Effect of zinc on phosphorus and calcium digestibility in post-weaning pigs : a meta-analysis

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Florence, Italy
September 1st / September 5th

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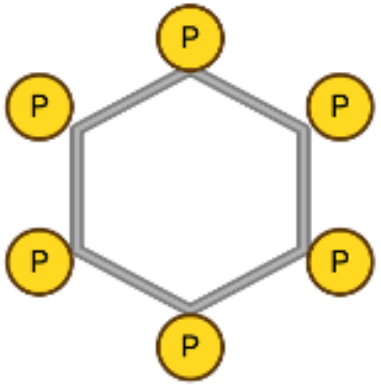
Background

- P excretion can lead to environmental problems such as eutrophication in regions of dense animal production *(Dourmad et al., 2020)*

- Rock phosphate is a non-renewable resource whose peak production has been estimated around 2033 and whose reserves are expected to be exhausted within 100 years *(Illakwahhi et al., 2024)*

- But P is essential for multiples functions and a component of bones and muscles *(Suttle, 2010)*

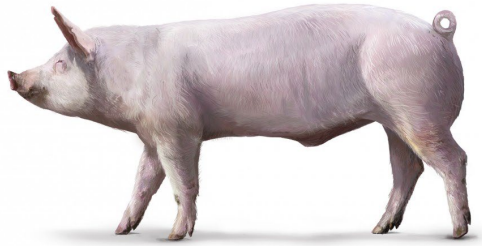
Background



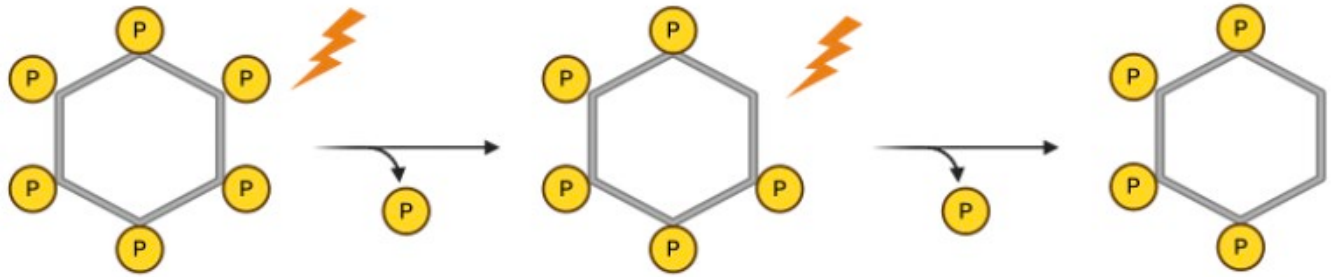
P phytic

50 à 70 % of P from plant materials

20 % is absorbed

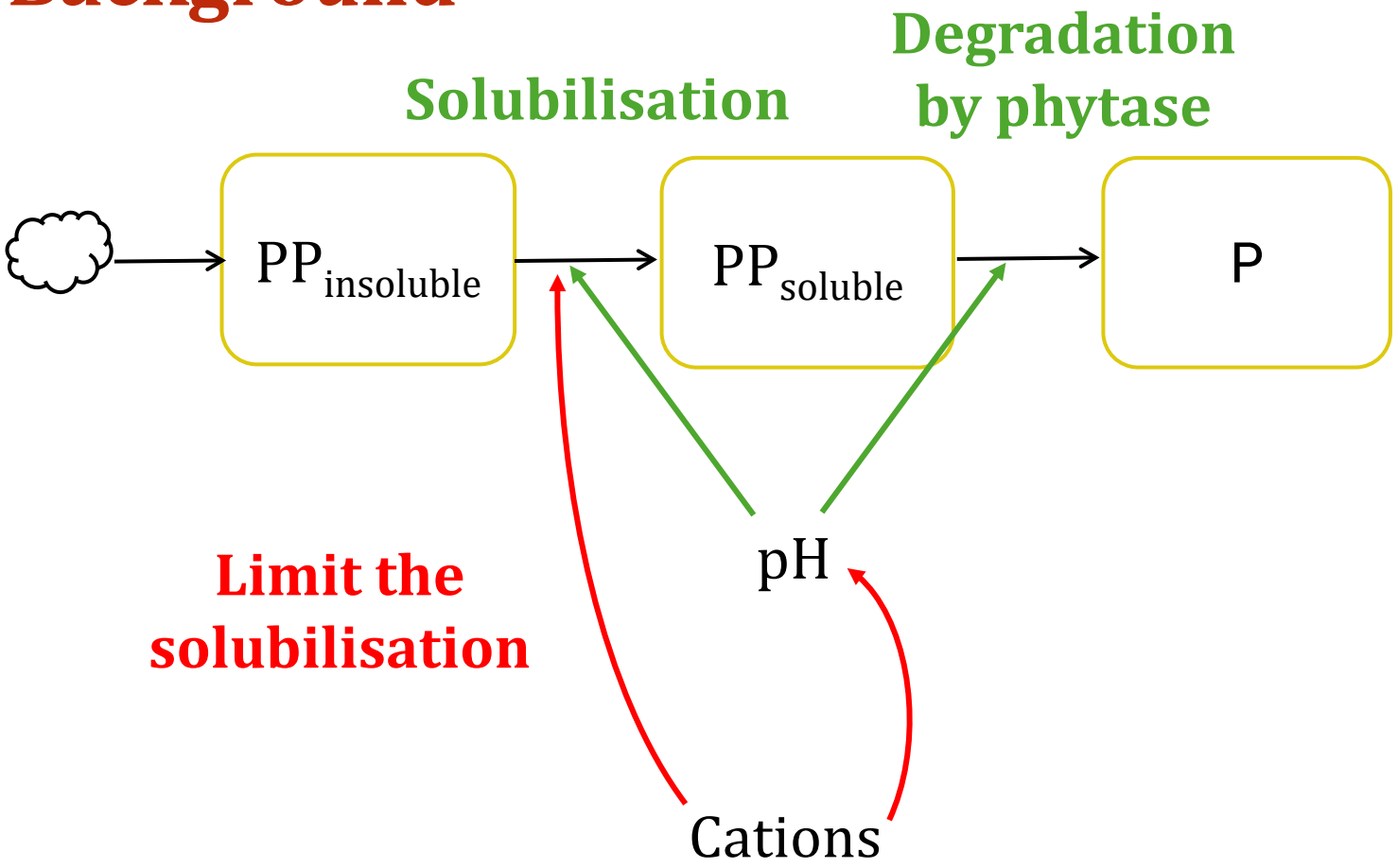


Feed industries used phytase to increase the availability of P phytic



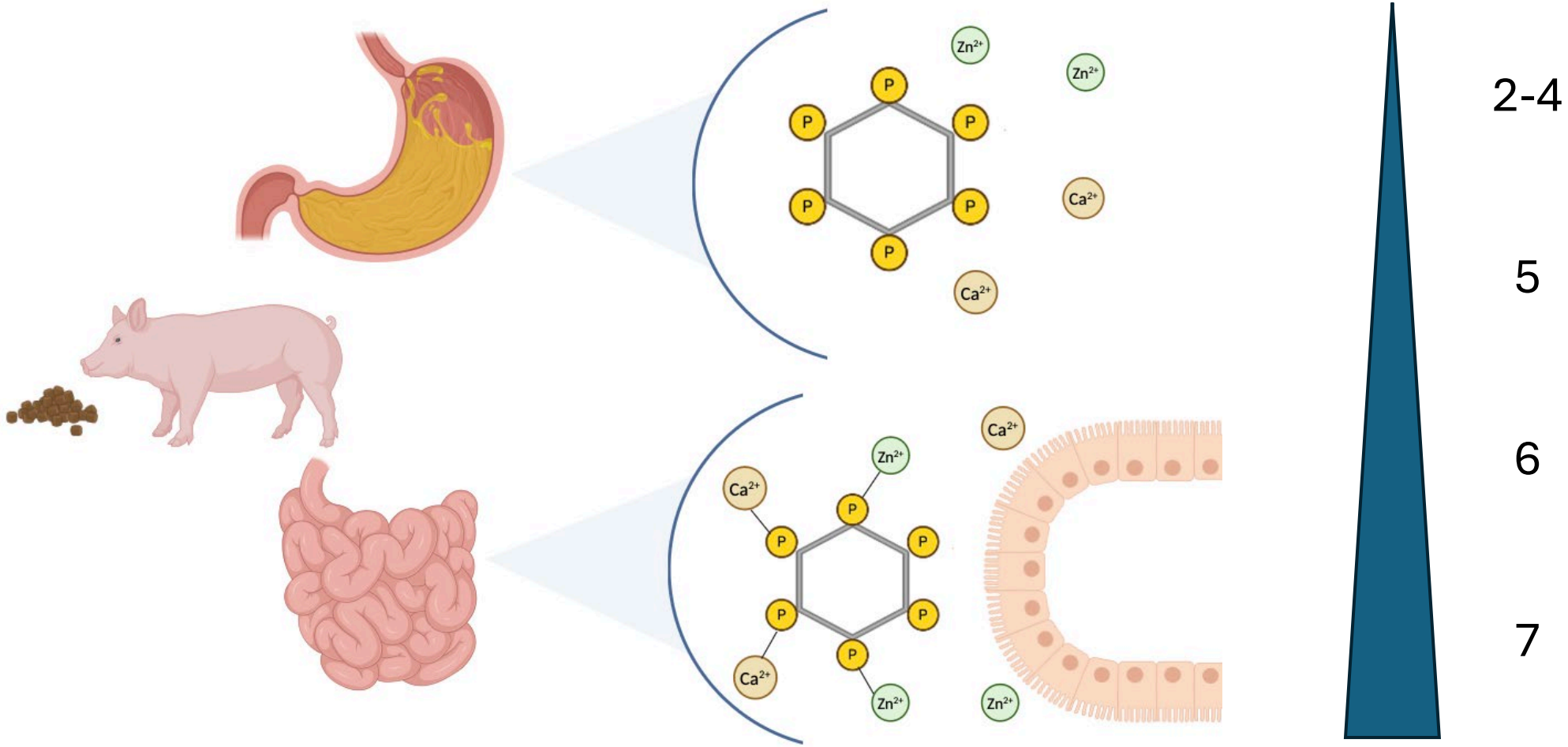
Letourneau-Montminy et al., 2012; Sauvant et al., 2004

Background



Letourneau-Montminy et al., 2011

Background



Letourneau-Montminy et al., 2011

Background

The most important cations in pig diet are

<u>Calcium</u>

- Ca is well-known to antagonize with phytate *(Selle et al., 2009)*
- It has been reduced in the past decades to optimize the use of P

<u>Zinc</u>

- Still use at high dose as zinc oxide in post-weaning in some countries
- The zinc has high ability to chelate phytate *(Maenz et al., 1999)*
- It has been reported that Zn can reduce the efficacy of phytase *(Blavi et al., 2017)*

Objective

Quantifies the effect of zinc in post-weaning pigs on P and Ca apparent total tract digestibility by meta-analysis

Maenz et al., 1999;

Materials and methods

Literature search :

“pig” , “phytase” and “zinc”

Criteria of inclusion:

1. Diet composition
2. Variation of phytase or zinc

Maenz et al., 1999;

Materials and methods

$$Y_{ij} = \mu + s_i + b_k X_{ij} + b_2 Z_{ij} + \alpha X_{ij} Z_{ij} + + e_{ij}$$

Dig P or Ca (ATTD x Diet concentration; g/kg)

Random effect of study

Phytase (FTU/kg of diet)
Ca (g/kg of diet)
P (g/kg of diet)
PP (g/kg of diet)

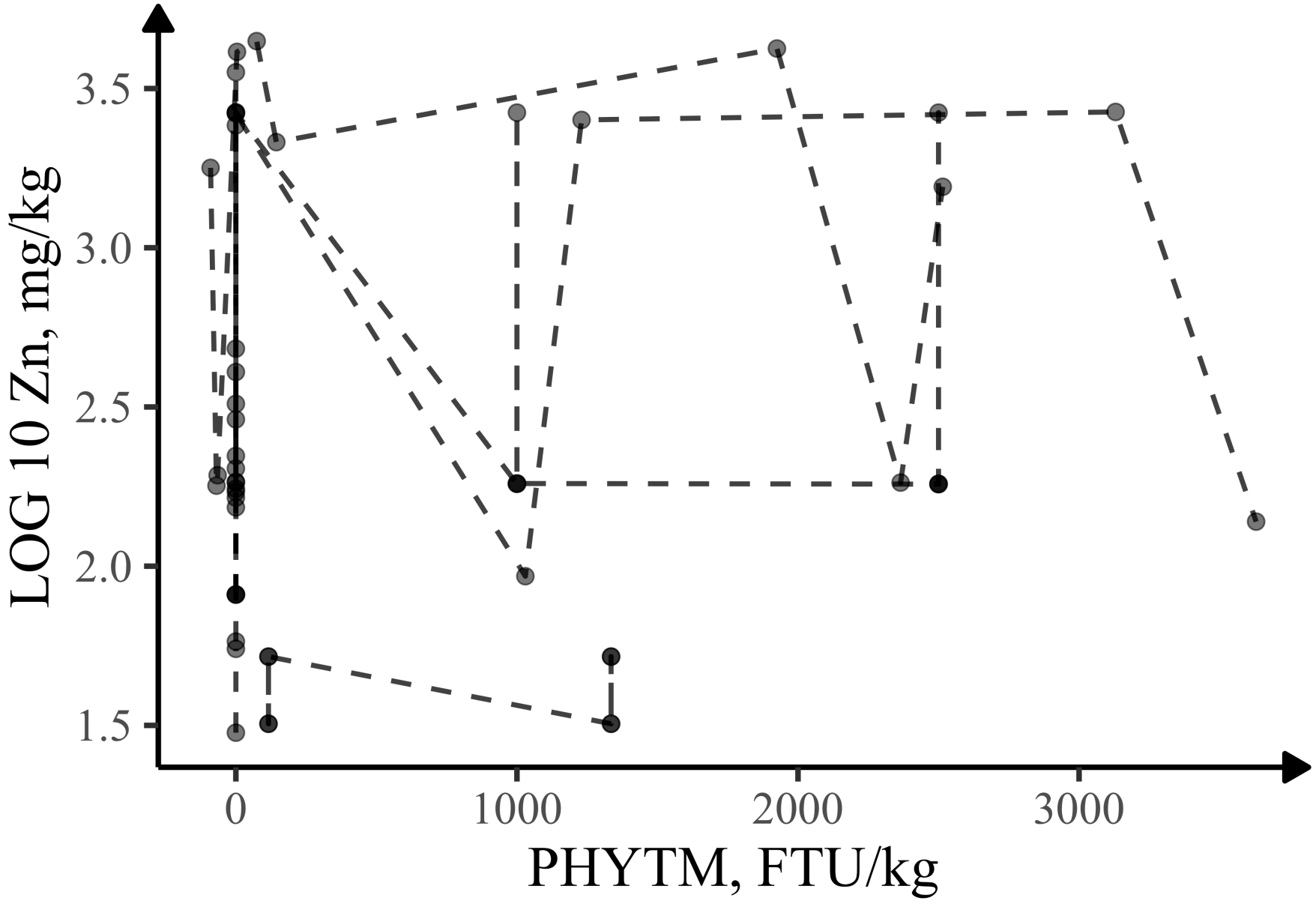
Zn (mg/kg of diet)

Interaction between phytase and zinc

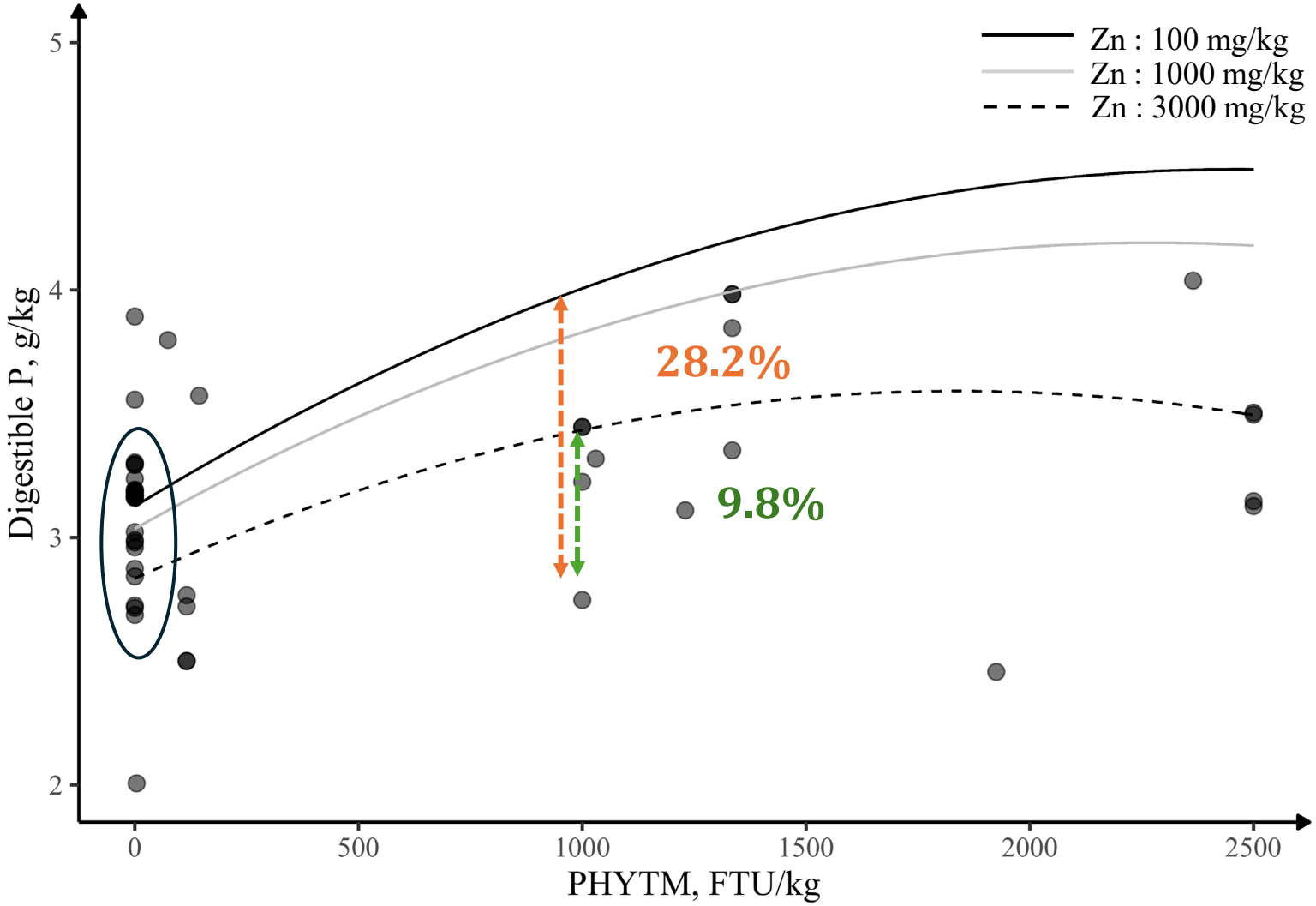
Error

Meta-design

In diet



P digestibility



Dig P (g/kg)	Coefficient	*P*
Constante	-0.299	0.58
Zinc	-0.01	<0.001
PHYTM	0.111	<0.001
PHYTM^2	-0.02	<0.001
P	0.529	<0.001
Zinc x PHYTM	-0.001	0.001

$R^2 = 0.92$; RMSE = 0.28 (g/kg)

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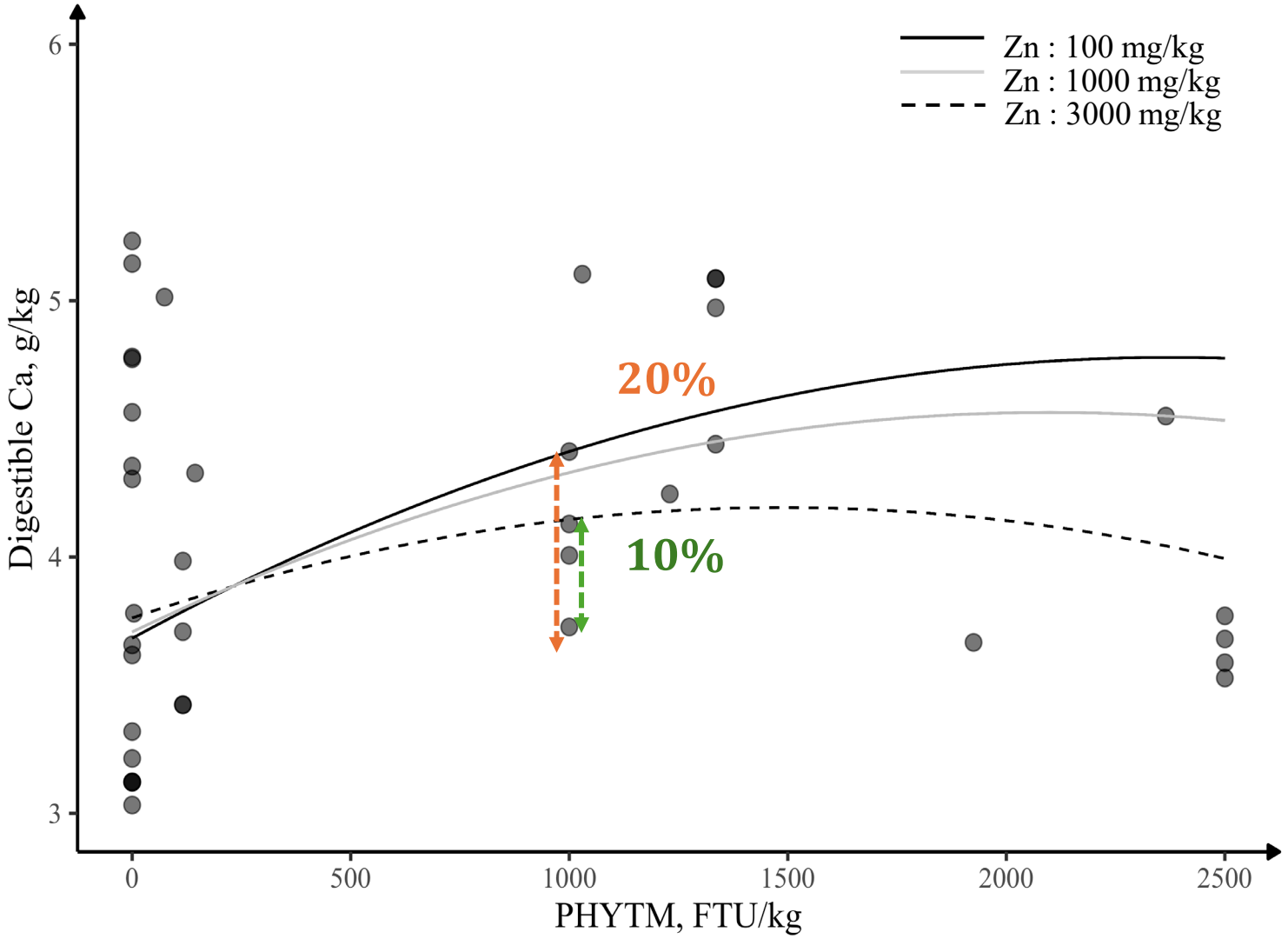
Ca digestibility



Dig Ca (g/kg)	Coefficient	*P*
Constante	3.992	0.03
Zinc	0.002	0.08
PHYTM	0.093	<0.001
$PHYTM^2$	-0.002	<0.001
Ca	0.522	<0.001
PP	-1.965	0.005
Zinc x PHYTM	-0.001	<0.001

$R^2 = 0.96$; RMSE = 0.26 (g/kg)

Discussion

- Microbial **phytase improves** the digestibility of dietary P and Ca in a linear and quadratic manner *(Létourneau-Montminy, 2012)*

- Zn influences the linear component of the response due to :

  - **interaction** between phytic P and Zn *(Champagne and Fisher, 1990)*

  - **buffering effect** of the main source of ZnO : **pH of the stomach** is a key component of the **phytic P solubilisation** and **phytase activity** *(Lawlor et al., 2005; Pontopiddan et al., 2007; Menezes-Blackburn et al., 2015;*

Discussion

- Zn reduced the P digestibility **when no microbial phytase is added : formation of complexes between** phytic P and Zn in the small intestine *(Champagne and Fisher, 1990)* that reduce the mucosal phytase effect ?

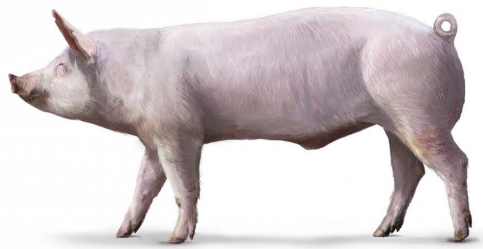
Conclusion

- High ZnO doses is forbidden in Europe, but are still in use in many countries such as in North and South America and they can impact P and Ca digestibility

- Zn impact the phytic P degradation by microbial phytase and mucosal phytase

- Research are needed to understand the mechanisms implicated and we need more data with new generations of phytase

Thank for hour attention !



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