Peer Community In
Animal Science

Measuring resilience in farm animals: theoretical considerations and application to dairy cows

Aurélien Madouasse *based on peer reviews by* ***Ian Colditz*** *and 2 anonymous reviewers*

Friggens, N. C., Adriaens, I., Boré, R., Cozzi, G., Jurquet, J., Kamphuis, C., Leiber, F., Lora, I., Sakowski, T., Statham, J. and De Haas, Y. (2022) Resilience: reference measures based on longer-term consequences are needed to unlock the potential of precision livestock farming technologies for quantifying this trait. Zenodo, ver. 5, peer-reviewed and recommended by Peer Community in Animal Science.
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Farm animals differ in their ability to respond to the many environmental challenges they face. Such challenges include infectious diseases, metabolic diseases resulting from inadequate coverage of dietary needs, as well as the diverse consequences of climate change. Various concepts exist to characterise the responses of animals to different types of challenges. This article by Friggens et al. (2022) focuses on resilience, providing a conceptual definition and proposing a method to quantify resilience in dairy cows.

The first part of the paper provides a definition of resilience and highlights its differences and relations with the related concepts of robustness, and, to a lesser extent, resistance and tolerance. In essence, resilience is the ability of an animal to bounce back quickly after a challenge of limited duration. On the other hand, robustness is the ability of an animal to cope with conditions that are overall unfavourable. From these conceptual and intuitive definitions, there are several difficulties precluding the design of concrete methods to measure resilience. First, there is some degree of overlap between the concepts of resilience, robustness, resistance and tolerance. Secondly, resilience is a multidimensional concept whereby resilience to a given perturbation does not imply resilience to other types of perturbation, e.g. resilience to a challenge by a specific pathogen does not imply resilience to a nutritional challenge. A further difficulty in the measure of resilience is the fact that different animals may be exposed to challenges that are different in nature and in number. The

authors argue that although resilience cannot be measured directly (it should be seen as a latent construct), it is possible to quantify it indirectly through its consequences.

In the second part of the paper, the authors propose a method to quantify resilience of individual dairy cows. The method is based on the premise that resilient animals should be kept longer in their herd than non-resilient animals. The main criterion in the evaluation is therefore the ability of cows to re-calve. Each cow that is calving receives a certain number of points, to which, in each lactation, bonus points are added for higher milk production and penalty points are removed for each insemination after the first one, for each disease event and for each day of calving interval above some herd specific value. Therefore, cows have a resilience score in each lactation. They also have a lifetime resilience score obtained by summing the scores for all the lactations, that gets bigger as the cow has more calves, and that also takes the age at first calving into account. In a previous study, Adriaens et al. (2020) showed that higher resilience scores were associated with fewer drops in milk yield and more stable activity dynamics.

Starting from theoretical considerations on the notion of resilience, this paper describes a concrete method to quantify animal-level resilience on farm. Such quantification will be useful for breeding and culling decisions. Finally, the general framework to design resilience measures that is presented will be useful to researchers working on the quantification of farm animal resilience using new methods and data sources.

References:

Adriaens I, Friggens NC, Ouweltjes W, Scott H, Aernouts B and Statham J 2020. Productive life span and resilience rank can be predicted from on-farm first-parity sensor time series but not using a common equation, across farms. Journal of Dairy Science 103, 7155-7171.https://doi.org/10.3168/jds.2019-17826

Friggens, N.C. , Adriaens, I., Boré, R., Cozzi, G., Jurquet, J., Kamphuis, C., Leiber, F., Lora, I., Sakowski, T., Statham, J., De Haas, Y. (2022). Resilience: reference measures based on longer-term consequences are needed to unlock the potential of precision livestock farming technologies for quantifying this trait. Zenodo, 5215797, ver. 5 peer-reviewed and recommended by Peer community in Animal Science. https://dx.doi.org/10.5281/zenodo.5215797

Reviews

Evaluation round #1

DOI or URL of the preprint: https://doi.org/10.5281/zenodo.5215797

Authors' reply, 26 November 2021

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Decision by Aurélien Madouasse, posted 26 October 2021

Moderate revision

In this preprint the concept of resilience in livestock is discussed and operational measures of resilience in dairy cows are proposed. The article nicely mixes conceptual definitions, practical implications for the measure and an application.

Three experts in the field reviewed the article. They highlighted the relevance of the question addressed and the overall good quality of the work presented. However, they also raised a number of questions and made comments that I would like you to address.

From the different comments, it seems that some clarifications are needed, either in the definition section or in the discussion, on the relationships between resilience and other concepts such as robustness, productive efficiency or disease resilience. As part of this, careful consideration should be given to Figure 1.

Lastly, PCI requires authors to make the raw data, codes and scripts available. Reading the paper, the origin of the data used in the example (1800 lactations from Table 2) was not clear to me. Could you clarify this?

I invite you to respond to the reviewers' comments, and I look forward to receiving a revised version of your work.

Reviewed by anonymous reviewer 1, 16 October 2021

Dear editor,

This is a very well written manuscript that presents and discusses important concepts and applications of animal resilience. This is a great contribution to the literature, but I suggest that the authors clarify some points:

1) They have not addressed well the relationship between productive efficiency and resilience or robustness. For example, in Figure 1 it seems to be assumed that robustness is always linked to lower production levels. This is likely the case for most animals, but there are multiple studies showing that there is still within-population variability. Based on the Figure presented, one might assume that it could be more economically feasible to improve the environmental conditions instead of breeding for more robust animals. I am aware that this is not feasible in some production systems, but my point is: we should not disregard the production level when evaluating robustness and resilience or assume that more resilient/robust animals will always be less productive. In my opinion, more direct indicators of productivity should be taken into account.

2) I question the novelty of the strategy proposed to quantify resilience in dairy cattle. As the authors are likely aware, dairy cattle selection indexes include all the variables suggested in their resilience index and many other indicators of resilience: age at first calving, interval from first to last insemination, calving internal, milk production, health traits (somatic cell count and clinical mastitis, metabolic diseases, reproductive disorders), longevity/stayability, and many others. The weighting approach suggested by the authors might actually be unfair to certain animals evaluated during more unfavourable conditions, which doesnt seem to be taken into account in their weighting strategy. For example, in an extensive production system, it is more likely that cows will be more fertile (less inseminations required) during the seasons with greater pasture quality or lower temperatures. However, not all cows in the herd will be in a breeding stage at the same time. Will their ranking approach take all these factors into account? For example, in L399, they mention an adjustnemtn for "herd average", which is not very representative of all these environmental factors influencing animal performance. A genetic evaluation and selection index would consider all these factors and therefore, it would seem to be a better strategy. In other words, wouldnt it be better to create a selection sub-index for resileince instead of ranking the animals based on their "almost unadjusted" phenotypic records alone? Especially from a breeding perspective, it is not clear to me how this ranking strategy is more benefitial compared to the selection indexes already in place in most countries around the world.

3) In Table 2, how would they take culling reason into account? For instance, I dont think a cow that was culled due to temperament/behavior should be considered less resilient than a cow due with fertility issues.

4) L325: the authors discuss about the challenges of using disease event records, but no clear solution or potential alternatives are indicated at the end. I suggest adding a closing sentence to this section.

L68: ...herd for a long time...

L86: Please cite some examples of these studies.

L94: ...from an evolutionary...

L122: I disagree that a ”good and stable environment requires NEITHER resilience or robustness…”. It is almost impossible to have a production system with no environmental challenges. Maybe this could be rephrased as ”a good and stable environment is less depedent on the resilience and robusteness level of the animals…”.

L160: I would also add, what are the trade-offs between resilience and productive efficiency? Can we simultaneously breed for more resilient and productive efficient animals?

L242: …have been…

Reviewed by anonymous reviewer 2, 25 October 2021

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Reviewed by Ian Colditz, 03 October 2021

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