

Predicting dairy cattle heat stress indicators using machine learning and mid infrared spectral data



Corresponding author: ldale@lkvbw.de

Interreg



Co-funded by
the European Union

North-West Europe

HoliCow

L.M. Dale¹, E.J.P. Strang¹, P. Lemal², M. Jattiot³, A. Werner¹,
HoliCow Consortium⁴, ResKuh Consortium⁵, H. Amamou⁶, N. Gengler², H. Soyeurt²

¹Regional association for performance testing in livestock breeding of Baden-Wuerttemberg Heinrich-Baumann-Str. 1-3, 70190 Stuttgart, Germany

²Gembloux Agro-Bio Tech, University of Liège, Passage des Déportés 2, 5030 Gembloux, Belgium

³INNOVAL, 35538, Noyal-sur-Vilaine, France

⁴<https://holicow.nweurope.eu/>, 4 Rue des Champs Elysées, 5590, Ciney, Belgium

⁵<https://agroecologie-rhin.eu/de/klimaco-2/>, 2 rue de Rome, 67013, Schiltigheim, France

⁶High School of Agriculture of Kef, University of Jendouba, 7119, Le Kef, Tunisia

HoliCow - Enable small/med dairy farmers to benefit from big data for holistic decision-making



Several topics – 3 work packages:

Tools for farmers

- WP1 Data for farm tools
- WP2 Tools for farmers
- WP3 People for farmers

Connexions:
 -between farmers
 -between farmers and ...



Community database



Co-funded by the European Union

North-West Europe



HoliCow

Milk yield decline:

- 0.08 and 0.26 kg for every **increase** in THI unit

THI>68

- milk production 21.0%
- dry matter intake 9.6%

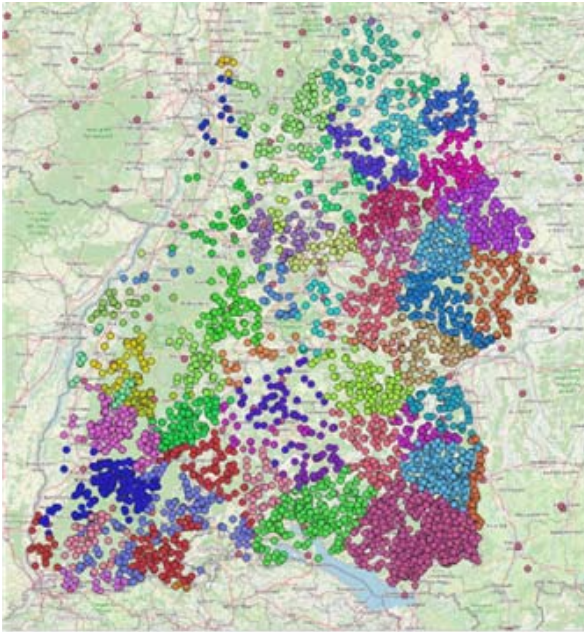
THI threshold:

- US: 72
- Italy : 73-76
- Spain : 73
- Germany : 60
- Luxembourg : 62

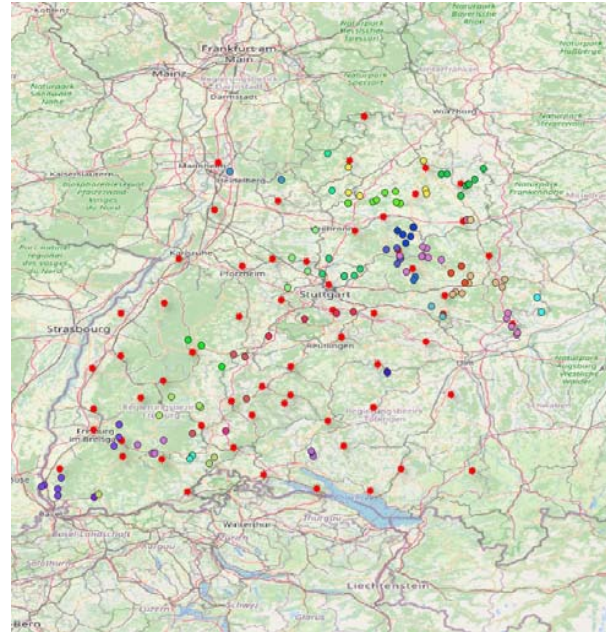


Brügemann et al., 2012

Dairy farms: 8000
Weather stations (WS): 67
Period: 2012-2019



Selected Dairy farms: 120
Weather stations: 67
Period: 2012-2019



THI prediction based

Material:

- Bentley MIR spectral data
- WS Mean 3 days THI

Method:

- GLMNET Machine Learning



HoliCow

Identification results of the final model:

CowTHI3mean - MIR spectral predictions based on Weather Station (WS)

THI3mean:

- spectral model (**1st Calibration**),
- animal model (**2nd Calibration**)
- and **Cross Validation** model

1st Validation : Spectra Selection

- 70% calibration model
- 30% validation model

2nd Validation : Animal validation

- 70% calibration model
- 30% validation model

3rd Validation : Cross validation

- All data

Model	N	Min	Mean	Max	SD	SEC	R2	RPD
1st Calibration	98434	25	50	75	7.92	2.58	0.89	3.08
1st Validation	42184	23	50	75	7.93	2.58	0.89	3.08
2nd Calibration	98435	24	50	75	7.93	2.58	0.89	3.07
2nd Validation	42183	23	50	73	7.93	2.57	0.9	3.09
Cross validation	140618	23	50	75	7.93	2.58	0.89	3.08

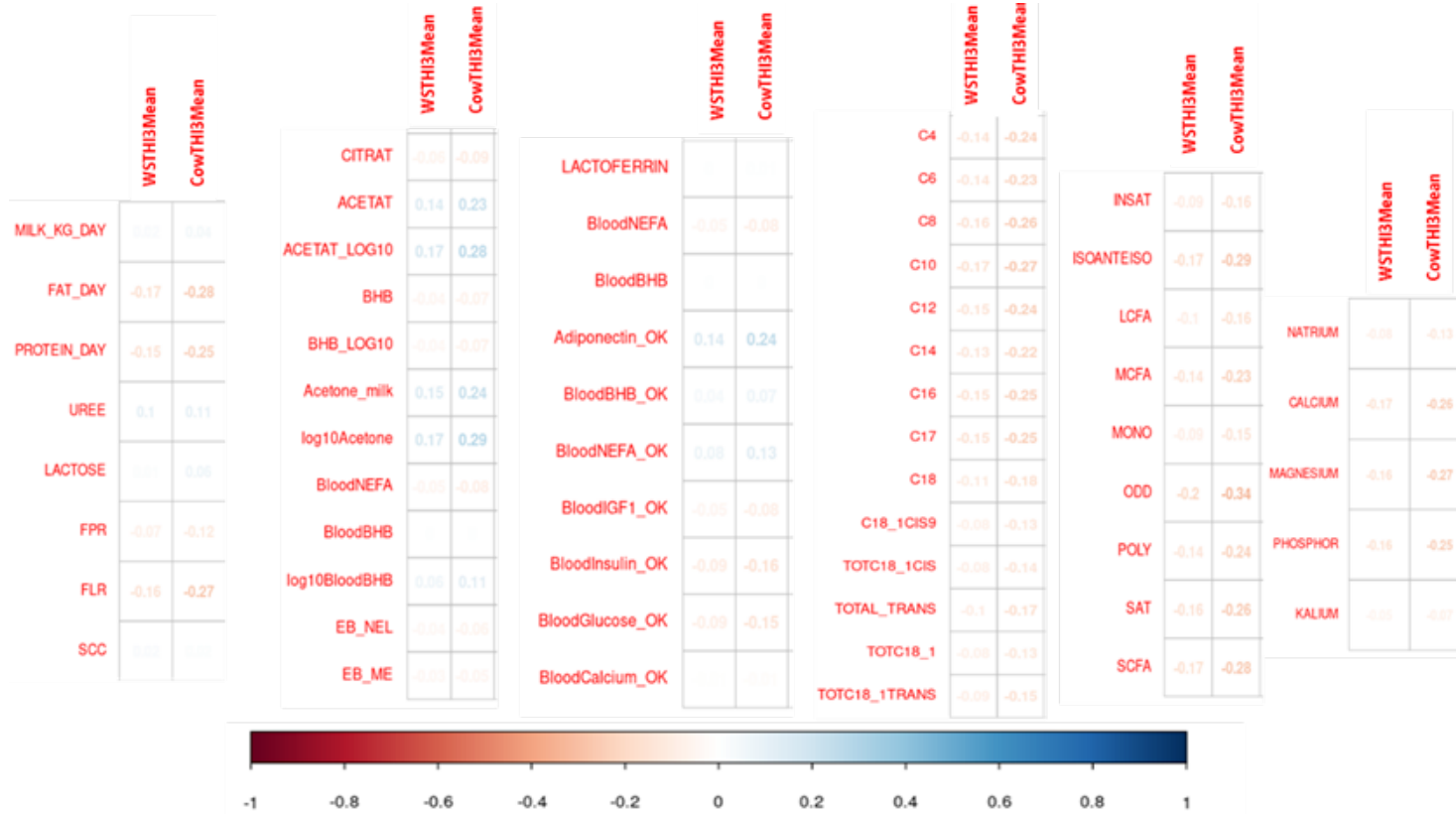


Pearson correlations between milk parameters and WSTHI3Mean and CowTHI3mean values



WSTHI3Mean =
Weather Station THI 3 days mean before the test day

CowTHI3Mean =
MIR predicted THI based on MIR Spectra and animal reaction on WSTHI3Mean



Description

Dairy Herds

Spectral Data

Selected Data (Soyeurt et al., 2024)

Summer Data

After Outlier detection

*

*only data with MIR prediction only positive values and ICAR norms on the milk recording data

Co-funded by



Initially proposed in ICAR meeting, 25th May 2023

Update for ICAR meeting, 20th May 2024

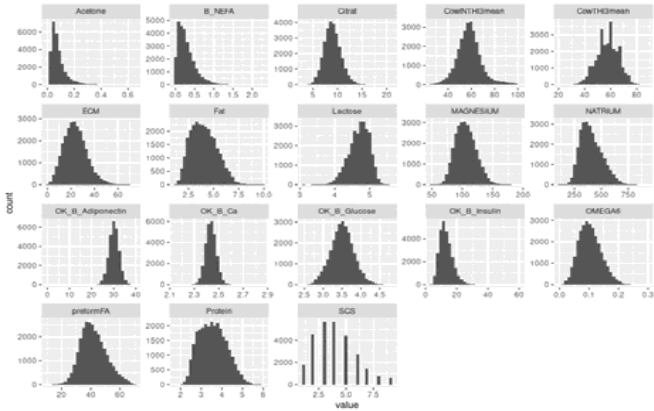
World representative spectral database (WRSD)

H. Soyeurt, C. Nickmilder, S. Franceschini, M. Whittaker, F. Dehareng, M. Bahadi, J. Leblois, L. Dale, K. Sanders, C. Grelet

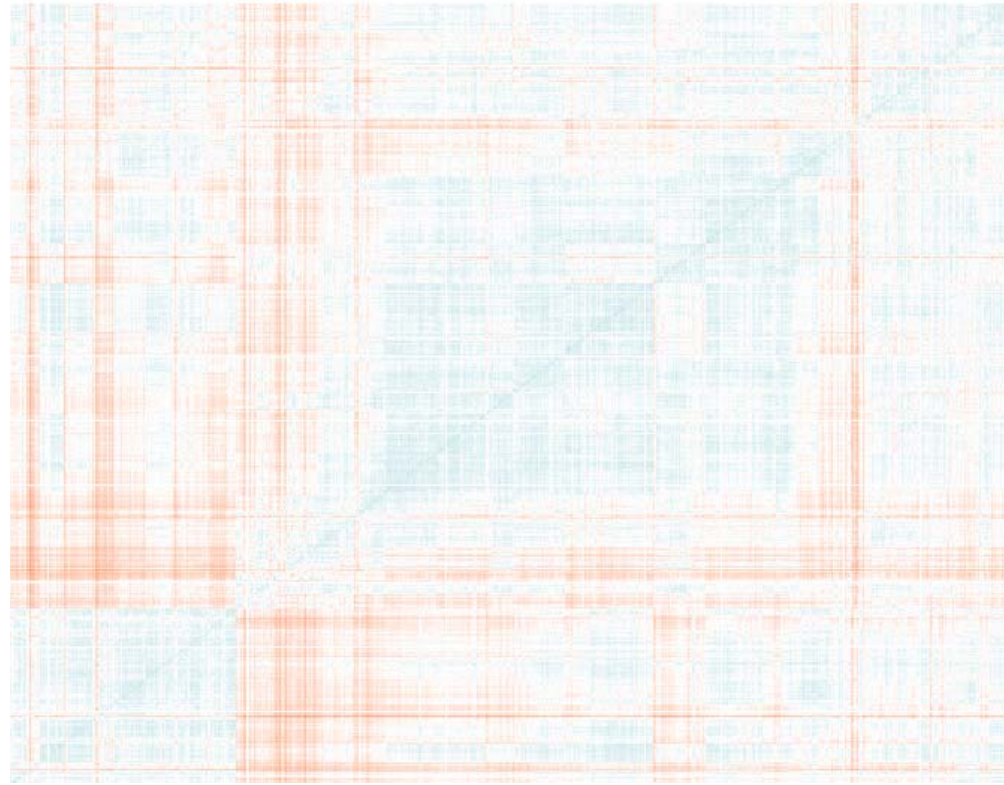


Data used in unsupervised clustering

Description	Data
After Outlier detection	27,584

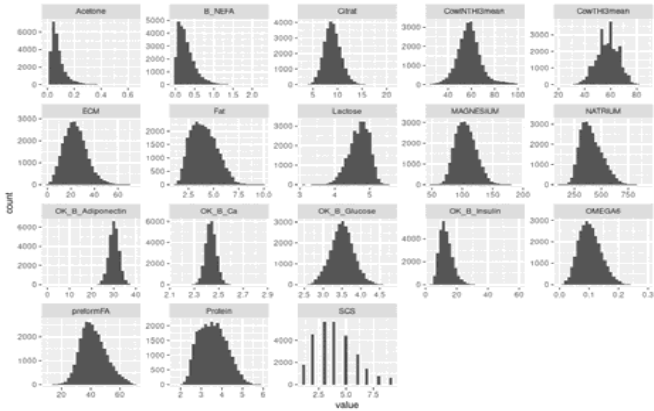


Enhanced Distance Matrix Computation and Visualization

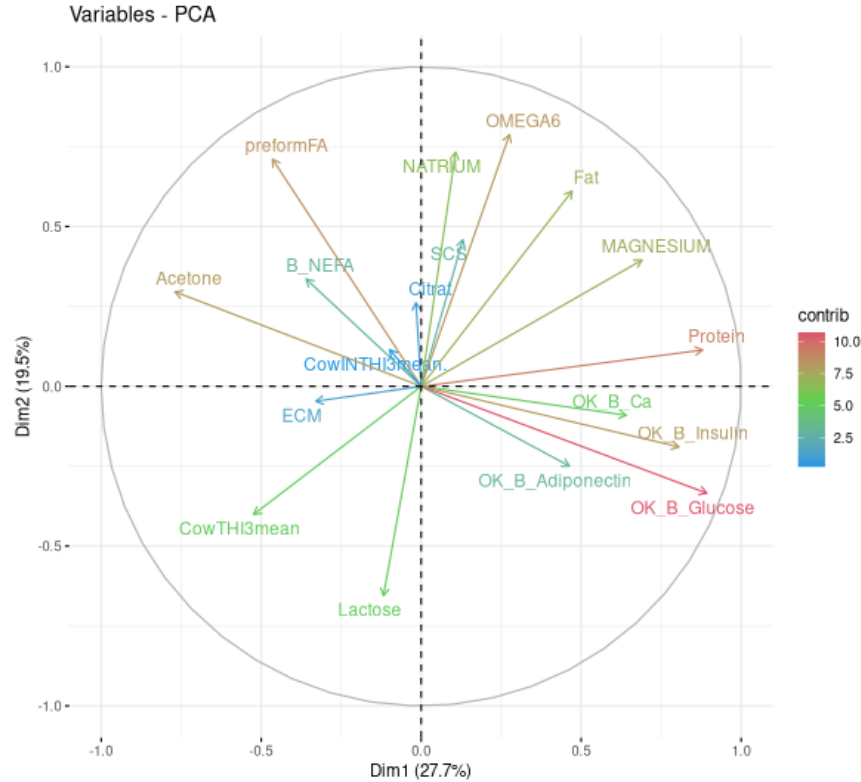


Data used in unsupervised clustering

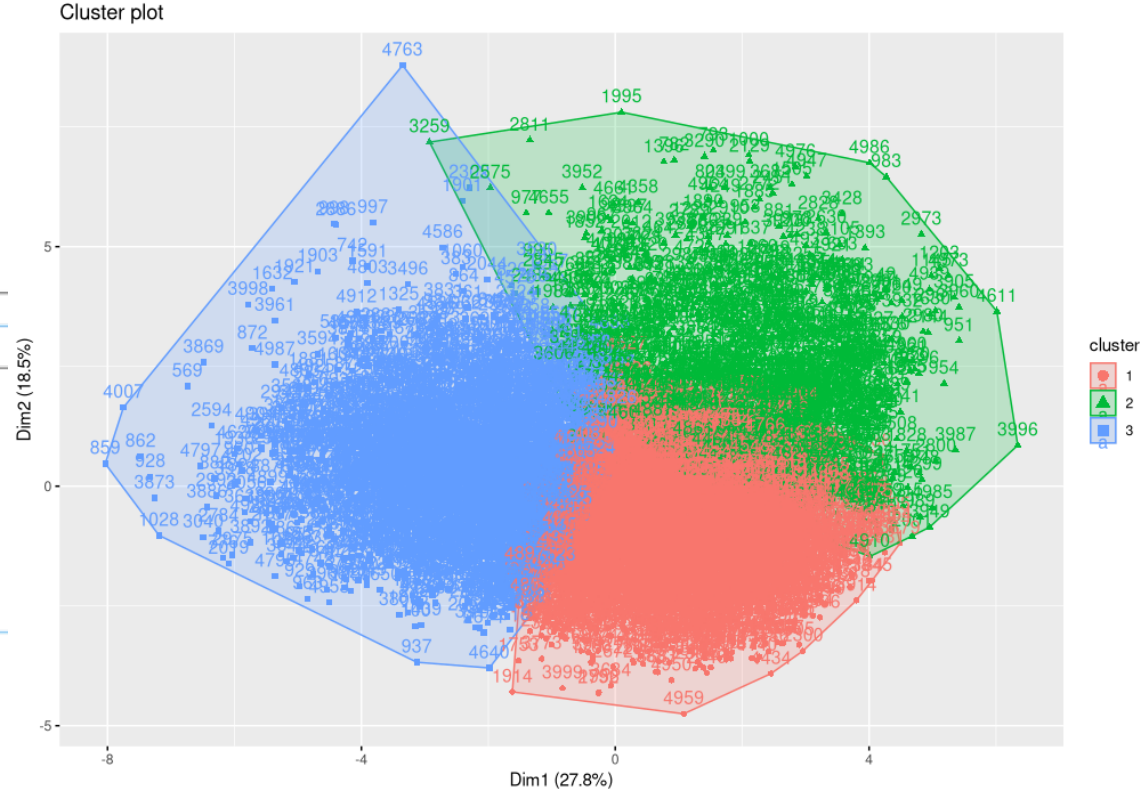
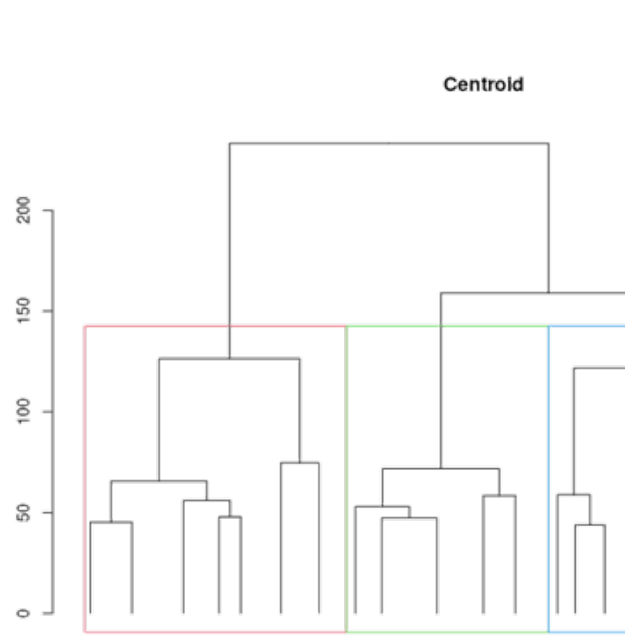
Description	Data
After Outlier detection	27,584



Extract and visualize results for variables

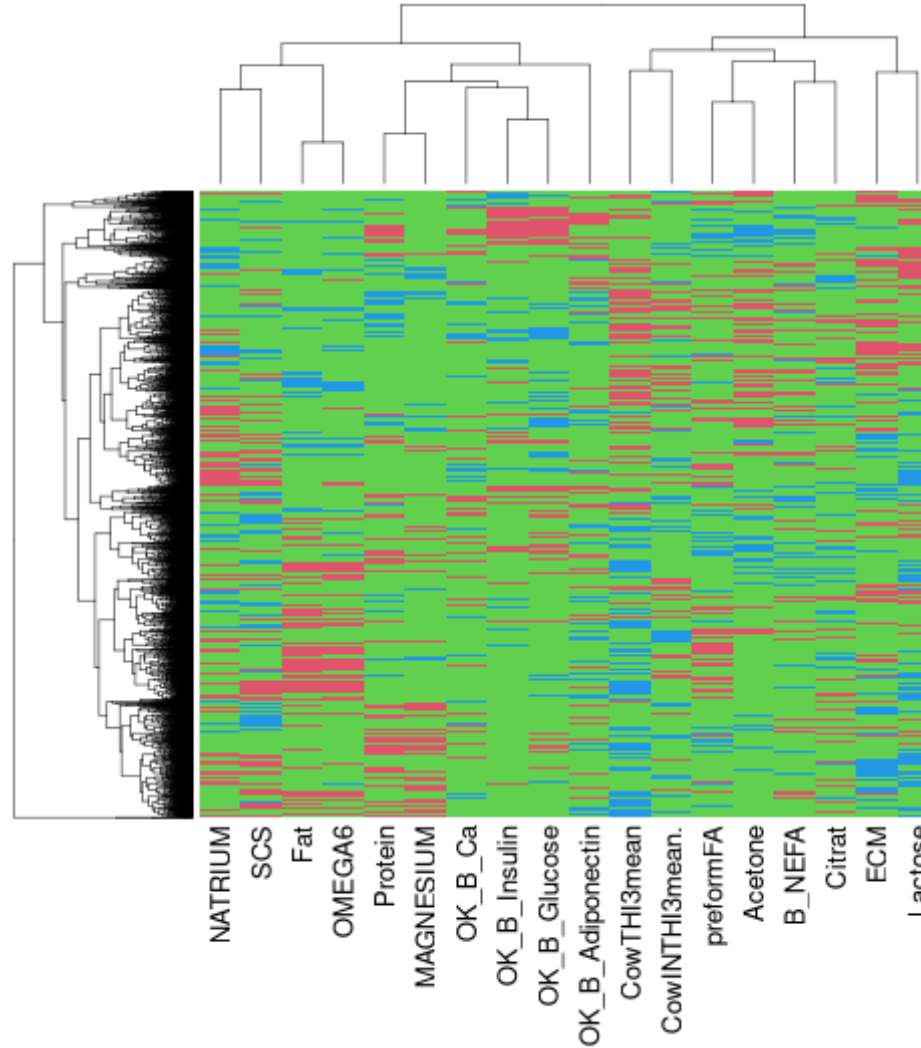
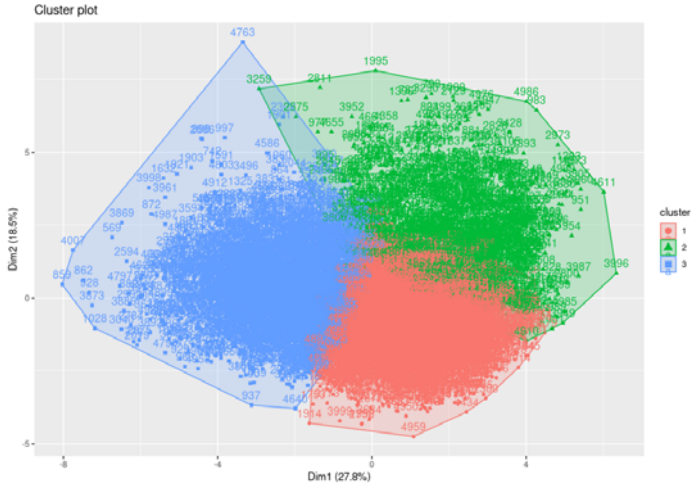


Cluster Analysis: Hierarchical clustering LKVBW data set



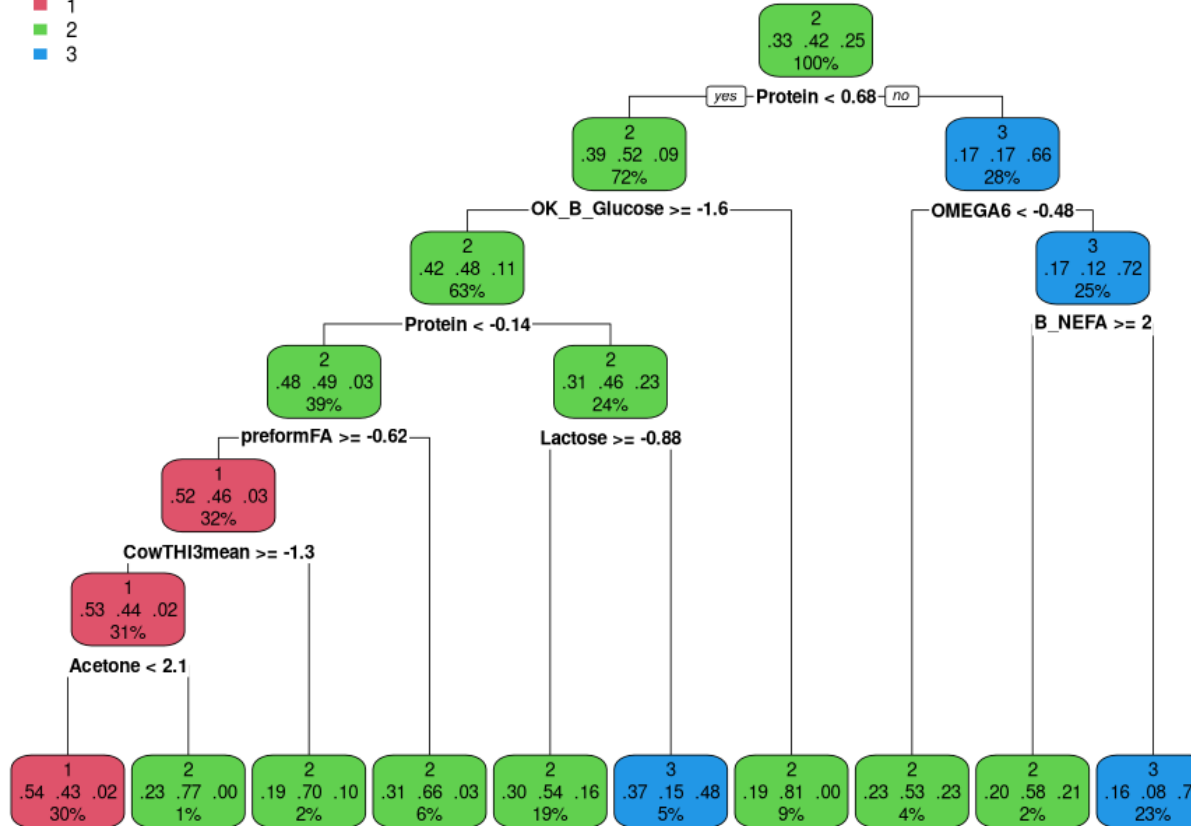
Heatmap: Static and Interactive

Hierarchical clustering



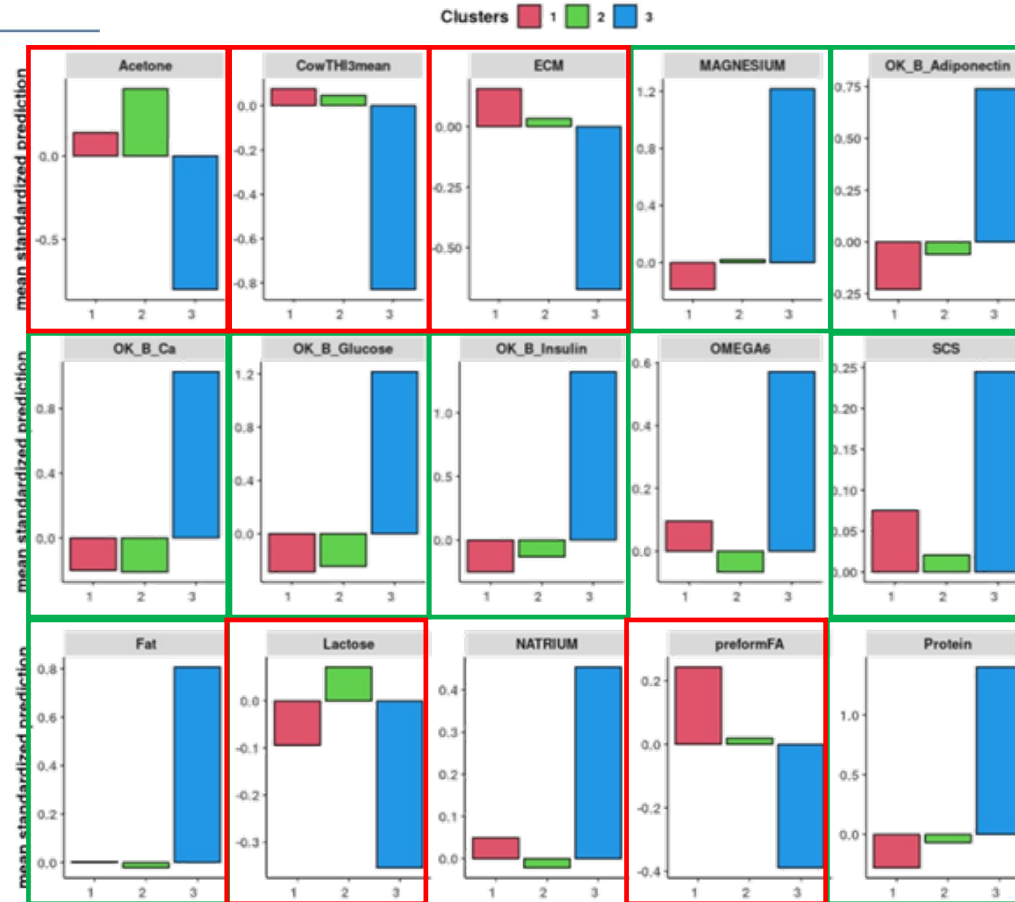
- 1
- 2
- 3

Classification and regression trees based on the cluster analysis



HoliCow

Correlation between cluster response and milk recording data and MIR spectra predictions used for clustering



In the initial phase of the HoliCow project, significant progress and promising results have been noted.

The early findings suggest that the project is on track to deliver valuable insights and advancements in the field, setting a strong foundation for further research and innovation.

It is crucial to refine the outcomes and improve the quality of clustering for practical implementation in pilot farming scenarios.



Validating the predictions against heat stress or health problems situations by utilizing the same animals in the time series analysis and closely monitoring the development of the clusters.

Cluster analysis is an iterative procedure, and plans are underway to interpret the results effectively to gain a deeper understanding of each cluster's characteristics in the upcoming phase of the project.



Predicting dairy cattle heat stress indicators using machine learning and mid infrared spectral data



Thank you for your attention!



Corresponding author: ldale@lkvbw.de

Interreg



Co-funded by
the European Union

North-West Europe

HoliCow

L.M. Dale¹, E.J.P. Strang¹, P. Lemal², M. Jattiot³, A. Werner¹,
HoliCow Consortium⁴, ResKuh Consortium⁵, H. Amamou⁶, N. Gengler², H.
Soyeurt²

¹Regional association for performance testing in livestock breeding of Baden-Wuerttemberg Heinrich-Baumann-Str. 1-3, 70190 Stuttgart, Germany

²Gembloux Agro-Bio Tech, University of Liège, Passage des Déportés 2, 5030 Gembloux, Belgium

³INNOVAL, 35538, Noyal-sur-Vilaine, France

⁴<https://holicow.nweurope.eu/>, 4 Rue des Champs Elysées, 5590, Ciney, Belgium

⁵<https://agroecologie-rhin.eu/de/klimaco-2/>, 2 rue de Rome, 67013, Schiltigheim, France

ICAR 2024 - Bled