

INTRODUCTION

Agricultural workers are exposed to various risks: chemical agents, noise and many other factors. One of the most characteristic and less known risk factor is constituted by the microclimatic conditions in the different phases of work (in field, in greenhouse, etc). A typical condition of thermal stress due to medium and high temperatures is represented by the working operations in the cow barn with the natural ventilation. Object of this work is to assess the thermal discomfort through main microclimate-index: Predicted Mean Vote (PMV) index and Wet Bulb Globe Temperature (WBGT).



Figure 1: The monitored farm.

MATERIALS AND METHODS

The WBGT Index

In order to evaluate thermal stress in hot environments, different criteria can be used, which are based on different indexes. The ISO 7243 standard refers to the WBGT index, whose aim is to limit excessive thermal stress for people working in hot environments, assuming a maximum limit that implies a limited increase (1°C) of body temperature. According to the American Conference of Governmental Industrial Hygienists (ACGIH, 2010), the maximum limits of the WBGT index are calculable in relation to the work load and the work/rest alternation (table 1) and presume light clothing (0.4 to 0.5 clo) with normal permeability to steam.

Work/Rest	Work Load ^[a]		
	Light	Moderate	Heavy
Continuous work	30.0	26.7	25.0
75% work - 25% rest	30.6	28.9	25.9
50% work - 50% rest	31.4	29.4	27.9
25% work - 75% rest	32.2	31.1	30.0

Table 1: Maximum values of the WBGT index (°C). - [a] It is only possible to exceed the indicated limits after a medical check-up that confirmed tolerance of being able to work in hot environments.

The WBGT is calculated with the following equation (this equation is for external conditions with exposure to sun):

$$WBGT = 0.7 t_w + 0.2 t_g + 0.1 t_a$$

where: T_w : natural wet-bulb temperature;
 T_g : black globe temperature;
 T_a : (shade) air temperature.

The PMV and PPD Index

The Predicted Mean Vote (PMV), is an index for assessing the state of well-being of an individual and takes into account the subjective and environmental variables and is thus a mathematical function that results in a numerical value on a scale with range -3 (index of feeling too cold) to +3 (index of feeling too hot), where zero represents the state of thermal comfort. Since an average index for a group of individuals, the achievement of the PMV zero does not mean that the entire group reached the welfare conditions.

The Percentage of Person Dissatisfied (PPD) gives the percentage of dissatisfied people in a given environment (ISO 7730).

Instruments

The measurement system used the following instruments: a multi-acquiring LSI (LSI LASTEM s.r.l., Settala, Italy) BABUC M instrument with six inputs; probes for measuring microclimatic parameters, a holder for the probes, and a tripod. To survey environmental parameters, the LSI BABUC M was connected to four probes (all probes are in compliance with ISO 7726).

MONITORED FARM

The Monitored Farm

A farm near Viterbo (central Italy) was monitored to evaluate the risk of excessive thermal load for workers, using the PMV and PPD index and the WBGT index.

The measurements was done from 10 July to 05 September 2010.

RESULTS

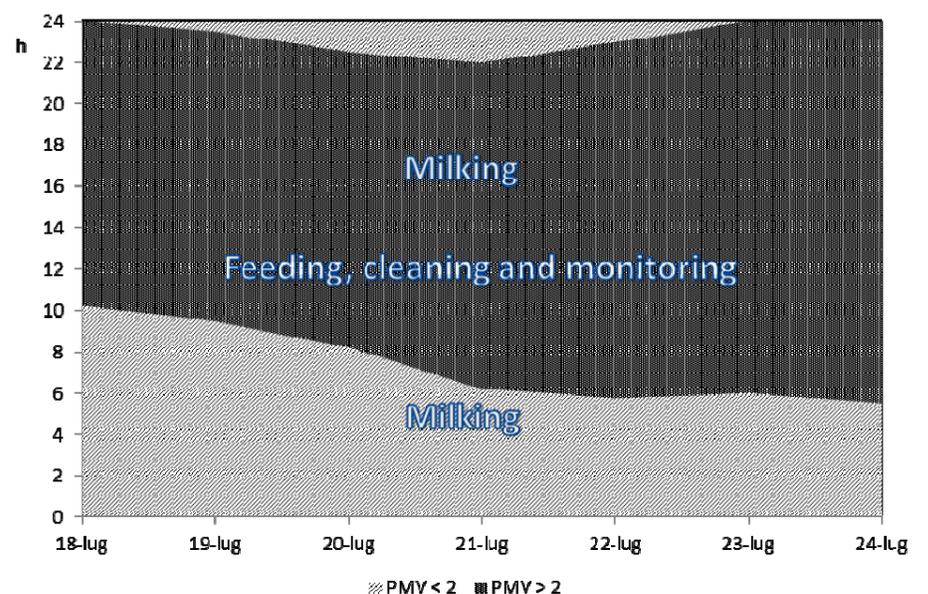


Figure 2: Exceeding of limits PMV value ≥ 2 and comparison with the workers activities.

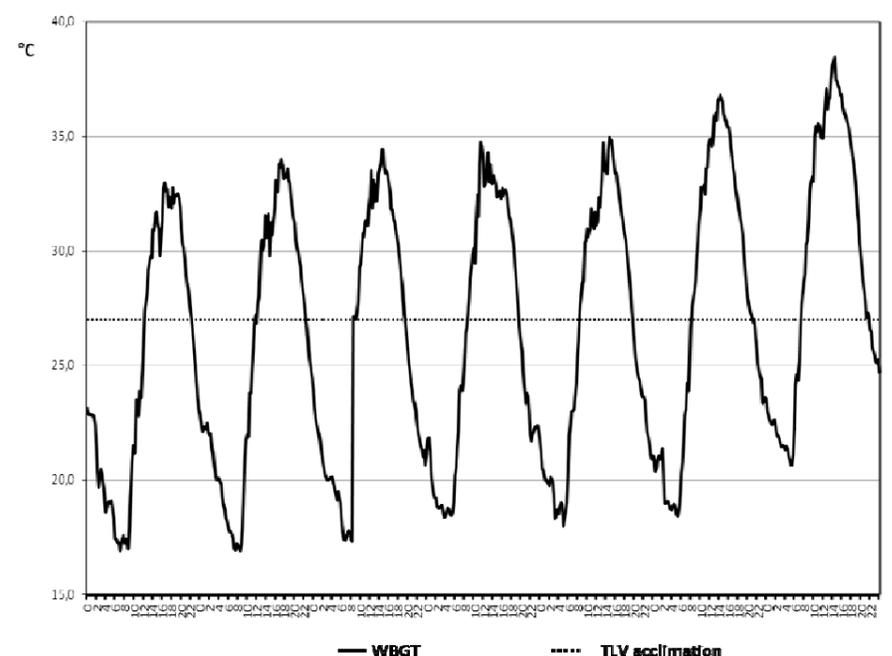


Figure 3: WBGT values tested for the period examined and TLV.

CONCLUSIONS

A series of microclimate measurements were performed in different kinds of cow houses in a farm near Viterbo. The number of animals in the structures varied from 30 to 600. Measurements were made in summer conditions with ambient temperatures from +20°C to +36°C. The results showed that there were differences in microclimate depending on design of structures, outside temperature, wind and ventilation rates. Thermal discomfort is particularly derived from high temperatures during summer period. In any cases the risk is amplified due to the lack of acclimatization of the workers and the high temperatures.