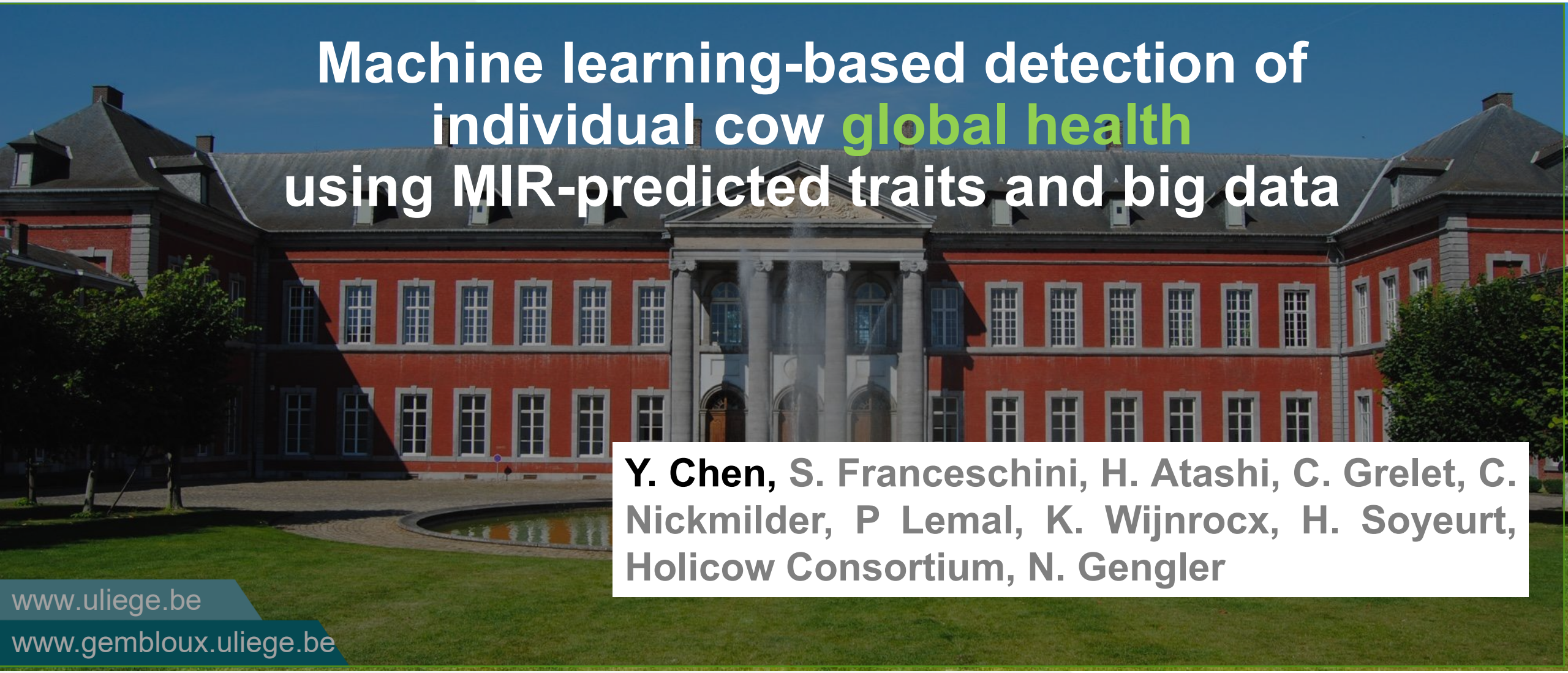
EAAP
European Federation of Animal Science

Artificial Intelligence 4 Animal Science

LIÈGE université Gembloux Agro-Bio Tech

Machine learning-based detection of individual cow global health using MIR-predicted traits and big data



Y. Chen, S. Franceschini, H. Atashi, C. Grelet, C. Nickmilder, P Lemal, K. Wijnrocx, H. Soyeurt, Holicow Consortium, N. Gengler

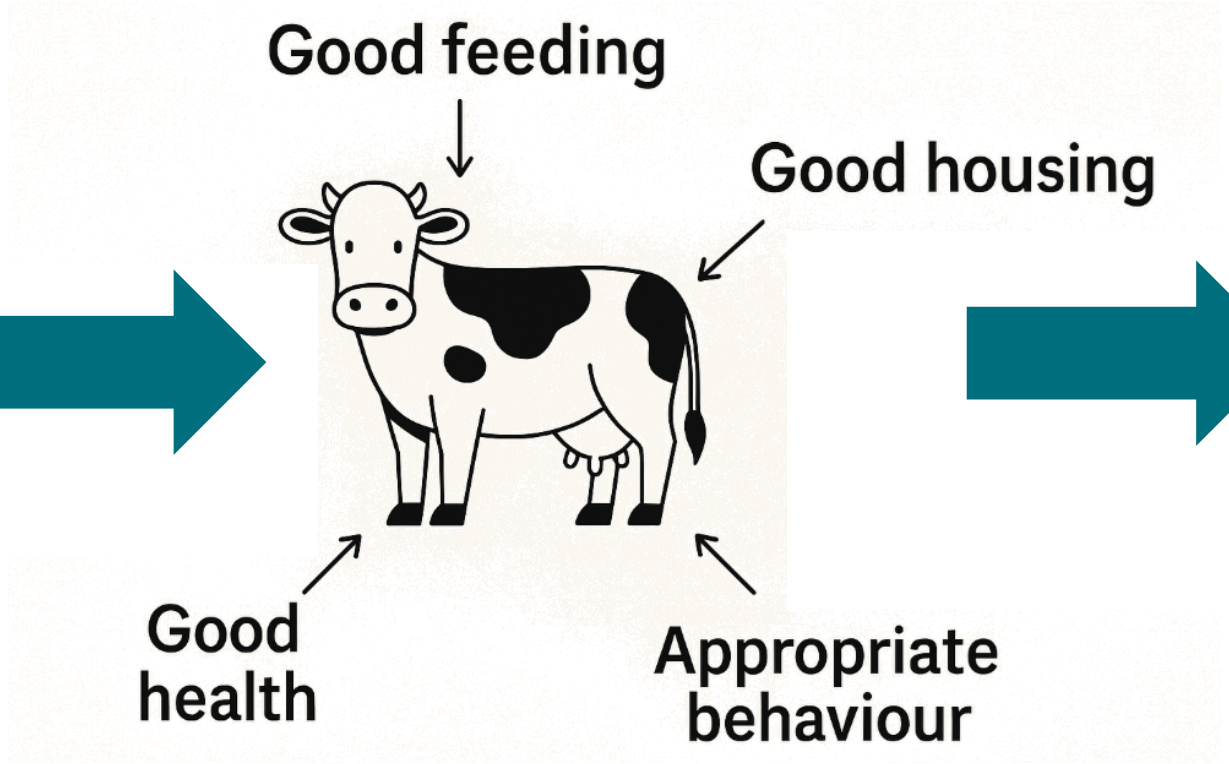
www.uliege.be
www.gembloux.uliege.be

Background

Global health from Well-being

5 freedoms

Freedom from hunger, thirst, discomfort, pain, injury, disease, fear, and freedom to express normal behaviors



Production performance

Welfare Quality Network

Welfare Quality asseement protocols: 12 Welfare criterias

Background

Global health from Well-being

Well-being

- ✓ Housing
  - temperature, humidity,ventilation...
- ✓ Feeding
  - Feed quality and availability, water…
- ✓ Health
  - Body temperature, heart rate, respiration..
- ✓ Behavior
  - Social interactions, walking, lying, eating, ruminating…

Background

Measure well-being routinely possibility

Milk Sampling

Collect 50 ml milk from cow

Each month

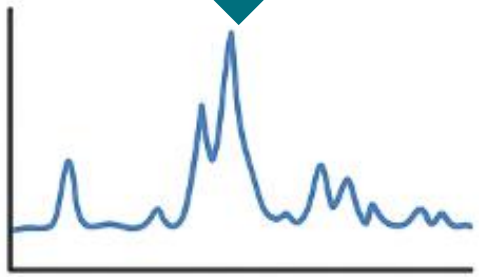
DHI center

Predict

Milk fat %

Protein %

Modeling



Milk Infrared Spectrum

Modeling

300+ Novel Phenotypes

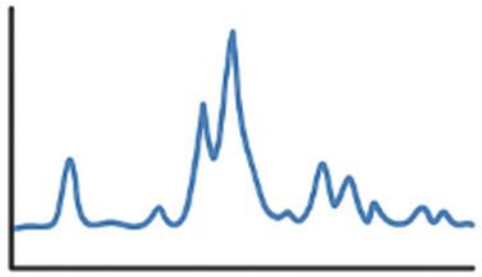
- Milk Fatty Acids
- Nitrogen Use Efficiency
- Methane Emission
- Etc.

Background

Measure well-being routinely possibility

Well-being

- ✓ Housing
- ✓ Feeding
- ✓ Health
- ✓ Behavior



Milk Infrared Spectrum

- ✓ Housing
  - THI, Milk pH
- ✓ Feeding
  - Milk composition (fat, protein, minerals…)
  - DMI, body weight, nitrogen use efficiency…
- ✓ Health
  - Blood NEFA, BHB, IGF-1...
  - Milk Nagasem citrate acetone…
- ✓ Behavior

Background

Cow global health

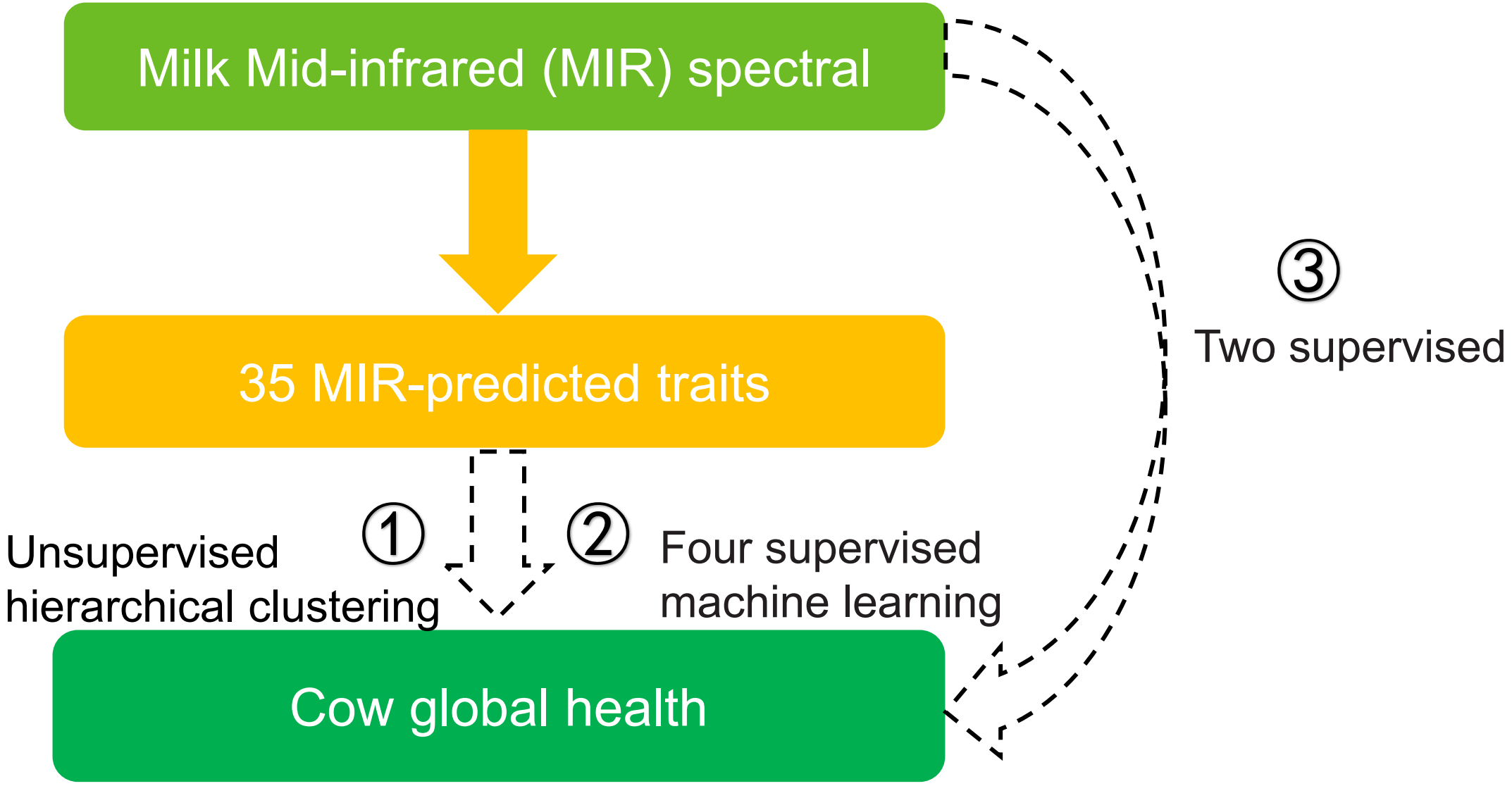
- ✓ Environmental
  - THI, Milk pH
- ✓ Feeding
  - Milk composition (fat, protein, minerals…)
  - DMI, body weight, nitrogen use efficiency…
- ✓ Health
  - Blood: NEFA, BHB, IGF-1...
  - Milk: lactoferrin, citrate, acetone…
- ✓ Behavior

J. Dairy Sci. 105:6760–6772
https://doi.org/10.3168/jds.2022-21975

Can unsupervised learning methods applied to milk recording big data provide new insights into dairy cow health?

S. Franceschini,[1]* C. Grelet,[2] J. Leblois,[3] [illegible] Gengler,[1] GplusE consortium,† and H. Soyeurt[1]
[1]University of Liège, Gembloux Agro-Bio Tech (ULiège-GxABT), 5030 Gembloux, Belgium
[2]Walloon Agricultural Research Center (CRA-W), 5030 Gembloux, Belgium
[3]Walloon Breeders Association Group (Elevéo by Awé group), 5590 Ciney, Belgium

Aim


Milk Mid-infrared (MIR) spectral
35 MIR-predicted traits
①
Unsupervised
hierarchical clustering
②
Four supervised
machine learning
③
Two supervised
Cow global health

Data

Whole dataset

- ✓ ~41 million records
- ✓ 17 breeds

mean+-3SD

Cleaned dataset

- ✓ ~28 million records
- ✓ 11 breeds

Sample dataset

- ✓ ~5.5 million records
- ✓ 11 breeds

Interreg Co-funded by the European Union
North-West Europe
HoliCow

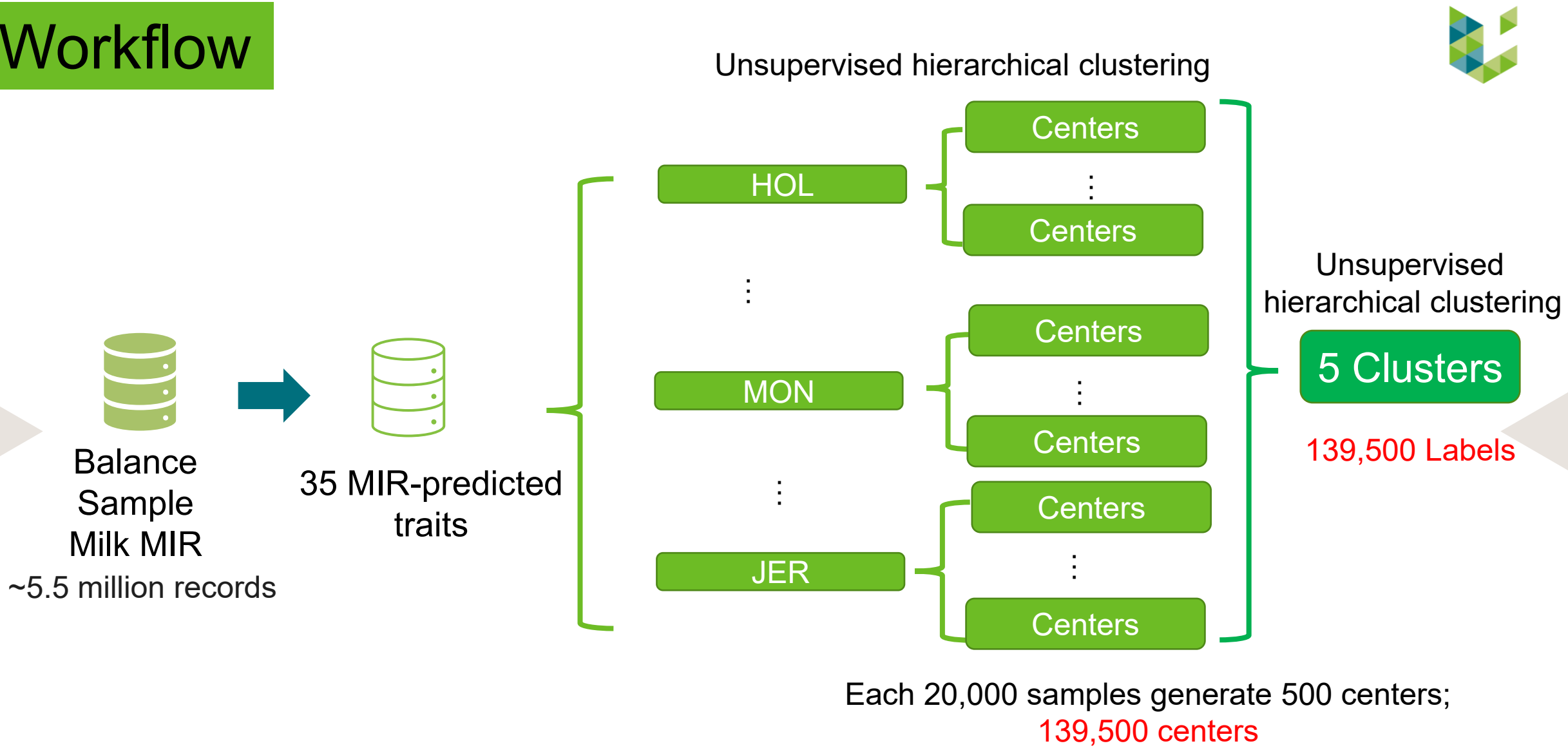
- ✓ **Environmental (2 traits)**
  - THI, Milk pH
- ✓ **Feeding (18 traits)**
  - Milk fat, protein, minerals…(15)
  - DMI, body weight, protein efficiency
- ✓ **Health (15 traits)**
  - Blood: NEFA, BHB, IGF-1…(6)
  - Milk: lactoferrin, citrate, acetone…(9)

MIR predicted models

- ✓ 300+

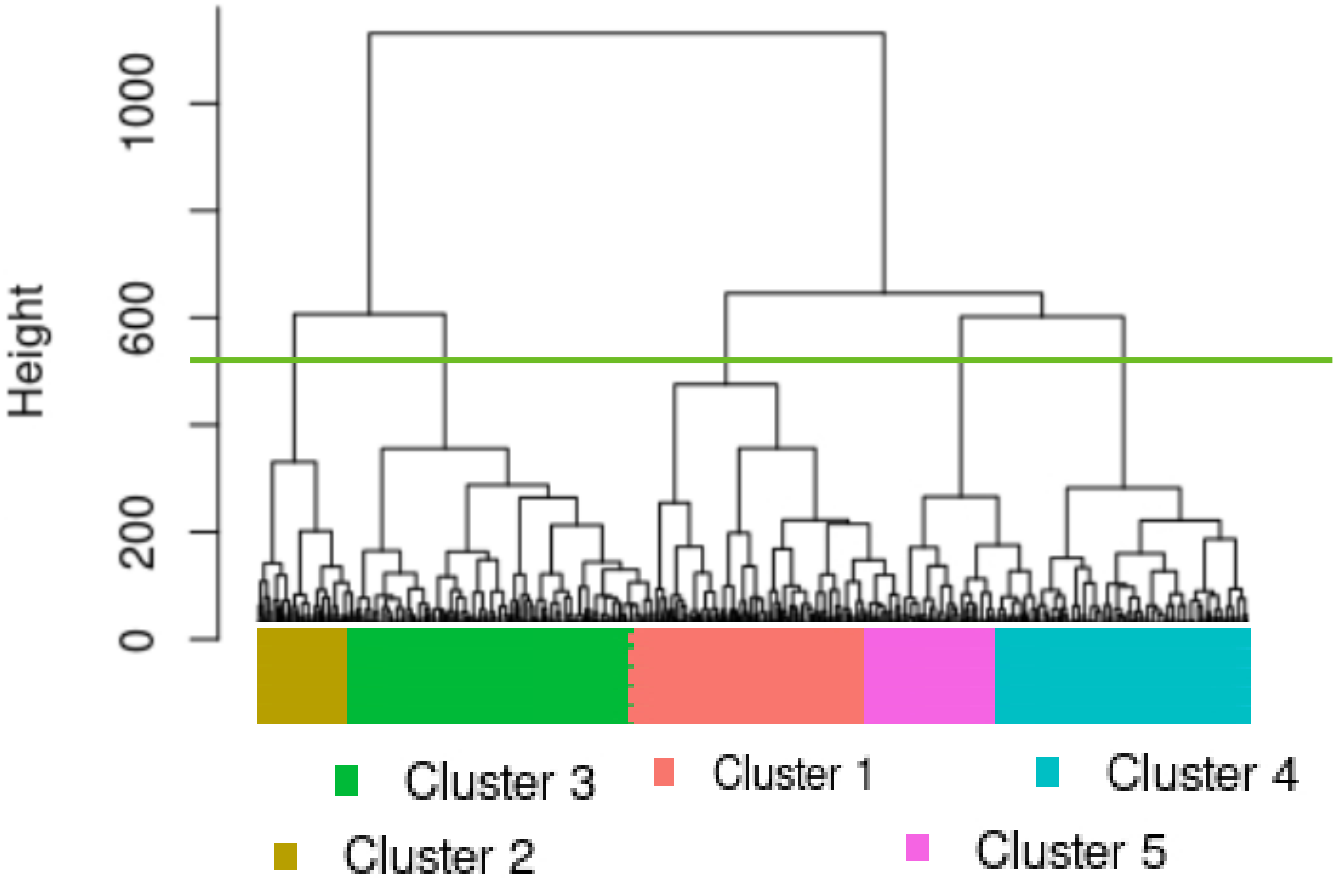
35 MIR predicted models

Workflow


Unsupervised hierarchical clustering
Balance
Sample
Milk MIR
~5.5 million records
35 MIR-predicted
traits
HOL
MON
JER
Centers
Centers
Centers
Centers
Centers
Centers
Unsupervised
hierarchical clustering
5 Clusters
139,500 Labels
Each 20,000 samples generate 500 centers;
139,500 centers

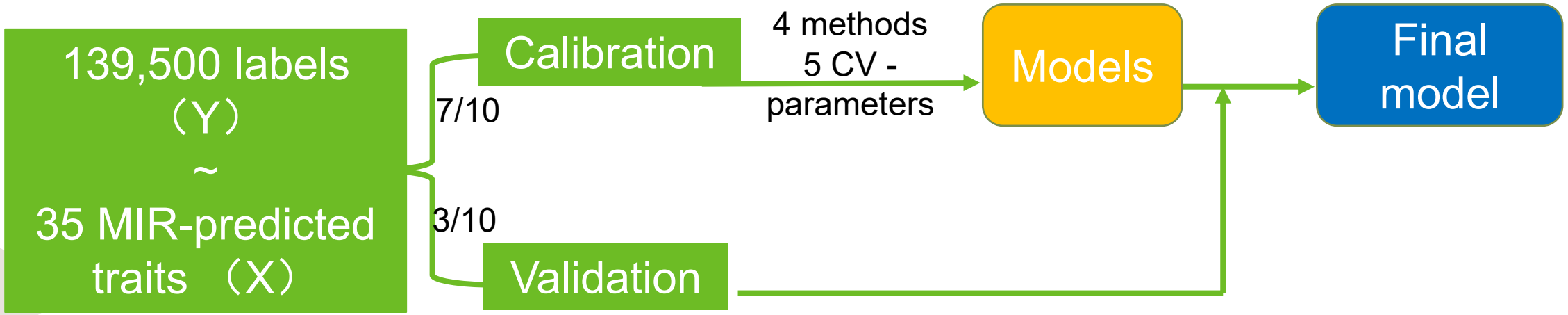
Results

Why chose 5 clusters



Results

35 MIR-predicted traits model



Method	SVM	NN	PLS-DA	RF
Calibration	0.73	0.80	0.70	0.83
Validation	0.74	0.80	0.70	0.83

SVM：Support Vector Machine；**NN**：Three-layer Feedforward Neural Network；**PLS-DA**：Partial Least Squares Discriminant Analysis; **RF**：Random Forest

Results

Cleaned dataset:~28 million (35 MIR-predicted traits model)

Cleaned dataset Milk MIR
~28 million records

35 MIR-predicted traits

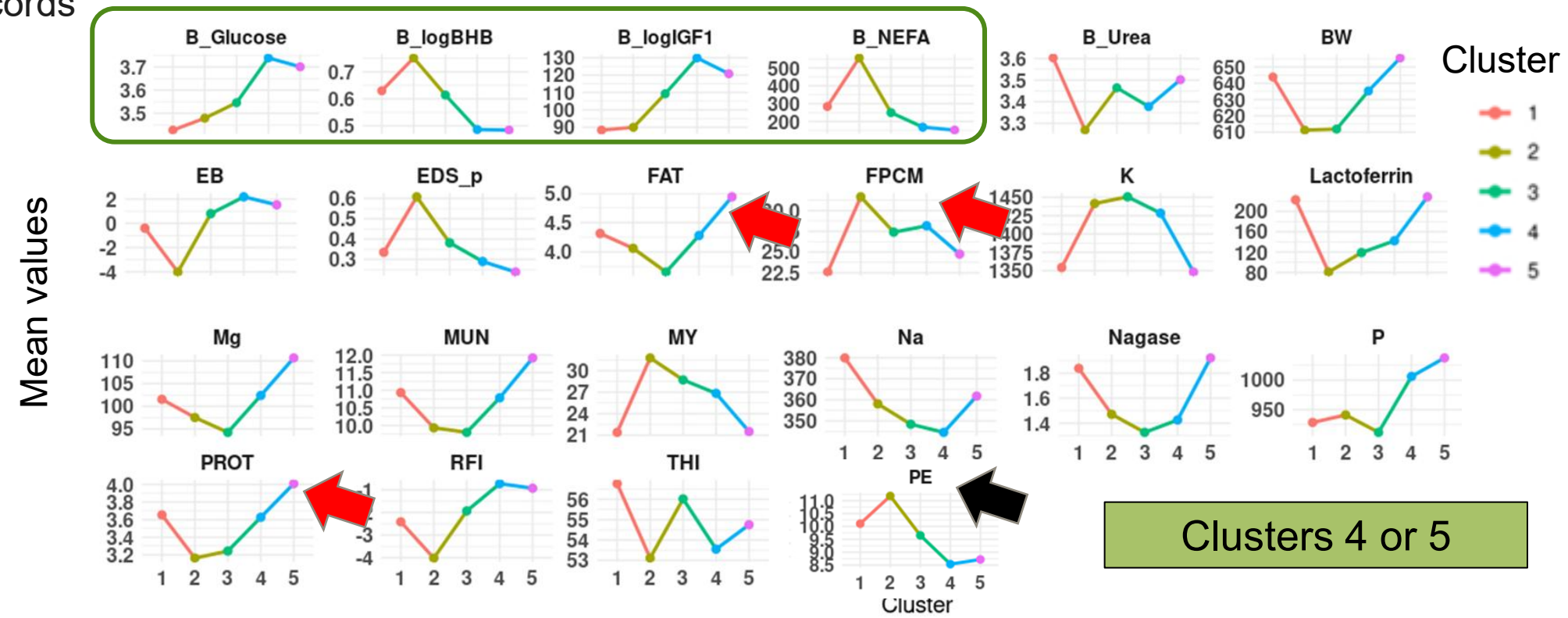
35 MIR-predicted model

5 clusters

~28 million records

Avarage

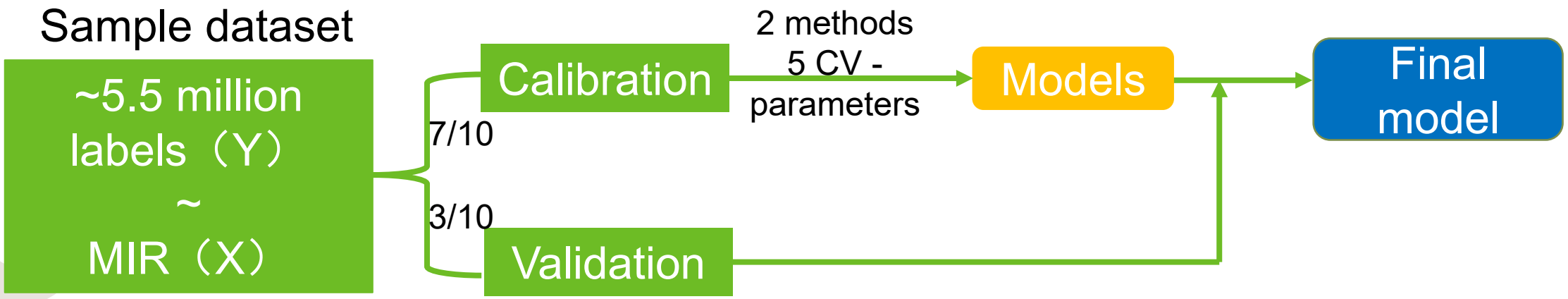
Mean each trait



Clusters 4 or 5

Results

Developing the MIR predicted model



Method	PLS-DA	RF
Calibration	0.70	0.83
Validation	0.70	0.83

PLS-DA：Partial Least Squares Discriminant Analysis; **RF**：Random Forest

Results

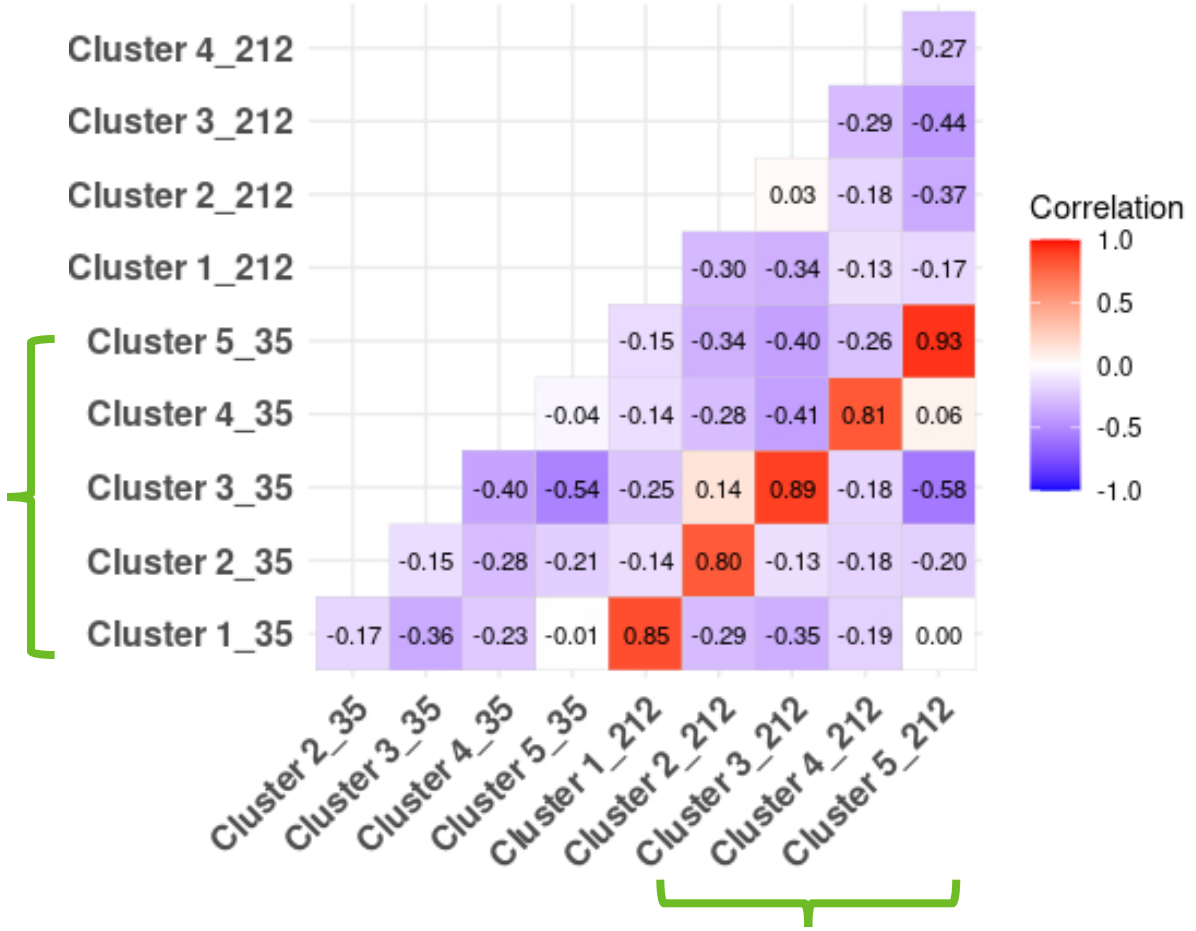
Validate the clusters based on reference data

Welfare Quality
Assessment protocol for dairy cows

ScorWelCow
（ D65-1420 ） project

Belgium:
1,870 Global health score (1-100) records

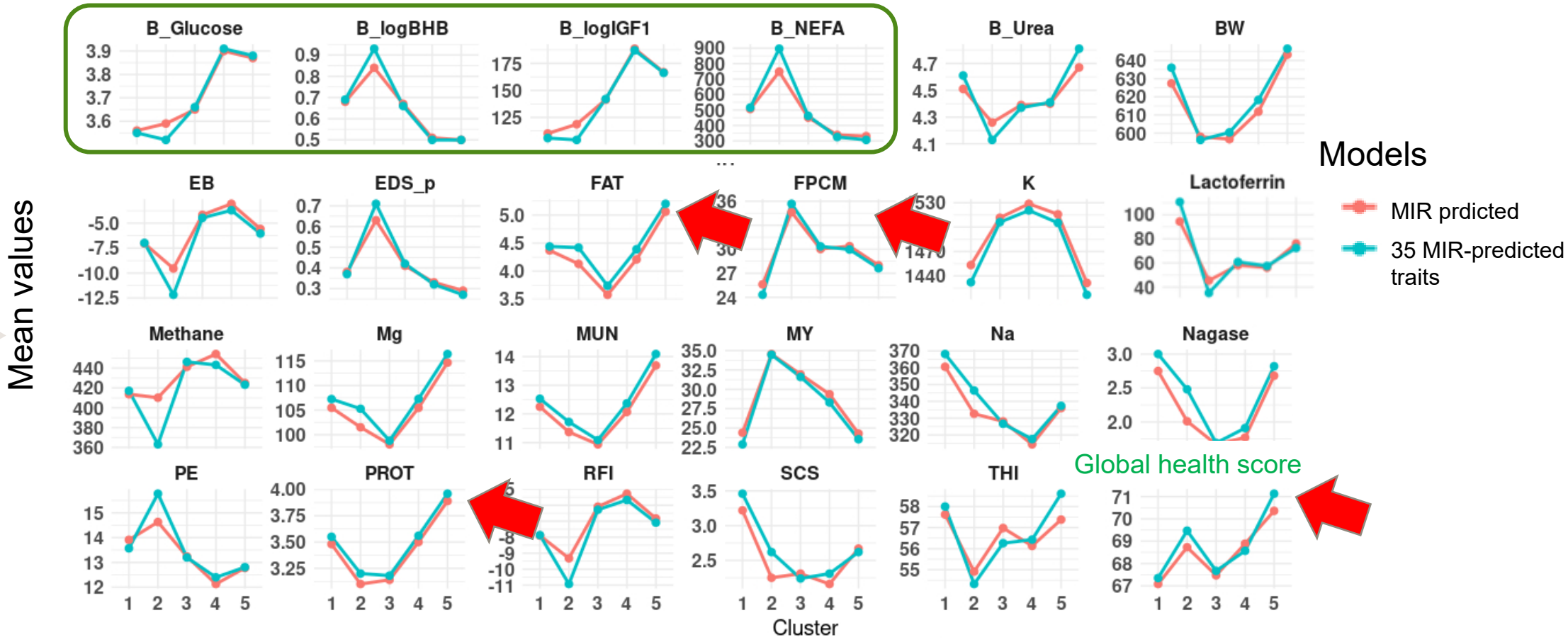
35 MIR-predicted traits model



MIR prdicted model

Results

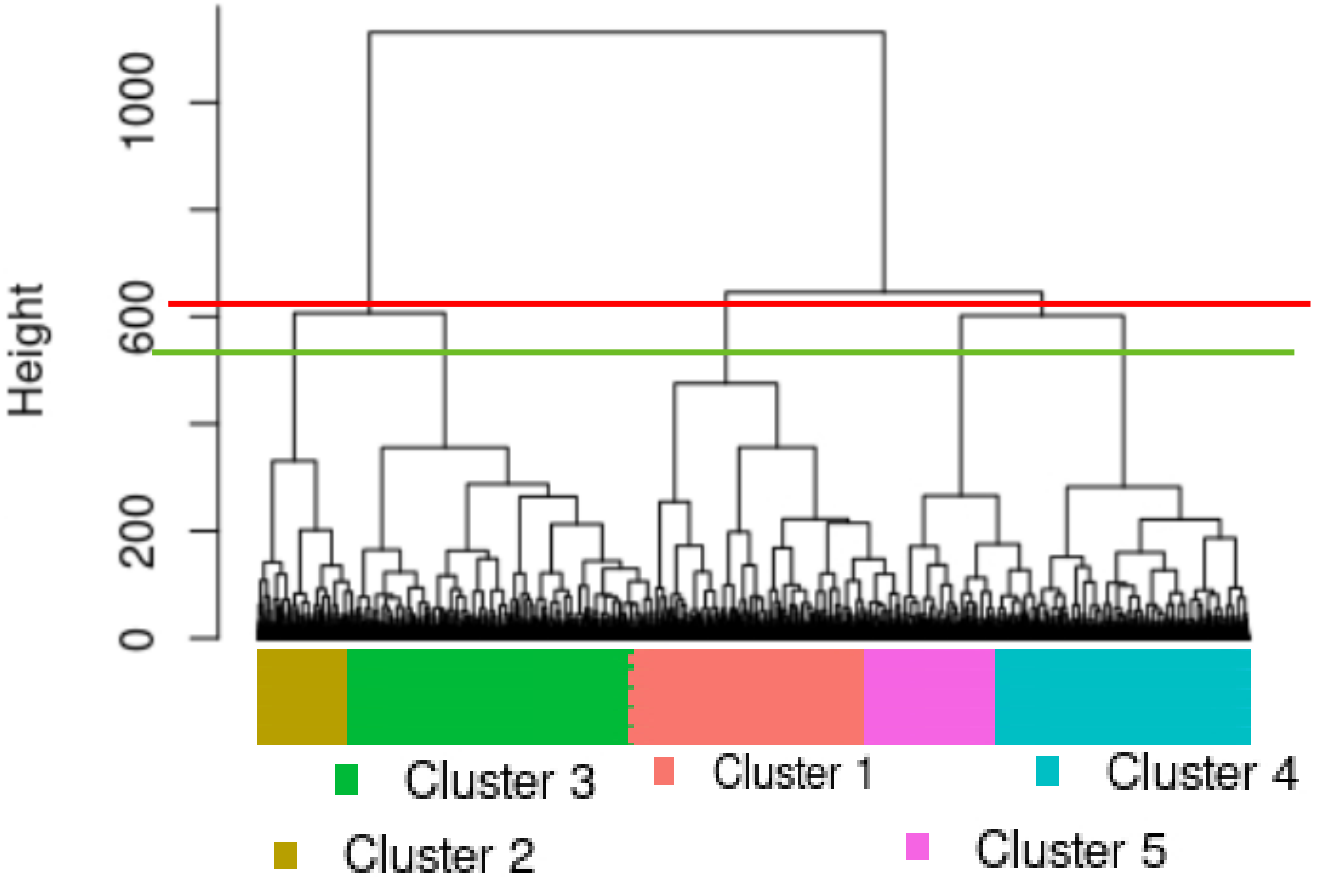
Validate the clusters based on reference data



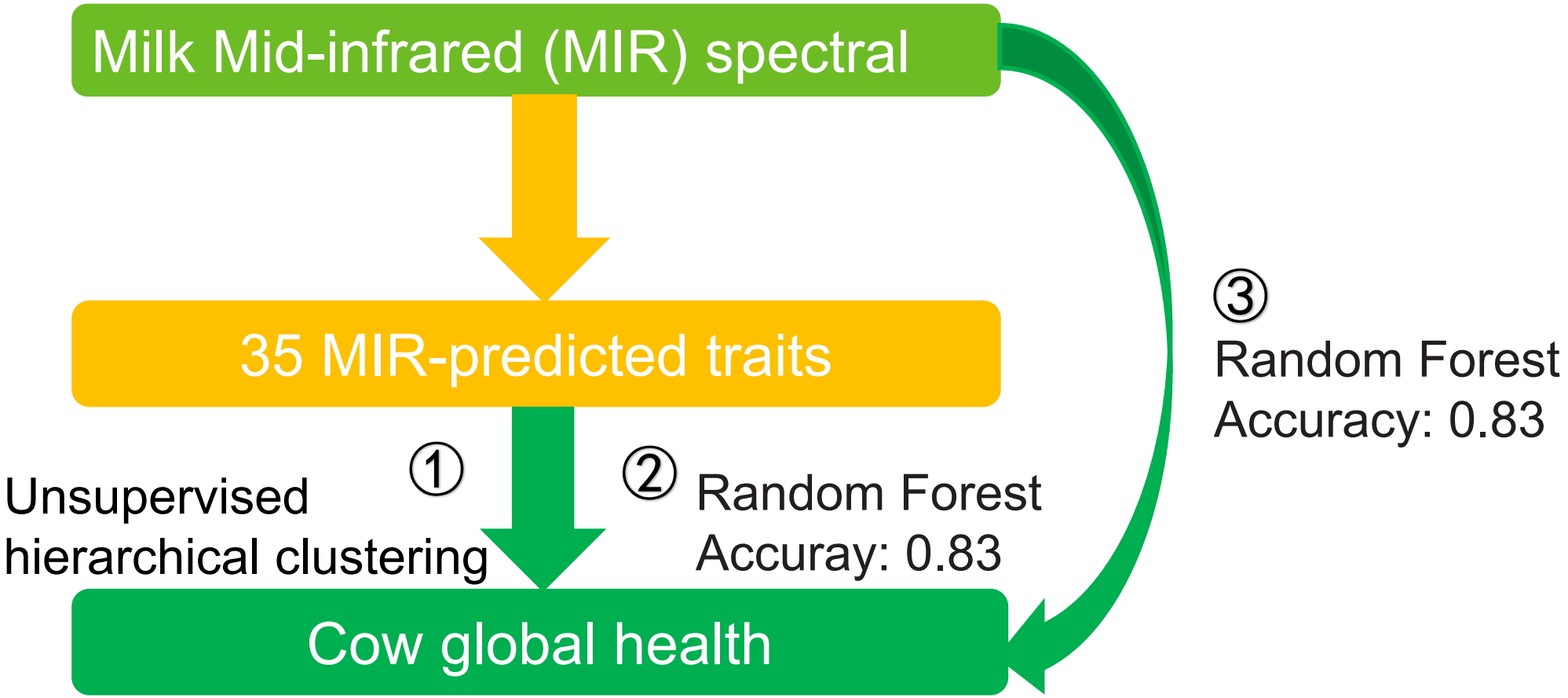
Clusters 4 or 5

Conclusions

Cluster 4 or 5: Global health (middle milk production and stable heath)



Conclusions



Interreg North-West Europe

Co-funded by the European Union

HoliCow

LIÈGE université Gembloux Agro-Bio Tech

Thank you for your attention!

Y. Chen, S. Franceschini, H. Atashi, C. Grelet, C. Nickmilder, P. Lemal, K. Wijnrocx, H. Soyeurt, Holicow Consortium, N. Gengler

yansen.chen@uliege.be

eleveo by awé
ensemble vers le meilleur élevage en Wallonie

Avec le soutien de la Wallonie

ScorWelCow
D65-1420