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Integrating Infrared Thermography to Assess Thermal Stress and Behavior in Dairy Goats

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Integrating Infrared Thermography to Assess Thermal Stress and Behavior in Dairy Goats- Background

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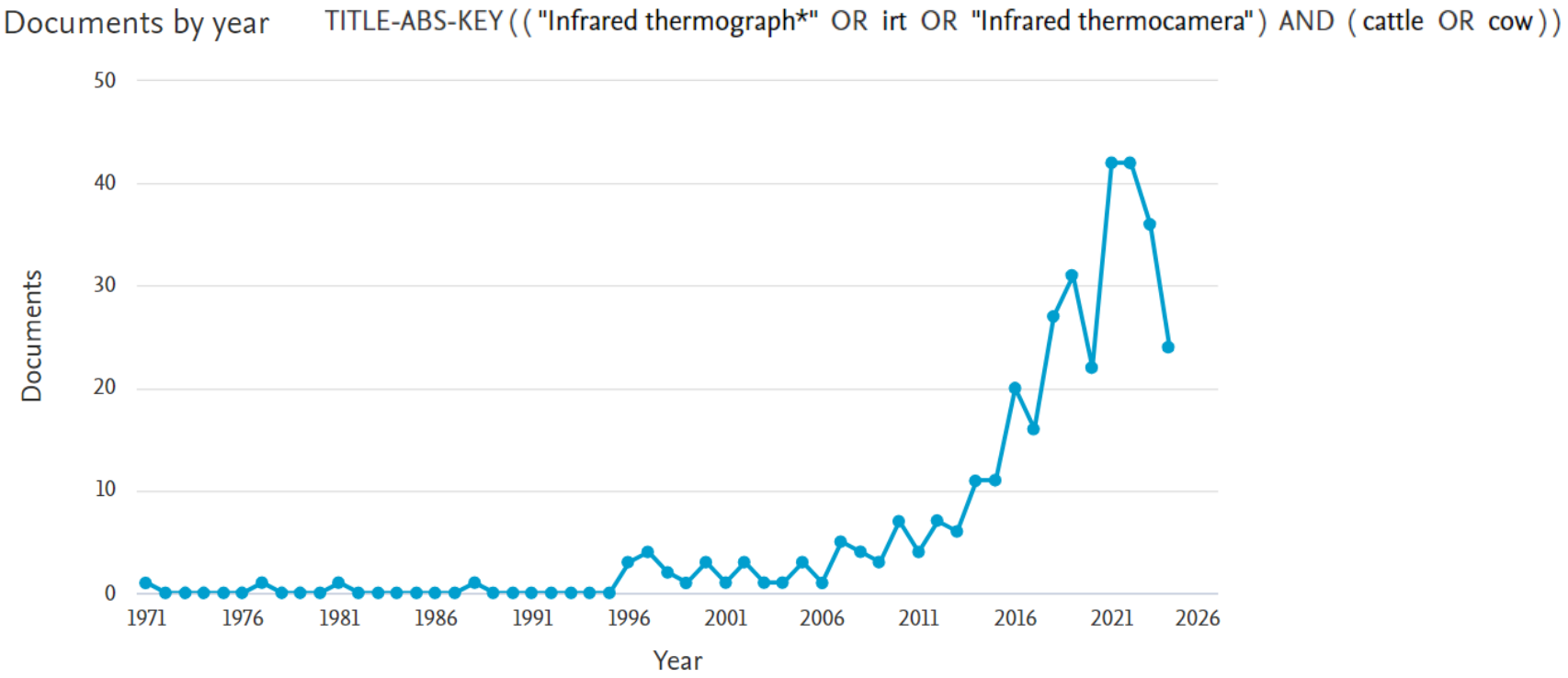
Why goats?

- «Cinderella» of Animal Science
- Almost unique capacities to deal with harsh foraging and environmental conditions
- Promising potential in a changing climate

Integrating Infrared Thermography to Assess Thermal Stress and Behavior in Dairy Goats- Background

Infrared Thermography (IRT) has been applied in several livestock species, but few and recent studies exist on IRT application on goats.



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Integrating Infrared Thermography to Assess Thermal Stress and Behavior in Dairy Goats- Background

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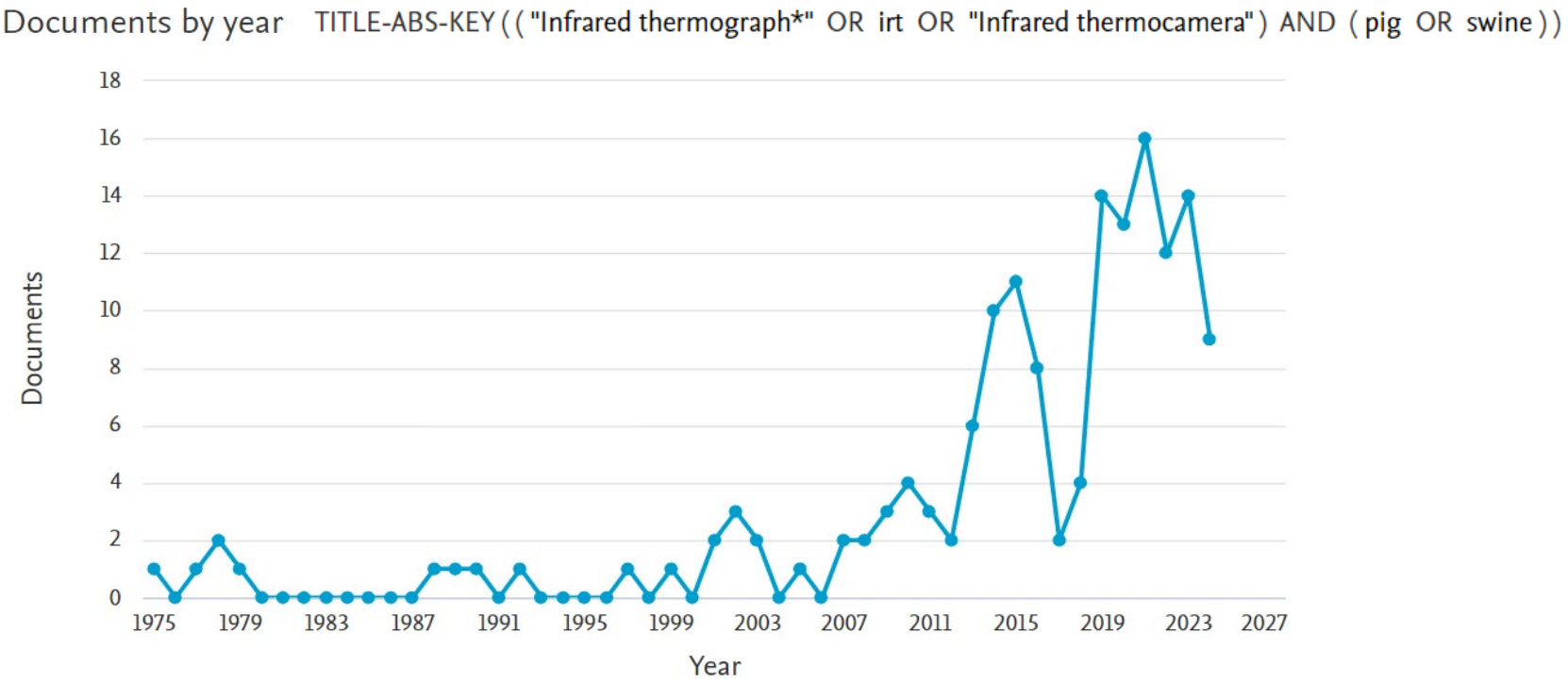

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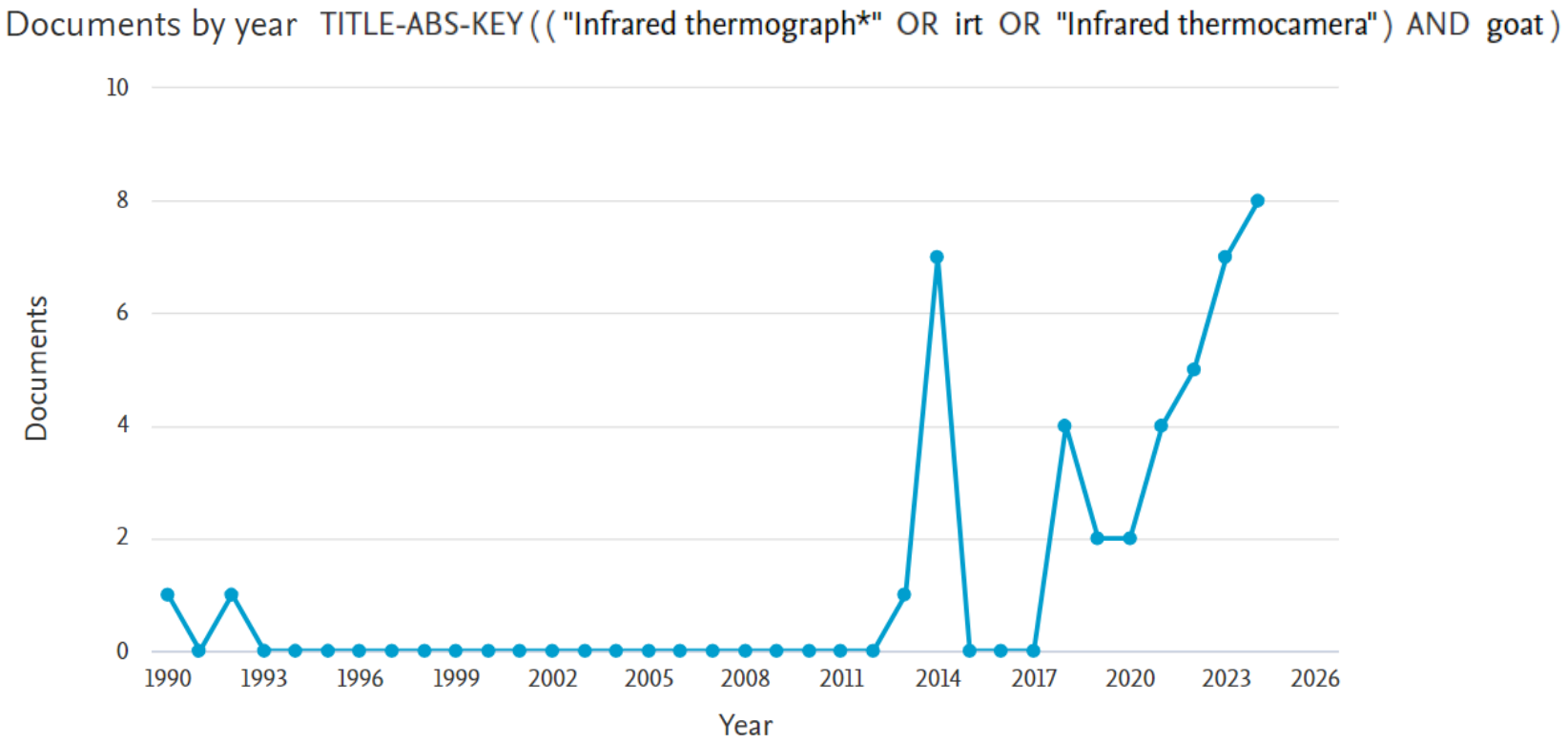

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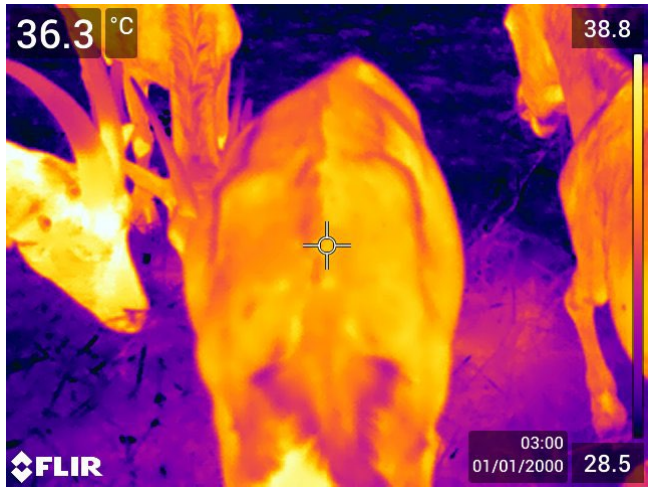
Integrating Infrared Thermography to Assess Thermal Stress and Behavior in Dairy Goats- Scope

Determine the association between Temperature Humidity Index (THI) and changes in goats' behaviour and Superficial Skin Temperatures (SST) across various body regions.



Integrating Infrared Thermography to Assess Thermal Stress and Behavior in Dairy Goats- Scope

Determine the association between Temperature Humidity Index (THI) and changes in goats' behaviour and Superficial Skin Temperatures (SST) across various body regions.

Will we find differences in goats' SST depending on THI?

What is the best thermal window among the goats' body regions?

Will we find differences in goats' behaviour depending on THI?

Integrating Infrared Thermography to Assess Thermal Stress and Behavior in Dairy Goats- Materials and Methods

Animals: 18 female Alpine Dairy goats, aged from 1.5-8 years.
Housed in 3 pens with ad libitum water (drinking bowls), in the teaching dairy goat farm at the Department of Veterinary Medical Sciences, University of Bologna.

6 days of observation between July and August 2023

Environmental conditions measurement starting 12 hours before the observation days with Kestrel 4000 pocket weather tracker

Video recordings: 10 minutes of video recording at 7 AM and 7 PM

Infrared Thermography (IRT) after videorecording: using a portable IRT camera (FLIR E76 24), pictures taken at 80 cm distance from the target body regions (left eye, back, flank, front legs).

Rectal temperature

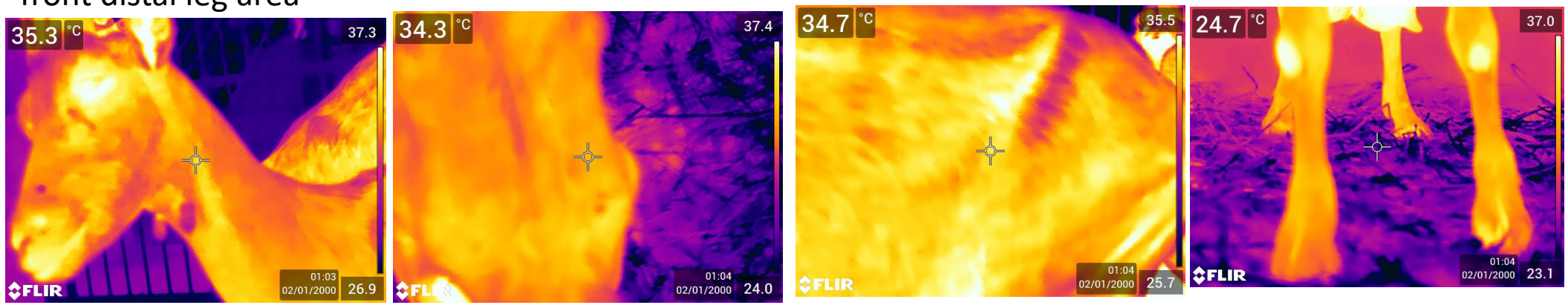
Integrating Infrared Thermography to Assess Thermal Stress and Behavior in Dairy Goats- Materials and Methods

Behavioural analysis: ad libitum sampling method (10 minutes -> 600 s)

Mutually exclusive behaviours	Definitions
Walking	The goat stands on four legs and moves around by taking more than one full step.
Standing	The goat is standing on all four legs, without moving.
Sternal Recumbency	The goat is lying with the sternum in contact with the ground; all limbs are under the body or one front limb is extended.
Lateral Recumbency	The goat is lying with the majority of body on the left or right side in contact with the ground with all limbs outstretched to respective side.
Feeding	The goat takes food into its mouth.
Rumination while standing	The goat is standing on all four legs, without moving while a bolus goes back into its mouth and the goat chews it.
Rumination while lying	The goat is lying while a bolus goes back into its mouth and the goat chews it.
Drinking	The goat drinks from a drinking bowl.

Integrating Infrared Thermography to Assess Thermal Stress and Behavior in Dairy Goats- Materials and Methods

IRT SST: maximum Eye T (lacrimal caruncle); average SST for back (loin area), flank, knee calloused area, front distal leg area



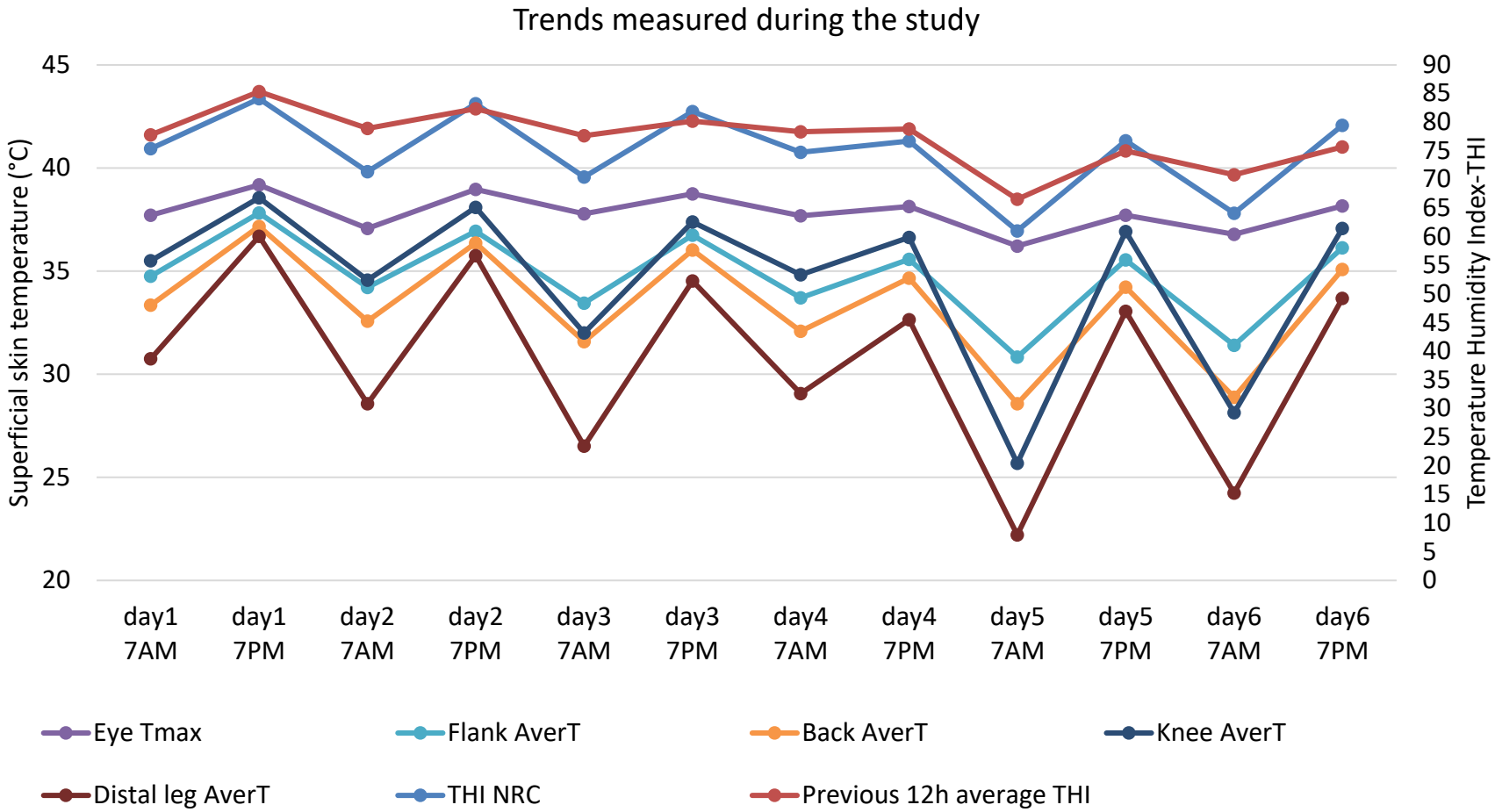
Statistical analysis on R environment:

-association between environmental parameters and SST for the different body regions: GLM with the goat as random effect and backward stepwise selection of independent variables

-association between THI classes and behavioural changes with GLM using Poisson distribution

-association between time spent ruminating and distal leg average SST with a logarithmic function

Integrating Infrared Thermography to Assess Thermal Stress and Behavior in Dairy Goats- Results

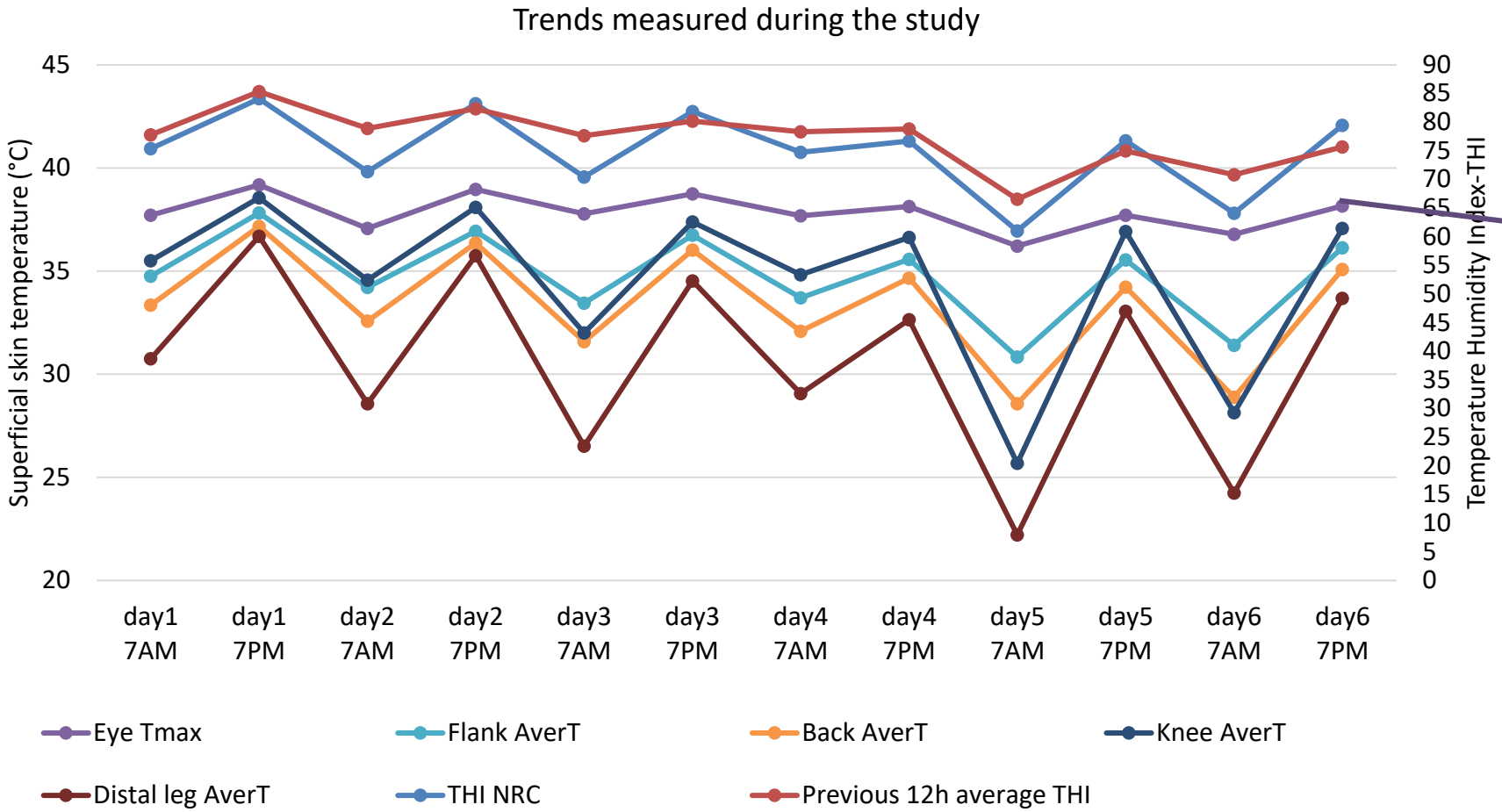


Box:
-T(°C): from 16.2 to 34.5, mean ± SD: 26.9 ± 5.5
-H(%): from 34 to 74, mean ± SD: 55.8 ± 11

Rectal temperature (°C) in the normal range, with a maximum of 39.3°C.

Rectal temperature was significantly associated with previous 12 hours minimum T ($p<0.001$)

Integrating Infrared Thermography to Assess Thermal Stress and Behavior in Dairy Goats- Results



Results of associations between environmental conditions and SST for different body regions:

Eye Tmax: THI and previous 12 h THI entered in the model, $p < 0.001$, Marginal R^2/ conditional R^2= 0.682/ 0.682

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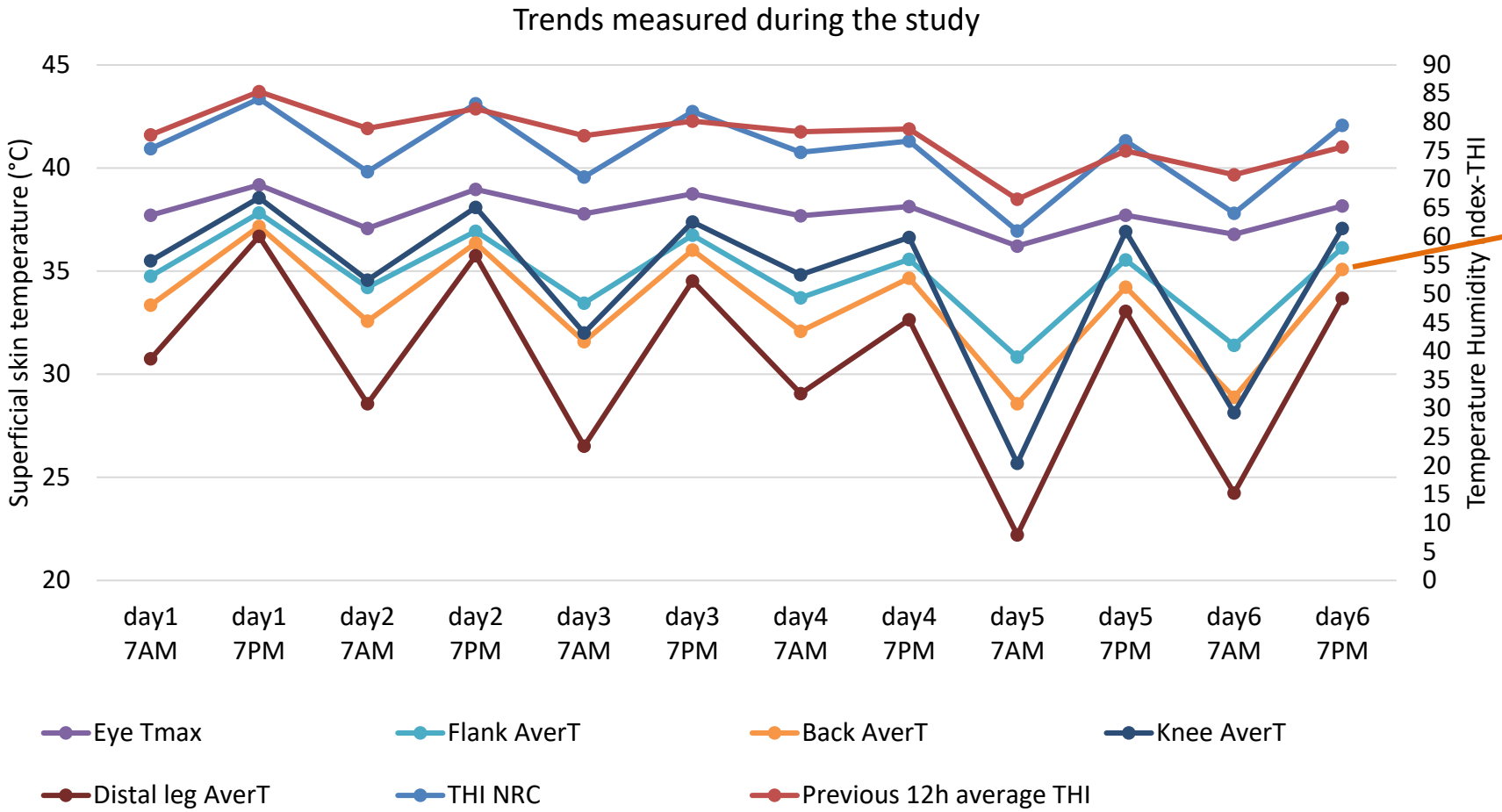
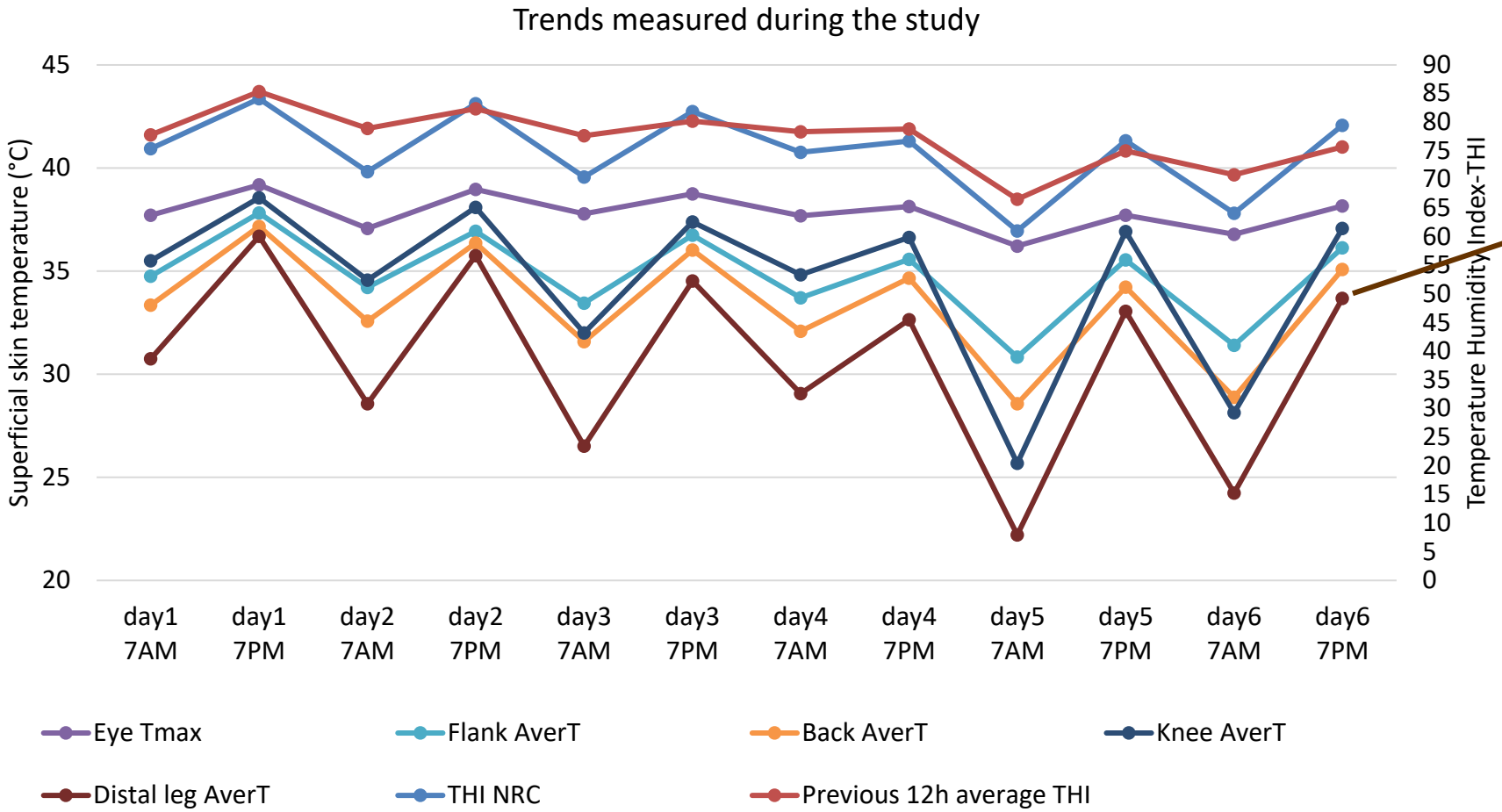


Results of associations between environmental conditions and SST for different body regions:

Flank average SST: THI and previous 12 h THI entered in the model, $p < 0.001$, Marginal R^2/ conditional $R^2 = 0.893/0.919$

Integrating Infrared Thermography to Assess Thermal Stress and Behavior in Dairy Goats- Results

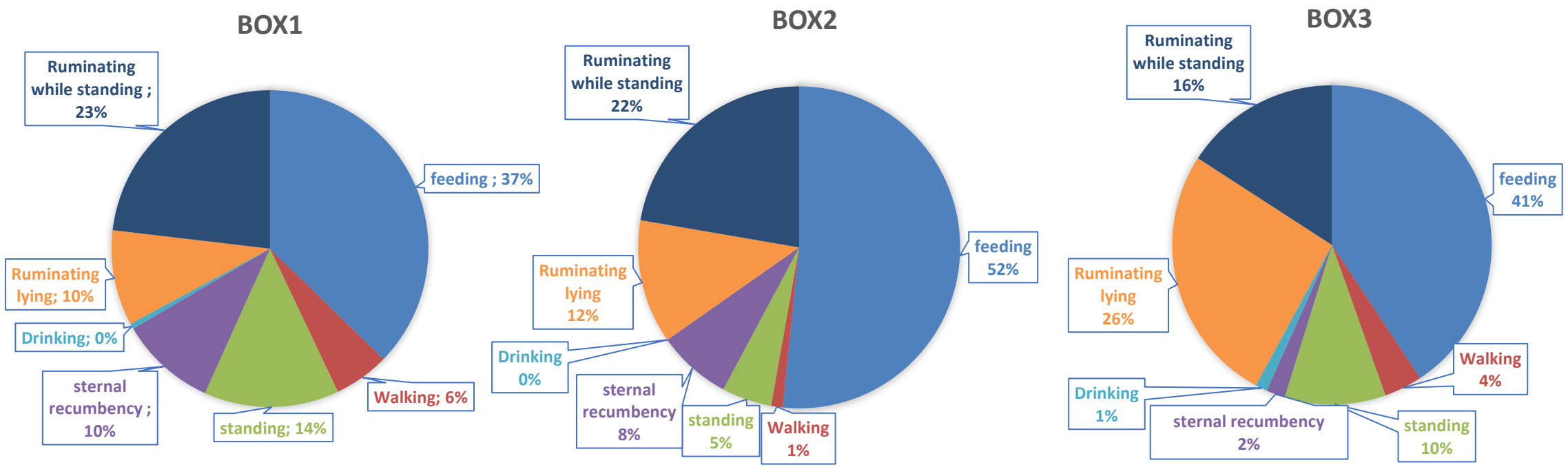


Results of associations between environmental conditions and SST for different body regions:

Distal leg average SST: THI and previous 12 h max T entered in the model, $p < 0.001$, Marginal R^2/ conditional $R^2 = 0.887/0.908$

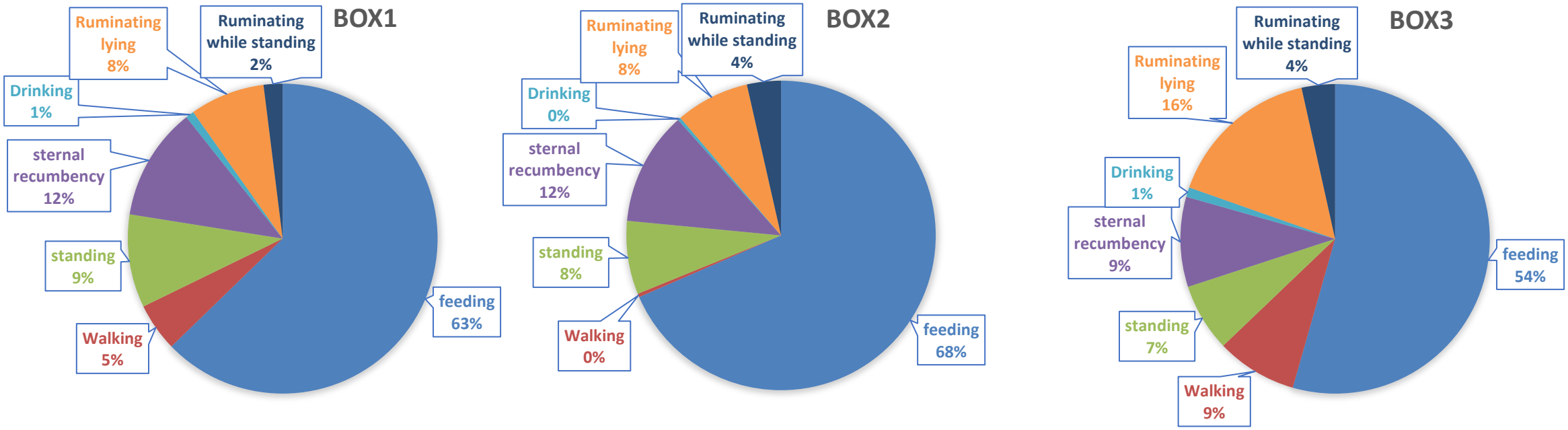
Integrating Infrared Thermography to Assess Thermal Stress and Behavior in Dairy Goats- Results

Time budget (10 minutes) of goats exposed to mild heat stress (THI<75)



Integrating Infrared Thermography to Assess Thermal Stress and Behavior in Dairy Goats- Results

Time budget (10 minutes) of goats exposed to moderate heat stress (75 ≤ THI ≤ 80)



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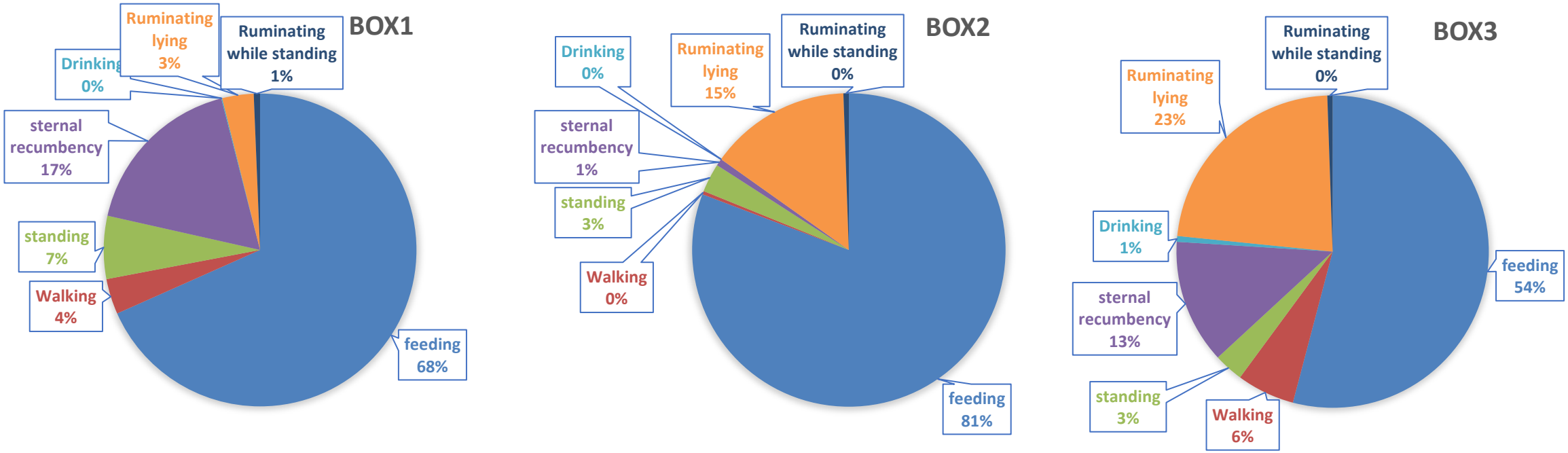
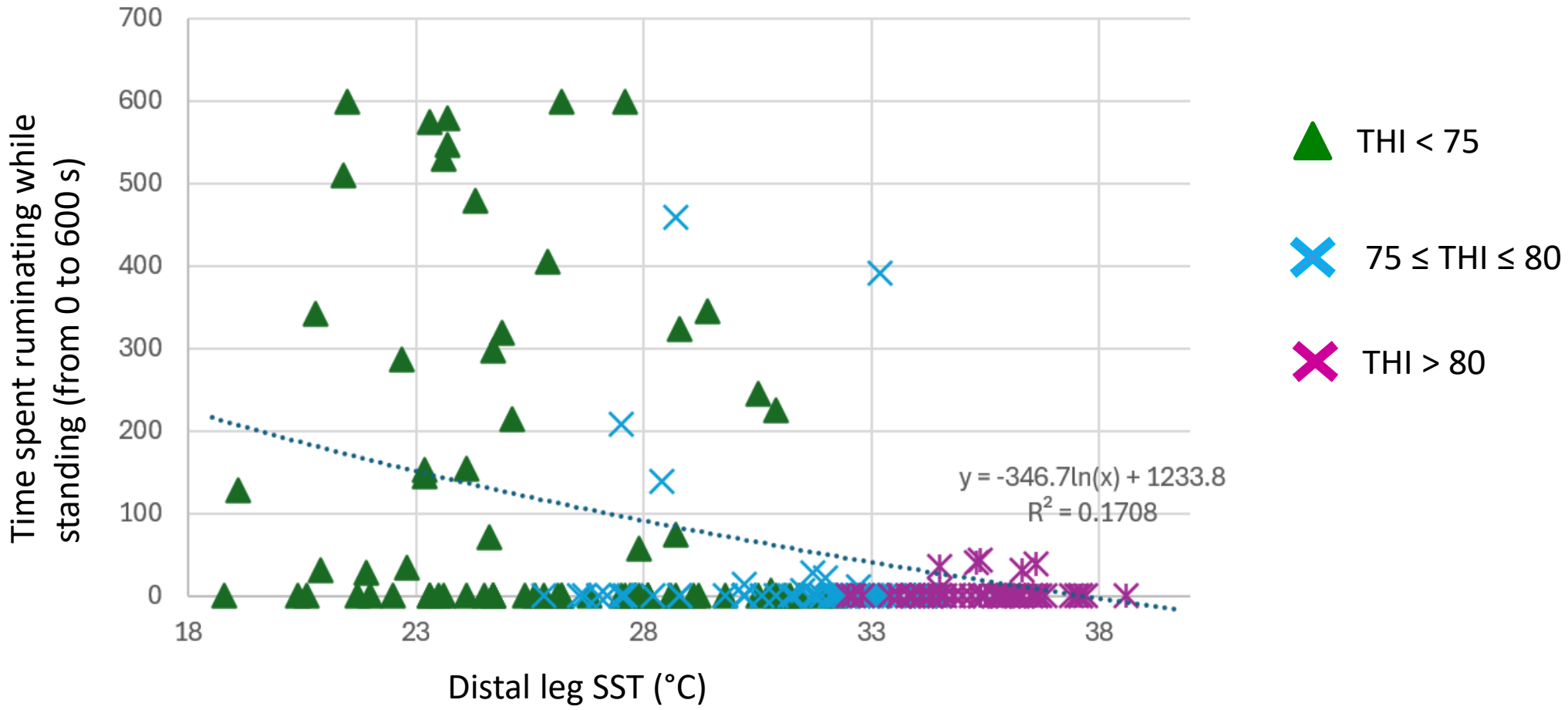
Integrating Infrared Thermography to Assess Thermal Stress and Behavior in Dairy Goats- Results

Time budget (10 minutes) of goats exposed to severe heat stress (THI>80)



$P < 0.001$

Integrating Infrared Thermography to Assess Thermal Stress and Behavior in Dairy Goats- Results



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Integrating Infrared Thermography to Assess Thermal Stress and Behavior in Dairy Goats- Conclusions

YES! – IRT SST were significantly associated with environmental conditions, as THI increases, IRT was able to identify variations in SST.

Flank and distal leg areas were found to be the best thermal windows, mimicking THI variations in heat stress conditions.

Our animals were actually in heat stress as their behaviour changed depending on the THI, and in particular they spent less time ruminating.

When heat stress was mild goats showed more variable SST, suggesting that IRT may be a tool to measure individual differences in how the animals cope with heat perception.

Integrating Infrared Thermography to Assess Thermal Stress and Behavior in Dairy Goats- Acknowledgements

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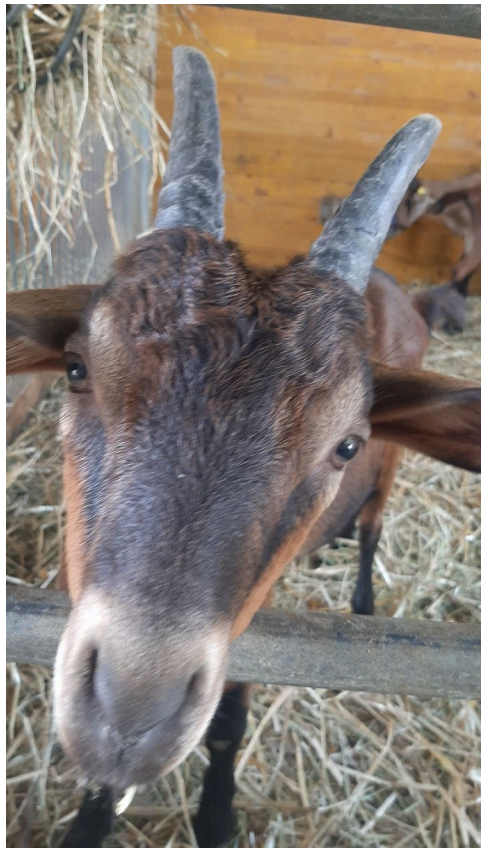
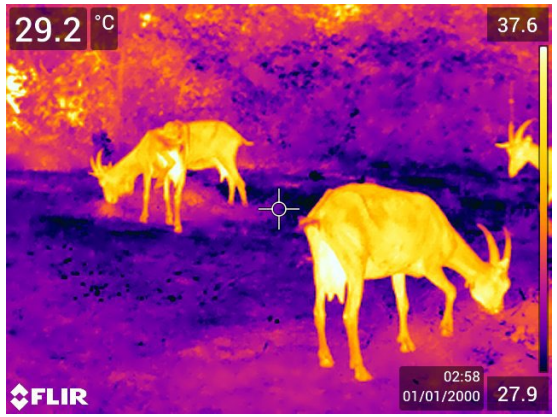
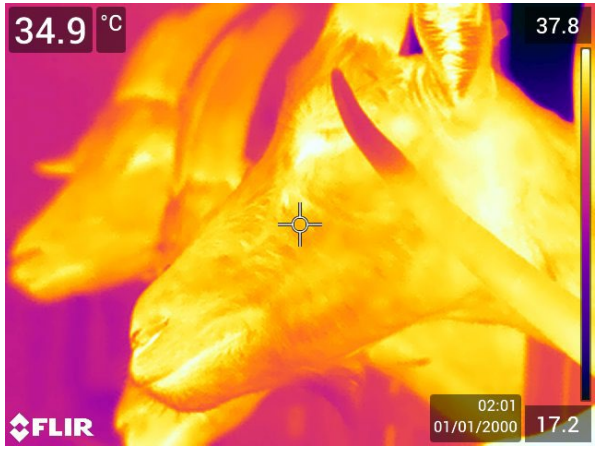


THANKS FOR YOUR ATTENTION

QUESTIONS?





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Integrating Infrared Thermography to Assess Thermal Stress and Behavior in Dairy Goats- THI thresholds

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Appropriate THI model and its threshold for goats in semi-arid regions of India

A. Srivastava, P. Yadav, A. Mahajan, M. Anand, S. Yadav, A.K. Madan, B. Yadav *

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Table 3
The degree of heat stress in terms of THI in case of Jamunapari and Barbari goats.

THI	Physiological Response		Breed	
	Jamunapari	Barbari	Jamunapari	Barbari
<71.78	No change in PR, RR, RT	No change in PR, RR, RT	Comfortable	Comfortable
71.78 to 75.14	Shift in PR, No change in RR, RT	No change in PR, RR, RT	Mild Stress	
75.14 to 79.48	Shift in PR, and RR; No change in RT	No change in PR, RR, RT	Stressful	
79.48 to 84.40	Shift in PR, and RR; No change in RT	Shift in PR, No change in RR, RT		Mild Stress
84.40 to 85.94	Shift in PR, and RR; No change in RT	Shift in PR, and RR; No change in RT		Stressful
>85.94	Shift in PR, RR and RT	Shift in PR, and RR; No change in RT	Extreme stress	