3D phenotyping of beef calves : scaling image processing into edge-AI and extending predictions across breeds

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Funders :

Why such a project?
→ Limits in performance monitoring

Weighing + scoring (19 traits) used for genetic evaluation and advisory services for farmers

More than 400,000 calves recorded in 10 beef breeds

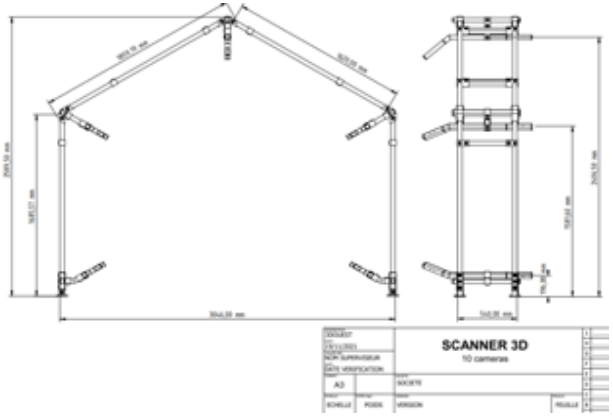
- Expensive training system
  - Initial training
  - Homogenization Sessions
  - Breed approvals
- High turnover in structures & difficulty in recruitment

- Scorer effect (+ farm effect, region, etc.)
  - Notation differences between 2 scorers
  - Over/undervaluing an animal compared to a previous one

1) Project goal

Goal : Automate the collection of live weight and the 19 note of scoring (4-12 months) on the 10 beef breeds

3 sets of deliverables :



A 3D scanner for high-throughput phenotyping in farm

3D OUEST

Prediction algorithms

Service for breeders

Consortium Animal 3D

Weighing and scoring of beef calves using 3D imaging

With technical support from:

With financial support from:

Avec la contribution financière du compte d'affectation spéciale développement agricole et rural CASDAR

3) Training 3D based AI : data collection method

80 farms (10 beef breeds) and 100 configurations tested

Reference scoring

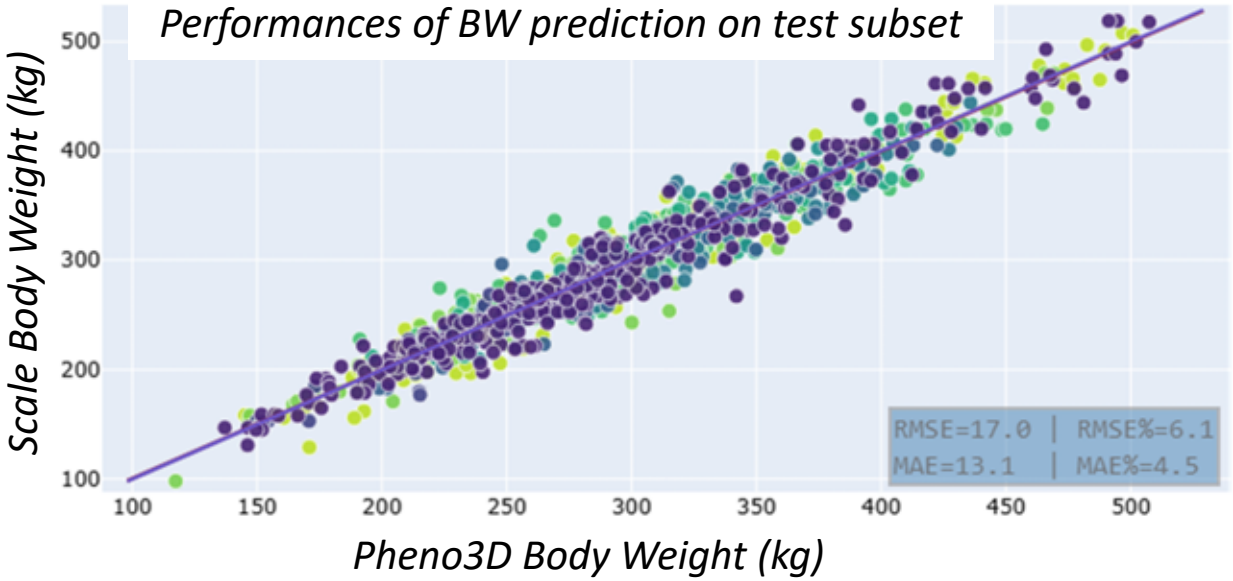
3D scan
Reference weighing

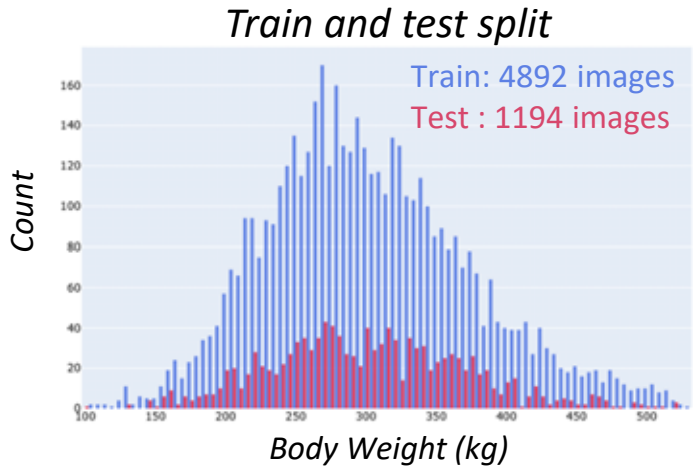
3) Reference measurements collected on the animals

Breed	Number of scanned calves	Number of useful images for weight prediction	Number of useful images for scoring prediction
Charolaise	1 114	1 954	1 483
Blonde d'Aquitaine	894	1 119	821
Limousine	637	747	612
Parthenaise	716	740	418
Aubrac	411	468	420
Salers	412	369	275
Rouge des Prés	239	343	320
Gasconne des Pyrénées	185	175	165
Blanc Bleu	219	173	130
Bazadaise	65	90	74
Total	**4 892**	**6 178**	**4 718**

Most of the calves has been scanned twice, Data filtering on data quality and diversity

4) Results : BW prediction performance on all breeds

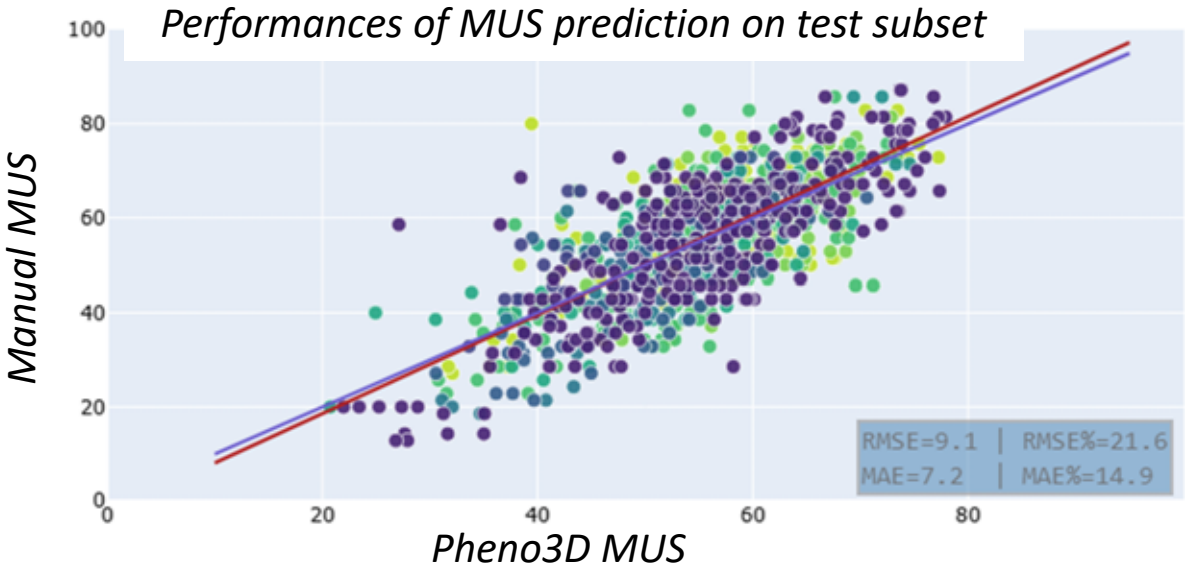


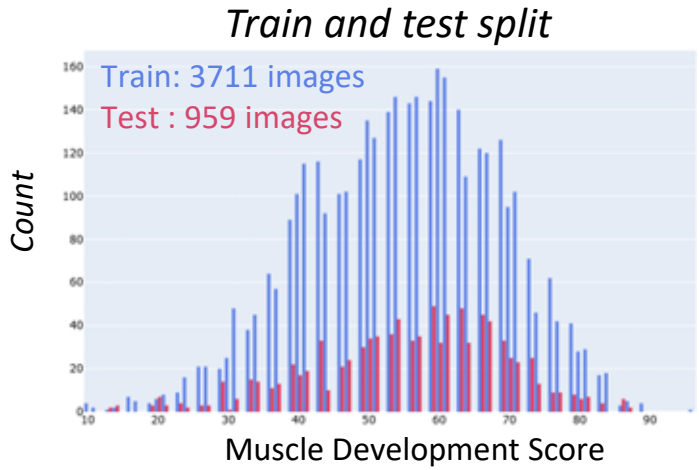


BW prediction remains highly accurate (4.5% MAE),

- Consistent with results reported in Charolaise cattle only (4.2% MAE; Bruyas et al., 2024).
- Performance varies by breed (4.2–5.4% MAE).
- **Improvements are ongoing to strengthen robustness and breed-effect handling.**

4) Results : Muscle Development Score (MUS) prediction performance on all breed



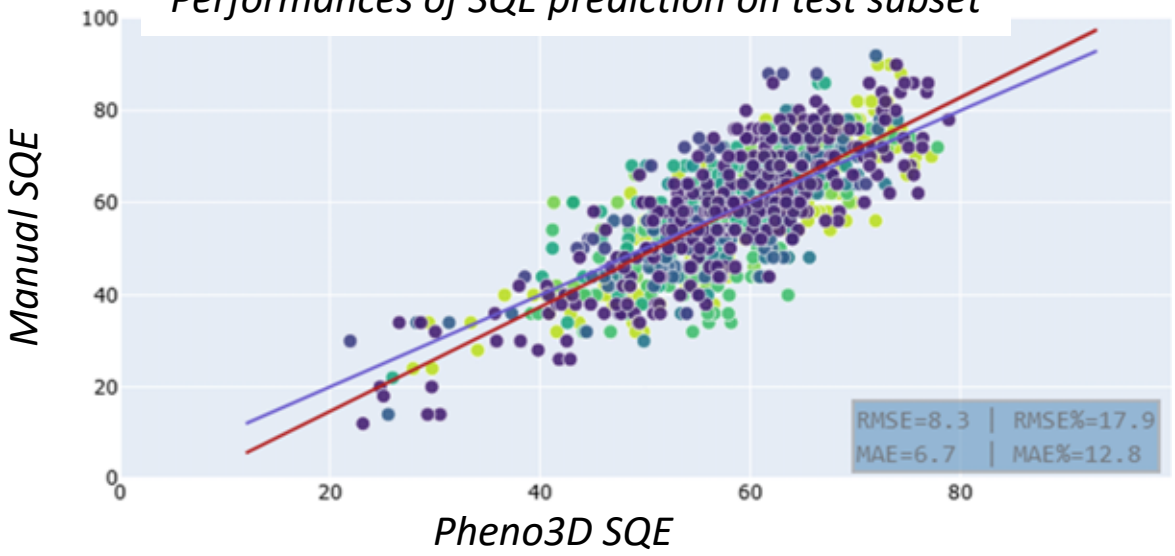


MUS prediction remains accurate (MAE = 7.2, r_spearman = 0,71),

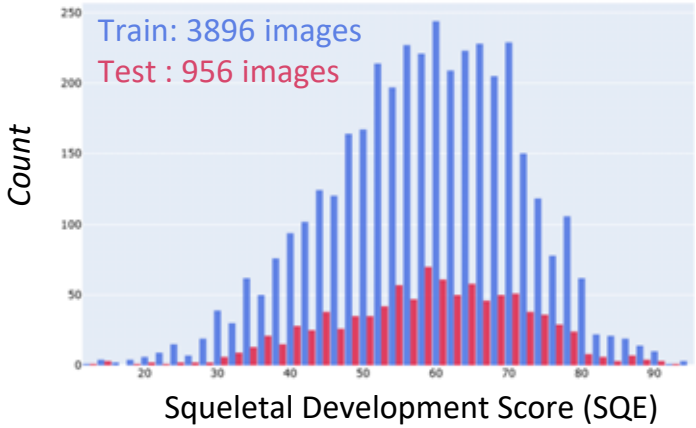
- consistent with targets MAE = 7.4, r_spearman = 0.77, a bit below performances on Charolais only (Bruyas et al., 2024)
- Performance varies by breed (MAE = [6.2 – 8.7]).
- **Improvements are needed to strengthen robustness and breed-effect handling.**

4) Results : Squeletal Development Score (SQE) prediction performance on all breed

Performances of SQE prediction on test subset



Train and test split



SQE prediction remains highly accurate (MAE = 6.7, r_spearman = 0.76),

- consistent with targets MAE = 8.0, r_spearman = 0.73, a bit below performances on Charolais only (Bruyas et al., 2024)
- Performance varies by breed (MAE = [5.4 – 9.7]).
- **Improvements are needed to strengthen robustness and breed-effect handling.**

4) Edge AI Deployment Results

On 6 farms (402 animals) :

Overall success rate
80.1%

Average prediction time
(after the passage of the animal)
8.3 seconds

Main Sources of Prediction Failures

- Animal not found in the input inventory
- Incorrect animal positioning during acquisition (jumping, off-center, abnormal posture, etc.)
- Presence of a human or another object/animal in the scanning area
- Incomplete or poor-quality 3D reconstruction

Key Actions to Improve Prediction Success Rate

- Data management
- Acquisition protocol
- Operator training
- Algorithm robustness

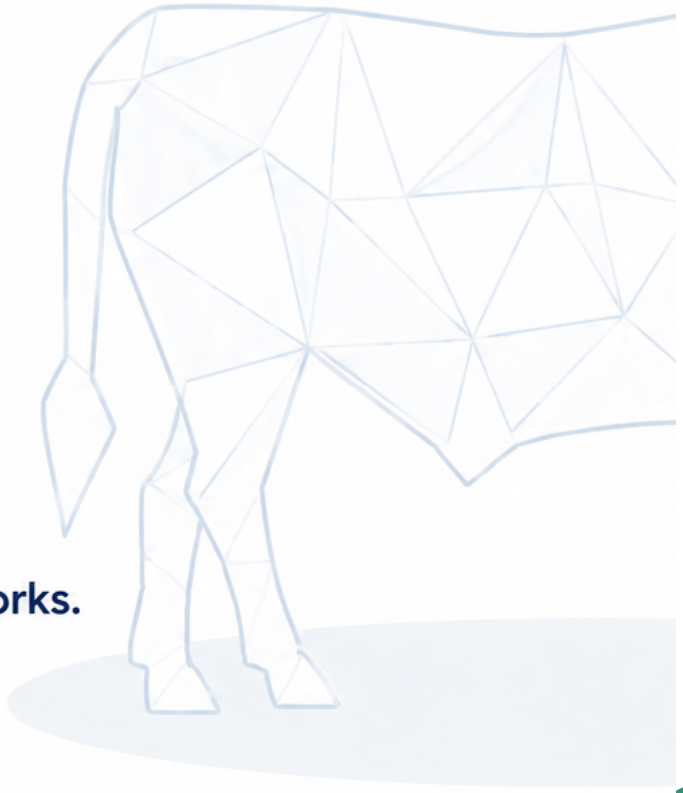
5) Take home messages

Real-time and non-invasive
3D phenotyping for beef calves
is possible !

With an operational level
that is compatible with
routine on-farm service

Prediction models proved favorable outcomes
in terms of body weight, skeletal development,
and muscular development, while keeping
compatibility with existing genetic evaluation frameworks.

Works on 10 French beef breeds



5) Perspectives

1. 

Completion of the integration of all 10 breeds
and validation under real-field conditions

2. 

Connection with existing genetic evaluation systems
for automated data transfer

3. 

Assessment of the impact of PHENO3D data
on genetic evaluations

4. 

Start of industrialization and pre-commercial deployment
in early 2027

Thank you for your attention !

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