



EAAP 2016

67th Annual Meeting of the European
Federation of Animal Science

Belfast UK, 29 Aug – 2 Sept 2016 

Biological characterization of the estrous cycle in lactating Holstein cows

Y. Montanholi¹, S. Bourgon¹, A. Macdonald², P. Park², S. Lam², M.
Kozak², B. Potvin², K. Colliver², L. Haas², A. Rocha², S. Miller^{2,3}

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DALHOUSIE
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2

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of GUELPH

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agresearch

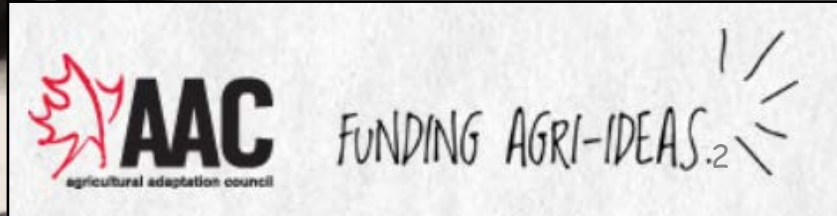
Farming, Food and Health. **First**™
Te Ahuwhenua, Te Kai me te Whai Ora. **Tuatahi**



Rationale & objective

"Map" biological responses to estrous state

Multi-stream assessment of estrous in dairy cows

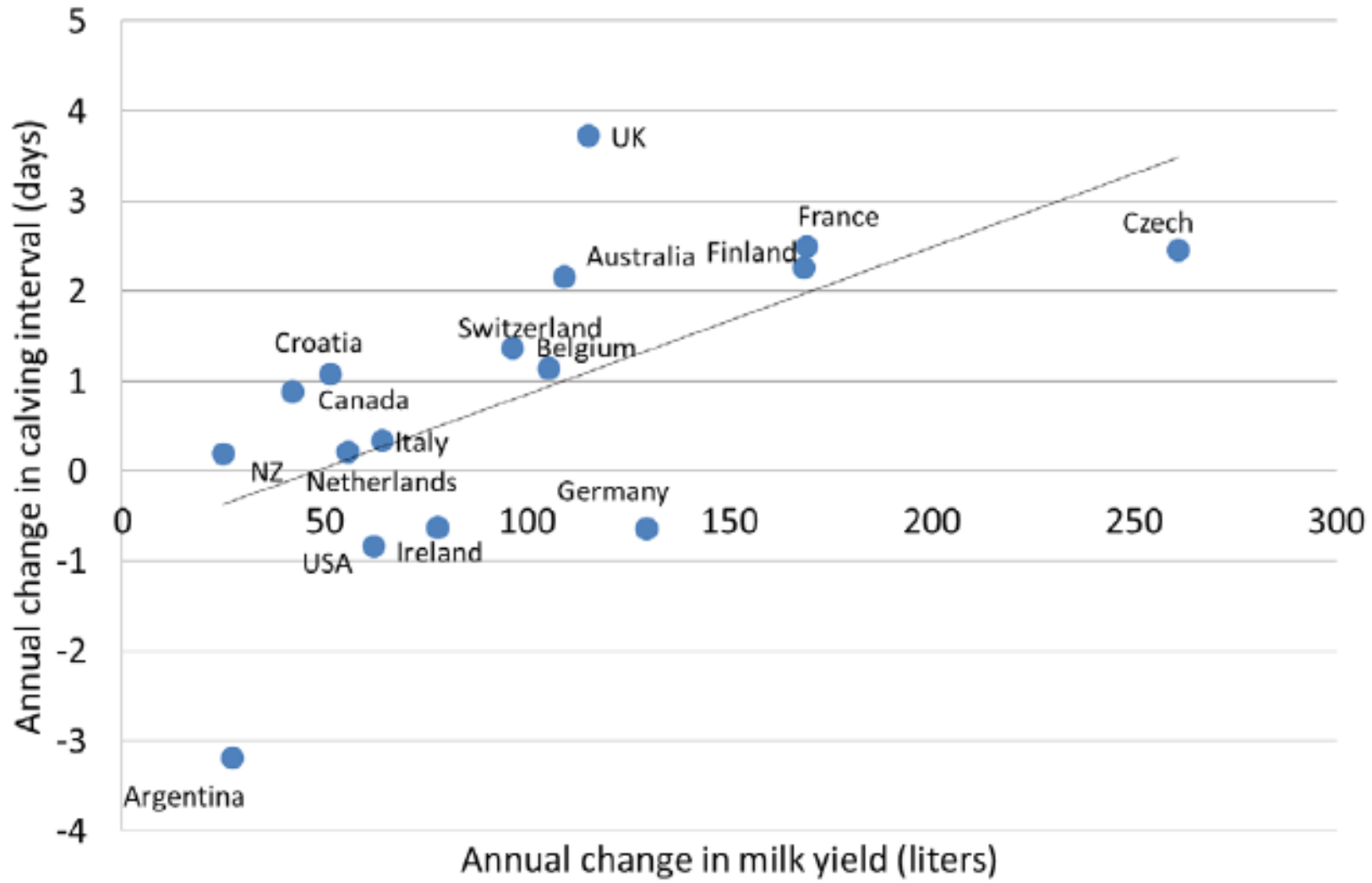




Rationale & objective



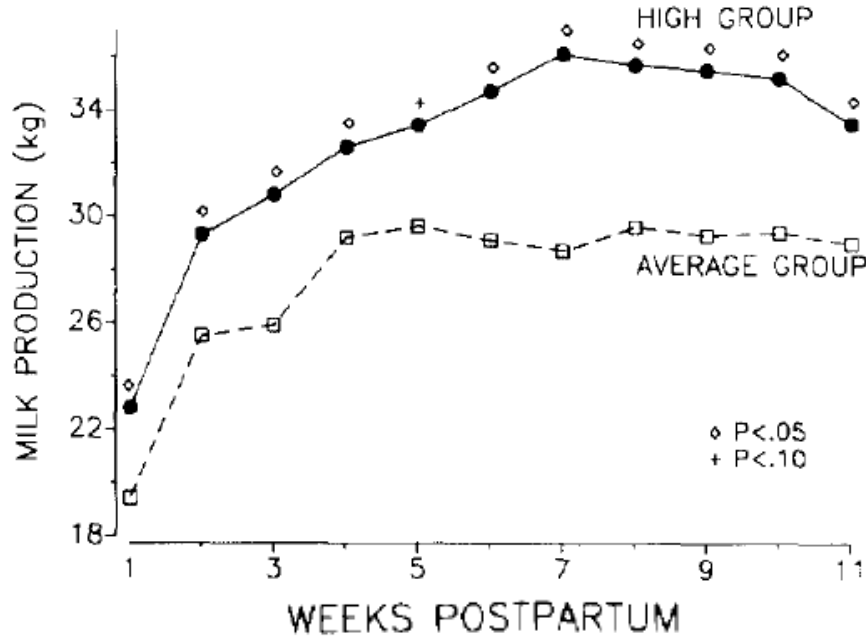
➤ Dairy cow fertility: increase in productivity





Rationale & objective

➤ Dairy cow fertility: increase in productivity



Gillette Emperor Smurf
217,000 L in 11 lactations



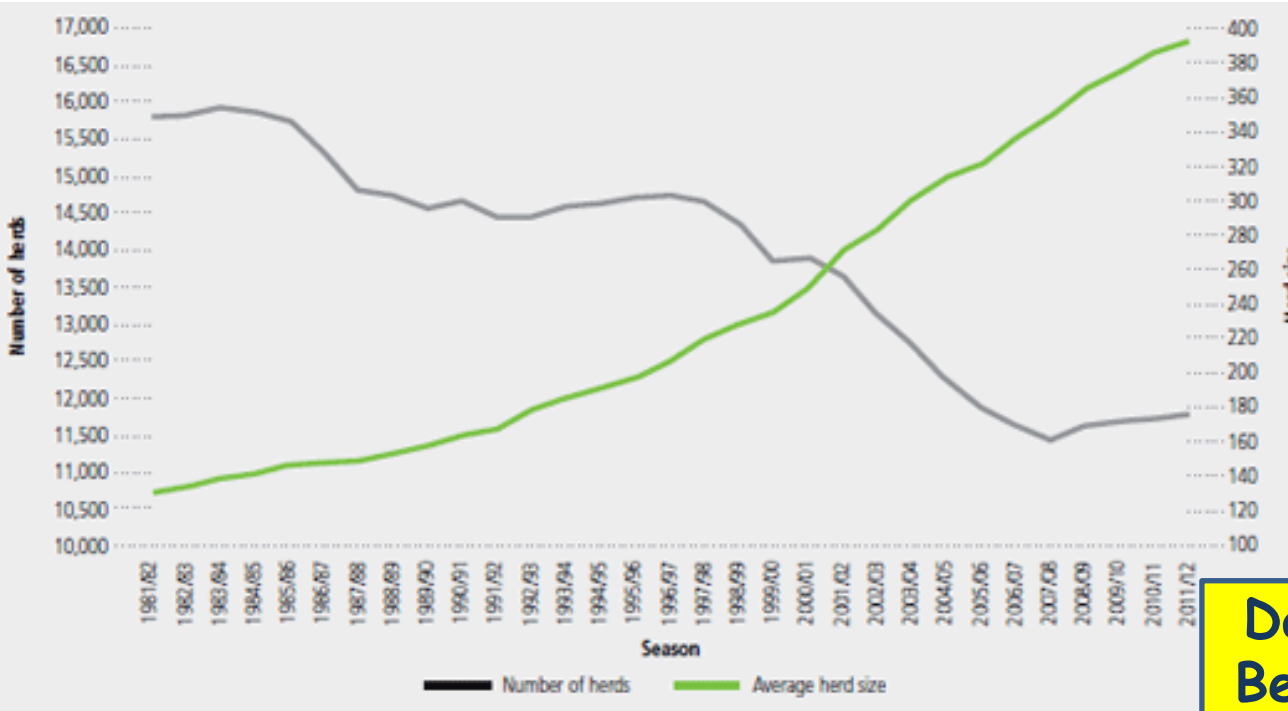
Silent estrous

Traits	High	Average
Days to estrous	66	43
Ovulations before estrous	1.6	0.7
Days to conception	217	74



Rationale & objective

➤ Dairy cow farming: increased herd size



Daisy, Molly,
Bella, Candie,
Buttercup...

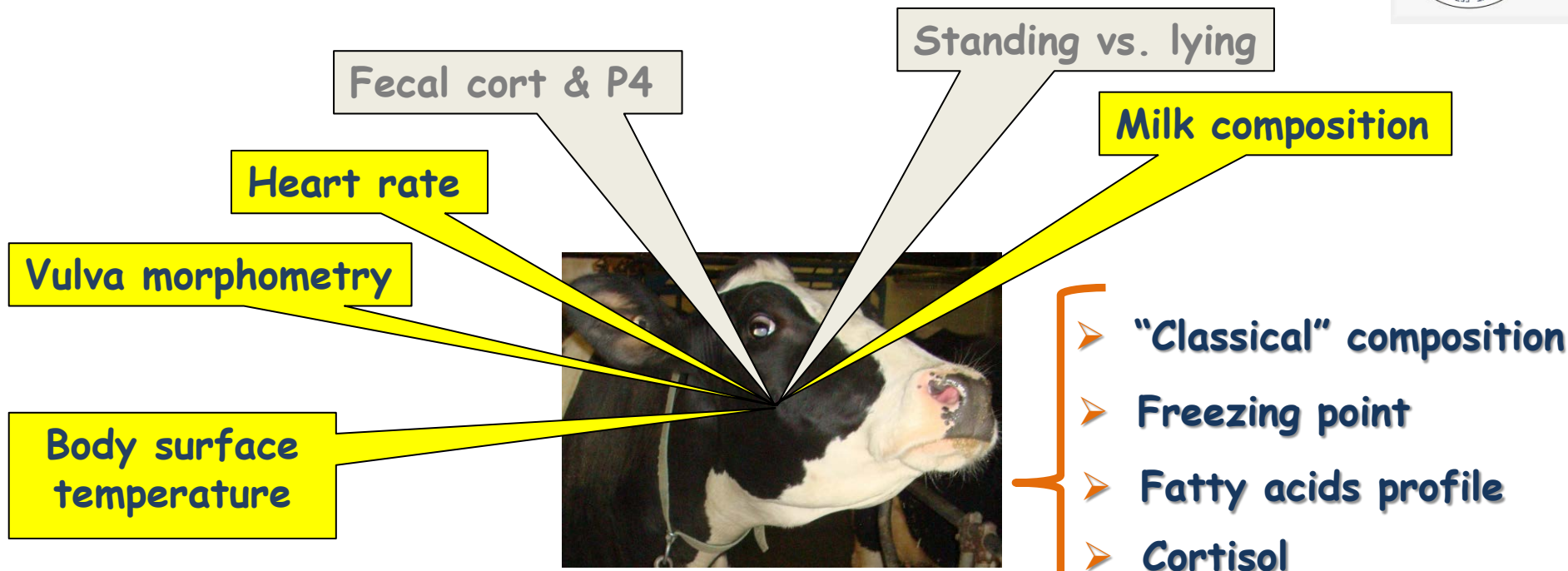


China constructs 100,000-cow dairy unit

NEWS 06 JUL 2015 JOEL DURKIN

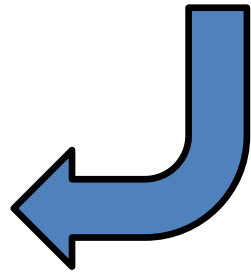
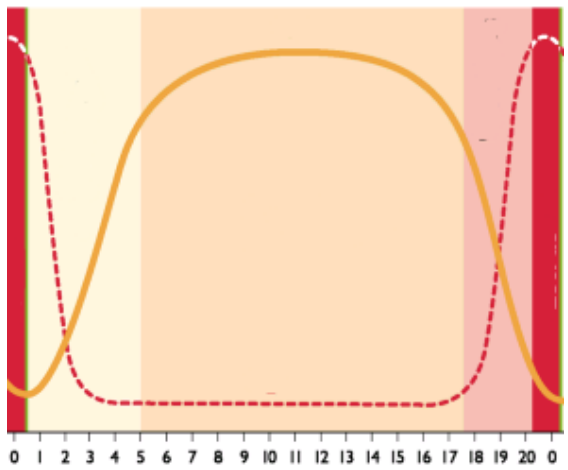
The project will be the world's largest dairy farm and will supply milk and cheese to Russia

Rationale & objective



- "Classical" composition
- Freezing point
- Fatty acids profile
- Cortisol
- Progesterone

- Infrared imaging
- Contact temperature





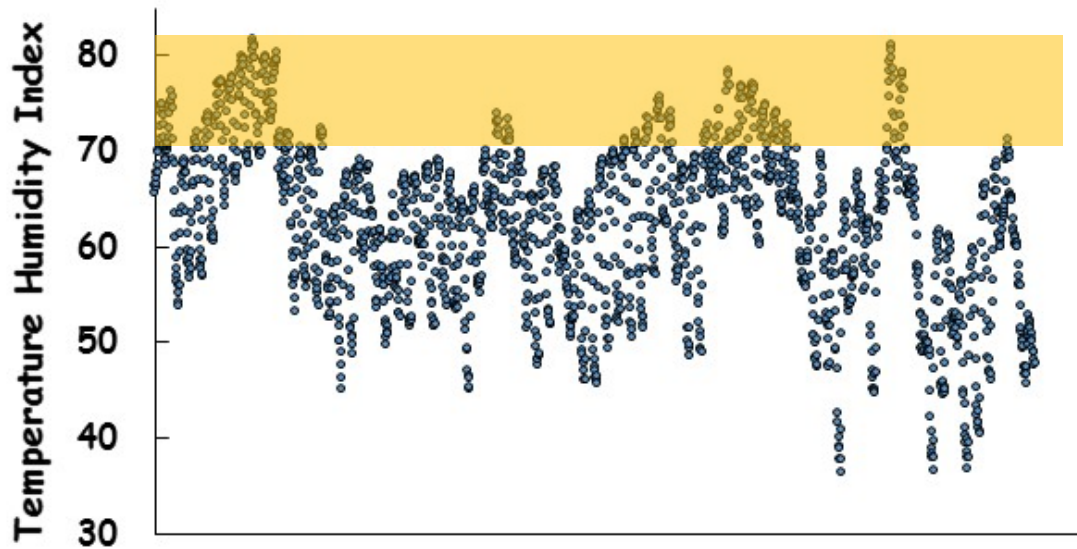
Material and methods

➤ Dairy cows: housing, feeding and biometrics



Performance	Value
TMR feed intake (kg/d)	44.08
Milk yield (kg/d)	33.20
Crude fat content (%)	3.58
Crude protein (%)	2.96
Lactose content (%)	4.63

Ingredients	% DM
Wheat straw	30.80
Alfalfa haylage	11.60
Corn silage	34.90
Premix	22.70



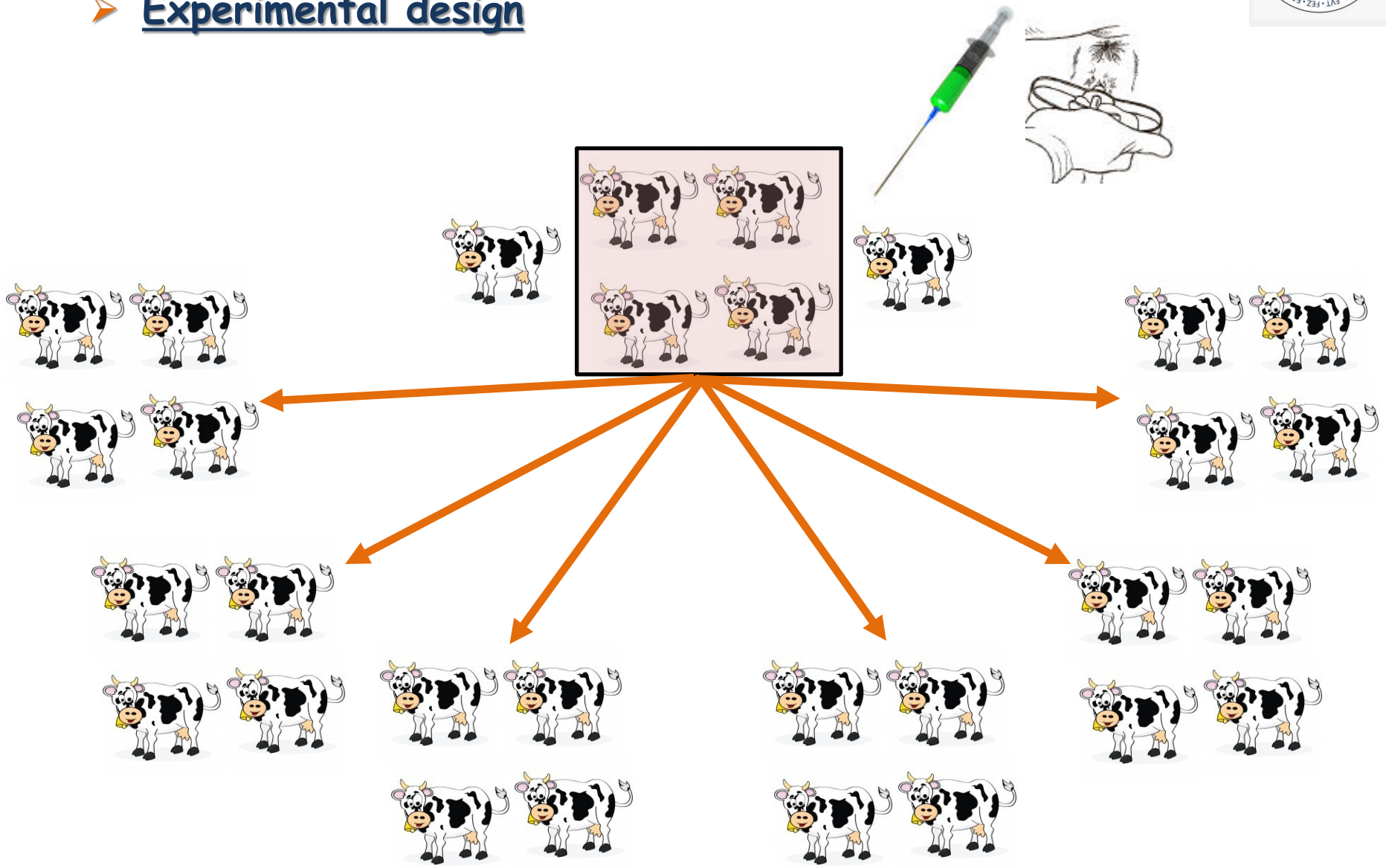
July 15 to September 20



Material and methods



➤ Experimental design

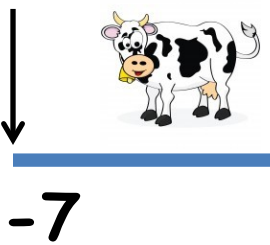




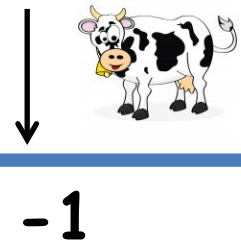
Material and methods

➤ Estrous synchronization

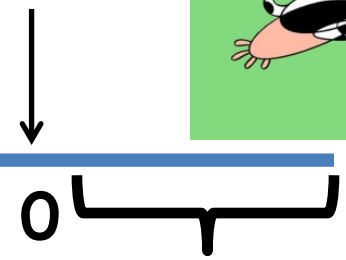
Insert
CIDR (progesterone)



PGF2a



Remove
CIDR



Check for estrous

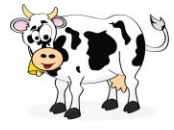
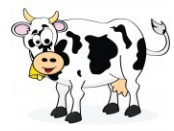




Material and methods



➤ Experimental timeline



Day - X		Day 1	Day 19	Day 22	Day 24
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Infrared imaging	AM/PM	-----	FULL	-----	➔
Surface temp.	FULL	-----	-----	-----	➔
Heart rate			FULL	-----	➔
Milk composition	AM/PM	-----	-----	-----	➔
Vulva metrics	AM/PM	-----	-----	-----	➔



Material and methods



- Milk analysis: progesterone and cortisol



- *Coat-A-Count Cortisol*
- *Coat-A-Count Progesterone*

SIEMENS

AM/PM —————>



Material and methods



➤ Milk analysis: composition and freezing point



FOSS

FAT

PROTEIN

UREA

LACTOSE

FREEZING POINT

SOMATIC CELL COUNT

**Milkoscan
FT6000**

**Fossomatic
FC**

AM/PM →



Material and methods

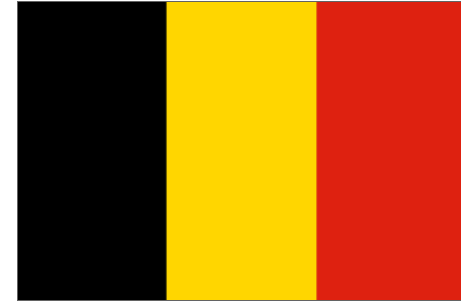
➤ Milk analysis: Fatty-acid profile determination

J. Dairy Sci. 89:3690–3695

© American Dairy Science Association, 2006.

Estimating Fatty Acid Content in Cow Milk Using Mid-Infrared Spectrometry

H. Soyeurt,^{*†1,2} P. Dardenne,[‡] F. Dehareng,[‡] G. Lognay,^{*2} D. Veselko,[§] M. Marlier,^{*2} C. Bertozzi,[#] P. Mayeres,^{*#2} and N. Gengler^{*||2}

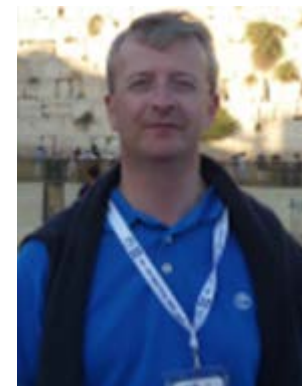


Nicolas Gengler



H el ene Soyeurt

Cl ement Grelet



Fr d eric Dehareng

Am lie Vanlierde

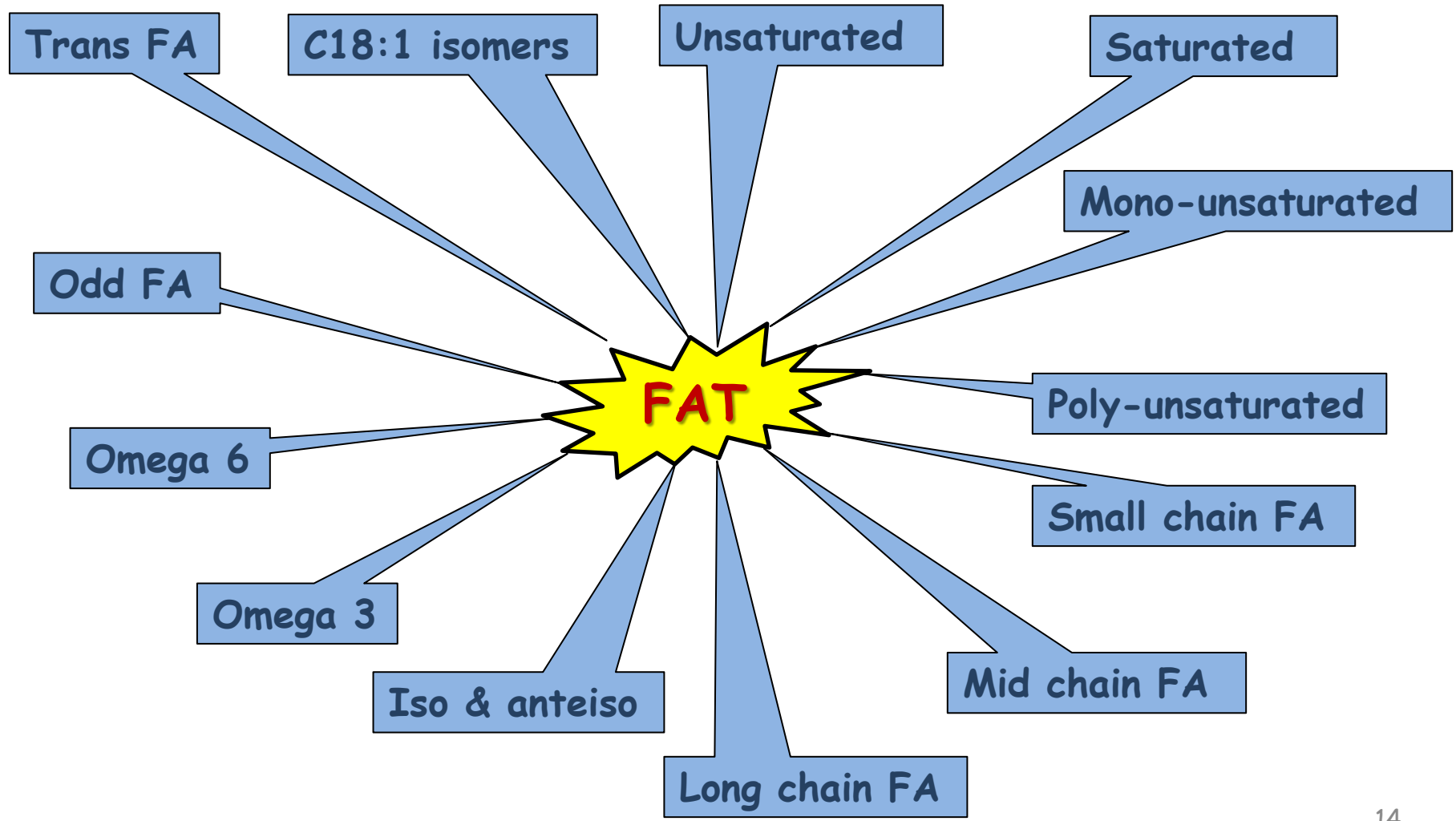




Material and methods



➤ Milk analysis: Fatty-acid profile determination

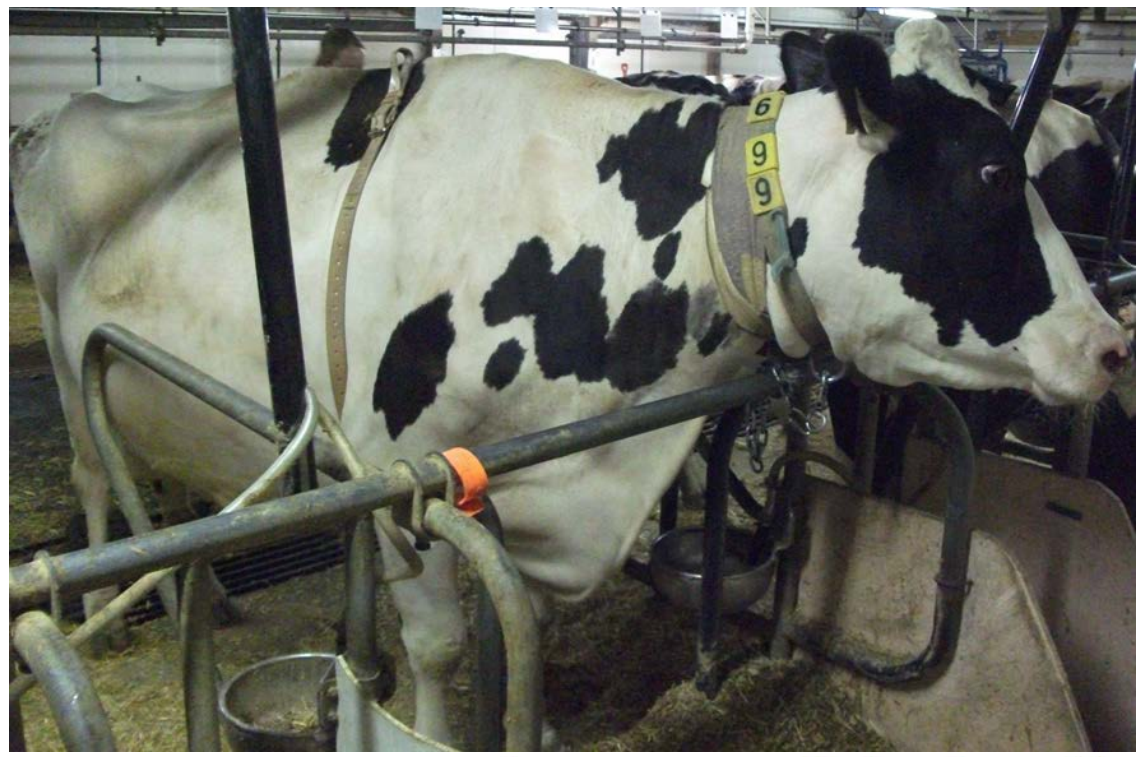




Material and methods



➤ Body surface temperature: thermochrons



AM/PM



Material and methods

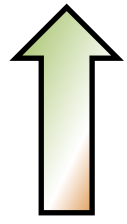
➤ Body surface: Infrared imaging instrumentation



**Model A320
Automated**

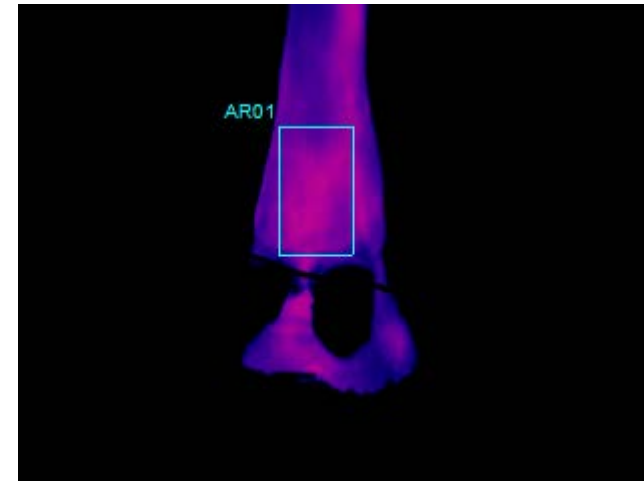
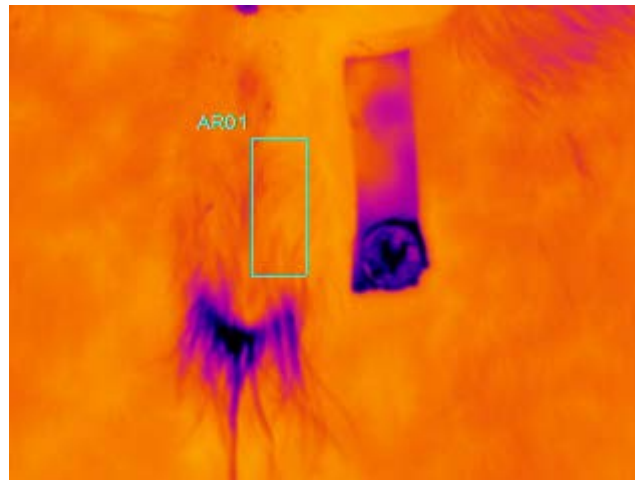
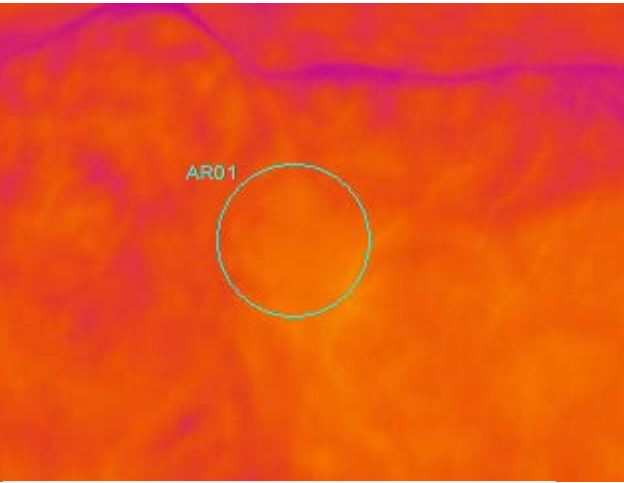


**Model SC2000
Handheld**



Material and methods

➤ Body surface: Infrared imaging analyses



ThermaCAM™ Researcher Pro 2.10

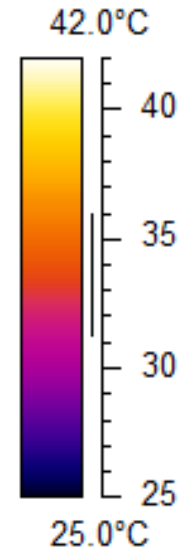
Right and left flanks

Front and back foot

Vulva

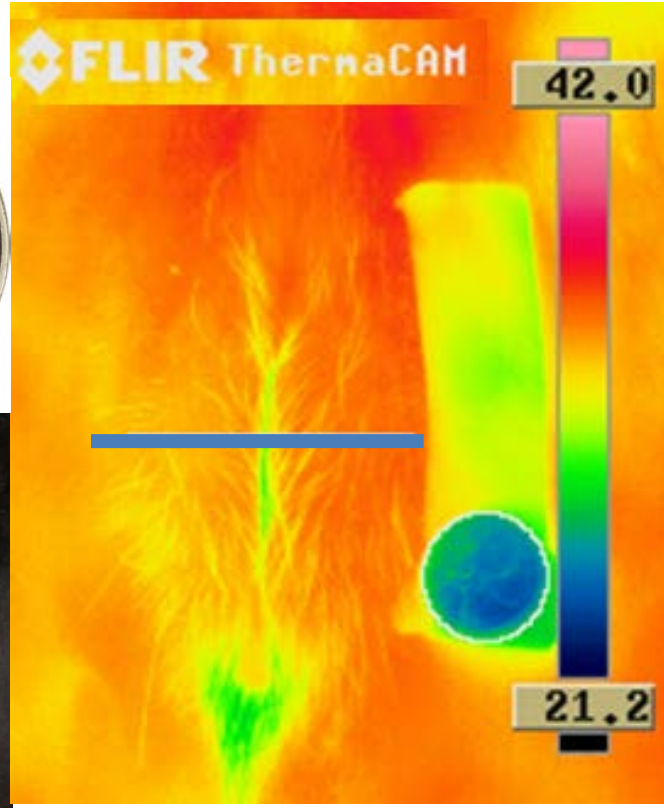


Maximum
&
Average temp



Material and methods

➤ Vulva morphometry



ImageJ
Image Processing and Analysis in Java

Material and methods

➤ Heart rate: Electrode-based heart rate

Model RS800 CX



POLAR



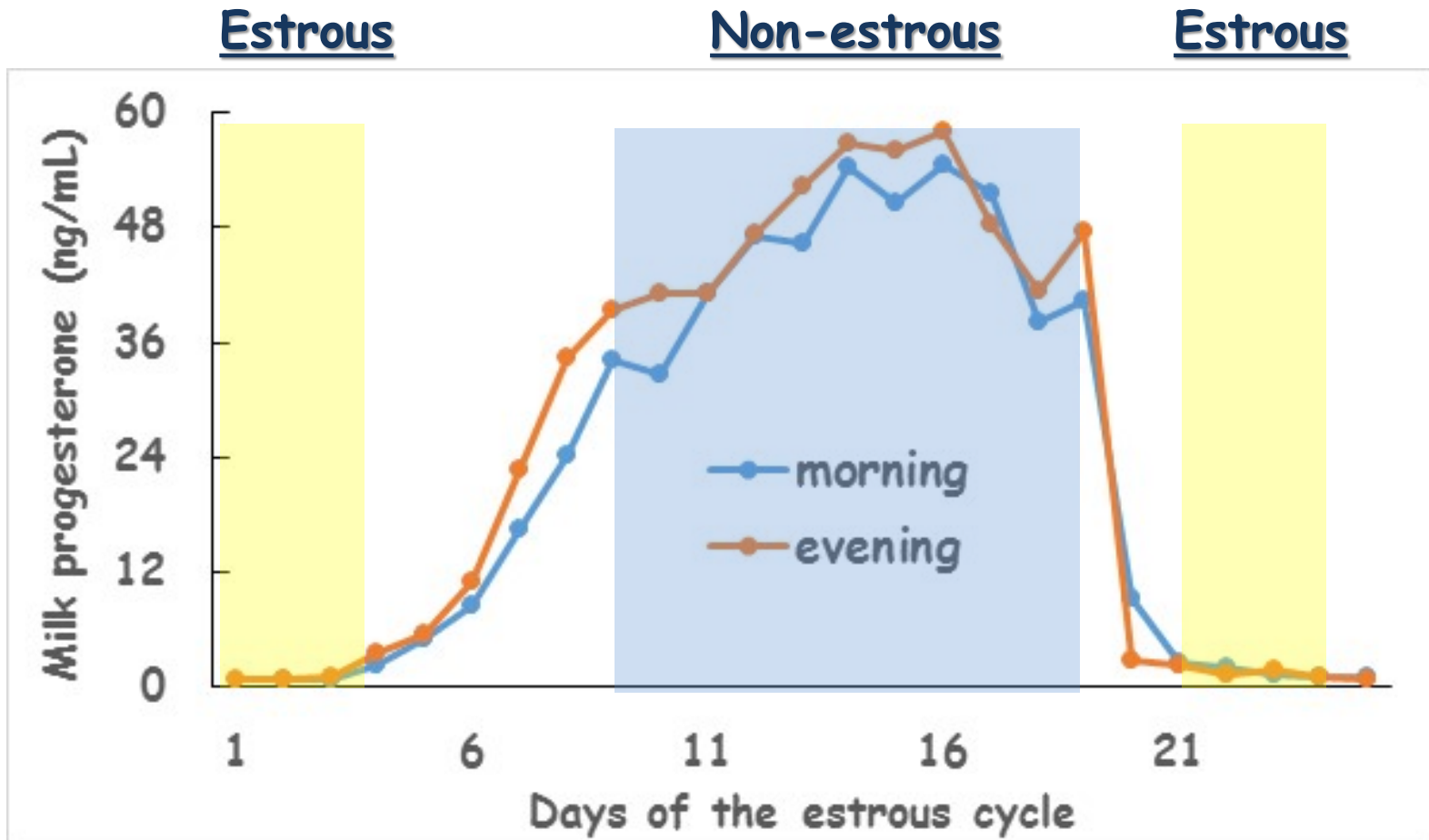


Material and methods



➤ Statistical analysis

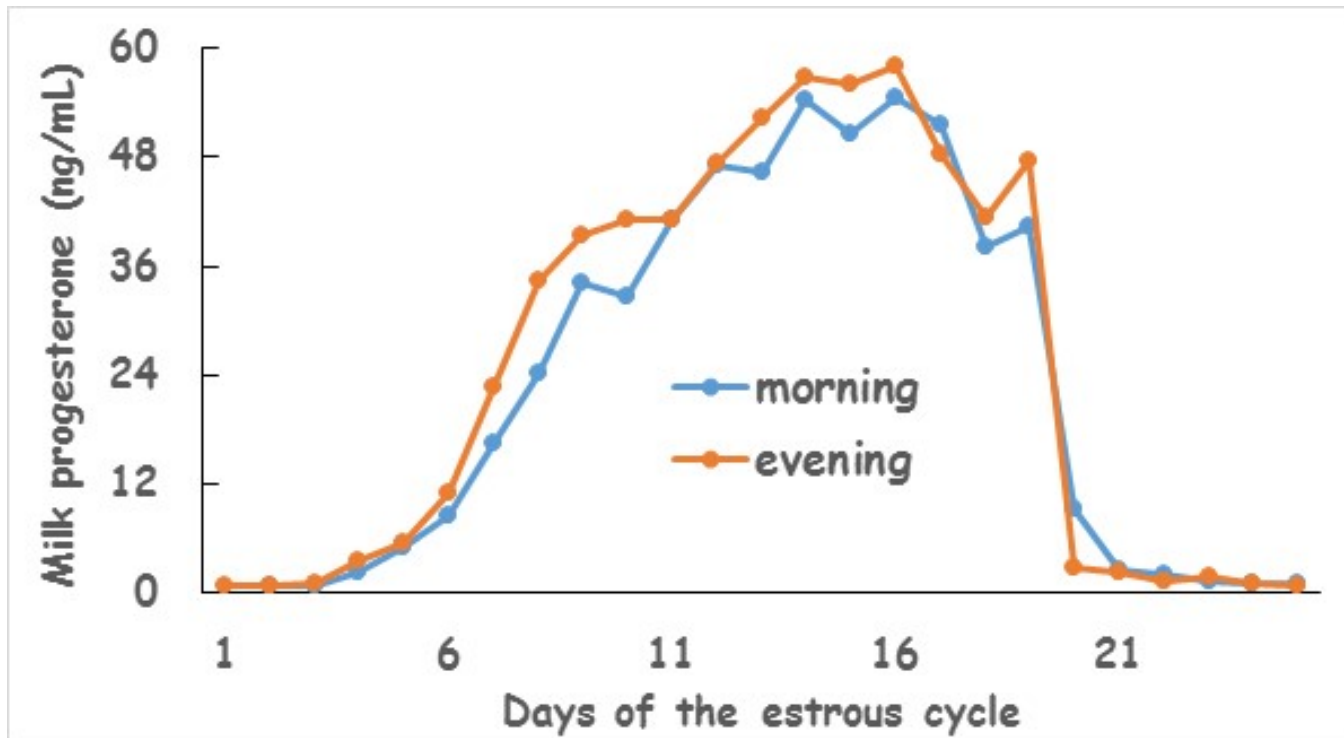
Repeated measures mixed models - THI covariate





Results and discussion

- Milk analysis: progesterone
- Estrus: >2.4 ng/mL (Roelofs et al 2006)
- Estrus cycle duration: 17 to 25 days





Results and discussion

➤ Milk analysis: cortisol (ng/mL)

State	Morning	Evening
Non-estrous	1.32	1.09
Estrous	1.31	1.69
<i>P</i> value	0.94	0.02

➤ THI & cortisol $r = 0.23$ ($P = 0.03$)

➤ 86% of THI > 71 - evening

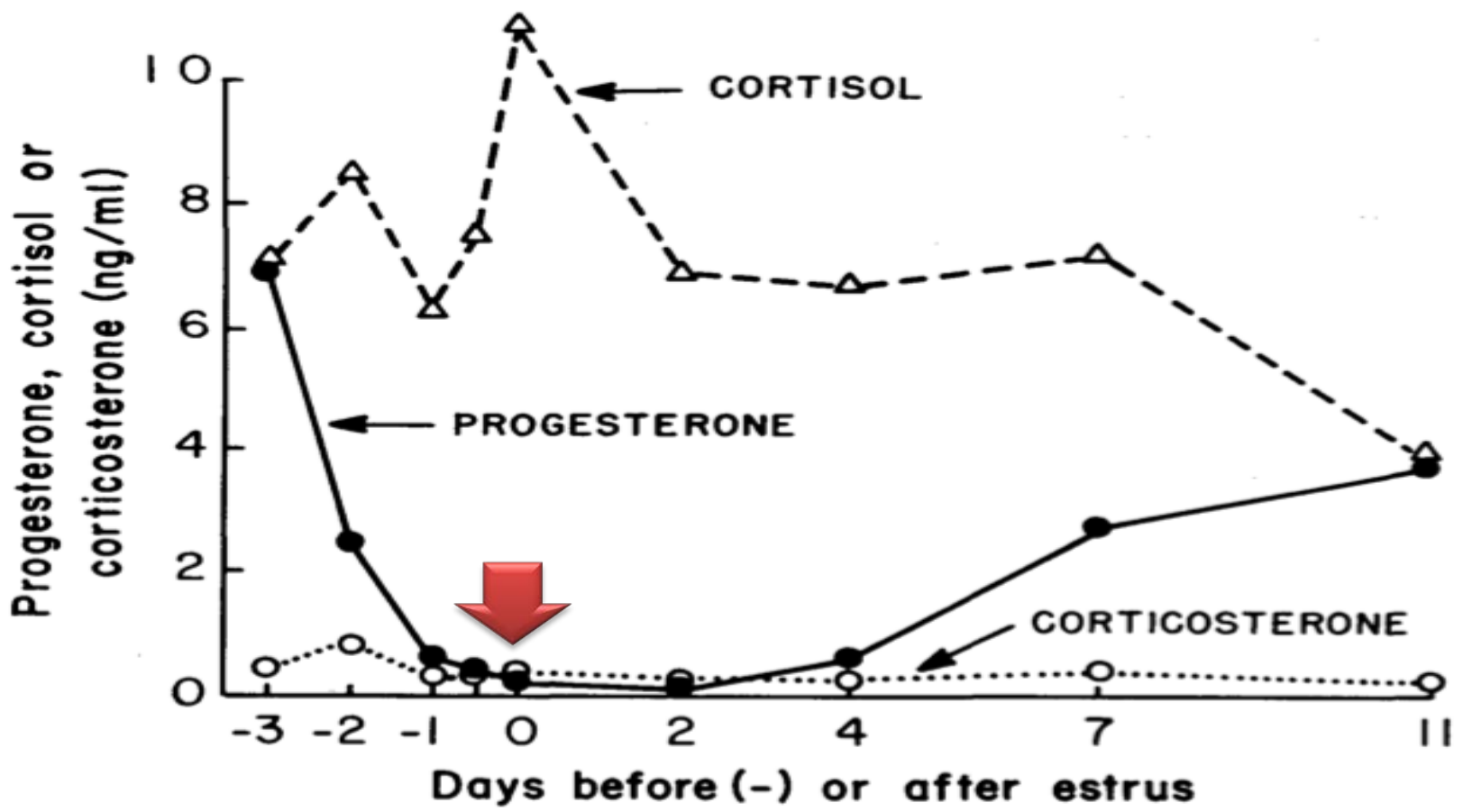
➤ Fecal cortisol metabolites: another dimension



Results and discussion



➤ Milk analysis: cortisol



Swanson et al 1972



Results and discussion



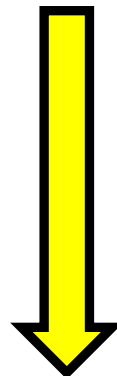
➤ Milk analysis: composition & freezing point

Analyte	Estrous	Non-estrous	P value
Fat (%)	3.48	2.94	0.11
Lactose (%)	4.68	4.59	0.07
Protein (%)	2.82	2.95	0.04
Urea (mg/dL)	121	113	0.33
Somatic cell count (1000s/mL)	249	622	0.05
Freezing point (°C)	-0.560	-0.555	0.03



? FAT

Lactose



SCC

Freezing point

Protein

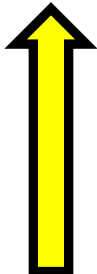
Results and discussion

➤ Milk analysis: Mid-infrared spectra for fat acids

Fat acids (g/L)	Estrous	Non-estrous	P value
Mono-unsaturated	1.14	0.92	0.03
Poly-unsaturated	0.14	0.12	0.08
Unsaturated	1.29	1.04	0.03
Long chain	1.68	1.33	0.02
Omega 3	0.025	0.020	0.09
Omega 6	0.091	0.079	0.09
Trans	0.16	0.13	0.04
C18:1 isomers	1.02	0.81	0.02



=



FAT-ACIDS

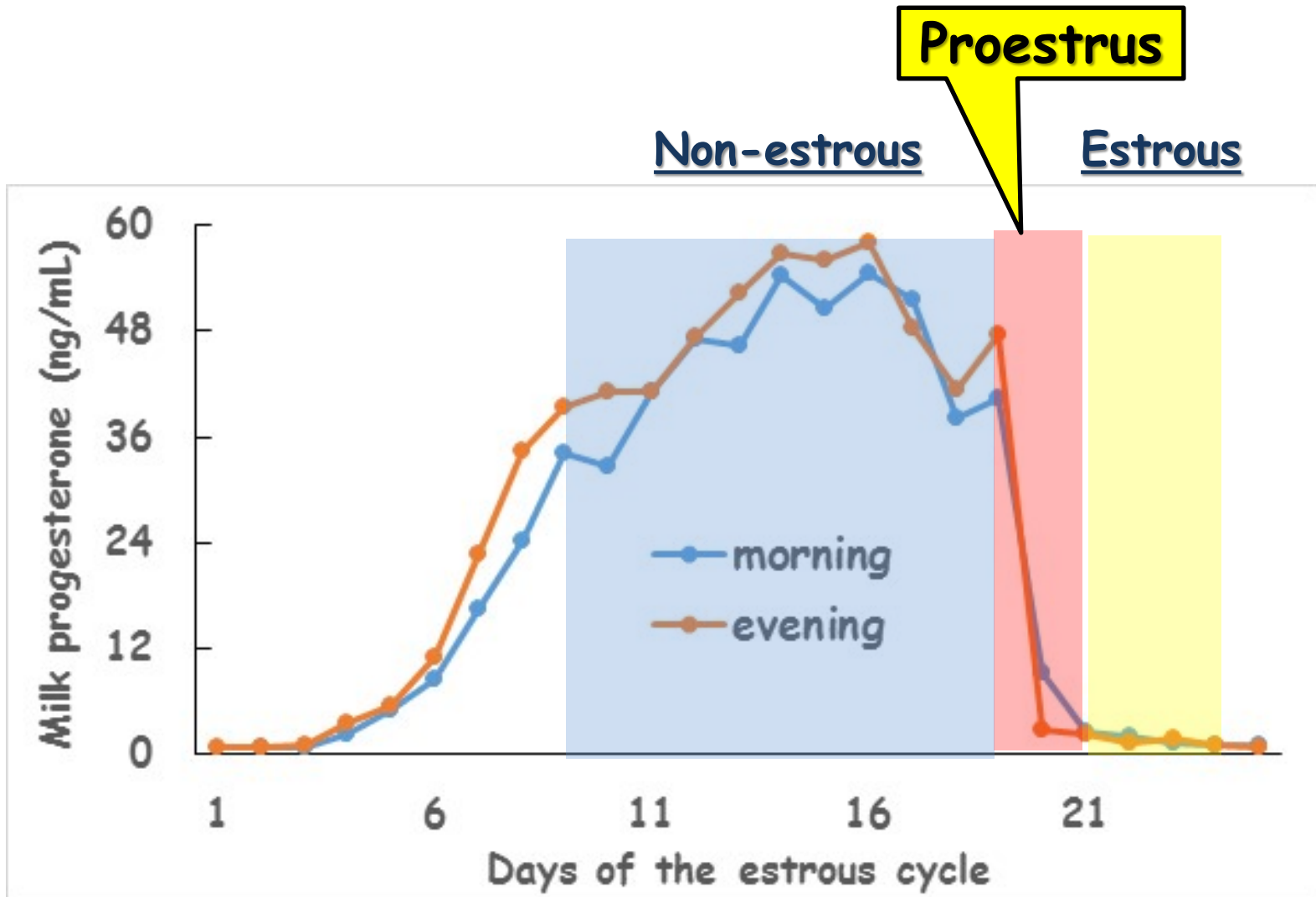




Results and discussion



➤ Body surface temperature: Contact device

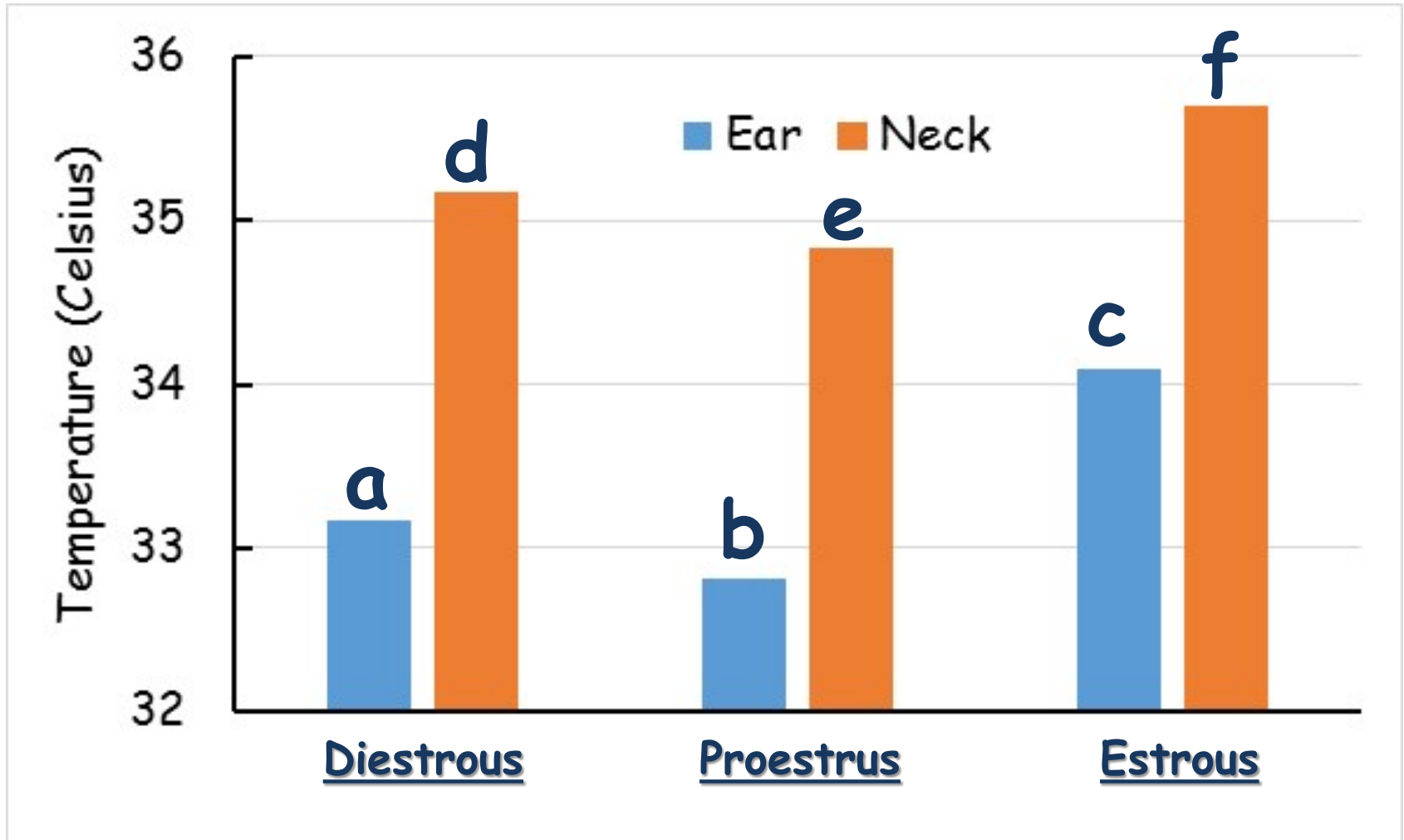




Results and discussion



➤ Body surface temperature: Contact device



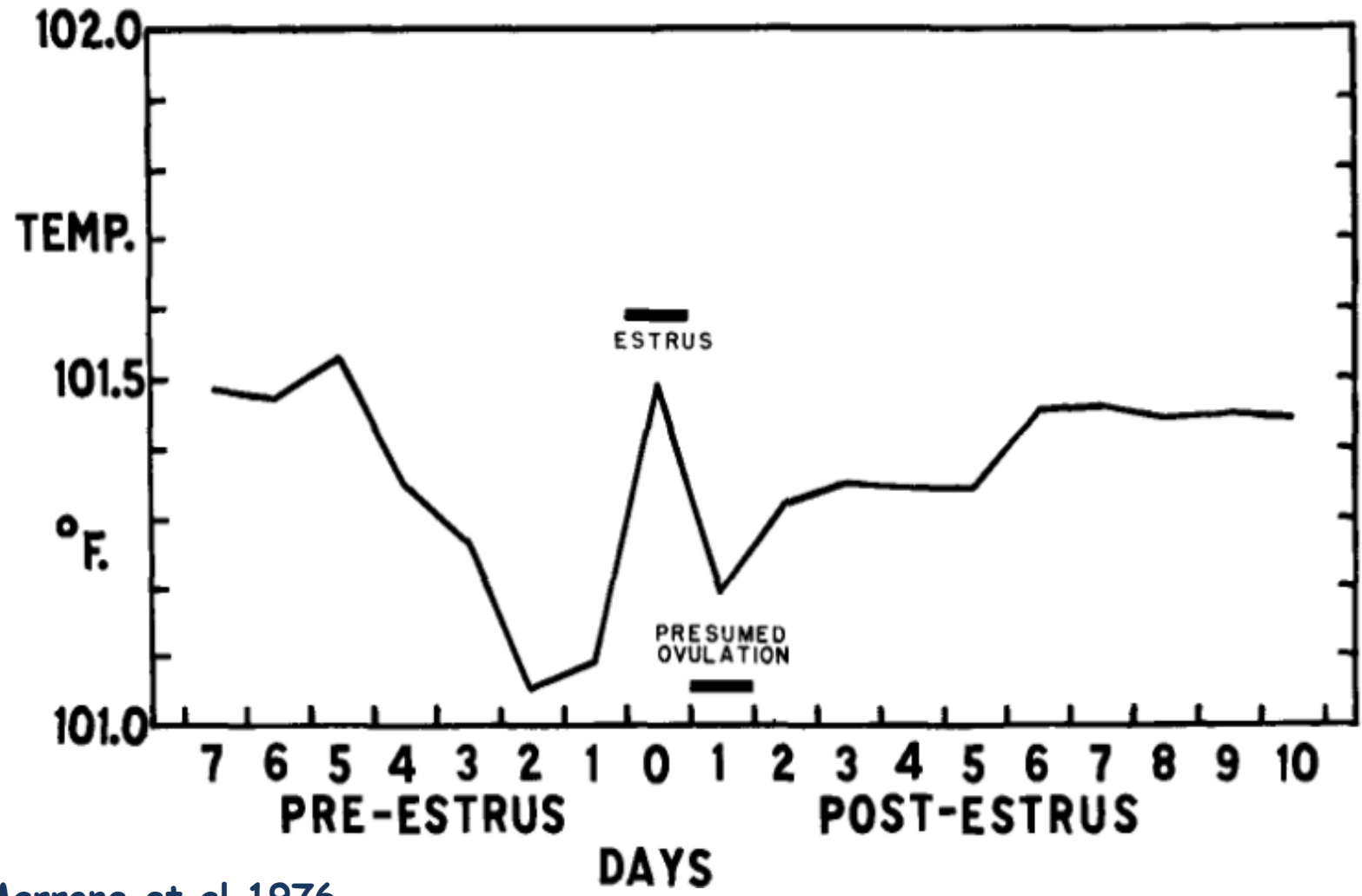
Differing letters within body location are different.



Results and discussion



➤ Body surface temperature: Contact device

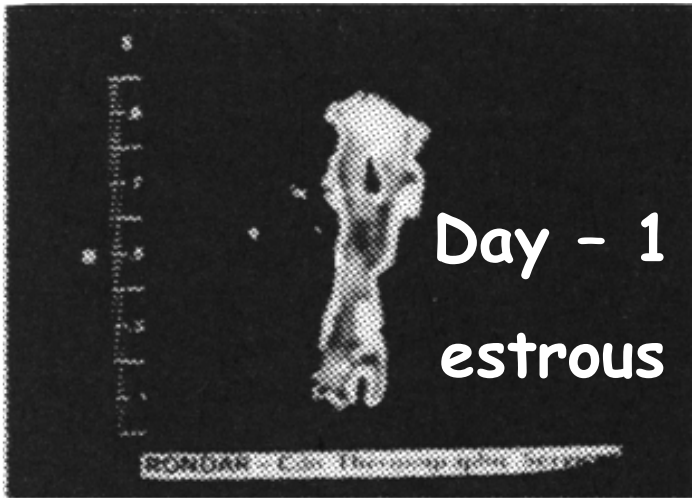


Marrone et al 1976

Results and discussion

➤ Body surface temperature: Infrared imaging

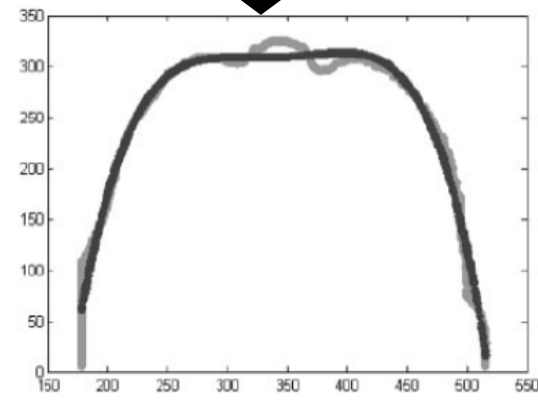
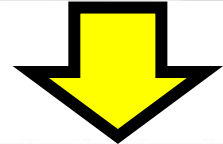
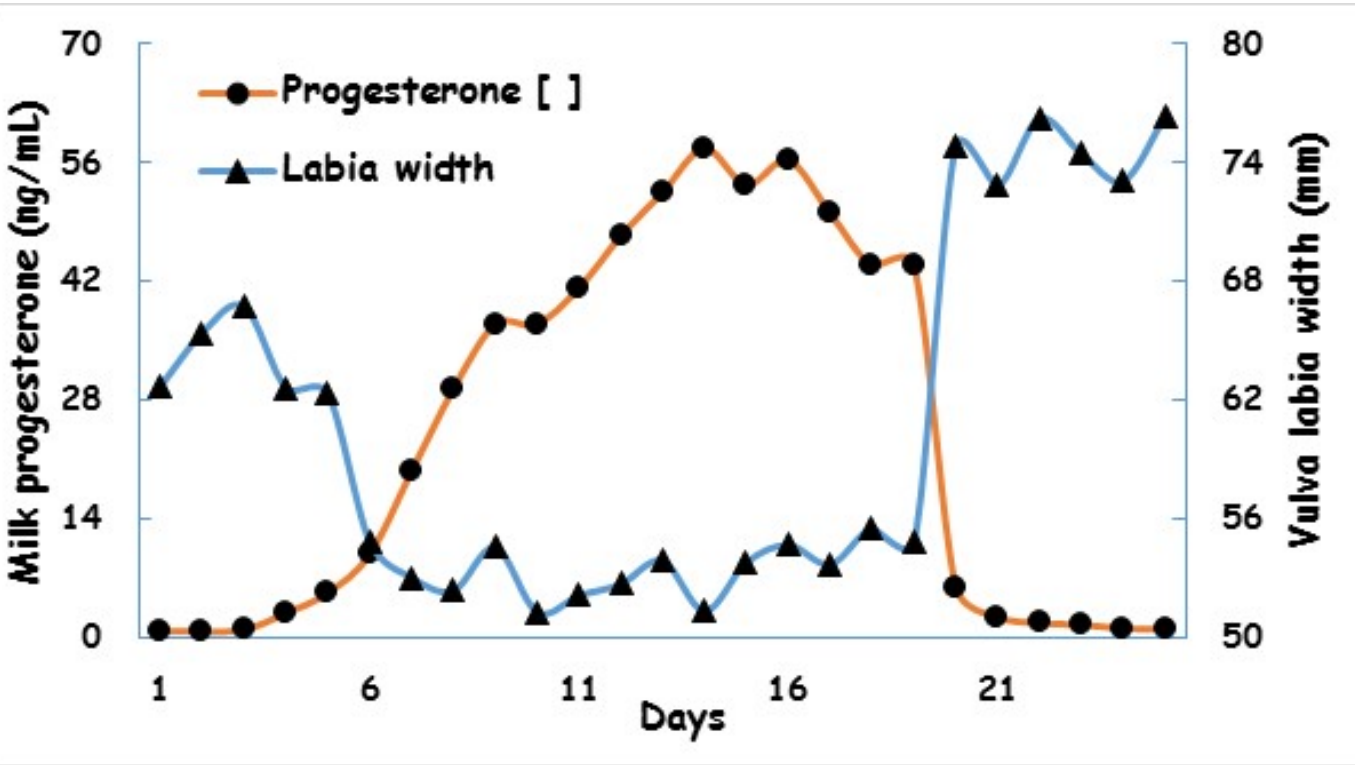
Location	Estrous	Non-estrous	P value
Foot	31.24	30.48	0.08
Flank	34.70	33.39	0.03
Vulva	34.41	33.90	0.11



Hurnik et al 1985

Results and discussion

➤ Vulva morphometry



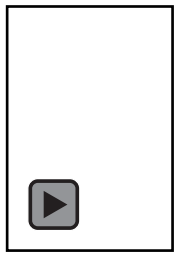
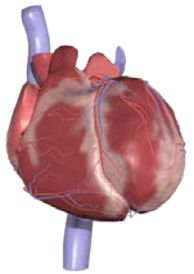
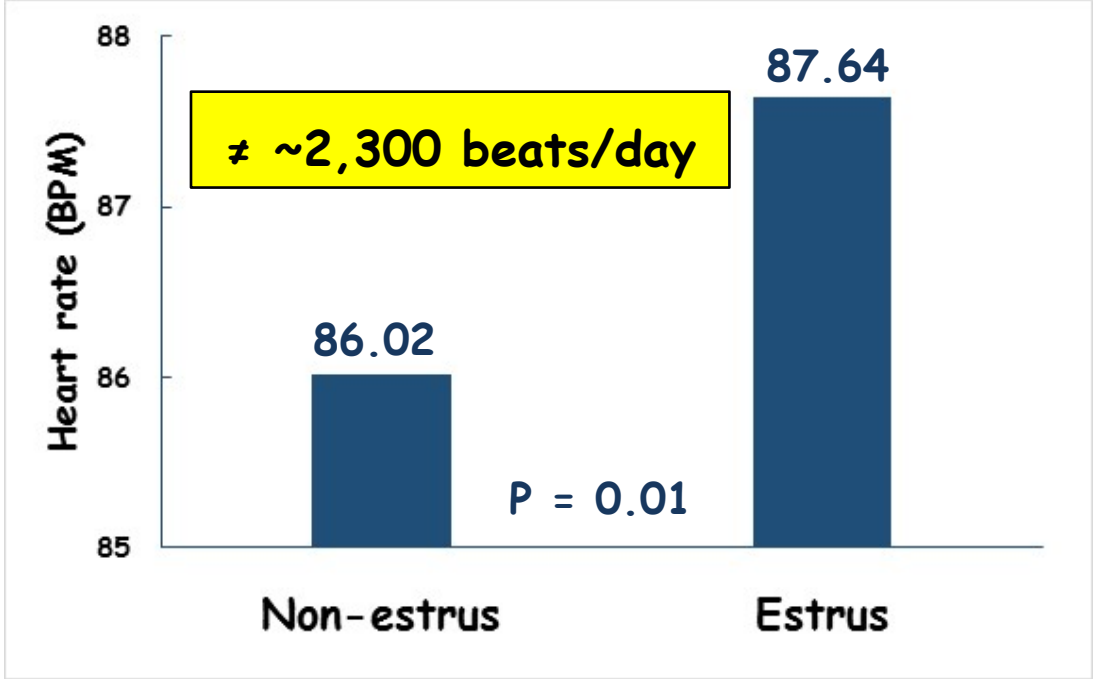
Halachmi et al 2008



Results and discussion

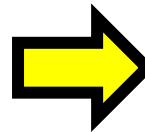


➤ Heart rate



Remarks

➤ Possibilities for inline milk analysis



➤ Possibilities for body surface temperature monitoring

➤ Technologies based on multi-proxies and multi-proxies with application for \$\$ / ENVIRO relevant traits.

Financial & technical support

