SmartCow

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

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Newsletter – Issue 8

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This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 730924.

Summary

SmartCow final conference

René Baumont - Project Coordinator (INRAE)

The final conference of the SmartCow project took place on April 6th in Brussels in a mixed format allowing for on-site and remote participation. It brought together a total of more than 100 participants from the European cattle sector, including research, training and development actors from public and private organizations. The aim of the conference was to present and discuss the main advances that have been made possible by the SmartCow project and to present the future perspectives of the consortium. In the first part of the conference, we presented the results obtained in the networking of cattle infrastructures through the development of an interactive map and a survey of cattle facilities across Europe, and in standardizing vocabulary and methods and sharing data through the improvement of animal trait ontologies for cattle, the writing of living "Book of Methods" and the setting of a cloud-based data platform. We presented the advances in cattle phenotyping capabilities allowed by the SmartCow project through refining gold standard methods in cattle nutrition, developing and validating proxies based on infrared techniques and biomarkers to predict feed efficiency and emissions, and on data from sensors techniques to phenotype behaviour and health. All these efforts in adopting best practices and experimental methods, in developing non-invasive alternative methods through proxies concur to implement the 3R principles (Replace, Reduce, Refine) in experiments on cattle and to improve the ethics of animal research. Finally, a

highlight was put on the Transnational Access program that allowed to support 25 research projects in the research infrastructures of the SmartCow consortium and thus to open access of cattle facilities to new academic and industry users that were opportunities to develop new collaborations with SmartCow partners. Three beneficiaries of the SmartCow Transnational Access program gave us a feedback on their experience using SmartCow Research Infrastructures: Angela Schwarm (Norwegian University of Life Science, Norway); Raphaël Boré (Idele, France); Joan Edwards (Palital Feed Additives; The Netherlands).

In the second part of the conference, prospects for the SmartCow consortium, in particular in the framework of the Horizon Europe program were discussed. Jimena Arango-Montanez (European Research Executive Agency) presented the European Research Agenda on Research Infrastructures in the Horizon Europe program with the objective to address the green and digital transitions. Several calls in the work program for Research Infrastructures (RIs) may interest the SmartCow consortium: 1) INFRADEV: Developing, consolidating and optimising European RIs landscape, maintaining global leadership; 2) INFRASERV: RI services to support health research, accelerate the green and digital transformation, and advance frontier knowledge; and 3) INFRATECH: Next generation of scientific instruments, tools and methods and advanced digital solution. Jean-Charles Cavitte (DG Agri) presented the societal challenges and research need for the livestock sector according the European green deal and the Farm to Fork strategy proposed by the European Commission. To address the environmental, social and economic challenges livestock farming systems are facing, the SmartCow consortium may contribute to topics relevant to livestock in the Cluster 6 (Food, Bioeconomy, Natural Resources, Agriculture and Environment). The discussion continued with a round table in which industry (Arnaud Bouxin – FEFFAC, Ana Granados - EFFAB/ATF) and academic (Sven Dänicke -FLI; Nicolas Friggens - INRAE - GENTORE; Marc Vandeputte - INRAE – AquaExcel; Jaap van Milgen - INRAE - PigWEB) representatives expressed their feedback on SmartCow achievements and on the needs for research infrastructures in animal science. Finally, to close the conference, the future plans of SmartCow consortium with the launch of the SmartCow European Research Group and the participation in the INFRASERV AgroServ project were developed. The main outcomes of the SmartCow project and the final conference discussions are detailed in the following newsletter articles. The conference was entirely streamed, and all the material (slides and videos) are available on the homepage SmartCow website.

I would like to thank all the people from EAAP, Idele and INRAE Transfert who helped us to organize and facilitate this final conference and wish you a good reading of this 8th newsletter. It was a great pleasure for me to coordinate this project during the last four years and long live the SmartCow consortium!

René Baumont (INRAE)
SmartCow Coordinator

Fostering synergies through mapping of cattle infrastructures, technologies and research projects

Patricia Ryan - (TEAGASC)

As part of fostering synergies within the cattle sector across Europe a map of cattle research infrastructures (RI) was developed, which allows those involved in academia and industry to view the cattle RIs available across Europe (19 countries). The map, which is available on SmartCow website, gives an overview of the RIs of the 10 consortium members (INRAE, SRUC, Teagasc, Aarhus, IRTA, FBN, CRAW, CEDAR, WUR, and WU), across 7 countries. In total there are 18 RIs of which 14 are dairy focused, 3 beef focused, and 1 beef and dairy. The non-consortium RIs are also represented, accounting for 19 European countries. Each RI has a short summary outlining some general information about the RI as well as its site characteristics, animals, research equipment, ethical aspects and laboratory facilities.Users can refine their search of the map by using filters to select one of the following sector, membership type, and laboratory facilities. A more in-depth collection of data was carried out for the consortium members and covers an inventory of animal databases and research methodologies, together with a catalogue of equipment and techniques practiced throughout RIs within the consortium. This data is available to SmartCow members on Agrimetrics, a cloud based data platform. Overall, this work package has allowed sharing of resources across Europe. In turn allowing collaboration among researchers while also giving an opportunity to share information, generating a research support network.

Standards, common guidelines for measurements and data management

Björn Kuhla - (FBN)

Operation procedures collated by WP1 were analysed for their gaps, differences, similarities and general applicability. Within WP3 we deduced common guidelines among all RI's. 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. The book was published online as so-called "living handbook" with Open Access (CC BY 4.0) under the following link. 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. 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. A Data Management Plan was established by Agrimetrics. Based on this, a data catalogue and a cloud-based data platform was developed, which can be accessed under the following link. Both, the Data Management Plan and Data catalogue align with the FAIR principles. The cloud-based data platform has a Linked-data explorer, providing the opportunity to add tags to data and to connect data sets to similar data. It further allows the user controlled up- and download of all type of data. It further offers the opportunity to link data originating from various partners of the SmartCow consortium, but also to link data with other data sets from outside of the consortium. The platform has an advanced search functionality for the catalogue and data can be selected via a web API tool. The user may define permissions for data access and control. Training courses for users of the platform on how to use it and how to make advantage of it have been given. The ATOL and EOL have been implemented by SmartCow partners thanks to surveys or specific meetings. Furthermore, the website has been improved. The « Bovine specificity » from ATOL and EOL was extracted and sent to all partners of the consortium to improve the terms already present, and to develop and add new terms in order to promote the ontologies beyond the boundaries of the consortium. Thanks to surveys and different specific meetings, we added 190 new traits in ATOL and more than 40 in EOL. We have also developed links between guidelines developed in Task 3.1 and ATOL/EOL.

Fostering innovation through dissemination and knowledge transfer

Under EAAP leadership, WP4 was devoted to foster innovation through dissemination and knowledge transfer to SmartCow stakeholders and scientific community. The following intensive communication and dissemination activities were carried out during the project:

- The creation and maintenance of the SmartCow website (online since July 2018), with 287.465 total visits;
- The opening and animating project social media channels (Facebook: 204 posts, 333 Likes, 368 Followers; Twitter: 200 tweets, 484 Followers;
- The creation of 2 videos (one introducing the project and one describing the Research Infrastructures involved in the project);
- The publication of 7 issues of SmartCow newsletter with 50 articles and 221 subscribers;
- The participation to 15 conferences/workshops with 24 projects communications/presentations and 25 posters;
- Numerous open access publications in peer reviewed journals.

As far as stakeholder's involvement is concerned, 4 meetings of the project European Stakeholders Platform were organized along with 7 National Stakeholders workshops. During the course of the project, a database of more than 1.200 stakeholders contacts was created. In terms of capacity buildings, 1 study tour, 4 training courses and 6 web conferences courses aimed at highlighting project findings were organized.

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Evaluation and standardization of nutrient use efficiency and emission measurement techniques

Chris Reynolds - (UREAD)

A major focus of research activities in SmartCow was 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. These measurements included feed digestion and N utilization and methane emission measurements using respiration chambers. These 'basic' measurements of feed and N efficiency have been integral to the study of cattle nutrition since the 1800s, but are known to be subject to in many cases substantial variation. In this regard it has long been known that measurements of retained (body tissue) N in dairy cows can be biologically impossible, which may in part be the result of the loss of volatile N during excreta sampling and processing. By identifying and addressing sources of variation in measurements of digestion and N balance, as well as methane emissions, our objective was to increase precision and accuracy of the measurements, and thereby minimize the number of animals required for future studies (3 Rs).

Meta-analysis of existing measurements of N balance in cattle found that experiment and site both accounted for a greater proportion of variation than the methods used per se, suggesting that how methods are used at individual locations (human behaviour) contributes more to variation across sites than the methods used themselves. This emphasizes the importance of training of staff and students undertaking experimental methods, as well as the need for strict attention to detail in the methodology employed. A similar meta-analysis of methane measurements found that variation due to chamber facility (site) was much lower than variation due to experiment (e.g. diet composition), suggesting more comparability in the methodology used for respiration chamber measurements. To compare measurements of methane emission using respiration chambers at SmartCow facilities a ring-test of methane recovery was undertaken by partners National Physical Laboratories (UK). The tests highlighted sources of variation at specific facilities, such as leaks and flow meter calibrations, but found very good comparability across the SmartCow facilities tested. At INRAE and the University of Reading (CEDAR), new digestion stalls were developed that were adaptable to the size of the animal and type of trial, which improved animal welfare and the safety of staff working with the animals and collecting samples. Adjustable panels restrict movement during sampling for safety and water beds markedly improved cow comfort. In addition, adaptations to faecal and urine collection equipment reduced the amount of cross contamination and limited volatile N loss during collection.

At each SmartCow location sources of variation specific for the methods used for digestion trials and N balance measurements were evaluated and addressed. Some examples include:

- At Aarhus University the optimum number and frequency of spot faecal samples was determined for trials utilizing TiO2 as a marker for digestibility measurements.
- Work at FBN demonstrated the effect of drying and grinding on feed and faeces N concentration, emphasizing the need to minimize N loss during sample processing.
- Work at Wageningen University showed the magnitude of ammonia loss during excreta collection and the value of measuring it when cows are housed in respiration chambers during excreta collection. Wageningen University also found for their system diet N concentration was higher when measured by Dumas (combustion) compared to Kjeldahl analysis.
- The University of Reading found that urine N concentration was lower after freezing for 2 weeks compared to fresh analysis, which has previously been reported in the literature.
- A study at INRAE with growing bulls determined the effect of days of excreta collection on the repeatability of digestibility and N balance measurements, which was highest after 10 days of collection.

Similarly, the minimum detectable difference also increased, showing that by increasing days of collection the number of animals required to detect a difference in N balance or diet digestibility was reduced.

Overall, the results emphasize the importance of strict attention to details in the conduct of digestion trials and measurements of N balance. For N balance measurements, immediate analysis of excreta on the day of sampling is the 'gold standard', but frozen bulked samples provided comparable concentrations for feeds and faeces, but not urine, as long as volatile N losses during sample processing are minimized. Cow adaptation to digestion stalls and comfort are also important, as variation in feed intake (and composition) are very important sources of variation.

Promising proxies to predict feed efficiency and its determinants in dairy and beef cattle

Cécile Martin - (INRAE)

Research activities in SmartCow aimed to increase phenotyping capabilities while implementing the 3R principles (refine, reduce and replace) in cattle nutrition and behaviour studies. Development and validation of non-invasive proxies of feed efficiency (FE) and its determinants were undertaken with the goal of minimizing handling of experimental cattle. A database of individual phenotypes and proxies from different easily accessible matrices (milk, faeces, blood, breath gas, urine) for beef and dairy cattle was built through a collaborative network among SmartCow collaborators. Models were tested for different proxies to predict phenotypes across diets and between-individuals. Meta-analysis demonstrated that the natural 15N abundance in animal proteins has a stronger predictive ability than plasma- or milk-urea to discriminate dietary treatments, as well as individual variation in FE of beef cattle and nitrogen (N) use efficiency of dairy cattle. Models based on faecal near-infrared spectra (NIRS) discriminated dietary treatments and extreme individuals in terms of organic matter digestibility. Milk mid-infrared spectra (MIRS) models predicted enteric methane (CH_4) emissions, and fecal NIRS showed potential for estimating CH_4 emissions of non-lactating animals. Potential of new proxies, like milk MIRS, breath volatolome and plasma metabolites, for rumen diagnostics and prediction of urinary N, have also been investigated using more limited datasets. First results highlighted the need to assess repeatability of proxies across time. Common and standardized protocols for reference measurements and aggregation of data from different sources will aid development of proxies. Open access guidelines for using the most promising proxies will be developed, which will strengthen cattle phenotyping capabilities and contribute to sustainability of the livestock sector.

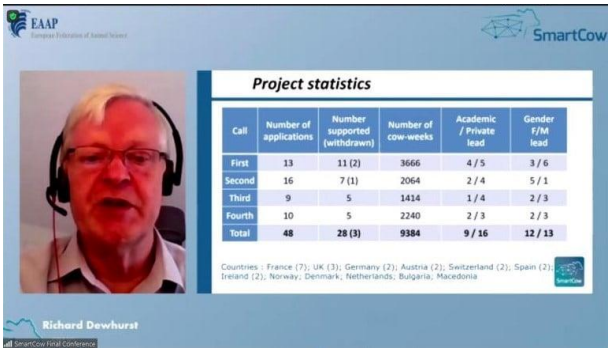
Thanks to automatic recording by sensors, animal behaviour will play a key role in animal productions

Animal behaviour makes a link between the animal and its environment, so that we suspected that behavioural traits may predict more complex traits such as feed efficiency or sensitivity to health disorders. The behaviour is also a manifestation of the animal internal state, so that we questioned to what extent we could detect specific states such as stress and health disorders – from so-called sickness behaviour -. Nowadays many sensors are available to

Isabelle Veissier - (INRAE)

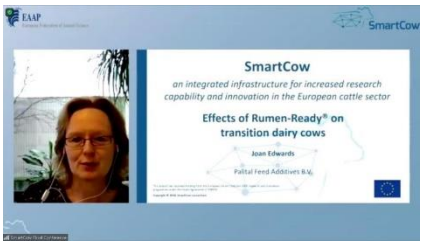
record animal activity automatically, e.g. electronic feeders to record feeding time and feed intake, accelerometers or real time locating systems to record gross activities (resting, standing, walking, eating), … Cows were equipped with such devices for several months. We explored the links several cow traits (e.g. feed efficiency) or states (health, stress, reproduction event) and behaviour described by several attributes calculated from data provided by sensors (time-budget, variations across days, rhythmicity …). Regarding feed efficiency measured by milk production divided by food intake, 27% of the variation between cows could be explained by feeding behaviour: The slower the cow eats and the more variable its feeding frequency from one day to another, the more efficient the cow is. Regarding health, 38% of the variability between cows in their susceptibility to disorders after calving could be predicted from their behaviour before calving: The more a cow shows cyclic patterns of activity before calving, the better its health after calving. This confirms the crucial role of biological clocks. Finally, machine learning applied to data from activity meters allows to detect and discriminate several cow states: oestrus, calving, mastitis, lameness, acidosis, other diseases, accidents, and stress due to mixing. Such a detection can often be made one or two days before the observation of the corresponding state by caretakers. We can now propose several descriptors of cow activity to be extracted from data provided by sensors, they give access to complex behavioural traits such as rhythmicity. This offers researchers new possibilities of investigation, especially from datasets collected routinely in experimental or commercial farms, reducing the need for experimentation. The results we obtained open possibilities for refining animal phenotyping especially for animal selection on the one hand and for early detecting of reproduction states and disorders for operational management on the other hand.

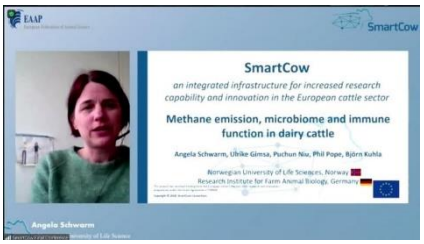
Transnational Access in the SmartCow project



Richard Dewhurst - (SRUC)

The Transnational Access (TNA) programme of the SmartCow project set out to provide access for industry or academic groups to run studies in facilities of SmartCow partners. The programme had a budget of €1.5 million and targeted expansion of the user community and support for early career researchers and researchers lacking access to specific facilities in their region. Proposals were evaluated by our own evaluation panel, which included internal and external experts. The main causes of rejection were lack of scientific novelty and/or weak experimental design. We evaluated 48 proposals submitted to four calls over the period 2018 to 2020 and were able to support 25 projects, so an overall success rate of just over 50%. In fact, 28 projects were initially selected, with three withdrawn owing to lack of co-funding for analysis. We spent slightly more than the budget and projects were on average slightly larger than expected with overall 9,384 experimental cow-weeks provided. In some cases, industry partners added to the SmartCow funding to strengthen the projects with additional measurements and/or longer recording periods. Nine of the projects had academic leads, whilst 16 were led by industry; there was an even balance of men (13) and women (12) as project leads. Projects came from a range of countries - France (7); UK (3); Germany (2); Austria (2); Switzerland (2); Spain (2); Ireland (2); Norway; Denmark; Netherlands; Bulgaria and Macedonia. It was particularly pleasing to receive good proposals from eastern Europe in the later TNA calls. Projects were in a range of topics, reflecting the overall emphases of SmartCow: production and feed efficiency (5); N-use efficiency (5); methane emissions (6); behaviour, welfare and heat stress (4); mineral nutrition (3); and milk and cheese quality (2). In some cases, TNA process allowed multi-site studies to strengthen the project, whilst in most cases TNA projects developed new collaborations. There were several examples of data/samples used in other SmartCow WP, particularly in work to develop new proxies or biomarkers for feed efficiency, N-use efficiency or methane emissions.





From left to right: Joan Edwards (Palital Feed Additives); Angela Schwarm (Norwegian University of Life Science); Raphaël Boré (IDELE)

Round Table: "Stakeholders' needs for research infrastructures in animal science"

The round table welcomed representatives from the industry and research:

- Arnaud Bouxin (FEFAC, European Federation of Animal Nutrition)
- Ana Granados (EFFAB European Federation of Animal Breeders SG/ATF Vice President)
- Sven Dänicke (FLI Friedrich Loeffler Institut -DE), SmartCow SAB (animal nutrition)
- Nicolas Friggens (INRAE – GENTORE coordinator)
- Marc Vandeputte (INRAE – AquaExcel coordinator, a more advanced community)
- Jaap van Milgen (INRAE – PigWEB coordinator, just granted)

From left to right: Florence Macherez (IDELE); Sven Dänicke (FLI); Jaap van Milgen (INRAE); Ana Granados (EFFAB/ATF); Marc Vandeputte (INRAE); Arnaud Bouxin (FEFFAC); Nicolas Friggens (INRAE - remotely).

It was moderated by Florence Macherez, in her quality of task leader for Task "4.2 – Stakeholder engagement", supported by Vincent Troillard, INRAE Transfert who moderated the chat and Klaxoon polls.

The panellists discussed what will be useful for stakeholders, from the large range of outputs from SmartCow: inventories of research infrastructures, equipment and samples, ontologies, books of methods, harmonisation of methodologies and proxies for measuring efficiency and emissions from cattle, tools to monitor animal behaviour, ethics in animal experiments, transnational access to research infrastructures. The sharing of standards, methods, proxies and protocols for measurement and datasets came first in the responses from the audience. For the breeding industry, the sharing of data and proxies towards the development of new breeding

traits is among the most promising outcomes, as well as protocols around ethics in animal experiments. From the animal nutrition industry perspective, we need infrastructures to support addressing the challenges faced by the sector, but also the mapping of them and sharing protocols. From the research side, the living book of methods will make it easier for future research, also the work on beef cattle and extensive systems has been very useful and filled a gap in knowledge and experience while PLF tools are currently much more adapted to the barn than to outdoor situations. Getting access to data, sharing protocols and building critical mass for datasets are strongly needed for research activities. Some data collected by precision farming technologies, but also genomic and genetic data is difficult to get out because companies are reluctant to share. There is a real need to be coordinating multi-sites experiments in Europe, taking advantage of the heterogenous environments and breeds across Europe, to which SmartCow has really contributed. To facilitate results uptake by stakeholders (industry, research, society, public policies), communication seems key, as well as involving them in projects, cobuilding, collaborating, setting up webinars, etc… Involving consumers and NGOs proved not easy to implement during the project, as well as in other related projects, due to limited budget. Since the very strong participation of end users in transnational access calls proved very efficient in terms of impact and dissemination.

Discussing about the improvement of services and new services needed from research infrastructures from the stakeholders' perspective, extension of the network to new partners, especially in Eastern Europe cam high in the responses, as a result of the consortium structure that we knew was Western Europe oriented. The continuation of collaboration is expected, as well as a code of practice for ethics and welfare in animal experimentation, open data reusable by researchers, advisory services and companies, and strong data infrastructures, extension to new phenotypes, updated and dynamic precision farming tools, ontologies…and above all serving a good user community around infrastructures, and the development of services should ideally respond to a demand from stakeholders. Also, from an industry and policy maker perspective, members states are bound to sustainability targets that need to rely on harmonised and reliable measurements, models and data. Participants agreed that a lot of synergies could be found in bridging not only infrastructures, but also research projects and datasets to serve a large community of public and private users. Finally, it would be very good that SmartCow continues, preserving what's already been done and allowing it to have a life beyond the project end date.

SmartCow Research Infrastructures video!

SmartCow integrates key European cattle research infrastructures to promote their coordinated use and development and thereby help the European cattle sector face the challenge of sustainable production. Covering all the relevant scientific fields and the diversity of cattle types and production systems, SmartCow provides the academic and private research communities with easy access to 11 major research infrastructures from 7 countries (18 installations) of high-quality services and resources. In this video some RIs are presented. Enjoy this interesting video to this link!

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SmartCow session EAAP in Porto

For the second year in a row the SmartCow project is organising a session dedicated to the presentation of its results during the EAAP annual conference which is taking place this year in Porto (https://eaap2022.org/). The session will take place on Tuesday afternoon, 6 September 2022 and is entitled "Methods and technologies for research and smart nutrition management in dairy and beef cattle." Twenty-five contributions have been accepted in the session, of which 13 will be presented orally. The main results obtained in the SmartCow projects on refining experimental methods in cattle nutrition studies, on implementing the 3Rs principles in cattle research, on new methods to phenotype N balance, methane emissions and health and behaviour will be presented and discussed. The session will be introduced by Nicolas Gengler (University of Liège, Belgium) who will present a keynote entitled "Collaboration is imperial or how to address this critical issue when developing novel traits". Original research results from beneficiaries of the SmartCow Transnational Access program and contributions outside SmartCow participants will complete the program. We hope to see many of you at this session!

Future of SmartCow

SmartCow was a first step that has proven the interest and the possibility to 1) open the access of major European cattle research infrastructures to the academic and industrial scientific communities, 2) improve the quality and ethics of research by harmonizing and improving experimental methods and data sharing, and 3) increase the capacity of study and phenotyping in cattle by improving and developing new tools based on biomarkers, proxies and data collected by behavioural sensors. It has allowed the development of new collaborations and scientific advances on challenges related to efficiency, emissions as well as behaviour and welfare in cattle.

The consortium has the willingness to continue to integrate and develop the SmartCow community to further 1) strengthen ethics in animal experimentation, 2) expand the phenotyping capabilities, 3) investigate the role of cattle in sustainable agri-food systems and for the agroecology transition, and 4) develop links with other integrated RIs in animal science.

The fourteen partners of SmartCow have decided to continue their activities as a "European Research Group". This is a simple co-operation instrument to sustain networking and exchanges between partners from in-kind contributions. It will allow to 1) sustain the website and common tools, 2) update the mapping, data catalogue, common guidelines for measurement, ethical procedures, etc., 3) maintain training and dissemination activities, dialogue within the scientific community and stakeholders etc., 4) strengthen collaborations with partners within and outside Europe, and 5) promote research priorities in national and European agendas and act as a platform for building up new proposals.

SmartCow will be part of the Horizon Europe "AgroServ" project that was selected to the call of proposals INFRA-2021-SERV-01-02 "RI services for a sustainable and resilient agriculture and agro-ecological transitions." The mission of AgroServ is to support research and innovation by providing customised and integrated RI services with the aim to 1) advance knowledge on agronomic and husbandry practices, preserving biodiversity and reducing the impact of agriculture on climate, and 2) support the development of new agroecological practices by fostering trans-disciplinary approaches and integrating the socio-economic dimension.

The AgroServ project is led by the CNRS (France) and brings together more than 70 partners from 12 recognized European Research Infrastructures (EU Openscreen, MIRRI, ELIXIR, EUROBIOIMAGING, EMPHASIS, EMBRC, AnaEE, SmartCow, MetroFOOD, IBISBA, LifeWatch, Social Sciences Services). The project will start in September 2022 for 5 years. It will develop a multi-scale approach to provide services on plant, soil, animals, ecosystems, agrifood…, and a multi-actor approach through involvement of living labs.

In AgroServ, SmartCow service proposals will be focussed on 1) the phenotyping and evaluation of efficiency and emissions (GHG, N), health, resilience and welfare, 2) the access to cattle phenotyping data, and 3) the evaluation of agro-ecological (grass-based, agroforestry…) practices and systems. SmartCow will lead the work-package on Access Quality Management and Ethics.

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