EAAP 2018
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Pathways to Innovation in Precision Livestock Farming (PLF)

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INRA
SCIENCE & IMPACT

Pathways to Innovation in Precision Livestock Farming

1/ Introduction: assessing impacts of innovation

→ a long-term perspective

2/ Precision livestock farming: an “area of innovation”?

3/ Breaking an animal science paradigm by considering animals as individuals

4/ Some examples of current research at Inra on PLF

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Assessing impacts of innovation

An innovation = an invention which found a market → users

A standardized method = **Asirpa** (Socio-economic Impacts Analysis of the Public Agricultural Research)

3 tools : chronology (time), impact pathways (steps), impact vector (politic, sanitary, economic, environmental, territorial/social)

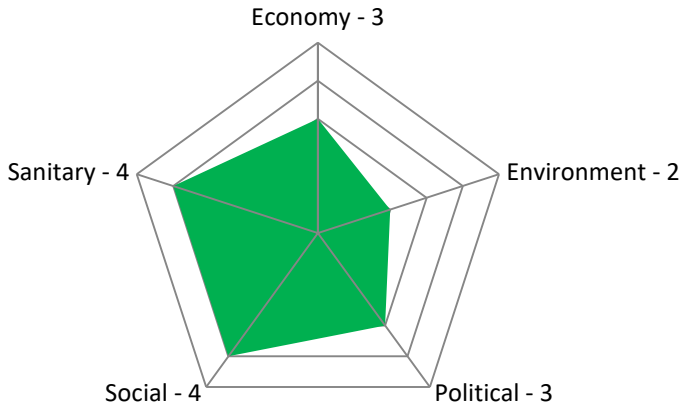
More than 40 case-studies

Time-scale = 20 years, from research to 1rst societal impacts

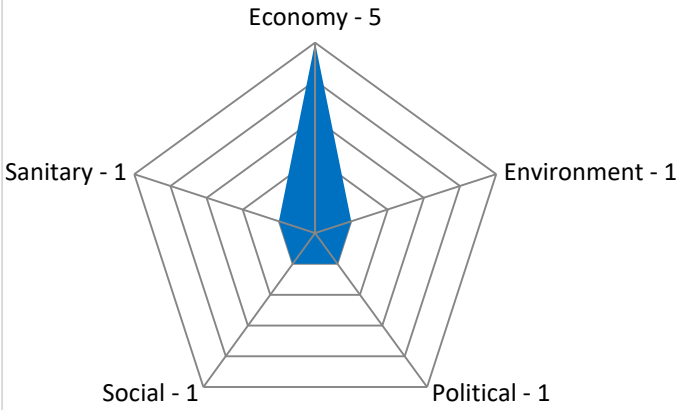
https://www6.inra.fr/asirpa_eng/

Some examples of impact vectors

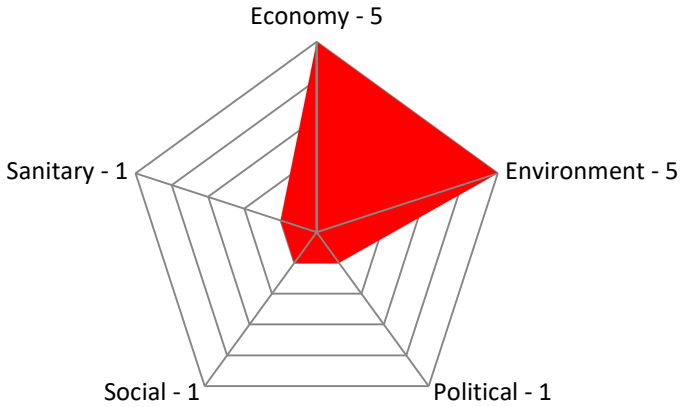
Sheep's Scrapie



Bovine Genomic Selection



Nitrogen Fertilization



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Innovation: a participatory process

INRA planned to strengthen collaborations with stakeholders in fields of research which have a strong potential for innovation (strong impact).

→ so-called “areas of innovation” (n =17)

11 areas of innovation involve livestock + 6 others (crops, forest, processing)

- **Precision livestock farming**
- Animal genetics
- Innovation for animal health in farming systems
- Micro-organisms for human and animal health
- Proteins for human and animal feeding
- Urban agriculture
- Financing eco-services provided by agriculture
- Water, soils, effluents
- Climate change
- Digital agriculture
- Agro-ecological transition in food systems

Innovation: a participatory process

Precision livestock farming (PLF) is one of these "**areas of innovation**"

PLF has been identified as having the potential to improve the economic, environmental, and social (ie welfare and product quality) performances of livestock systems

Precision Livestock Farming: potentially perceived in a contradictory way, inside and outside the “animal science” field

A potential negative perception:

- **A way to increase productivity (quantity *vs* quality)**
- **A way to replace humans by technologies (labor & skills)**
- **It is expensive and thus useful only for big farms**
- **Farmers can loose information, overwhelmed by the data reported in several web or mobile applications**

Precision Livestock Farming: potentially perceived in a contradictory way, inside and outside the “animal science” field

A potential positive perception:

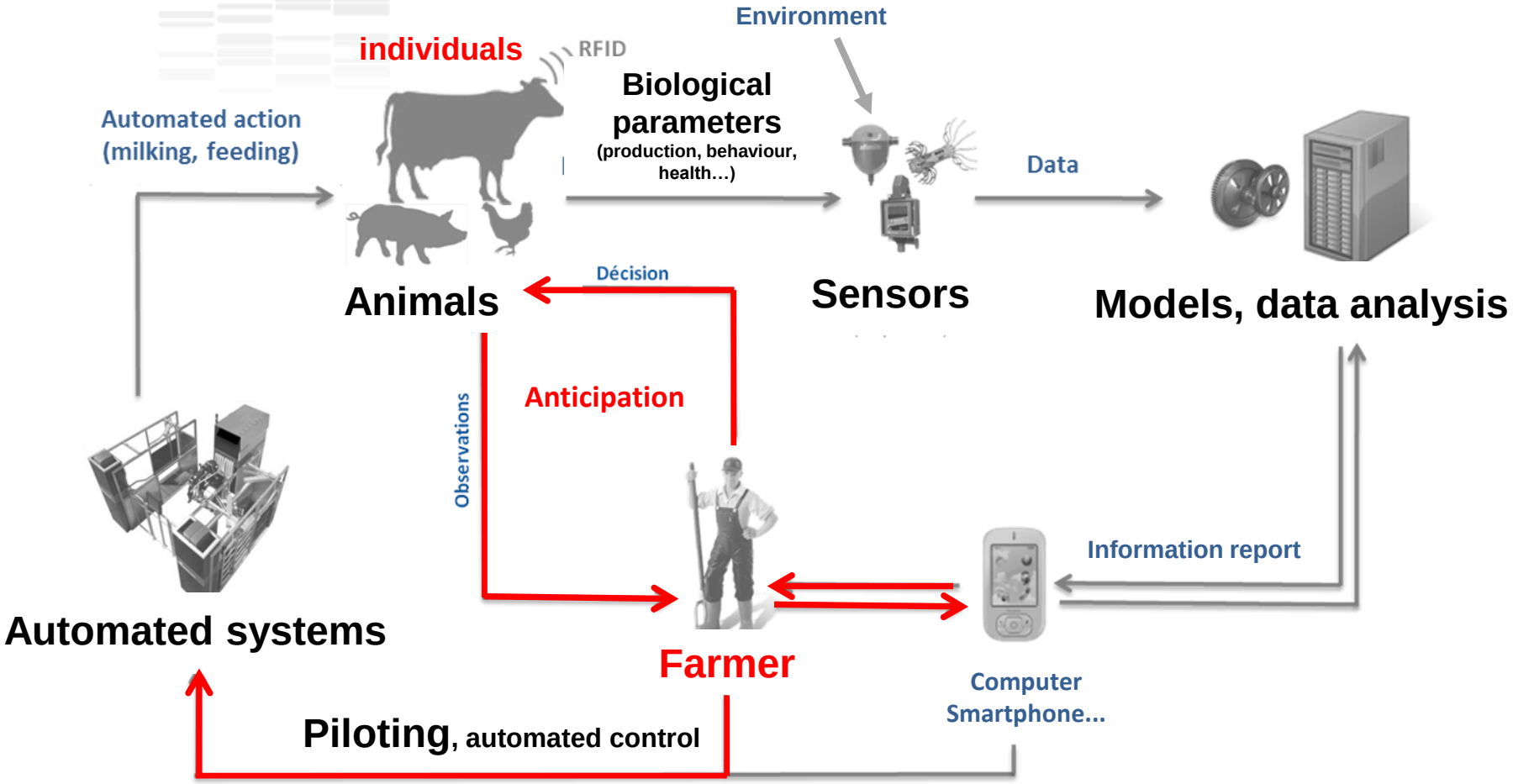
- **A way to become more efficient with feed resources**
- **A way to know/drive biological processes (*vs* artificial inputs)**
- **A possibility to take advantage of biological variation among animals**
- **A way to answer societal questioning on animal health and welfare**
- **An opportunity to address environmental performance management**

Precision Livestock Farming

Focused on farming practices & dedicated to:

- **Animal welfare and health**
- **Feeding efficiency**
- **Breeding efficiency**
- **To make farmer's job easier and attractive**

Precision Livestock Farming



Structuration of the INRA PLF' area of innovation

Animal		Feed
Welfare/Health	**Breeding**	**Management / Efficiency**
Behavior monitoring	Detection of events	Prediction of feeding behavior Individual's needs
Clinical markers of health	Gametes, eggs, embryo phenotyping	New feeding strategies
Biomarkers of welfare	Biomarkers of breeding phenotype	Reduction of negative environmental impacts

Access to data, traceability, storing, sharing

Labour issues

Design of decision making tools

Labour issues

Studies to determine consequences of PLF on farmer's labor (work duration, arduousness, skills, human-animal relationships)

- **Time saving due to automation, information generated by pre-set alerts, and "the per animal approach"**
- **Some references : milking robots (- 30% in working hours), feed distribution (- 50% in working hours)**
- **Different uses of time saving by farmers : reinvested in production-related tasks, farm management, or personal activities (more free time)**
- **More flexibility in farmers' labor than an overall decrease in labor**

Hostiou *et al.*, 2014

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The end of « average individual »?

Similarity (clones, useful for stats) vs diversity (real life, useful for selection)

→ the diversity of components can enhance resilience, robustness & efficiency of the global system (session 21)

- **What are the relationships between the resilience of the system at level n and the diversity of its components at level n-1?**
- **Does diversity increase the level and the constancy of performances over a long-term period? What are the conditions for that?**
- **In what extent does taking into account diversity generates a higher capacity to innovate in livestock farming practices?**

The end of « average individual »?

Implications/needs:

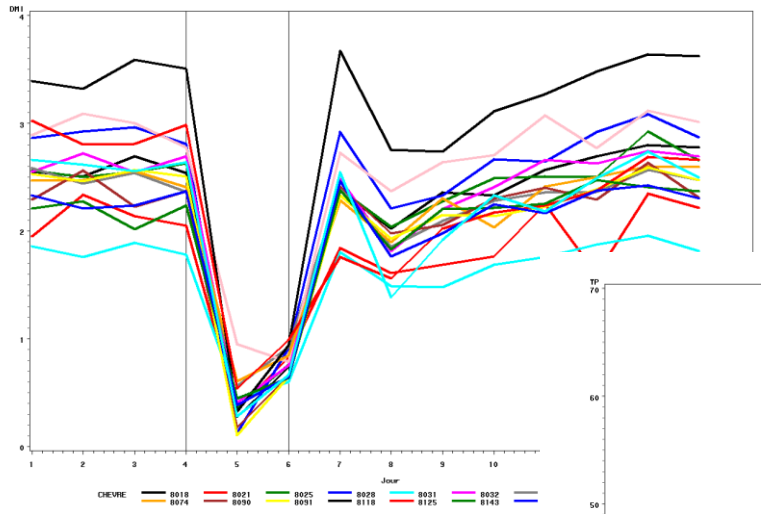
- **Characterising diversity**
  - **To define tools, methods and time-scale, according to the kind of diversity (parameter) and the level of organisation (genes, biological function, animal, herd, territory…)**

- **Managing/driving diversity (session 22)**
  - **Defining management rules of diversity, by understanding what are the drivers**
  - **Defining a collective organisation, considering the different stakeholders (farmers, breeders, nutritionists, vets, …)**

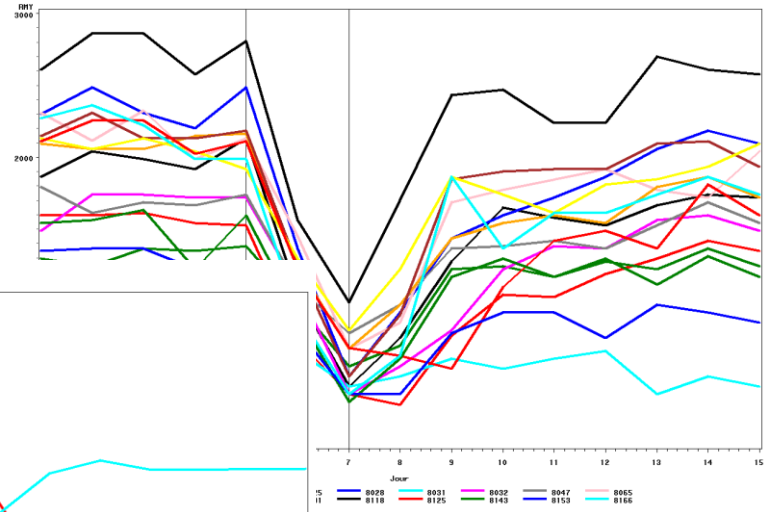
Examples about resilience modelling: goats

- **Goats followed during a control period, a nutritional challenge and a recovery period**

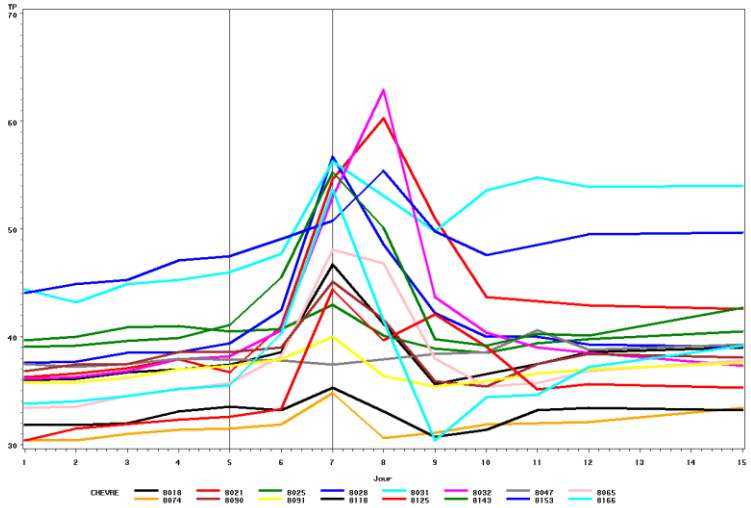
Dry matter intake



Milk yield



Milk protein content



(Friggens et al., 2016)

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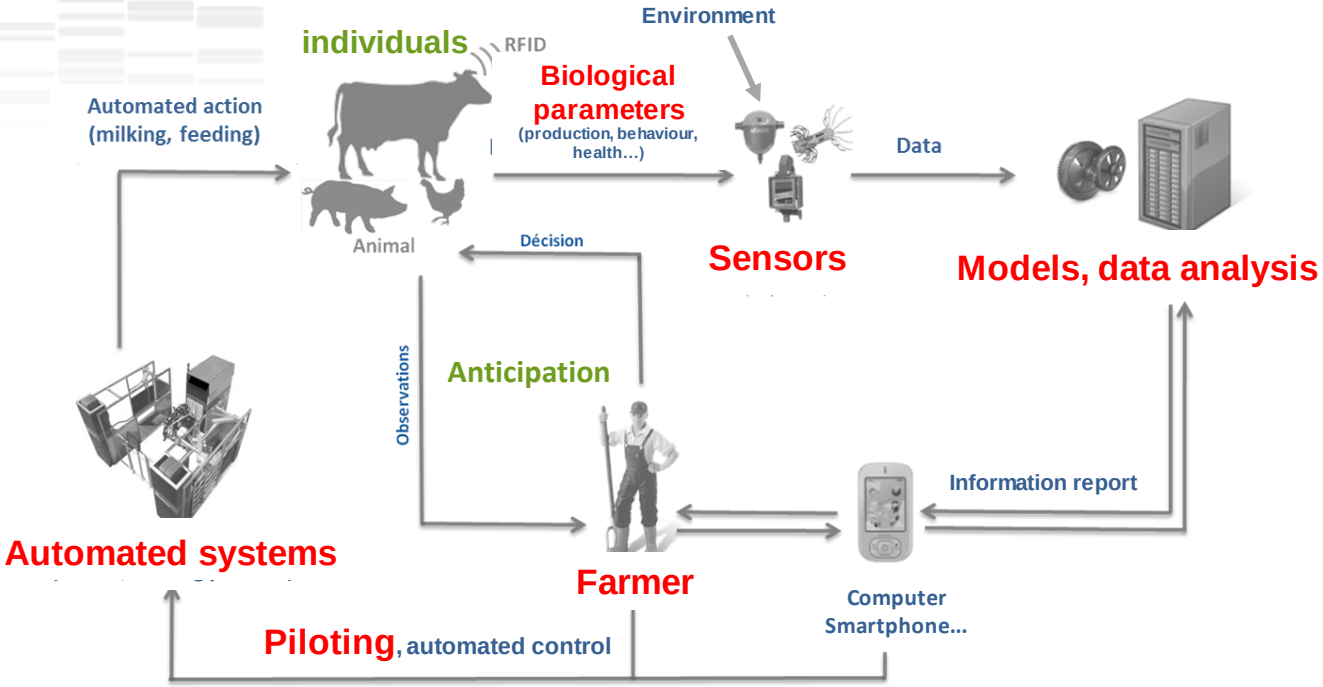
INRA researches in precision livestock farming



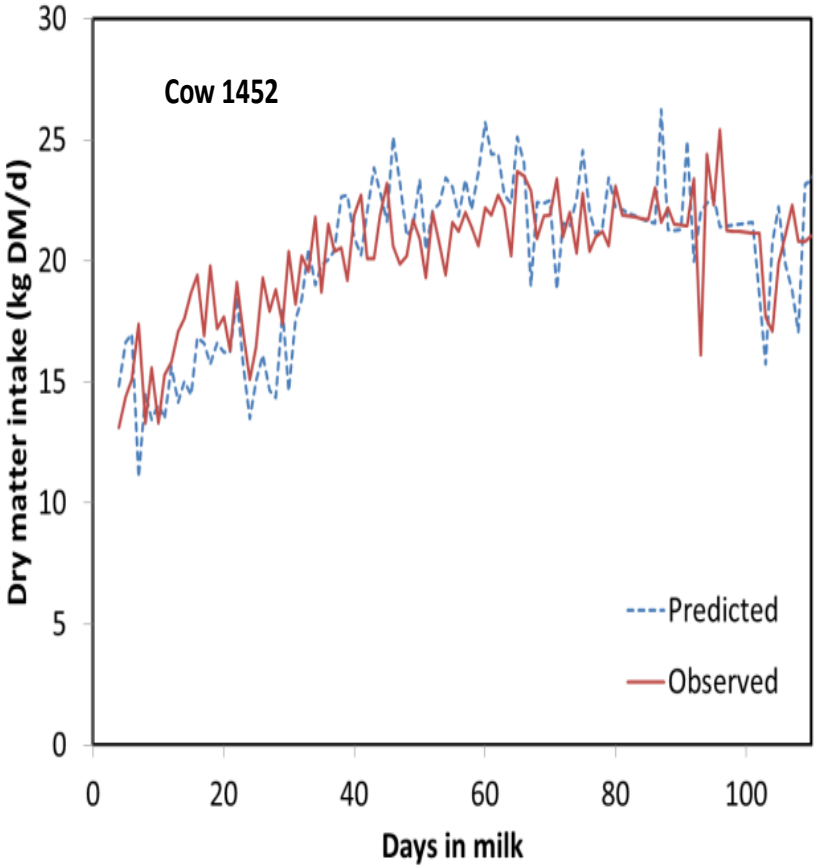
- **Topics / applications**
  - Feeding / nutrition
  - Health, welfare
  - Breeding

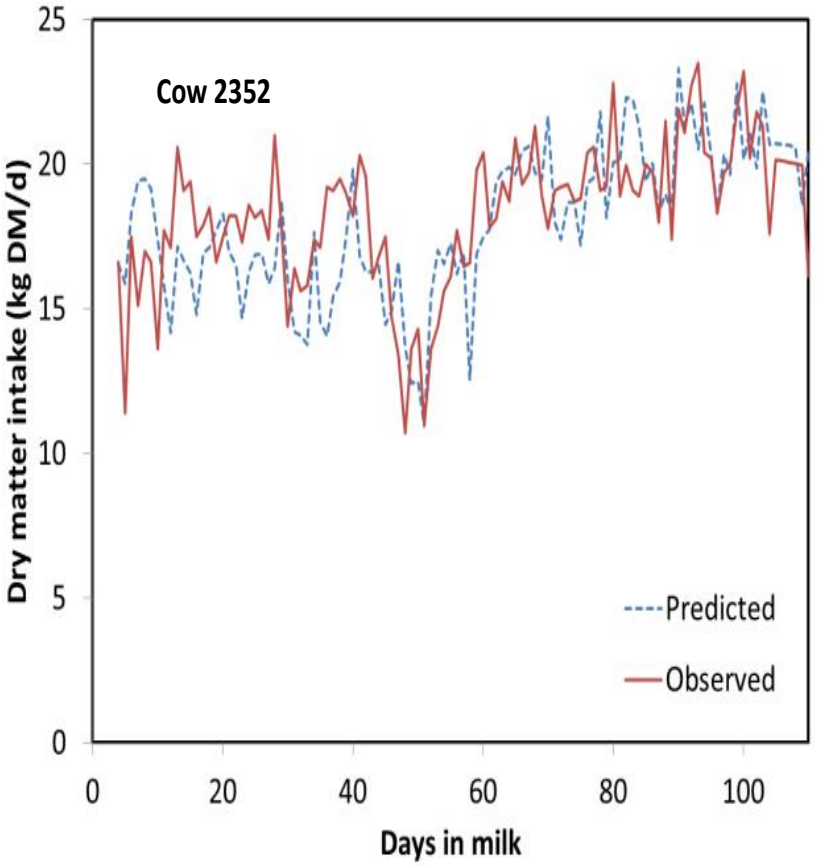
Prediction of dry matter intake of lactating dairy cows with daily live weight and milk yield

- **Data on milk production and animal weights are now widely available in commercial farms**
- **However, the feed intake monitoring of the dairy cows remains largely absent of monitoring**
- **Is it possible to estimate variation in dry matter intake (DMI) with the two kinetics of body weight and milk yield?**

(Faverdin et al., ECPLF 2017)

A satisfying model to predict changes in DMI … in spite of day to day inaccuracy





(Faverdin et al., ECPLF 2017)

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

- **On farm method: BCS (body condition score)**
  - scoring according to a chart (1 chart / country) visually and / or by palpation
  - commonly used on-farm BUT too subjective, too less repeatable and time-consuming

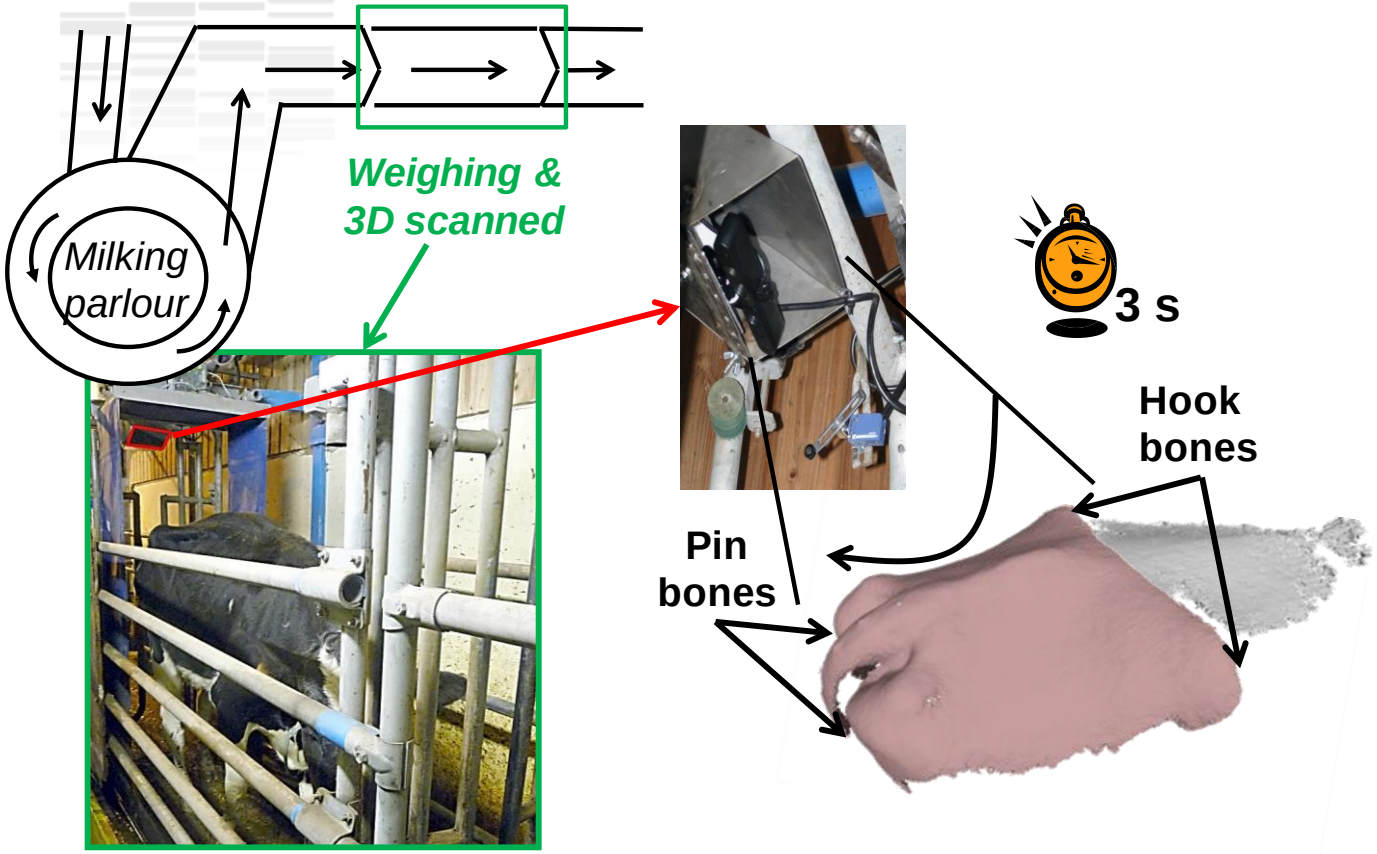
- **Body condition ➔ monitoring body reserves variation**
  - Too low / high level of variation = indicator of health or nutrition issues + source of health or reproduction problem

⇨ **Monitoring reserves variation = key issue on farm to manage cows**

- **Aim of the project : to *develop and validate* a method assessing *automatically BCS* from *3-D* surfaces of Holstein rear**

(Fischer et al., ADSA Join Annual Meeting, 2015)

Acquisition system of 3-D surface

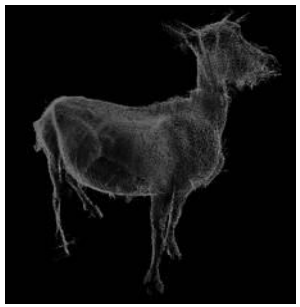


- **Objectives:**
  - capture the 3D-surface of the rear
  - quick capture
  - high resolution

(Fischer et al., 2015)

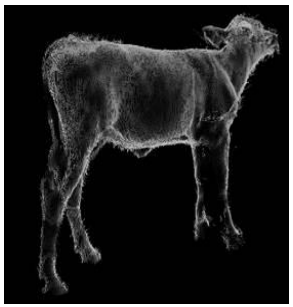
A promising automatic BCS & morphology of the whole body

- **Perfect calibration, more repeatable than BCS, and automation as performant as manual points**
- **For a high throughput phenotyping**
- **Offering new perspectives**
  - Easy adaptable on other species
  - Assessing other important phenotypes (rumen size, pregnancy stage, lameness...)



Goat

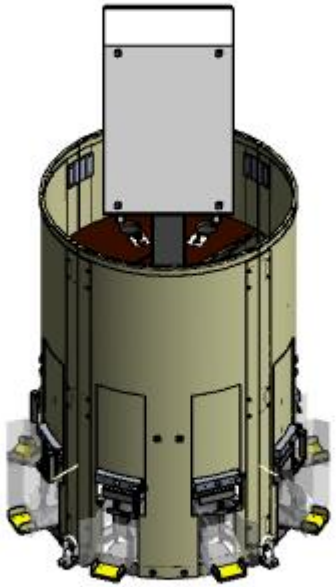
Calf



(Fischer et al., 2015; Caillot et al., EC PLF 2017)

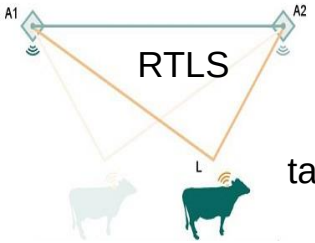
A individual feeder for poultry

The prototype for chickens (n=1)



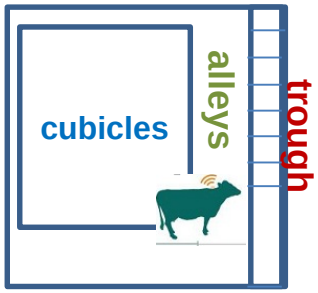
The current project with a private company

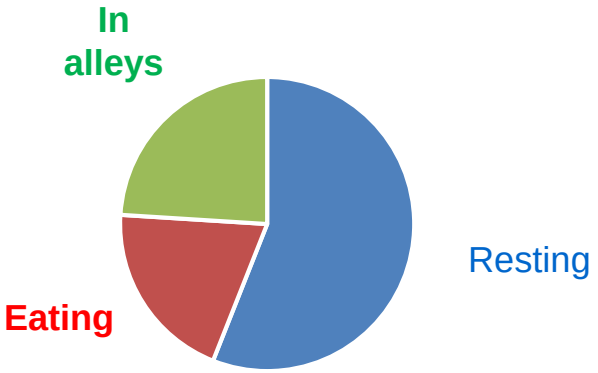
Detection of cow activity with CowView



Antennas

tag



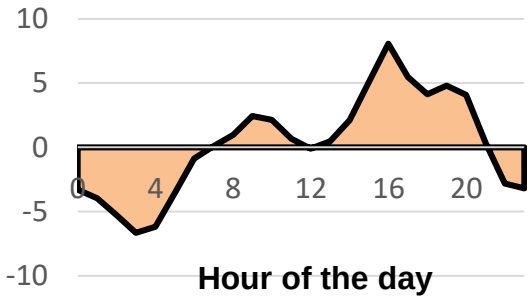


Daily time in each activity

- **Description of the normal time budget of each cow**
  - Cow more active than normal ➔ alarm: oestrus?
  - Cow less active than normal ➔ alarm: disease?

Circadian rhythm of activity

Activity level = -0.34 resting +0.29 in alleys + 0.52 eating



Activity indicators

Mean daily activity
Mean activity in the morning
Circadian variations
…

RTLS: real time location system

Veissier *et al.*, 2017

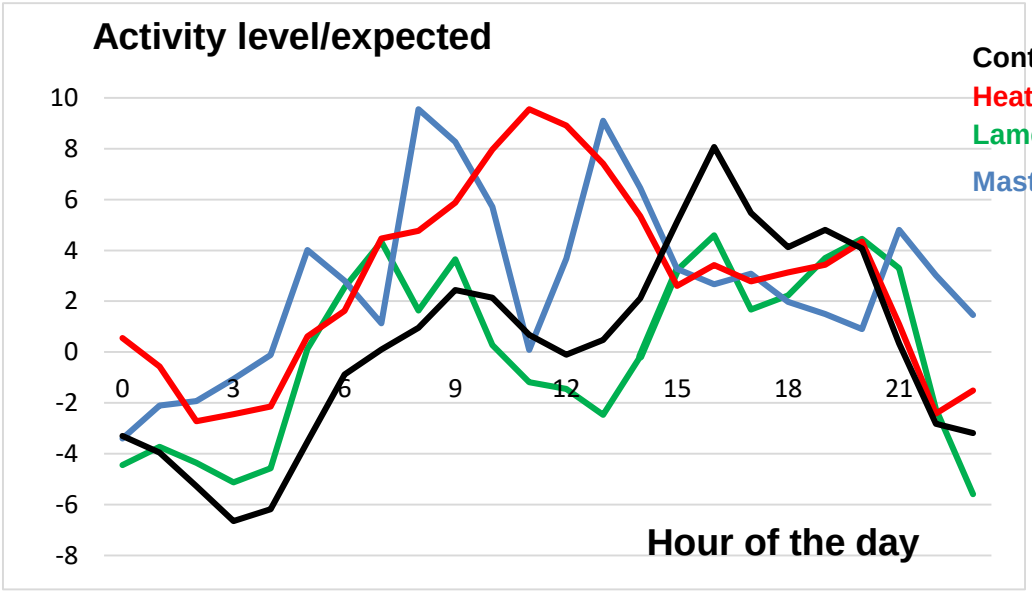
PLF and health management
Several activity indicators and diseases

❖ Behavior modified in relation to stress situations or disease

- **Social events**, like repeated mixing → more marked circadian activity rhythm (Veissier *et al.*, 2001)
- **Diseases** :
  - *pneumonia*: alteration of circadian rhythm 2 days before occurrence of symptoms (Veissier *et al.*, 1989)

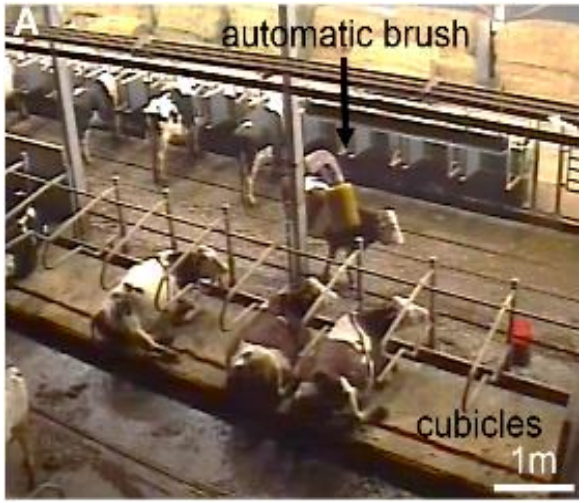
❖ How to detect behavioural modifications?

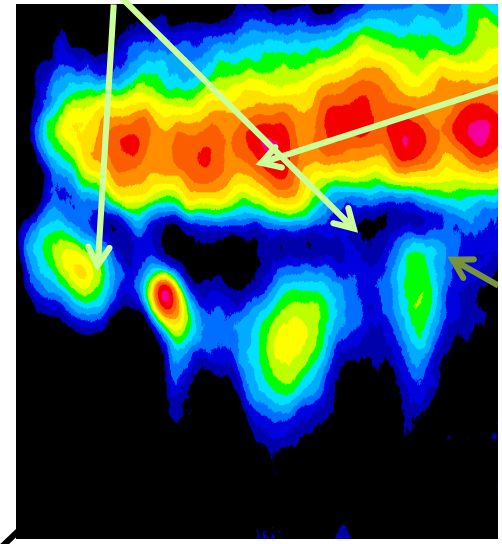
Level of activity of a cow and its variations change with specific states, i.e. heat, lameness, mastitis

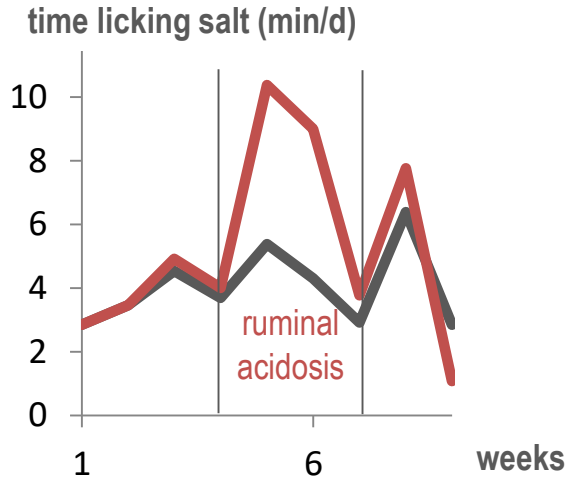


Veissier *et al.*, 2017

PLF and health management
Several activity indicators and diseases







Increased time spent licking salt could be used as an alarm.

Silberberg *et al.*, 2017

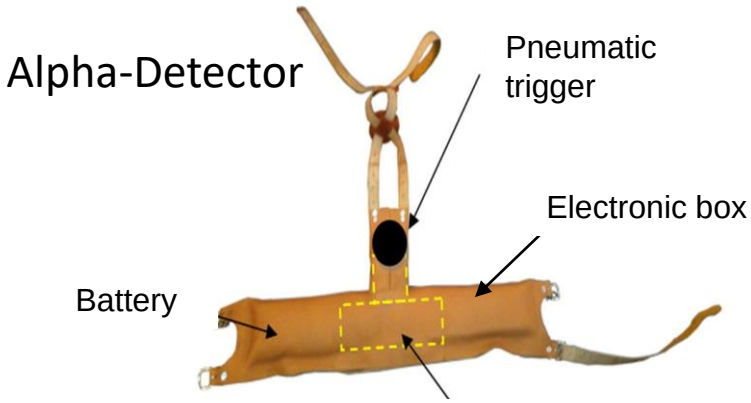
Heat detection in sheep

Bocquier *et al.*

❖ Principle

Equipped ram

Identified ewe
Alpha-Receptor



❖ A system in last stage of development

❖ Facilitation for heat detection

- ❖ Which female to inseminate
- ❖ Diagnostic for pregnancy
- ❖ An alternative to hormonal treatment

Ram straddling an ewe

Organic pig farming facilities dedicated to PLF

4 x 12 sows

Including fattening

Organic:

to provide “high welfare” conditions

to monitor individuals within groups

to design “high-tech” systems, societally desirable

A project for 2019 (still virtual!)

Conclusion

- Innovation in PLF should lead to good animal health and welfare, environmental protection, farmers well-being (including €) and consumers/citizens satisfaction → which pathways?
- To build the pathways, more accurate technology means are becoming available: sensors, automated systems, data storage, models;
- There is still a great step to make until the gap between monitoring possibilities and tools really usable for farmers is filled → this is our job!
- There is a dramatic opportunity for PLF by promoting:
  - - diversity and individual-based farming practices;
  - - anticipation allowing to avoid negative events

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