Response to reviewers

Dear Recommander,

Please find here enclosed our revised version of the manuscript “Diversity of performance patterns in dairy goats: multi-scale analysis of the lactation curves of milk yield, body condition score and body weight ” for recommendation in Peer Community in Animal Science. We are grateful to the reviewers for their interesting suggestions that helped us to improve the readability and the quality of our manuscript.

As suggested by the reviewers, we revised our manuscript to clarify English aspects, some terminology used, and improve some elements in the methods and discussion sections.

Sincerely,

Nicolas GAFSI, on the behalf of the authors.

Revision Round #1

Review: anonymous reviewer 2

Comments

The topic of this paper (Diversity of performance models in dairy goats: multiscale analysis of milk production, body condition score and body weight trajectories) is very interesting and with a rather innovative modeling approach to evaluating recordings as milk yield, body weight and body condition score. The dataset on which the study is based is relevant, especially as regards the goat species.
This work analyzes the variability of the curves of milk yield, of body weight, and of body condition score (BCS) of Alpine and Saanen goats during their lifetime, firstly by characterizing their individual curves, then exploring how the different curves of milk yield, body weight, and body condition score are associated between them during the same lactation, and finally assessing the shape of the different curves on successive lactations.
The abstract starts pointing out that “in the French dairy goat sector, low longevity is a key issue leading to higher replacement rate in the herd and poor dilution of does rearing costs. There is a need to better understand determinants of lifetime performance". However, it must be considered that the dataset, although very large, derives from the routine recordings of the variables considered in the study of only two farm realities. This could be seen as a limit, but anyway it is a good starting point.
The conclusions recognize that “further analysis are needed to include reproductive performance in analyzing lifetime performance profiles and better identify profiles or combinations of profiles at risk in terms of culling.” In the introduction it could be emphasize this aspect.

Authors : Rather than in the introduction, we added the following paragraph in the discussion section L824-830: "Our dataset is relatively large and the frequency of measurement of the different variables is high. However, it only reflects the management of 2 farms. The observations made here are a starting point for a better understanding of the relationships between milk production, body condition score and live weight in the goat but will need to be confirmed in various systems. In addition, it will be necessary to add reproductive performance, which is also taken into account when making decisions about culling."

Specific comments

Title
Line 2: for the title I suggest to find another word for substituting "trajectories". The classic term "curves" sounds better. In the whole manuscript "trajectory/ies" appears more then 130 times, therefore it is suggested to reduce this frequency by applying other terms like "curves", for BW and BCS "changes", or "dynamics".

Authors : The title was changed for : "Diversity of performance patterns in dairy goats: multi-scale analysis of the lactation curves of milk yield, body condition score and body weight". Done we changed trajectories by "milk yield curves" and "body weight and body condition score curves" for the whole manuscript.

Keywords
Line 41: It is suggested to change "milk yield trajectories" with "milk yield curves".

Authors : Done.

Line 42: It is suggested to change "body condition score trajectories" with "body condition score changes".

Authors : Done.

Introduction
Lines 76-77: the sentence "It is also …. is impaired (Friggens, 2003)" needs to be explain more clearly.

Authors : We added a sentence L74-77 : ". It is also known that priorities can be modified to cope with nutritional constraints. For instance, most of female mammals will not invest energy in pregnancy during feed shortage (Friggens, 2003)."

Material and methods
Lines 125-128, 136-137: the acronyms for MY, BW, BCS have already been specified, so they should be used.

Authors : Done.

Line 129: the cited paper of Morand-Fehr and Hervieu (1999) is missing in the references section.

Authors : Done.

Line 225: the cited paper of Grossman et al. (1999) is missing in the references section.

Authors : Done.

Line 232 (figure 2): it is suggested to add on the figure the annotation “plateau phase”.

Authors : Done.

Results
Line 358 (figure 4): it is suggested to change the colors of the clusters YpM- and YpH because it’s easy to confound them.

Authors : The color of the YpH was changed.

Line 554, 556, 565, 573, 577, 591: it is suggested to change LUM+ with LUM (without +), and STM+ with STM, in accordance with the fact that the depletion is of medium intensity and not of high intensity. In accordance with this change, also the notes of the figure have to be modified.

Authors : Done

Discussion
Lines 817, 825, 837, 898-900, 915, 918, 953, 981: the references (Gipson and Grossman, 1990; Safayi et al., 2010; Rupp et al., 2011; Waltner et al., 1993; Garnsworthy and Jones, 1987; Garnsworthy and Topps, 1982; Dumont et al., 2020, Inra, 2018; Puillet and Martin, 2017; Poppe et al., 2020) are missing in the references section.

Authors : References were added.

Lines 819-821: It is suggested to give more details regarding the cited paper of Arnal et al. for a better comprehension.

Authors : We added these sentences L839-844: “These clusters, in terms of shape, were close to the mean curve of cluster 2, which represented the most common shape of lactation observed by Arnal et al. (2018) over the French dairy goat population. This cluster 2 represented 39 % of the French dairy goat population, characterized by a marked peak and a medium persistency, i.e. a low persistency for our study because Arnal et al. had an additional atypical cluster with a very low persistency”.

Lines 878-879 (Our … system): it is suggested to add a reference.

Authors : Done

Lines 915-918 (On the …Inra, 2018)): it is suggested to make this sentence clearer; furthermore, please note that the reference to Inra 2018 is missing in the references section.

Authors : We changed the sentence L945-948 for : "On the other hand, this diversity raises questions about feeding systems that assumed a relationship between a BW and a MY curve. There is a need to better quantify body reserves contribution in terms of energy to goat's requirements (Inra, 2018)." And the reference was added.

References
Line 1099: this citation needs to be more precise.

Authors : Done

Review by anonymous reviewer 1

Diversity of performance patterns in dairy goats: multi-scale analysis of milk yield, body condition score and body weight trajectories

GENERAL COMMENTS

Interesting and original paper on the multi scale analysis of productive trajectory of goats, with many interesting insights and innovative approaches to explore the topic.

The English requires a substantial revision. Common problem regards the syntax, with unproper subjects or construction of the sentence, erratic commas and parenthesis. I will give a non-exhaustive list in the specific comments.

Authors : Thank you for your helpful comments. Following your recommendation, the manuscript was reviewed by a native speaker, and we hope that this revised version will enable a better understanding.

There is not information of the prolificacy of the animals, which might have affected all trajectories studies. This information should be considered for each single animal studied, considering that goats can have very high prolificacy. Also, milk fat was not considered (maybe not available), making MY less accurate than could be

Authors : Regarding prolificacy, in our datasets, most of goats had single kid (33%) or two kids (51%). Goats with three kids and more represented only 16%. Unfortunately, this variable presented a high number of missing values leading to 35 % loss of lactation number. Accordingly, we chose to not consider it for cluster analysis. However, to check we did not miss any interesting effect, we projected prolificacy as a supplementary variable in the PCA and we did not see any effect on the clusters. Regarding milk fat, some data are available but with a low frequency (less than one measure per month). Therefore, we chose to not consider this factor. We mentioned these two aspects, prolificacy and milk quality, in our discussion (see lines 936-943 and 982-987)

The is not information on the type of diets used in the two farms. Did they allow individual adaptation of intake to requirements, as it occurs in TMR diets not too rich

in NDF? Were concentrates (some or all) supplied in equal doses at milking, for lactating animals? How was the nutritional level set? By group? Were the diets different between primiparous and pluriparous? Where these categories physically separated or kept together in the same pen?

Authors : During the long period of time for data collection (1996 to 2020), feeding systems in Grignon and Pradel remained stable overall. In Grignon farm, animals received an ad-libitum TMR (10 to 15 % refusal), mainly based on forages (hay, dry lucerne, and beet pulp) and complemented about ,20 % of commercial concentrate and 1 % minerals-bicarbonate. For Le Pradel, the diet is composed of lucerne or sainfoin hay (65%), pasture (11%) and concentrates(24%). Diets were elaborated in accordance with the French feeding system recommendations (INRA, 1997, INRA 2007, INRAE 2018).

Primiparous and multiparous goats are managed together and received the same diet. They are physically separated for some targeted periods (reproduction, kidding).

All the abbreviations regarding the synthetic indicators reported in tables 3 to 6 (e.g. YPl-3..) should be listed in an initial table with a brief description of their meaning. It is hard to follow the text with all those abbreviations.

Authors : An initial table with cluster description was added.

The discussion is kind of weak regarding the reasons that caused disconnected trajectories (see comments for L 893-395 and L 913-921)

SPECIFIC COMMENTS

L37: comma after goats

Authors : Done

L57: Not only the French sector…

Authors : We modified the sentence.

L57: comma after challenges.

Authors : Done

L95 : “were used” should go in line 96 after 2003)

Authors : Done

L97: Here and in the rest of the paper: why do you put a comma before the parenthesis when citing a paper? cut the comma before parenthesis

Authors : Done

L107: why recent? Do we have old studies similar to yours? If yes, why there are not valuable?

Authors : Indeed no previous studies in dairy goats performed analysis like ours so we suppressed the term “recent” in the sentence.

L119: no information on prolificacy of the goats and diets used in the two farms. Any general climatic difference among the two farms

Authors : See answer in the general comments for prolificacy and diets. Interesting remark, there is a difference in terms of climate because one of the Farm is located in North of France (Grignon) and the other is located in the South-Est (Le Pradel). The climate effect was thought taken into account in the farm effect in our analysis.

L 209, 2013, 225: cut the commas, see comment for L97. I will not write this anymore, but there are many citations like this in the whole paper

Authors : Done.

L 249: why did you put the names within parenthesis and not only the year? Does not make sense

Authors : It's a mistake, the format was changed.

L 312: VS is an abbreviation, it should have a dot "VS." Put a comma after WEIGHT

Authors : Done.

L320 BY THE two phenotypic clusters. Which type of clusters, do you mean primiparous and multiparous? WERE, not ARE

Authors : Done. The contingency tables were performed to analyze associations for example between clusters of milk and body weight for primiparous and multiparous goats.

L321 WAS associated

Authors : Done.

L329 comma after association

Authors : Done.

L 517: three clusters is repeated twice

Authors : Done.

L 612: BETWEEN is a comparison of 2 things, among of more than two things. Use AMONG here and in the rest of the text when needed (most of the cases in your paper)

Authors : Done.

L822, 823; comma after parenthesis

Authors : Done.

L827. Comma after CORRELATED

Authors : Done.

L829: I would put AND instead of THEY

Authors : Done.

L830. Comma after PROFILE

Authors : Done.

L850: comma after KG

Authors : Done.

L857 cut FOR

Authors : Done.

L858: put comma before PRIMIPAROUS, put a comma before WHILE. I will stop correction commas, too many wrong ones, but remember that before whereas, while, which is usually needed. Also, many other commas are wrong or, more frequently, missing.

Authors : Done.

L866 THEY need to be..

Authors : Done.

L868: why comma before Sauvant? The sentence is interrupted after BY?

Authors : we modified the sentence L887-889 for : "A breed effect was observed for BW curves: Saanen goats were more represented in the high-level clusters for all parities (W^{p}_{H-}, W^{m}_{H}). They were generally heavier than Alpine goats (Sauvant et al., 2012)."

L 878 THOSE for sternal..

Authors : Done.

L879 cite the French feeding system. Which version?

Authors : Done.

Line 881, 883 DID NOT PLAY

Authors : Done.

L893-895: it might also suggest great diversity in intake (and thus in feed efficiency) more than in energy partitioning, or differences depending on the numbers of kids per parturition. It is also possible that the indicators you considered were not accurate enough to detect consistent patterns. For example, we know that BCS in goats is nor very accurate, precise, and repeatable, being a subjective metho. In addition, goats accumulate a lot of visceral fat when in positive energy balance, and this is difficult to detects by using BCS, which tend to level of even though body fat keeps accumulating

Authors : We modified this aspect in the text L936-943.

L895 cut ASSESSING . Associations AMONG…WERE…

Authors : Done.

L 902: you should explain/describes the four trade-offs, otherwise the citation is useless

Authors : We described these trade-off profiles L922-926: "The first trade-off profile represented cows giving priority to lactation instead of reproduction, the second trade-off profile represented cows giving priority to reproduction instead of lactation. The third trade-off profile represented cows with poor performances in all functions, and the last trade-off profile represented cows with no trade-off among functions".

L909 you should motive more clearly this point. E.g. could be a problem of diet quality that limited intake in some animals?

Authors : We modified this aspect in the text L9310-935: ". Another possible explanation for the lack of strong associations found in our study is that trade-off between life functions, and therefore correlations between traits, are well expressed when animals face feed shortage (Blanc et al., 2006; Friggens et al., 2017). Our data came from two experimental farms where we can assume that animals are well managed and not so constrained in terms of nutrition".

L913-921: not clear to me. Adaptive capacity does not imply that milk yield, BW, and BCS score trajectories are disconnected. In addition, even at individual level the energy balance cannot skip the rule of energetics. Thus, unless measurements are inaccurate (see comments above for BCS; in addition, milk fat might vary a lot at equal MY), trajectories must be connected. Of course, you do not know individual intake, and this might partially explain the disconnection

Authors : We modified this aspect in the text.

L925 . primiparous GOATS

Authors : Done.

L 937 ..speed, so THEY were..

Authors : Done.

L949 : why you did not consider litter size in your study?

Authors : See answer in the general comments

L967 IT RAISED A QUESTION… awkward sentence, not coordinated with the rest of the sentence

Authors : We changed for L1002-1006: "However, because the BW (dataset 1) and BCS data were less frequent (datasets 1 and 2) less elaborate models were used. This then meant that a more simple set of summary indicators was used to characterize these curves, which may not be as informative as those for MY"

L 191-982 awkward sentence

Authors : We modified this sentence L1018-1020 by : "Intense and rapid MY or BW losses might be used as indicators of disease or metabolic disorders. Being able to identify these animals is of great interest for farming management."

L1015 AMONG goats

Authors : Done.

L1099 ????

Authors : Done.

Review by Kristen Reed

The manuscript presents a very interesting and novel approach to using time-series data on milk yield and body-weight measurements from dairy goats to group animals into different categories based on their energetic partitioning.

I believe this work will be a valuable contribution to the literature and would like to spend more time reading and reviewing it. However, given the current constraints on my time I can only offer a partial review and hope the feedback I have at this point will be useful and that we can continue the conversation in the future. I also hope that the authors might be able to make some changes that would help improve the clarity of the manuscript for myself and future readers.

I have attached a PDF with some specific comments but here are couple of general comments/suggestions:

- I think the methodology section would benefit from moving some of the details of the data collection, and curve fitting to an appendix or supplementary

material and more description of the clustering, PCA methods, and how the authors used that information to achieve their objectives. My understanding at this point is that it is those two methods for distilling the information and grouping animals into clusters or profiles followed by how the authors analyzed the results of those clusters that allowed the authors to get to results like those in Figures 7-9. However, these methods are not well described.

Authors : We recognize a lack of clarity about description of the clustering approach, so we tried to improve the quality of this part. However, we decided to keep the data collection and curve fitting in the manuscript because we think that if we put these parts in a supplementary material, the paper will lose of understanding, before submission we've already simplified the methodology and kept the essential parts.

- I suggest considering changing the use of the term 'trajectory'. This word includes an aspect of forward movement and implies an analysis of what will happen in the future. However, as I understand it at this point, this is a retrospective analysis of the correlations between the patterns in different performance metrics as summarized by lactation and growth curves. Perhaps something as simple as 'patterns' or 'behaviors' would be a better choice for this analysis since you are not predicting what will happen to animals in the future.

  Authors : We agree with this suggestion, another reviewer also suggested to change the term. So we decided to use curves for milk and change for body weight and body condition score.

Here we addressed answer to your specific comments

ABSTRACT :

L31 : Is this cluster changes of individuals between parities? If clusters are defined for each parity it is not entirely clear to me how it is identified that a cluster in one parity is the same or different from a cluster in another parity.

Authors : Indeed it is cluster change of individuals between parities. Our statistical unit is the lactation. So after clustering process, to each lactation is attributed a cluster (e.g., the goat X in parity 1 was in the cluster YpL+ ..). For example, for MY the clustering was performed by parity group the clusters for primiparous are different than those for multiparous. But for multiparous clusters are the same but a goat in parity 2 that was in the YmM- can change to another cluster in parity 3 etc..

L32 : Suggest change to numerals (4 and 3)/ The meaning of profiles is not entirely clear at this point. Can you use a different word or provide a definition prior to use in the abstract?

Authors : Done for the numerical change. We changed profiles to keep cluster.

IMPLICATIONS :

L45 : This is a new term for me. After a quick google I think I have a vague understanding of what is meant by it but perhaps different wording would be a better choice for animal science audience

Authors : We changed for “Sustainability”.

L45 :...finding managment strategies that improve animal robustness and efficiency...?

Authors : We changed by your suggestion.

L46 : I think that the term robust implies a wider range of characteristics than the production based qualities that you focused on in this study. For example, heat stress tolerance, reproductive efficiency, and metrics of health/disease tolerance should be considered to characterize animals as robust. I suggest changing this wording to be more specific to your work and then you can bring in this term when discussing future work.

Authors : We agree that robustness is a complex trait, based on many underlying components, like those ones you cited. We modified the text accordingly (see lines 43-46) to explain that we address one feature of robustness. In our study, robustness is addressed through the ability of an animal to adapt to nutrition challenge, while maintaining milk production. Our study investigated the variability of the adaptation strategies among goats in two farms.

INTRODUCTION :

L84 :I have not heard of this term used as a class or type of models. Can you please clarify?

Authors : We changed for mathematical models

L101 : This phrase is not clear for me. In particular, it does not make senset ot e to have a sequence of trajectories because term phenotypic trajectory implies the path followed by the animal over their lifetime. Perhaps the word 'trajectory' can be replaced here by 'pattern' if the authors mean to say that they are studying the sequence of phenotypic patterns during different life stages over the course of the animal's lifetime?

Authors : Another reviewer pointed out this term “trajectory”, so we changed for curves.

METHODS :

Dataset : I suggest moving the detailed description of the datasets to supplementary materials and providing a summary table of the dataset that includes summary statistics of production and managment factors

Authors : See the answer in the general comments

L127-128 : When was the BW measured?

Authors : BW was measured one time per month for Le Pradel farm, this was corrected in the manuscript.

L234 Fig 2 : Please ensure all variable names are defined

Authors : Done.

L258 Fig 3 : Please ensure all variable names are defined

Authors : Done.

Table 2 : I suggest moving the superscript #2 to the column title 'Indicator' and providing definitions of alll variables

Authors : Done for the superscript #2. Done.

L307-308 : Suggest removing this statement. It is clear from the rest of the description

Authors : Done.

L310-311 : How was the strength of these factors determined?

Authors : For parity, when we kept all groups of parities together for MY and BW, some clusters contained more than 75 % of primiparous or multiparous. For BCS primiparous and multiparous were well distributed among clusters. For Breed and Farm, they were globally well distributed in each cluster.

L315 : What were you assessing for differences between clusters? MY? The synthetic metrics in Table 2?

Authors : to characterize the difference between clusters, ANOVA was performed on synthetic indicators that were used to create the clusters and reported in table 3.

L319-325 : Sorry but I do not understand what this sentence is trying to convey

This part of the methodology needs more clarification for me. Can it be represented by equations?

Combinations of profiles that do what?

Authors : We reformulated the paragraph L317-329 and we hope it will improve clarity. This paper counts a lot of descriptive methods. "To assess the associations between MY, BW and BCS curves at the lactation scale, we produced two-way contingency tables. After clustering, each lactation was assigned a MY, BW or BCS cluster. A contingency table summarized the conditional frequencies of two clusters (e.g., MY and BW clusters). It was used to assess if a cluster membership for a given phenotypic curve was associated to a particular cluster membership for another phenotypic curve, i.e. it showed how these two clusters were dependent on each other. MY, BW and BCS records concerned different numbers of lactations, so each contingency table (e.g., MY with BW or MY with lumbar BCS) considered different sub-populations. Chi-squared tests were performed to assess for associations, between phenotypic curves. Cramer's V test was performed on significant associations to evaluate the strength of the associations. Cramer's V values ranged from 0 to 1. Values close to 1 indicate a strong association, whereas values close to 0 indicate a weak association."

RESULTS

L385 Fig4 : How were the average and 'paragon' lactation curves identified? Please definie a paragon trajectory

Authors : we calculated the mean production for each day of lactation, from 0 to 300 days, for each cluster, based on all individual lactations assigned to the given cluster (YpL+,YpL-…).. The paragon was the most representative goat for a cluster and it was obtained after clustering with FactoMineR package in RStudio.

Providing the description for how the clusters were assigned these names in the methodology would benefit the reader

Authors : We added this description in table 3 title

L395 : The jumps bewteen the terms profiles and clusters are difficult to follow

Authors : We kept only cluster terminology in the whole manuscript.

L436 : Suggest referring to this as parity group since multiparous animals include multiple parities

Authors : Done.