Assessing body condition of dairy cows from 3D surfaces of the rear

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CONTEXT

Why focusing on body condition in dairy cattle?

- To assess indirectly body reserves and their variations ➔ indicator of energy status
- To monitor indirectly health & reproductive performances

Measuring body condition:

BCS (body condition score): scoring according to a chart visually or by palpation ➔ commonly used on-farm BUT too subjective, too less repeatable and time-consuming.
CONTEXT: new affordable technologies

“the body shape of a fatter cow is more likely to be round than that of a skinny cow” (Halachmi et al., 2008)

How to assess body condition from a shape which is 3-dimensional in the space ?

Previous attempts:
Mostly 2 dimensioned images & partial use of the information kept in the shape (angles, areas, depth…)
⇒ Only Azzaro et al. (2011) dealt with the whole information in performing PCA
Aim of the project

To develop and qualify a method assessing BCS from 3D surfaces of the Holstein’s rear summarized by PCA
PLAN: process to develop a new method

- METHODOLOGY used for Calibration
  - 3D-Surface’s process
  - Calibration: assessing BCS from 3D

- METHOD’S QUALIFICATION
  - Validation: quality of 3D-BCS’ estimation
  - Reproducibility

- CONCLUSION
METHODOLOGY used for Calibration
Methodology: 3D-surface’s process

Acquisition’s system

Weighing & 3D scanned

Milking parlour

Trough

3 s

Hook bones

Pin bones
Methodology: 3D-surface’s process

**AIM**: to find the common area between the 3D-surfaces used for the calibration

- **Aligning**
- **Re-sizing on a same rear size**
- **Restrict the surface on the common area**

22,500 3D-points

67,500 data / surface
Methodology: calibration on BCS

1) Defining set of 3D-surfaces used to calibrate on BCS (57 cows)

2) Summarizing the 3D-information by PCA

22,500 points
3 dimensions

PCA

1 point
57 dimensions

3) Calibration:

\[ \mu + \left( \sum_{i=1}^{57} a_i \times \text{coordinate on eigenvector i} \right) + \varepsilon = \text{BCS} \]

\[ R^2 = 1 \]
\[ \sigma = 0 \]
METHOD’S QUALIFICATION
Method’s qualification: validation

**AIM:** to estimate the error done when assessing BCS from 3D for external 3D-surfaces?

Is the calibration’s set robust enough?

**Validdiff:** 25 cows out of calibration

**Valididem:** 25 cows from calibration BUT other dim
Method’s qualification: validation

<table>
<thead>
<tr>
<th></th>
<th>Validdiff</th>
<th>Valididem</th>
</tr>
</thead>
<tbody>
<tr>
<td>$R^2 / \sigma$</td>
<td>0.79 / 0.27</td>
<td>0.91/ 0.30</td>
</tr>
<tr>
<td>RMSEP</td>
<td>0.32</td>
<td>$\approx$ 0.31</td>
</tr>
<tr>
<td>Random error</td>
<td>70.3 %</td>
<td>95.4 %</td>
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</tbody>
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- Each 3D-BCS measure includes **0.32 unit BCS error**
  - Similar to error observed in literature
- Error similar for validdiff / valididem **BUT** more biased for Validdiff
  - enrich the calibration’s set with other surfaces?
Method’s qualification: reproducibility

- Each measure of 3D-BCS includes an error of 0.1 unit BCS (CV = 4%) directly associated to the methodology.
- 3D-BCS is 2.8 times more reproducible than mean BCS scored by 3 experts.
- 3D-BCS’ quality highly limited by BCS’ reproducibility ➔ Calibration on a more reproducible method (ex: ultrasonography ?)

6 cows scanned 8 times in 1 day
CONCLUSION
CONCLUSION

- A promising method
  - a perfect calibration on BCS
  - good validation, improvable with another method
  - 2.8 times more reproducible than BCS

- for a high throughput monitoring
  phenotyping condition and variation of body reserves
  more accurately, more rapidly and more precisely
  - access to mobilised / deposited energy
  - determinant of feed efficiency

- to be improved prior to monitoring
  - to automate landmarks’ extraction
  - validation on other herds
I would sincerely thank...
...3DOuest for their all days motivation, expertise and patience
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