Dear Dr. Machado,

Thank you for your remarks and suggestions. We have modified the text accordingly. Please find below each point addressed.

I have noticed some spacing and a lack of capital letters in the abstract; please reread it you will find it

All typographical errors have been corrected.

Line 31: Please add a citation to the end of the sentence

We added the corresponding citation: « (Sicard et al., 2021b) »

Line 36: Also, a citation after the mention of AI would be helpful

We added the corresponding citation: « (Picault et al. 2019) »

I would also suggest you remove the many ..etc. from your examples it is not necessary, you could use, e.g., to represent that those are examples but not limited to that list

Thank you for this relevant remark. All instances of 'etc' or ellipses have been replaced with 'e.g.'

Line 80: When you describe the levels in which you say fine-grained level, it would be useful if you could add a figure here to represent all levels you have included in your model

We added a specific figure (Figure 1) to represent explicitly the different levels involved in the model and their relationships.

Line 105: For the physiological states you have fixed it, is it possible to comment on the possibility of varying it around a mean value, given that production is never perfectly dated?

We modified the sentence to integrate the possible modularity of statuses (l. 110):
"In the field, the duration spent in different states may vary, especially due to variations in parturition timing. These variations can occur within a time window of two days, either before or after the predicted date. However, the practice of all-in-all-out remains observed on farms. This means that the timing of animal movement can be deterministically scheduled in the model.".

Line 113: It would help to have a diagram showing how rooms were divided to see where the direct and indirect transmission forces act.

We added a specific figure (Figure 4) to represent physical adjacence of the pens in rooms with network contact. This Figure allows for better understanding of the different transmission forces.

While Figures 4 and 5 are useful for EMULATION user, adding a diagram with it would make this more friendly for no-EMULATION users.

We modified Figures 4 and 5 into a single figure (Figure 3) to be more explicit. The YAML description has been moved to the supplementary material section. This adjustment makes it easier to focus on the diagrams.

In your pen-level network, nodes were metapopulation or agents?

In the pen-level network, the nodes represent the pens themselves, which are represented as an agent within the simulation architecture. These "pen" agents store information about number of infected individuals among all individuals located in its space. This specific information represents a portion of the pen's population, which is not, strictly speaking, a metapopulation.

For all scenarios, the introduction of the infected gilt was at the same pen? If not, could up please describe, if no, where was this pen located in the barn?

Indeed, this aspect needed to be explicitly specified, and it has been addressed it in the text (l. 203): "The virus was introduced through an infected sow in batch 1, at the beginning of the third reproductive cycle of the batch, assuming the introduction of an infected gilt into the system (294 days). In terms of the allocation process, the gilt was assigned to litter 1, indicating its location in room 1, pen 1 within the gestating sector."

Line 238: You say several studies and cite only one; please cite more

In fact, the citation refers here to the state of the art, which reports studies about the spread of different pathogens in pig production units. We modified the text as follow for better clarity (l. 257): "A literature review highlighted the role of mathematical models as tools for improving the understanding of viral infection spread in pig production units (Andraud and Rose, 2020)."

Line 240: Also missing appropriate citations
Line 264: Also missing citation

We added the appropriate citation (l.261): "(Reynolds et al., 2014; White et al., 2017; Andraud et al., 2008; Salines et al., 2020)"

Dear reviewer,

Thank you for your suggestions and comments, we have carefully followed them. Hereafter, we will develop each point and refer to the modified section in the manuscript.

Introduction

14- The
19 – Avoid acronyms in the abstract or define SEIR.

We defined acronyms and corrected other clerical errors.

30 - Develop shortly the concept of multi-level agent-based modelling or add a reference

We chose not to delve into multi-level agent-based modelling concepts but instead refer to an article that develops this point, as you suggested. We added the citation -l.31): "(Sicard et al. 2021b)"

34-37 – This sentence is not very understandable for me, especially the contributions of "Artificial Intelligence methods". It might be better to rephrase.

Je ne sais pas trop comment reformuler, ça me paraissait clair...

38-40 – Based on EMULSION software ?

We provided a clarification on this matter in the text (l.38): "In a previous study, we first developed a model of swine influenza A in pig farms, highlighting the impact of the spatio-temporal structure of the herd on the transmission dynamics and its impact on virus spread and control based on EMULSION extended with an organizational pattern (Sicard et al., 2021a)."

43-46 – Is this the purpose of this study or is this a previous project? If it is the purpose of this study, it would be better to add this sentence to the end of the section.

This point was clarified (l.42): "Therefore, the present study aims to account for the interplay between infectious dynamics, clinical consequences, and management practices"

52-55 – MLABS are an evolution of ABS models ? These models are included in EMULSION framework? The relationship between these approaches is not clear for me.

Actually, these elements are explained in Picault et al. 2019. MLABS are parts of ABS, they provide a multi-level approach in the ABS. We added the citation « (Mathieu et al., 2018) » at line 56 to provide more explicit information. The framework EMULSION is specifically based on MLABS.

67 – Specify that in this article the scenarios tested are on the management policy of breeding sector (reassignment / sow grouping).

We clarified this point in the text (l.65): "We propose a prototype model architecture accounting for the complex interplay between pathogen transmission dynamics and consequences of clinical cases on herd management, by coupling a mechanistic multi-level agent-based modelling approach (EMULSION framework) with specific organizational considerations, including exceptions in management practices re- lated with clinical consequences of infections in reproductive sows. The

EMULSION modelling framework enables the specification of different scenarios by varying the population dynamics in the breeding sectors (e.g. batch management, exceptions). These scenarios were used to assess the impact of clinical outcomes of infectious diseases on population and transmission dynamics at the herd level. We illustrate this approach through a PRRSv-like disease spreading in a fine-grained realistic pig farm model"

Materials and Methods

70-73 – Perhaps these 2 sentences are more suitable as an introduction for the presentation of EMULSION?

We moved the two sentences to the end of the introduction to introduce EMULSION.

74 – Population dynamics section ?

We add a section « Model overview ».

75 – It would be better to rephrase, by avoiding use of ().

Thank you, we rephrase the lines to be smoother flow (l.75): "The management of the involved batches aligned with the procedures described in (Sicard et al., 2022), such as sector allocation according to physiological state durations. To represent the clinical reproductive consequences of infections in sows, a probability of insemination failure was considered, leading to potential batch downgrading for infected sows. Infection consequences were modulated upon different periods of gestation with specific impacts on the health status of piglets at birth, including abortions, vertical transmission, and maternally derived antibodies delivery. Furthermore, the model was able to represent batch management at a fine-grained level, encompassing both litter and pen levels (Fig. 1), thus providing the ability to represent zootechnical practices such as adoptions, pig gathering procedures, and sow renewal process."

101 – The information is already written line 97.

The sentence was removed

105 – insemination (24 days) à 34 days (Figure 2).

The duration has been corrected to 34 days (Figure 3).

Figure 2 it might be useful to represent the culling stage or the impact on the cycle of insemination failure. Figures 2 and 3 could be combined into one.

We have combined figures 2 and 3 and integrated the population dynamics, including insemination failure.

Figure 4 is not really exploited in the text. Is it relevant? Or perhaps add as supplementary material.

Figure 4 belongs in the supplementary material section.

121 - The tested approach does not consider the possibility of performing adoptions between litters in the same "batch" (or between batches ?)

We clarified this important point in the text (l.303): "We did not consider the potential for adoption between litters, whether within the same batch or from different batches. However, this aspect could be a topic for future research."

122 – 18 pens per batch and per organizational level ? (insemination / gestating / farrowing ?). The relationship between 29 sows at initialization and the organizational level of 18 pens is not clear for me. It could be interesting to add this information on Figure 2.

This point was clarified by the addition of the Figure 5, and by including clarification in the text (l.130): "The pen organization level included determining the number of pens required to accommodate all sows in case of overcrowding due to insemination failures or gestation-related abortions in other batches (Figure 1)"

140 - How does the model arbitrate between the replacement of a culled sow and a dead sow? Are gilts used primarily to replace dead sows and then culled sows? More generally, how is the sow mortality rate simulated/managed?

We added (l.150): "Sow replacement was managed as follows: a sow with parity rank higher than 5, or after two unsuccessful inseminations, could be culled. The adjustment of the number of sows was evaluated regardless of the reason for replacement, due to culling."

Figure 5 is not cited in the text.

As for the figure 5, its place is in the supplementary material section.

150 – inseminate status is different than inseminationStatus ? and X days ? gestation control is not performed at fixed duration after insemination ?

InseminationStatus is the name of the state machine, where 'inseminate' represents the status of this machine. This distinction was clarified in the text (l.159). The duration marked as 'X' was corrected to '42'. The issue was fixed, and the various corrections in the text contributed to a clearer understanding of this aspect.

151 – How "proba_failure_ins" is determined ?

The probability of insemination failure was based on expert opinion.

159 – This information is not represented in Figure 3.

It was a referencing mistake. This information is now available in Figure 5, which has been remade.

157 – 160 It would be necessary to further explain the 2 machine states : health_state and maternal_immunity or to refer to a previous article.

Indeed, with the new figures of the state machines and their respective associated text, the two state machines are more explicit.

Table 1 – "Duration in M" is related to duration of state M ?

This point is now clearer with explanation provided in the text above.

163 – Add a sentence to explain the choice of the 3 other parameters.

We added an explanation about parameters (l.173): " Parameter β_{ind} represented the rate of transmission resulting from occasional contacts between individuals from adjacent pens. Parameter β represented the direct transmission between individuals. Parameter γ corresponded to the recovery rate, i.e., the rate at which individuals become recovered (R). The duration in state M was distributed according to a gamma distribution, after which pigs became fully susceptible."

166-167 – A Figure to illustrate could be useful.
168 – Is it related to the "nodes" cited in legend of Figure 5 ?

We added the new Figure 4.

186 – And abortion ?

The term "abortion" was missing in the text, is has now been corrected.

Table 2 – In results section, you are not using the scenario numbers but rather the Bind parameter. Add for each scenario tested, the corresponding parameter.

We refined the naming of the scenarios in the results section (e.g., scenario 1, scenario 2, etc.), and added descriptions of these scenarios to ensure consistency and accuracy across both sections

Results

Results Section – Named the corresponding scenarios

195 – One room per batch is related to "All-in-One grouped sows" ? it is not described in the 4 scenarios.
Figure 6 – Named the corresponding scenario number – For the time scale, explain that it is the number of days since the beginning of the simulation (or start at 0 = day of infection to be consistent with the text).

The caption of Figure 6 has been updated.

Discussion

I think the Discussion part needs to be improved. In my view, the choices of model parameters are not discussed clearly enough.

With all modifications made to the overall text, this point is now more clearly addressed and addresses your remark.

It might be interesting to discuss the robustness of the modeling approach (related to RFF), and in particular its sensitivity to the various parameters tested.

We added this paragraph to specifically address the robustness of our approach (l.254): "The integration of AI methodologies into epidemiological modelling, including simulation architecture and knowledge representation methods, extends the capabilities of epidemiological models. This approach, through MLABS enhanced with organizational concerns (OMLABS), allows for the

representation of mechanisms previously unconsidered in the field. OMLABS allows the study of various scales in a single simulation, facilitating a detailed analysis of the impact of each level in the overall dynamic. This, in turn, allows for a focused identification of effective measures and provides specific recommendations for action."

I think it would be interesting to discuss more about the contributions of this model compared to the one tested on Influenza A.

The model dedicated to the Influenza A virus did not take into account the clinical aspects. This key difference was highlighted in the objectives of the study. Consequently, we did not elaborate on this aspect further in the text.

230 – Maybe, discuss more the contributions of AI based approach to model interplay between herd organization and disease dynamics (or refer to previous article).

To address the contribution of AI approaches to epidemiology, we added the citation : « (Ezanno et al., 2020 »

261 - I am not an epidemiologist and therefore it may be linked to my lack of understanding, but from my point of view the "indirect contact rate" parameter is not sufficiently explained in the scenarios.

Indirect transmission parameter reflects the airborne transmission route (l.268)

262 - Are the number of infected animals and the transmission dynamics presented representative of the information available in the state of the art?

At this stage, the results are purely theoretical. The study's goal was to evaluate the consequences of infections, taking into account the interplay between clinical outcomes and population dynamics. Utilizing our framework, we demonstrated how this interplay can influence transmission dynamics at the herd level. This underscores the need to delve deeper in this direction, incorporating both disease-related deviations in husbandry practices and structural changes in population dynamics, such as cross-fostering and pig gathering methodologies. Subsequently, we could represent herd-specific structures and assess transmission dynamics using actual data.