Peer Community In
Animal Science

Tracking large numbers of hens in aviary housing: validation of a Radio Frequency Identification system

Anna Olsson *based on peer reviews by* ***Mona Giersberg*** *and* ***Arjen van Putten***

Sabine G. Gebhardt-Henrich, Alexander Kashev, Matthew B. Petelle, Michael J. Toscano (2023) Validation of a Radio frequency identification system for tracking location of laying hens in a quasi-commercial aviary system. bioarxiv, ver. 3, peer-reviewed and recommended by Peer Community in Animal Science.
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With the increasing use of cage-free housing systems for laying hens comes the challenge of monitoring the behaviour of individual hens in large enclosures where they can be not only on the floors but on different levels. The aim of the present study by Gebhardt-Henrich et al., (2023) was to validate a Radio Frequency Identification (RFID) system with the capacity to track a large number of hens for different research and applied purposes where behaviour monitoring is relevant, such as heritability estimates for breeding programs.

In a housing system with 225 birds per pens, 26 antennae were placed at different locations. All birds in 5 pens were equipped with a glass tag in a custom-developed leg band. For validation purposes, the behaviour of three hens who could move between two pens was also monitored on video. Equipping these hens with colour-coded backpacks made them identifiable on video.

Matching the antennae detection of the focal birds with the behaviour observation showed that the antennae were able to detect a hen on the right tier in > 90% of cases, but that match on antenna level was lower.

The limitations of the system are also discussed in this concise methods paper that will be helpful to many researchers interested in tracking laying hens in loose housing systems.

Gebhardt-Henrich, S.G., Kashev, A., Petelle, M.B., Toscano, M.J., 2023. Validation of a Radio frequency identification system for tracking location of laying hens in a quasi-commercial aviary system. bioRxiv 2023.02.16.528820. ver. 3 peer-reviewed and recommended by Peer Community in Animal Science. https://doi.org/10.1101/2023.02.16.528820

Reviews

Evaluation round #2

DOI or URL of the preprint: https://doi.org/10.1101/2023.02.16.528820
Version of the preprint: 2

Authors' reply, 16 August 2023

Dear editor
Thank you for spotting the typo and the awkward expression. We corrected both.
Kind regards,
Sabine Gebhardt-Henrich
Download tracked changes file

Decision by Anna Olsson, posted 29 July 2023, validated 30 July 2023

very minor revision in the Results section

Dear Sabine,

This paper is now very close to being ready for a recommendation, but please have a look at line 135 in the Results section. The sentence "When the registrations of the litter were excluded" is not understandable. I think this is about the phenomenon that is discussed on lines 180-181 in the Discussion section, but the paper needs to be understandable when read from the beginning to the end! It needs some more words to be understandable, and I don't think you ever have registrations "of the litter" - registrations will be either "of the hens when on the litter" or "by antennae placed on/in the litter".

And when you are correcting this please also correct the typo "differend" on line 145.

Best regards,
Anna Olsson

Reviewed by Mona Giersberg, 28 July 2023

Dear authors,

Thank you for responding to my comments of the previous round. The queries were well addressed and clarified in the manuscript. The new figures also add to this. Overall, it is a concise methods paper that will be helpful to many researchers interested in tracking laying hens.

Evaluation round #1

DOI or URL of the preprint: https://doi.org/10.1101/2023.02.16.528820
Version of the preprint: 1

Authors' reply, 16 June 2023

Download author's reply
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Decision by Anna Olsson, posted 18 April 2023, validated 19 April 2023

Revision

Dear Dr Gebhardt-Henrich,

Thank you for submitting a manuscript to PCI Animal Science.

Your submission has been reviewed by two independent reviewers who are both of the opinion that the work has merit but have highlighted a number of issues that need addressing. If you think that you can address these, I welcome you to submit a revised version.

It is really appreciated that you use PCI Animal Science to obtain feedback on your paper.

Yours sincerely,

Anna Olsson

Reviewed by Arjen van Putten, 18 April 2023

First of all my apologies for the delay. I hope my review still helps you.

In general this is a well written and clear paper. My respect for the scale at which this research was done. The tables and figures are clear, as well as the nice pictures. I need some clarification on the method, but aside from that it looks fine.

The scale of the used data with 3 hens and 10 hours of tracking does not reflect the variation in hen behaviour which I expect is available from all other hens. A comparison could have been made between the behaviour of these 3 hens and the movement of all others, but I expect this will be mentioned in another paper. Despite the scale, this is still a very interesting paper in my opinion. A lot of practical challenges are still making tracking a difficult task, and this paper provides more insight in how to make it work. Also, the provided scripts and data will help everyone in this field.

The abstract and introduction are fine.

Method:

Frequency of recording rfid is not mentioned but could be found later in the analyses section.

My main concern is that it's not completely clear to me what has been marked on the video. Did you draw a bounding box and calculate when the box was on average within the area marked above an antenna? This is not clear to me from the text. The orientation and distance of the tags relative to the antennas is of importance for registering the presence of a tag. The fish-eye effect of the camera which I clearly observe in figure q requires some form of calibration and warped image before being able to connect the presence of a hen in one area. Also, did you take into account where the tag is placed on the hen? Currently I am unable to repeat your method due to this missing information.

In the method you could also have given more

Are all antennas tuned exactly the same in the aviary? For instance, what is the minimum distance for a tag to be picked up?

Results:

3a and b could be combined in 1 table, but leaving it like this is fine.

Discussion:

Synchronization errors are mentioned between the camera and rfid system. Please mention the video quality and frequency as well as that of the RFID system. If video is collected at a regular 20 fps and the RFID

records at 10 Hz, it should be possible when all systems are connected to the same network. Of course having a stable network on farm is impossible and I understand the difference between them.

The additional data and scripts are easy to understand and work with. I could not look into the sas files since I will not use the program, but the xlsx (use csv next time), and R scripts look fine. My R is a bit rusty but the way you write code is quite similar to Python. The read_me file could provide more info on the connection between the different files but this is quite standard.

Reviewed by Mona Giersberg, 28 March 2023

PCI Animal Science ArticleID #193 review

In the present study, the authors validate an RFID system for location tracking of laying hens housed in a semi-commercial environment by means of video analysis. In general, this manuscript is a concise report which highlights the importance of thorough validation when using new technologies in animal behaviour research. As we frequently see a lack of validation of technologies applied both in research and on-farm, this subject cannot be emphasized enough. For detailed comments, see below.

Line remarks:

Title

The title reflects the content of the article. However, the term “commercial aviary” is a bit misleading, as only 225 (or 450) hens were housed per group in one pen of an aviary system (which indeed contained most elements of a commercial system). On commercial farms, several sections of those systems are placed in a row, allowing the hens (often about 6000 individuals per group) to move longer horizontal distances on one tier. As this may influence transitions to different zones, I would suggest to use the terms “semi-commercial (aviary) system/semi-commercial conditions” or “quasi-commercial (aviary) system” when referring to the present set-up.

Introduction

The motivation for the present study and the research question are clearly stated. The depth of the introduction and the extent to which previous relevant research is discussed is appropriate to the overall length of the manuscript.

L. 53: Not clear what is meant by “invisible”. Are the hens occluded/covered/hidden by conspecifics and/or equipment of the aviary?

L. 58: For which aims or in which situations is it important to track all individuals of a group? For commercial applications I would suppose that knowing whether “the flock” uses a certain functional area would be sufficient. What would be the consequences in such a setting if single individuals would or would not use that area? Tracking of all individual of a group may be of particular interest in research contexts.

Ll. 58-59: How is it possible to validate automated tracking devices with video observations if tracking hens visually is limited (as stated in l. 53)? It is accounted for this limitation in the discussion section. However, at this point is reads as a contradiction.

Methods

More detail is needed on the RFID system (e.g. were the antennae coated (plastic box) or used as bare wire? With which kind of device were the antennae connected?). Alternatively, a reference to a previous (open access) paper in which the same system is described in more detail could be provided. With the current information given, it is not possible to replicate the study. The same is true for the description of the aviary system. It is stated that 26 antennae (l. 69) were placed in the aviary. In Fig. 1, 12 of these antennae are visible (2 are not visible because they are near the pop holes). If the other side of the aviary would look the same, there should

be 28 antennae, or is the veranda only accessible from one side of the barn? Adding a schematic figure of one whole pen of the system may be useful.

Ll. 73: Not clear why birds in 5 pens were fitted with RFID tags. In this study, only two connected pens are used. It should be stated if this validation study was part of a larger experiment (preferably with a reference to a pre-print or paper, if available).

L. 78: Could the hens move freely between the two connected pens?

L. 78: Where those back-packs custom made or commercially available? This information would be very helpful for other researchers, as it is often difficult to design suitable backpacks. There is a photo of the leg bands; it would be useful to include one of the back-packs as well.

L. 82: How where the times of the video recording system and the RFID system synchronized? Did they use the same time source (e.g. radio clock, web clock)? It is accounted in the discussion section for the limitation of exact synchronization. However, it would be useful to describe the method of initial time synchronization between the two systems.

L. 104: Is it correct that for initial data procession, R was used and for running the statistical tests/models SAS was used? Why was it chosen to use both programmes?

L. 107: Table header: sentence structure does not seem correct.

L. 110: Table 2: I wonder whether "test" is the right word here. Which calculations were made to create the variables?

Table 2: "Side correction needed": How was this done precisely? A second person checked all data from the video observations for plausibility?

Results

L. 117: …was detected within 1 min. By the RFID system?

L. 130: "…including the litter…"

L. 134: And other occasions: please be consistent using either "1 min" or "one min".

Table 3 a: It is interesting that the sensitivity of the observer is quite low. Would you expect this to be the case with other observers as well (e.g. because of occlusions, low video-quality)?

Table 3 b: last row seems to be incorrect (same results as in a, but n = only 158).

Discussion

L. 150: "Non-RFID systems" is quite broad. At least one example should be given, e.g. what was the sensitivity when Montalcini et al. 2022 validated their low-frequency tracking system with active tags in the same barn?

L. 156: Full stop missing after reference.

L. 158-159: Very useful practical recommendation.

L. 164: In which contexts/cases is this level of accuracy necessary?

L. 176: Not clear what is meant by "…the system's physical and spatial configuration."

L. 180: Are there any results available on this improved design or is the research still ongoing?

L.193: Is the cause only not obvious or can it also not be explained?

L. 196: Is this due to the level of experience etc. of the observer or is it due to the set up (e.g. low video quality, frequent occlusions)?

L. 199: Not clear where the 96% come from. The sentence is also a bit misleading as it suggests that tracking in the litter had a sensitivity of 96%. The concluding statement of the abstract is preferable.