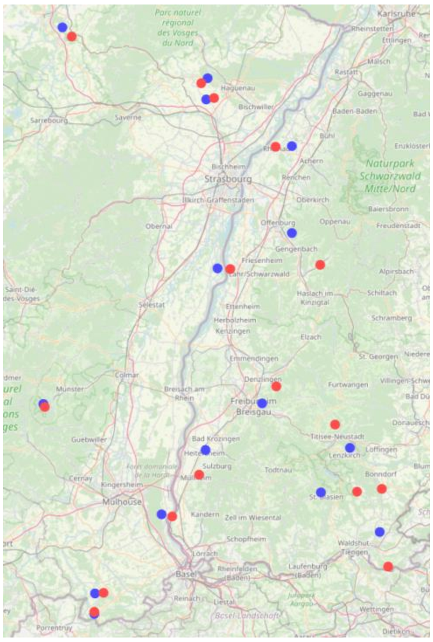
HEAT STRESS IN DAIRY FARMING: EFFECTS ON BUILDINGS AND CONSEQUENCES FOR MILK PRODUCTION



▲ *Fig. 1: Blue: the 16 pilot farms.*

MoBiMets and Pessl sensors were installed in the buildings of 16 pilot farms (blue dots) to collect temperature (T) and humidity (H) data. This made it possible to build up a THI database (indicator of thermal comfort) in the barns.

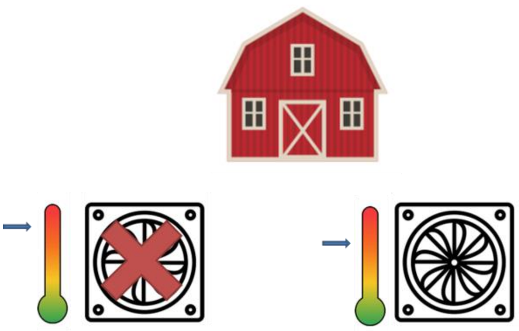
$$THI = (1{,}8T + 32) - ((0{,}55 - 0{,}0055H) \times (1{,}8T - 26))$$

On the other hand, milk samples were collected to quantify the milk produced per cow and to perform spectral analyses.

With these data sets, a statistical model was created that allowed the calculation of an estimated THI for each cow.

Fig. 2 ▶
The Pessl and MoBiMets sensors measure humidity and temperature in real time.

Building impact

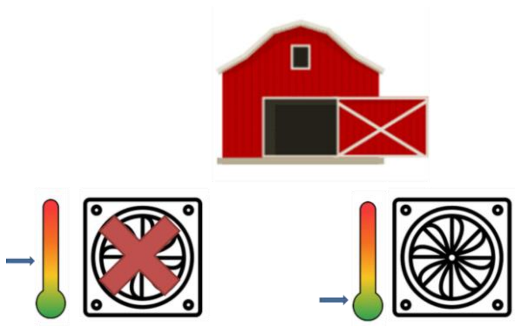


Characterisation of the buildings (ventilation, openings, etc.) identified effective factors for mitigating heat stress.

Mechanical ventilation is the discriminating feature for reducing the estimated THI. However, the combination of building opening and fans is the most effective (-8 units on the estimated THI).

Conversely, the presence of mists or translucent materials showed no significant effects in this study. In contrast, other studies show an increase in heat stress in the presence of translucent materials (in conjunction with the increased solar radiation).

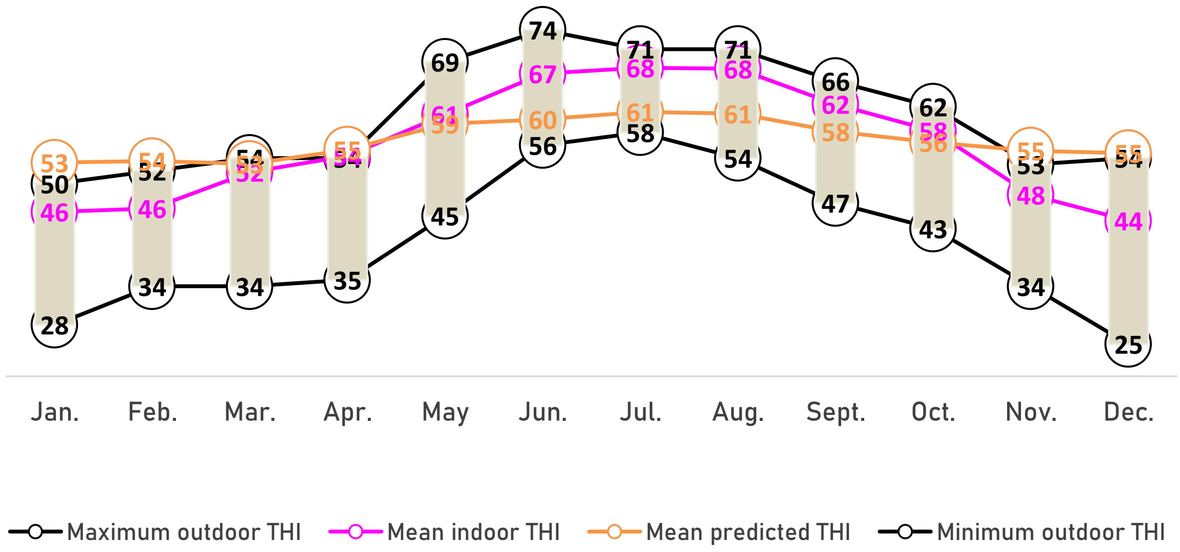
Similarly, the presence of showers and mists can improve the thermal comfort of animals. However, by increasing the humidity in the barn, this can also have an opposite effect and increase the THI. Good ventilation is therefore crucial for controlling the barn climate.



Impact on dairy production

All the data collected and calculated using the statistical model show a clear increase in THI during the summer.

Fig. 3 ▶ *Annual development of the external and internal THI as well as the predicted THI (statistical model).*



By applying the statistical model to climate projection scenarios, the trend of the development of milk production in the Upper Rhine can be estimated.

25 °C
40 % Humidity
THI = 71
Threshold value for initial heat stress in dairy cows

INITIAL HYPOTHESIS
based on the mean climate values on the Upper Rhine in summer

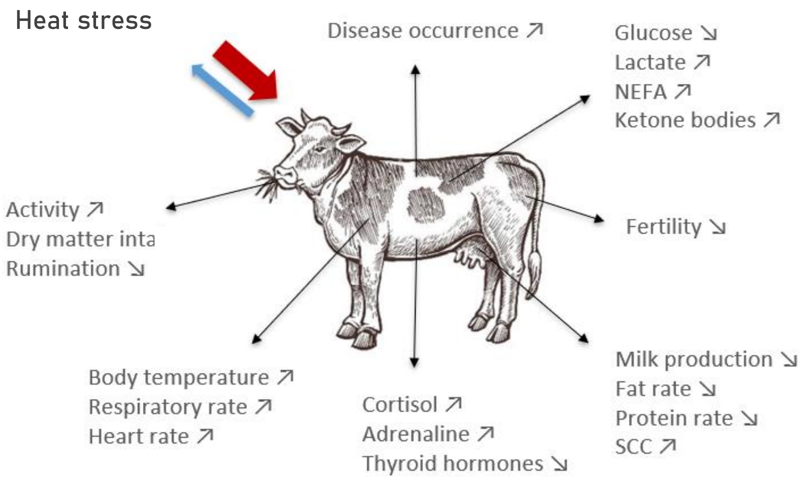
-1,4 kg ECM (corrected milk) / cow / day

TB : -0,9 g / kg milk / cow / day

TP : -0,6 g / kg milk / cow / day

29 °C
40 % Humidity
THI = 76
moderate heat stress

HYPOTHESIS 2050
Application of the RCP8.5 scenario (IPCC report), i.e. +4°C (without climate protection policy).



▲ *Fig. 4 : Effects of heat stress in dairy cows. Source: Lemal and Wijnrocx, 2022.*

ANIMAL HEALTH AND WELFARE

The statistical model for estimating THI from spectral analysis of milk gives us an insight into how heat stress and the different milk components correlate with each other. For example, we can show that the fat content of milk is strongly negatively correlated with THI (-0.43), but the protein content is less so (-0.22).

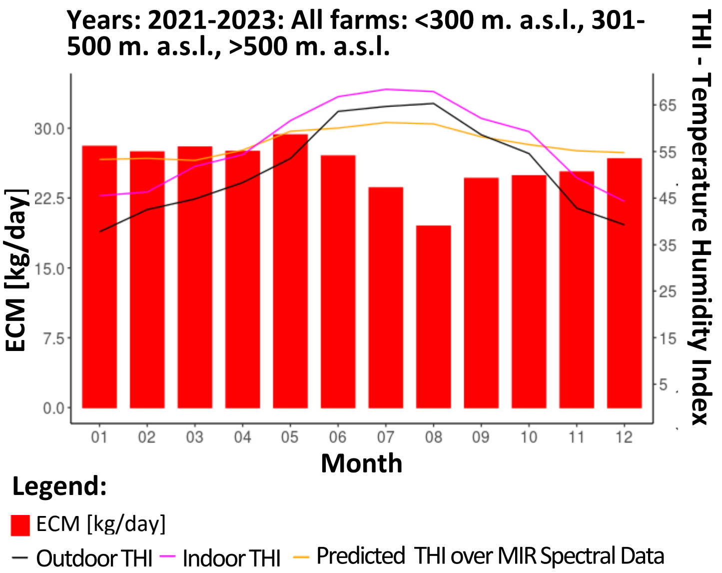
Ingredients of the milk or indicators	Pearson's coefficient
Adiponectin in Blood	0,24
Energy Balance (NEL)	0,12
Lactoferrine	0,05
MMI (Mastitis-Indicator)	0,03
FE_ECM (Indikator für die Futtereffizienz)	0,03
Urea	-0,01
Calcium in Blood	-0,02
FLR (fat to lactose ratio)	-0,03
Lactose (%)	-0,11
ECM (fat and protein corrected milk kg)	-0,16
TOTC18_1 (Fatty acid)	-0,22
Protein %	-0,22
C18_1CIS9 (Fatty acid)	-0,23
Magnesium	-0,24
Long chain fatty acid	-0,27
Poly fatty acid	-0,29
OMEGA 6 Fatty acid	-0,33
OMEGA 3 Fatty acid	-0,33
BHB (Indicator of ketosis)	-0,36
C17 (Fatty acid)	-0,36
Short-chain fatty acid	-0,41
Fat %	-0,43

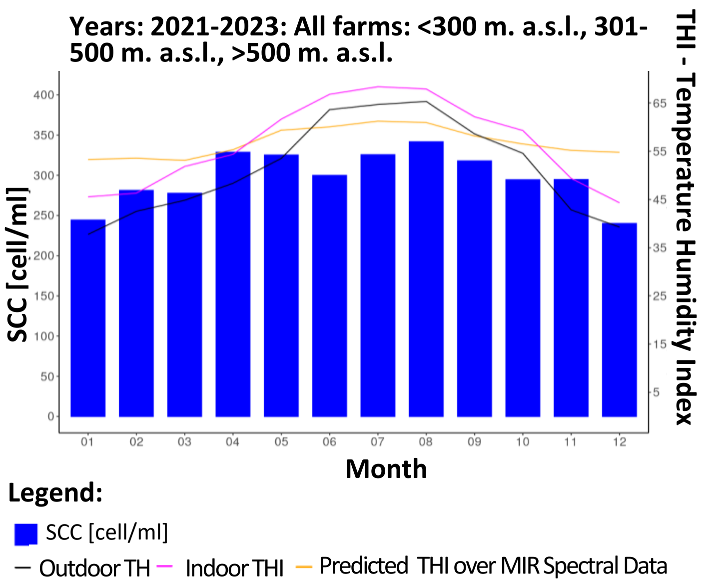
Positive correlation: The higher the THI, the higher the milk ingredient or indicator.

Negative correlation: The higher the THI, the lower the milk ingredient or indicator.

▲ *Fig. 5: the Pearson coefficients define the strength of the relationship between two variables (here the estimated THI and the ingredients of the milk) and their association with each other.*

The closer the Pearson coefficient is to 1 as an absolute value, the stronger is the correlation between the two variables.





▲ *Fig. 6 : The analysis of the spectral data of the milk makes it possible to investigate the relationship between the THI and the various ingredients of the milk (here the corrected milk quantity and the cells).*