

SmartCow: an integrated infrastructure for increased research capability and innovation in the European cattle sector

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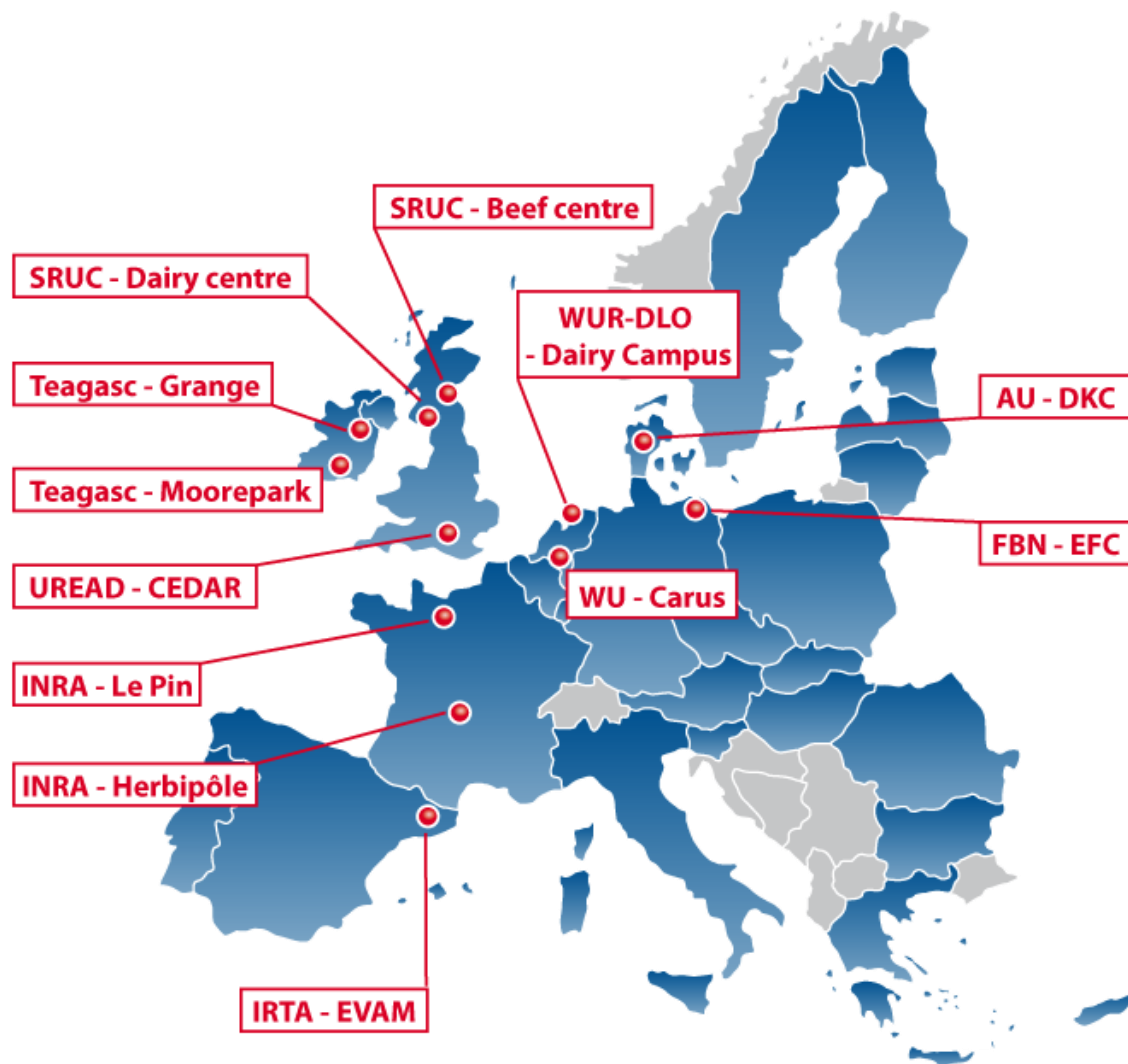
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Concept and objectives of SmartCow project

- Better coordination of research infrastructures (RIs) in the cattle sector is necessary to develop more efficient approaches to address the various challenges in cattle breeding and research
- SmartCow is a first step towards the integration of RIs for the European cattle sector, developing:
 - **Networking activities:** mapping RIs, adopting common language, the best standardized techniques and data sharing
 - **Joint research activities:** Improved and new methods to enhance phenotyping of new and more complex animal traits
 - **Transnational access:** Giving access to the infrastructures to conduct new research projects

14 partners across Europe



9 partners that bring RIs

- 11 major RIs distributed in 7 EU countries
- 12 locations, which include 18 installations
- 2500 dairy and 750 beef cows
 - *Part of the animals are genotyped*
 - *Possible link with gene banks through identification number*

5 other partners for specific skills

- Agrimetrics : Cloud based data-platform
- CRA-W : NIR and MIR techniques for phenotyping
- Idele and EAAP: Dissemination and stakeholders
- INRA Transfert: Project management

A large range of measurement capabilities in nutrition, physiology and behaviour



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Outcomes of networking and research activities

- Mapping of RIs in the consortium and across Europe
- Inventory equipment and related techniques
- Inventory of animal databases and sample banks
- Develop unified guidelines for specific measurements (book of methods)
- Improve the animal trait ontology for cattle (ATOL and EOL)
- Develop a cloud-based data platform to gather and share data
- Refine methods in the field of nutrient efficiency and emissions
- Develop proxies (biomarkers) to predict nutrient efficiency and their determinants
- Develop a multivariate approach to phenotype behavioural, health and feed efficiency traits based on sensor data

→ *Implementation of 3R principles (Replace, Reduce, Refine)*

SmartCow portal of Cattle RIs *(Teagasc, Idele, EAAP)*

- To inventory European cattle RIs and give them more visibility through the interactive map and so foster synergies and new cooperation
- Interactive Map
www.smartcow.eu/map/
- Online survey to extend the mapping of RIs
www.smartcow.eu/participate-to-smartcow-survey/



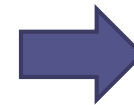
List of Institutes

Institute	Research Facility/Installation	Address	Farm Type	Stakeholder type	Website
Aarhus University, Department of Animal Science	Danish Cattle Research Centre	AU Foulum, Blichers Alle 20, 8830 Tjele, Denmark	Experimental Farm	Public	go to website
CRAW	Experimental dairy farm	Rue de Liroux 8 5030 Gembloux, Belgium	Experimental Farm	Public	go to website

Book of methods in cattle physiology *(FBN-Leibniz and all partners)*



- Metabolic, digestive, anatomic, behavioural traits
- Mostly Innovative and/or minimal invasive tools/instruments
- Links with animal trait ontology (ATOL www.atol-ontology.com)
- Avoiding duplicates and taking ICAR guidelines in consideration



For each method:

- Pre-requisite
- Preparation
- Recording
- Validation (if necessary)

Publication of the book planned beginning 2021

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Refine reference measurement methods of nutrient efficiency and emissions *(UREAD, WU, INRA, SRUC, FBN, AU)*

- To identify and address sources of variation in key *in vivo* measurements of dietary nutrient use efficiency and associated emissions of methane and nitrogen by cattle
- To improve the accuracy and precision of measurements
- Unify the methods used across SmartCow infrastructures
 - Develop (or standardize) optimised diet digestion and N balance procedures
 - Perform 'ring tests' of respiration chambers and optimise procedures for methane measurements



Evaluation of proxies to predict feed efficiency and its determinants in cattle *(INRA, CRA-W, AU, SRUC, UREAD)*

To identify their **range of applicability** across **diets** and **individuals**

Parameter (GSM)	Proxies	Matrices	Status
<ul style="list-style-type: none"> • Total tract digestibility • N partitioning • Animal feed efficiency 	<ul style="list-style-type: none"> • NIR • Urea-N; 15N natural abundance • Urea-N; 15N natural abundance • Metabolites 	<ul style="list-style-type: none"> • Faeces • Milk, blood, Urine, faeces • Blood 	<ul style="list-style-type: none"> • Solid • New
<ul style="list-style-type: none"> • CH4 emission • VFA, ammonia, pH (rumen) 	<ul style="list-style-type: none"> • MIR • NIR • MIR • Volatile metabolome 	<ul style="list-style-type: none"> • Milk • Faeces • Milk • Breath gas 	<ul style="list-style-type: none"> • Solid • New

- **Creation of databases and sample banks**
- **Laboratory analyses; Meta-analysis of the data**

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Sensor data to phenotype behavioural traits, health and feed efficiency *(AU, WUR-DLO, INRA, IRTA)*

- Develop and test uniform guidelines for validating the output from sensors for recording of animal behaviour
- Develop novel algorithms for phenotyping cows based on sensor recordings of behaviour

=> www.smartcow.eu/guidelines-for-validation-of-sensor-output/#



A checklist to validate sensor output for the recording of cattle behaviour

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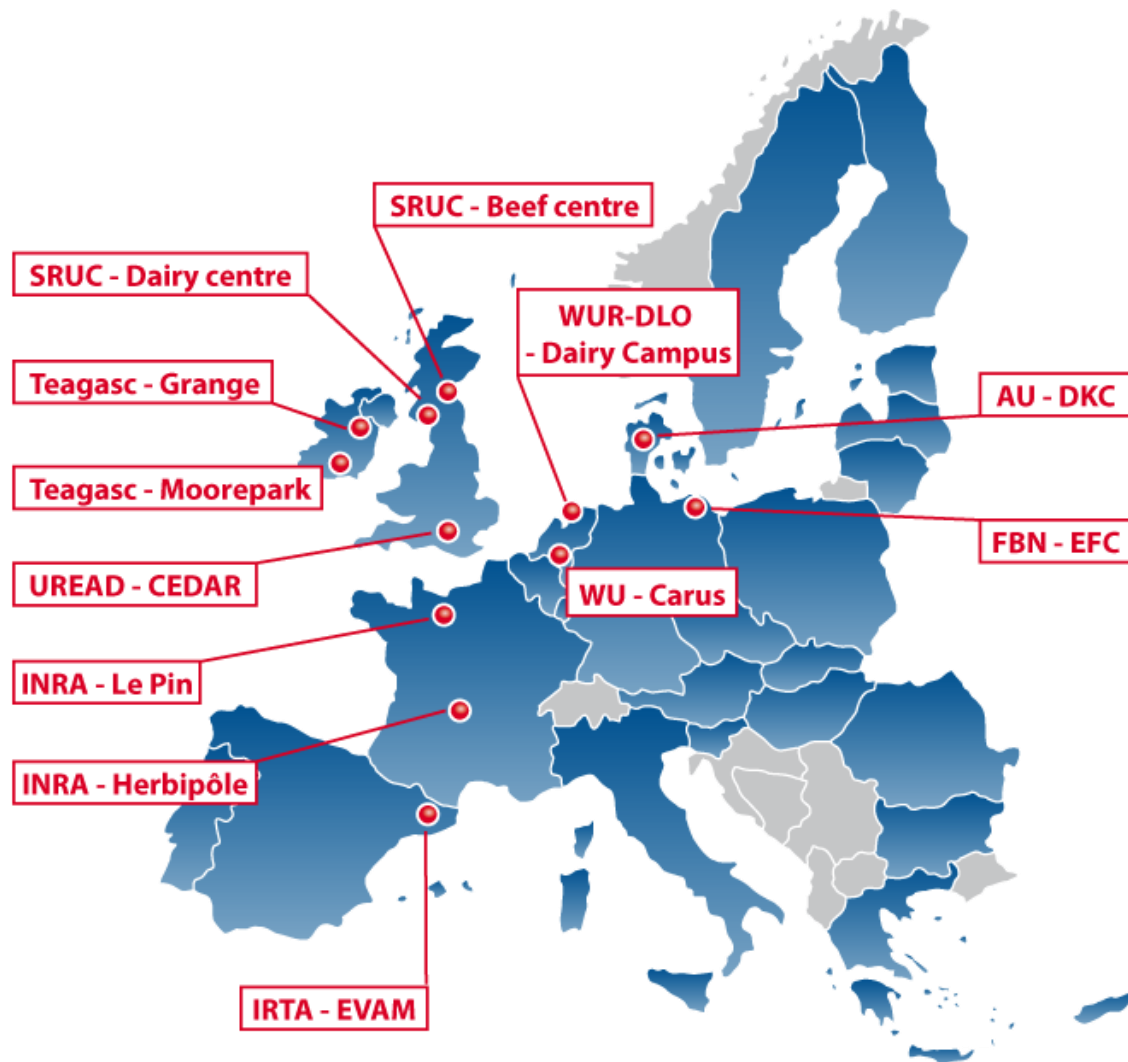
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Transnational Access to RIs *(SRUC, INRA, AU and all partners)*

- Funding for other industry/academics to run studies in facilities of SmartCow partners
- Transnational = in a different state (generally member/associated state of the EU)
- Project funds only host facility costs – such as animal care, monitoring, sampling & sample preparation
- Budget to fund around 30 experiments
- Two stages application procedure (pre- and full proposals)
- Evaluation of full proposals: Science quality, innovation, expected impact, feasibility
- First call in 2018
 - 11 projects accepted: 4 industry/7 academics; 8 countries: UK, AU, FR, CH, DK, SP, DE, BE
- 2nd call in 2019 : 18 pre-proposals received
- 3rd and last call should be open in 2020 (www.smartcow.eu)

SmartCow at a glance



First-class Cattle Research Infrastructures (RIs) across Europe:

- 11 major RIs distributed in 7 EU countries
- 12 locations, which include 18 installations
- 2500 dairy and 1000 beef cows

- **Networking of RIs** to inventorize resources, harmonize procedures, and share data
- **Joint research activities** to improve experimental methods and phenotyping capability
- **Interaction with stakeholders** to stay in line with industry needs and improve dissemination

<http://www.smartcow.eu/stakeholders/>

TRAINING PROGRAM

For Scientists, Technicians, Stakeholders, PhD students

- Face-to-face training courses
- Free web-conferences
- One-day study tours in 4 different countries

<http://www.smartcow.eu/resources/training/>

TRANSNATIONAL ACCESS CALLS

Offers external users (academic and industry) free access to SmartCow RIs

- 30 projects during the 4 years of SmartCow
- Access to around 10,000 cow-weeks

<http://www.smartcow.eu/calls/>



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How to succeed ?



From our experience, some recommendations :

- 1. To build the highest quality consortium as possible*
- 2. To find the right balance between scientific issues and improving infrastructure services. All project actions must contribute to the improvement of the services provided by the RIs.*
- 3. To respond as best as possible to all terms of the call. Do not neglect any aspect, in particular dissemination, stakeholder involvement, project organisation and management. Think carefully about the impacts...*
- 4. To be help by people who are qualified in project management (INRA Transfert in our case), because scientists are generally not*