Horizon 2020 Programme

INFRAIA-02-2017
Integrating Activities for Starting Communities

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

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

Project ID: 730924

Deliverable number: D3.3

Deliverable title : Book of experimental methods in Ruminant Physiology

EC version: V1

Due date of deliverable	31/01/2021 (M36)
Actual submission date	18/02/2021 (M37)

This project has received funding from the European Union's Horizon 2020 research and innovation programme under the Grant Agreement n°730924

DOCUMENT INFO

1. Author(s)

Organisation name lead contractor	FBN

Author	Organisation	e-mail
Sadjad Danesh Mesgaran	FBN	danesh-mesgaran@fbn-dummerstorf.de
Gunther Viereck	FBN	viereck@fbn-dummerstorf.de
Björn Kuhla	FBN	b.kuhla@fbn-dummerstorf.de

2. Revision history

Version	**Date**	**Modified by**	**Comments**
1	01.02.2021	Björn Kuhla	

3. Dissemination level

PU	Public	X
CO	Confidential , only for members of the consortium (including the Commission Services)	☐

EXECUTIVE SUMMARY

Background	*Existing operation procedures and guidelines are summarized and comprehensively published in a book of experimental methods in ruminant physiology and cattle behaviour.*
Objectives	*The objective of task 3.1 is to define common guidelines for research and routine data recording and make an inventory of experimental protocols and ethical aspects.*
Methods	*Currently existing operation procedures at involved RIs for routine data recording were summarised and categorised by circulating spreadsheets among partners together with WP1. Operation procedures were analysed for their gaps, differences, similarities and general applicability. Common guidelines among all RI's were deduced. These standardised operation procedures are based on current best practices and include experimental planning (e.g. statistical power analysis, repetitions, experimental duration), calibration (e.g. gas concentrations), feed, frequency for automated measurements on animals (e.g. body weight, feed intake), environmental impacts (e.g. temperature, humidity), manual data recordings of clinical aspects (e.g. health checks, veterinary treatments, body temperature, mobility, diseases, rumination activity, ovarian cycle, reproductive performance), and where applicable data processing, calculation, and formatting. Utilisation of Animal trait ontologies (ATOL) and environmental ontologies (EOL) and recommendations for animal welfare and ethics in experimentations were introduced in the guidelines. Furthermore, some protocols were contributed or extended by scientists not involved in the SmartCow project, or mined from the literature. At or even after the end of the project, and based on the outcomes of the WP 5, 6, and 7 (JRA projects), the established protocols will further be improved and refined if necessary.* *Each chapter of the book was language and format edited as well as reviewed and approved by the SmartCow Executive Committee. Funding for the publication was recruited from the Leibniz Association and the Open Access Fund of the Leibniz Institute for Farm Animal Biology (FBN), Dummerstorf, Germany.*

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement N°730924

Results & implications	*The book is published online as so-called "living handbook" with Open Access (CC BY 4.0) under the following link: https://books.publisso.de/en/publisso_gold/publishing/books/overview/53/* *The book currently includes a foreword, 1 chapter on ethics and animal welfare in experiments, and 18 chapters related to animal experimentations. Each chapter is assigned to an individual digital object identifier (DOI) number, and can be downloaded as .pdf or .ris files, or directly printed from html files.* *The release of the publication will be communicated to WP4 for public dissemination including among others the International Committee for Animal Recording (ICAR).*

Table of contents

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement N°730924

1 Introduction

The book entitled "**Methods in cattle physiology and behaviour research – Recommendations from the SmartCow consortium**" was written between 2018 and 2020. All chapters published so far went through a multi-step quality control by English native speakers, independent reviewers and the Executive Committee of SmartCow to secure scientific standards. The chapters were format edited internally at FBN and bibliographically edited by the publisher. The majority of chapters were published in M35 but due to missing copyright transfers or submission of image files missing high enough resolution from some authors, the publication process for four chapters has been delayed. Nevertheless, all chapters foreseen for online publication were open access available at the end of M36.

2 About the book

The book is published in Open Access as a living handbook, which allows the improvement and refinement of single protocols at latter times if necessary. Thus, the outcomes of the WP 5, 6, and 7 can be considered to improve protocols if required. Furthermore, individual chapters can be added to the book, revised or deleted whenever whished.

The book is published online and open accessible (CC BY 4.0) on **Publisso** https://books.publisso.de/en/publisso_gold/publishing/books/overview/53. The publication was funded by the Open Access Fund of the Leibniz Association and the Open Access Fund of the FBN.

This book provides an inventory of guidelines for different recordings in an experimental unit. The chapters of the book encompass methods that deal with measuring different metabolic, digestive, anatomic and behavioural traits in cattle. The experimental methods were divided into two main categories:

a) routine measurements, conducted in different research infrastructures, e.g. daily feed or water intake of cattle, heat detection, body condition scoring and back-fat thickness measurement;

b) specific recordings, using particular methods, such as: estimating passage rate of digesta, respiratory chamber and/or nitrogen balance experiment.

***Figure 1**. Homepage of the book at:*
https://books.publisso.de/en/publisso_gold/publishing/books/overview/53/186/about

In the lower third of the page (Figure 1), six menu bars can be found providing more detailed background information and the content of the book.

The **Editorial Board** can be seen at:
https://books.publisso.de/en/publisso_gold/publishing/books/overview/53/editorial%20board

One or two people from all SmartCow RI partner institutions served as editors and are listed in the following: Sadjad Danesh Mesgaran (FBN), René Baumont (INRAE), Lene Munksgaard (AU), David Humphries (URead), Emer Kennedy (Teagasc), Jan Dijkstra (WUR), Richard Dewhurst (SRUC) , Holly Ferguson (SRUC), Marta Terré (IRTA) and Björn Kuhla (FBN).

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement N°730924

3 Quality assurance

Wherever possible, the authors sought to include the most recently established, innovative and non-intrusive tools/systems for each of the enlisted methods. Individual chapters were approved by all authors of each chapter. Authors were predominantly from SmartCow partner institutions but also from extern. All authors of the book had to register online with Publisso with their affiliation and contact details and sign the author contract and copyright declaration according to the **Manuscript Guidelines** presented in one of the menu bars (Figure 1).

https://books.publisso.de/en/publisso_gold/publishing/books/overview/53/manuscript%20guidelines

Authors are given the opportunity to present their names, affiliations, contact details online in the author list, and upload their photograph during or after registration. The summary of authors who choose this opportunity can be found under the menu bar "**Authors**":

https://books.publisso.de/en/publisso_gold/publishing/books/overview/53/authors

If authors were not native speakers, documents were English edited by Holly Ferguson (SRUC). She is not responsible for the scientific content of the chapters.

Before publication, each chapter of the book was reviewed and approved by the SmartCow Executive Committee. Reviewers were: René Baumont (INRAE), Michael O'Donovan (Teagasc), Richard Dewhurst (SRUC), Björn Kuhla (FBN), Christopher K. Reynolds (URead), Cécile Martin (INRAE) and Lene Munksgaard (AU). After Lene Munksgaard's retirement, Isabelle Veissier (INRAE) served as Executive Committee member.

Gunter Viereck (FBN) did the format editing to ensure an even layout between chapters. He is not responsible for the scientific content and the quality of images provided by authors.

4 Chapter list

The reader of the book can get an overview about book content (Foreword and 20 chapters) by clicking on the menu bar "**Overview Chapters**":
https://books.publisso.de/en/publisso_gold/publishing/books/overview/53/overview%20chapters

The chapter titles and the author names are listed in the following:

Foreword
Philippe Chemineau
DOI: 10.5680/mcpb022

Ethics in experiments on live cattle: A pragmatic approach
Isabelle Veissier, Véronique Deiss, Mette S. Herskin, Emer Kennedy and Kenny Rutherford
DOI: 10.5680/mcpb019

Feed and water intake
Sadjad Danesh Mesgaran, Björn Kuhla, David Humphries, Peter Lund, Emer Kennedy, Michael O'Donovon, Michelle Liddane, Norann Galvin, Jan Dijkstra and René Baumont
DOI: 10.5680/mcpb002

Reproductive assessment
Sadjad Danesh Mesgaran, Björn Kuhla, Michael O'Donovan, Peter-Christian Schön and Volker Röttgen
DOI: 10.5680/mcpb003

Bodyweight, body condition and anatomy
Sadjad Danesh Mesgaran, Martin Riis Weisbjerg, Alex Bach, Jennifer Salau, Jan Henning Haas, Wolfgang Junge, Georg Thaller and Björn Kuhla
DOI: 10.5680/mcpb001

Body temperature and thermal imaging
Michael Dineen, Malcolm Mitchell, Björn Kuhla and Sadjad Danesh Mesgaran
DOI: 10.5680/mcpb004

Rumen fluid sampling via oral stomach tubing method
Wouter Muizelaar, Paolo Bani, Björn Kuhla, Mogens Larsen, Ilma Tapio, David Yáñez-Ruiz, Sanne van Gastelen
DOI: 10.5680/mcpb008

Ruminal pH
Sadjad Danesh Mesgaran, Michael Dineen, Björn Kuhla and Mathieu Silberberg
DOI: 10.5680/mcpb005

Stress and health assessment
Sadjad Danesh Mesgaran, Björn Kuhla and Jan Langbein
DOI: 10.5680/mcpb006

Nutrient digestibility and balance studies
Sadjad Danesh Mesgaran, Björn Kuhla, René Baumont, Gonzalo Cantalapiedra-Hijar, Pierre Noziére, Peter Lund, David Humphries and Jan Dijkstra
DOI: 10.5680/mcpb007

Milk intake, body anatomy and composition in calves
Sadjad Danesh Mesgaran, Dominique Pomies, Volker Röttgen, Björn Kuhla, Stefan Nüske, Alex Bach and Armin M. Scholz
DOI: 10.5680/mcpb009

The gas recovery test of respiratory chambers
Sadjad Danesh Mesgaran, Anne Louise Frydendahl Hellwing, Peter Lund, Michael Derno, Björn Kuhla, Marcel Heetkamp, Gemma Miller, David Humphries, Frédéric Anglard, Yvanne Rochette, Cécile Martin, Tom Gardiner and Marc Coleman
DOI: 10.5680/mcpb010

Respiratory chamber facility
Sadjad Danesh Mesgaran, Michael Derno, Björn Kuhla, Karen Beauchemin Cécile Martin, Anne Louise Frydendahl Hellwing, Peter Lund, Gemma Miller, David Humphries, and Marcel Heetkamp
DOI: 10.5680/mcpb011

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement N°730924

Greenfeed system
Cécile Martin, Yvanne Rochette, David Humphries and Gilles Renand
DOI: 10.5680/mcpb012

Sulphur hexafluoride (SF6) tracer technique
Yvanne Rochette, Arjan Jonker, Peter Moate, Amélie Vanlierde, and Cécile Martin
DOI: 10.5680/mcpb013

A checklist to validate sensor output for the recording of cattle behaviour
Matthieu Bouchon, Alex Bach, Bruno Meunier, Emma Ternman, Kees Van Reenen, Isabelle, Veissier and Lene Munksgaard
DOI: 10.5680/mcpb014

Behavioural tests
Emma Ternman, Guilherme Amorim Franchi, and Lene Munksgaard
DOI: 10.5680/mcpb015

Lying, standing and eating behaviour
Lene Munksgaard, Emma Ternman, Isabelle Veissier, Carol-Anne Duthie, and René Baumont
DOI: 10.5680/mcpb016

Rumination activity
Danesh Mesgaran S, Munksgaard L, Baumont R, Kuhla B, Humphries D.
DOI: 10.5680/mcpb017

Lameness detection and scoring
Sadjad Danesh Mesgaran, Juan Haladjian, Stefan Nüske, Dorothée Ledoux, Dave Humphries Lene Munksgaard and Isabelle Veissier
DOI: 10.5680/mcpb018

The chapters are not numbered to enable future insertion, deletion, or renaming of single chapters. By clicking on the chapter title, the chapter content opens as html file. In this view, the authors, their affiliations and the corresponding author including her/his email address can be seen.

In general, each chapter starts with a short Introduction followed by the Prerequisites listing among others the animal traits considered in each particular chapter and referring to their identifiers in the Animal Trait Ontology of Livestock and the Environmental Ontology of Livestock (https://www.atol-ontology.com/en/erter-2/)

On the left hand site, the citation note for each chapter can be found. Each chapter has its own digital objective identifier (DOI) number. Chapters can be downloaded as .pdf or .ris files, or directly printed from html files by clicking the links on the right hand site of the chapter page.

According to the project plan, a specific chapter on ethics and animal welfare in experiments was planned and delivered with the chapter on “Ethics in experiments on live cattle: A pragmatic approach”. Due to the increasing importance of ethical aspects but also because of the identified legal differences in animal experimentation and ethical approval procedure between countries, the Editorial board saw the necessity for publishing these issues as well. Therefore, another chapter entitled

"**Ethical aspects in experiments with cattle**" **by** Jan Langbein, Veronique Deiss, Mette S. Herskin, Antonio Velarde, Frédéric Dehareng, Emer Kennedy, Rob Steenmans and Kenny Rutherford is currently written and will be published in the book of methods in the 4th year of the project.

Some chapters may be updated at or even after the end of the SmartCow project, according to the results from joint research activities in SmartCow.

5 Dissemination

After publication of the first chapter of the book, the partners from WP4 (EAAP) were informed during the Annual Meeting (13-15 October 2020) who disseminated the results. The publication was also announced at the FBN homepage https://www.fbn-dummerstorf.de/en/ and Twitter https://twitter.com/fbnbehavphys?lang=de.

The results were announced also to the International Committee for Animal Recording (ICAR). Roel Veerkamp from ICAR informed on his part that the ICAR functional trait working group has produced extensive documents on bovine functional traits at:
https://www.icar.org/Guidelines/07-Bovine-Functional-Traits.pdf

Despite of some seemingly overlaps between the ICAR document and the chapter about "Lameness detection and scoring" of the present book, the latter represents guidelines on how to set up technical and methodological aspects. Those guidelines are not included in the ICAR document.

As the book is now almost complete, further dissemination actions through SmartCow and partners' websites, as well as social media will be undertaken together with WP4 (EAAP). Further communications are planned to TNA beneficiaries, GRA, and ICAR, at national conferences and at the next EAAP annual conference in August 2021.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement N°730924