Early and automated detection of BRD disease in young bulls using activity and rumen temperature

J.M. Gautier, M. Guiadeur, B. Mounaix, C. Allain, J.J. Bertron, A. Philibert (Institut de l'Elevage)
L.A. Merle (Experimental farm, Les Etablières)
S. Assie (ONIRIS)
D. Concordet, M. Chassan (ENVT)

73rd annual meeting of EAAP
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Financial support

Why this project ?

Limited sensitivity

Infrared oricular thermography 54.1%
(Schaefer et al., 2007)

Temperature sensing ear tag 46%
(McCorkell et al., 2014)

= Previous studies on biosensors

BRD in feedlot = **1st health issue**
(Bareille et al., 2008)
1st cause of antimicrobial uses
Economic losses

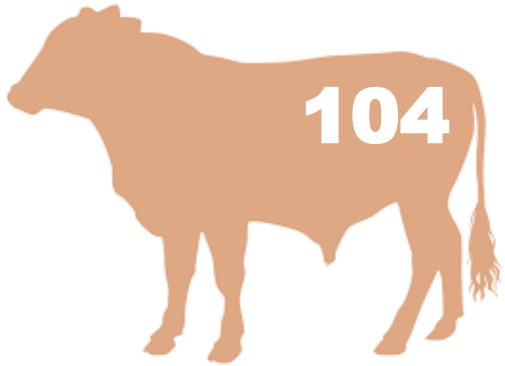
Usually based on visual appraisal = **Not accurate**
(Timsit et al., 2011)
Low sensitivity (61.8%)
(White and renter, 2009)

Accurate detection = Key for treatment success

Could the combination of different parameters measured by sensors improve precocity and sensitivity of the BRD detection ?

Experimental design

Data collection
Sensors + clinical signs of BRD
1st month of fattening



- Charolais
- No primary vaccination
- No metaphylactic antibiotic treatment

2 studied periods

2019 Nov. 6th → dec. 9th

313 kg +/- 34
229 days old +/- 25

2020 Nov. 10th → dec. 10th

341 kg +/- 42
248 days old +/- 21

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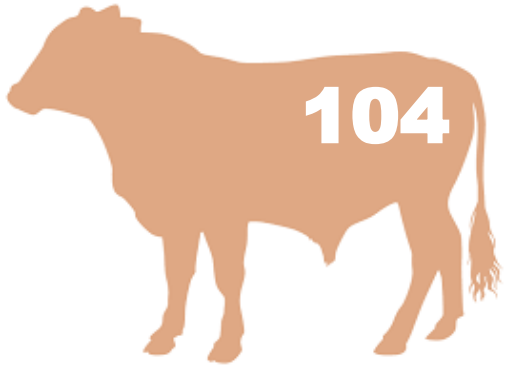
Experimental design

Data collection
Sensors + clinical signs of BRD
1st month of fattening

Health status

→ Individual visual daily screening of clinical signs of BRD
- Nasal and ocular discharge
- Cough (strengh and frequency)
- Depression
- Respiratory rate and amplitude
- Rumen fill score

→ Rectal temperature (1/week)



Define a clinical score

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Clinical score

How we define a sick animal based on clinical signs ?

Healthy animal — CONTINUUM — Sick animal

Respiratory score

Nasal discharge or Cough
+
Cough strengh and frequency
+
Ocular discharge
+
Respiratory rate > 40
+
Increased respiratory amplitude

General score

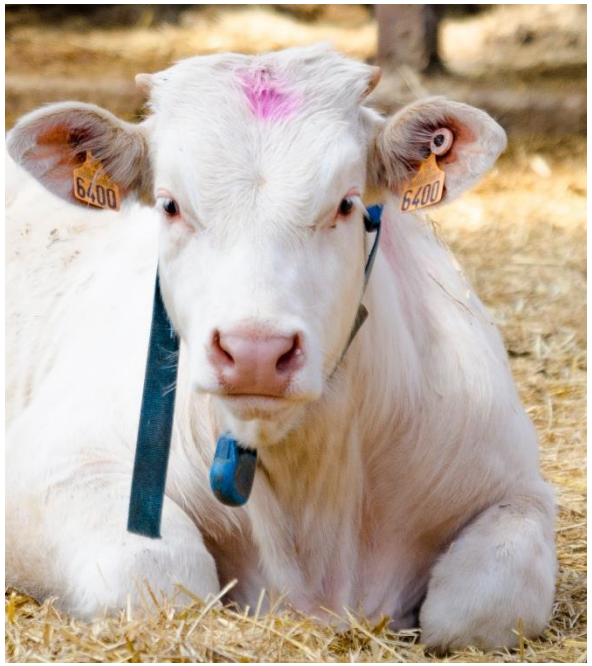
Hyperthermia (T°C>39.7)
+
Depression
+
Appetite
+
Rumen fill score

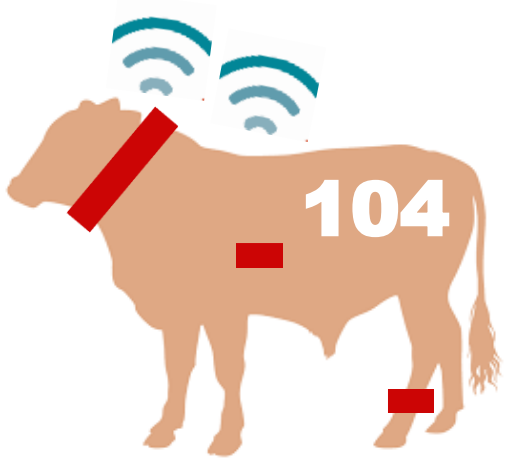
Clinical score — For each animal each day

Sick animal = clinical score > 4

Experimental design

Data collection
Sensors + clinical signs of BRD
1st month of fattening





Heat Time – Dairy Master

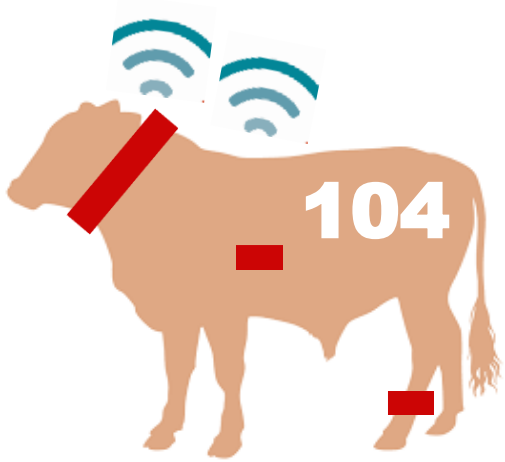
Activities & ruminal temperature

Accelerometer collar

→ Rumination
→ Feeding time
→ Rest
Every hour

Experimental design

Data collection
Sensors + clinical signs of BRD
1st month of fattening



IceCube - Icerobotics

Activities & ruminal temperature

Accelerometer collar
- → Rumination
- → Feeding time
- → Rest

Every hour

Pedometer
- → Nb of steps
- → Time and duration of lying bouts

Every 15 min

Experimental design

Data collection
Sensors + clinical signs of BRD
1st month of fattening

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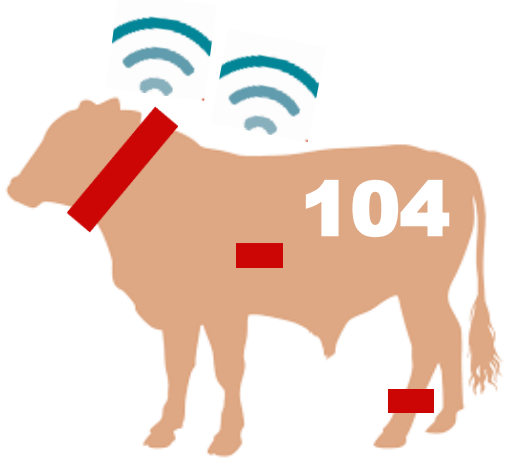


Activities & ruminal temperature

Accelerometer collar
- → Rumination
- → Feeding time
- → Rest

Every hour

Pedometer
- → Nb of steps
- → Time and duration of lying bouts

Every 15 min

Thermoruminal bolus
- → Rumen temperature
- → Moments of drink

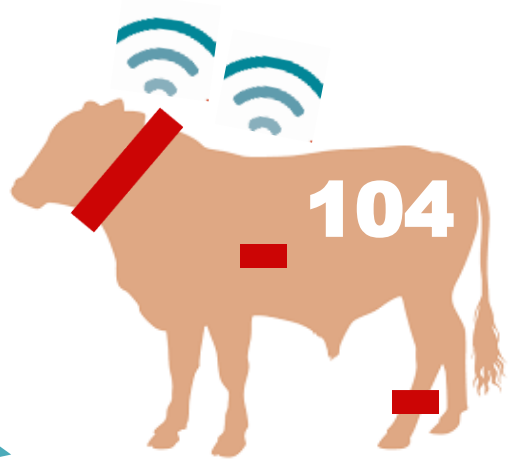
Every 5 min

Experimental design

Experimental design

1 Data colletion
Sensors + clinical signs of BRD

Health status



Activities & ruminal temperature

Linked activities and health status with a global and rational vision

2 Build a predictive model and evaluate its performance

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DIGIFERMES

Results
Model and performances

8 measures from **sensors**

- Nb of steps
- Nb of lying bouts
- Standing time
- Resting time
- Ruminaton time
- Average rumen temperature
- Maximum rumen temperature
- Moments of drink

160 predictiv variables

- Raw data from d-4 to d
- Derived measures (normalisation…)

Selection of variables of interest to obtain the best performance (cross validation Leave One Out)
Minimising $(1-Se)^2+(1-Sp)^2$

Mathematical model

Early detection of sick animal from healthy ones
Based on the clinical score defined in this project

2 Build a predictive model and evaluate its performance

Evaluation of health status of each animal each day **by a vet**

- Clinical observations
- Rectal temperature

Results
Model and performances

Mathematical model

Ability to detect a sick animal ?

Pedometers + Collars + Bolus
77 variables

We use datas from d-3 to d-1 to predict the health status of d-day

Sensitivity
= % of real sick animal that we detect as sick

74 %

Specificity
= % of real healthy animal that we detect as healthy

74 %

Prevalence 54.4%
→ VPP 77%
→ VPN 70%

Results
Model and performances

Mathematical model

And without the bolus ?

Podometers + Collars ~~+ bolus~~
67 variables

We use datas from d-3 to d-1 to predict the health status of d-day

Sensitivity
= % of real sick animal that we detect as sick

72 %

Specificity
= % of real healthy animal that we detect as healthy

71 %

Prevalence 54.4%
→ VPP 75%
→ VPN 68%

Conclusion & discussion

Is it relevant to monitor activities of young bulls to predict BRD ?

YES ! But activities of each young bull affected by BRD seems to be affected differently

Are we able to detect BRD, early and automatically ?

YES ! 24h before occurrence of clinical signs, and so 24h before farmer or vet

With which performances ?

Depends of the number of sensors used
→ loss of specificity without the bolus

- 2 points of sensitivity = % of sick animals detected as sick

- 3 points of specificity = % of healthy animals detected as healthy

In the future ?

Proof of concept

Studies needed

→ Define treatment strategies
→ Impact on zootechnical & economical performances

Decision making tool

THANK YOU for your attention !

+ d'infos

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Or by mail

Clement.allain@idele.fr

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