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General aspects of measuring animal health and welfare using sensor technology

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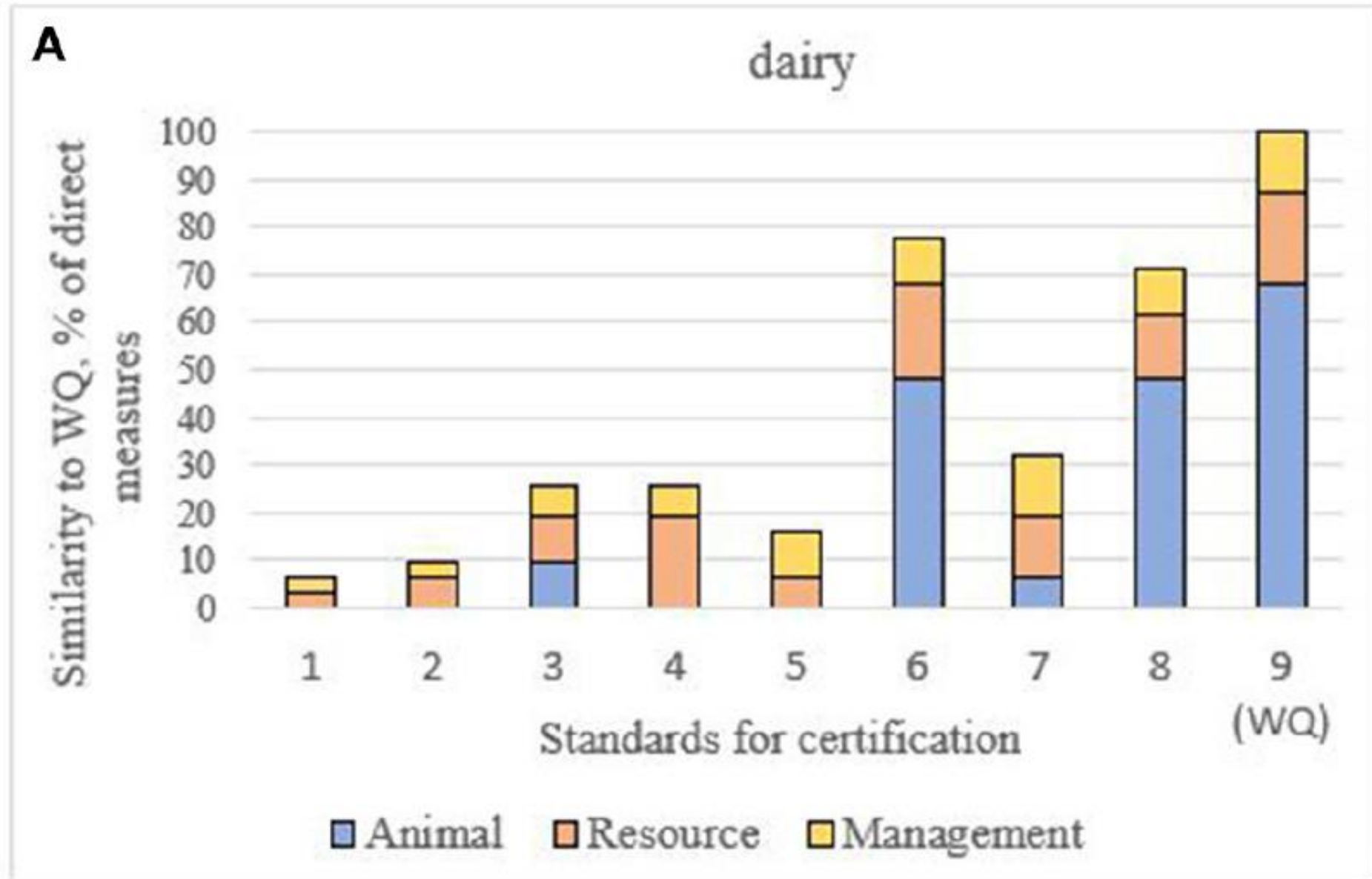


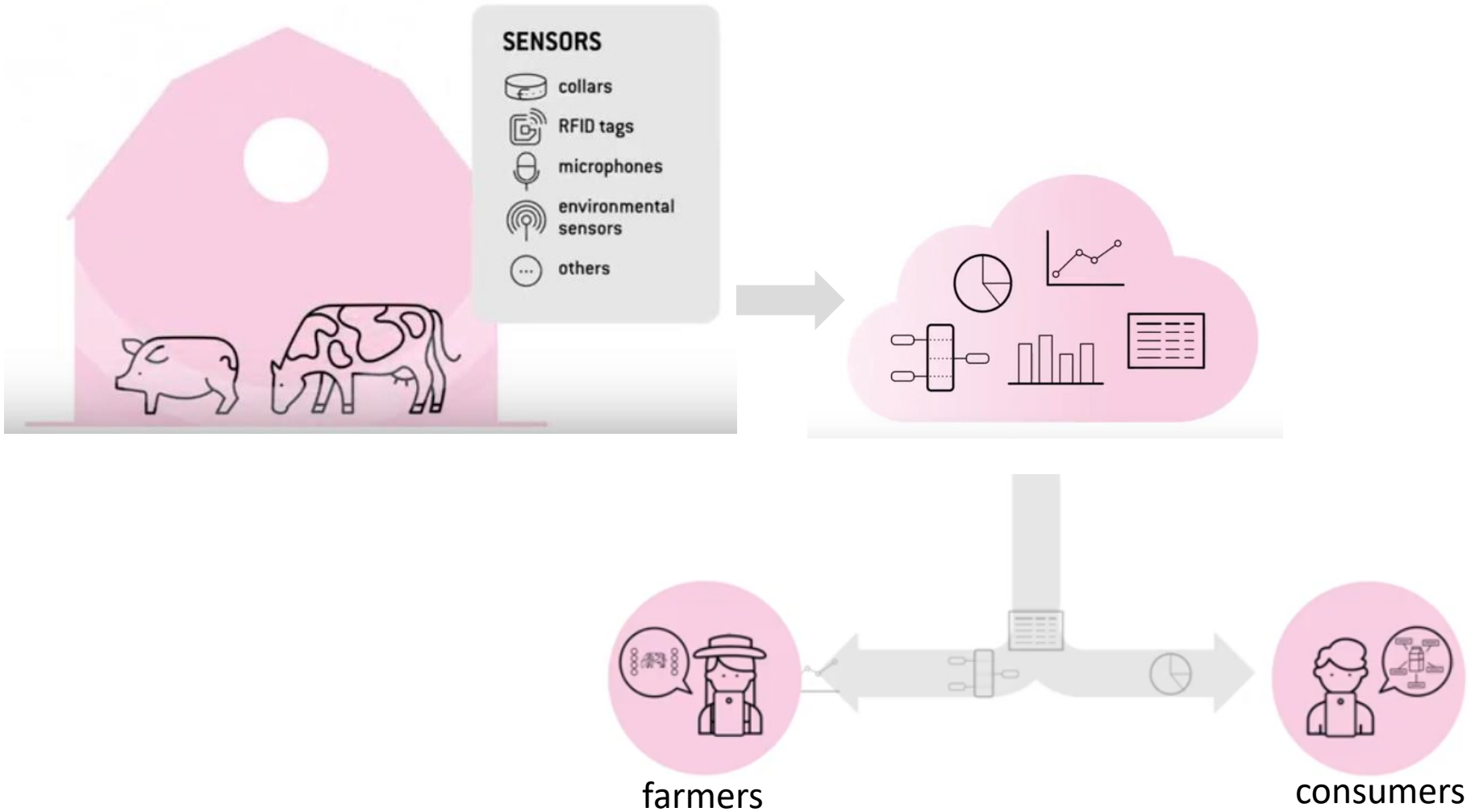
This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 862919


Milk, but which one?



How are consumers informed about animal welfare?





A woman in a blue uniform is holding a tablet and looking at it. In the background, there are several black and white cows in a barn. The text "Is it possible to classify dairy cattle according to their welfare status using sensor data?" is overlaid on the left side of the image.

Is it possible to
classify dairy
cattle
according to
their welfare
status using
sensor data?

Poor

Average

Good

Good

Small pilots: February-June 2021



Herd size (enrolled to the pilots)

220 (50)
120 (50)

350 (50)
140 (50)

260 (50)
60 (50)

6 herds and 318 cows

A woman with brown hair, wearing a blue button-down uniform, is looking down at a tablet computer she is holding with both hands. She is standing in a barn, and in the background, several black and white cows are visible, some standing and some lying down. The lighting is soft and natural, suggesting an indoor setting with large windows. The overall tone is professional and focused on data collection or monitoring in a farm environment.

Data labelling

Welfare index → based on WQ (14 measures):

- ✓ Good feeding (1)
- ✓ Good housing (4)
- ✓ Good health (9)

WQ visits or medication data

Weather data

Severity and duration (literature)

A photograph of two black and white cows in a muddy stall. A large yellow arrow points from the top text 'Good welfare 0' down to the bottom text 'Bad welfare 16'. The cows are standing in deep mud, and the stall has a metal bar across the front.

Good welfare 0

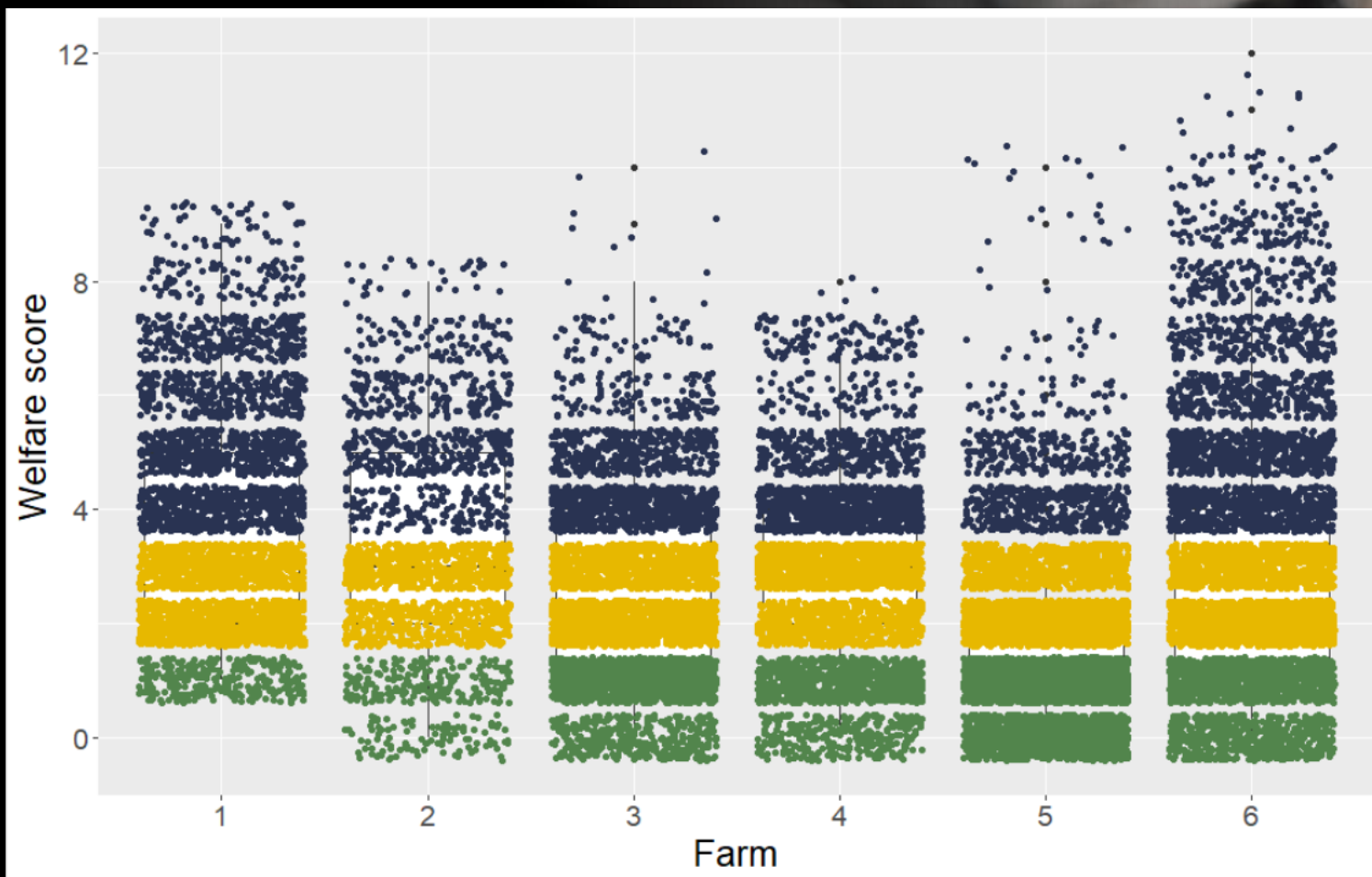
Bad welfare 16

Few examples:

Mastitis → score 2 for 21 d

Locomotion → score 1 or 2
for 45 d

Heat Stress → score 1 for a
given day



A woman with brown hair, wearing a blue button-down uniform, is looking down at a tablet computer she is holding with both hands. She is standing in a barn, and in the background, several black and white cows are visible, some standing and some lying down on the straw-covered floor. The lighting is soft and natural, typical of an indoor farm setting.

Sensors (27,500 rows of data):

- 1) Accelerometers (walking, standing, lying, eating, ruminating, other behaviour)
 - 2) Milk production data (kg)
-

Non-sensor data:

- 1) Days in milk
- 2) Lactation number

A woman with brown hair, wearing a blue button-down uniform, is looking down at a tablet computer she is holding with both hands. She is standing in a barn, and in the background, several black and white cows are visible, some standing and some lying down. The lighting is soft and natural, suggesting an indoor setting with large windows or open doors. The overall tone of the image is professional and focused on technology in agriculture.

Features processing:

- 1) Smoothening of sensor features – moving average for different window widths (5, 7 and 10 days)
 - 2) Normalization (Min-max and Z score)
-

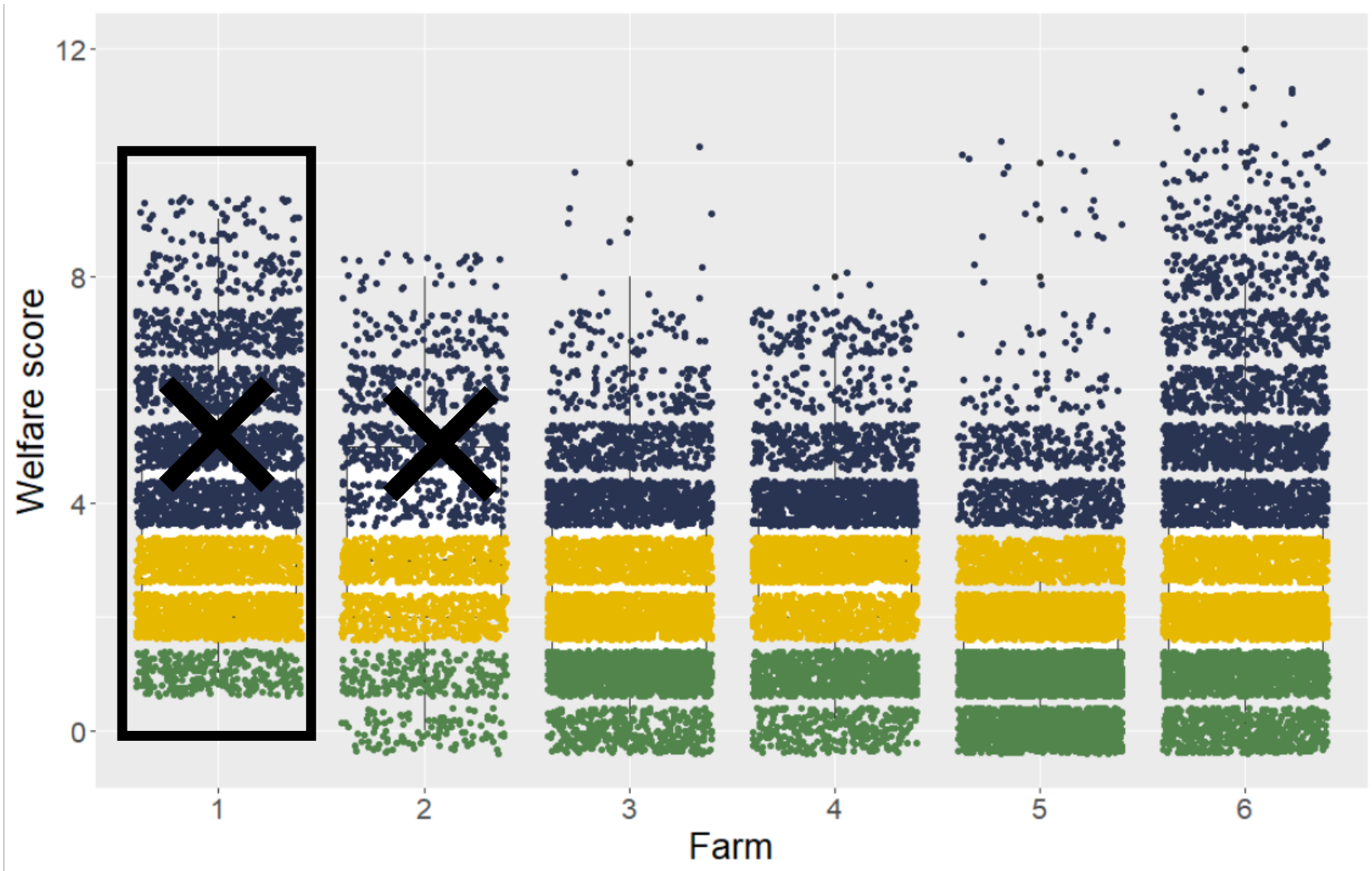
Modelling approach



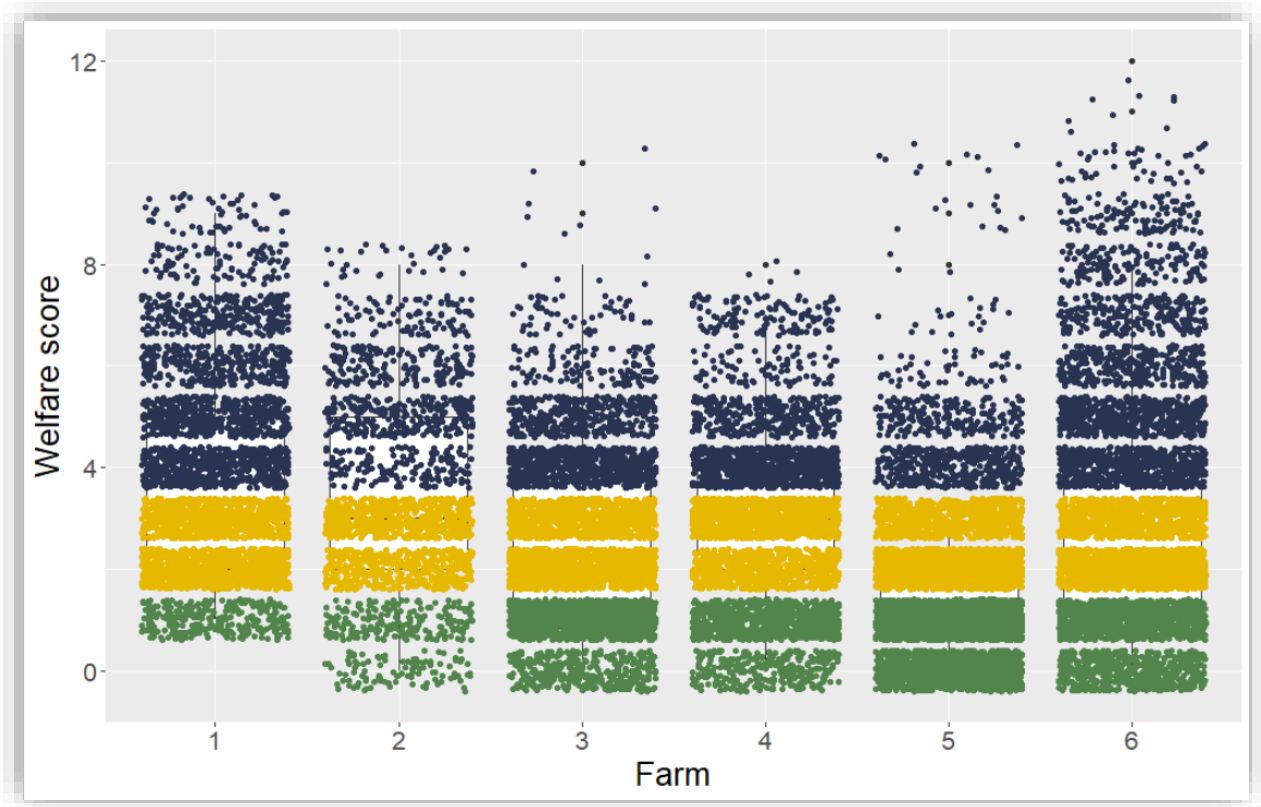
- Model building XGBoost (eXtreme Gradient Boosted trees)
- Objective – multi classification (multi:softprob), but can be also binomial or regression
- XGBoost Hyperparameters selection (e.g. Eta- learning rate, Max_dept – depth of the tree, Min_child_weight – control overfitting)
- Model input → around 30 variables (mean and sd of sensor data, slope and differences in time windows, days in milk and lactation number)
- Data weighing procedure – combination on time from WQ assessment and frequency information

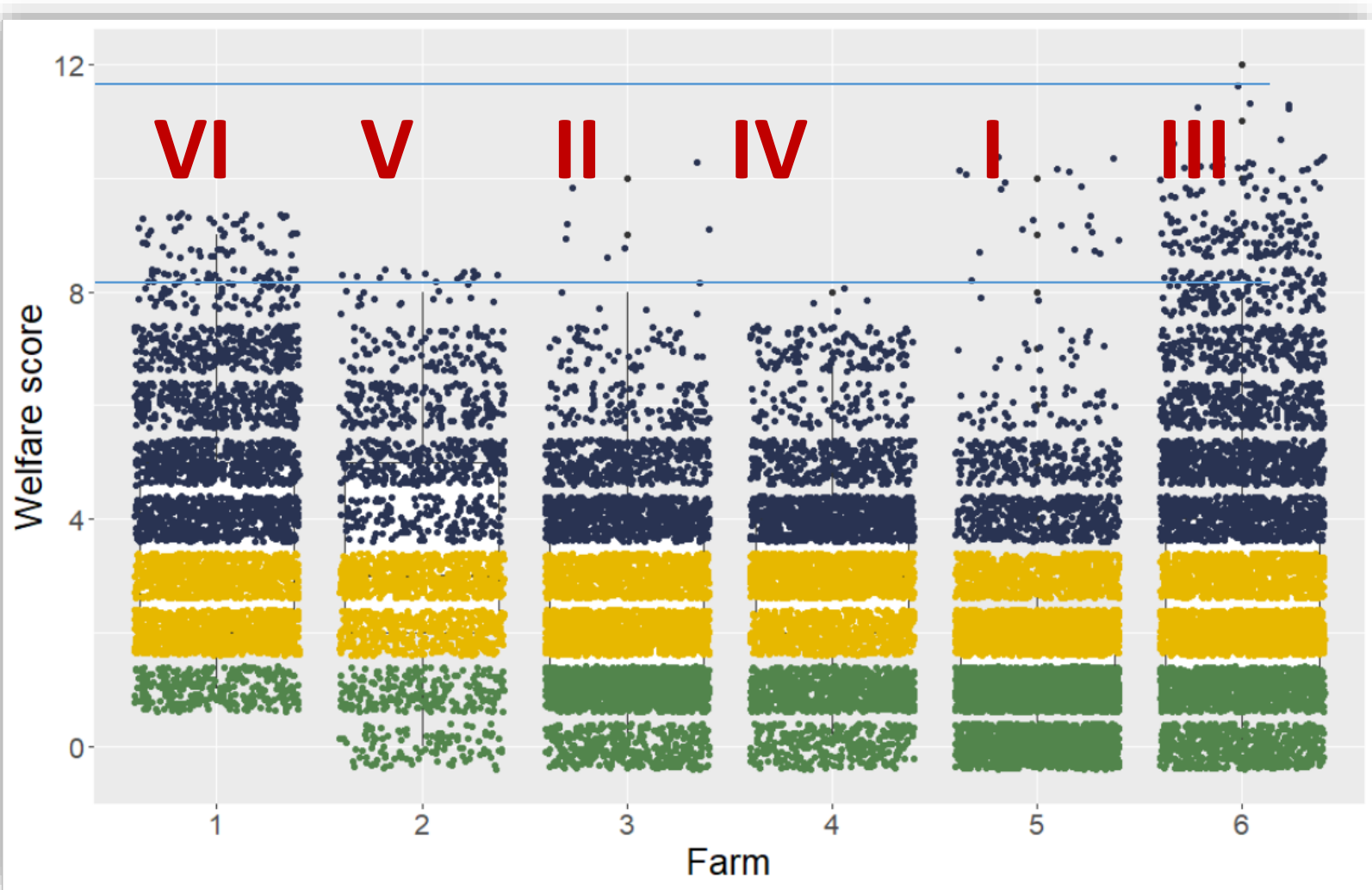


Global & herd specific models



Cross-validation strategies	Sensitivity	Specificity	AUC	Balance accuracy Yellow class	Balance accuracy Blue class
The global model	0.43 (± 0.22)	0.68 (± 0.12)	0.53 (± 0.04)	0.52 (± 0.10)	0.63 (± 0.02)





Computation time in herd specific model was 2 minutes 28 seconds

Lesson learned –implications from the proof-of-concept



- 1) **Model robustness**- a combination of in-person and algorithm-based welfare evaluation is needed to
- 2) **Welfare definition**- still challenging
- 3) **Missing predictors** - farms with varying degrees of digitalization
- 4) **Stakeholder engagement** - to meet the needs of the end users

Thank you for your attention!

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