



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

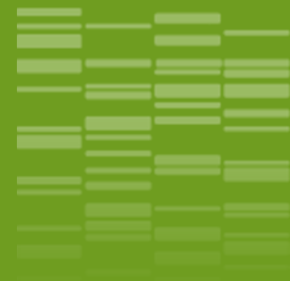
❖ METHODOLOGY used for Calibration

- ❖ 3D-Surface's process
- ❖ Calibration: assessing BCS from 3D

❖ METHOD'S QUALIFICATION

- ❖ Validation : quality of 3D-BCS' estimation
- ❖ Reproducibility

❖ CONCLUSION

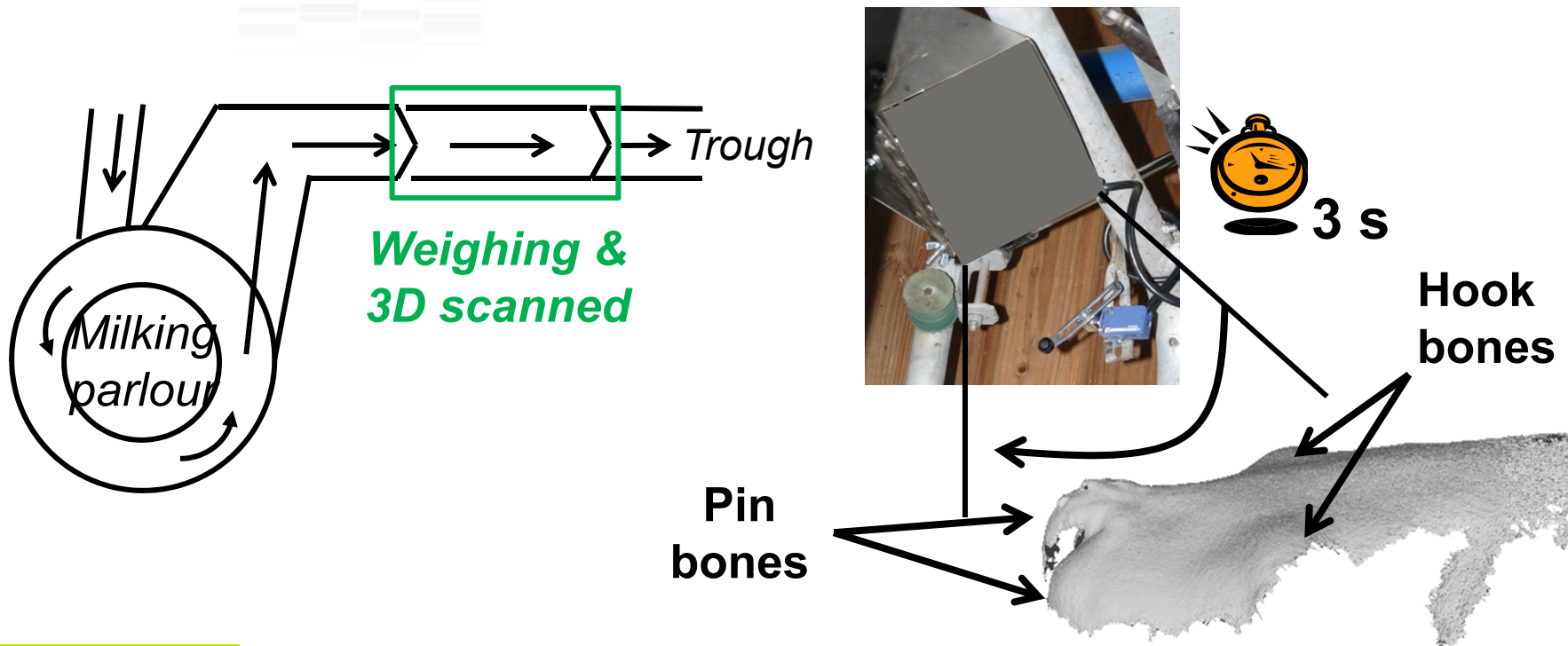


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METHODOLOGY used for Calibration

Methodology : 3D-surface's process

Acquisition's system



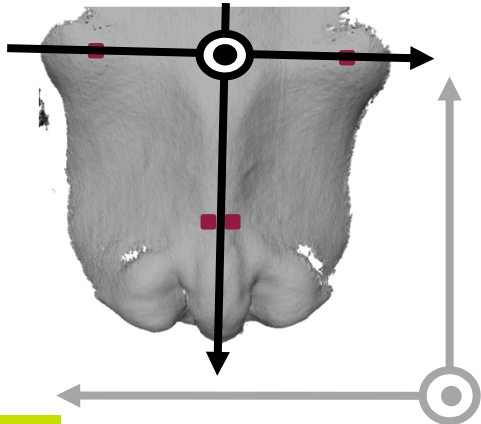
Methodology : 3D-surface's process

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](#)

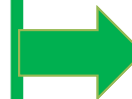
22,500 points
3 dimensions

PCA

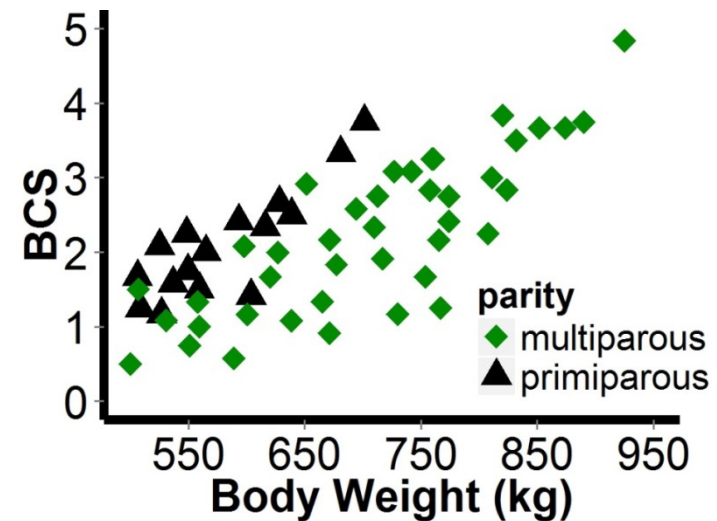
1 point
57 dimensions

- 3) Calibration :

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



$$R^2 = 1$$
$$\sigma = 0$$





02

METHOD'S QUALIFICATION

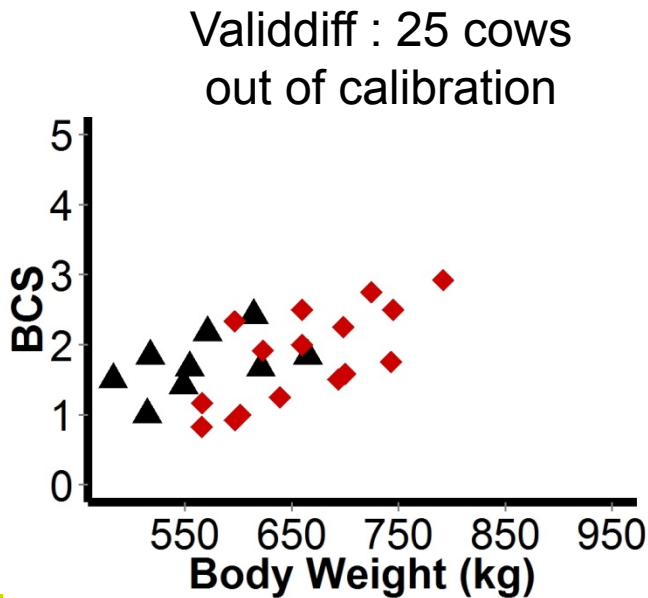
AIM : to estimate the error done when assessing BCS from 3D for external 3D-surfaces ?
Is the calibration's set robust enough ?

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Validdiff : 25 cows
out of calibration

A scatter plot showing the relationship between Body Weight (kg) on the x-axis and Body Condition Score (BCS) on the y-axis. The x-axis ranges from 550 to 950 kg with major ticks every 100 kg. The y-axis ranges from 0 to 5 with major ticks every 1 unit. There are 25 data points represented by black triangles and red diamonds. The points are scattered, showing a general upward trend but with significant variability. The text 'Validdiff : 25 cows out of calibration' is displayed above the plot area.

Body Weight (kg)	BCS
520	1.6
530	1.1
540	2.0
550	1.5
560	1.8
570	2.3
580	1.2
590	1.0
600	2.5
610	1.8
620	2.0
630	1.3
640	2.0
650	1.9
660	2.5
670	1.6
680	2.3
690	1.5
700	2.8
710	2.5
720	1.8
730	2.9

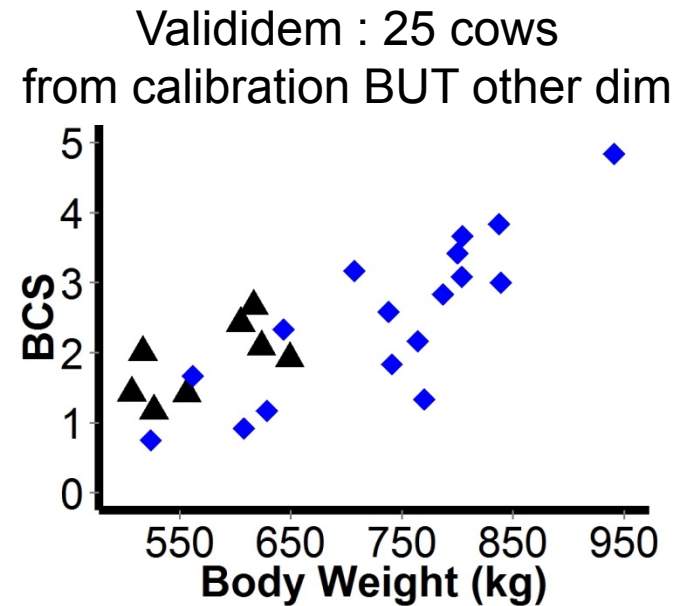


Valididem : 25 cows
from calibration BUT other dim

BCS

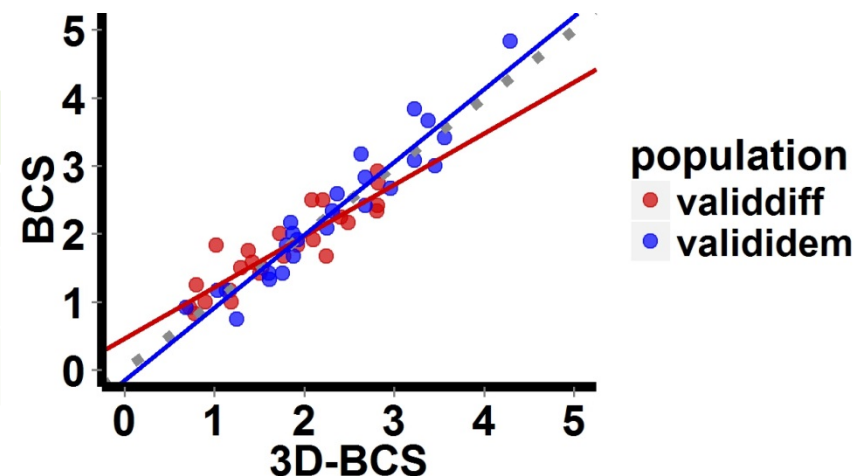
Body Weight (kg)

Body Weight (kg)	BCS
500	1.5
520	2.1
540	1.3
560	1.5
580	1.7
600	2.5
620	2.8
640	2.1
660	2.0
700	3.2
720	2.6
740	1.9
760	2.2
780	1.4
800	2.9
820	3.7
840	3.1
860	3.9
900	4.9



Method's qualification : validation

	Validdiff	Valididem
R^2 / σ	0.79 / 0.27	0.91 / 0.30
RMSEP	0.32 $\approx$	0.31
Random error	70.3 %	95.4 %



- ❖ 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

6 cows scanned **8 times** in **1 day**

- ❖ 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 ?)



CONCLUSION

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❖ **A promising method**

- ❖ a perfect calibration on BCS
- ❖ good validation, improvable with an other 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
- ...the team of **UMR INRA-PEGASE** and **Agrocampus-Ouest** for their support and motivation
- ... **INRA-PHASE** for their confidence in the project
- ... **Institut de l'élevage** for supporting my current work and PhD.

