

*Technical Session:
Advanced analytics for adding value to livestock data*

A machine learning approach to describe the welfare status of dairy herds and analyse its association with performance and economics

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Research background

- Animal welfare (AW) is part of certification programs¹
 - Implementation of **AW solutions** is linked with their **economic return**
 - **Unclear** relationship between **AW** and herd **performance** and **economics**
 - High milk production associated with high prevalence of lameness in tie-stall barns (N = 100 Farms)²
 - Low milk production associated with low prevalence of knee lesions and lameness in free-stall barns (N = 130 Farms)³
- Objectives
 1. Describe the welfare status of Quebec dairy herds
 2. Analyse the relationship with productivity, profitability, and longevity

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1. Dairy Farmers of Canada, 2018, proAction®: Reference manual; 2. Villettaz Robichaud et al., 2019, JDS 101(3):2350-2358; 3. Villettaz Robichaud et al., 2019, JDS 102(5):4341-4351



Research approach – Data

2,980 Quebec Dairy Herds – 2016 to 2019



Welfare

- proAction®¹
 - Body condition score (% BCS ≤ 2)
 - Hock lesion (%)
 - Knee lesion (%)
 - Neck lesion (%)
 - Lameness (%)
- Herd Status Index (HSI)²



Performance and Profitability

- Energy corrected milk (ECM; kg)
- Milk value (\$CAD)
- Longevity
 - Length of productive life (years)
 - Cows on 3+ lactation (%)



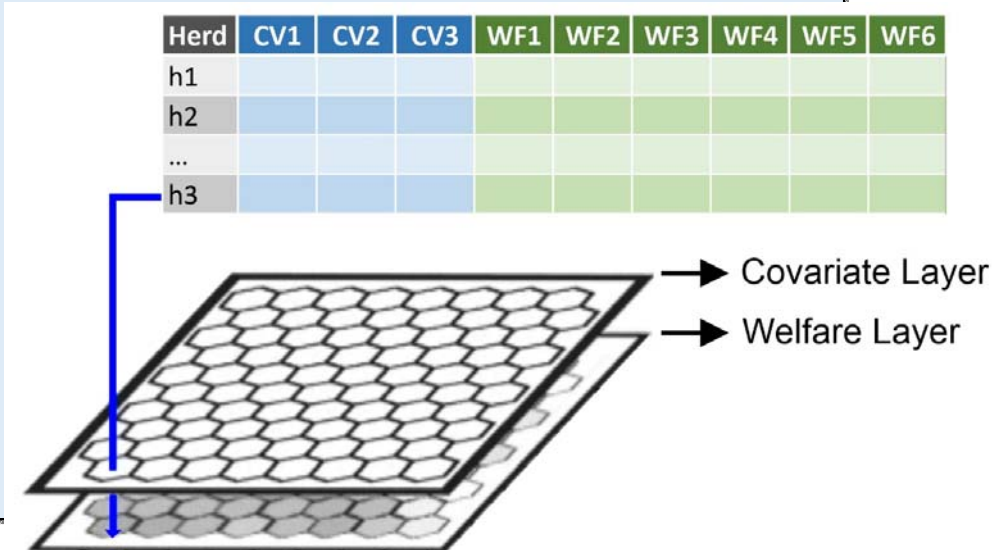
Three-year



Research approach – Statistical analysis

Statistical Analysis

- Self-Organizing map¹
 - Artificial neural network that creates a nonlinear, ordered, and smooth mapping of high-dimensional data into a regular 2-dimensional array¹
 - Two-layered map
 - 1st layer = Barn type and year-season
 - 2nd layer = Welfare data





Research approach – Statistical analysis

Statistical Analysis

- Self-Organizing map¹
- Clustering
 - Partitioning around medoids, hierarchical, and normal mixture model-based
 - Cluster quality and cluster stability
 - Chose the clustering algorithm
 - Chose the number of clusters



Research approach – Statistical analysis

Statistical Analysis

- Self-Organizing map
- Clustering
- Machine learning models
 - Tree-based (RPART, GBM, XGBM, RF) and support vector machine
 - 80:20 data split ratio -> Training and validation
 - Models trained using 10-fold cross-validation
 - Describes welfare clusters
 - Predict **cluster labels** using welfare indicators as inputs + Partial dependency plots
 - Evaluate relationship with performance and profitability
 - Predict **cluster labels** using productivity and performance indicators as inputs + Accumulated local effects



Technical results

- Stable and homogeneous welfare clusters!

- Algorithm = Partitioning around medoids
- Clusters = 3

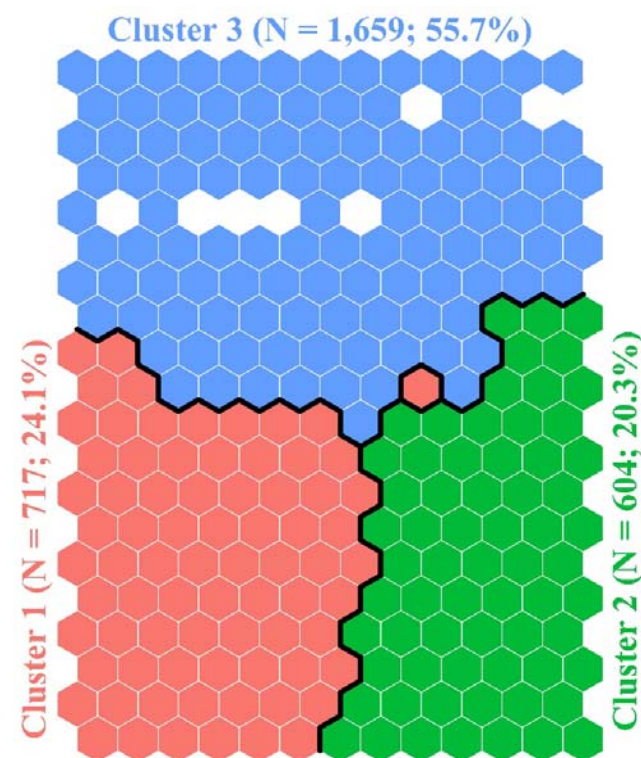
- Describing clusters

- Support vector machine model
 - Overall accuracy = 0.85 (0.81 – 0.87)



- Performance and profitability

- Extreme gradient boosting machine (XGBM)
 - Weighted classification (W = Number of herds)
 - Overall accuracy = 0.44 (0.40 – 0.48)





Practical results

- Describing clusters
- Performance and profitability

High probability

Average

- Describing clusters

Animal Welfare:

- High BCS ≤ 2 (5.2%), high lameness (17.3%) and high hock lesions (26.2%)

Performance and Profitability:

- High milk value (CAD\$8,081.3) and low 3+ lactation (42.3%)

- Performance and profitability

Cluster 3 (N = 1,659; 55.7%)

Animal Welfare:

- Best overall welfare status

Performance and Profitability:

- High ECM (11,271.6 kg), low milk value (CAD\$7,955.7), and high 3+ lactation (41.3%)

Cluster 1 (N = 717; 24.1%)

Animal Welfare:

- High neck lesions (9.9%) and high knee lesions (16.2%)

Performance and Profitability:

- No association



What can we take from our results?

- Flexible analytical approach
 - Hierarchical representation of data structure
- Different herd welfare profiles/clusters
 - Development of targeted solutions
 - Adapt management practices and housing
- Weak association between welfare and both performance and profitability
 - Need more comprehensive indicators
 - Welfare and both performance and profitability
 - Measures of good welfare instead of *not-bad* welfare



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Fonds de recherche
Nature et
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CowLife McGill

Thank you!

Questions?