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Effect of health and production on the resumption of estrous cyclicity in post-partum dairy cows

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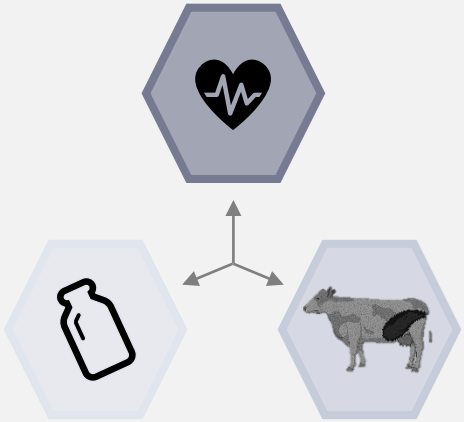
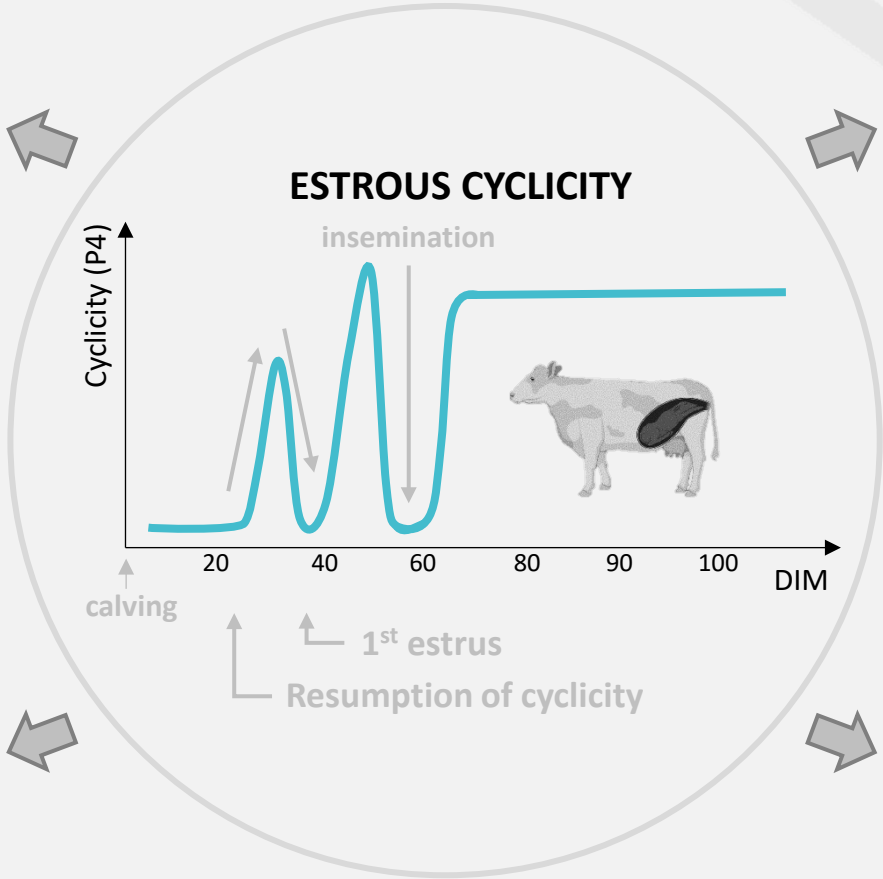
Why is early resumption of estrous cyclicity important?

Sustainability dairy farm

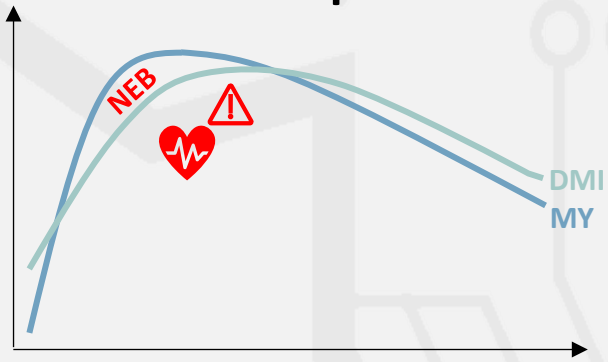
- Calving interval
- Longevity
- Replacement

Fertility is complex





Crucial transition and early lactation period



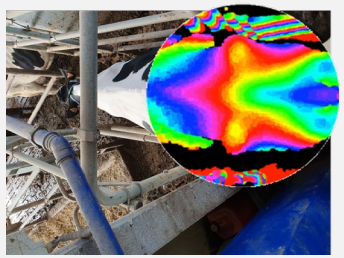
Identify early risk factors

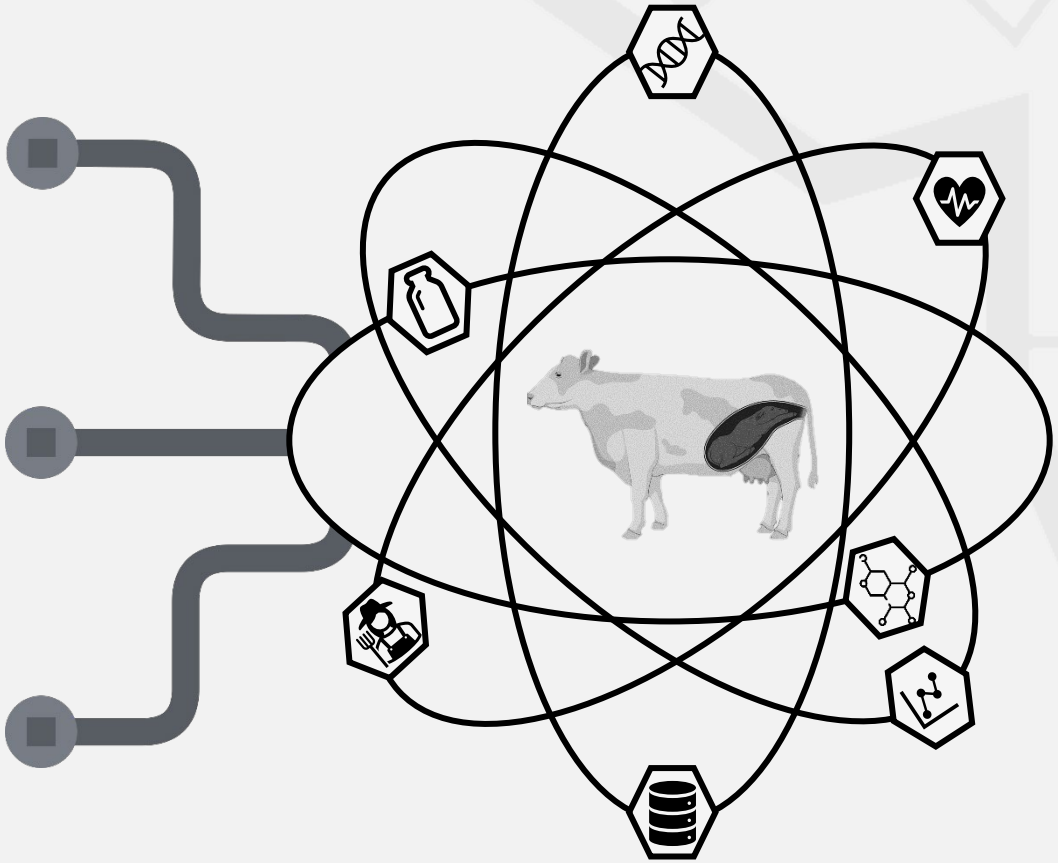
Sensor technology to study complex dairy cow traits

Milk progesterone monitoring system

Automatic milking system

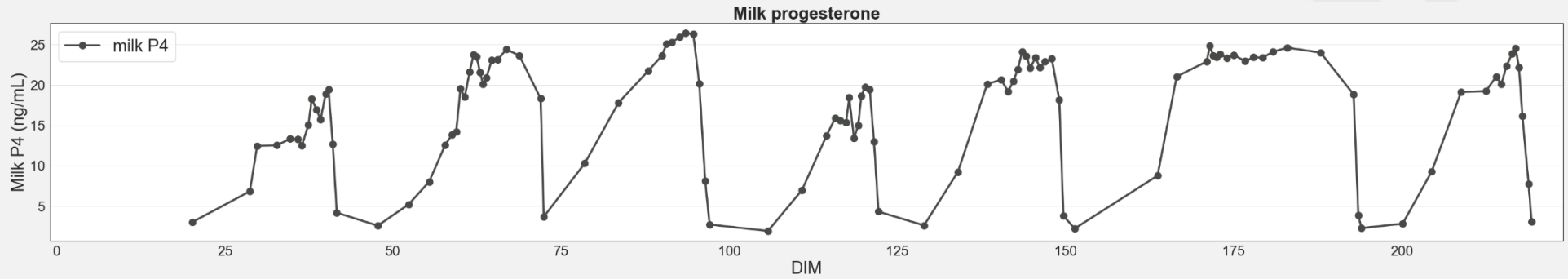
Body condition score camera

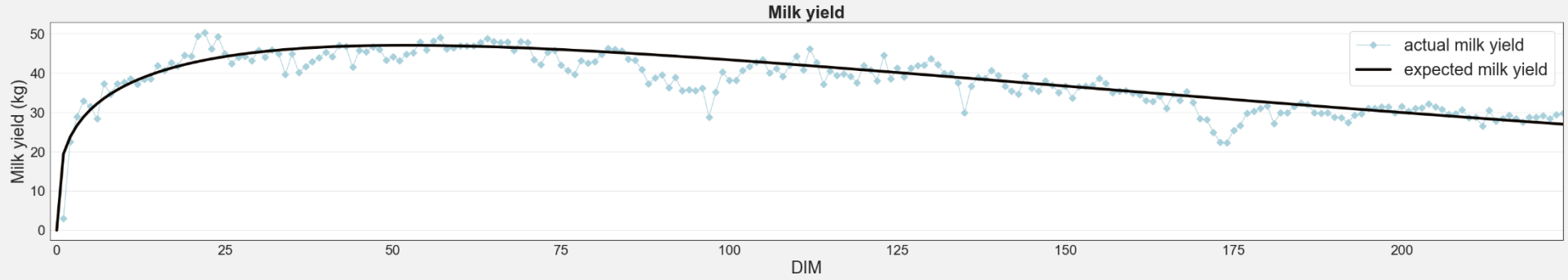


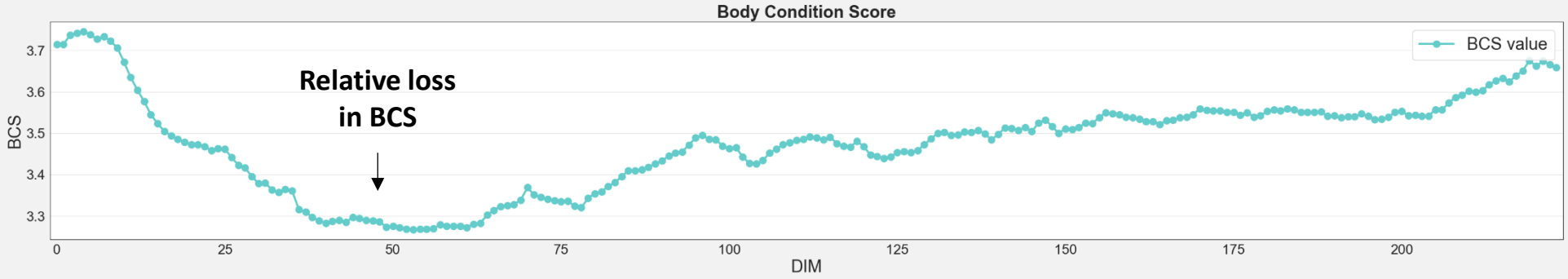


Multivariate data analytics

Calculation of fertility, health and production characteristics







Milk P4 to derive **fertility** characteristics

Milk yield to derive **production** characteristics

Body condition scores to derive **health** characteristics

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Research question

How do these milk production and BCS characteristics affect the DIM at 1st estrus in dairy cows?

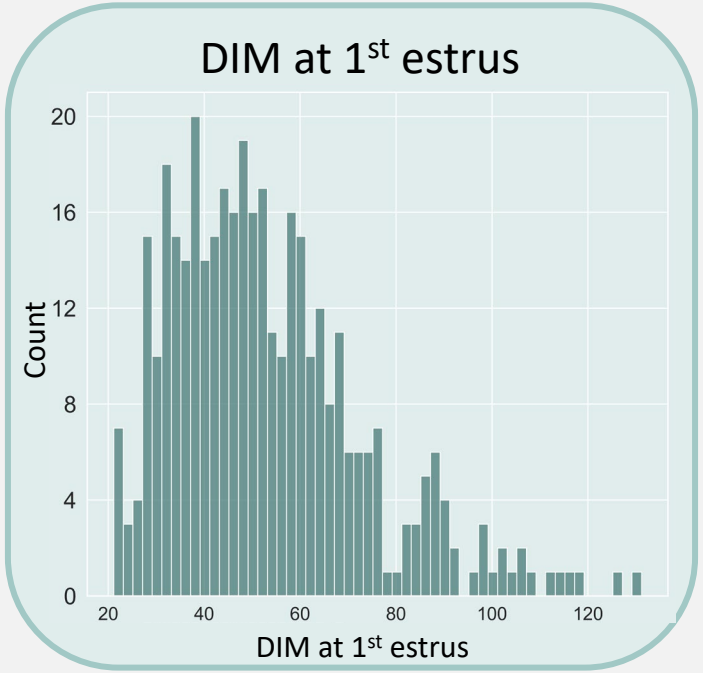
Dataset and analysis

4 farms

335 cows

380 lactations

Dependent variable



Independent variables

Fertility

- DIM at 1st estrus previous lactation

Animal

- Age of cow

BCS

- Mean BCS previous lactation
- Std BCS previous lactation
- Min BCS previous lactation
- Max BCS previous lactation
- End BCS previous lactation
- BCS at calving
- BCS at week 7
- Loss in BCS week 1 to 7

Production

- Dry period length previous lactation
- 305d MY previous lactation
- Total milk yield week 1 to 3
- Total milk yield week 4 to 7
- Milk loss week 1 to 3
- Milk loss week 4 to 7
- Peak yield
- DIM at peak

Analysis

(1) Random forest regression

- Nested 5f CV
- Feature importance + stability

(2) Random forest classification

- Early ⟺ late DIM at 1st estrus
- Nested 5f CV
- Prediction performance

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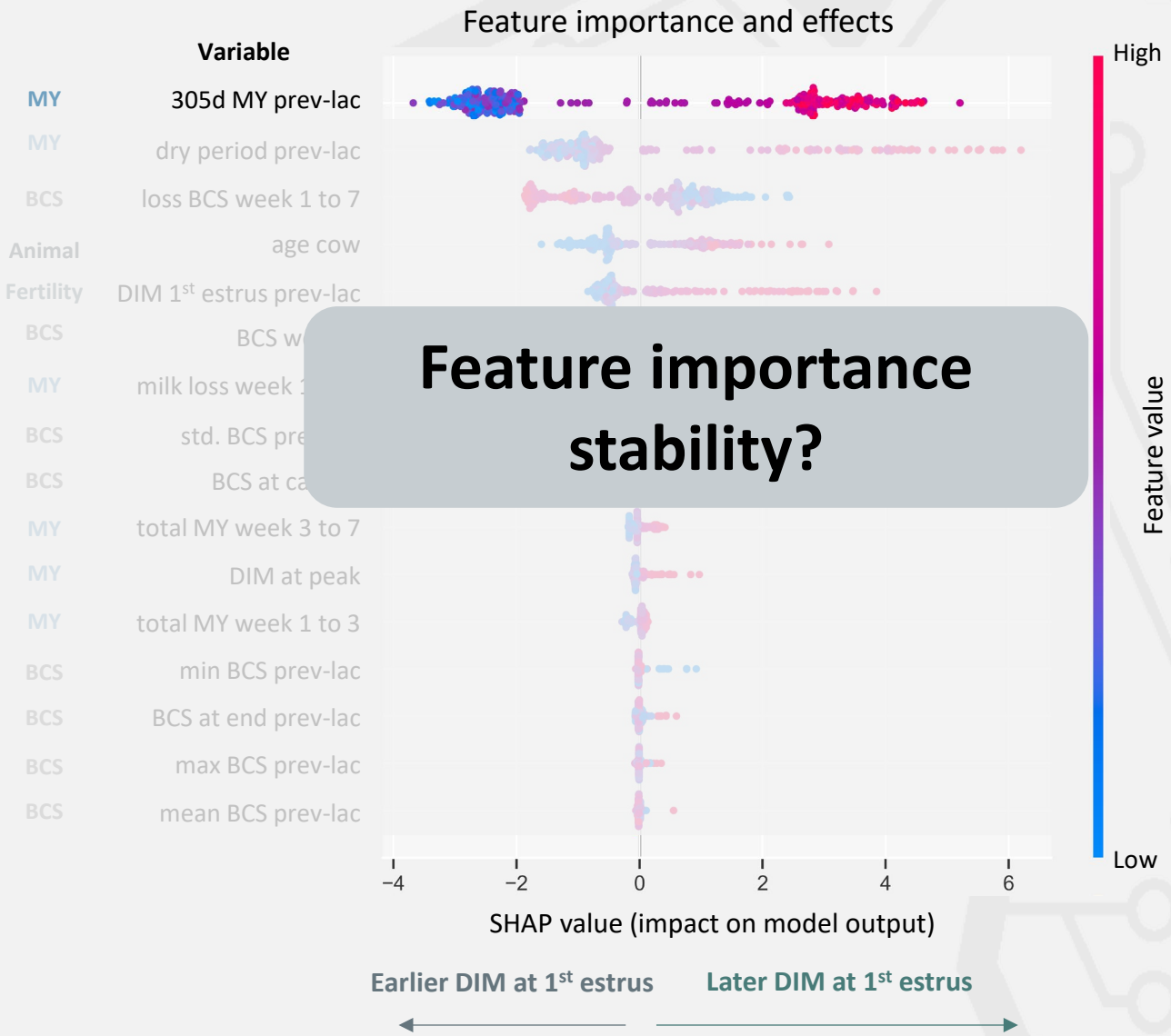
Results – (1) RF regression – feature importance

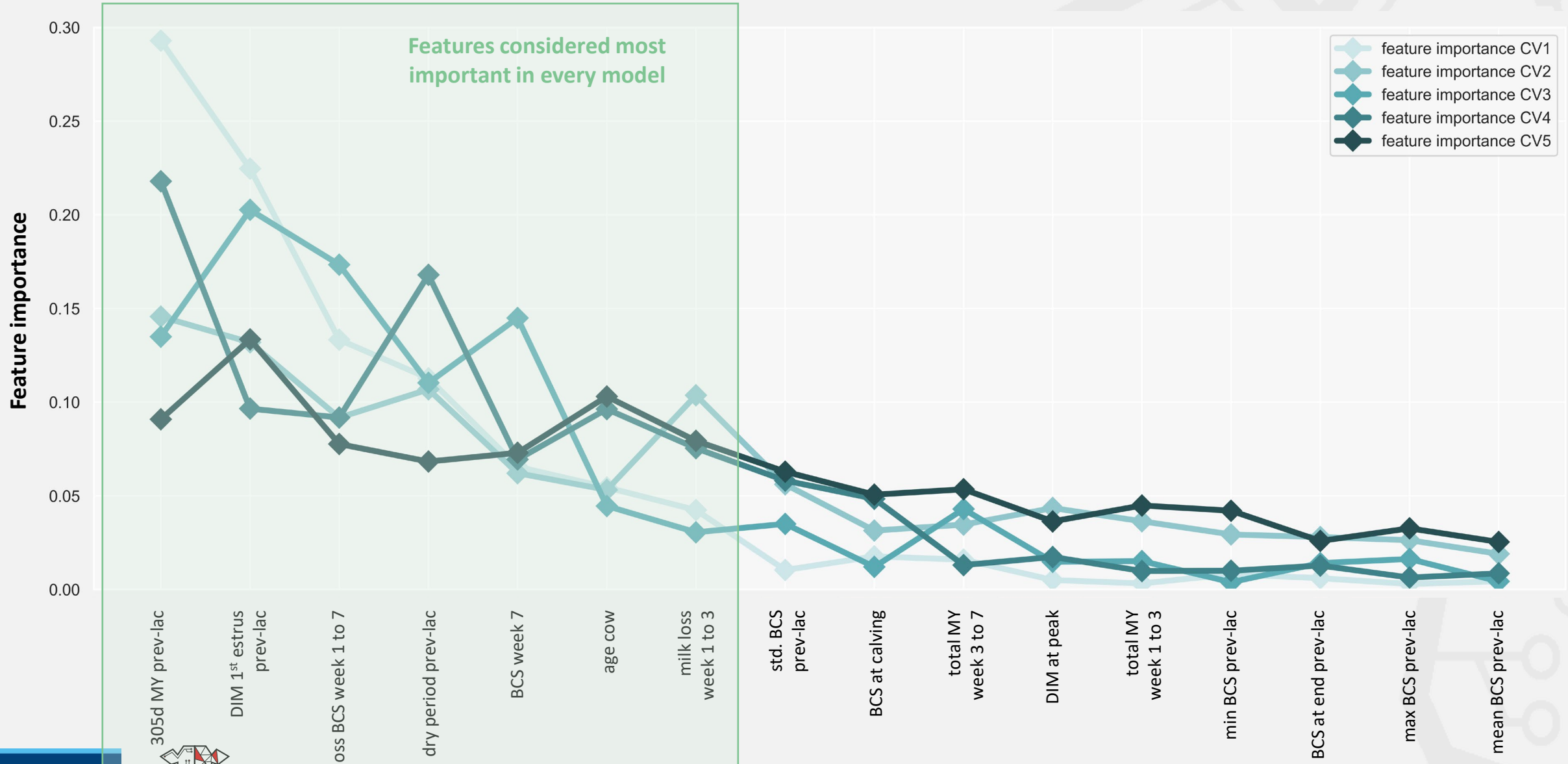
- RF regression models performed quite well
  - r^2: 0.10 ± 0.05
  - r_s: 0.31 ± 0.09

- Predicted values were not able to capture the full range of the observed DIM at 1st estrus
  - lowest – highest observed = lowest – highest predicted ☑

- How do the BCS + production features impact the DIM at 1st estrus?
  - SHAP values



Results – (1) RF regression – feature stability



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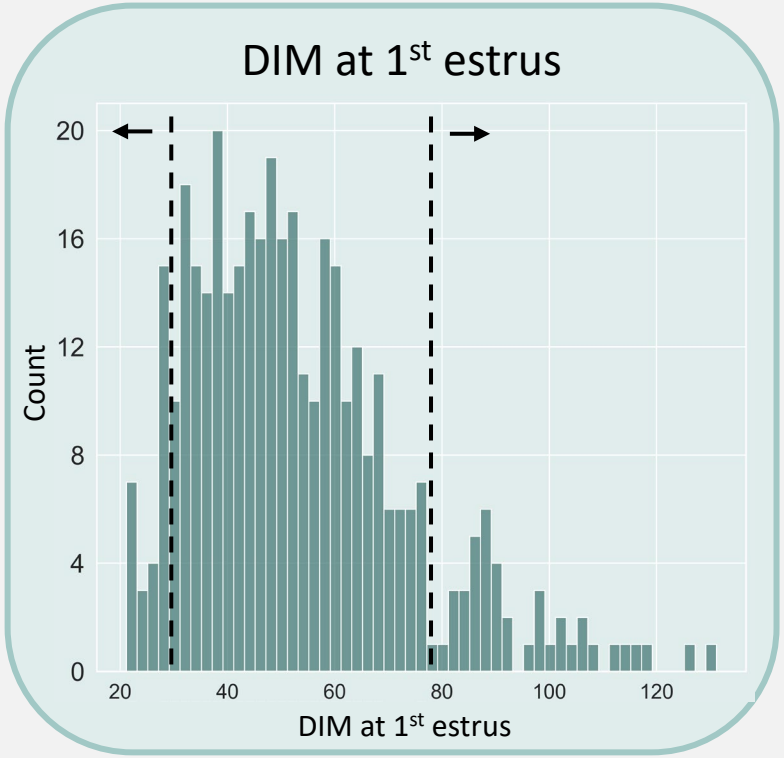
Results – (2) RF classification – prediction performance



To distinguish very early vs very late:

- 0: **Early** – DIM at 1st estrus < 30 n = 40
- 1: **Late** – DIM at 1st estrus > 80 n = 40

5f CV

OBSERVED

PREDICTED	**Class 1:** Late	**Class 0:** Early
Class 1: Late	**TP** 6 ± 0 [6 – 7]	**FP** 2 ± 1 [0 – 2]
Class 0: Early	**FN** 2 ± 0 [1 – 2]	**TN** 6 ± 1 [6 – 8]

Mean ± S.D. across 5 CV test-sets

accuracy	sensitivity	specificity
0.80 ± 0.07	0.80 ± 0.06	0.80 ± 0.10

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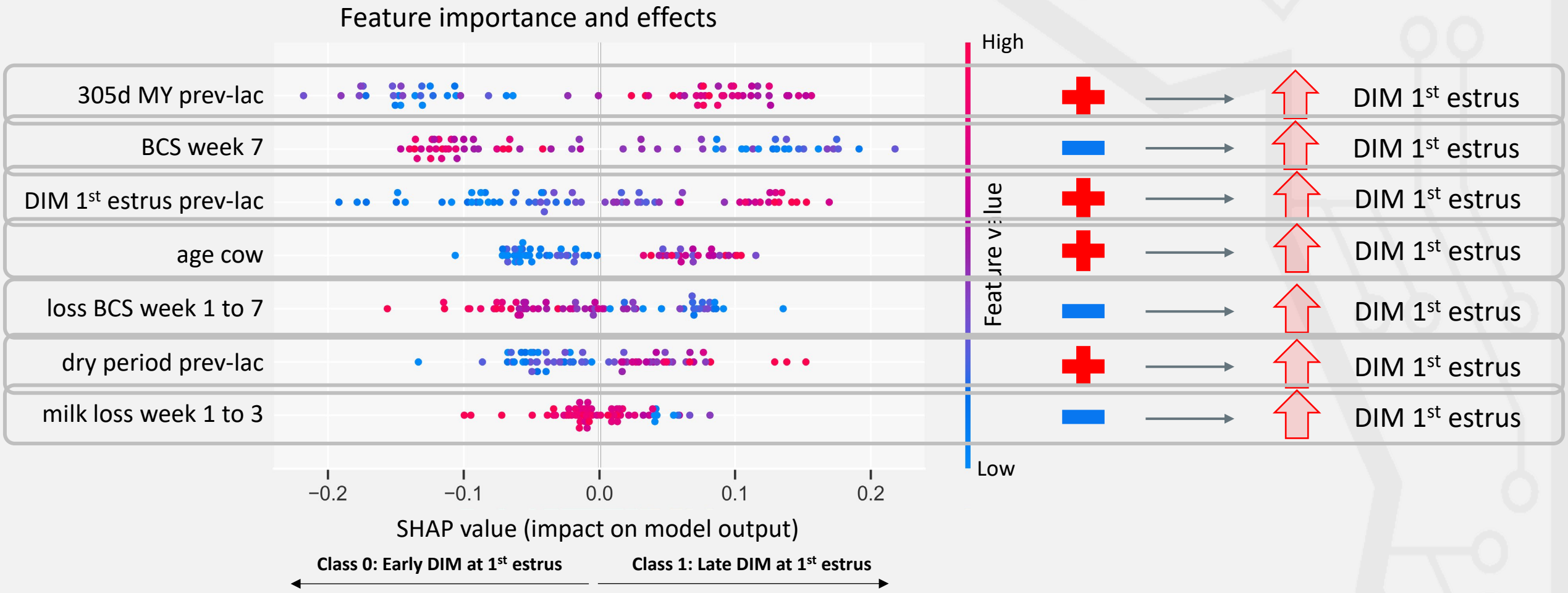
Results – (2) RF classification – important features + effects



Take home message

- Good **resumption to estrous cyclicity** is important for the **sustainability of a dairy farm**
- We can predict the **DIM at 1st estrus** based on **BCS and production traits** for an individual cow
  - ➢ Distinguish animals with **early** and a **late DIM at 1st estrus**
- Early identification of risk factors → adapting the management strategy of farmers to the animal's needs

Thank you for your attention!

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Prof. Dr. Ben Aernouts & Dr. Ines Adriaens

Meuwissen, D., Gote, M., Adriaens, I., Aernouts B. (2024). Effect of health and production on the resumption of estrous cyclicity in post-partum dairy cows.