PREDICTION OF CALVING TIME BASED ON SENSOR MEASUREMENTS OF BEHAVIOR IN CATTLE

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OUTLINE

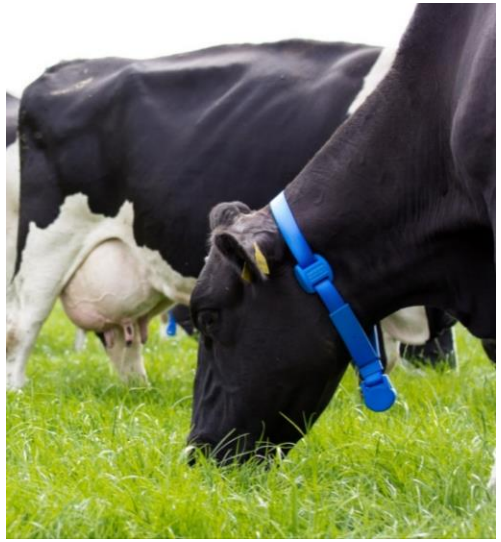
- ❑ Introduction.
- ❑ Objective.
- ❑ Material.
- ❑ Methods.
- ❑ Results.
- ❑ Conclusions.

❑ INTRODUCTION

- **True calving date varies between 267 and 295 days.**
- **Cow and calf welfare.**
- **Economic aspects.**

- **The objective of the study is to predict a calving time based on previous behavioral symptoms in cows of two breeds.**

❑ MATERIAL



N=64

n= 38

N=54

n= 14

❑ METHODS

View of the structure of system, transmission routers and data analysis (Grodkowski et al., 2022).

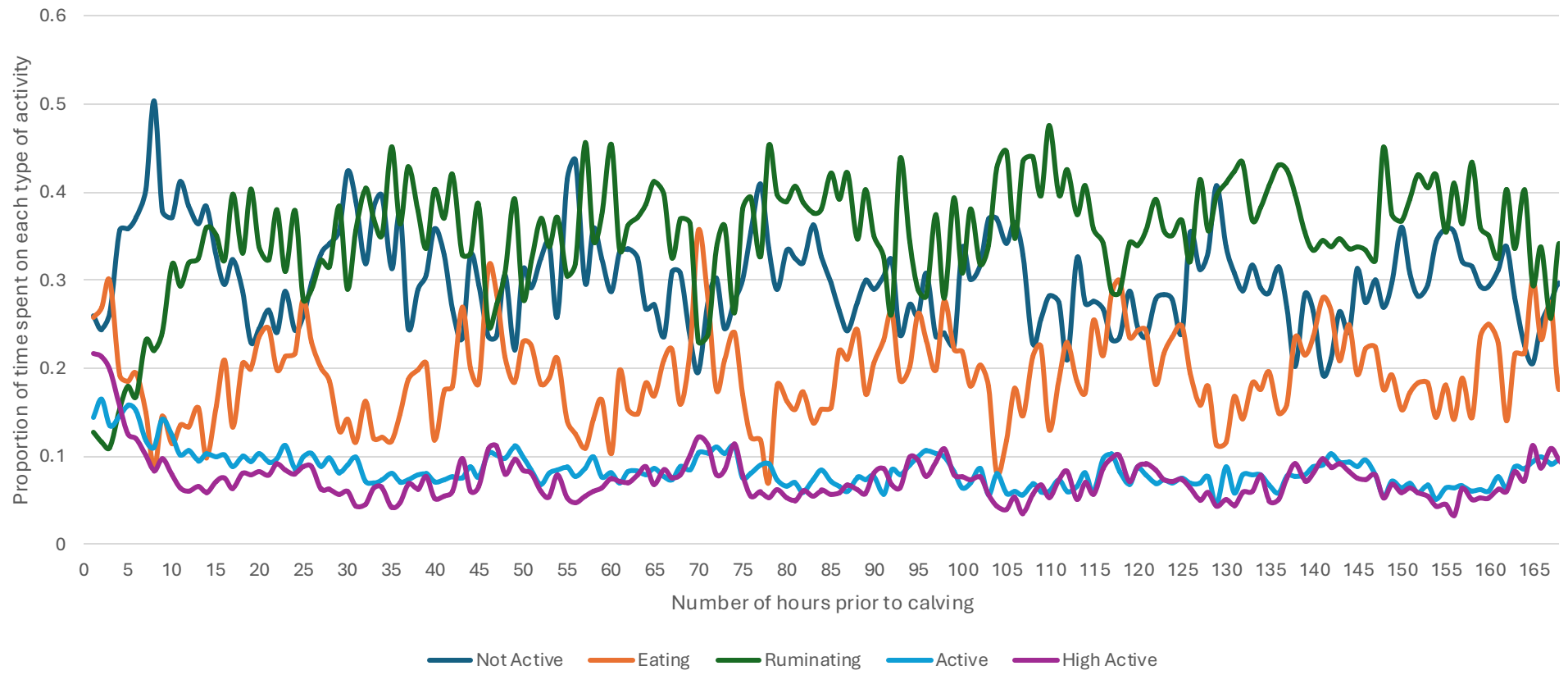
❑ MATERIAL

CowManager Sensor

Recorded traits:

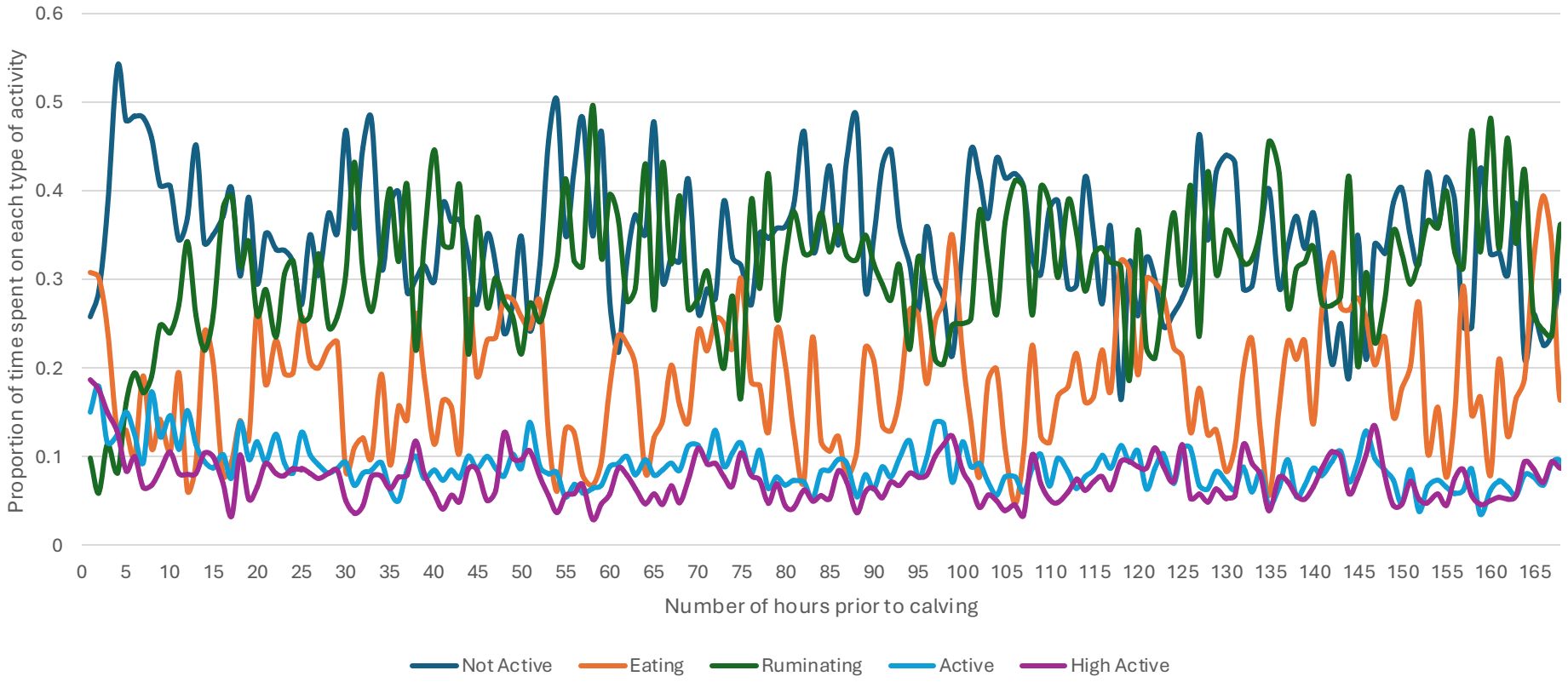
- calving date and hour,
- gestation length,
- feeding time,
- rumination time,
- resting time,
- time of low activity,
- time of high activity,
- lactation number,
- lactation length,
- milk production,
- health status.

❑ METHODS



Distribution of activity types before calving in HF cows.

❑ METHODS



Distribution of activity types before calving in BS cows.

❑ METHODS

Statistical analysis

➢ **Bootstrap method**

@ Recursive Feature Elimination with Cross-Validation (RFECV) algorithm

@ Logistic regression:

$$logit(p) = \log\left(\frac{p}{1-p}\right) = \theta_0 + \theta_1 x_1 + \theta_2 x_2 + \theta_3 x_3 + \theta_4 x_4 + \theta_5 x_5$$

where: p **- the probability of "success" - calving at a given time,** x_1 **– proportion of inactive time,** x_2 **- proportion of time of feed consumption,** x_3 **– proportion of ruminating time,** x_4 **– proportion of low activity time,** x_5 **- proportion of high activity time, as well as** θ_0, θ_1, θ_2, θ_3, θ_4, θ_5 **– model parameters.**

❑ METHODS

Statistical analysis

Criteria for evaluation of the predictive ability of the model (1):

$$Accuracy = \frac{TP + TN}{TP + TN + FP + FN}$$

$$Precision = \frac{TP}{TP + FP}$$

where: TP – true positive, TN – true negative, FP - false positive, FN – false negative.

❑ METHODS

Statistical analysis

Criteria for evaluation of the predictive ability of the model (2):

$$Recall = \frac{TP}{TP + FN}$$

$$F1\ Score = \frac{2 \cdot TP}{2 \cdot TP + FP + FN}$$

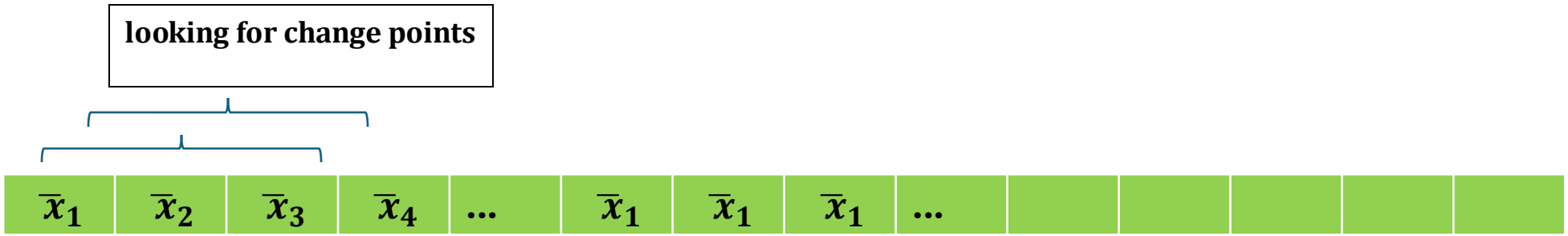
where: TP – true positive, TN – true negative, FP - false positive, FN – false negative

❑ METHODS

Statistical analysis

- **Detecting change points in a time series - binary segmentation based on clustering method (Hinkley 1970)**

- **The time series was constructed using moving averages calculated from six-hour periods starting from the 168th hour, shifting by one hour (mean $\bar{x}_1$ z 168 - 163 from hours; then $\bar{x}_2$ 167-162 etc.).**



❑ METHODS

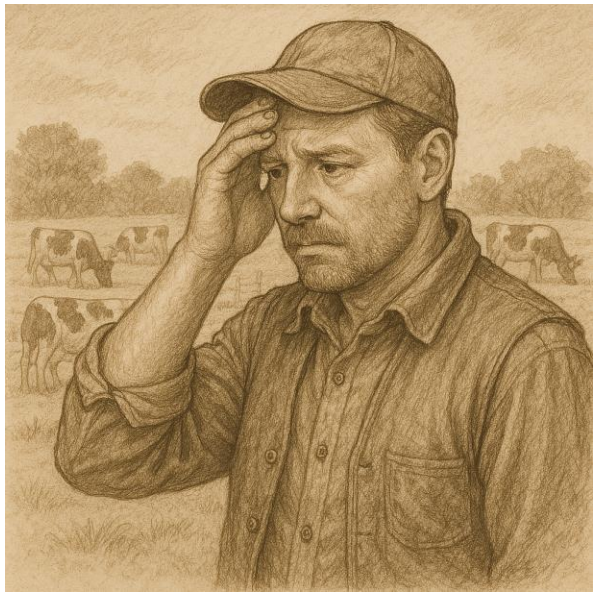
Statistical analysis

looking for change points

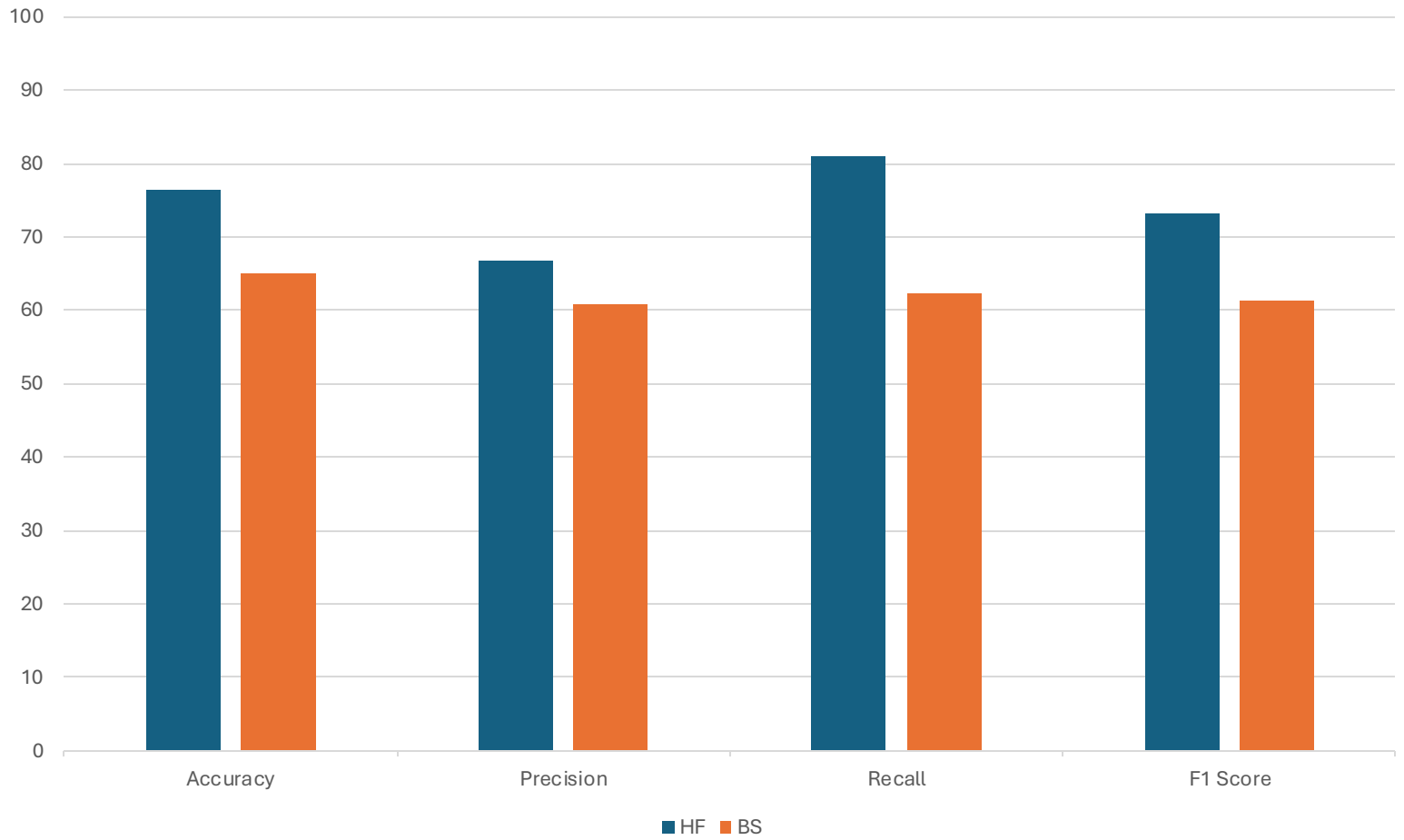
$\bar{x}_1$	$\bar{x}_2$	$\bar{x}_3$	$\bar{x}_4$	...	$\bar{x}_1$	$\bar{x}_1$	$\bar{x}_1$	...					

Significant change points were categorized:

- **12 hours before calving**
- **24 hours before calving**
- **48 hours**
- **72 hours**
- **96 hours**
- **120 hours**
- **144 hours**
- **168 hours**

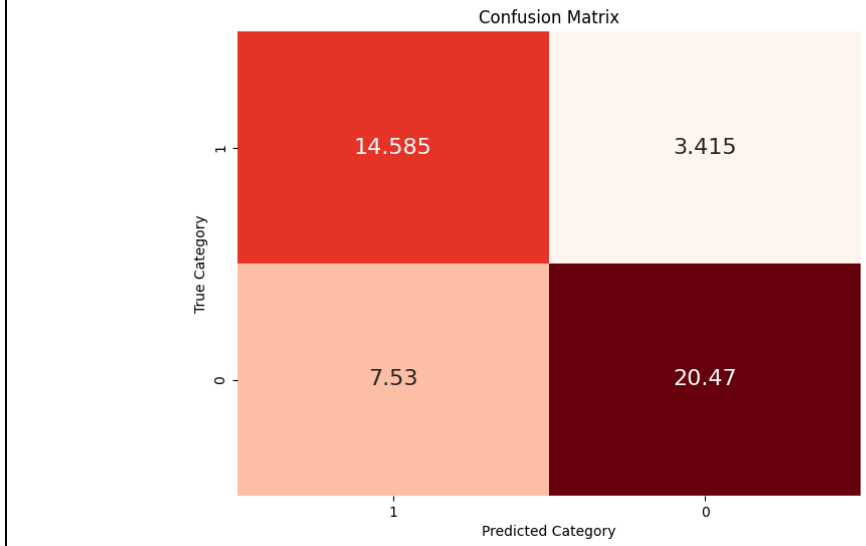
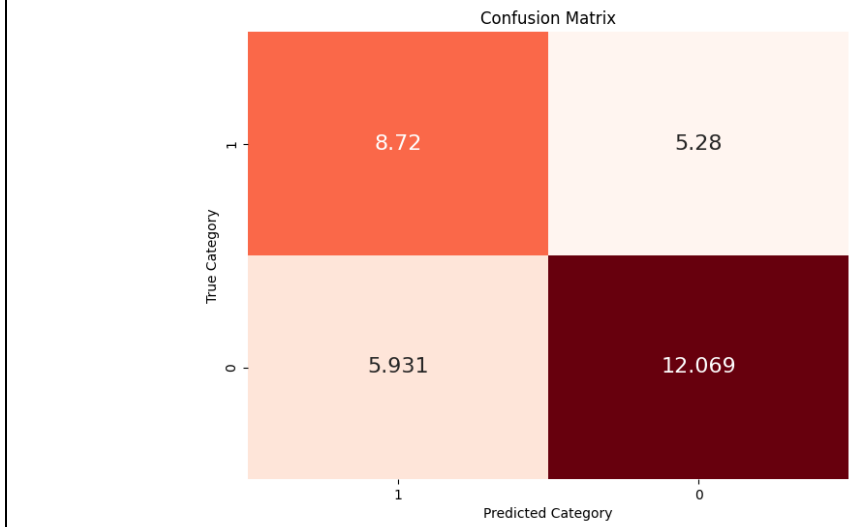


❑ RESULTS



Evaluation of the model based on four criteria (%)

❑ RESULTS

HF	
BS	

Confusion matrixes, where 0 – no calving; 1 – calving.

❑ RESULTS

Percentage of cows (with significant change points) and number of changes in ruminating per cow (in parenthesis) in time periods before calving.

Number of hours before calving (day number before calving)	HF breed	BS breed	Both breeds
0-24 (0)	95 (1.69)	71 (1.70)	88 (1.70)
25-48 (1)	79 (1.43)	86 (1.58)	81 (1.48)
49-72 (2)	74 (1.64)	64 (1.89)	71 (1.70)
73-96 (3)	87 (1.67)	64 (2.22)	81 (1.79)
97-120 (4)	87 (1.79)	86 (1.92)	87 (1.82)
121-144 (5)	63 (1.25)	64 (1.44)	63 (1.30)
145 (6)	0	0	0

❑ RESULTS

Percentage of cows (with significant change points) and number of changes in no active per cow (in parenthesis) in time periods before calving

Number of hours before calving (day number before calving)	HF breed	BS breed	Both breeds
0-24 (0)	84 (1.81)	93 (1.23)	87 (1.64)
25-48 (1)	89 (1.50)	71 (2.00)	85 (1.61)
49-72 (2)	87 (1.61)	57 (1.75)	79 (1.63)
73-96 (3)	76 (1.45)	79 (1.36)	77 (1.43)
97-120 (4)	87 (1.55)	71 (1.40)	83 (1.51)
121-144 (5)	63 (1.50)	57 (1.88)	62 (1.59)
145 (6)	0	0	0

❑ CONCLUSIONS

- **The applied methodology has shown satisfactory effectiveness in predicting the time of calving.**
- **Interbreed changes in the behavior of animals in the last days before parturition have been demonstrated.**
- **It is possible to effectively identify cows covered by pre-partum monitoring.**

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Thank you very much for your attention.