Description of the impacts of acute heat stress on dairy cows

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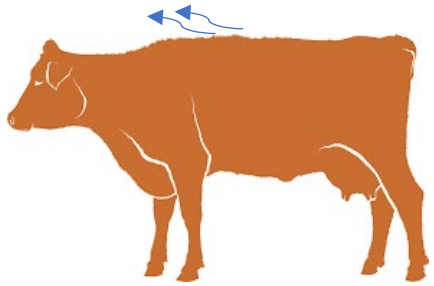
Ferme expérimentale Les Trinottières

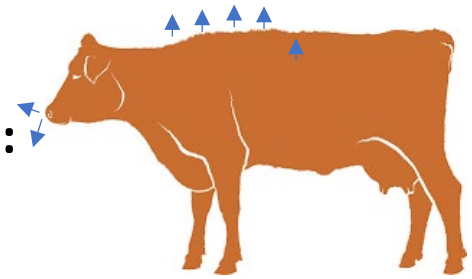
Cows' adaptation to acute Heat Stress (aHS)

Convection :



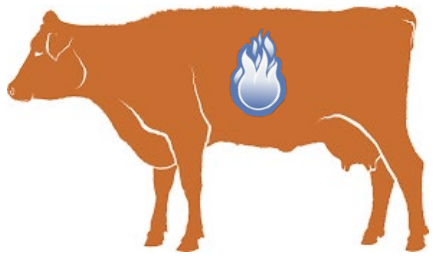
- Increased cardiac rhythm
- Increased blood flow to extremities
- Increased standing time (at the expense of rest time)

Evaporation :



- Sweating (75 %)
- Panting (25%)
- Increased water intake

Reduction of internal heat production :



- Decreased DMI
- Decreased milk production
- Decreased activity
- Decreased immune function …

→ Reduction of physiological functions

Shepard and Maloney, 2023 ; Cartwright et al., 2023

Explore cows' adaptation profiles to aHS

- Inter-individual variability in the implementation of these regulatory mechanisms

→Varying impacts on cow' **welfare** and on **livestock systems**

Objectives:
1 - Carry out a multi-criteria assessment of dairy cows' adaptation to aHS
2 - Classify cows according to their response, to reflect diversity

Experimental scheme

- Longitudinal monitoring of Holstein cows during 1 lactation
- 24 cows (12 primi -12 multiparous) in 2021/2022
  Milk = 25kg/d
- Natural heat stress during late lactation (focus on June – dry off in July)
- Indoors during the day / Pasture during the night (no competition for shade)

Measurements and Data analysis

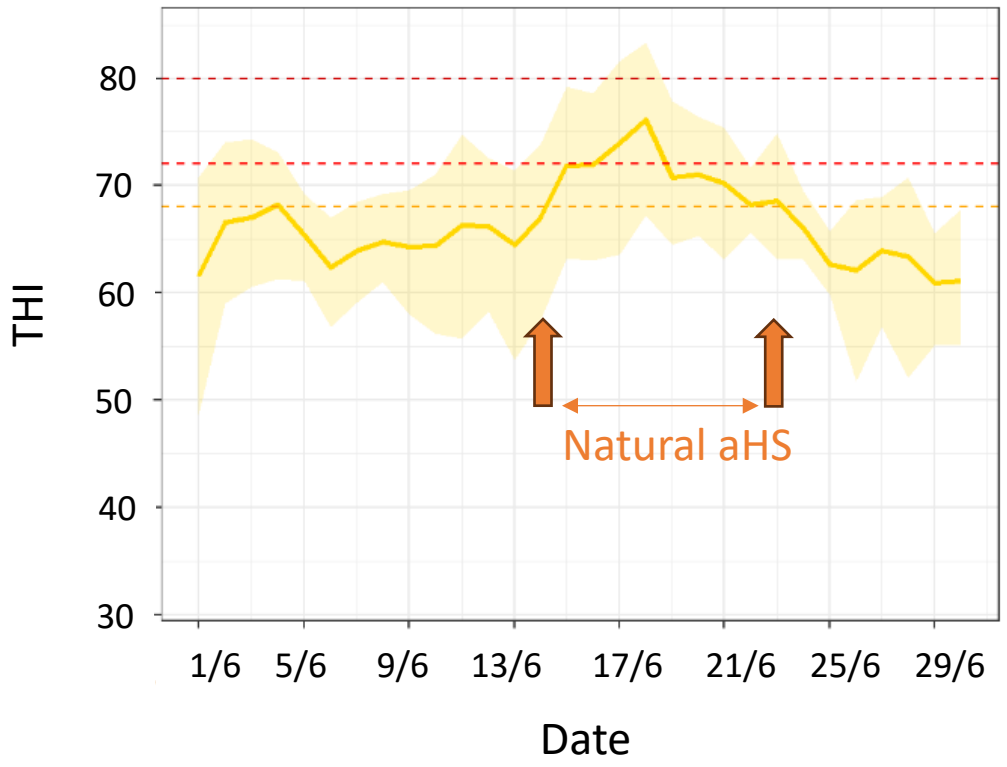
- Environmental indicator : **THI** = 0,8 Ta + RH/100*(Ta-14,4) + 46,4
- Cow-centred indicators :

Indicators	Methods	Timing
Time budget (rumination, ingestion, resting, panting, overactivity)	Collars activimeters	Continuous
Ruminal temperature	Thermobolus	Continuous
Milk production	Milk meters	2x/d
Milk composition	IR spectrometry	2x/w
Weight + BCS at dry-off	Scale, BCS scoring	1x/d +
S-thyroxin, s-NEFA, s-Cortisol	Radioimmunology and biochemistry	Heat wave (3 time points)
IGG colostrum	IDR	Calving
Veal weight	Scale	Calving

- Data analysis: PCA, HAC with k-means adjustment, clusters' characterisation by all variables

*(Mader et al., 2006)

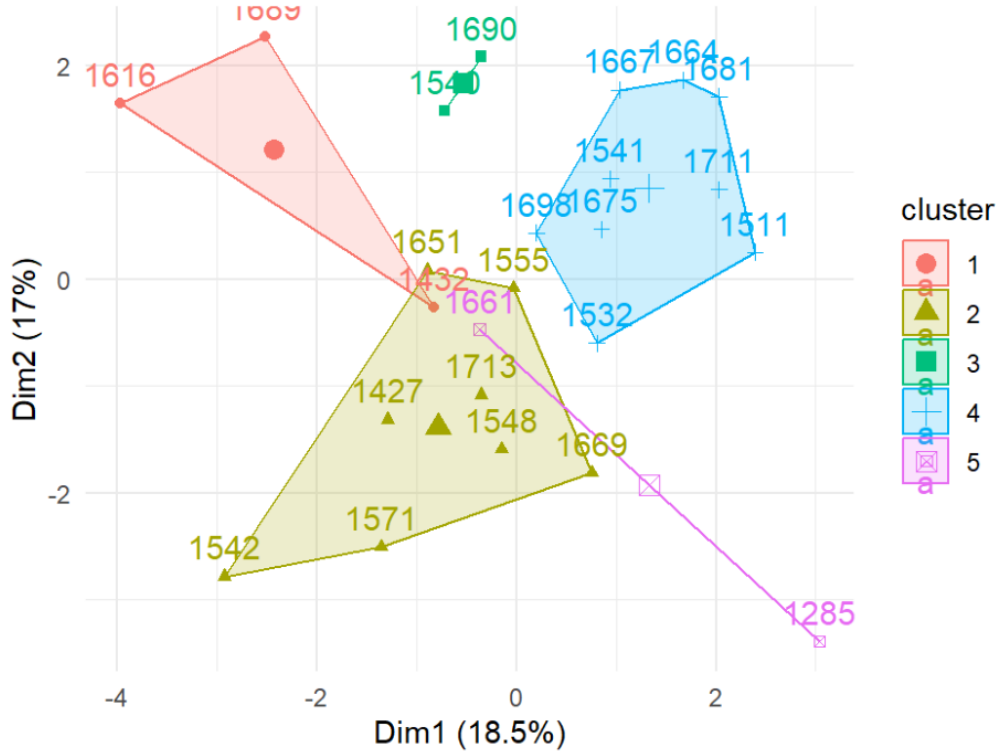
Weather conditions in June 2022

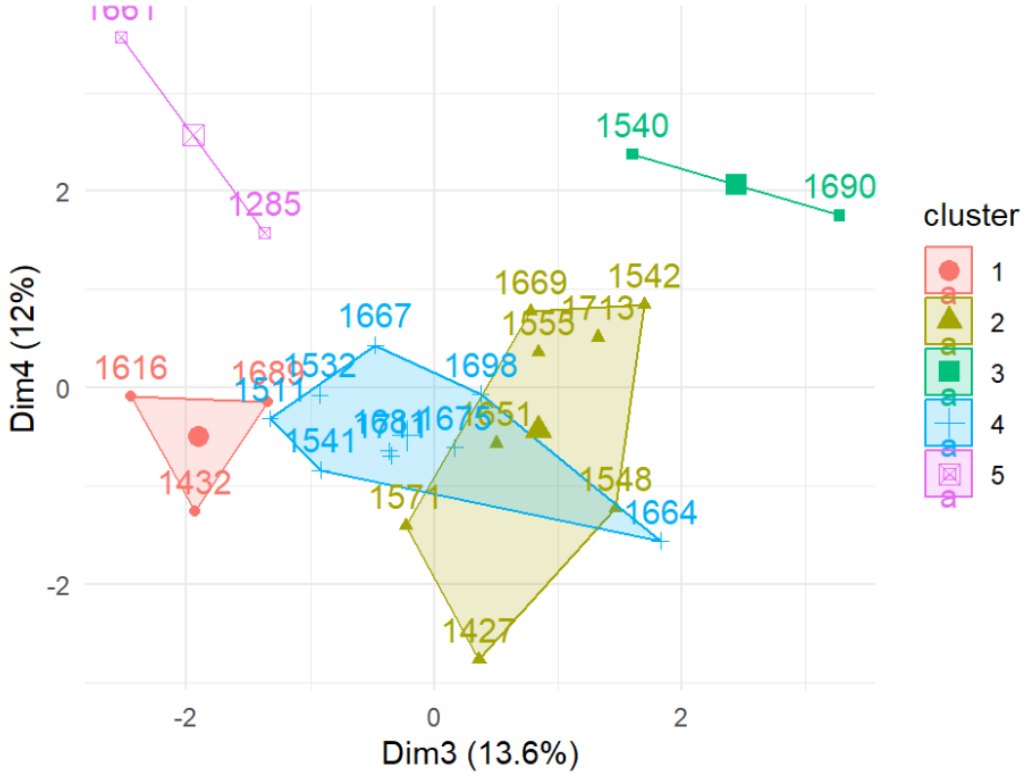


Ranges of THI (av. 24h)	Nb of days
0-67 – no HS	20
68-72 – slight HS	8
72-80 – moderate HS	2

- Textbook case to study cows' response to acute HS : one heat wave easy to identify
- References:
  TN conditions *before* HS = 12-14/06
  HS = 17-19/06
  TN conditions *after* HS = 23-25/06

Diversity of cows 'response to aHS





Diversity of cows 'response to aHS

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Homeothermy	Ruminal T °C	+0,35	+0,35	+0,4	+0,25	+0,20

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Convection	Resting (min/d)	=	-36	=	-36	- 48

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	Rumination (min/d)	- 24	-48	-48	=	- 12
	Veal Weight	=	=	=	=	=
	IGG colostrum	=	=	--	=	=
	Cortisol	=	=	=	=	++

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	Veal Weight	=	=	=	=	=
	IGG colostrum	=	=	--	=	=
	Cortisol	=	=	=	=	++

Characterization of cows in Cluster 2 and 4

	Cluster 2	Cluster 4	*P*-value
Parity	1,75 (+/- 0,7)	1,3 (+/-0,5)	0,35
Weight at dry-off (kg)	720 (+/- 45)	660 (+/- 45)	0,02
Milk210 yield (kg/d)	28 (+/- 2,8)	28 (+/- 4,8)	NS
Fat210 (g/kg)	45,8 (+/- 4.1)	42 (+/- 3.6)	0,08
Protein210 (g/kg)	34,9 (+/- 2.1)	32,7 (+/-0.8)	0,24

Take home messages and perspectives

- Multi-criteria thermotolerance phenotyping
- Enlarge the study to more cows, more contexts, and focusing on other functions like reproduction, health …to better capture all trades-off when coping with HS
- Coming soon : intergenerational study on the impacts of late gestation HS on the progeny with epigenetics insights (INRAE BREED)

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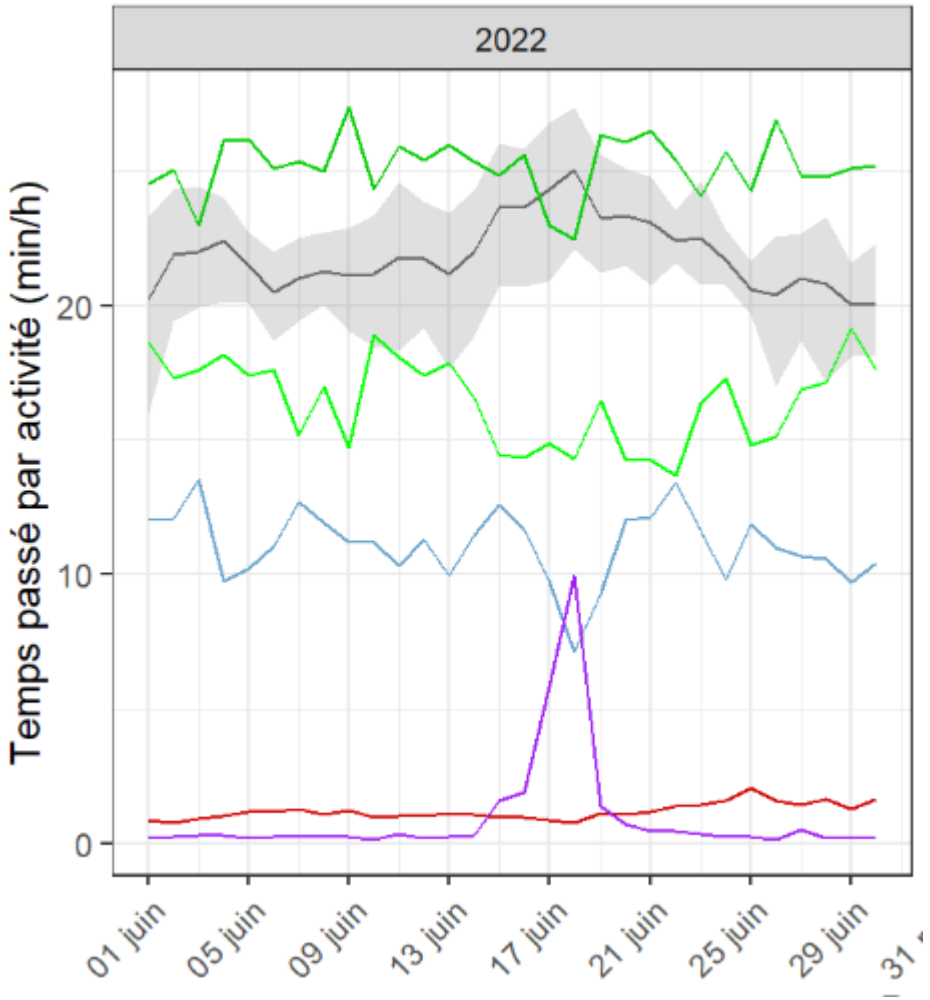
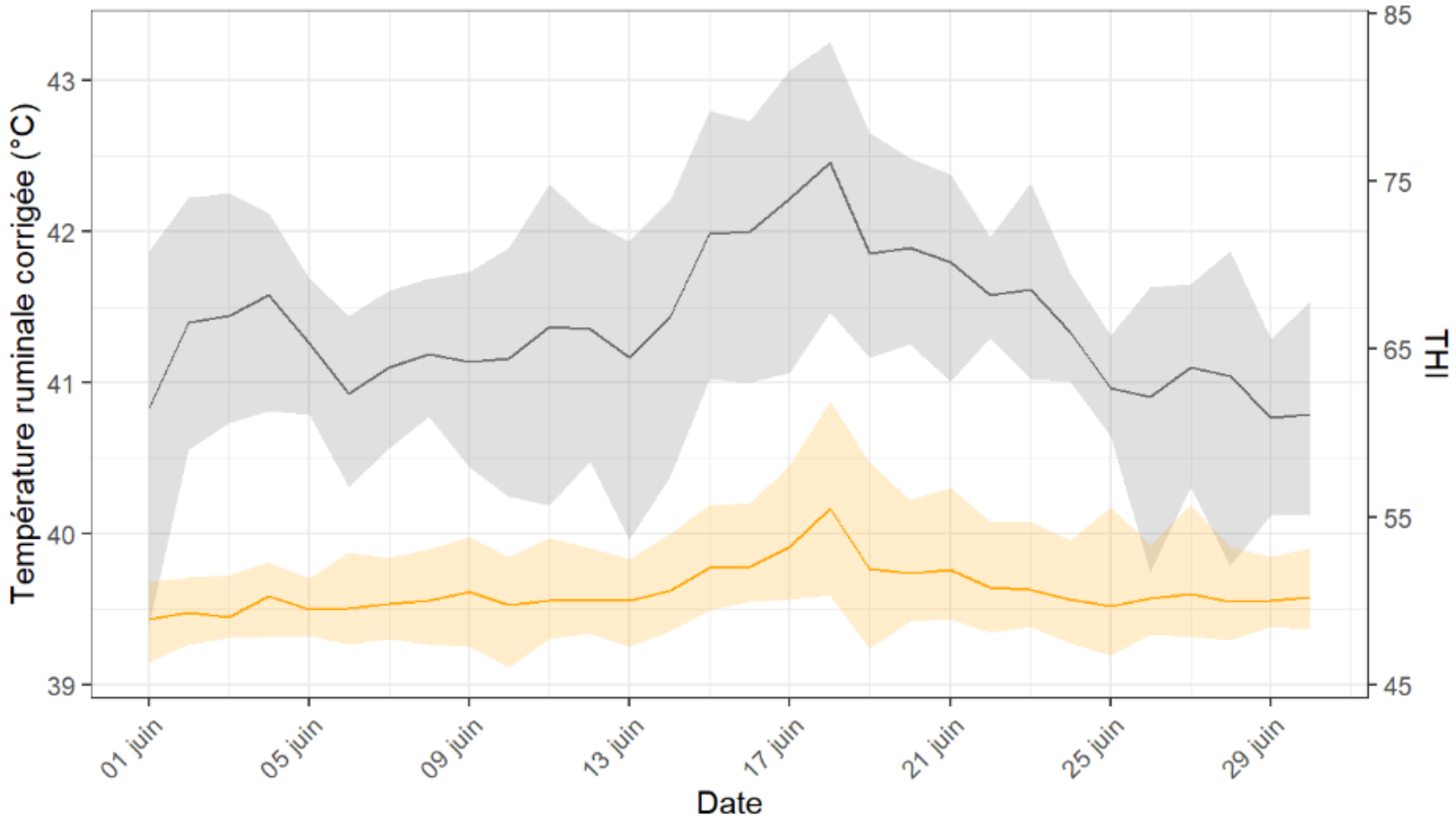
Extra-slides



- en vert foncé : la rumination
- en vert clair : l'ingestion
- en bleu clair : le repos
- en rouge : l'activité élevée
- en violet : le halètement

Extra slides



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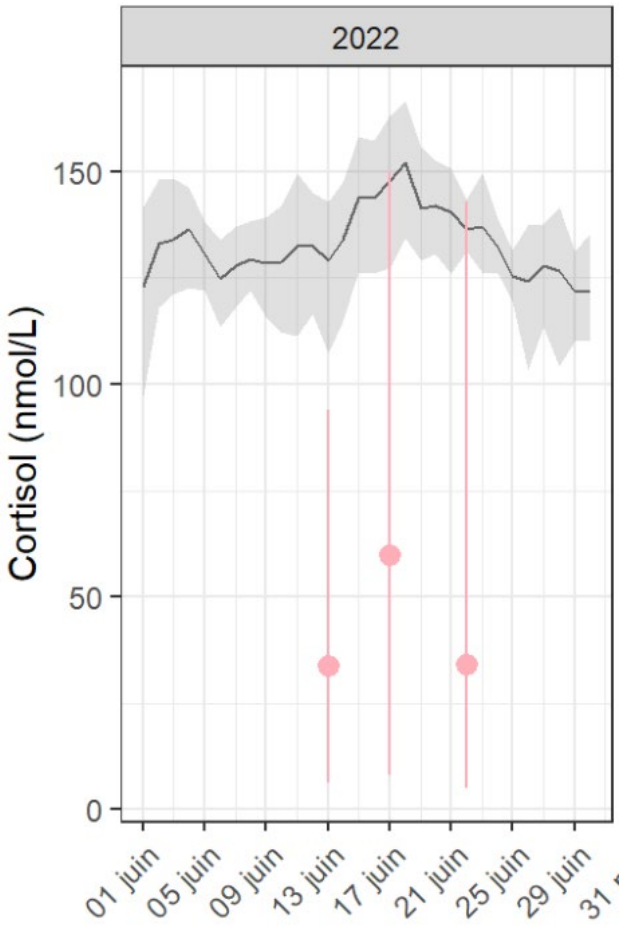

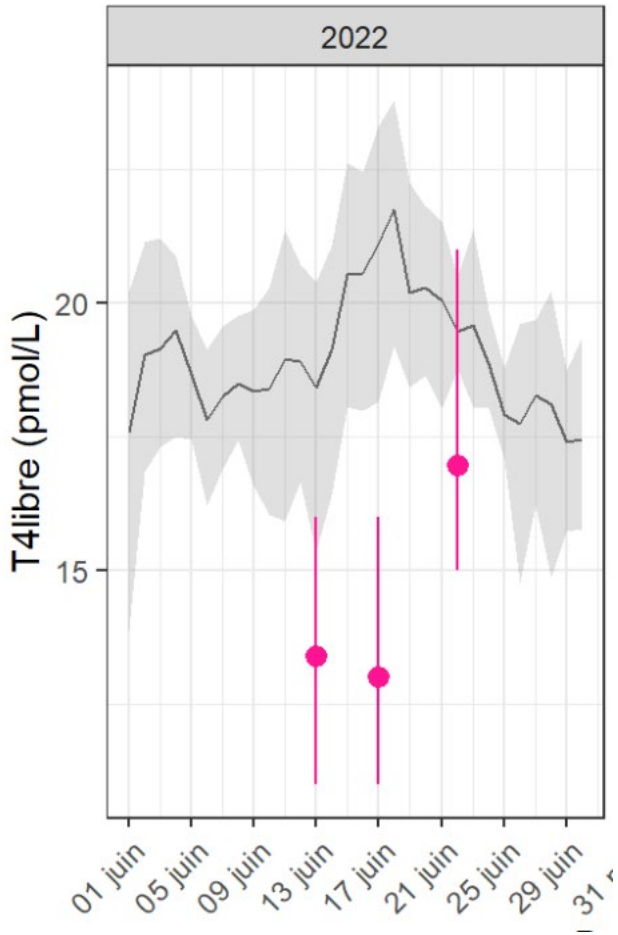

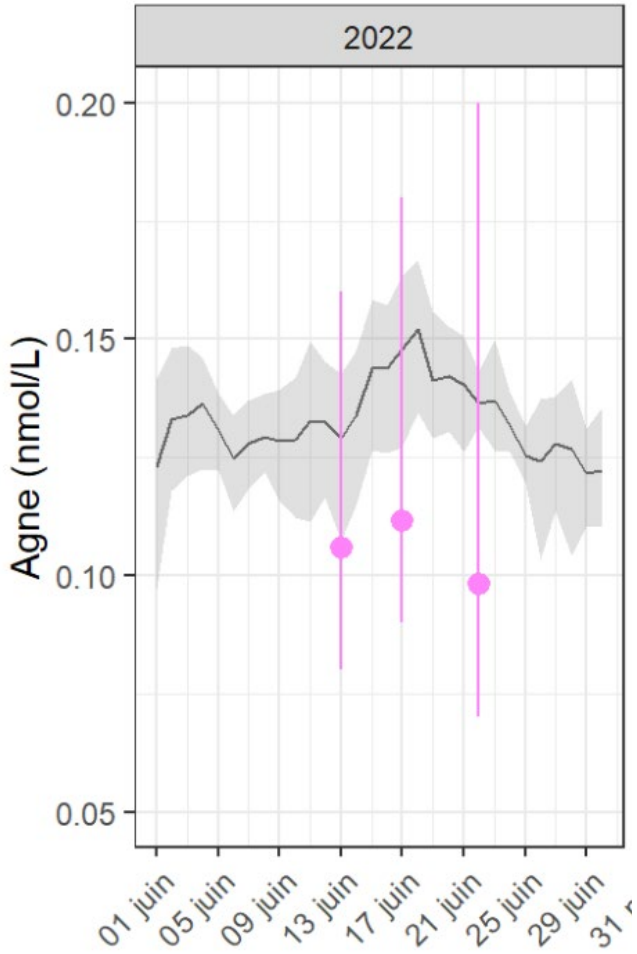

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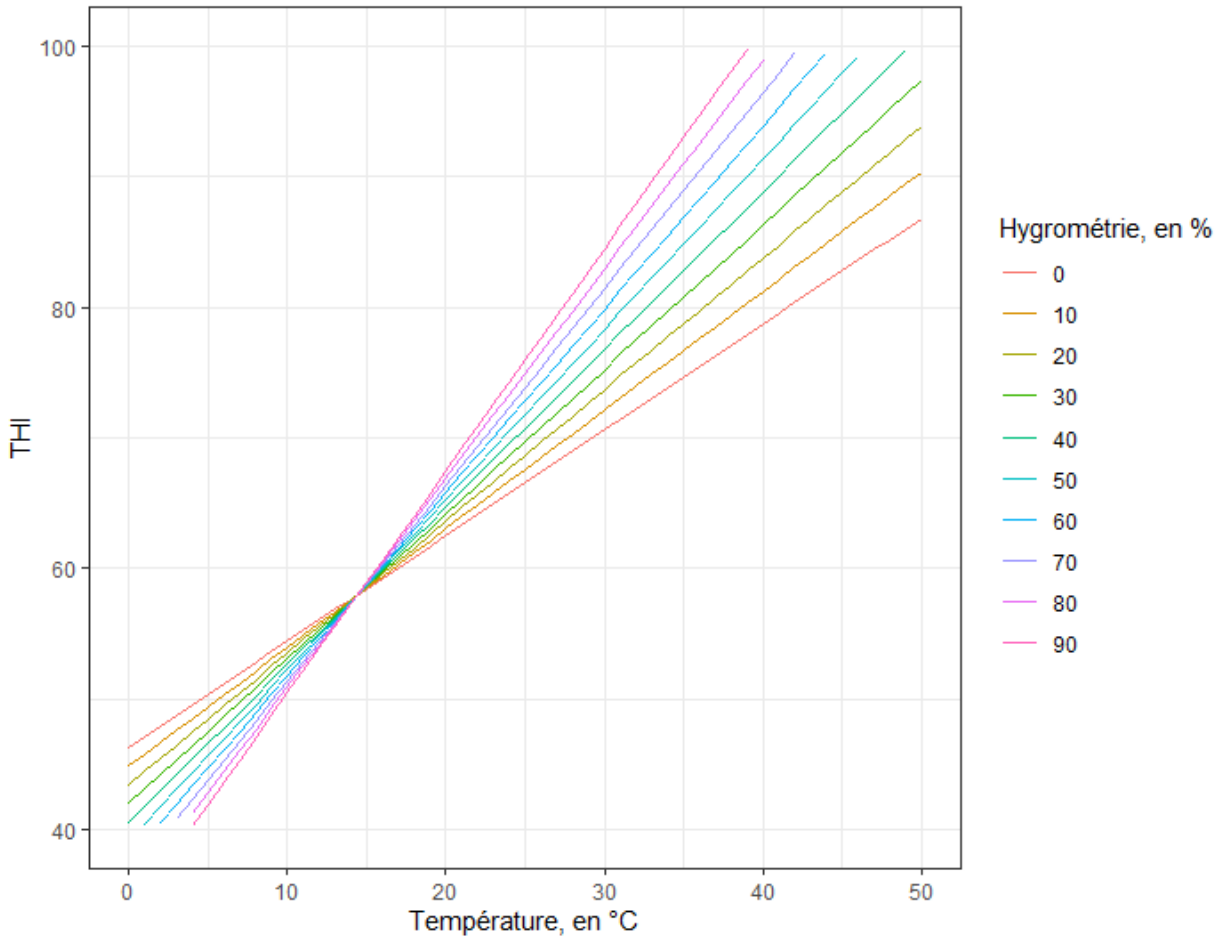

Cows' characteristics

Parity	Nb of cows
P1	12
P2	9
P3, P4	3

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	Veal Weight	=	=	=	=	=
	IGG colostrum	=	=	--	=	=
	Cortisol	=	=	=	=	++