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Green Roofing against Dairy Cow Summer Heat Stress

Heat stress for cows already starts at 21 °C temperature in the stable and affects milk yield negatively above 25 °C. An improvement in house climate can be attained through various measures: reducing the radiation energy from surrounding constructional parts, improved heat dissipation through higher wind speeds or by latent heat with air humidifiers. To test radiation energy reduction, a green roof with marsh plants was put on a steep sloped roof on a dairy cow house. The inside temperature could be lowered 5 °C through this, compared to fibre cement roofing.

The reduction of summer heat stress for dairy cows is an important question for the design of dairy buildings [1, 2, 4]. Parallel to an increasing milk yield metabolic energy production of cows is rising as well [5], inducing the necessity for addition energy transfer. Heat stress for dairy cows starts with 20 to 21 °C ambient temperature and has negative effects on milk yield when exceeding 25 °C. Changes regarding the lying behaviour indicate heat stress at 21 °C [6]. Lying time for cows at a thermoneutral climate is significantly longer, this may be another reason for a reduced milk yield as well. A technical parameter to measure heat stress is the temperature-humidity-index THI. According to [3], the THI should be used weighted regarding the climate zone.

[9] used a system sprinklers, shading and ventilation and gained 1.4 kg/milk/cow and day, compared to exclusively utilized sprinklers. Evaluation of economic losses by heat stress in animal housing in general were calculated to be 897 Mio $ per year in the US.

Material and methods

The solution of the cooling green roof presented here was developed by the Textile Research Institute of Saxony (STFI) at Chemnitz (Germany). At the Federal Agricultural Research Centre (FAL) at Braunschweig (Germany) one of two identical dairy buildings was equipped with the marsh plant green roof (*Fig. 1*). Both dairy buildings had measuring devices for ambient temperature and humidity. A meteorological station was placed close to the buildings to record outdoor climate parameters. Within a second configuration level it is planned to collect the water for irrigating the roof in a storage basin beside to reuse it. The water may be elevated to the roof by a solar powered pump.

The marsh plants consist almost of sedge varieties (Carex), *Mimulus lutus, Lythrium salicaria, Iris pseudacorus* etc. The plants were pre-cultivated on mats beside the building and fixed on the roof three months later. A foil was placed between roof (fibre ce-

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Keywords
Heat stress, dairy cows, cooling, green roof

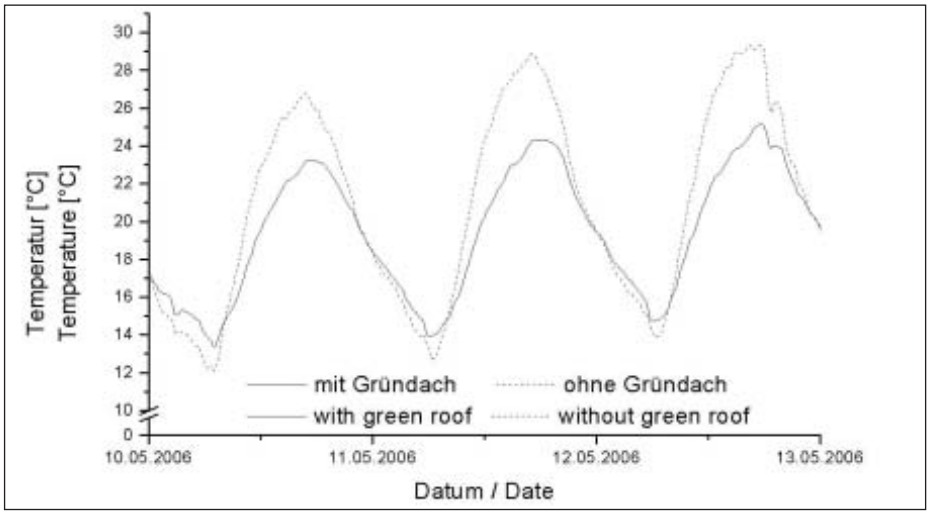

Fig. 1: Profile of daily temperature measures inside the stable of the green roof and roof without plants in May 2006

ment) and the mats carrying the plants to prevent roots from growing between the roof tiles. The watering of the plants is controlled by an irrigation microcomputer, the water overflow is collected using the eaves gutter.

Results

Analysis of ambient temperature in both dairy barns demonstrates that a reduction of ambient temperature by 5° C could be realized using marsh plant green roof. The ambient temperature in the green roof barn did not exceed 25°, whereas the control building temperature came up to 30 °C during afternoon. *Figure 2* describes the run of temperature curves during May 2006 for the two equal buildings. The difference of -5 °C could be achieved from June to September, too. A comparison of the temperature under the roof of both, green roof and fibre cement, gave us a difference in mean temperature (on the surface) of 25 to 30 °C (*Fig. 3*). The green roof acted as a shield to protect from solar radiation. The marsh plants were stimulated by the solar radiation to evaporate more intensively, which may lead to an additional cooling effect.

Conclusions

The presented alternative way of cooling down a dairy building by green roofing could reduce ambient temperature by 5 °C, compared to a fibre cement roof. Further investigation will be done to measure thermal comfort and THI, to evaluate the cooling effect in comparison with evaporative cooling and fans. Other investigations are planned to compare the efficiency of "low cost cooling" by just watering the roof tiles with the green roof.

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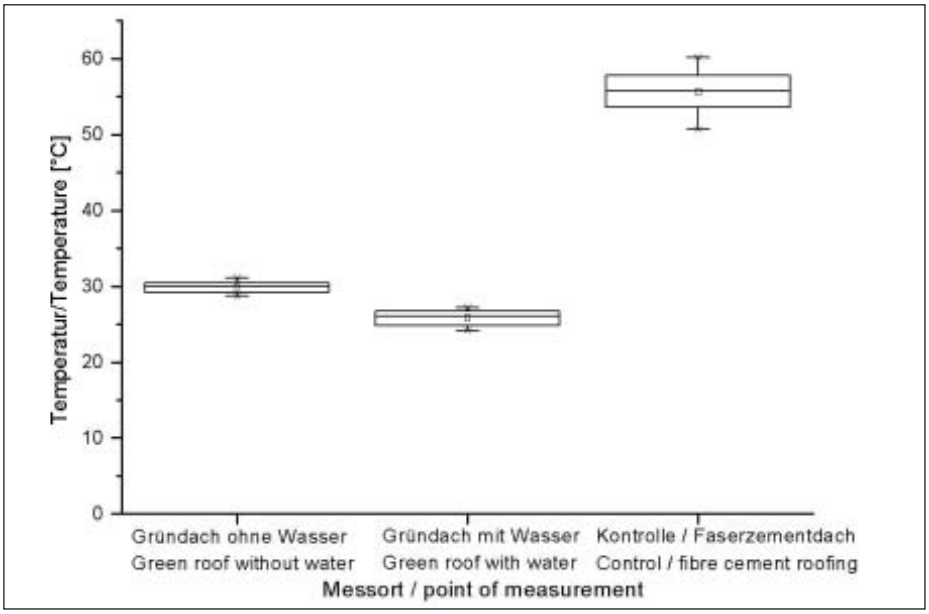

Fig. 2: Distribution of temperature measures at the bottom side of the green roof compared to control without green roof