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

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

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EXECUTIVE SUMMARY

Background

The Scientific Advisory Board (SAB) is composed of international leaders recognized for their scientific expertise in a field of importance to SmartCow. It will provide the Executive Committee with strategic feedback regarding the project progress and contribute to maintain scientific and technological excellence of the project. Scientific Advisory members will be invited to attend the project meetings and workshops where appropriate to provide advice for improvement and/or reorientation of the project, and to get their feedback on project outputs. They will have access to the EC periodic reports, deliverables and publications (prior the beginning of its activity, each member will enter into a non-disclosure agreement). The Scientific Advisory Board will be also requested to evaluate the sustainability of the SmartCow, and to provide advice when applying for an advanced community.

Organisation	Name	Expertise
Federal Institute for Animal Health, Institute of Animal Nutrtion, Braunschweig	Prof. Dr. Sven Dänicke	Ruminant Nutrition and Physiology
University of British Columbia	Prof. Jeffrey P. Rushen	Animal Welfare, Animal Health, Animal Ethics
AAC - Lethbridge Research Centre	Dr. Karen Beauchemin	Ruminant Nutrition, Emissions
Iowa State University	Prof. James Reecy	Cattle genetics and genomics, Animal trai ontology, Computational biology
INRA-IFREMER	Dr. Marc Vandeputte	Research Infrastructures (AquaExcel^{2020} coordinator)
Agroknow	Dr. Nikos Manouselis	Computer Engineering, Management, sharing and discovery of agricultural data (co-founder and CEO of Agroknow)

Objectives

The objective of the first report of the SAB was to give feedback on the progress made by the project at mid-term after two years and advices for the next two years.

Methods

It was initially scheduled to prepare the report just after the 2nd annual meeting scheduled in March 2020. Due to Covid-19 crisis, the annual meeting was cancelled and rescheduled in October 2020. As we could not delay to much the report of the SAB, all interactions with members of the SAB had to be done through emails or skype meetings. As a consequence, this slowed down the process and made the work of SAB members more difficult.
The first periodic report and the slides of the 5th Executive Committee meeting were provided to the SAB members together with a template including general and more specific questions to the different WPs. All SAB members were invited to answer to the general questions and to the specific questions depending on their fields of expertise.

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Results & implications	Regarding SAB member's first review report after two years of processing, SmartCow project shows a valuable progress in terms of collaboration and share of information within and outside the project scape. The major impediments to the research at this point appears to be the effects of Covid-19. A tight collaboration within SmartCow consortium is far-reaching outlining procedures and guidelines. Thus would contribute to in fine a standardization of methods among research labs and be used as training tools for the community. Within WP3, the key results are i) standardised operation procedures for performing routine data recordings, ii) inventory of best operation procedures published in book form, iii) important training resource. Creating an environment of collaboration and the facilitation of data sharing and training result to a harmonisation among research institutes. This includes in particular optimizing data management (organisation and connexion) to the history of animals. Research goals of the project are ambitious and rely on large database for which it is important to ensure these are living databases that can continue to be added to in time by partners until the end of the project and beyond. The immediate visibility of the project remains a crucial point. Within the WP2, it is important to promote and highlight TNA success stories. Having an overview on the mobilized TNA capacity would be a plus. Beyond this aspect, the release of public deliverables and more creative content as short videos would help to catch a larger target group in rural communities and civil society. Regarding the Covid-19 effects, it would be more relevant to develop and organise alternative approaches to planned on-site training and face-to-face meetings.

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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: General comments on the project

1.1 Progress made compared to the DoA in terms of objectives reached, results achieved or deviations:

(James Reecy) Overall, the project is making progress along the proposed area of effort. This type of project is not a simple one, even though in concept it should be. For example, getting everyone to communicate about the procedure they are using for measurement of X variable is not simple. Folks traditionally keep this information as a lab protocol that this not share with others. Making progress to share this information is very helpful both within and outside of this project. That effort is to be commended. Furthermore, moving toward industry best practices is also a very laudable goal. Again, this takes time and effort, which the team is applying. However, in both cases, it would have been nice to see more progress.

(Karen Beauchemin) Most of the results achieved relate to creating an environment of collaboration and the facilitation of data sharing and training. These objectives have largely been met and will set the stage for the second half of the study. Many of the important milestones in the final months depend on these objectives (databases/platforms/websites), which appear to be generally on track. Deviations at this point in the project have been relatively minor, and not likely to have long-term impact. The major impediments to the research at this point will be the effects of Covid-19. The management team will need to develop alternative approaches to planned on-site training and face-to-face meetings.

(Nikos Manouselis) SmartCow project is crucial to the food supply chain. Sensors and proxies techniques mobilize digital techniques. The wealth of data in SmartCow is that there is a big variety of data from physiological (and potentially genomic) to phenotypic data. Interesting questions in SmartCow project are "What can I measure using sensors?" and "What can I understand of the animal using these sensors?" Issues in the data management in SmartCow are to find a way to organize and to connect data to the history of animals, to visualize all the data of the sensors ant to predict, that means to use all the historical data to assess something to the future.

(Marc Vandeputte) Globally, the project seems to progress according to schedule, with a low number of unavoidable problems and delays.

1.2 Significant results that can be highlighted

(James Reecy) The assembly of the lab protocols is a tremendous accomplishment. I think this is something that the group should highlight as it will have an impact beyond this immediate project. It is a resource for the world.

(Karen Beauchemin)
- Networking & training accomplished is a significant result that could be highlighted.
- Data sharing and creation of databases of historical studies from numerous sites to set groundwork for modelling efforts is a major outcome.
- Collaborative platform to facilitate sharing is notable.

2 WP1: Fostering synergies through mapping of cattle infrastructures, technologies and research projects (Marc Vandeputte, INRAE)

2.1 General comments

RI map: The choice of the characteristic looks relevant but not too difficult to collect, this is good. However, the layout on the website is not attractive, both for the map and the information sheet for each RI. No external structures appear at M25. Is this normal as all info is supposed to have been collected by M22? I suggest that the contact for each RI opens an email link.

Sample bank is an interesting but difficult issue. What is going to be made publicly visible?? Not clear if only sample banks are identified, or if also protocols /samples within sample banks are identified. Just sample banks might not be enough to promote re-use of samples.

2.2 What are the key results you expect until the end of the project?

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I expect most infrastructures, in and out of the project, to be visible on the RI Map. Do you have an estimate of how many do exist, and a target in terms of number or share?

2.3 Have you seen particular risks?

If there is not enough details on the content of sample banks, and it is not made publicly available, it will not be used. How to deal with the ethical aspects, especially if old samples before implementation of Directive 2010-63-EU are being stored and could be potentially re-used?

2.4 Do you see missing information to add to the database created?

For the infrastructures, I think the information is not too large and well chosen.
For the samples bank, not clear for me which information is included.
How will the information on the equipment and techniques available be publicised?

2.5 What criteria would you choose to add RIs in the SmartCow consortium?

I do not know cattle infrastructures, but the basic answer to this is infrastructures that can provide services/capabilities that are not available in the consortium and are of high interest for the general aim of the project.

3 WP2: Promotion, management and evaluation of transnational access (Marc Vandeputte, INRAE)

3.1 General comments:

In the procedural manual, obligation to publish open access goes beyond EC requirements. Open access publications are compulsory only for the beneficiaries, which TNA users are not.

3.2 What are the key results you expect until the end of the project?

I would like to see TNA success stories highlighted on the website.
I would also have liked to see how much of the TNA capacity has been mobilized for call 1 and call 2 accepted projects. Is it likely that all TNA will be consumed at the end of the project?

3.3 Have you seen particular risks?

How large is the user base? (Meaning outside of the participating institutions)

3.4 What could be improved in our TNA project selection and monitoring process?

To improve the management of TNA, there is now a specialized software developed by INstruct –ERIC (ARIA) – see https://instruct-eric.eu/help/about-aria (ok I saw afterwards that you chose another solution)

3.5 Would you refine research priorities?

No, I think it is good that TNA is as widely open as possible

3.6 What advice could you give us to enlarge TNA users, in particular from eastern and southern European countries?

Do a webinar on TNA and promote it to potential user organisations in those countries. Put TNA success stories on the website. Important for people to realize that TNA is not necessarily for others. Be open about the high success rate of applications. People are used to think that project application success rate is low.

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4 WP3 – Standards, common guidelines for measurements and data management

4.1 Task 3.1: Define common guidelines for research and routine data recording and make an inventory of experimental protocols and ethical aspects (Karen Beauchemin, AAC - Lethbridge Research Centre)

4.1.1 General comments

Will help to improve harmonization among research institutes and train new professionals. The task is on-track to meet expectations. The outline of the book is very comprehensive. Many of the potential risks have been mitigated by choosing to publish a peer-reviewed, open access and living handbook, which gives universal access and allows for updates over time. This handbook will be very useful especially to young researchers. Peer reviewed journal articles are moving towards shorter papers with very limited description of methods. Thus, some of the detailed methodology is being lost. Transfer of "know-how" from experienced researchers to early career researchers and students is important. Therefore, in addition to standardization of methods among research labs, this book could be a tremendous training tool for students and other researchers.

4.1.2 What are the key results you expect until the end of the project?

-Standardised operation procedures for performing routine data recordings.
-Inventory of best operation procedures published in book form.
-Important training resource.

4.1.3 Have you seen particular risks?

There is a need for standard operating procedures to be specific, but they also have to be flexible enough to be used across sites. One potential difficulty is to ensure the procedure can be adapted to various sites, and is not too site specific without losing the needed standardization. Examples may be calibration steps required for respiratory chambers, which to some degree can be site specific, although the principles are the same across sites.

Another risk is motivating groups to change their procedures, because tradition can dictate.

There can be disagreement among researchers on what constitutes a best practice. Some researchers feel strongly about certain methods, and it might be difficult to come to a consensus. Many of the chapters are authored by a relatively small number of researchers, so it will be important that input be sought within or externally to the consortium before the chapter is finalized.

Another risk is that there can be more than one valid method to achieving an endpoint, and this needs to be recognized. A very simple example is determining the nutrient composition of a diet and accounting for sampling error and variability. Does one sample the mixed diet, if so how often, or does one sample the ingredients, and calculate the diet composition? Both may be correct, if done properly. Alternative approaches need to be recognized.

4.1.4 Do you identify missing methods in the book?

Wondering if rumen sampling for fermentation and pH measurements will be dealt with in "Nutrient Digestibility and Balance". Also wondering if feed sampling will be dealt with in "Feed and water intake"? Otherwise, very comprehensive.

4.2 WP3 – Task 3.2: Development of a data management plan, organise the flow of data from the project and develop a cloud-based data platform (Nikos Manouselis, Agroknow)

4.2.1 General comments:

1) The dataspace is huge and endless. The challenge is to limit and focus the work of technology people
2) Try to highlight the benefit of using technology, which is sometimes difficult
3) Try to develop links with European Open Science Cloud (EOSC), by participating to the dialog and meetings of EOSC. EOSC will connect all repositories in Europe. It will work as a website where we can search for data. For the ones who have not an infrastructure, it will give the service to upload data
4) Is there a connection between the SmartCow platform and other platforms? Make connection with existing systems of data management (each organization has his own platform) would be a plus

4.2.2 Have you seen particular risks? What is your opinion on the capabilities and the facility of utilisation of the cloud based platform? What are the improvement you could suggest to facilitate interoperability of data?

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Building a cloud-based data platform as in SmartCow is a useful tool, but this is based on well-known technology. It will always be difficult to convince organization that have their own data management platform to upload their data on another platform. Think to connect existing platforms for the future.

4.2.3 Do you have specific recommendations concerning the management of data in SmartCow?

1) The knowledge organization scheme developed by Agrimetrics can be used as a data translation tool. INRA Montpellier has a portal with all ontologies.
2) Look at the Research Data Alliance (RDA), a forum to discuss things. How to organize the research data in the RDA.
3) SmartCow could be a use case for the EOSC.

Here links to the relevant resources from the AGINFRAplus project where Agroknow and INRA were partners:
- Final review presentation: that tells the story of how Agroknow use data and a digital infrastructure to support scientific case studies (https://docs.google.com/presentation/d/1LPvTbPlp2NJ689GKuBEG-f9R89oHCuPiV9_koxNc5d8/edit?usp=sharing) Please pay particular attention to slides after s.153, as they explain also Agroknow involvement at RDA and EOSC.
- Final review report: https://docs.google.com/document/d/14vJxLCmGbs-VhMwHZHta1LP21sGOl7bV0qOawa_0mC0/edit?usp=sharing Please take a closer look at p.52 on WP8 that details the liaison of Agroknow with EOSC and other strategic initiatives.
- Digital science recommendations discussion paper: http://plus.aginfra.eu/content/digital-science-recommendations-food-agriculture

Proposal to make a link between SmartCow and another project in which Agroknow is involved:
Furthermore, Agroknow confirm their availability and intention to be part of the next plenary meeting of SmartCow, if we can find a way to exchange experiences between SmartCow and BigDataGrapes (http://www.bigdatagrapes.eu/) where INRA is again a partner.
The pilot contribution of Agroknow in the BDG project is supported by our food safety monitoring and assessment platform FOODAKAI (https://reports.foodakai.com/we-support). The platform analyses and combines data sources such as food product recalls, lab test analyses, legislation, etc. We often find data indicating that a chemical or microbial risk has affected the animal from which the food product comes. As we are looking for joint use cases with other projects, a case study looking e.g. at the dairy sector would be interesting.

4.2.4 For a future project, which of the European Open Science Cloud (EOSC) system open access database should be used?

Try to develop links with European Open Science Cloud (EOSC), by participating to the dialog and meetings of EOSC. EOSC will connect all repositories in Europe. It will work as a website where we can search for data. For the ones who have not an infrastructure, it will give the service to upload data. SmartCow could be a use case for the EOSC.

4.3 Task 3.3: Improving bibliographic resources on cattle phenotypes and animal trait ontologies for cattle (James Reecy, Iowa State University)

4.3.1 General comments:

The project appears to have embraced the use of ontologies to annotate the data that is being collected in the project. This has resulted in the addition of terms to the ATOL, EOL and AHOL, which is good to see. The problems that the team have encountered, e.g. lack of a good definition for a term is a very common one. However, this is also an opportunity for the team as it would be a very good addition to the community knowledgebase by establishing an informed definition for the terms.

4.3.2 Have you seen particular risks?

One risk that I have seen is the addition of species to terms in the ontology. If I understand it correctly, this was done in order to retrieve bovine data easier. This however is not the right approach. Simply add another term to the database where data is stored to denote the species. By adding the species modifier to a term, you limit the utility of any given term to a single species and to overcome this one has to keep adding a new term to the ontology every time a new species is added. This defeats one of the purposes of an ontology, ie. Reuse of terms across domains when appropriate. Simply add species as a term in the database to denote the species. Now you can query on either the species or the trait or in combination. By combing them into a single term, now you limit to only that species trait combination.

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I also believe that the team should be looking to use other ontologies to annotate the data collected. The ATOL, EOL and AHOL are not going to have all of the terms that should be used to describe the data. This info may be available in other ontologies. If so, embrace their use.

It also appears that the ontologies are available via a none secure website. As a result, many potential users will not go to the website as it will be seen as a risk. I would encourage the team to move to https.

Another risk is that the ontology deviates from the desired outcome in order to make it easier for someone to understand it. The relationships between terms mean something, they needed to be followed. It is very tempting to make exceptions so that something can be done in one part of the ontology, but this would not apply to other areas of the Ontology.

4.3.3 How would you apply ontologies in the project?

- How would you use ontologies to annotate data shared in our data platform?

I would try to use every ontology possible to annotate the data. This will most likely necessitate working with these other communities to get new terms added to those ontologies. I do not see that this is happening. This is also not easy, as very likely not every ontology will be included as a source of ontology terms from the inception of the project, thus changes to the database structure may need to occur in order to support the use of new ontologies.

- What do you suggest to convince researcher to strengthen the use of ontologies in their work?

You need to show them the value of using ontologies. Have some use cases where you can show them how you can now do something that they otherwise would not be able to accomplish. For many folks until they see the utility of ontologies they will not support them.

- Are you aware of further important physiological traits without assigned ontology number?

The easy answer is yes. There is no way that the whole of physiological traits for the species of interest have been incorporated into the ontology. However, it may be possible that the ontology terms needed by this specific project. One has to ask themselves what is the objective of the ontology? To serve a given project or to serve an entire community? This will then shape the extent to the size of the endeavour.

- Are ontology numbers sufficiently considered in the book of methods and retrievable in the database?

This is also not a simple question. One has to define what is the desired outcome? Is it for this project or something greater?

5 WP4: Fostering innovation through dissemination and knowledge transfer to SmartCow stakeholders and scientific community

5.1 General comments:

(James Reecy) Overall, I like the effort and focus of the project. It is a challenging thing to get everyone to come together to agree on a given item, e.g. this is the protocol to use to measure X. That said, I also believe there is an opportunity for the project to develop new standardization steps embedded within lab. For example, here are the community agreed upon calibration steps for assay Y. If this occurs then folks can have more confidence in the data in the database. By calibrating measurements, end users of the data will know how useful a given data set is relative to other data sets.

(Marc Vandeputte) Low twitter activity (2/month), low number of twitter followers (244). But good to have had several stakeholder meetings (platform, national, international)
I could not find any deliverable on the project website. This should be corrected for public deliverables. As this is now we do not see that the project produces something

(Karen Beauchemin) Very attractive web site, user friendly, and good visibility. Strong content on rationale for the project; however, was hoping to find more Project Outcomes available and more scientific content, as we are mid-way through SmartCow.
Stakeholder engagement is always difficult, but perhaps short virtual webinars may be more effective than in-person meetings for the second half of the project. Good dissemination to scientific community. Alternative plans may need to be adopted due to Covid-19.

5.2 What are the key results you expect until the end of the project?

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(James Reecy) I would hope that the team can work on the calibration aspects of laboratory assays so that the ability to compare across studies is increased. Right now, it is hard to combine data across projects to perform a meta-analysis because, even though a study was in theory measuring the same thing, in name any way, the reality is that difference exist so that the data are not actually comparable across studies.

(Marc Vandeputte) I would like to see nice presentations of the main JRA results as well as TNA success stories, with nice layout and clear messages.
At the scientific level, it is difficult to promote adoption of ontologies. Try to ensure that all publications from the project and from TNA use these ontologies. Nowadays they are NOT used

(Karen Beauchemin) A wide awareness of the project and its outcomes with researchers, stakeholders and others.

5.3 Have you seen particular risks?

(James Reecy) COVID-19 is a huge risk. It is also a great opportunity to embrace new ways of operating in order to accomplish team goals. Hopefully, this will be such an opportunity for this group.

(Marc Vandeputte) The newsletter layout is not very attractive

(Karen Beauchemin) Obviously, Covid-19 will impact in-person dissemination actions. Alternative methods will need to be used.

5.4 Do you have recommendations to enlarge the impact of our dissemination actions, in particular to rural communities and civil society?

(James Reecy) In the United States, I would have highly encouraged the incorporation of extension faculty and staff in the project as this would help with the dissemination of the findings of the project so that they could be implemented as rapidly as possible by the industry. Not sure, what the equivalent is in Europe of even if this is common across the EU or only available in certain countries.

(Marc Vandeputte) First show results on the website. Stakeholder events are also important, but you need to have fancy dissemination material

(Karen Beauchemin) For dissemination, it might be worthwhile producing a few short videos for the website that are aimed at rural communities and civil society. These could feature some of the research facilities and studies, and be more oriented towards general interest. For example, the work on methane production, prediction, and proxies would be of general interest and always seem to garner media attention.

5.5 Do you have recommendations to strengthen stakeholder involvement in the project?

(James Reecy) I would highly encourage the use of virtual webinars focused on different stakeholders. Partner with existing networks to connect with others throughout the EU in order to use their prior efforts to help in the dissemination of your information.

(Karen Beauchemin) The use of webinars with short presentations given by a researcher(s) can be very effective to encourage stakeholder engagement. These can be later put on the website for future reference. People don't seem to have enough time to dedicate to in-person attendance and written literature anymore.

5.6 Do you have suggestions to develop tighter links with MSc programs to strengthen our training activities?

(Karen Beauchemin) None

6 WP5: Evaluation and standardization of nutrient use efficiency and emission measurement techniques (Karen Beauchemin, AAC - Lethbridge Research Centre)

6.1 General comments:

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The aim 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 will help improve the quality of measurements, interpretation, and will lead to improved standard operating protocols. The first objective focuses on optimized procedures for digestibility studies using total collection of feces and urine; however, it will be important to assess the use of markers (internal and external) for indirect measures as well, because many institutes are not able to perform total collections due to costs and animal welfare restrictions. It appears that use of an external marker approach has been included in the WP, which is commendable. It might be worthwhile adding an internal marker as well (perhaps iNDF). Plans and protocols for accomplishing the second objective of performing ring tests of respiration chamber gas recovery to identify sources of variation and develop optimized procedures for measuring whole animal methane emissions are in place, but it is not clear what (if anything) has been done so far. Overall this is a very ambitious WP, with multiple objectives and sub-objectives, each requiring a lot of work.

6.2 What are the key results you expect until the end of the project?

- Optimised digestion trial protocols based on total faecal collection from growing and lactating cattle.
- Optimised N balance procedures that minimise unaccounted for N losses and measurement error.
- Optimised methane emission protocols for chambers that minimise variation and measurement error.

6.3 Have you seen particular risks?

All the deliverables are at the end of the project, thus the milestone delays encountered may or may not impact the final deliverables for this WP. The milestone at month 18 on identifying sources of variation using historical data is behind schedule. The historical measurements of diet digestion and N balance for lactating dairy and growing beef cattle using meta-analysis seem to be underway, with sources of variation identified, with plans to report on results by June 2020. However, this may be further delayed due to Covid-19. But overall, this delay should not be a major limitation to the milestone delivery at the end of mo 48. Delayed progress of the WP seems to be very much a function of staffing (postdoctoral position) difficulties and concerns of data sharing (contracts). Not clear how these limitations are being dealt with.

6.4 Do you see other critical points in addition to those we identified on the nutrient use efficiency and emission measurement techniques?

In addition to the inclusion of an external marker for the digestibility measurements, it might be worthwhile adding 1 or more internal markers (iNDF, AIA), as many labs can no longer perform total collection due to animal welfare and cost concerns. The present study would be an ideal opportunity to make this comparison.
No concerns with the methane ring test.

6.5 What benefit would you see from the utilisation of the cloud-based data platform of the project for WP5 activities?

Obvious benefit is enhanced data sharing and harmonization of techniques across labs.

6.6 What would you suggest for further ring test studies in a future project?

There is a lot of effort put into standardizing and calibrating chambers, but many groups are using the GreenFeed system with non-standardized methods for instrument use, data collection, and especially data analysis. Perhaps some kind of ring test might be worthwhile, or at the very least a set of operational guidelines with recommendations for data processing would be useful.

7 WP6: Evaluating proxies to quantify feed efficiency and its determinants in cattle (Karen Beauchemin, AAC - Lethbridge Research Centre)

7.1 General comments:

Objectives are evaluation of proxies to predict digestibility, N partitioning and animal feed efficiency and evaluating proxies to investigate rumen fermentation parameters. This WP involves a number of partners contributing data, which is beneficial but makes it more difficult to manage timelines. However, progress is good, preliminary findings are encouraging, and deliverables are on time.
The first milestone of creating a common inventory file among partners and collaborators on phenotypes & proxies from historical trials with descriptive analysis is completed. Identification of individual data & samples to be analysed for proxies is completed. The decision to continue expansion of the database is worthwhile to improve its power for prediction.
Overall the WP is on-track with no major issues. Evidence of strong collaboration among research partners.

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7.2 What are the key results you expect until the end of the project?

-Improvement of existing equations from proxies to determinants of animal feed efficiency across diets and individuals for dairy and beef cattle. Here it is important to point out the proxies will be more useful for determinants of feed efficiency, rather than efficiency per se.
-Development of new equations to predict determinants of animal feed efficiency in dairy and beef cattle
-Publication of standard guidelines for using the most promising proxies of feed efficiency and its determinants in beef and dairy cattle

7.3 Have you seen particular risks?

Although the initial database has been constructed, additional data needs to be added because of the many predicted variables, and the numerous proxies. Additional data added could be used as a validation dataset. Some proxies and variables may need to be eliminated so priority can be given to the most promising ones.
Some delays in statistical and lab analysis encountered (6.1) due to personnel issues (hiring of post-doc), but it seems that a replacement has been identified. It is likely that progress will be delayed further by Covid-19.

7.4 How would you use the proxies studied in WP6?

7.4.1 For large-scale phenotyping studies?

Some proxies might be useful, especially for phenotyping in genetic selection studies where direct measurement on a large number of animals is difficult (intake, methane). May also be useful for national GHG inventory calculations (methane, digestibility) when using Tier 3 or 3 approaches.

7.4.2 As alternative of invasive techniques, in particular fistulated animals?

As some research labs (countries) are phasing out the use of cannulated animals, proxies may offer an alternative. However, precision and accuracy of these proxies will be important to establish. It will be important to be clear and up-front about the limitation of proxies, as they can never completely replace animal data.

7.5 Do you identify other proxies that should be worthy to study in a future project?

Very comprehensive list, nothing to add.

8 WP7: using sensor data for a multivariate approach to phenotype behavioural traits, health and feed efficiency (Jeffrey Rushen University of British Columbia)

8.1 General comments:

The initial stages of the project were to ensure consensus between partners on how to proceed through a series of meetings. This was obviously achieved and guidelines appeared to have been developed to ensure validity and standardized use of instruments for automated measurement of behaviour. I think the idea of developing a checklist to be used for all devices rather than a detailed instructions for each device to be appropriate. I have not seen the guidelines or the check list.

8.2 What are the key results you expect until the end of the project?

A check list of procedures for assessing the valid use of the devices so far used with guidelines to be publicly available.

8.3 Have you seen particular risks?

As the range of devices increases through the addition of new technologies with little in common (automated video analysis for detection of movement patterns, social proximity analysis through LPS etc.) I suspect it may become harder and harder to come up with common criteria for ensuring consistent use that can be applied to all devices.
The general risk I see with all uses of automated devices is that focus shifts to measuring behaviours that can be more easily measured automatically (by the devices on hand), even if these are not the most important behaviours.
Task 7.2 aims to develop a summary score for combining health characteristics of cows. I assume this is to be achieved principally through statistical modelling. I am sceptical how much this can be achieved in the absence of a clear theoretical basis for a "common currency" to rank different illness for their effect on animals. Is the plan to rank illness for economic impacts or on the welfare of the animals?

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The analysis of individual differences or "personality" is difficult with dairy cows because the use of only a small number of inbred breeding bulls at each institute means that few herds contain all of the genetic variability available. Also, the similarity of housing and management systems and raising of young animals used also decreases the phenotypic variability that is available.

8.4 How would you use sensors studied in WP7?

8.4.1 For large-scale phenotyping studies?

Not sure.

8.4.2 As alternative of invasive techniques?

Few invasive procedures are used in behavioural research. Automated devices reduce the need for confinement of animals necessary for direct observation or even video. Automated detection of social grouping through proximity detectors would be the greatest need.

8.5 What are your suggestions to deal with the difficulty to access to raw data of sensors developed by private companies?

Clear legal agreements at the beginning of the project. Work only with companies that do provide such data (if possible).

9 Task 8.4 – Ethics (Jeffrey Rushen, University of British Columbia)

9.1 General comments:

Planned goals seem to have been achieved.

9.2 What are the key results you expect until the end of the project?

Agreement between institutes on a common method of assessing ethics of animal use.

9.3 Have you seen particular risks?

Scientists always seem hesitant to treat ethics seriously and to be willing to make real changes to what they do in response to ethical concerns.
Ethical management always risks becoming purely bureaucratic with boxes to be checked, rather than focussing on actual implications for the animals.

9.4 What do you think about the implementation of 3R and more generally of the ethic assessment in the project and in the TNAs?

Not enough detail in report to judge.

9.5 What key-points concerning ethics would you suggest to develop in a future project?

Expand ethical concerns beyond animal welfare to consider environmental impacts and public availability of data and overall value of publicly funded research.

10 Conclusion: impact and recommendation for future work

10.1 General comments:

(James Reecy) The project is well on it way to having a positive impact on cattle research. The work on pulling together as many research protocols/procedures will provide a great resource for the project as well as the world. The work to standardize procedures across universities will also allow for more meta-analysis in the future as research will be conducted in a more standardized manner in the future. Also, the joint database being developed will facilitate new research in the future.

(Karen Beauchemin) Overall, this is an incredibly ambitious project that combines the knowledge and resources of a large number of researchers, research institutions, and stakeholders and hence has tremendous potential to impact the way animal studies are conducted in the future within the EU and elsewhere. The goals are very ambitious and comprehensive, and hence many of the important milestones will be delivered in the final months of the project. At this mid-point, almost all deliverables are on-track with some minor exceptions that are likely not to impede final completion of the project. A number of important databases have been initiated for development of predictions and proxies. It will

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be important to ensure these are living databases that can continue to be added to in time by partners and other collaborators as new information becomes available, but it is also important that the continued growth of the databases not delay the next steps, thus a balance will be needed. At this point in the project, progress is very good, and there is a high probability of success. It is unclear what the impact of Covid-19 will be on the project, but the management team are addressing this issue.

10.2 What impacts will SmartCow allow?

(James Reecy) All of the positive items listed above will allow the project to have positive impacts beyond just the work completed here. The available resources, e.g. research protocols, will allow others to benefit from the work done here in ways that would not otherwise be possible. This is a very good thing.

(Karen Beauchemin) The harmonization of standard operating procedure and coordinated approach to research will help the European cattle sector as a whole to face the challenges of sustainable production, in terms of production economics, animal well-being, and environment (efficient use of resources, enteric methane mitigation).
Tremendous opportunities for development of highly-skilled trained young researchers to ensure future capacity within the cattle sector.
Wide sharing of data and enhanced meta-analysis will enhance the impact of individual projects, and improve cost effectiveness of animal research, which is costly.

10.3 Recommendations concerning future work:

10.3.1 For the actual project?

(James Reecy) This project should allow for more meta-analysis across research projects that is not currently possible. If this is not the case, I would see it as a short-coming of the current project. If it does, it will open up whole new areas for future research.

(Karen Beauchemin) Not sure, what conditions have been laid out in the collaborative research agreements, but it would be important to ensure that the databases created continue to exist after M48, as this could be a tremendous resource that outlives the project. There would need to be consideration of a curator(s) to add new data as it becomes available. Might need to think about plans for this well in advance of M48.

10.3.2 For a future project (advanced community)?

(James Reecy) I would expect the work conducted here to lead directly to more coordinated research across universities/research units across Europe so that higher order research with a greater potential impact to be conducted. Only with this coordination will really tough problems be resolved, e.g. development of a comprehensive portfolio of ways to address the impact of climate change on livestock production.

(Karen Beauchemin) The ground work in this project would lend itself to a project on smart farming, where the cow is integrated with crops, forages, manure, soil quality, air quality, carbon storage, etc to examine overall farm efficiency and environmental sustainability using a holistic approach and big-data.

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