Byproducts in Ruminant Feeding: Exploring their Mitigating Effects on Enteric Methane Emissions

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INTEGRITY

INTRODUCTION 1/3

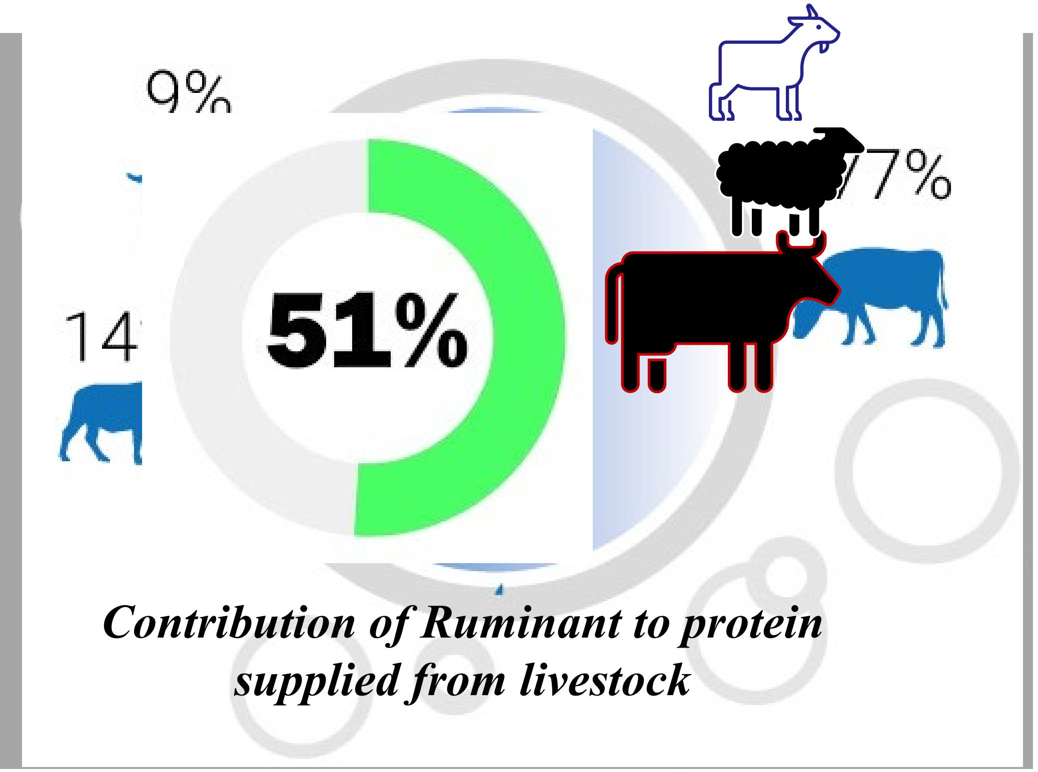

Plate 1: Contribution to the global enteric methane emissions by ruminant species .
Source: FAO, 2024

- ✓ Ruminants play an important role in ***global food security and nutrition***, farmers' livelihoods, and those along the agri-food chain.
- ✓ The enteric fermentation process naturally occurring in ruminants is one of the main drivers of methane emissions globally.
- ✓ Enteric methane mitigation strategies were classified into three main categories: ***animal and feed management, diet formulation, or rumen manipulation***.

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- ✓ By-products are secondary products obtained during the harvest or processing of a principal commodity (Grasser *et al.*, 1995)

Plate 2: Mixture of lentil screenings. A high protein source that mixes well into a ration of straw and low-quality forage.
Source: Beef Cattle Research Council, 2023

- ✓ The use of by-products in ruminant diets is becoming more prevalent, due to a simultaneous ***increase in their availability*** and as a ***strategy to reduce dependence on cereals and oilseeds-based feeds lowering costs of production compared to traditional feedstuffs*** (Lingnau, 2011)

- ✓ By-products in the diet of ruminants substantially decreases (***15-20% reduction in GHG emissions***) the environmental impact of livestock farming (Pardo *et al.*, 2016; Salami *et al* 2019)

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- ✓ Due to the ***expensive*** and ***laborious*** nature of quantifying enteric methane *in situ*, there is an increase in ***mathematical models***, including those recommended by the Intergovernmental Panel on Climate Change (IPCC), commonly used to estimate methane emission factors of ruminants.

- ✓ Several predictive models have been developed which offer valuable insights for methane mitigation strategies. However, no study has ***developed empirical predictive CH4 emission models exclusively focused on the use of agro-industrial by-products (AIBPs) in ruminants' diets*** with CH4 mitigating strategies. Hence, this study

Does the inclusion of AIBPs in ruminants' diets mitigate enteric methane emissions (g/day), yield (g/kg DMI), and intensity (g/kg ECM)?

SPECIFIC OBJECTIVES

1

To categorize AIBPs into clusters based on their chemical composition

2

To identify predictors for predicting enteric daily methane production (g/d), yield (g/kg DMI), and intensity ((g/kg ECM) in dairy cattle fed AIBP-based diets (***variable selection & model development***)

METHODOLOGY

1). Agro-industrial by-products: *chemical composition*

Clustering analysis (*Unsupervised machine learning*)

Creation of database

2). Model development

CH_4 quantification

(Animal characteristics & performance: DMI, Milk yield,, digestibility, etc.)

Steps: n =***13 studies, 46 records***

1. *Pub* selection using ***Prisma Scheme***

2. Metanalysis: ***Mean effect size*** **&** ***Linear mixed model***

3. Model development (***5 levels of complexity***) and evaluation

RESULTS & DISCUSSION 1/4

✓ *Variability exists in the chemical composition of AIBPs*

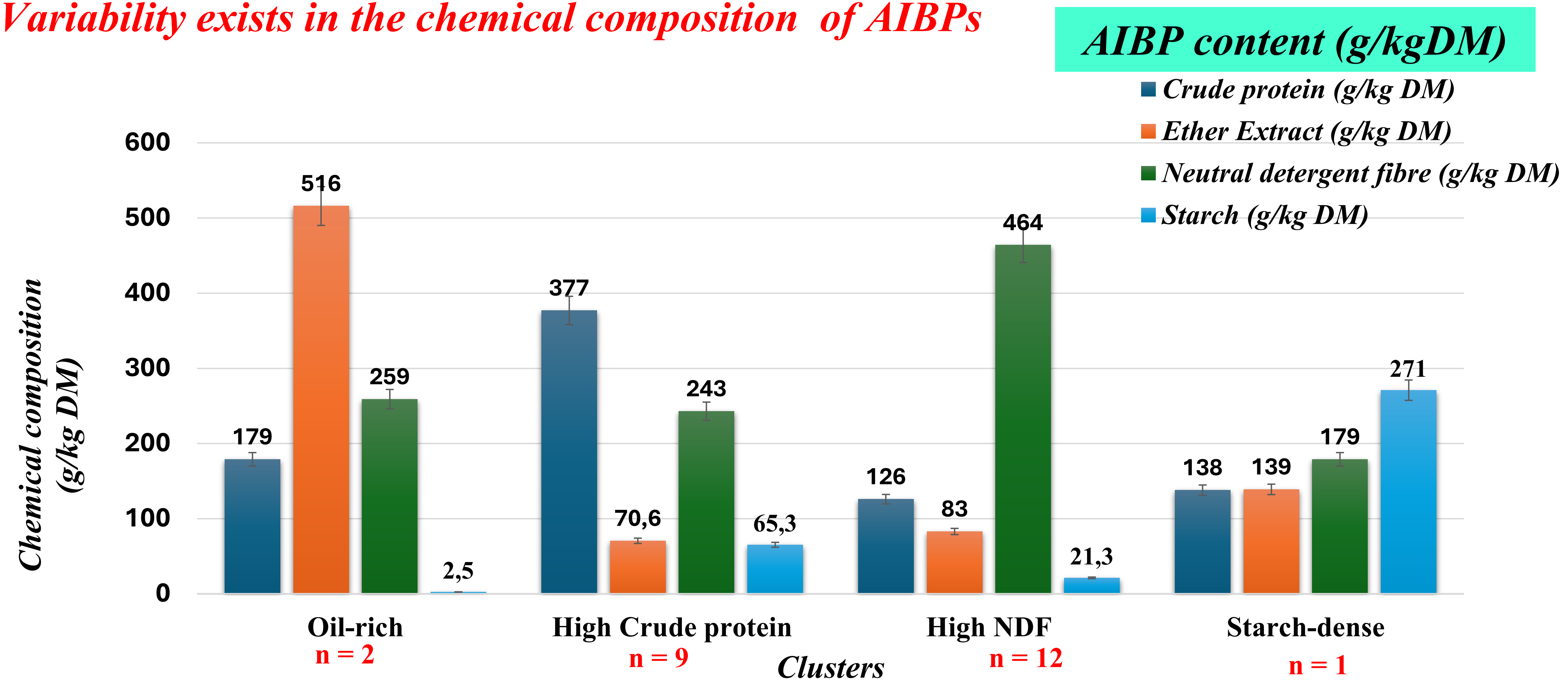

Figure 3: Mean chemical composition of the 24 AIBPs by Cluster

RESULTS & DISCUSSION 2/4

The influence of AIBPs on CH4 differs

1. LI: Level of inclusion

2. Chemical composition

3. Basal diet

4%contribution to the whole-diet chemical composition

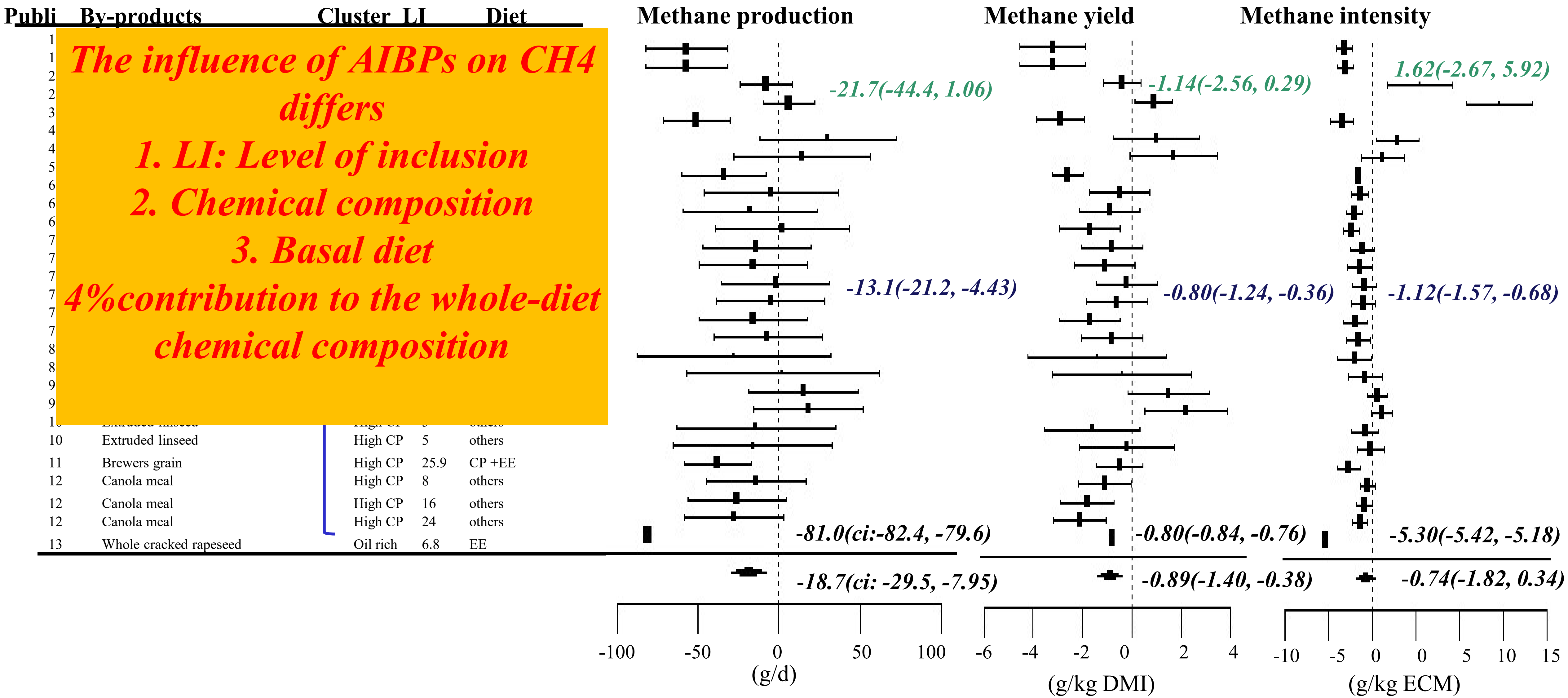

Figure 6. Mean differences to control in CH_4 production (g/d), yield (g/kg DMI), and intensity (g/kg ECM)

RESULTS & DISCUSSION 3/4

Table 2: Best prediction equations of methane emissions (g/d per cow), CH4 yield (g/kg DMI), and intensity (g/kg ECM)

Level	Models	N	RMSPE	RMSPE (%)	ED (%)	CCC	RSR
	CH_4 emissions (g/day)						
2	CH_4 emissions = 551 (507, 594) - 1.49 (-2.04, -0.93) × **EE** - 1.20 (-2.13, -0.28) × **PCO**	39	50.8	11.4	98.2	0.34	0.90
	CH_4 yield (g/kg DMI)						
1	CH_4 yield = -17.2 (-33.4, -1.05) + 50.5(28.0, 72.9) × **OMD**	23	1.41	7.20	99.9	0.77	0.60
	CH_4 intensity (g/kg ECM)						
2	CH_4 intensity = 30.8 (20.6, 40.9) - 0.06 (-0.10, -0.02) × **EE** - 0.59(-1.05, -0.14) × **DMI**	37	4.80	31.7	97.0	0.20	0.96

CH4 = Methane, EE: ether extract concentration, DMI: dry matter intake; OMD: Organic matter digestibility; PCO: percentage of concentrate,, CH4: methane, N: number of observations, RMSPE: root mean square prediction error (in the same unit as the response parameter), RMSPE %: RMSPE as % of observed mean of the response parameter; ED% expressed as a percentage of RMSPE: error due to the disturbance CCC: concordance correlation coefficient (dimensionless), RSR: RMSPE-to-Standard deviation Ratio

✓ ***EE (g/kg DM) is consistent with a negative relationship with CH_4 (g/d) and intensity (g/kg ECM)***

RESULTS & DISCUSSION 4/4

✓ *Underprediction of observed values for CH4 intensity (g/kgECM)*

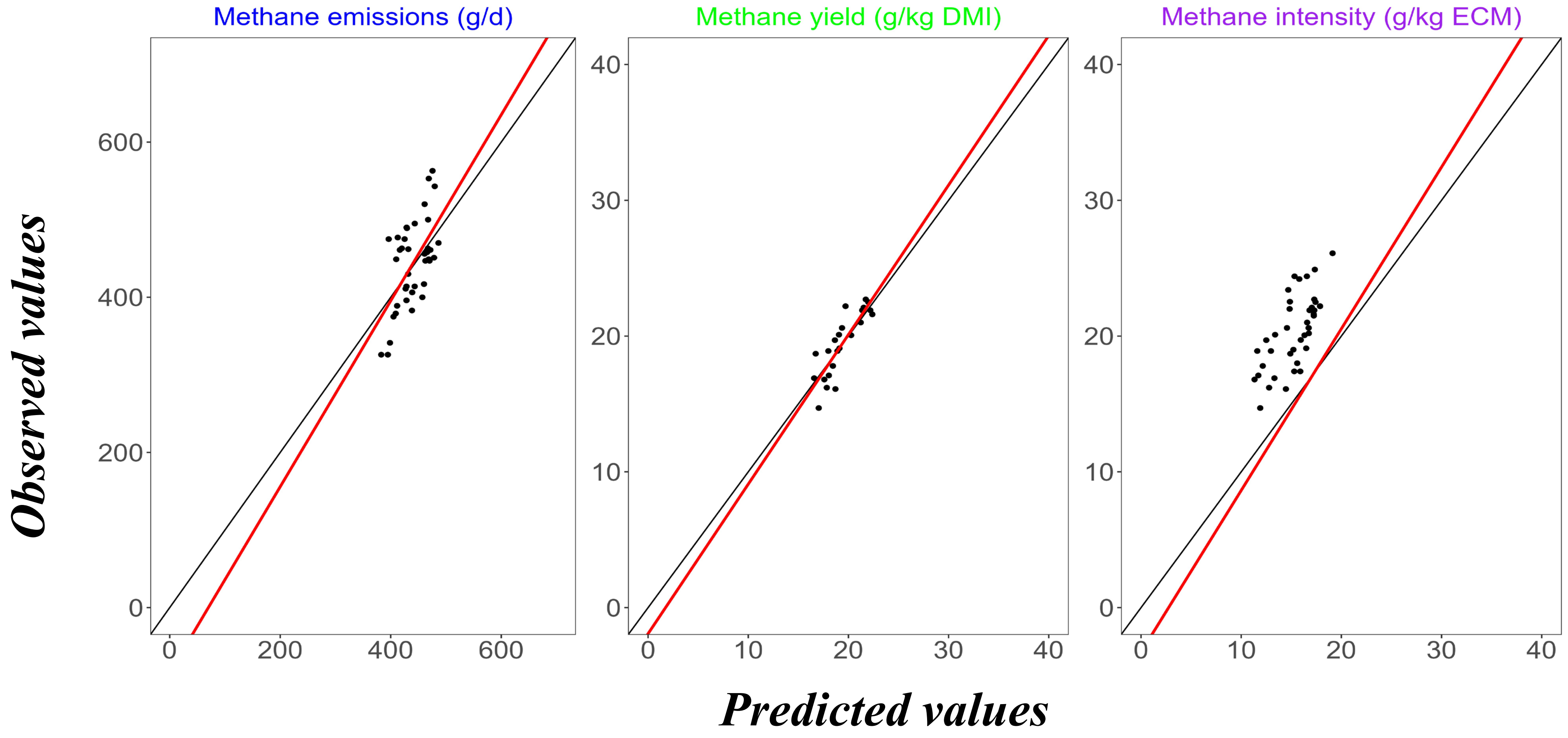

Figure 5: Predicted vs. Observed value plots based on CH_4 emissions(g/day per cow), CH_4 yield (g/kg DMI), CH_4 intensity (g/kg ECM)

CONCLUSION

Influence of AIBP's on methane depends on:

- ✓ ***The nature*** (origin of the primary product and processing methods)

- ✓ ***Chemical composition***: Methane emissions (g/day) were best predicted by the ***(EE) ether extract content (g/kg DM) and the percentage of concentrate (PCO)*** in the whole diet; yield (g/kg DMI) by ***OMD***; and intensity by ***EE(g/kg DM) and DMI kg/day***.

- ✓ ***The level of inclusion***: Increased level of inclusion of AIBP decreased enteric methane emissions (g/day per cow); however, reduced effects were observed for AIBPs in the High fibre cluster.

THANK YOU!

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