



ULiège-GxABT using sensor data to identify and exploit new behavioral phenotypes in dairy cows

Background:



LIÈGE université
Gembloux
Agro-Bio Tech

and



Activities of Nicolas Gengler's lab



From phenotyping to genomic evaluation: supporting breeding decisions for performance, sustainability and animal welfare

► Dairy cattle

- **Sensor-based welfare traits:** Development of new behavioral and welfare-related traits from sensor data, with a focus on genetic parameters and genomic prediction
- **Milk mid-infrared (MIR) spectra:** Large-scale phenotyping tools to predict novel traits related to milk composition, efficiency, health, welfare and the environmental impact
- **Heat stress and thermotolerance:** Identification of indicators of heat stress using sensor, milk MIR spectra, health and production data to support selection for more resilient dairy cows

► Piétrain genetic evaluations

- Genomic evaluations of Piétrain boars on crossbred (Landrace) in Wallonia for growth, feed efficiency and carcass quality, with a focus on boar taint

► Dairy & dual-purpose cattle evaluations

- Routine regional and international genomic evaluations for Holstein and dual-purpose cattle, including INTERBULL/MACE, breed assignment and transition toward Single-Step

AMS-derived behavioral phenotypes: USA–Wallonia Collaboration

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Research Objectives

Derive new **behavioral traits** based on **AMS data**



→ Evaluation of the **variability** of these traits throughout **lactation**

(Co-)variance components estimation based on **genomics**

→ Estimation of **genetic parameters** (h^2 and **repeatability**)

→ Calculation of **genetic correlations**

→ Including in breeding programs for greater **sustainability**?

→ Opportunity for Walloon farmers ?



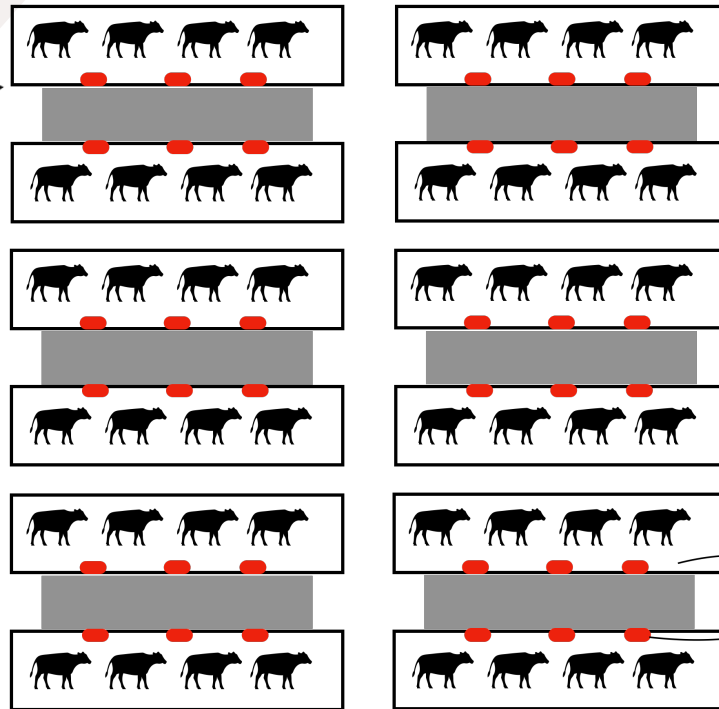
Trait Definition

Seven behavioral traits based in AMS :

- ▶ Average milking time (**AMT**)
- ▶ Total milking time (**TMT**)
- ▶ Milking time interval (**INT**)
- ▶ Number of visits (**NoV**)
- ▶ Number of successful entries (**NSE**)
- ▶ Percentage of successful milking (**PSM**)
- ▶ Preference consistency score (**PCS**)



Phenotypic Dataset



• 5,645 cows



7,136,116
phenotypic records

• 12 pens



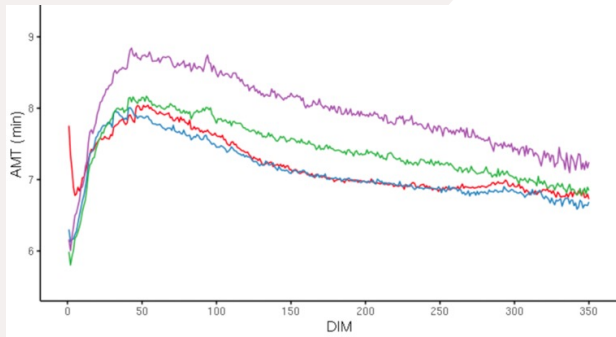
36 AMS
(3 per pen)

Pen
AMS

Phenotypic Distribution

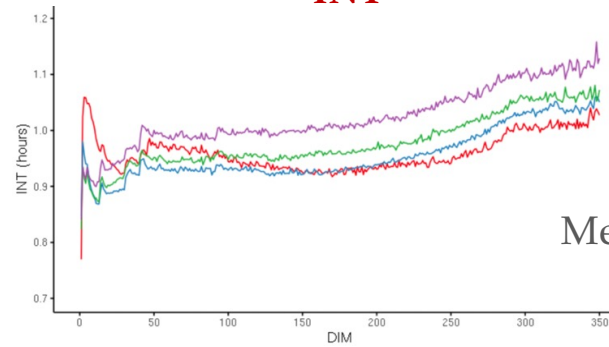


AMT



Mean = 7.23 min

INT

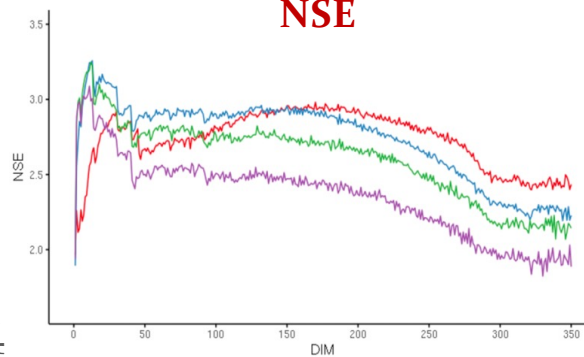


Mean = 8.5 hr

Parity

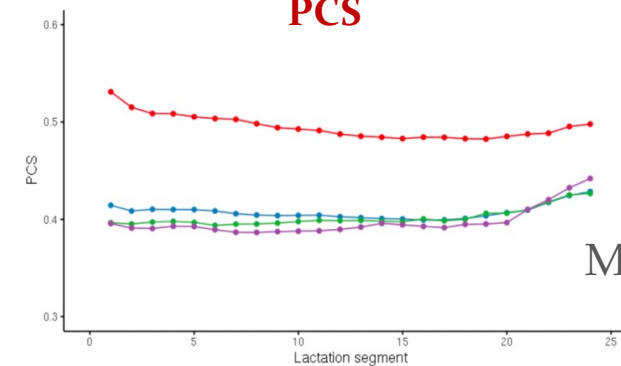
- 1
- 2
- 3
- 4+

NSE



Mean = 2.84

PCS



Mean = 0.42

Genetic Parameters

TRAITS	h^2
AMT	0.46 ± 0.02
TMT	0.27 ± 0.01
INT	0.08 ± 0.01
NoV	0.10 ± 0.01
NSE	0.10 ± 0.01
PSM	0.05 ± 0.01
PCS	0.09 ± 0.01


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Investigating the genetic background of novel behavioral indicators of robotic milking efficiency in North American Holstein cattle

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AI-generated image

Heritabilities and Genetic Correlations



Traits*	AMT	TMT	INT	NoV	NSE	PSM	PCS
AMT	0.46	0.84 ± 0.02	0.24 ± 0.05	-0.36 ± 0.01	-0.34 ± 0.05	0.38 ± 0.05	-0.045 ± 0.06
TMT	-	0.27	-0.26 ± 0.05	0.12 ± 0.05	0.22 ± 0.05	0.012 ± 0.06	-0.20 ± 0.07
INT	-	-	0.08	-0.90 ± 0.02	-0.98 ± 0.05	0.71 ± 0.04	0.50 ± 0.06
NoV	-	-	-	0.10	0.92 ± 0.01	-0.94 ± 0.01	-0.44 ± 0.06
NSE	-	-	-	-	0.10	-0.72 ± 0.04	-0.35 ± 0.07
PSM	-	-	-	-	-	0.05	0.37 ± 0.07
PCS	-	-	-	-	-	-	0.09

h^2 on the diagonal ; r_g above



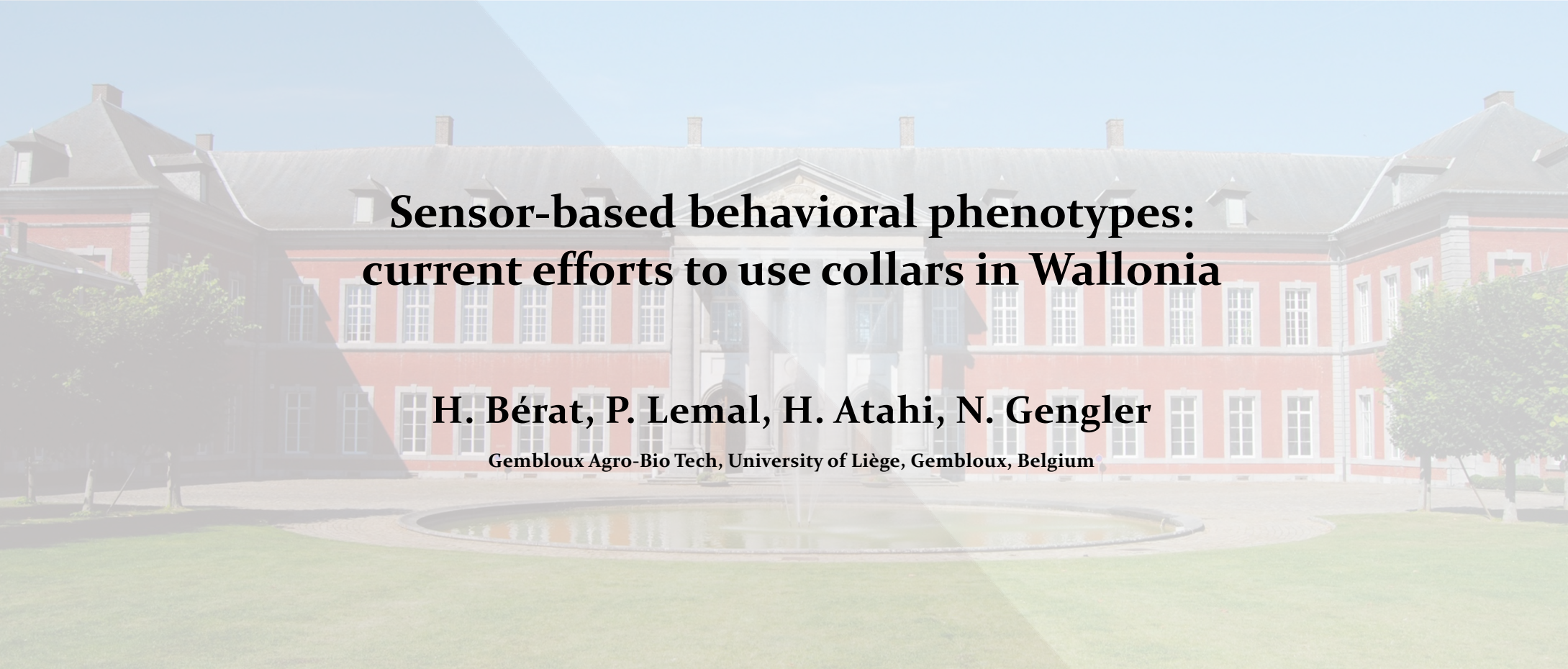
Conclusions

- ▶ Novel indicators for precision breeding can be derived from AMS
- ▶ Genomic selection is feasible for behavioral traits
- ▶ Behavioral phenotypes can enhance breeding objectives
- ▶ Selection for more, adapted, resilient and efficient cows

Next Steps and Perspectives

- ▶ Deriving SNP effects → generate DGV
- ▶ NEEDS to be solved: combining genomic data across populations*
- ▶ When available → Walloon Farmers and Breeders ← **W^ALLeSmart**

*Renzo Bonifazi "[Guidelines on combining genomic data across populations](#)" at ICAR-INTERBULL 2026 Meeting



Sensor-based behavioral phenotypes: current efforts to use collars in Wallonia

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Valorization of data from Walloon sensors



Currently available dataset ← agreement with 6 farmers

- Two record files: 2024 and 2025 SenseHub monitoring data
- Data collected from 6 farms
- Total population: 319 animals

Raw Monitoring Data

```
EXPL;ID_ANI;DATE_ACTIVITE;CD_ACTIVITE;VALEUR
614670;15729514;01-01-24 00:00;DailyRumination;504
614670;15729514;01-01-24 00:00;DailyEating;287
614670;15729514;01-01-24 00:00;ActivityTrend;288,95
614670;16279474;01-01-24 00:00;DailyRumination;589
614670;16279474;01-01-24 00:00;ActivityTrend;287,5
614670;16279474;01-01-24 00:00;DailyEating;238
614670;16327096;01-01-24 00:00;ActivityTrend;252
614670;16327096;01-01-24 00:00;DailyEating;245
614670;16327096;01-01-24 00:00;DailyRumination;594
```

Recorded traits



AI-generated image

Data structure at the beginning

- One line = one animal × one date × one activity trait
- Main variables: farm ID, animal ID, date, trait and the recorded value

Interest

These longitudinal sensor data can be used to describe individual behavioral patterns, monitor changes over time, and derive new indicators related to activity, feeding behavior and rumination ← heat-stress

Sensors and Heat-Stress Research



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Estimation of genetic parameters and single-step genome-wide association studies for eating time and rumination time in Holstein dairy cows

Hadi Atashi,^{1,2*}  Pauline Lemal,¹  Marie-Nguyet Tran,³ and Nicolas Gengler¹ 



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2024; 5:368–373

<https://doi.org/10.3168/jdsc.2023-0421>
Short Communication
Genetics

Adding behavior traits to select for heat tolerance in dairy cattle

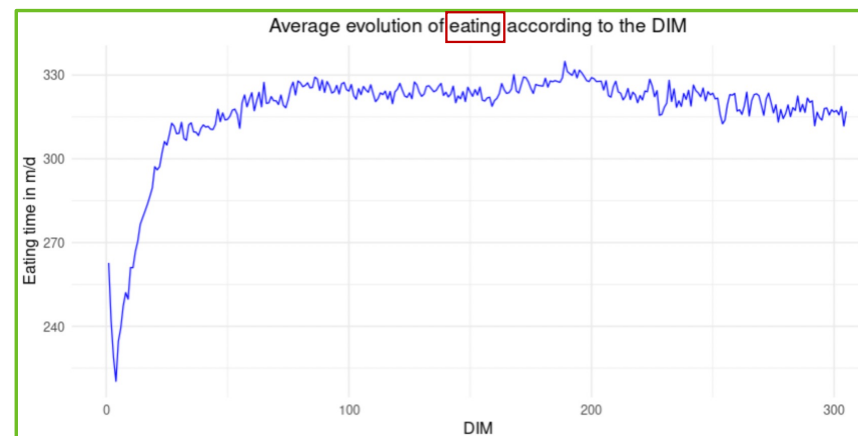
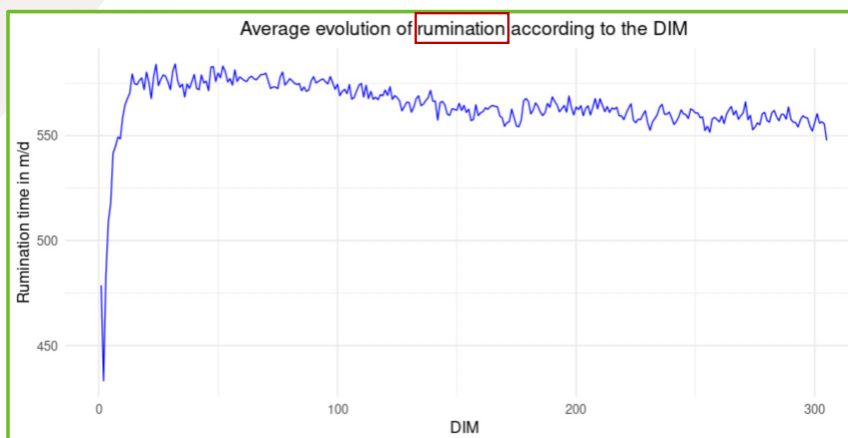
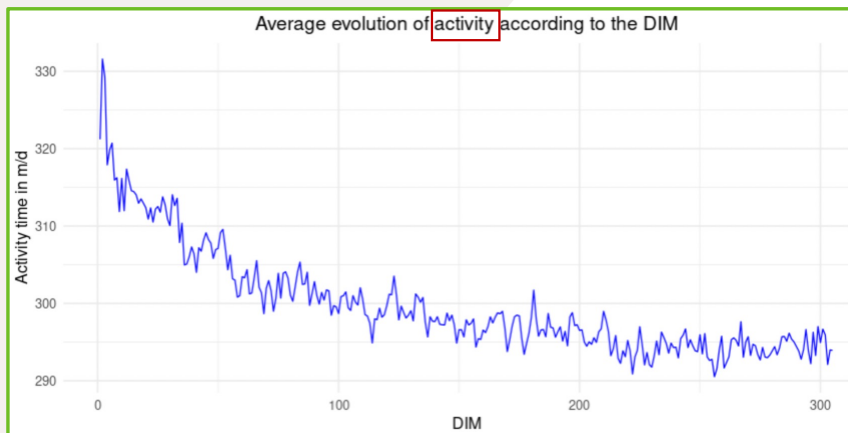
P. Lemal,^{1*}  M-N. Tran,² H. Atashi,^{1,3}  M. Schroyen,¹  and N. Gengler¹ 

Phenotypic evolution of sensor-derived traits across lactation



Reminder:

- 6 farms, 319 animals
- 2024–2025 SenseHub records, DIM 5–305

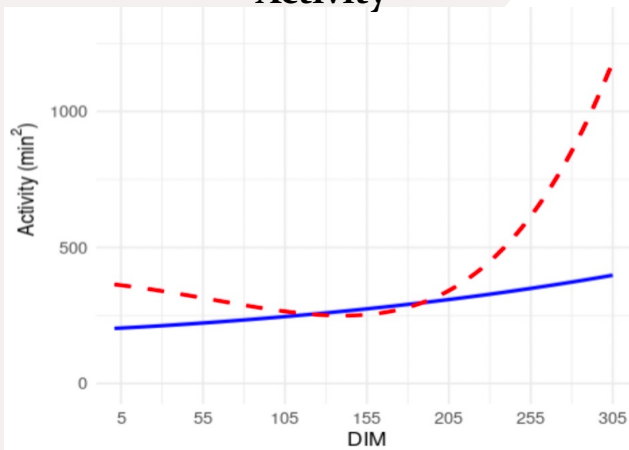


Trait	Mean	SD
Activity (min/d)	299.2	43.8
Rumination (min/d)	565.5	80.6
Eating (min/d)	320.1	87.5

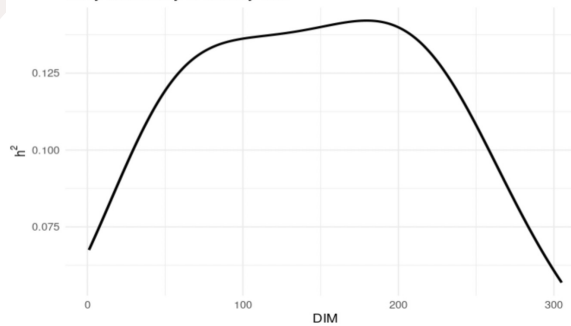
Variance components and heritability across lactation



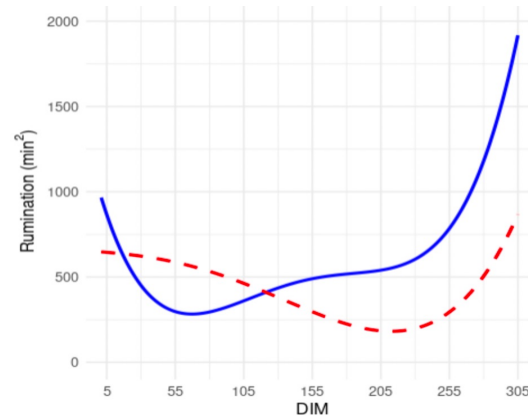
Activity



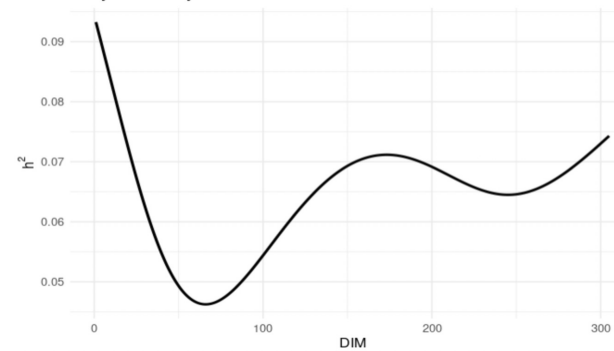
Daily heritability of activity trait



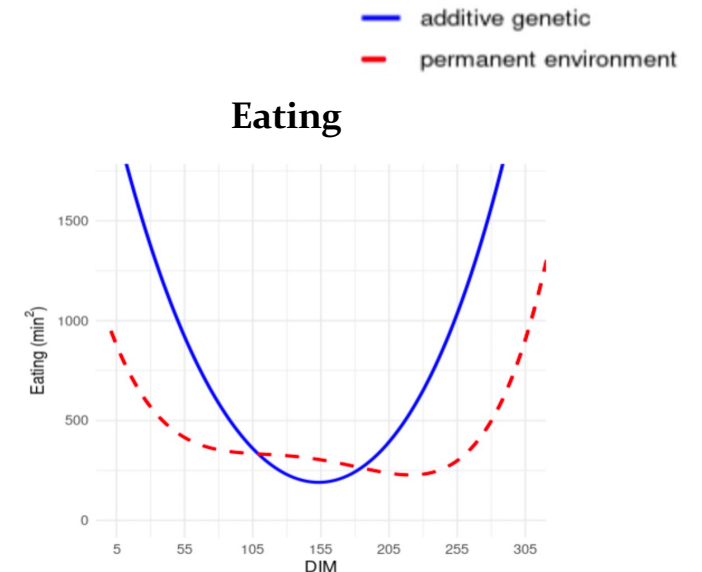
Rumination



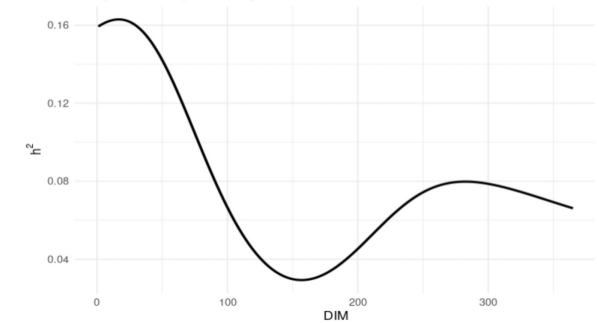
Daily heritability of rumination trait



Eating



Daily heritability of eating trait





Conclusions

- ▶ Currently available datasets small → but rapid extension possible
- ▶ Already showed their interest in context of heat-stress
- ▶ Able to **describe individual behavioral patterns**, monitor changes over time, and derive new indicators (needed)
- ▶ Very **complementary** to our access to large scale milk **MIR** mid-infrared data
→ MIR only once every 4 or 6 weeks

Next Steps and Perspectives

- ▶ Accumulating more data, including international level
- ▶ Developing appropriate models → GEBV → SNP effects → DGV
then DGV → Farmers and Breeders ← **W^ALLeSmart**



Thank you for your attention