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OPEN LETTER

REVISED The DECIDE project: from monitoring and surveillance data to decision-support for farmers and veterinarians

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Abstract

Farmers, veterinarians and other animal health managers in the livestock sector are currently missing sufficient information on the prevalence and burden of contagious endemic animal diseases. They need adequate tools for risk assessment and prioritization of control

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measures for these diseases. The DECIDE project develops data-driven decision-support tools, which present (i) robust and early signals of disease emergence and options for diagnostic confirmation; and (ii) options for controlling the disease along with their implications in terms of disease spread, economic burden and animal welfare. DECIDE focuses on respiratory and gastro-intestinal syndromes in the three most important terrestrial livestock species (pigs, poultry, cattle) and on reduced growth and mortality in two of the most important aquaculture species (salmon and trout). For each of these, we (i) identify the stakeholder needs; (ii) determine the burden of disease and costs of control measures; (iii) develop data sharing frameworks based on federated data access and meta-information sharing; (iv) build multivariate and multi-level models for creating early warning systems; and (v) rank interventions based on multiple criteria. Together, all of this forms decision-support tools to be integrated in existing farm management systems wherever possible and to be evaluated in several pilot implementations in farms across Europe. The results of DECIDE lead to improved use of surveillance data and evidence-based decisions on disease control. Improved disease control is essential for a sustainable food chain in Europe with increased animal health and welfare and that protects human health.

Keywords
Data-driven, decision-support, control, endemic diseases, animal health, welfare



This article is included in the Animal and Dairy Science gateway.



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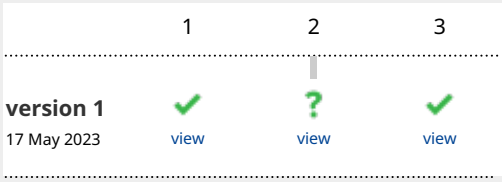

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REVISED **Amendments from Version 1**

In the revised version of the paper we added "monitoring" to the Title. In the Introduction we elaborate a bit more on the challenges and opportunities of data-driven decision support tools for endemic infectious diseases control. We added that the project started in 2021 and will reach conclusions in 2026 and that the content of WP6 and WP7 was communication, dissemination and coordination. All other changes are just minor adjustments to the text.

Any further responses from the reviewers can be found at the end of the article

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Introduction

Animal production is expected to intensify and expand due to an increasing demand for animal-derived food and the mounting pressure on land. Contagious livestock diseases impede the efficiency of animal production and lead to economic costs, poor animal welfare, and for certain diseases, have an impact on trade, public health, and consumer confidence. The European Union has a regulatory framework for all epizootic and other important contagious diseases listed in the Animal Health Regulation (Regulation (EU) 2016/429). The situation of these regulated diseases is generally well known. However, the situation for endemic contagious diseases that the private sector is supposed to deal with is different. Farmers, veterinarians and other animal health managers in the livestock and aquaculture sectors are currently missing sufficient information on the prevalence and burden of contagious endemic animal diseases. Diseases, such as porcine reproductive and respiratory syndrome (PRRS) virus, avian infectious bronchitis, cardiomyopathy syndrome in salmon or bovine coronavirus infection, are estimated to cause 10–15% reduction in performance efficiency of livestock farming, resulting in large financial losses and lower sustainability as well as affecting animal welfare (Delabouglise *et al.*, 2017) (Mohd Nor *et al.*, 2012) (Raasch *et al.*, 2020) (Rushton *et al.*, 2018) (Velarde *et al.*, 2015). Professionals in the livestock and aquaculture sectors are therefore in considerable need of adequate tools to assess the risks for contagion and associated losses, and to help prioritize the appropriate control measures for these diseases.

Existing on-farm data are numerous and heterogeneous, greatly limiting their direct use by farms, while they could be used to monitor deviations from the normal production processes indicative for infectious disease spread. (Baldin *et al.*, 2021) conclude that the scientific community has not been successful in developing, disseminating, and promoting a sustained adoption of integrated decision support systems based on continuous, multiple data streams on dairy farms. While studies also show potential for data usage in disease surveillance and decision support systems (Hepworth *et al.*, 2012; Niloofar *et al.*, 2021). Also, sensor data or (video) imaging, are currently already available in specific farms and species (Halachmi *et al.*, 2019). For salmon production, imaging is already used quite extensively, while in terrestrial species, it is still in an early adoption phase. Salmon can thus serve as an example for the other species. Still, much progress could be made in managing endemic diseases by using available data in decision support systems useful to the farmers and their veterinarians (Kasab-Bachi *et al.*, 2017; Rutten *et al.*, 2013) (Van Limbergen *et al.*, 2020).

In this context, in 2020 the European Commission launched a call for projects to improve knowledge on endemic contagious diseases in livestock and aquaculture [SFS-10-2020: Epidemiology of contagious animal diseases: from integrated data collection to prioritisation.]. In response to the call, the project "Data-driven control and prioritisation of non-EU-regulated contagious animal diseases" (DECIDE) was developed.

The DECIDE project develops data-driven decision-support tools that offer (i) robust and early signals of disease emergence and options for diagnostic confirmation, and (ii) options for controlling the disease along with their implications in terms of disease spread, economic burden and animal welfare. Together, all of this forms decision-support tools to be integrated in existing farm management systems wherever possible and to be evaluated in several pilot implementations in swine, poultry, cattle, and salmonid farms across Europe. The project started in 2021 and will reach conclusions in 2026.

The aim of this paper is to discuss the rationale behind the project and how the project tackles the challenges to eventually improve decisions to increase animal health and welfare.

The concept of the DECIDE project

The main goal of DECIDE is to develop and evaluate data-driven decision-support tools that allow stakeholders in animal health and welfare management to make improved decisions on controlling endemic infectious animal diseases. DECIDE focuses on respiratory and gastro-intestinal syndromes in the three most important terrestrial livestock species (swine, poultry, and cattle) and on growth reduction and mortality in salmonids, the most important aquaculture species (salmon and trout).

The key 'ingredients' for such decision-support tools are the following (Figure 1): (i) a clear view on the stakeholder needs, barriers and drivers; (ii) availability of and access to relevant data; (iii) early warning systems that can detect signals of potential disease emergence or spread; (iv) a set of potential control measures, along with associated costs; and (v) an understanding of the disease burden in terms of economic and welfare impact. The decision-support tool for a specific syndrome in a specific species gives various options. The tool ranks the possible control measures, including treatments and preventive measures for reduction of spread, economic costs and benefits and welfare implications. Based on embedded simulation models in the tool, stakeholders can see 'what-if' scenarios for a decision.

The data useful for DECIDE is existing data that can be used to monitor deviations from the normal production

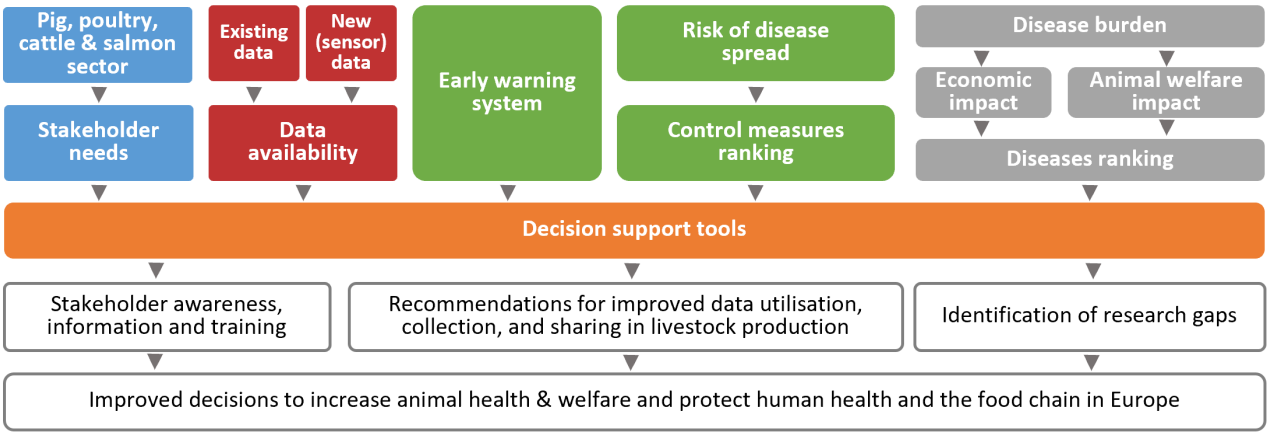

Figure 1. The concept of the DECIDE project.

process indicative of infectious diseases spread. We also investigate the usefulness of novel data *e.g.* sensor data or (video) imaging. Data availability is crucial for the DECIDE project, but access of data is restricted by laws, regulations, privacy concerns, and market pressures, as individual actors operate in a competitive environment. To overcome these challenges and assure availability of and access to relevant data, procedures to ensure access to data from the different species are developed and documented. In addition, innovative approaches for supporting data access are investigated *e.g.*, federated access and federated learning (Papst *et al.*, 2019).

The early warning system consists of data analysis that can detect aberrations from the normal variation in the monitoring data. "Early" should be interpreted in the sense that it detects signals indicative for disease timely enough for the stakeholders (*e.g.* farmers, veterinarians) to be useful for decision making on disease-mitigating actions. Frequently updated visualisation of data helps the users understand and be aware of trends, including an immediate shift or deviation. The data information also confirms what the user already suspects and can be used to support general control strategies. The risk of disease spread is a key determinant for disease mitigating actions of the stakeholders. The effectiveness of control measures greatly depends on the ability to reduce further spread. Therefore, in DECIDE, mechanistic disease models are developed to simulate the spread of contagious diseases in the production systems of the four studied animal species. The input parameters of the models can easily be adapted to simulate spread of different pathogens, for different species and herd-types.

Stakeholders often have a choice of control measures including doing nothing at all. To effectively support stakeholders in their choice, a ranking of control measures for effectiveness, costs and benefits, welfare implications, medicine use, *etc.* is needed. Obviously, whether to control a disease or not also depends on the impact of that disease on animal health and welfare. DECIDE develops a multidimensional burden of disease metric that contains the economic impact as well as the impact on animal welfare and possibly on antimicrobial use. Thus, diseases can be ranked for their expected burden to prioritise the limited resources of the stakeholders for disease control.

The above-mentioned key ingredients are combined in decision-support tools for the stakeholders. The adoption of tools also require in-depth understanding of stakeholder beliefs, needs and preferences. Incorporating social science methods, the tools are developed in close collaboration with the stakeholder end-users. The decision-support tools are incorporated in already existing platforms to facilitate uptake of the tools. We develop prototypes for each species that are tested in several partner countries in pilot implementations. The gained understanding of the stakeholders' needs and preferences does not only inform the development of the functionalities of these prototypes (*i.e.*, what it can do), but also the output visualisation (*i.e.*, how data is shown or how early warnings are framed). The pilot implementations are the 'playground' in which our innovative framework and tools are tested and adapted again, learning from experiences with stakeholders and users across species. Through the pilot implementations, we ensure that the generic methods and framework can be easily adapted and implemented for existing platforms. The long-term sustainability of the developed tools is ensured by an open science approach.

The overall structure of the workplan

In Figure 2 the overall structure of the workplan of the DECIDE project is depicted. The DECIDE project consists of seven work packages (WP). WP1-WP3 cover all data-oriented research and tool development. WP4 is dedicated to determining the economic and welfare burden of diseases and to generate cost-effective control measures. For stakeholder input, WP5 aims to assess the stakeholders' drivers, barriers and willingness to share data and to implement decision tools for health and welfare management at the farm level. The dissemination, communication and exploitation of results is organized in WP6, and the management and coordination of the project is overseen by WP7.

The technical work packages (WP1-5) in DECIDE are providing the necessary technical knowledge and scientific methods for the decision-support tools that are developed for each

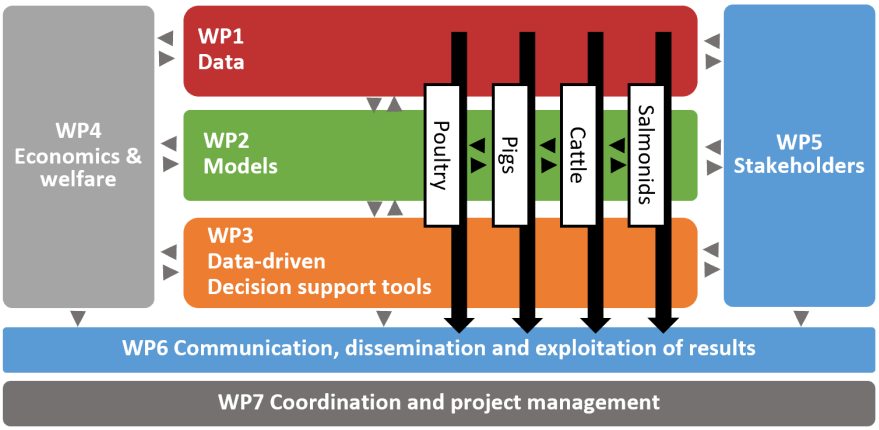

Figure 2. The work packages (WP) and species-specific workflows in the DECIDE project. Black arrows indicate the progress of the different species-specific decision-support tools through the WPs.

of the species in specific pilot implementations. The project is planned for a total duration of 5 years to give sufficient time for developing all 'ingredients' for the decision-support tools (in WP1, WP2, WP4 and WP5) and then for integrating and testing prototypes (WP3/WP5) of the decision-support tools in pilot implementations in at least two iterations within years 3 to 5. Some of the tools set up in WP3 may just be decision trees, while others are envisioned to be fully functional interactive dashboards. A key element of DECIDE is to build prototypes of the decision-support tools, one for each of the four species (pigs, poultry, cattle, salmonids). A prototype consists of generic models with country- and herd-specific baselines (*e.g.*, (ab)normal mortality levels differ between herds and countries) to detect aberrations in the data for the different syndromes. Each of the prototypes is tested and further refined in pilot implementations in at least two different countries. The administrative workpackages WP6 and WP7 are for communication and dissemination (WP6) and overall project coordination (WP7).

Content of the work packages

The main objective of WP1, Data, is to assure availability of and access to relevant data during the DECIDE project and to explore innovative approaches to combine, compare, and access data coming from numerous data sources for continuous use after DECIDE. As a first task in WP1 we review and compare data available in DECIDE, putting it in perspective with the General Data Protection Regulation (GDPR), and existing guidelines on best practices in usage of agricultural data, such as the 'EU code of conduct on agricultural data sharing by contractual agreement and the 'Privacy and security principles for farm data' of the US Farm Bureau. Following the FAIR principles, machine-readable ontologies describing concepts within animal health are created for each of the animal domains, and shared definitions are built where possible (Dórea *et al.*, 2019). Finally, different approaches to support data accessibility are tested and compared using as a basis the pilot implementations of the decision-support tool. A recent review (Papst *et al.*, 2019) provides an overview of the existing agricultural data exchange systems and proposed options for privacy-preserving data analytics. Essentially, three alternative data exchange approaches are implemented and compared in WP1, namely (i) direct data sharing; (ii) centralized data exchange using federated data access; and (iii) privacy-preserving data analytics using federated learning.

The overall objective of WP2, Models, is to develop the methods for data analysis and modelling. In essence, two kinds of models are developed: i) monitoring models and ii) mechanistic simulation models. The purpose of a monitoring model is to use observed data to estimate the state of a system, which can be a group of animals, a herd, a region, or a country. The state can either be expressed quantitatively (*e.g.* mortality or the prevalence of a syndrome) or qualitatively (*e.g.* "in control" or "out of control" where "out of control" should raise an alarm). The observation is based on data, typically originating from multiple sources (sensors as well as manually collected). In many cases, the state is not directly observable. In other words, the data only indirectly reflect the state. Since the data from a biological system shows completely random fluctuations, monitoring the state also has a data filtering purpose. If the state is expressed quantitatively, the output from the monitoring model may serve as valuable input to a mechanistic simulation model of the system as well as for economics and welfare modelling (tackled in WP4). If the state is expressed qualitatively, the output may serve as valuable input to decision-support (focus of WP3). The monitoring framework consists of statistical models for time-series data that can detect aberrations in the data. Specifically, we use state space models, where a latent vector of parameters describes the state of the system (Jensen *et al.*, 2017). Biologically meaningful disease-specific mechanistic models enable simulating pathogens' spread and syndrome occurrence at different levels (pen, farm, region), and thus to compare *ex-ante* and prioritize control options (Ezanno *et al.*, 2020). In DECIDE, the software EMULSION v1.1.1 (Picault *et al.*, 2019) is used to facilitate the development of the stochastic simulation models.

In WP3, Data-driven decision-support tools, we focus on the development and implementation of tools to deliver information in formats that are usable (user-friendly) and useful

(capable of providing insight to guide intervention and practice change) in supporting disease prioritization and control in practice. Tool prototypes are developed to the point that they can be used and tested, and evaluation is carried out in conjunction with WP2 and WP5 to further adapt to users' needs for baseline models in a co-construction approach. Data visualization and information delivery tools vary from decision trees to fully functional interactive dashboards. After one or two rounds of feedback from stakeholders through participatory workshops, prototype support tools are built for personal computers, as well as smart phones and tablets, and tested in practice through the pilot implementations. These prototypes are applied in practice and used as a basis for discussions on users' needs and evaluations of the tools' usefulness and usability through the pilot implementations for swine, cattle, poultry, and salmon.

WP4, Economics and welfare, estimates the investment in animals, describes the burden of animal health and welfare problems as a health loss envelope, attributes and prioritizes the health loss envelope by diseases and health and welfare issues to target interventions and supports the economic assessment of the interventions at all levels. WP4 initiates a process that is health and welfare-focused, leading to information on the relative importance of disease and health and welfare problems and indicating where there is weak resource allocation (Rushton *et al.*, 2018). The health loss envelope is based on developing input-output relationships for the current levels of production (Rushton, 2008) and estimating a utopian level of production based on what is achievable within the current systems of genetics of the animals, feed available and management, minus the impacts caused by health and welfare problems. The differences between the current and utopian input-output relationship represents the net loss in production and the expenditure on animal health and welfare – the health loss envelope. The types of modelling approaches to achieve this have been explored for cattle and bovine respiratory disease (Delabouglise *et al.*, 2017); for broiler chickens and coccidiosis (Gilbert *et al.*, 2020) and for PRRS in pigs (Thomann *et al.*, 2020). The information generated supports the selection of interventions (WP3) through careful cost-benefit analysis based on marginal cost and benefit calculations (Gilbert *et al.*, 2020; Thomann *et al.*, 2020) that are informed by risk and uncertainty (Rushton, 2008).

In WP5, Stakeholders, we explore how key and secondary actors, namely farm-staff and producers, veterinary and production advisors, engage with different data and information about diseases and what kind of decisions they make based on the data that is available to them. WP5 is made up of two sequential parts, 'Exploration' and 'Experimentation and Evaluation', based on the emerging concept of "Living Labs" for the co-creation and adoption of new services and technologies in multi-contextual real-life environments (Bergvall-Kåreborn & Ståhlbröst, 2009). This framework has been successfully employed in a wide range of sectors (Healthcare, Transport, among others) for technology-led decision-support innovations. The key parts of the methodological approach of WP5 are the involvement of multiple actors in real-life settings and use of multi-method approaches informed from wider social science disciplines (Klerkx *et al.*, 2019; Morgan *et al.*, 2001).

Discussion

Endemic contagious diseases are the main worry in day-to-day animal health management for farmers and their veterinarians. The so-called production diseases are often caused by multiple pathogens and pose the largest threat to animal health and welfare and, thus, to the productivity of both terrestrial and aquatic species. For DECIDE, we focus on the three most important meat-producing terrestrial species (swine, poultry and cattle) and the most important aquatic species, salmon and trout in Europe. For young, growing animals, gastro-intestinal and respiratory tract infections are the most prevalent syndromes that cause much growth reduction, mortality, and use of medicine. In salmonids, respiration is impaired by gill diseases, and diseases causing circulatory failure and inflammation of gastrointestinal organs lead to growth reduction and mortality. The four species have different levels of integration of farming and thus of available data and differ in the level of data (animal, herd, unit, cage). However, the concept that a contagious disease spreads in an epidemiological unit and causes disease is the same. When syndromes are noted, stakeholders such as farmers, veterinarians or other animal health managers need to decide on actions to prevent further spread, diagnose, treat, vaccinate, or take preventive actions for the next round of production. These decisions and choices are not necessarily rational and often not based on a sound quantitative basis (Kaler & Ruston, 2019). Why, how and when stakeholders decide to take action (the drivers) and why they do not (barriers) are some of the key-elements of the DECIDE project as depicted in the box "Stakeholder needs" in Figure 1. The social scientists in DECIDE ensure that in co-creation with the stakeholders, the project delivers suitable tools.

The DECIDE project leads to use of existing data for disease monitoring, to rank and prioritize disease control and decision-support for the stakeholders. DECIDE increases stakeholder awareness about infectious endemic disease control and identifies gaps for further training. The methods and framework developed in DECIDE are specific enough to support stakeholders for the focus species and syndromes in DECIDE, but can also be generalized across species, countries or diseases. Research gaps are identified and shared. The use of the co-created decision-support tools leads to improved decisions regarding disease control and thus results in improved sustainability, animal health and welfare. More efficient use of resources and less use of medicines will also positively impact human health and the environment.

Data availability

No data are associated with this article.

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Open Peer Review

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Version 2

Reviewer Report 08 September 2025

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✔ **Philip A. Robinson**
Harper Adams University campus, Harper & Keele Veterinary School, Newport, Shropshire, UK

I am content that the points I raised have been addressed and the article can be approved.

Competing Interests: No competing interests were disclosed.

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard.

Version 1

Reviewer Report 07 May 2024

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✔ **Dirk Pfeiffer**
[1] Centre for Applied One Health Research and Policy Advice, College of Veterinary Medicine and Life Sciences, City University of Hong Kong, Hong Kong, Hong Kong
[2] Centre for Applied One Health Research and Policy Advice, College of Veterinary Medicine and Life Sciences, City University of Hong Kong, Hong Kong, Hong Kong

DECIDE will produce decision support tools for early detection and control of selected diseases/syndromes in pigs, poultry and cattle as well as salmon and trout. It will integrate a variety of data sources and quantitative models to produce outputs that will be tailored to

different stakeholders, also taking into account economic considerations.

It is interesting that there is no mention of the environmental impact of production, disease and its control. DECIDE only seeks for optimisation of animal health and welfare, as well as monetary profit. Admittedly, taking into account environmental impact would add complexity, but it should either be attempted or be mentioned as an issue in the discussion. 'Sustainability' and 'environment' are briefly mentioned in the last paragraph in the discussion. It may also be useful to refer to the widely accepted need for food system transformation and how DECIDE can, may be, support that.

In terms of analytical methodology, it would seem timely to consider the use of artificial intelligence approaches.

The inclusion of social scientists in the project is to be commended, but I am unsure how an integration of the different types of knowledge or scientific evidence will be achieved.

Is the rationale for the Open Letter provided in sufficient detail? (Please consider whether existing challenges in the field are outlined clearly and whether the purpose of the letter is explained)
Yes

Does the article adequately reference differing views and opinions?
Yes

Are all factual statements correct, and are statements and arguments made adequately supported by citations?
Yes

Is the Open Letter written in accessible language? (Please consider whether all subject-specific terms, concepts and abbreviations are explained)
Yes

Where applicable, are recommendations and next steps explained clearly for others to follow? (Please consider whether others in the research community would be able to implement guidelines or recommendations and/or constructively engage in the debate)
Yes

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: veterinary epidemiology

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard.

Reviewer Report 19 April 2024

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?

Philip A. Robinson
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This article provides an interesting summary of the DECIDE project, a European research project designed to improve animal health and welfare by better utilizing a wide range of existing and novel on-farm data across pig, poultry, cattle and salmonid farms in Europe. The aim of the project is to improve decision-making around endemic contagious diseases of the respiratory and gastrointestinal systems of these species.

I think the title of the article should be slightly expanded to include the word 'monitoring' as the aim of the project is to utilize existing data, not just create new data i.e. 'The DECIDE project: from monitoring and surveillance data to decision support for farmers and veterinarians.' Surveillance is more active and intentional than monitoring, and I think both approaches to collecting and using data need to be considered. The word 'monitor' is indeed referred to at several points in the article.

It would be helpful to see some more introduction to the topic in terms of previously published attempts to better utilize data on endemic disease perhaps elsewhere in the world, and to illustrate the challenges involved. This will also help to elucidate why this project is novel and pioneering.

In terms of recommendations and next steps, the article is often written in the present tense, suggesting that the project is ongoing and has not yet reached its conclusion. This could be clarified for the benefit of the reader.

There is no mention of WP6 and WP7 in the section 'Content of the work packages' - I think there should be some reference made to them here as they are shown in Fig. 2.

Minor changes:

1. Abstract: 'currently missing sufficient information on **the** prevalence and burden...'

Introduction:
2. Line 22: 'as well as **affecting** animal welfare'
3. Lines 31-32: 'normal production process**es** indicative for infectious **disease** spread.'

Page 7:
4. Second paragraph, line 5: 'interventions and support**s** the economic assessment'
5. Second paragraph, lines 21-23: remove the word 'by' before each of the sets of references (x3)
6. Third paragraph, line 14: 'in real-life setting**s**'

Discussion:

7. 'For DECIDE, we focus on the three most important meat-producing terrestrial species...' - should the words 'in Europe' be added in here?

Is the rationale for the Open Letter provided in sufficient detail? (Please consider whether existing challenges in the field are outlined clearly and whether the purpose of the letter is explained)
Yes

Does the article adequately reference differing views and opinions?
Partly

Are all factual statements correct, and are statements and arguments made adequately supported by citations?
Yes

Is the Open Letter written in accessible language? (Please consider whether all subject-specific terms, concepts and abbreviations are explained)
Yes

Where applicable, are recommendations and next steps explained clearly for others to follow? (Please consider whether others in the research community would be able to implement guidelines or recommendations and/or constructively engage in the debate)
Partly

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: Veterinary epidemiology; social science approaches to animal health and welfare

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard, however I have significant reservations, as outlined above.

Author Response 03 May 2024

Gerdien van Schaik

Dear Philip Robinson,

Thank you for revising our paper and providing us with valuable comments for improvement of the paper. We agree that the data for the project is originating from both monitoring and surveillance activities. In the project we will use the data for decision support for disease management. We will change the title as the reviewer suggests to: 'The DECIDE project: from monitoring and surveillance data to decision support for farmers and veterinarians.' We included a few references in the Introduction to illustrate the challenges

of using data for endemic disease control in animal production. We hope that this additional text (in blue) is sufficient. The maximum length of the paper does not allow for much more examples. “Existing on-farm data are numerous and heterogeneous, greatly limiting their direct use by farms, while they could be used to monitor deviations from the normal production processes indicative for infectious disease spread. Baldin et al. (2021) conclude that the scientific community has not been successful in developing, disseminating, and promoting a sustained adoption of integrated decision support systems based on continuous, multiple data streams on dairy farms. While studies also show potential for data usage in disease surveillance and decision support systems (Hepworth et al., 2012; Niloofar et al., 2021). Also, sensor data or (video) imaging, are currently already available in specific farms and species (Halachmi et al., 2019). For salmon production, imaging is already used quite extensively, while in terrestrial species, it is still in an early adoption phase. Salmon can thus serve as an example for the other species. Still, much progress could be made in managing endemic diseases by using available data in decision support systems useful to the farmers and their veterinarians (Kasab-Bachi et al., 2017; Rutten et al., 2013; Van Limbergen et al., 2020).” We agree with the reviewer that it was not explicitly stated that the project is ongoing. We now mention in the introduction “The project started in 2021 and will reach conclusions in 2026”. We added: “The administrative workpackages WP6 and WP7 are for communication and dissemination (WP6) and overall project coordination (WP7).” All suggested minor changes were included in the revised version of the paper.

Competing Interests: No competing interests were disclosed.

Reviewer Report 08 April 2024

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Dennis Muhanguzi
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I would like to congratulate the authors on a very lovely project proposal. I would only like to bring their attention to one point they might need to think about going forward;

1. One of the production indices the authors propose to model in work package 4 is reduction in growth weight -see abstract; [in disease state] and probably the reverse in healthy state. Indices of productivity like weight gain are affected by many factors including genetics, nutrition and other management factors [environmental stressors]. Using such indices even when you are deploying robust modelling approaches might not tease out changes in body weight attributable to each of these collinear and / or interacting factors. It is therefore important that the authors either have

inbuilt values assigned to each of the factors to explain their effects on the measured outcome [weight gain] or they contend with errors borne with use of such indices in modelling socio-economic impact of livestock diseases. Use of growth rate as a production index would require that the study design is longitudinal with data generated from "with disease" and "without disease" scenarios where herds are of similar genotypes and kept in somewhat homogeneous production systems.

A related point to the above is use of the phrase " possibly on antimicrobial use" in the second paragraph on page 5. I would assume that Socio-economic impact assessments will consider the cost of treatments [including antibiotics] in high, medium and low disease burden herds / flocks / shoals. This being the case i would suggest this phrase should be changed to be in the affirmative.

Is the rationale for the Open Letter provided in sufficient detail? (Please consider whether existing challenges in the field are outlined clearly and whether the purpose of the letter is explained)
Yes

Does the article adequately reference differing views and opinions?
Yes

Are all factual statements correct, and are statements and arguments made adequately supported by citations?
Yes

Is the Open Letter written in accessible language? (Please consider whether all subject-specific terms, concepts and abbreviations are explained)
Yes

Where applicable, are recommendations and next steps explained clearly for others to follow? (Please consider whether others in the research community would be able to implement guidelines or recommendations and/or constructively engage in the debate)
Yes

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: Molecular epidemiology | Veterinary Sciences

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard.

Author Response 03 May 2024

Gerdien van Schaik

Dear Dennis Muhanguzi,

Thanks you for your thorough review of our paper. Please find our response to the issues

you raise below. Ad 1. In summary, you are concerned about the use of growth rate as a production index. As you rightly mention it would require that the study design is longitudinal with data generated from "with disease" and "without disease" scenarios. We will and are exploring options to look at the different issues and the points you raise with an adequate library of data on growth rates it should be possible to say something about an ideal growth rate under different environment and nutritional conditions and the type of genetics of the animal in order to understand what the gap is due to health. You will find that we are working on this as an approach within the Global Burden of Animal Diseases programme (Rushton et al, 2018, 2021, Gilbert et al, accepted). We are also exploring a partial and disaggregated estimation of the burden of diseases through looking at the relative burden of the diseases and the potential reduction of the burden through control options. The main approaches we use are meta-analyses (Boeters et al., 2023) and stochastic modelling (Sorin-Dupont et al., 2023) based on parameters from literature. In some cases we also have retrospective empirical data in which we can determine the associations between the presence of syndromes (respiratory or gastro-intestinal), pathogens and, for example, (variation in) carcass weight or pleurisy condemnations at slaughter. When we mention that we consider the antimicrobial use (AMU) in the burden of animal diseases, we mean that we will not only consider the direct costs and benefits of AMU but also consider the unfavourable consequences of superfluous AMU for antimicrobial resistance. The costs of treatment (including antibiotics) are already included in the economic burden estimations. However, the indirect negative impact of AMU will also be indicated in decision support tools to inform decision makers. Since the tools are not yet in that stage of development, we propose to stick to ". possibly on antimicrobial use".

Competing Interests: No competing interests were disclosed.