Modelling interactions between farmer practices and fattening pig performances with an individual-based model

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Figure S1 Class diagram of the model representing the interaction between animals, farm infrastructure and farm management. Dotted arrows represent information flow; Diamond arrows represent a composition relationship (i.e. the herd is composed of one or several batches); Lines represent binary association (i.e. One fattening room contains one batch)

Table S1 Example of input parameters used to perform a simulation with the fattening unit model.

|  |  |  |  |
| --- | --- | --- | --- |
| Name of the input | Value | Unit1 | Comments |
| Batch management | 21 | Day | Interval between the arrival of two batches on the farm |
| Number of pigs per place | 1 | Pigs/place | Number of pigs per place in a room |
| Shipment decision | 50 | Pigs | Minimum number of pigs detected ready to be sent to the slaughterhouse to schedule a shipment |
| Minimum weight range | 105 | Kg | The lower boundary of the part with the higher premiums in the slaughter weight range for carcass payment |
| Maximum weight range | 134.6 | Kg | The upper boundary of the part with the higher premiums in the slaughter weight range for carcass payment |
| Minimum optimal weight range | 111..5 | Kg | The lower boundary of the part with the maximum premiums in the slaughter weight range for carcass payment |
| Maximum optimal weight range | 127 | Kg | The upper boundary of the part with the maximum premiums in the slaughter weight range for carcass payment |
| Average daily gain estimated | 0.8 | Kg | Average daily gain estimated by the farmer to detect pigs that will be in the slaughter weight range the day of the shipment |
| Delay between counting and shipment | 10 | Days | Number of days between the counting of pigs and the shipment associated |
| Delay between pig selection and shipment | 3 | Days | Number of days between the selection of pigs and their shipment |
| Delay between two countings | 7 | Days | Numbers of days between two countings for scheduling shipments |
| Tolerance at shipment | 0.02 | Dmnl. | Rate of the number of pigs counted |
| Day of counting | Lundi | Dmnl. | Name of the weekday at which the countings are performed |
| Pig allocation to pens | 1 1 1 1 1 | Dmnl. | Practices to allocate pigs in pen (0: randomly; 1: by weight; 2: by gender; 12: by gender and weight). One practice per room. |
| Number of fattening rooms | 5 | Rooms | Number of fattening rooms in the farm |
| Number of pens per room | 20 20 20 20 20 | pens | Number of pens in each fattening room |
| Area allocated per pig | 0.65 0.65 0.65 0.65 0.65 | m² | Area allocated to each place of a pen |
| Number of places per pen | 20 20 20 20 20 | Places | Number of places in the pens of each room |
| Buffer room | 1 | Dmnl. | Use of a buffer room (0: no; 1: yes) |
| Area allocated per pig in the buffer room | 0.65 | m² | Area allocated to each place of the buffer room |
| Capacity of the buffer room | 0.05 | Dmnl. | Rate of the total number of places in the farm to calculate the number of places in the buffer room |
| Maximum time kept in the buffer room | 21 | Days | Maximum number of days that a pig is kept in the buffer room |
| Feed file | Aliment.rec | Dmnl. | Name of the file containing the information of the feed compositions. It is created using InraPorc®. |
| Feed sequence plan file | SepAliP.rec | Dmnl. | Name of the file containing the information of the feed sequence plans. It is created using InraPorc®. |
| Feed rationing plan file | RationP2.rec | Dmnl. | Name of the file containing the feed rationing plans. It is created using InraPorc®. |
| Profiles file | ProfilP2.rec | Dmnl. | Name of the file containing the profile used in the simulation with the use of one profile for all pigs |
| Choice of a feed rationing plan | Ad libitum | Dmnl. | Name of the feed rationing plan that will be used in the simulation in the fattening rooms |
| Choice of a feed sequence plan | Bi-phase AB | Dmnl. | Name of the feed sequence plan that will be used in the simulation in the fattening rooms |
| Level at which the plans are applied | 1 | Dmnl. | Level at which the pig performance are used for application of the feed sequence and rationing plans (0: room; 1: pen; 1: individual) |
| Choice of a feed rationing plan in the buffer room | Ad libitum | Dmnl. | Name of the feed rationing plan that will be used in the simulation in the buffer room |
| Choice of a feed sequence plan in the buffer room | Bi-phase AB | Dmnl. | Name of the feed sequence plan that will be used in the simulation in the buffer room |
| Average profile | Croissance std precoce | Dmnl. | Name of the profile used when the simulations is made with the same profile for all pigs |
| Female profile | Gilt\_moy | Dmnl. | Name of the average animal profile used for gilts |
| Male Profile | Barrows\_moy | Dmnl. | Name of the average animal profile used for barrows |
| Density effect | 1 | Dmnl. | Impact of the density of pigs in pen on feed intake (0: no; 1: yes) |
| Desinfection period | 3 | Days | Numbers of days for cleaning and disinfection between the emptying of the room with the last shipment of the batch and the arrival of a new batch in the room |
| Variability | 1 | Dmnl. | Representation of the variaibility in the model (0: one profile for all pigs; 1: all pigs have different profiles; 2: use of one average animal profile for gilts and one average animal profile for barrows) |
| Male profiles file | ProfilP2-males.rec | Dmnl. | Name of the file containing male profiles used in the simulation |
| Female profiles file | ProfilP2-femelles.rec | Dmnl. | Name of the file containing female profiles used in the simulation |
| Quantity coefficient | 1 | Dmnl. | Rate applied to the feed intake calculated using the adapted InraPorc model to change the intake of pigs  |
| Nitrogen coefficient | 1 | Dmnl. | Rate applied to the nitrogen intake calculated using the adapted InraPorc model to change the intake of pigs |
| Amino acid coefficient | 1 | Dmnl. | Rate applied to the amino acid intake calculated using the adapted InraPorc model to change the intake of pigs |
| Phosphorus coefficient | 1 | Dmnl. | Rate applied to the phosphorus intake calculated using the adapted InraPorc model to change the intake of pigs |
| Mortality | 0.03 | Dmnl. | Mortality rate corresponding the the mean mortality in a batch over the whole fattening period |

1 Dmnl., dimensionless

Table S2 Parameters used in the life cycle assessment in the model.

|  |  |  |
| --- | --- | --- |
| Parameter | Value | Unit |
| **Fattening unit** |  |  |
| Climate change impact of feed A | 0.6958 | kg CO2-eq./kg of feed |
| Climate change impact of feed B | 0.4871 | kg CO2-eq./kg of feed |
| Acidification potential of feed A | 7.19 | g SO2-eq./ kg of feed |
| Acidification potential of feed B | 6.62 | g SO2-eq./ kg of feed |
| Eutrophication potential of feed A | 3.827 | g PO4-eq./ kg of feed |
| Eutrophication potential of feed B | 3.345 | g PO4-eq./ kg of feed |
| Cumulative energy demand for feed A | 6.8472 | MJ/kg of feed |
| Cumulative energy demand for feed B | 5.049 | MJ/kg of feed |
| Land occupation for feed A | 1.3442 | m²y/kg of feed |
| Land occupation for feed B | 1.1679 | m²y/kg of feed |
| **Farrowing unit** |  |  |
| Climate change impact for lactation feed | 0.59 | kg CO2-eq./kg of feed |
| Climate change impact for gestation feed | 0.39 | kg CO2-eq./kg of feed |
| Acidification potential of lactation feed  | 6.57 | g SO2-eq./ kg of feed |
| Acidification potential of gestation feed | 4.73 | g SO2-eq./ kg of feed |
| Eutrophication potential of lactation feed | 3.64 | g PO4-eq./ kg of feed |
| Eutrophication potential of gestation feed | 3.22 | g PO4-eq./ kg of feed |
| Cumulative energy demand for lactation feed | 5.35 | MJ/kg of feed |
| Cumulative energy demand for gestation feed | 3.49 | MJ/kg of feed |
| Land occupation for lactation feed | 1.31 | m²y/kg of feed |
| Land occupation for gestation feed | 1.34 | m²y/kg of feed |
| Number of piglets weaned per sow per year | 28.9 | Piglets/sow/y |
| **Post-weaning unit** |  |  |
| Climate change impact for phase 1 feed | 1.03 | kg CO2-eq./kg of feed |
| Climate change impact for phase 2 feed | 0.77 | kg CO2-eq./kg of feed |
| Acidification potential of phase 1 feed  | 7.5 | g SO2-eq./ kg of feed |
| Acidification potential of phase 2 feed | 7.1 | g SO2-eq./ kg of feed |
| Eutrophication potential of phase 1 feed | 4.1 | g PO4-eq./ kg of feed |
| Eutrophication potential of phase 2 feed | 4.2 | g PO4-eq./ kg of feed |
| Cumulative energy demand for phase 1 feed | 6.97 | MJ/kg of feed |
| Cumulative energy demand for phase 2 feed | 6.75 | MJ/kg of feed |
| Land occupation for phase 1 feed | 1.42 | m²y/kg of feed |
| Land occupation for phase 2 feed | 1.44 | m²y/kg of feed |
| Mortality rate in post-weaning unit | 2.4 | % |

Table S3 Economic data used in the model.

|  |  |  |
| --- | --- | --- |
| Data | Value | Unit |
| **Fattening unit** |  |  |
| Cost of feed A | 265.70 | €/feed ton |
| Cost of feed B | 194.60 | €/feed ton |
| **Farrowing unit** |  |  |
| Cost of gestation feed | 206.35 | €/feed ton |
| Cost of lactation feed | 247.53 | €/feed ton |
| **Post-weaning unit** |  |  |
| Cost of phase 1 feed | 434.06 | €/feed ton |
| Cost of phase 2 feed | 290.33 | €/feed ton |

Table S4 Diet composition of feeds A and B used in the two-phase and ten-phase feeding strategies in the simulations.

|  |  |
| --- | --- |
|  | Feed |
|  | A | B |
| **Ingredient (g/kg of feed)** |  |  |
|  Wheat | - | 155.5 |
|  Maize | 471.3 | 500.0 |
|  Barley | 298.7 | 162.5 |
|  Wheat bran | - | 100.0 |
|  Rapeseed meal | 30.5 | 55.5 |
|  Soybean meal | 164.7 | - |
|  L-Lysine HCL | 5.3 | 2.7 |
|  L-Threonine | 2.2 | 0.4 |
|  L-Tryptophane | 0.7 | 0.2 |
|  L-Valine | 0.4 | - |
|  DL-Methionine | 1.4 | - |
|  Phytase  | 0.2 | 0.1 |
|  Monocalcium phosphate | 4.2 | - |
|  Salt | 3.6 | 3.6 |
|  Calcium carbonate | 11.8 | 14.5 |
|  Vitamins and mineral supplements | 5.0 | 5.0 |
| **Nutritional level (per kg of feed) 1** |  |  |
|  Net energy (MJ) | 9.8 | 9.8 |
|  SID Lys (g) | 10.5 | 5.1 |
|  Crude protein (g) | 161.8 | 110.0 |

1 SID Lys: standard ileal digestible lysine