Association Française de Zootechnie

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Prediction of the daily nutrient requirements of gestating sows based on behavioural sensor data and machine-learning algorithms

M. Durand[1], C. Largouët[2], L. Bonneau[2], J.Y. Dourmad[1], C. Gaillard[1]

[1]*PEGASE, INRAE, Institut Agro, 35590, Saint Gilles, France*

[2]*Institut Agro, Univ Rennes1, CNRS, INRIA, IRISA, 35000, Rennes, France*

Context

Monitoring of animals for multiple benefits

Environmental perturbations

Perception → Evaluation → Reaction

Variability of responses

Measured

Sensors or connected tools

Large amount of data

Durand M., Largouët C., Bonneau de Beaufort L., Dourmad J.Y., Gaillard C., 2023. *A dataset to study group-housed sows' individual behaviours and production responses to different short-term events. Animal Open Space*, 2, 100039

Identify changes in welfare status

Durand M., Largouët C., Bonneau de Beaufort L., Dourmad J.Y., Gaillard C., 2023. *Prediction of gestating sows' welfare status based on machine learning methods and behavioural data. Sci. Rep., 13, 21042*

Identify changes in behaviour

Durand M., Dourmad J.Y., Julienne A., Couasnon M., Gaillard C., 2023. *Effects of a competitive feeding situation on the behaviour and energy requirements of gestating sows. Appl. Anim. Behav. Sci.*, 261, 105884

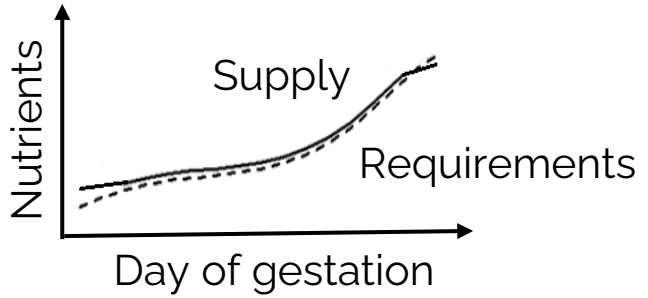
Identify changes in nutrients requirements

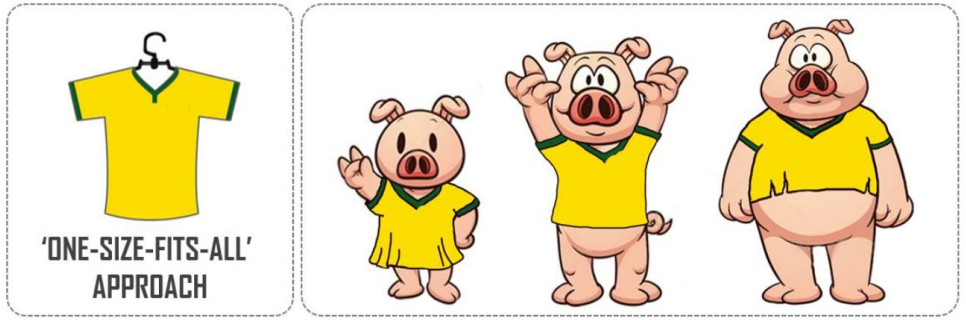
Durand M., Largouët C., Bonneau de Beaufort L., Dourmad J.Y., Gaillard C., 2023. *Prediction of daily nutritional requirements of gestating sows based on sensors data and machine learning algorithms. J. Anim. Sci.*, 101, skad337

Context

Precision feeding for gestating sows

Precision feeding aims to bring the proper amount of feed with the suitable composition to be supplied in a timely manner to individual animals (Pomar *et al.*, 2009).





Reduction of underfed and overfed animals

Decrease of nitrogen excretion by 18 % ans phosphorous by 9 %

Decrease of lysine intake by 25 % and phosphorous by 8 %

Crédit Photo : Remus *et al.*, 2019 ; Durand *et al.*, 2021 ; Gaillard *et al.*, 2022

Aim of the study

InraPorc®

ME SID Lys

Mechanistic model designed for precision feeding of gestating sows: daily metabolizable energy and standardized ileal digestible lysine requirements for each sow

Difficulty of using the model to estimate requirements → **Search for a new method made possible by the development of sensors**

Explore and evaluate the prediction of individual daily nutrient requirements, using data measured by sensors and machine learning algorithms

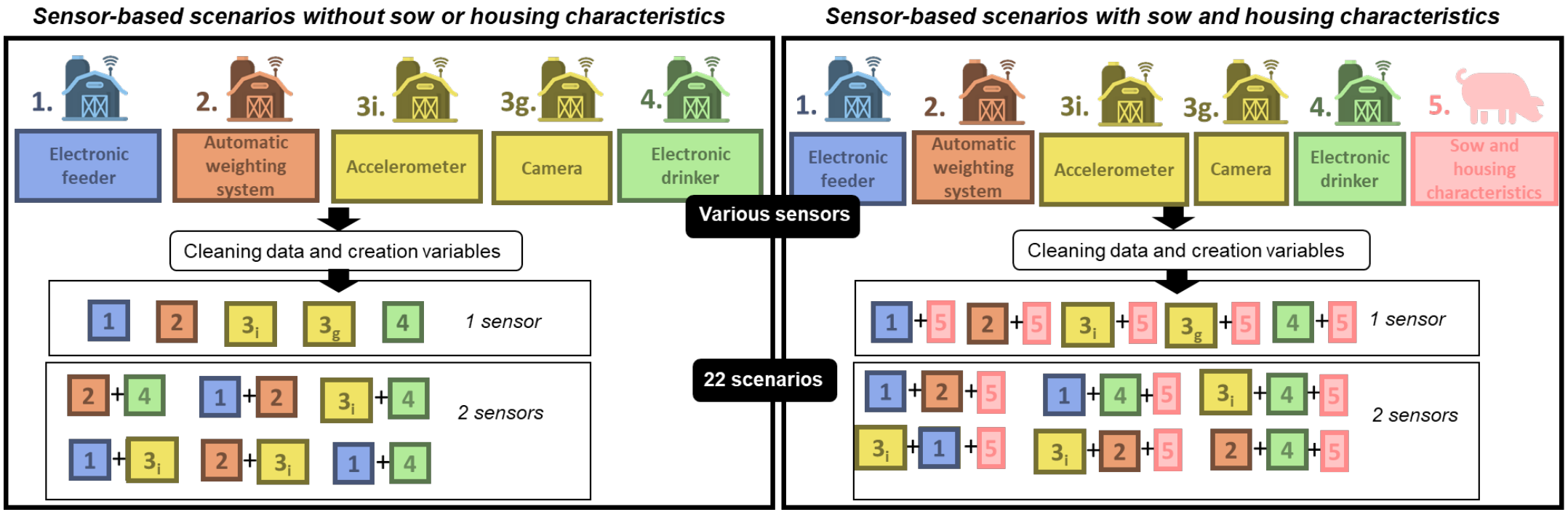
73 gestating sows (4 batches)

9 machine-learning algorithms

Various digital farm configurations (electronic feeder, drinker stations)

Material and methods (1/2)

Step 1: Scenarios definition



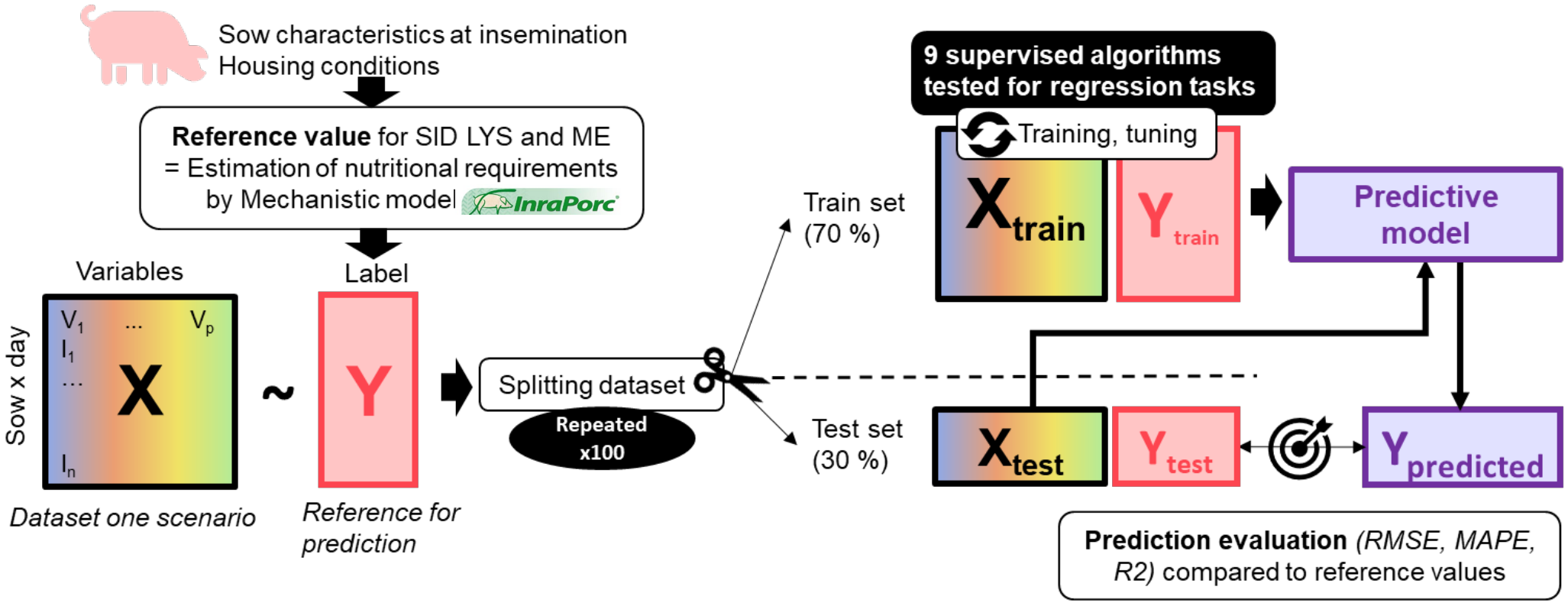
Material and methods (2/2)

Step 1: Scenarios definition

10 Scénarios
Sensors + Sow & housing characteristics (SP.)

10 Scénarios
Sensors data only (S.)

Step 2 : Prediction of nutrients requirements with 9 machine learning algorithms



Main results (1/3) : best equipments

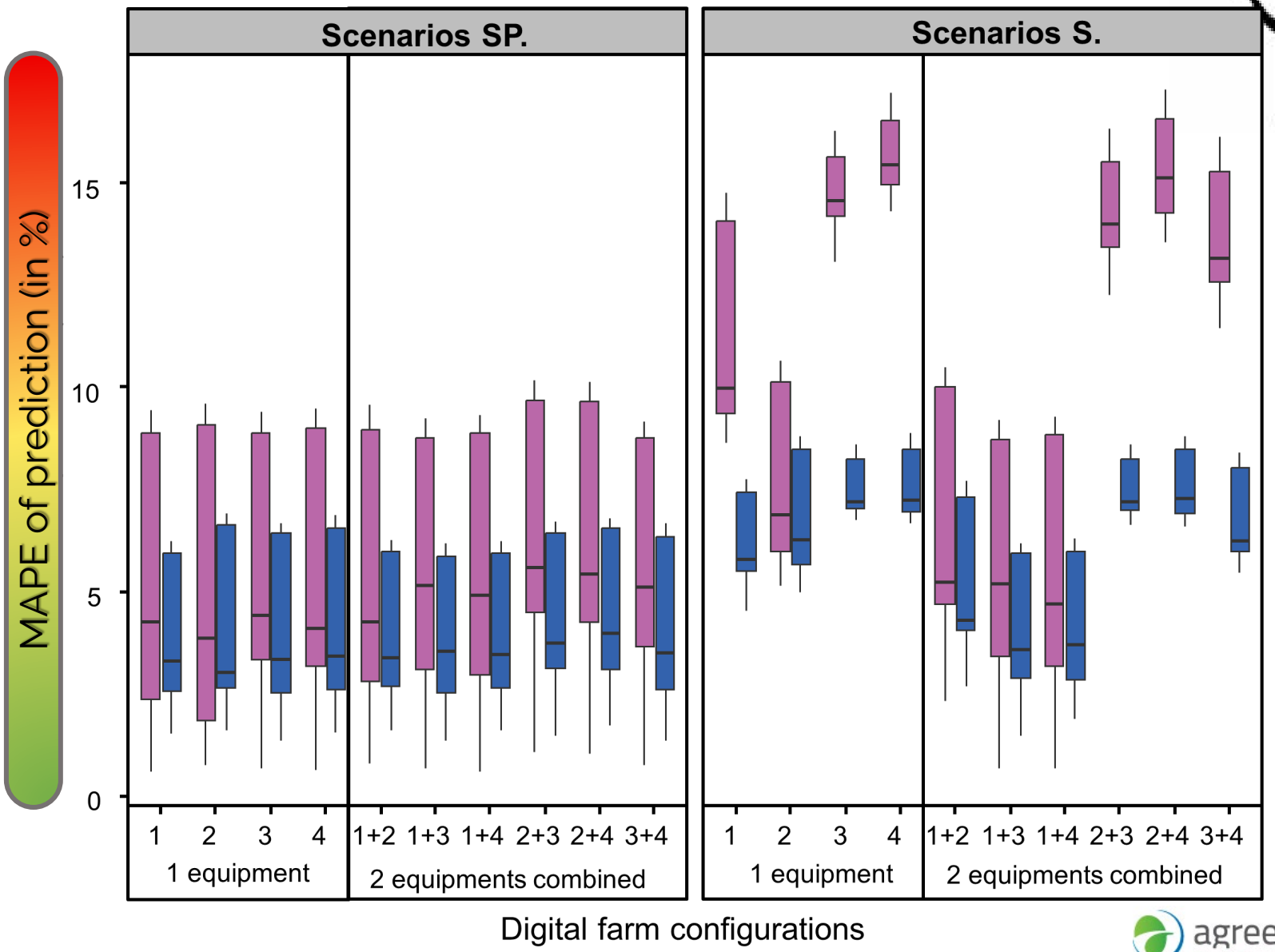
Metabolisable energy

Best performance obtained for scenarios with **electronic feeder alone** (R^2 = 0.74) **or combined** (R^2 = 0.75)

Standard ileal digestible lysine

Best performance obtained for scenarios with **electronic feeder or automatic weighting system** (R^2 = 0.92)

1: electronic feeder
2: automatic weighting system
3: accelerometer, camera
4: electronic drinker



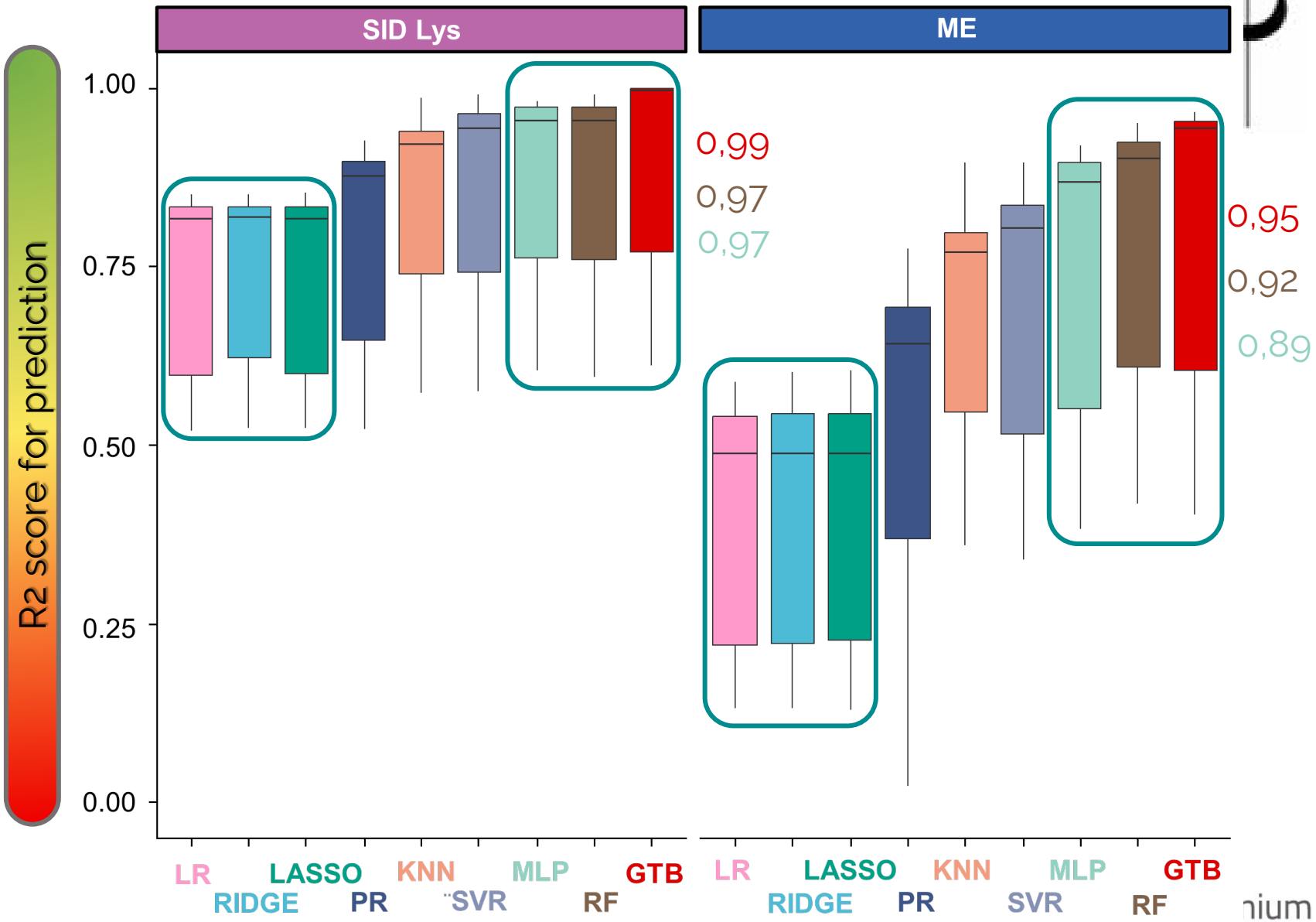
agreenium
l'institut agronomique, vétérinaire & forestier de France

Main results (2/3) : best algorithms

Best performance for GTB (MAPE = 0.91 MJ/d for energy and 0.08 g/d for lysine), followed by **RF and MLP**

Worst performance for linear regressions (MAPE = 2.75 MJ/d for energie and 1.07 g/j pour lysine)

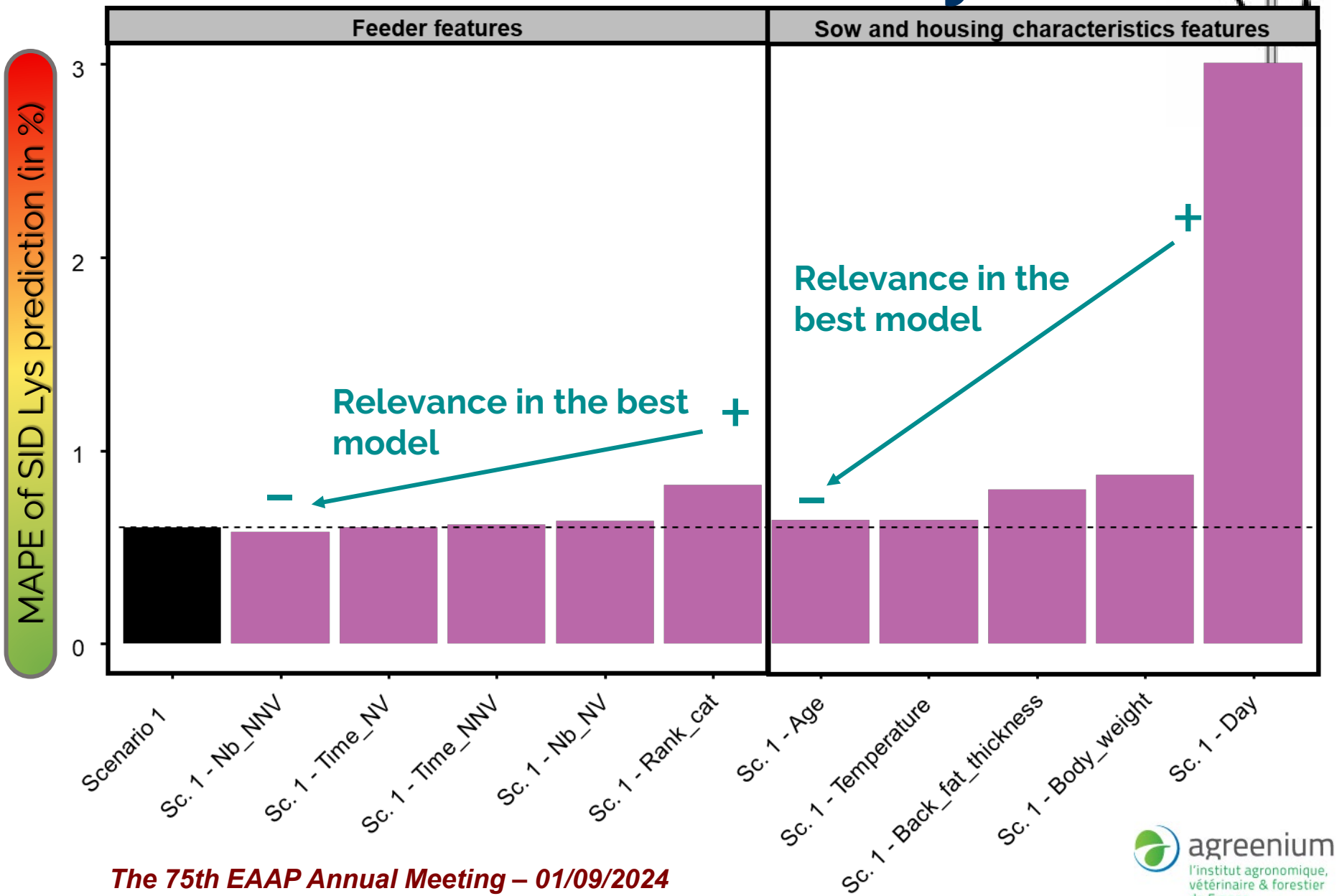
- Linear Regression (LR)
- LR with a RIDGE regularization (RIDGE)
- LR with a LASSO regularization (LASSO)
- Polynomial Regression (PR)
- k-nearest-Neighbors (KNN)
- Support Vector Machine for Regression (SVR)
- Multilayer Perceptron (MLP)
- Random Forest (RF)
- Gradient Tree Boosting (GTB)



Main results (3/3) : ablation study

Inclusion of sow and housing characteristics reduced the MAPE by 2.2 pts for energy and 5.6 pts for lysine

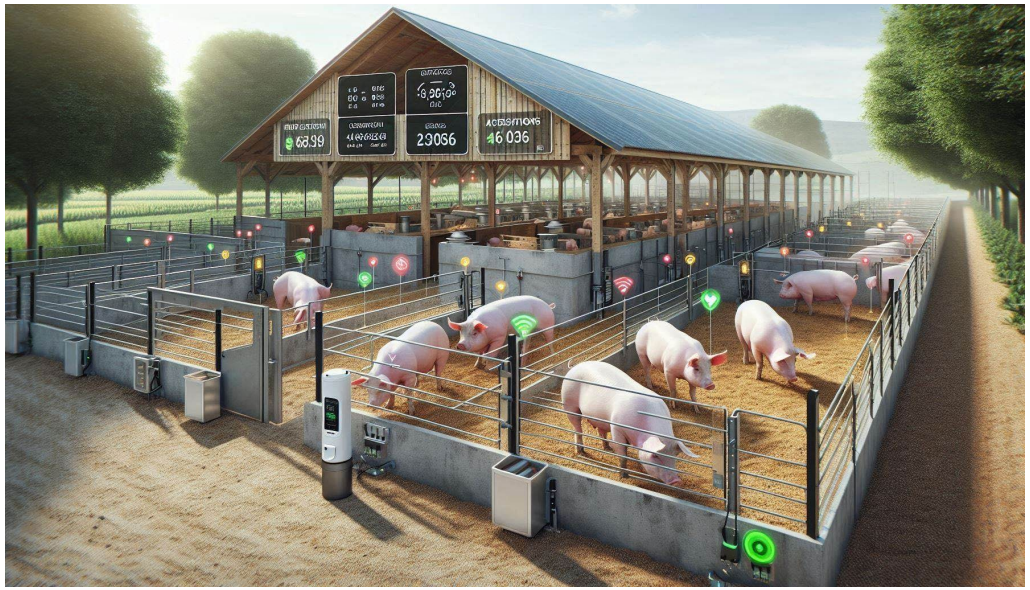
Relevance of features: Importance of feeder order, number of nutritive visit, day of gestation, BW and back-fat-thickness



NV : nutritive visit to feeder
NNV : non-nutritive visit to feeder

Conclusion

Prediction of the daily nutrient requirements of gestating sows based on behavioural sensor data and machine-learning algorithms



- Very good prediction performance with low errors (less than 5 and 7% for energy and lysine)
- Superiority of the electronic feeder among the tested scenarios
- Importance of including sow and housing characteristics to improve prediction
- Superiority of decision tree machine learning methods

Thank you for your attention