What Activity Monitors Can and Cannot Do Today

AMVPQ – ARC
Pre-Congress Seminar – Vetoquinol

Château Bromont, Bromont, QC
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R.L.A. Cerri, S. Moore, J. Marques, R. Conceição, A. Boyle, A. Bega, J. Denis-Robichaud, A. Madureira, T. Burnett, C. Baes, S. Leblanc, W. Heuwieser, S. Borchardt

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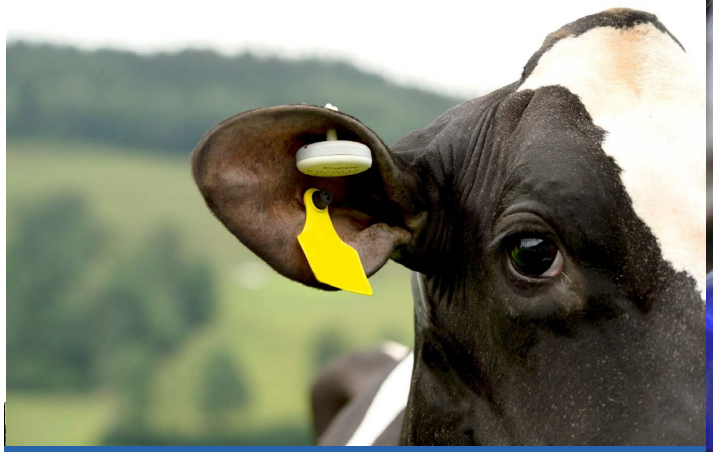
Outline

- Context
  - Validations
- Alerts and Intensity of Estrus
  - Programs (AI)
  - Associations with fertility (AI and ET)
- Interventions
  - Health data
  - Estrus prior to VWP
  - GnRH at AI
  - Genetic selection

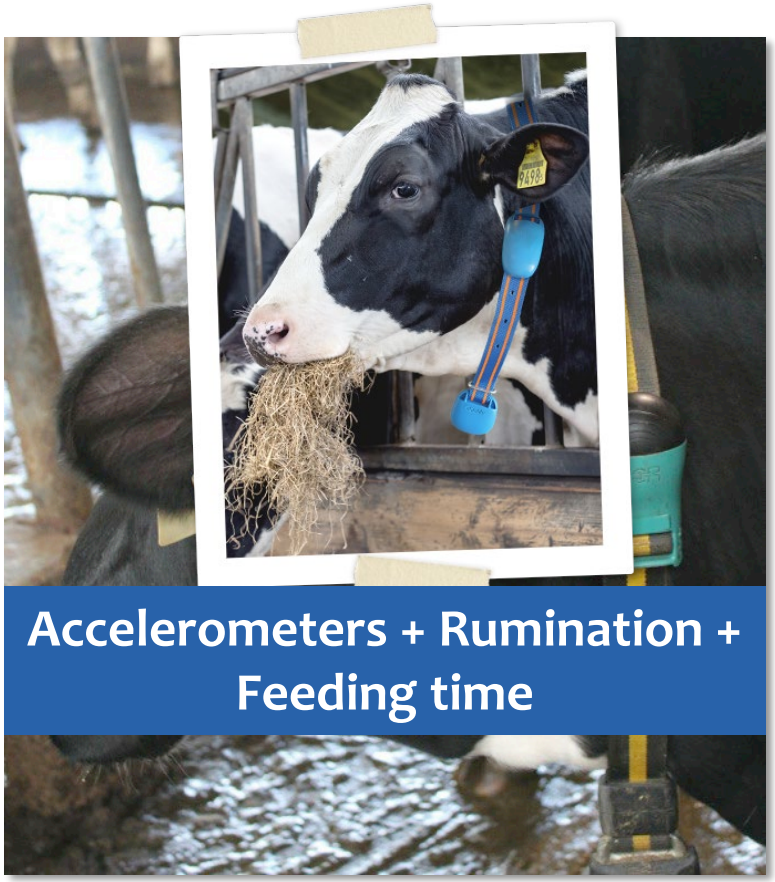
Precision Dairy Farming



Accelerometers + Rumination + GPS

Video Analysis

Pedometers + Lying time



Accelerometers + Rumination + Feeding time

Accelerometers + Rumination

Hardware and Software

- Sensor breaking
- Lost data
  - Caused by sensor malfunction
  - Caused by communication failure (wi-fi)
- Battery issues
- Reliability of alerts
- Integration
  - With other systems
  - Internal optimization

Activity Monitoring System Efficacy

Pedometry	CL regression only: Positive	CL regression only: Negative
Positive	93	0
Negative	43	29

Measure	%
Se	68.4
Sp	100.0
PPV	100.0
NPV	40.3
Accuracy	73.9

Pedometry	CL Reg. and Ovulation: Positive	CL Reg. and Ovulation: Negative
Positive	92	1
Negative	19	53

Measure	%
Se	82.9
Sp	98.1
PPV	98.9
NPV	73.6
Accuracy	87.9

Vilar et al. (University of Florida unpublished results)

Can we use sensors to detect resumption of cyclicity?

- 42.2 % of cows – false negative
- 15.9 % of cows – false positive

- Specificity – 84.0 %
- Sensitivity – 34.1 %

High specificity – effective detecting anovular cows
Low sensitivity – not effective detecting cyclic cows

Borchardt et al., 2023 (Abstract)

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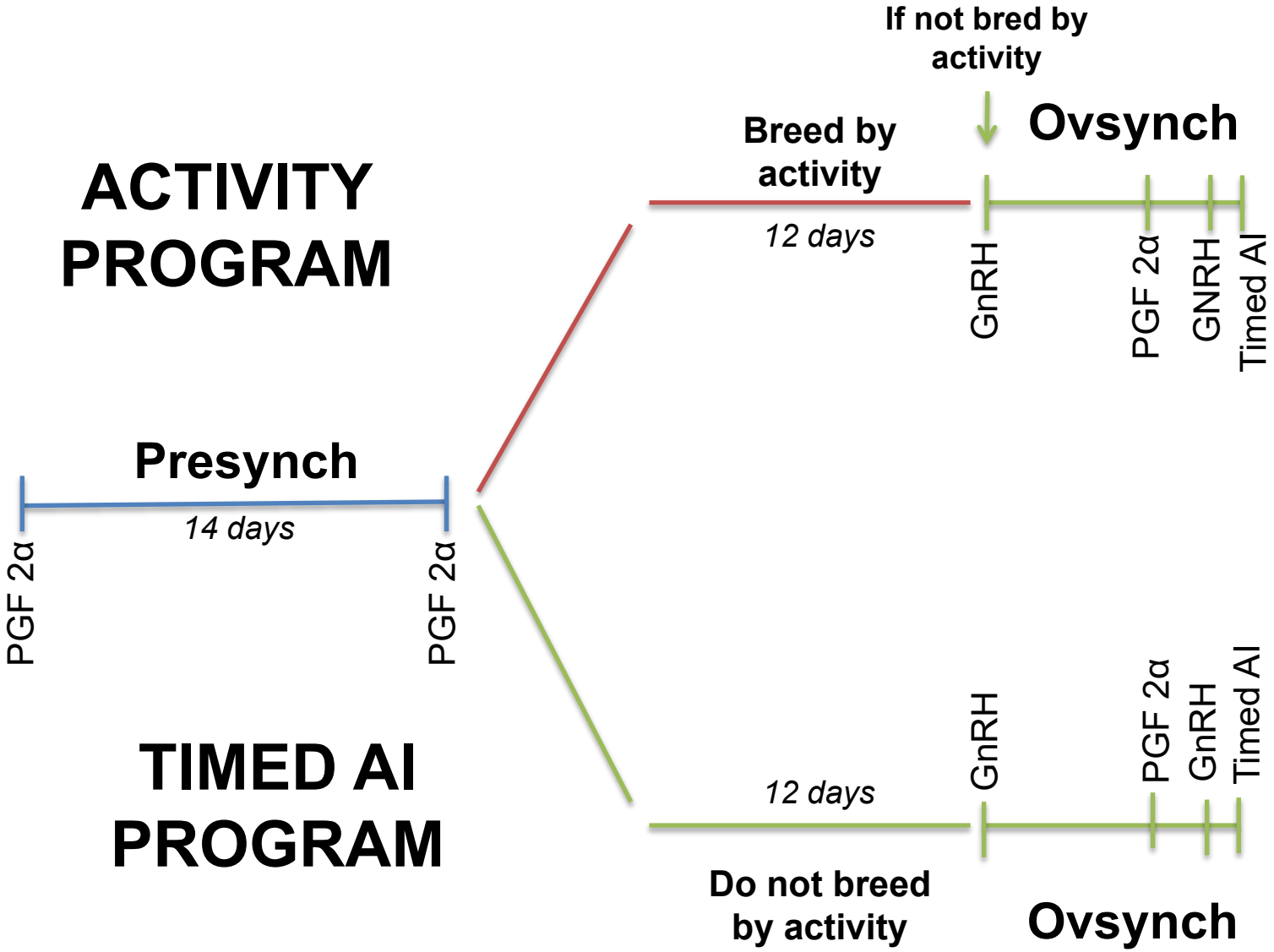
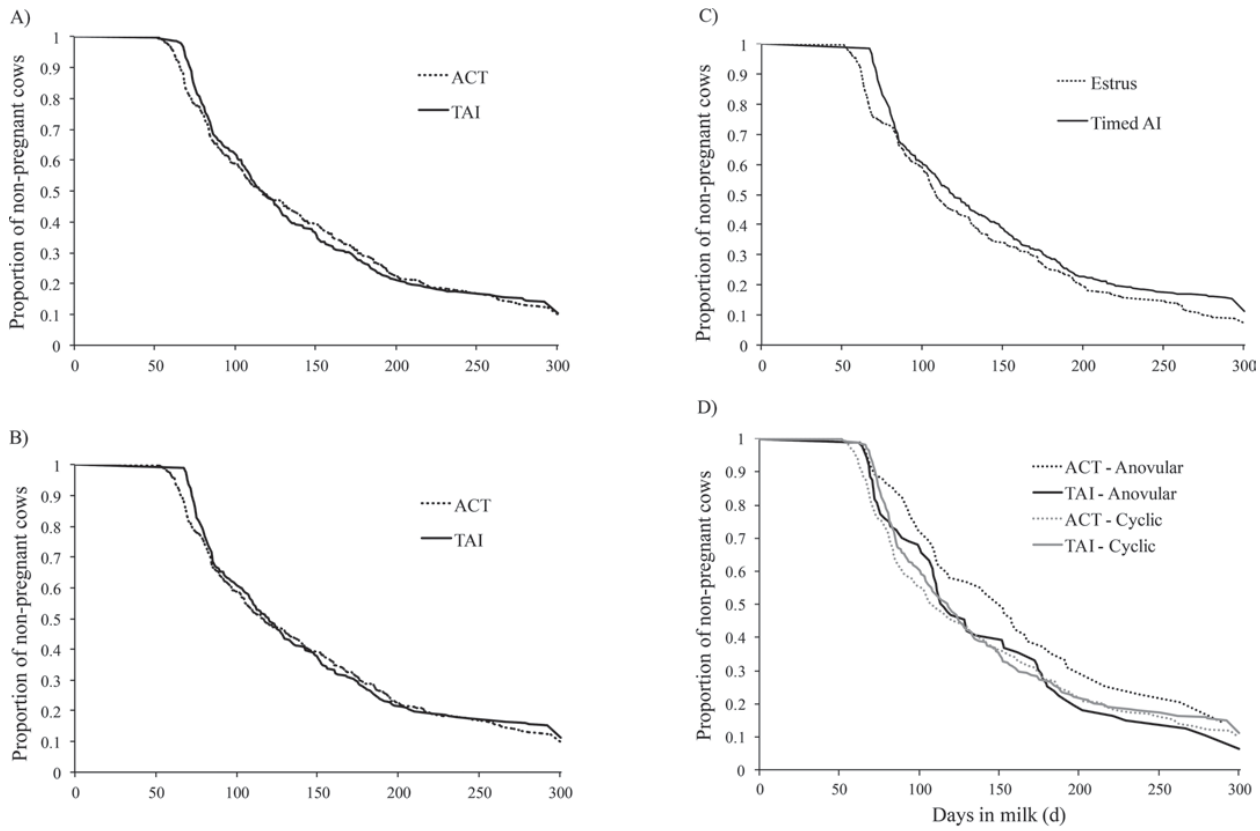
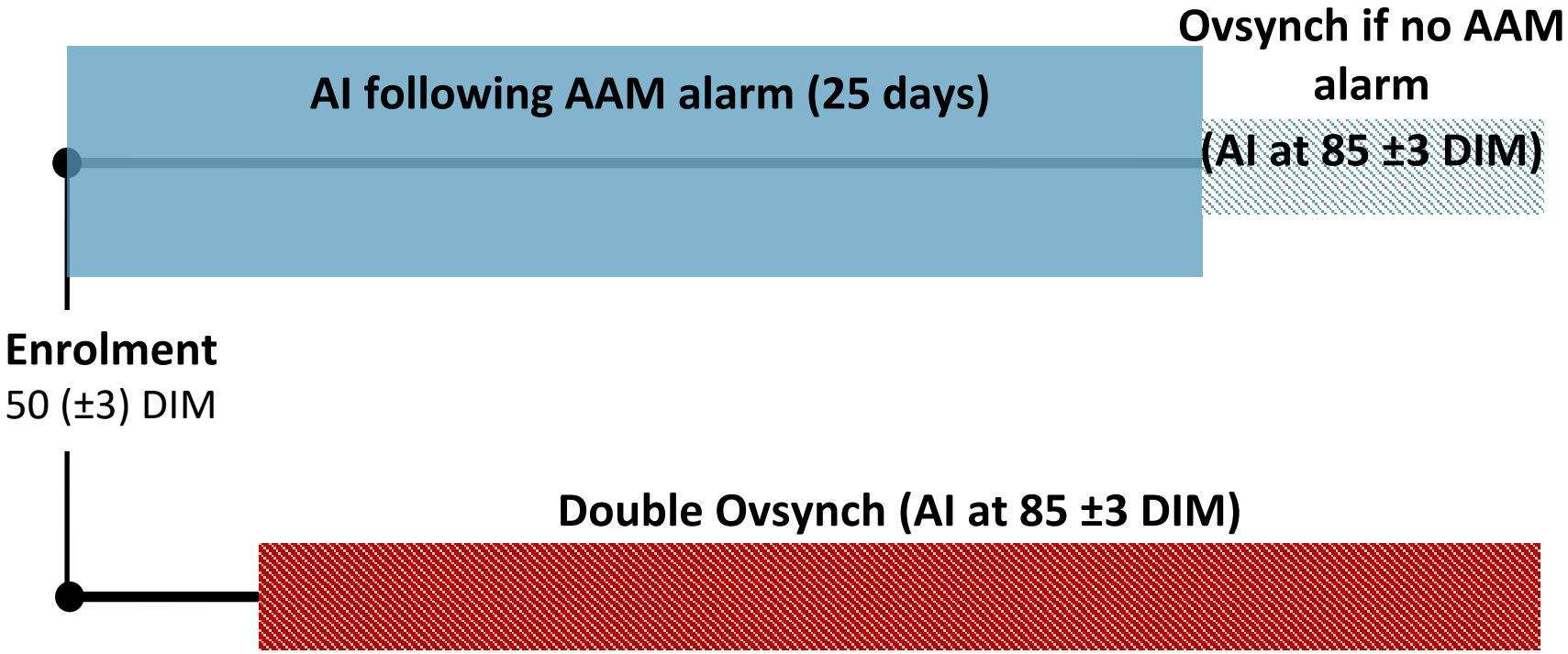


Burnett et al., 2017. J. Dairy Sci. 100:5005-5018



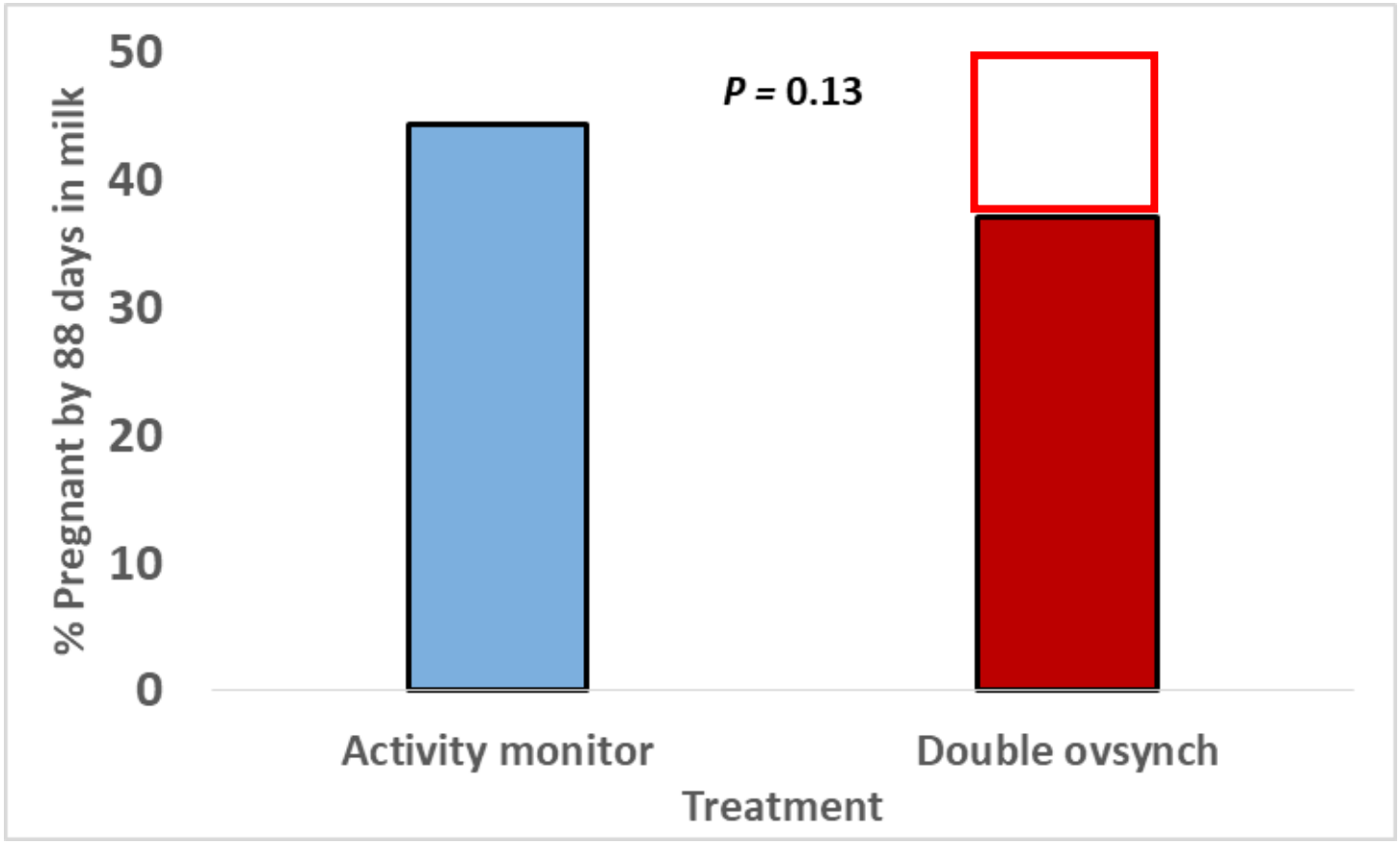
- Both reproduction programs had similar P/AI
- Breeding upon estrus or TAI generated similar P/AI
- Anovulation and health issues is more detrimental to estrus-based programs

Burnett et al., 2017. J. Dairy Sci. 100:5005-5018



Denis-Robichaud et al., 2018. J. Dairy Sci. 101:624-636

Possible to achieve top reproductive efficiency by optimizing detection of estrus



Denis-Robichaud et al., 2018. J. Dairy Sci. 101:624-636

J. Dairy Sci. 97:4296–4308
http://dx.doi.org/10.3168/jds.2013-7873

- VWP
  - Allowance for estrus detection
- Different Synch Protocols
  - Presynch/Ovsynch/Extras
- P/AI at 1st AI
  - Effect of DIM
- P/AI at 200 DIM and Days Open
  - Effect of several inseminations

n

of nonpregnant dairy cows at detected estrus resulted in similar reproductive performance to a program that favored timed artificial insemination

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Reproduction Programs

100% Double Ovsynch on 1st AI

Close to 100% Estrus Detection on 1st AI

DCRC

DAIRY CATTLE REPRODUCTION COUNCIL

http://www.dcrcouncil.org/

HOARD'S DAIRYMAN

The National Dairy Farm Magazine

Take Home Messages

* The combination of Estrus based AI and Timed AI still is the best approach.
  * Performance and economics.
* Further studies on identification of selective populations for TAI intervention are still underway. Decreasing interventions is likely the way to go.

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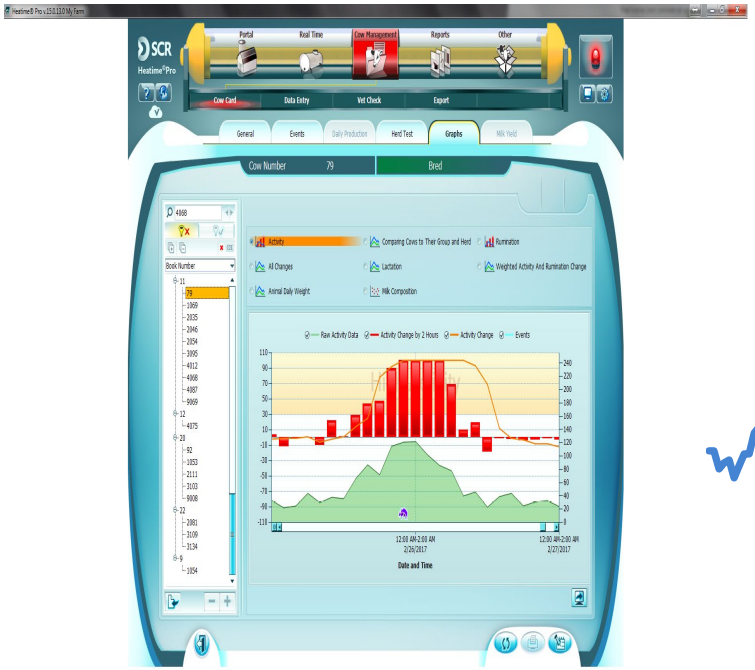
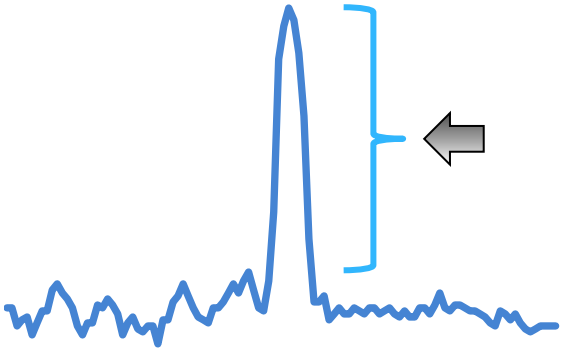
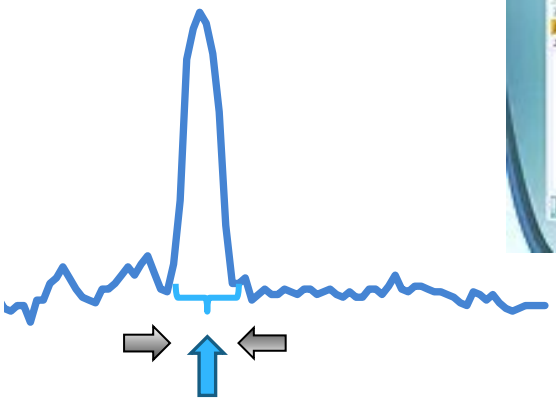
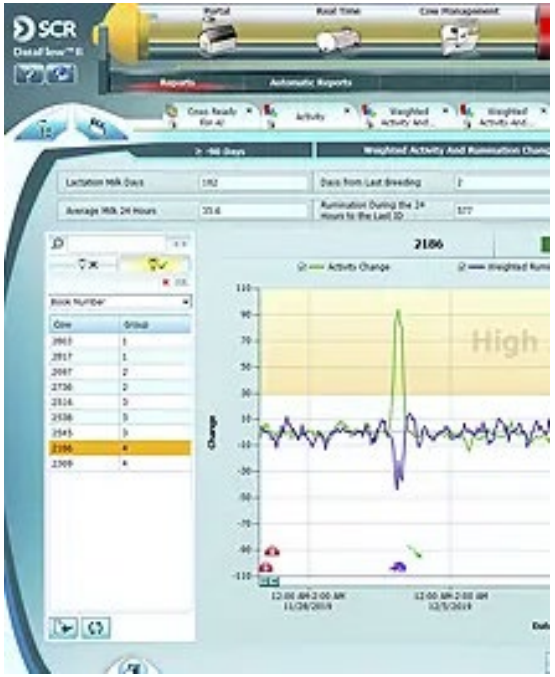
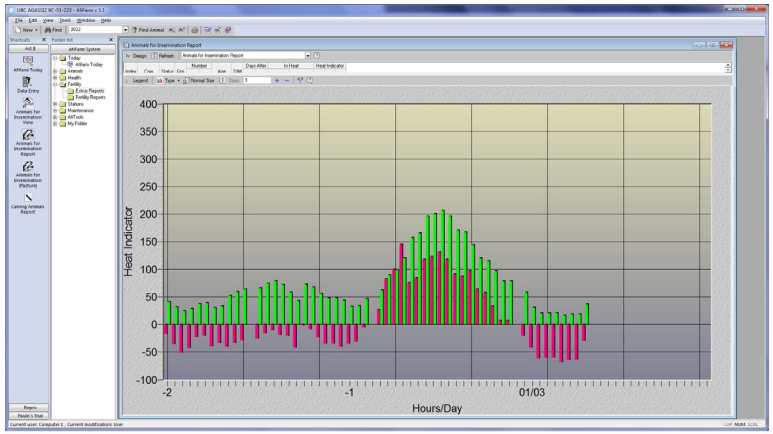
Intensity and Duration of Estrus





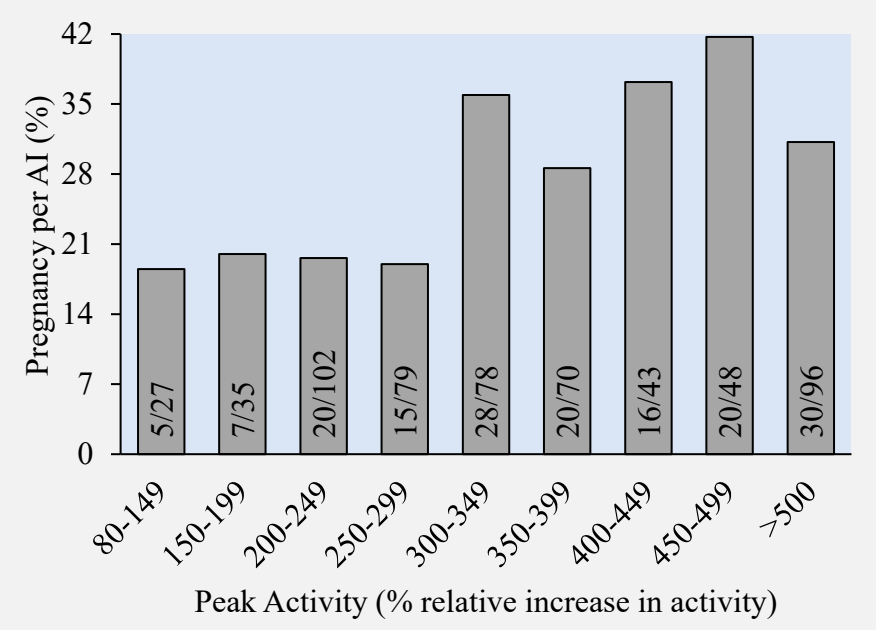




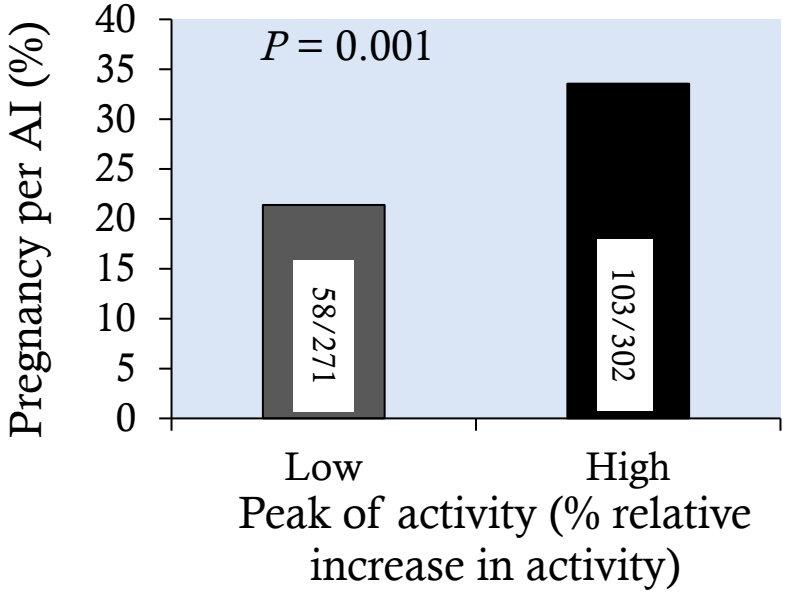


Pregnancy per AI – Canada Spontaneous Estrus

Distribution of P/AI according to peak activity during estrus:

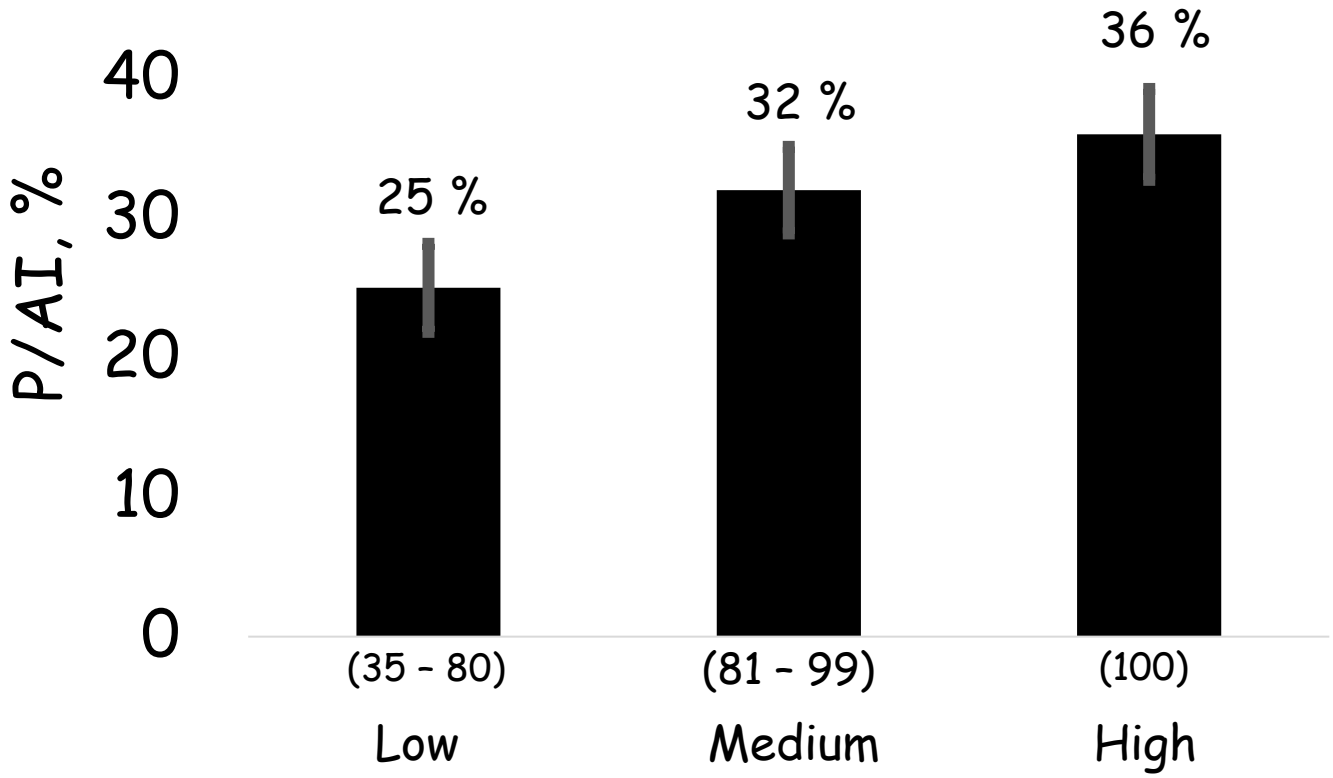


P/AI (%) according to categories of peak activity during estrus:



Madureira et al., 2015. J. Dairy Sci. 98:7003-14

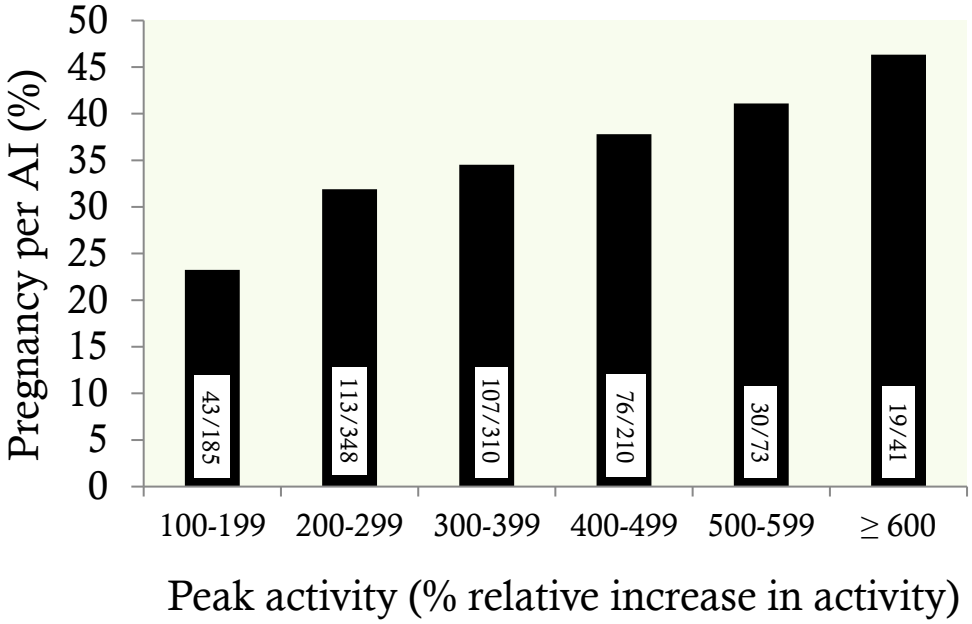
Pregnancy per AI – Germany
Spontaneous Estrus



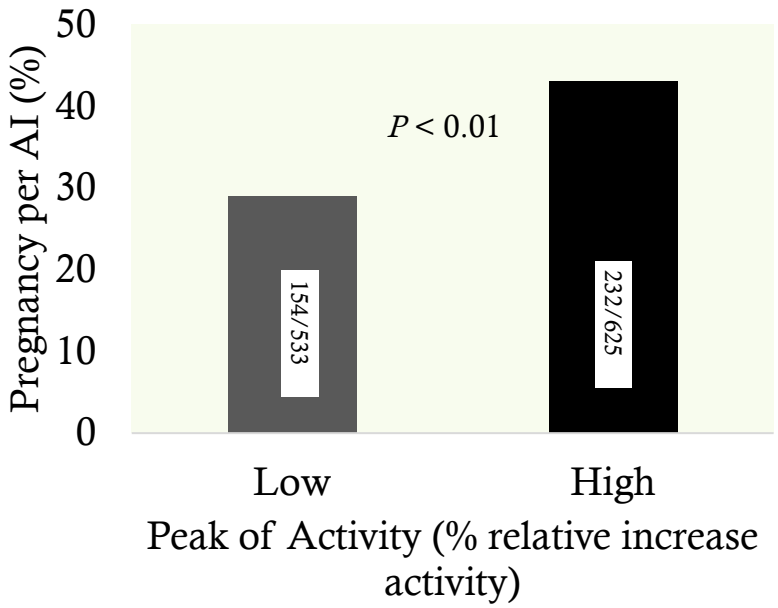
Slide gently ceded by S. Borchardt, Free University - Berlin

Pregnancy per AI – Brazil
ECP Induced Estrus

Distribution of P/AI according to peak activity during estrus:

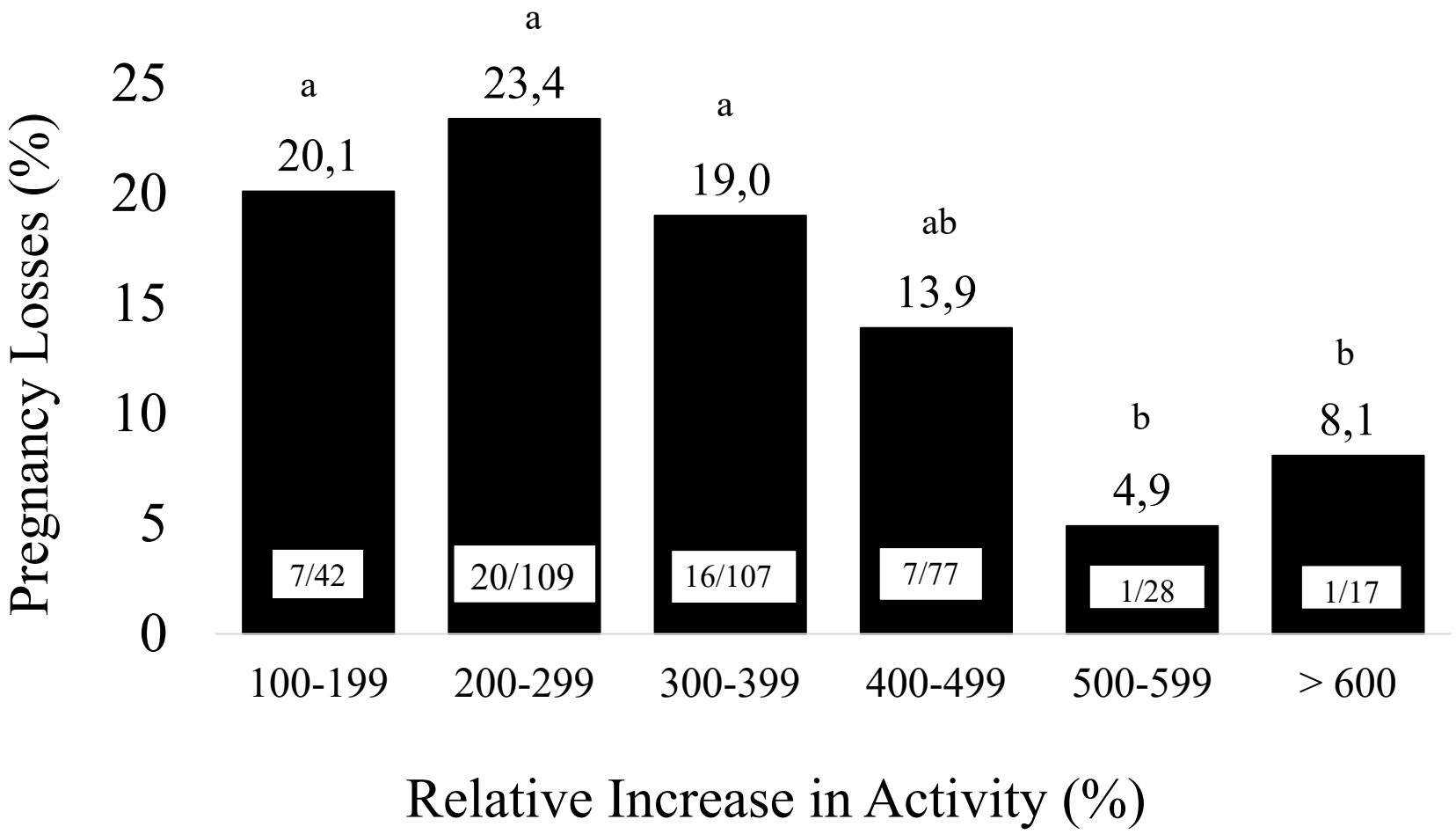


P/AI (%) according to categories of peak activity during estrus:



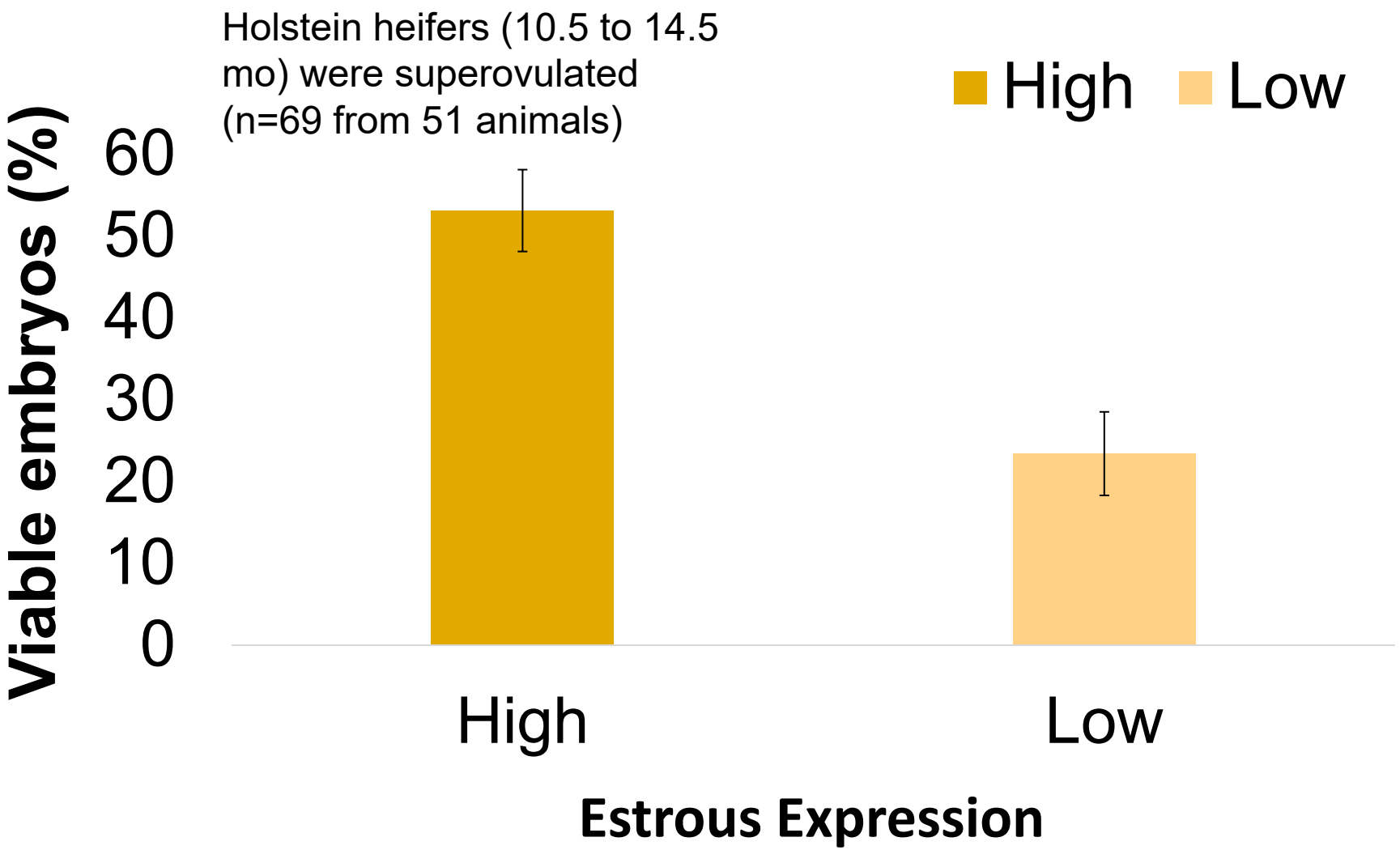
Madureira et al., 2019. J. Dairy Sci. 102:3598-3608

Distribution of pregnancy losses (%) according to relative increase in activity during estrus



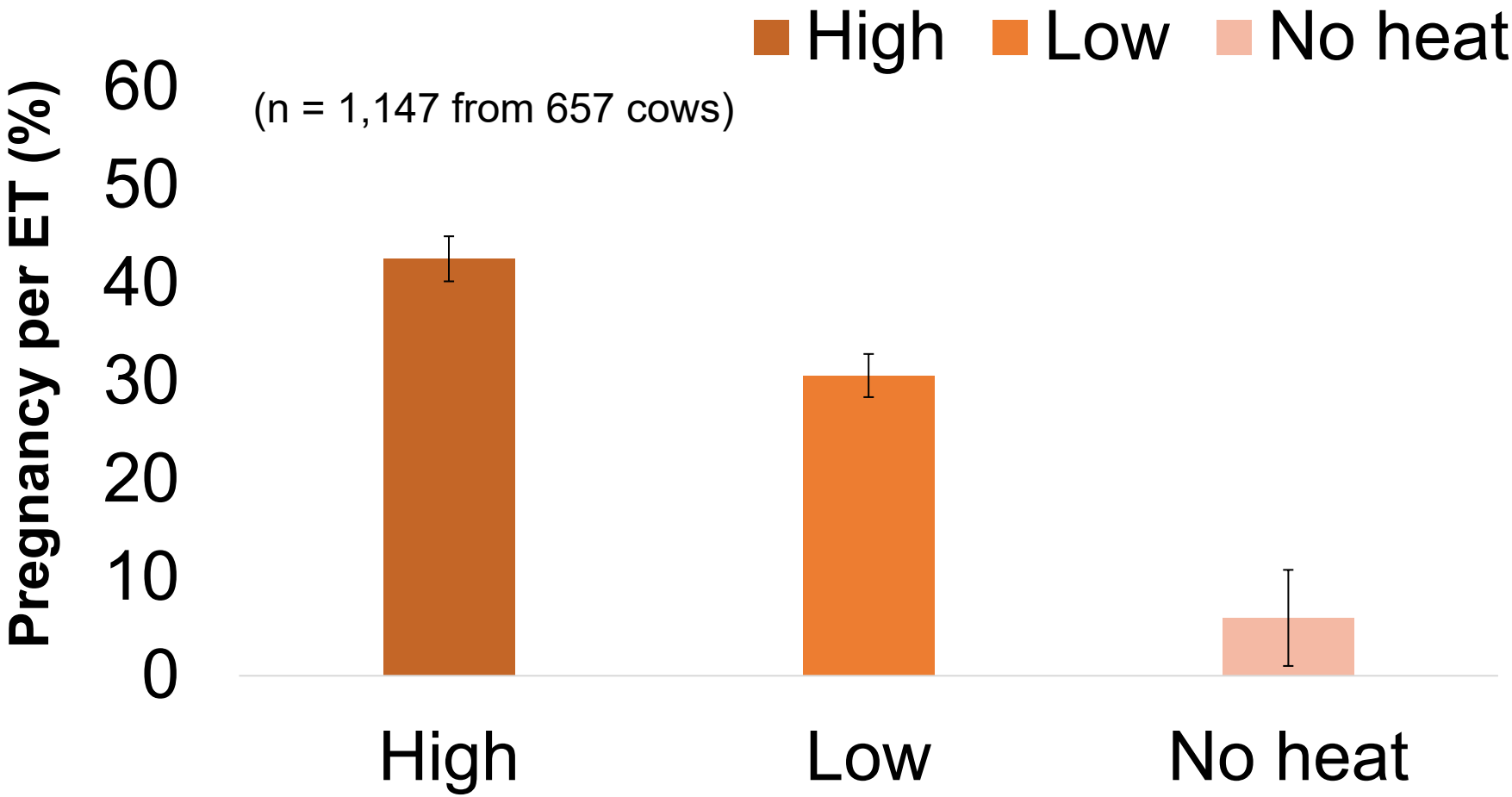
Madureira et al., 2019. J. Dairy Sci. 102:3598-3608

Increased Percent Viable Embryos



Madureira et al., 2020. J Dairy Sci. 103:5641-5646

Increased Pregnancy per Embryo Transfer



Madureira et al., 2020. J Dairy Sci. 103:5641-5646

Dairy heifers between 10 -12 months old Superovulation Protocol

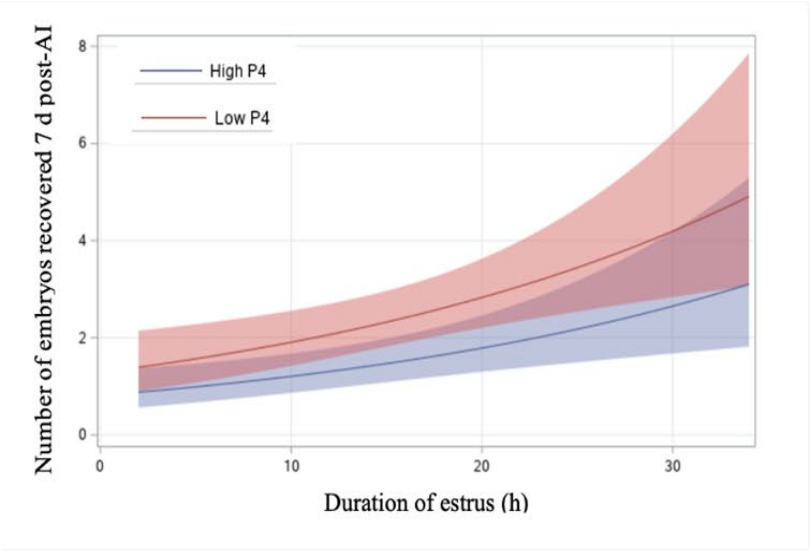
Results

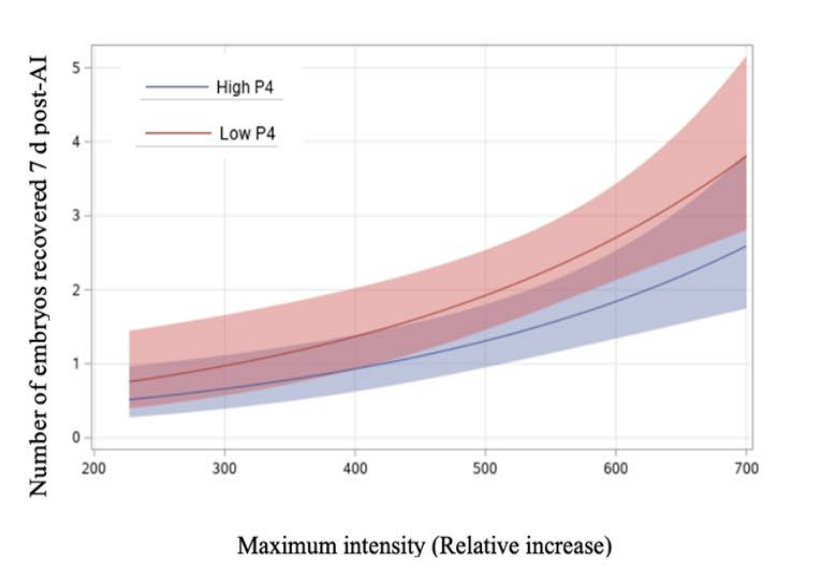
- *Estrous expression and embryo*

No effect on embryo stage ($P = 0.32$) or quality grades ($P = 0.45$).

However, the total number of embryos recovered 7d post-AI was found to be affected by estrus expression measurements ($P < .0001$).

n = 42 flushed heifers





Marques et al., 2023 (submitted)

Take Home Message

- Estrus is indeed important for fertility
- Not all estruses are equal
- Intensity of estrus and duration (captured by activity monitors) have a direct association on P/AI
- Association with P/AI, P/ET and pregnancy loss

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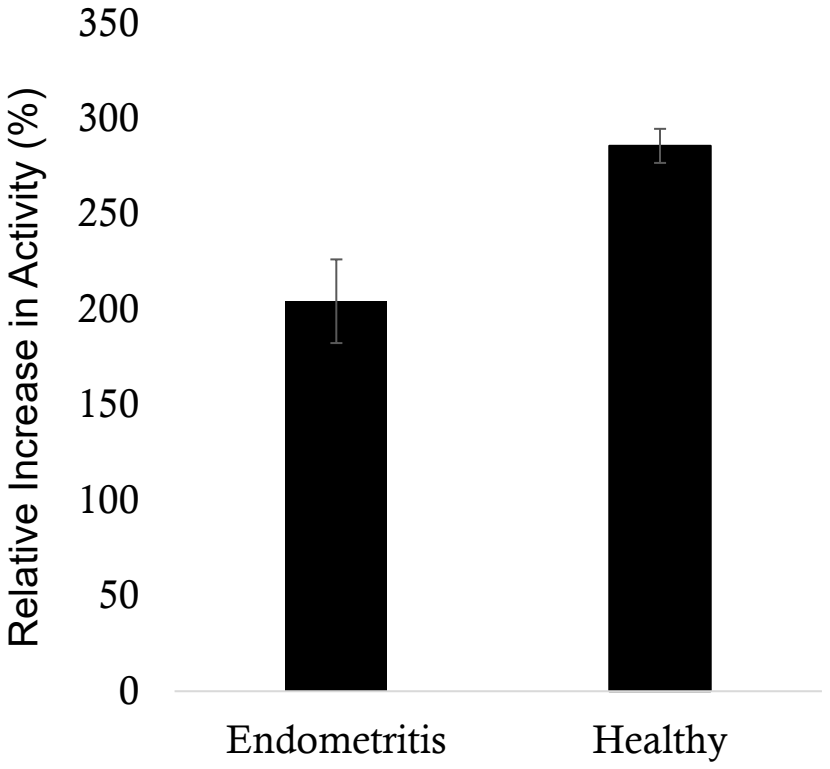
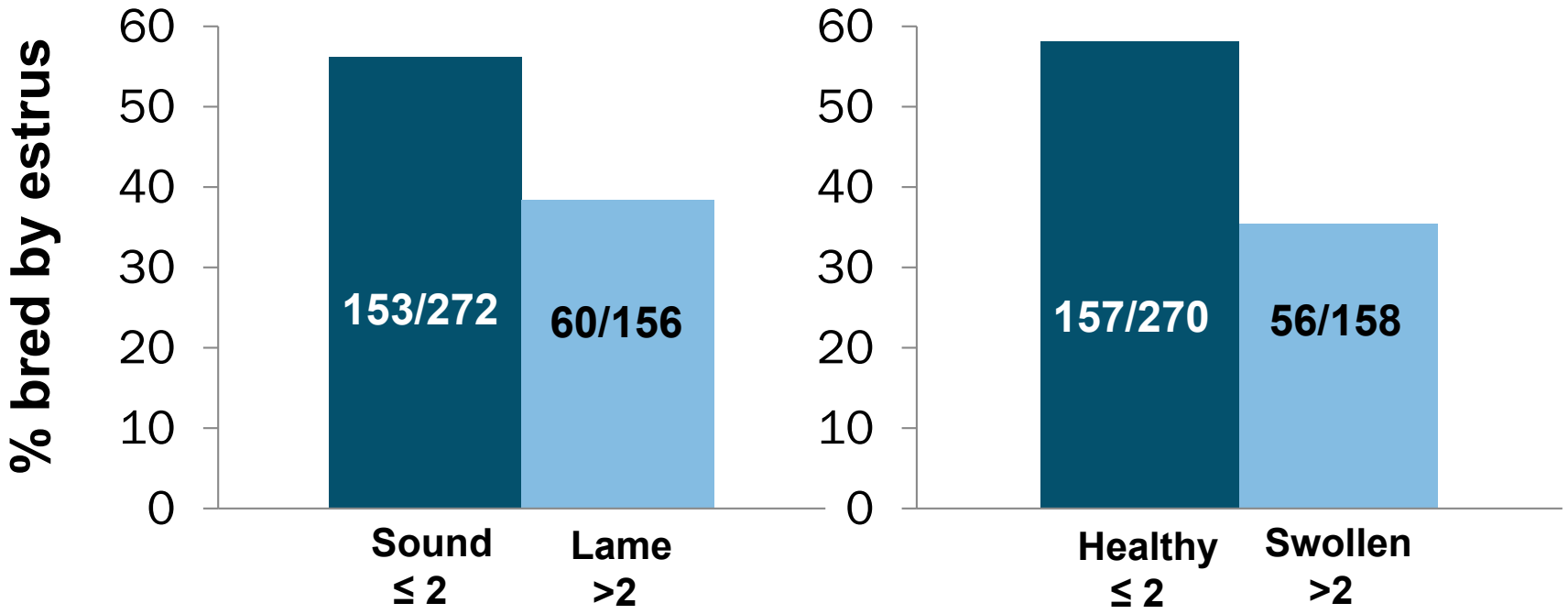
Heat Detection and Intensity in Cows Diagnosed with Endometritis

74.7% of animals with endometritis did not display estrus by 30 DIM



Madureira et al., 2017. J. Dairy Sci

Foot and Leg Problems Reduced Heat Detection by Automated Monitors



Burnett et al., 2018. J. Dairy Sci.

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J. Dairy Sci. 104:9195–9204
https://doi.org/10.3168/jds.2020-19705

Association of estrous expression detected by an automated activity monitoring system within 40 days in milk and reproductive performance of lactating Holstein cows

S. Borchardt,[1]* C. M. Tippenhauer,[1] J.-L. Plenio,[2] A. Bartel,[2] A. M. L. Madureira,[3] R. L. A. Cerri,[3] and W. Heuwieser[1]
[1]Clinic of Animal Reproduction, Freie Universität Berlin, Königsweg 65, 14163, Berlin, Germany
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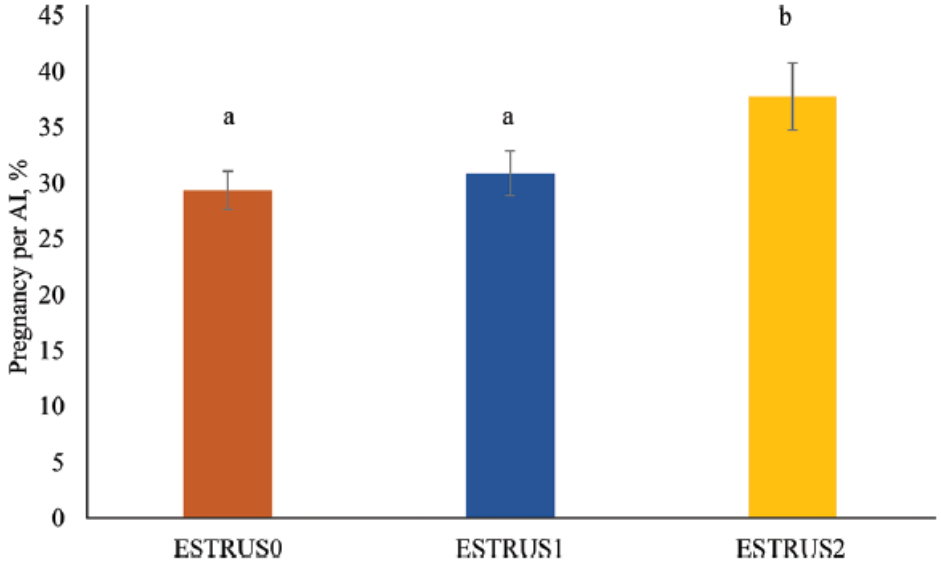
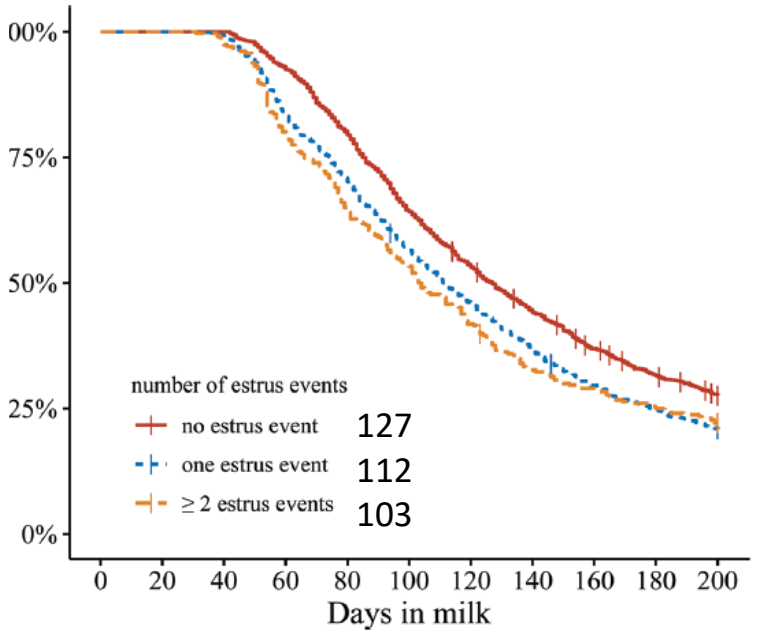
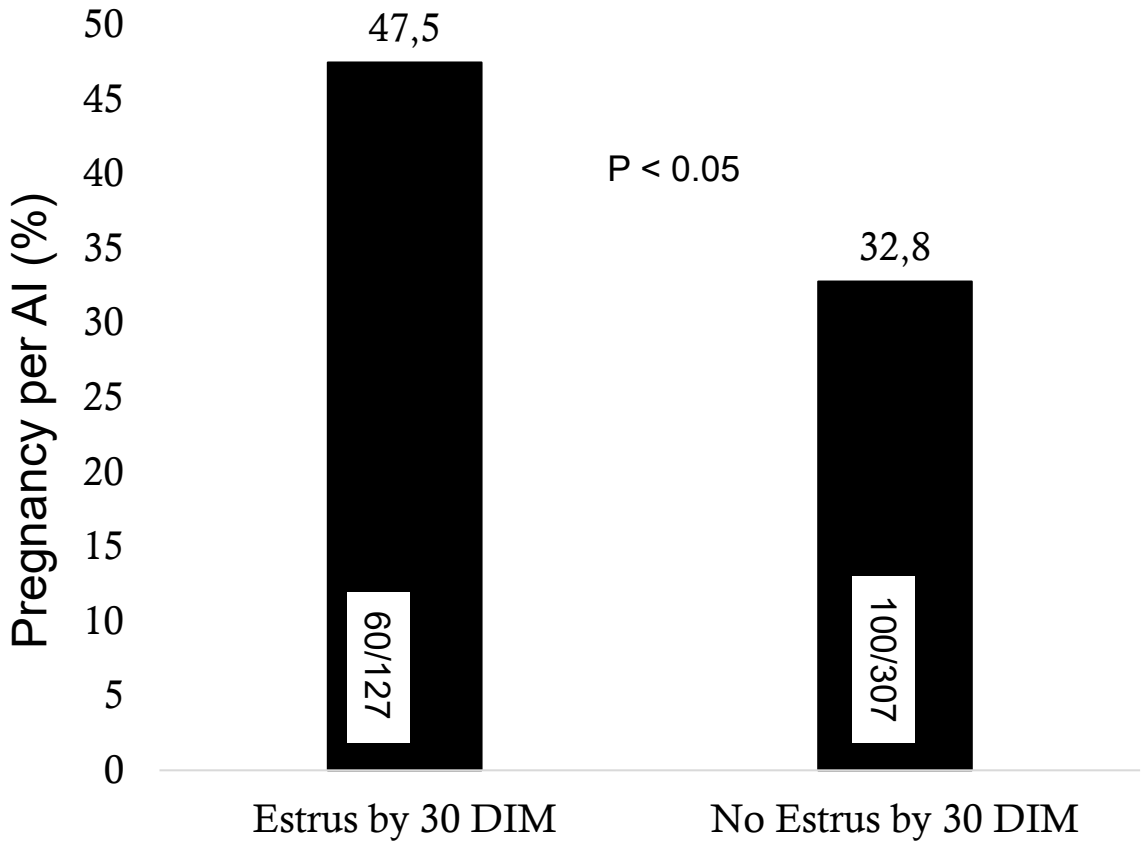
[3]Faculty of Land and Food Systems, University of British Columbia, Vancouver, Canada V6T 1Z4





Pregnancy per AI at 1st AI According to Estrus Detection before 30 DIM



Madureira et al., 2017. J. Dairy Sci

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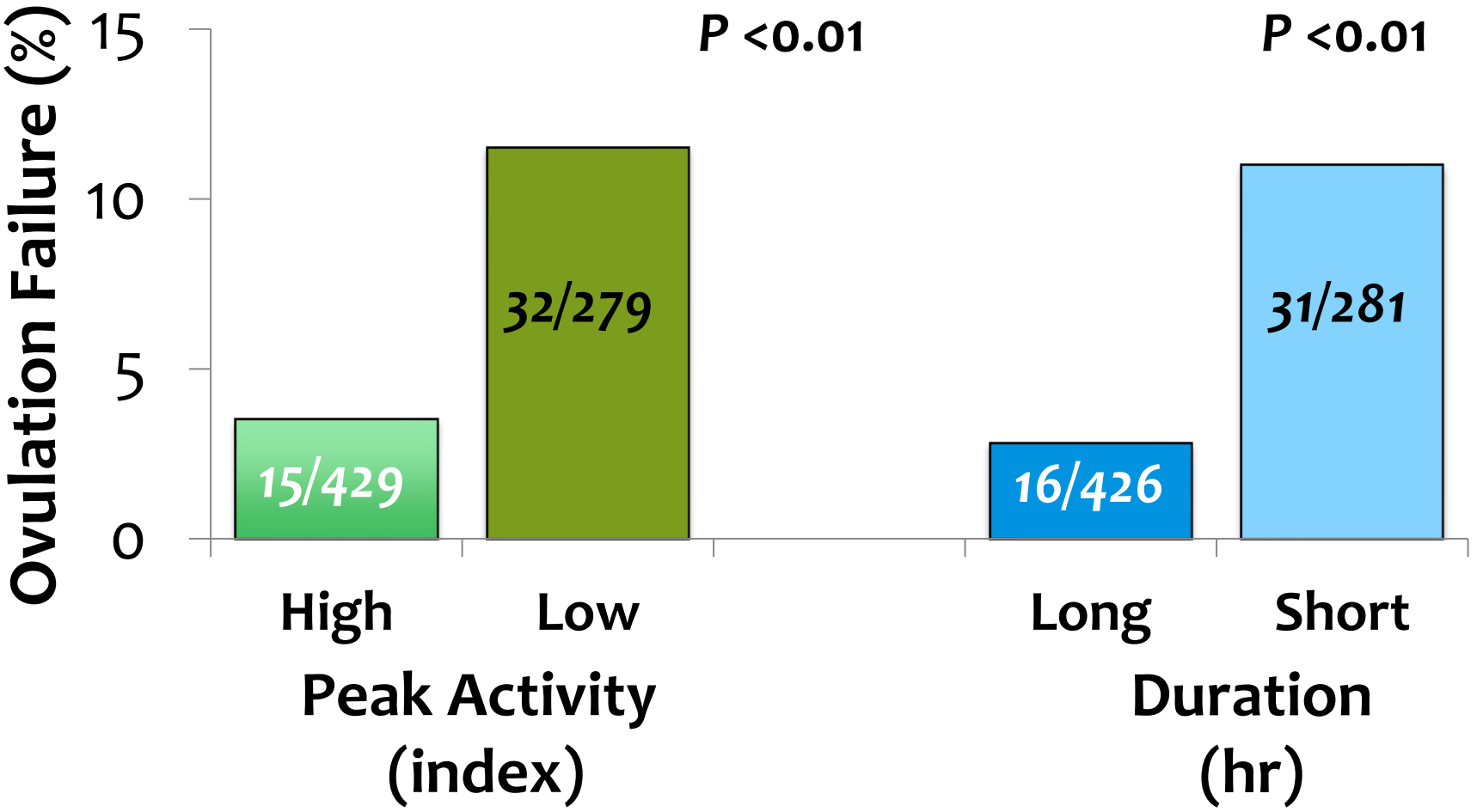
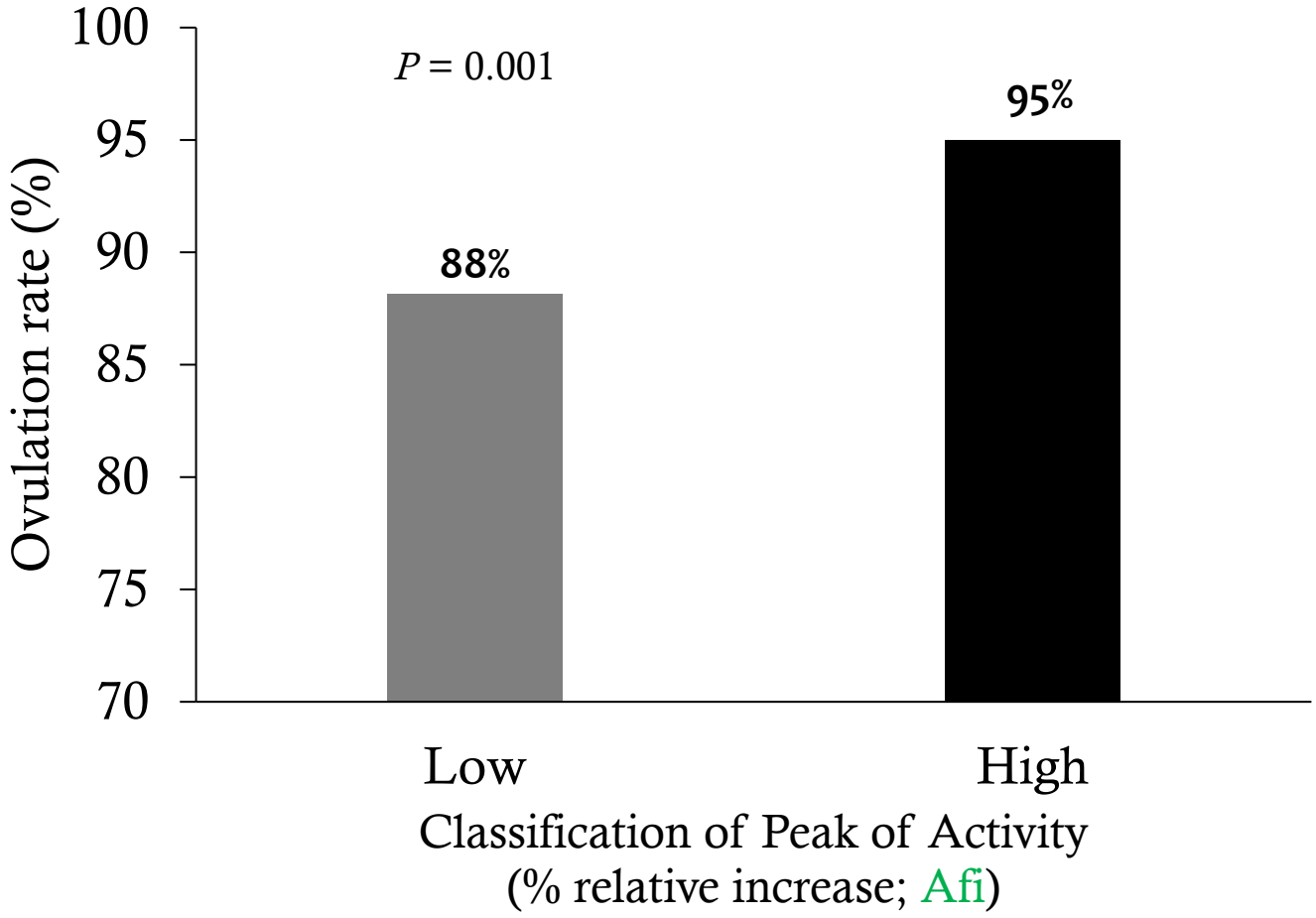
Reduced estrous expression resulted in more failed ovulations



Burnett et al., 2018. J. Dairy Sci. 101:11310-11320.

Ovulation rate from cows with different intensity of activity at the moment of estrus
Induced estrus (ECP)



Madureira et al., 2019. J. Dairy Sci. 102:3598-3608

Dealing with Ovulation

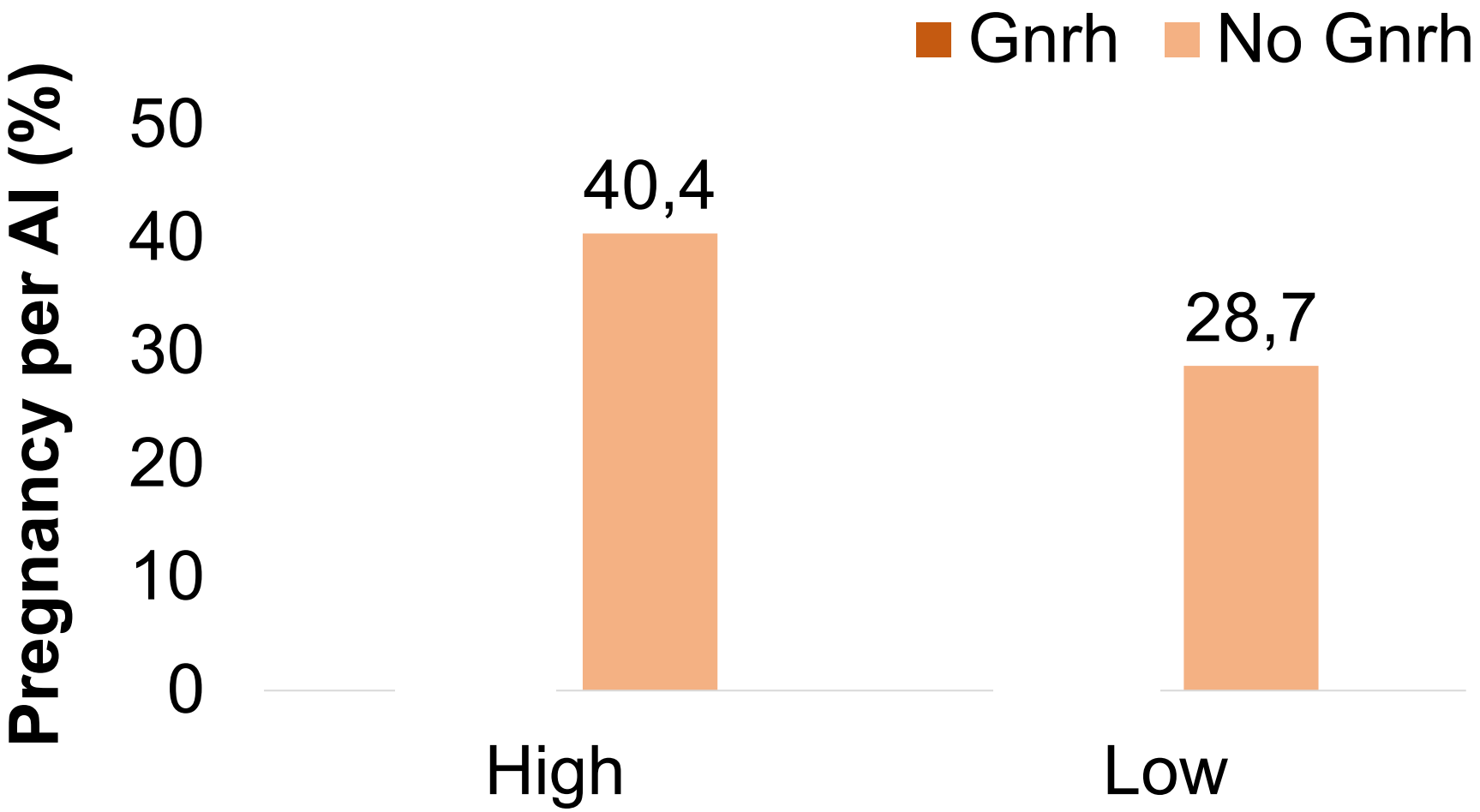
- GnRH would help cows with low estrous expression but would not impact those with high estrous expression

- Enrolled cows on three different farms
  Created 4 groups based on estrous expression and administration of GnRH at breeding:

  ✓ High estrous expression WITH GnRH
  ✓ High estrous expression WITHOUT GnRH
  ✓ Low estrous expression WITH GnRH
  ✓ Low estrous expression WITHOUT GnRH

Burnett et al., 2022. J. Dairy Sci. 105:1743-1753

Results - All Farms



Burnett et al., 2022. J. Dairy Sci. 105:1743-1753

Take Home Messages

* Automated records of postpartum estrus episodes could be used for management decisions
* Addition of GnRH at AI in cows detected in estrus seems to significantly increase P/AI. More so in estrus episodes of Low intensity
* The use of sensor data to select recipient cows can be a practical tool to improve P/ET or other value-added technology

THE Resilient Dairy GENOME PROJECT

http://www.resilientdairy.ca/

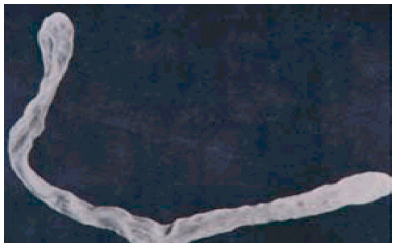
Factors that may help explain why high intensity estrus was associated with increased fertility at AI and ET

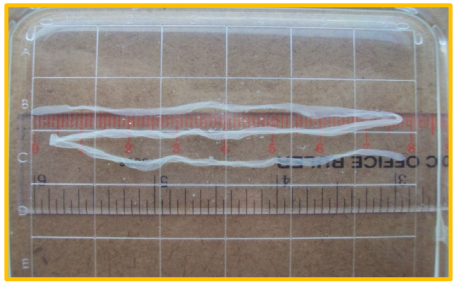
- Follicle and estradiol? Weak to no association
- Endometrium/Early embryo? Yes/ Association to estrus
- Progesterone? Yes/Cause-Effect
- Ovulation? Yes/Association

Ovarian and Conceptus Parameters Associated with Estrous Expression - Day 19 of Gestation

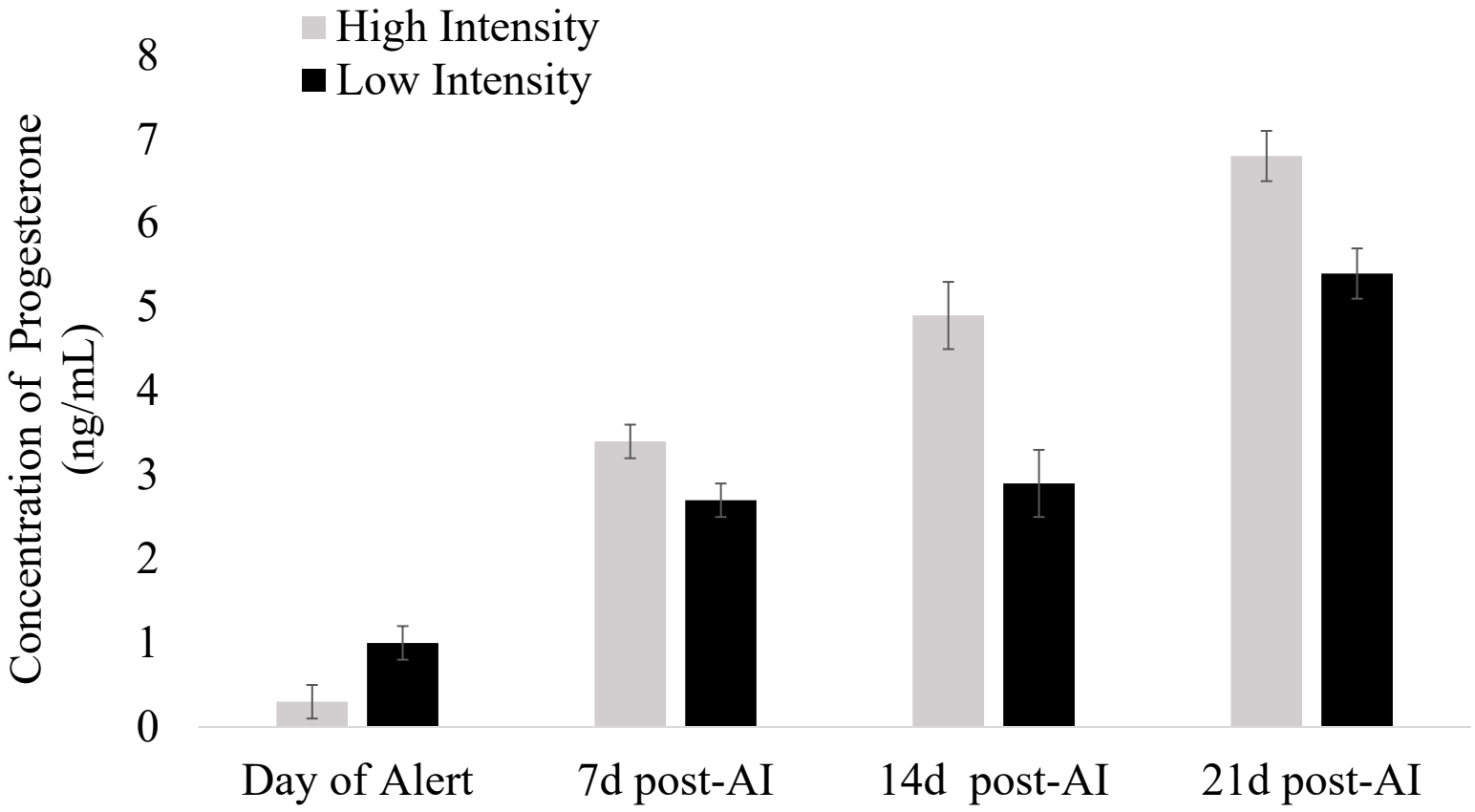
Parameteres	Estrus cows	Non-Estrus cows	*P*-value
Body condition score (1 – 5 scale)	3.30 ± 0.10	3.45 ± 0.10	0.10
Follicle diameter (mm)	14.0 ± 1.0	14.2 ± 1.0	0.89
Progesterone on d 7 (ng/mL)	3.8 ± 0.9	5.2 ± 1.0	0.34
Progesterone on d 18 (ng/mL)	3.9 ± 0.7	4.4 ± 0.8	0.62
Corpus luteum diameter on d 7 (cm)	6.9 ± 0.8	8.8 ± 0.8	0.10
Corpus luteum diameter on d 18 (cm)	10.5 ± 1.0	9.4 ± 1.0	0.45
Conceptus length (cm)	38.3 ± 2.8	28.2 ± 2.9	0.02
IFNT concentration (pg/mL)	8.3 ± 1.7	10.2 ± 1.9	0.47

Davoodi et al., 2016. Theriogenology 85:645-655



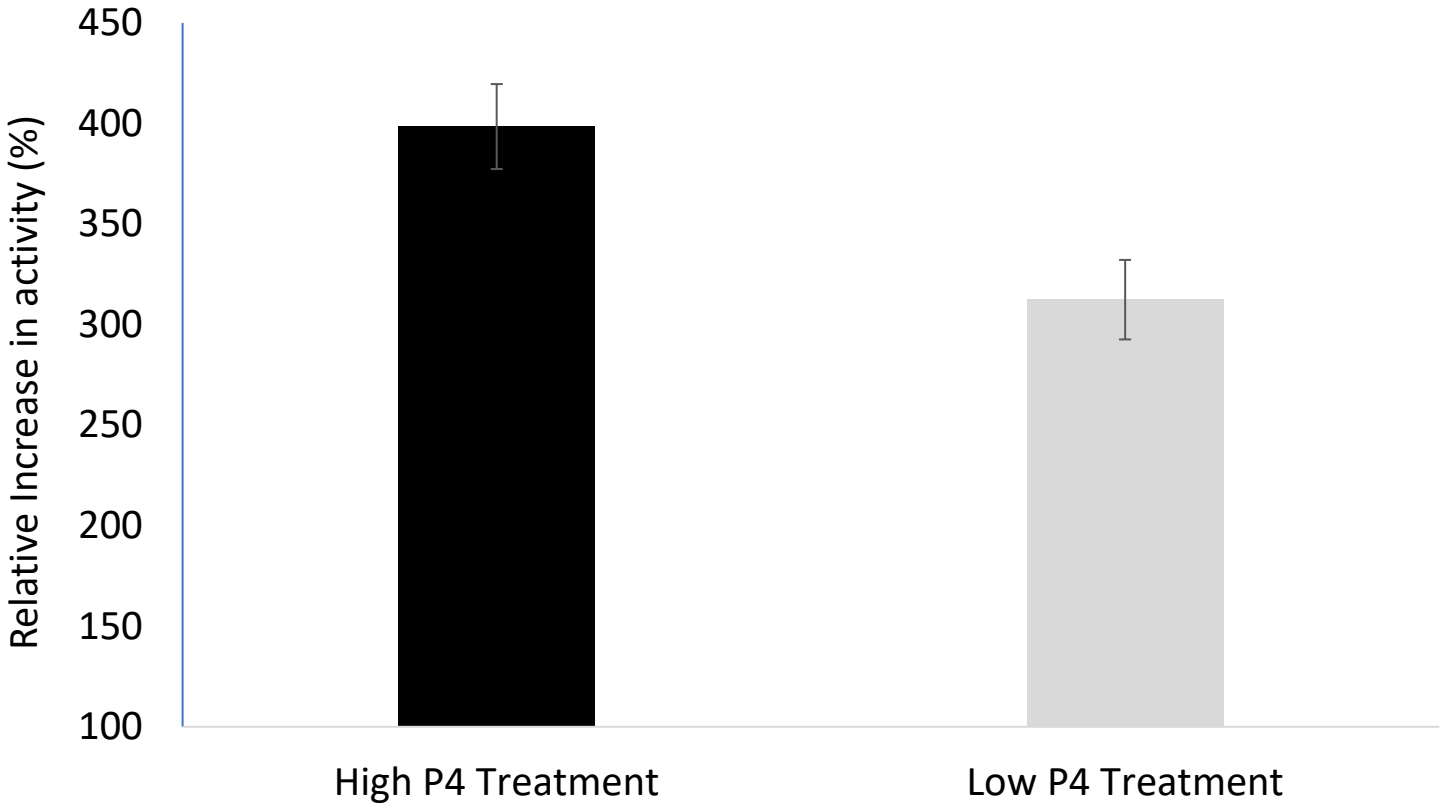


Concentration of P4 according to the intensity of estrus



Madureira et al., 2021. PLOS One 9;16(8)

Intensity of Estrus by Treatment



Conceição et al., 2023 in preparation

Effect of Progesterone Treatment on Estrous Expression in Heifers

Main Objectives

Ovulation Timing

Alert to Ov: HR=0.21 p=0.49

ECP to Ov: HR=0.60 p=0.06

Estrous Expression

PG to Alert: HR = 2.12, 95% CI = 1.14–3.95;

P = 0.02

P4 on d 0

P4 was lower after the high treatment than the treatment

P4 on d 7

There was no difference in P4 on d 7.

		PP			
Outcome	Treatment Classification	Marginal Means	SE	P-value	n
Relative Increase (index)	High	411.7	27.3	0.04	22
	Low	335.4	27.3		
Duration (hrs)	High	18.9	0.89	0.13	23
	Low	17.1	0.89		

Boyle et al., 2023 (in preparation)

Estrus-Sensor Phenotypes

1

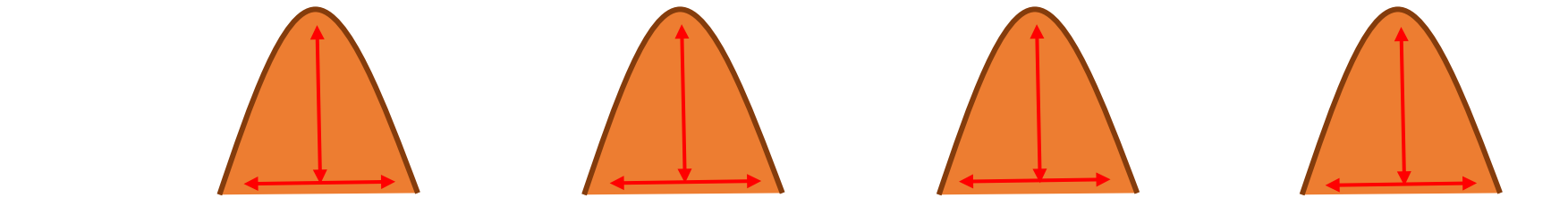
1st estrus event
- Days in milk
- Intensity

2

Intensity of estrus
- Relative increase
- Duration

3

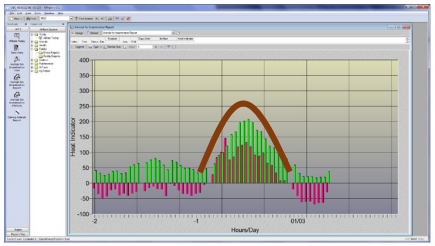
Repeatability
- First 3-4 episodes
- Combination



Calving

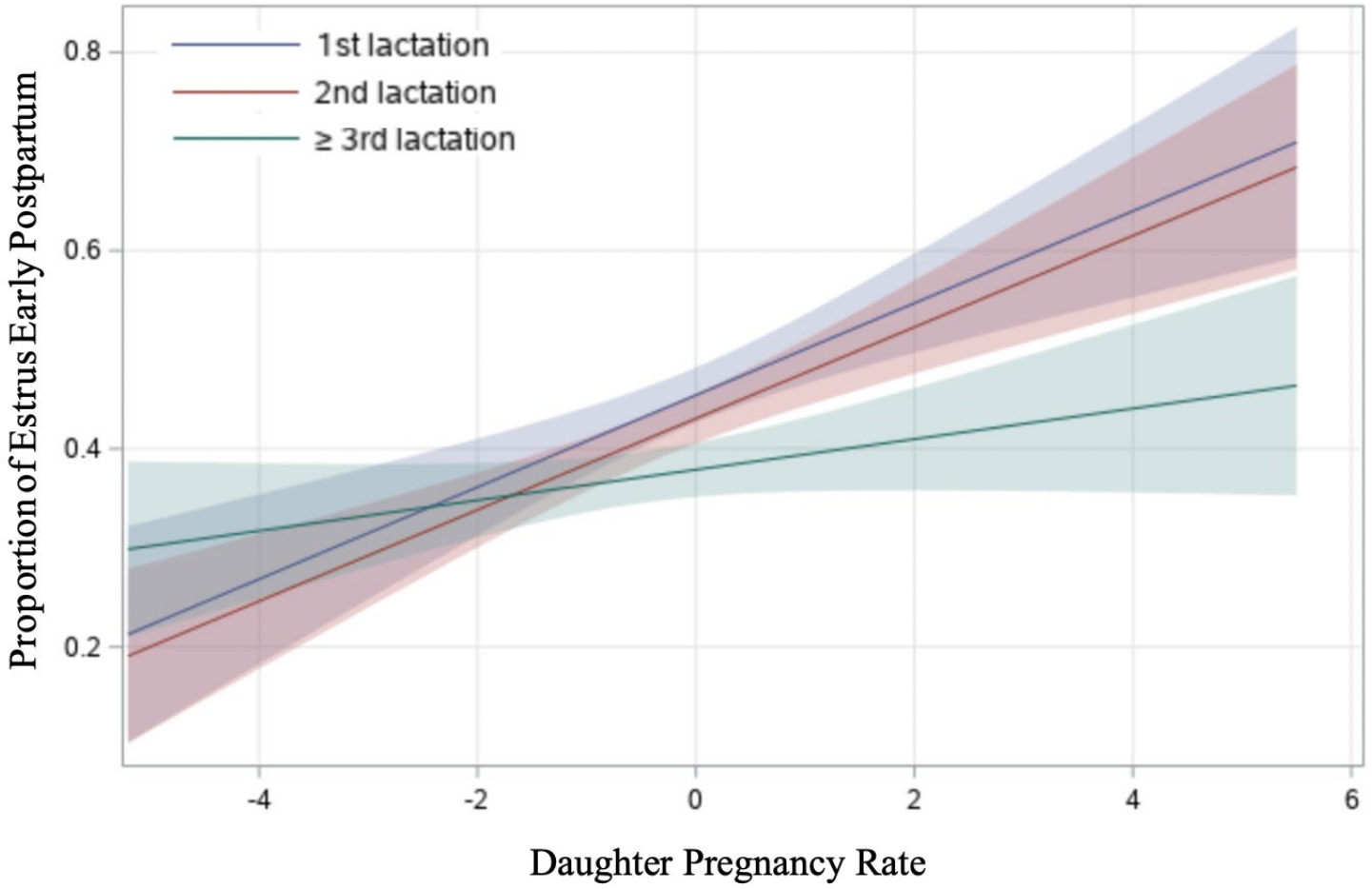
Inter-estrus interval

4



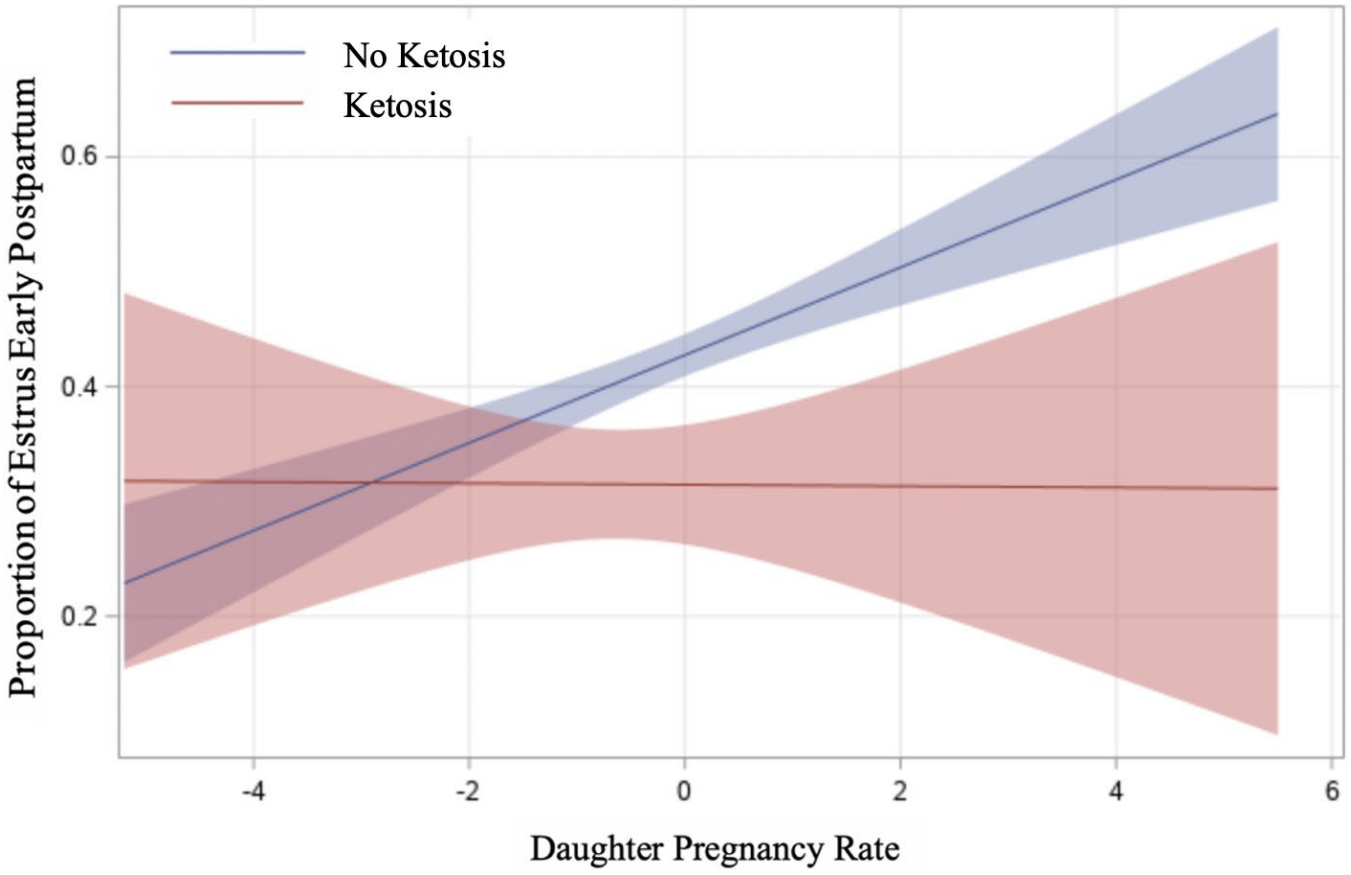
- Data collection and analyses
- Standardization of ≠ sensors
- Validation and reference pop.

Resumption of Cyclicity and DPR



Madureira et al., 2023 (submitted)

Resumption of Cyclicity + Diseases Postpartum and DPR

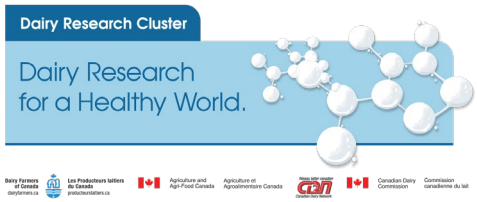


Madureira et al., 2023 (submitted)

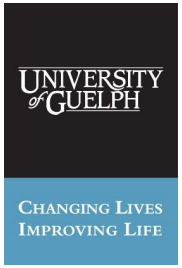
Take Home Messages

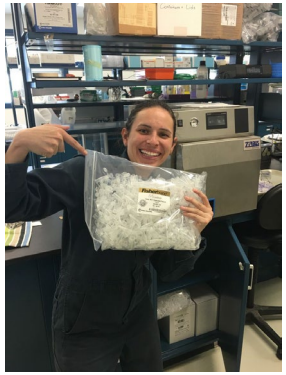
* Use of sensor data for genetic selection is promising. Potential for complex/low heritability traits (repro, health, thermotolerance).
* Improvements over current reproduction phenotypes is likely.
  * Biological significance of the data collected.

Acknowledgments



GenomeCanada





Thank you!

Thank you!
Questions