is quite surprising, considering that small ruminants should be less sensitive to heat stress than large ruminants. It is possible that in the microenvironment of the barn the temperature and humidity were higher than those measured by the meteorological station. However, measurements carried out in 10 dairy sheep farms showed that milk yield was negatively affected when the THI was above 65 (Peana *et al.*, 2007), confirming the results found in our experiment. Milk yield losses were also observed when the maximum THI (maximum THI value calculated every 24 h) was higher than 72-75 and at increasing cumulative THI-hours calculated for different thresholds. In other experiments, milk yield was reduced by heat stress when the maximum THI was above 73 (Finocchiaro *et al.*, 2005), in agreement with our findings. Sevi *et al.* (2001) reported that milk yield decreased only when the maximum THI was above 81. However, in that experiment, milk yield was much lower than in ours and in that of Finocchiaro *et al.* (2005). Probably, DMI was also lower in the trial of Sevi *et al.* (2001), explaining the observed differences in sensitivity to heat stress. In our trial, morning and evening milk yields did not differ. Heat stress had no marked effects on milk composition, except for milk somatic cell count, which increased from 236,000 to 375,000 cells/ml as maximum temperature passed from 21-24 °C to 33-36 °C. Heat load markedly decreased DM, NDF and NEL intake. From day 10 to day 20, when the minimum temperature increased from 12 °C to 16 °C, DM intake dropped by 20%

and milk yield by 18%. Estimation of energy balance showed a 20% reduction of NEL intake, which was explained only by one third by the reduction of milk energy output. This suggested that the other two thirds of decrease in energy intake were at the expenses of body reserve deposition. In conclusion, despite their small body size, which should favour heat dissipation, lactating Sarda ewes appeared to be very sensitive to heat stress. This should induce farmers to use any possible management technique to reduce the heat stress on lactating ewes.

Figure 2. Effects of minimum temperature (above) and THI (below) on daily milk yield.



We would like to acknowledge the assistance of Dr. Ana Helena Dias Francesconi in translating and reviewing this publication.

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