

Nutri-Mod



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➤ Modelling the digestive utilisation of calcium and phosphorus in laying hens

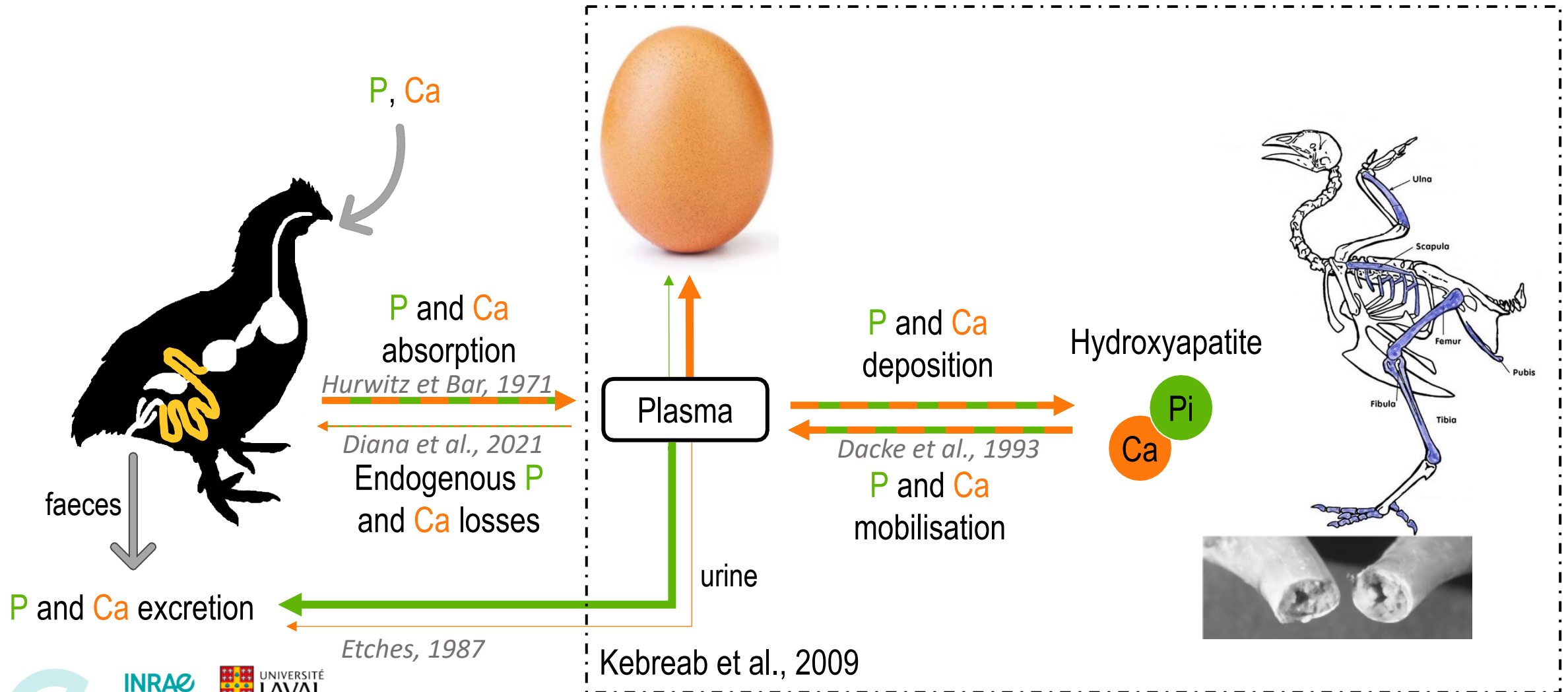
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Introduction

Calcium and phosphorus flows dynamics in the laying hen

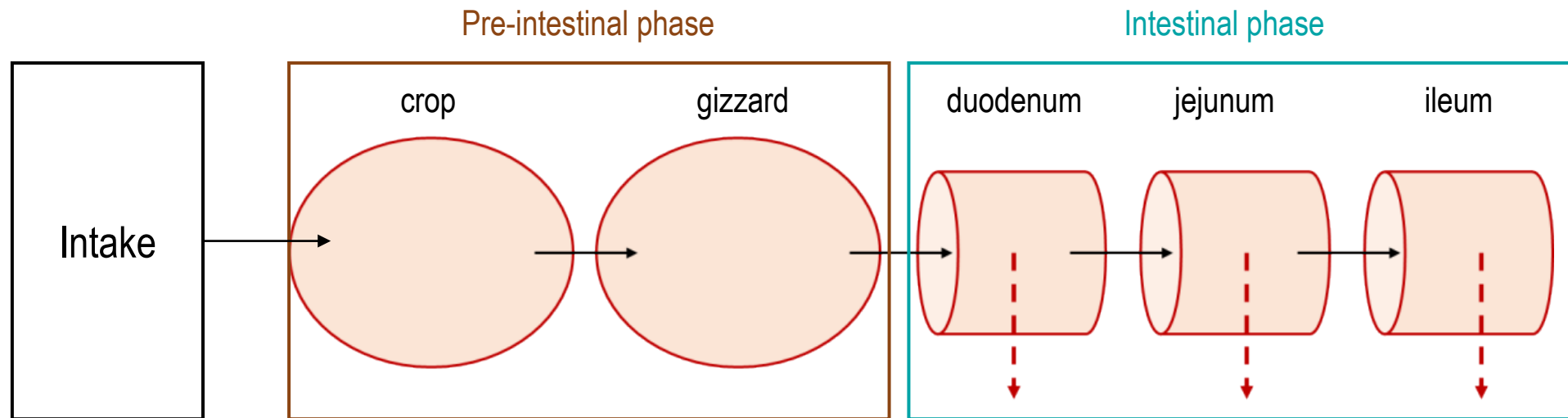


Objectives of the study

Develop a compartmental, mechanistic and deterministic model describing the fate of Ca and P along the digestive tract of the laying hen, integrating the main factors modulating their utilisation and considering the eggshell formation cycle.

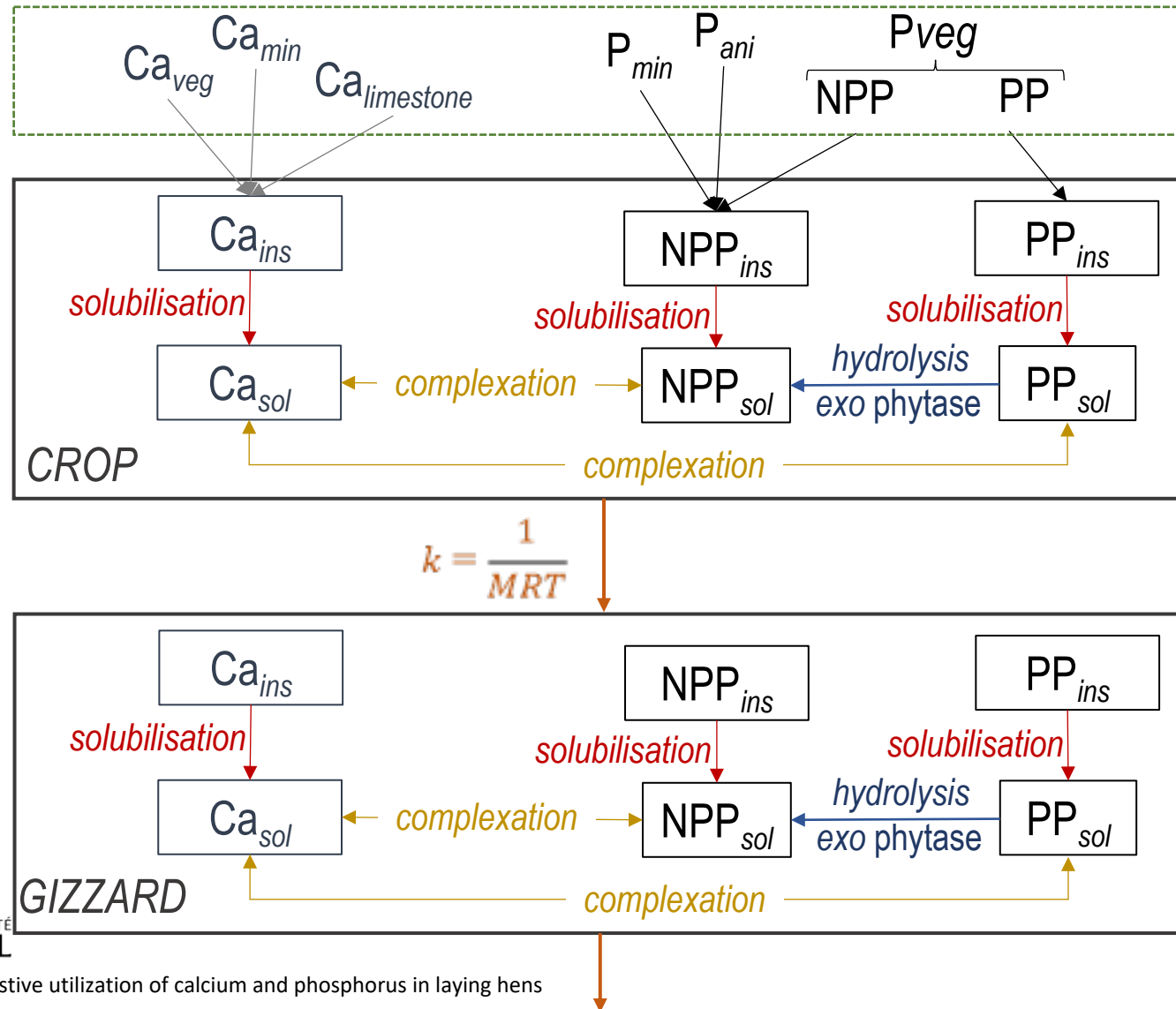
5 compartments: crop, gizzard, duodenum, jejunum and ileum.

2 phases: pre-intestinal phase and absorption phase.



Material and method

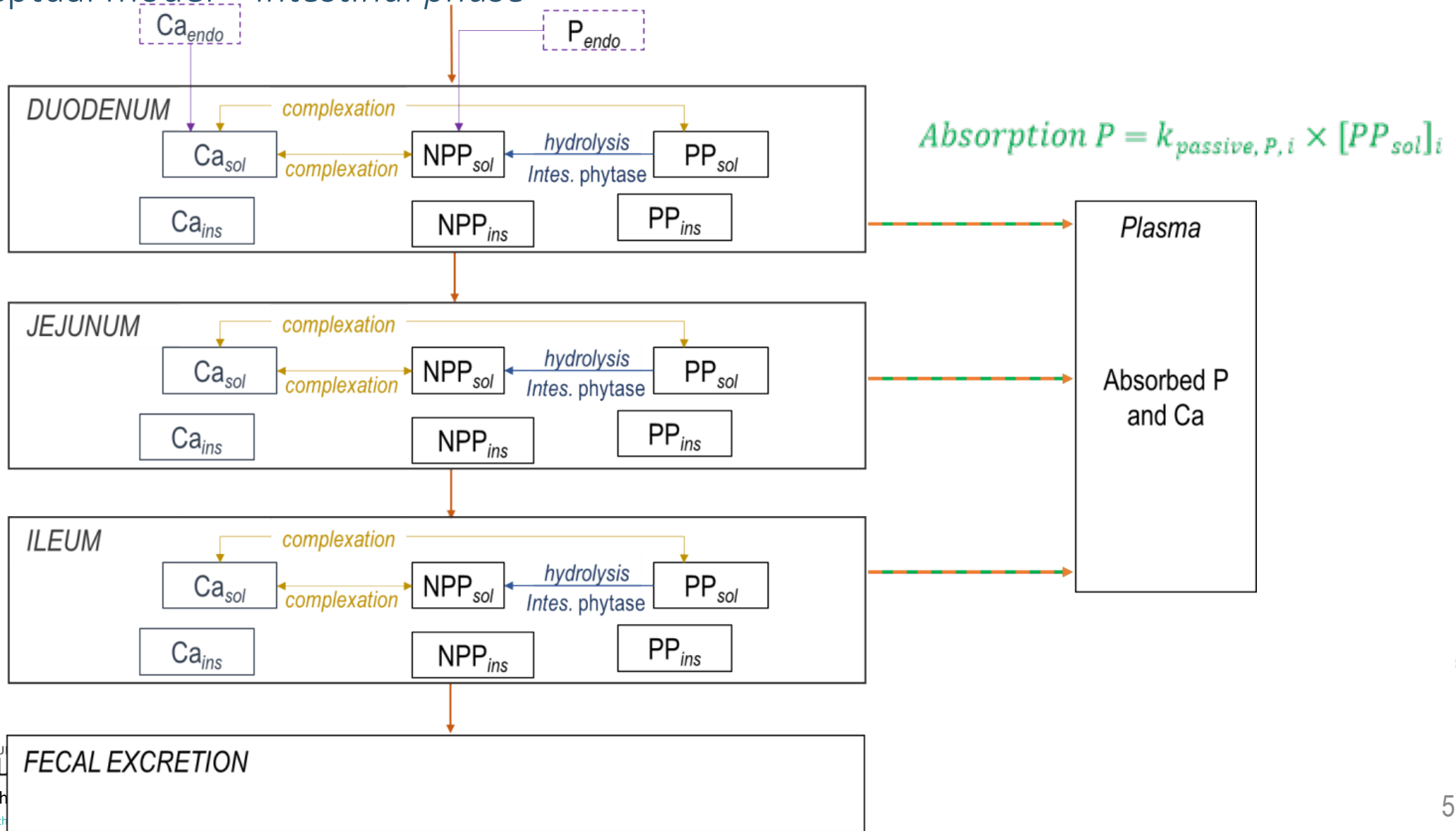
Conceptual model – Pre-intestinal phase



Bo-Linn et al., 1994
 Menezes-Blackburn et al., 2015
 Selle et al., 2007
 Bastianelli et al., 1996

Material and method

Conceptual model – Intestinal phase



Marounek et al., 2010
 Selle et al., 2007
 Hurwitz et al., 1973
 Liu et al., 2016

Material and method

Model validation

- Univariate sensitivity analysis

varying the main input variables by ± 1.5 SD

calculation of the sensitivity index = $\frac{(R_{ana,p} - R_{ref,p})}{R_{ref,p}} \times 100$

- Evaluation of the predictive capacity of the model

37 observations of PP disappearance from 5 publications

58 observations of the ileal digestibility of P and Ca from 12 publications.

Determination of the MSPE and decomposition into EC, ER and ED.



Results

Sensitivity analysis

Variation, %	-1.5 SD	0	1.5 SD
<i>Ca solubilisation</i>			
coarse limestone MRT _{Gizzard}	-14.1	0	0.2
coarse limestone k _{dissolution}	-34.3	0	15.2
<i>PP hydrolysis</i>			
crop pH	11.1	0	-40.3
Ca MRT _{Crop}	-11.9	0	2.4
P MRT _{Crop}	16.2	0	-4.9
<i>Ca absorption</i>			
V _{max} jejunum	-18.5	0	12.6
k _{eggshell} jejunum	-21.5	0	11.9
<i>P absorption</i>			
V _{max} jejunum	-5.8	0	4.4
k _{eggshell calcification} jejunum	-0.3	0	1.8

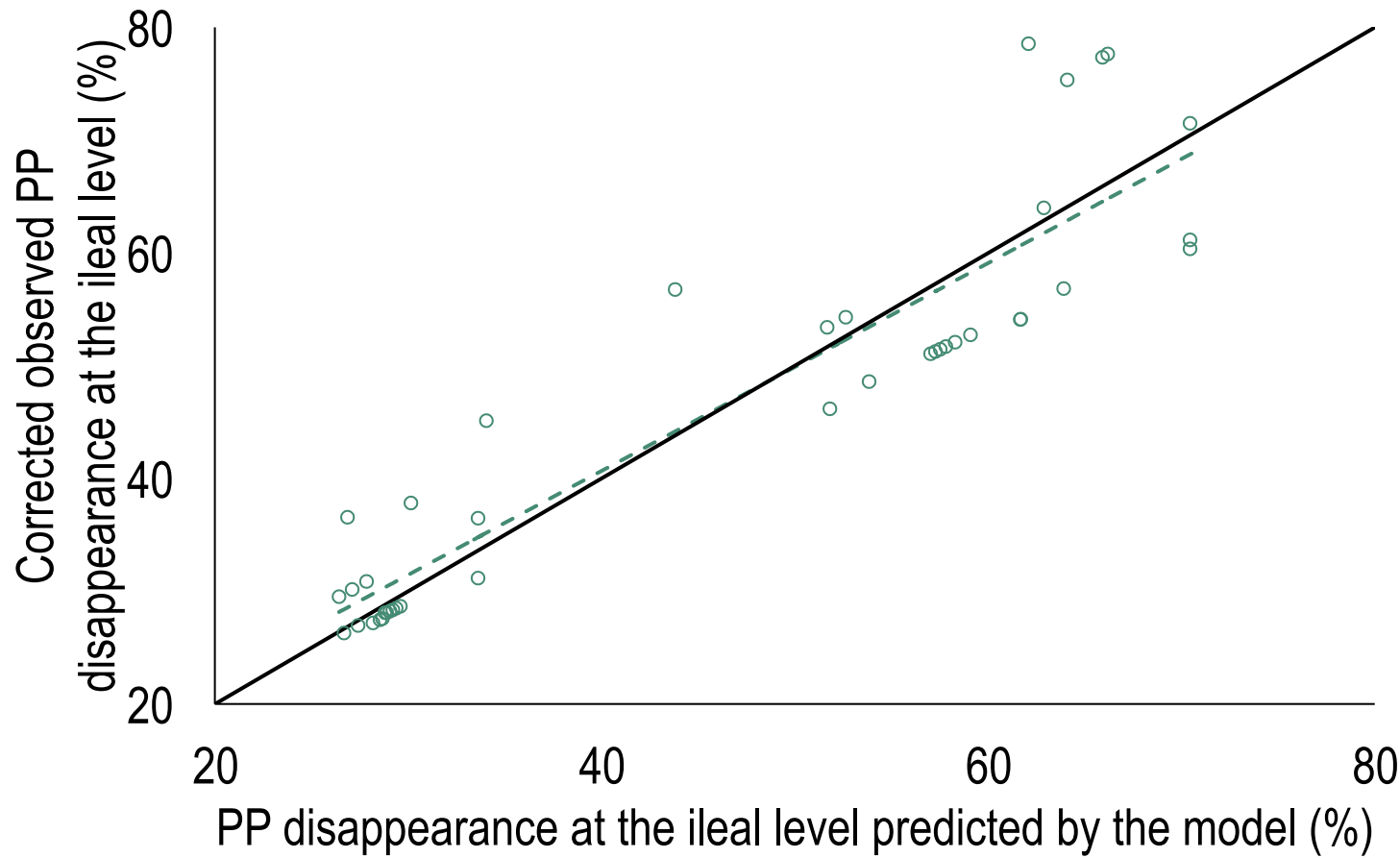
Pre-intestinal phase plays a key role on minerals utilization

Eggshell calcification cycle play a key role on Ca absorption



Results

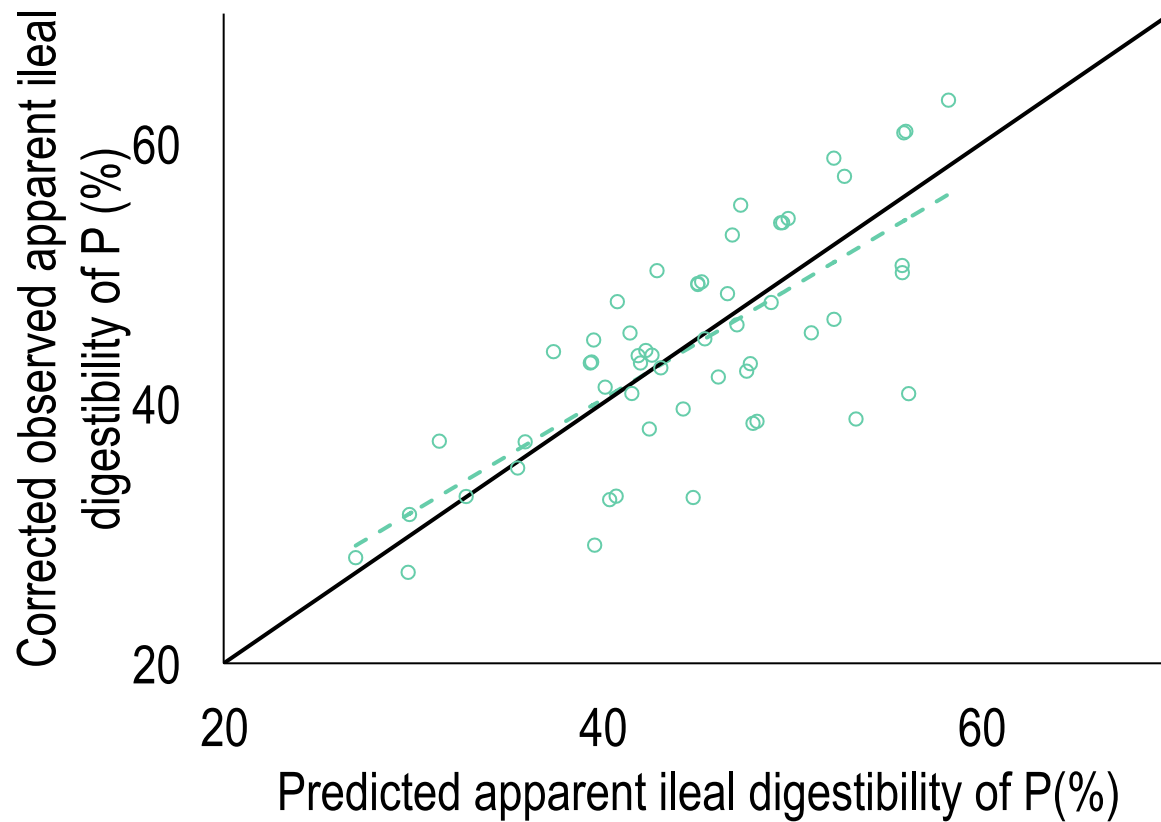
PP degradation by phytases along the GIT



<i>Model</i>	
Intercept	2.95
Regression coefficient	0.93
R ²	0.87
<i>Relative prediction error (%)</i>	
MSPE	13.31
EC	0.60
ER	12.57
ED	86.83

Results

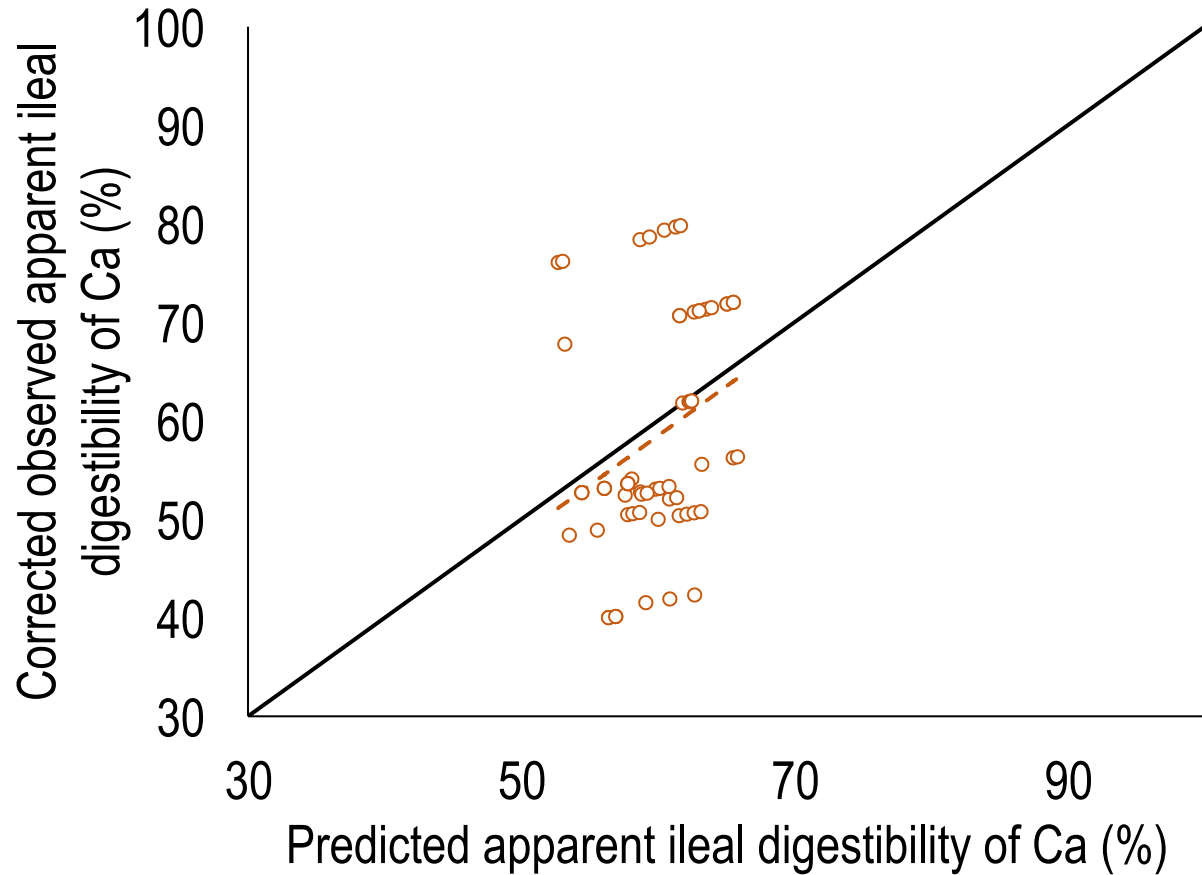
Apparent ileal digestibility of P



<i>Model</i>	
Intercept	5.76*
Regression coefficient	0.86*
R ²	0.53
<i>Relative prediction error (%)</i>	
MSPE	14.42
EC	0.23
ER	17.23
ED	82.54

Results

Apparent ileal digestibility of Ca



<i>Model</i>	
Intercept	-1.77
Regression coefficient	1.01
R ²	0.05
<i>Relative prediction error (%)</i>	
MSPE	19.45
EC	1.79
ER	4.53
ED	93.68

Conclusion

- 🐔 First model describing the digestive utilisation of Ca and P in laying hen → representing the complexity of Ca and P utilisation in laying hens
 - 🐔 Close interaction between the digestive and metabolic spheres → link the metabolic and the digestive models
- ➔ First step towards the development of precision nutritional strategies.



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Thank you for your attention

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