Decreasing feed-food competition by use of cereal by-products in grower-finisher pig diets

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Background and Aim

Background

- Sustainability and circularity of animal production increasingly important
- Circular food production systems: arable land primarily used for human food
- Pigs raised on human inedible products can make an important contribution
- Pig diets (NL) typically contain ~60% cereal grains and 15% soybean meal (SBM)

Aim

Impact of replacing wheat, SBM, and palm kernel meal by cereal grain by-products in diets for growing-finishing pigs.

- Animal performance and carcass characteristics
- Faecal consistency
- Nutrient excretion and carbon footprint

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Material & Methods

- Laverdonk, Heeswijk-Dinther, NL
- Grower-finisher pig facilities

- 884 Tempo x TN70
- Boars and gilts separately housed
- 25 kg to ± 120 kg (slaughter weight)
- 5 rounds

- Trial set-up: 2 x 4 factorial arrangement
- 2 energy levels x 4 by-product levels
- 10-12 replicates (pens)/ treatment
- 2-phase feeding (25-50 kg and 50 kg-end)
- Ad libitum feed and water

- Trial period: mid-end 2022

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Dietary treatment

- 2 Energy levels (9.5 & 10 MJ NE/kg) x 4 levels of by-product inclusion
- 2 Phase feeding: grower 25 - 50 kg, finisher 50 kg – slaugher (~120 kg)
- Amino acids and minerals: CVB recommendations

- **By-product diets**
  - Exclusion of wheat, soybean meal, palm kernel (55-65%)
  - Inclusion of cereal BP: wheat middlings, mais DDGS, wheat gluten feed meal (RSM)
  - 15% barley and ~10-15% maize in each diet
  - SID AA-levels balanced, CP levels varied accordingly

- **Dietary energy**
  - High NE diets contained more starch
  - High by-product diets had higher NSP and fat content

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Treatments and design

Treatment	Energy level	By-products	Pens
1/ A	**LOW** **9.5 MJ NE**	**Low, 0%**	14
2/ B		33%	12
3/ C		67%	12
4/ D		**High, 100%**	14
5/ E	**HIGH** **10.0 MJ NE**	**Low, 0%**	14
6/ F		33%	12
7/ G		67%	12
8/ H		**High, 100%**	14

- Rooms with 8 pens, for all treatments, boars and gilts separately
- 6-10 pigs per pen

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Observations

Individual BW:	Day -1 at approximately 25 kg Day ±29 at approximately 50 kg Day ±68 at approximately 85 kg Day ±98 at approximately 120 kg – first delivery to slaughter Day ±105 at second delivery to slaughter
Feed intake (pen):	Simultaneous to BW measurement
Carcass characteristics:	Dressing%, fat (mm), muscle (mm), lean meat%
Faecal consistency:	Visual score (score 1 firm i.e. good to 3 severe diarrhoea)
Health and mortality:	Daily registration. Visual scores of damaging behaviour (when occurring).

Grab sampling of faeces, 3-d period at ~85kg; results not included

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Calculations and Statistical analysis

Calculations

> N and P retention, excretion and utilisation with adopted constant body N and P-content
> CFP of feed ingredients (CO2 eq./kg) expressed per kg feed and body gain

Statistical analysis

> Randomized complete block design, pen as experimental unit.
> Generalized linear mixed model analysis (SAS Proc GLIMMIX)
> Fixed effects of Energy level, By-product level and interaction
> Random effects of Round and Room
> Faecal consistency, ordinal regression.

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Results

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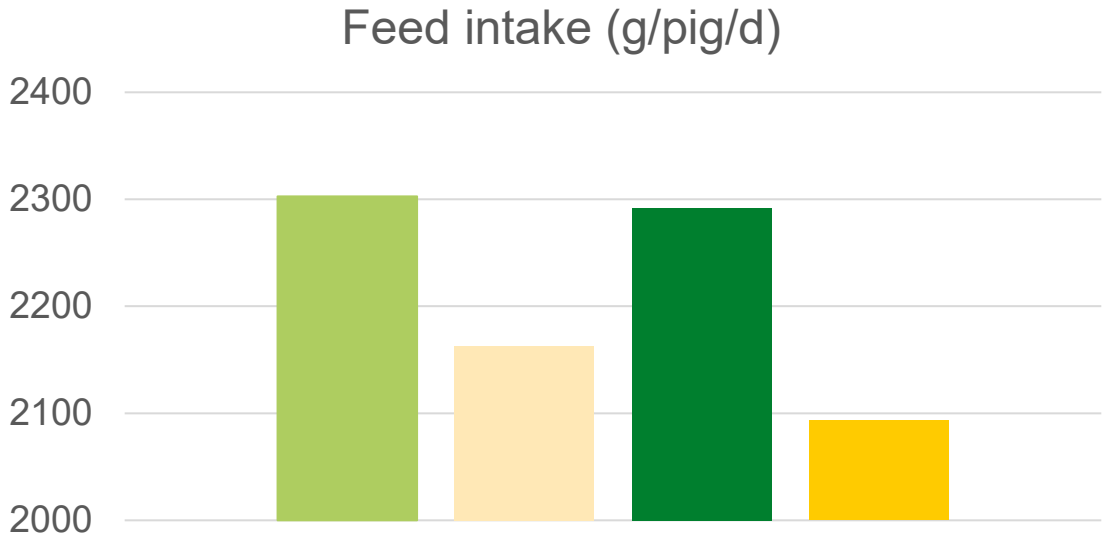
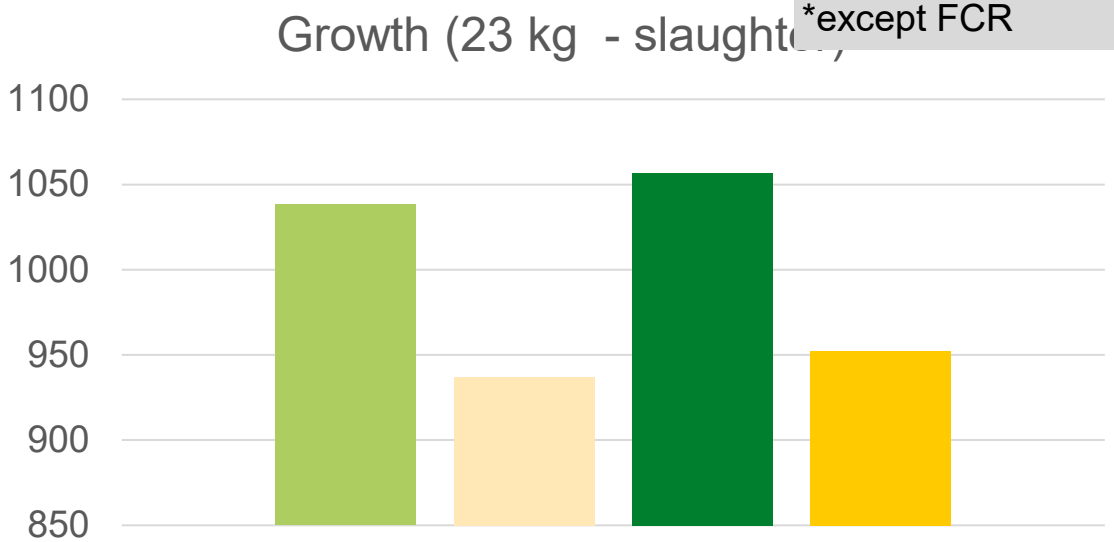
Growth performance reduced by inclusion of by-products

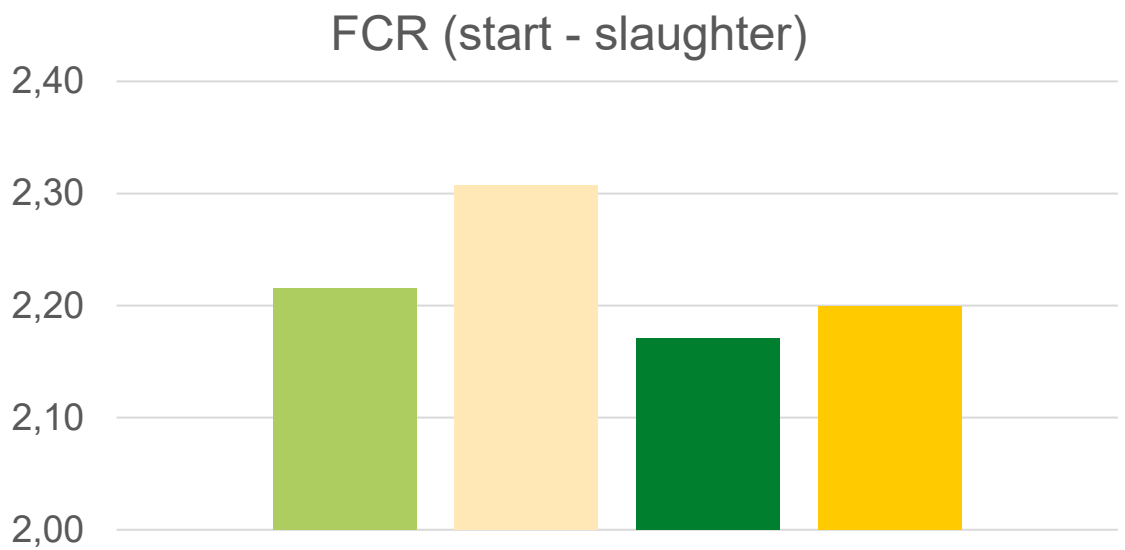
P-value$_{EW}$: <0.05
P-value$_{BP}$: <0.05

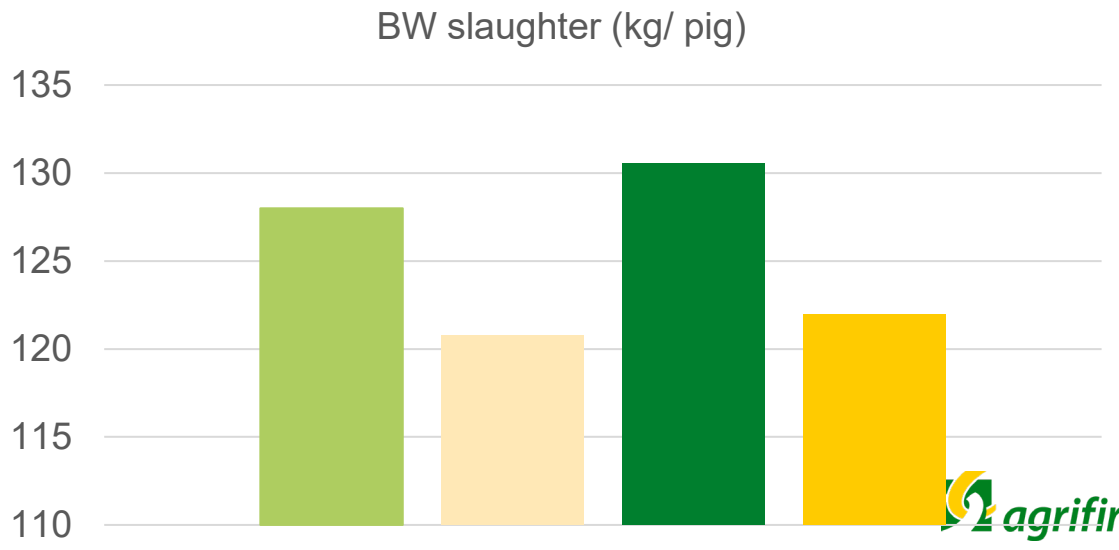
P-value$_{EW*BP}$*: >0.05
*except FCR





Control - Low EW | By-products - low EW | Control - high EW | By-products - high EW





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Carcass characteristics; negative effect of inclusion of by-products

Treatment	A	D	E	H				
	Control	100% BP	Control	100% BP	SEM[1]	P-value	P-value	P-value
	low EW	low EW	high EW	high EW		EW	BP	EW*BP
Days to slaughter	102	106	103	105				
Slaughter weight (kg)	128.0^{AB}	120.8^{D}	130.5^{A}	122.0^{CD}	2.14	0.006	<0.001	0.827
Carcass weight (kg) 1)	97.2^{BC}	95.7^{C}	98.9^{A}	96.4^{BC}	0.69	0.006	<0.001	0.064
Dressing (%) 1)	77.4^{ABC}	75.9^{D}	78.2^{A}	76.4^{CD}	0.6	0.006	<0.001	0.145
Fat depth (mm) 1)	11.8^{B}	12.9^{A}	12.7^{BA}	13.4^{A}	0.4	<0.001	0.006	0.794
Muscle depth (mm) 1)	68.5^{AB}	66.0^{AB}	69.1^{A}	65.3^{B}	2.3	0.792	0.001	0.745
Meat percentage (%) 1)	60.6^{A}	59.7^{BC}	60.0^{ABC}	59.4^{C}	0.3	<0.001	0.001	0.859

With (live) slaughter weight as covariate

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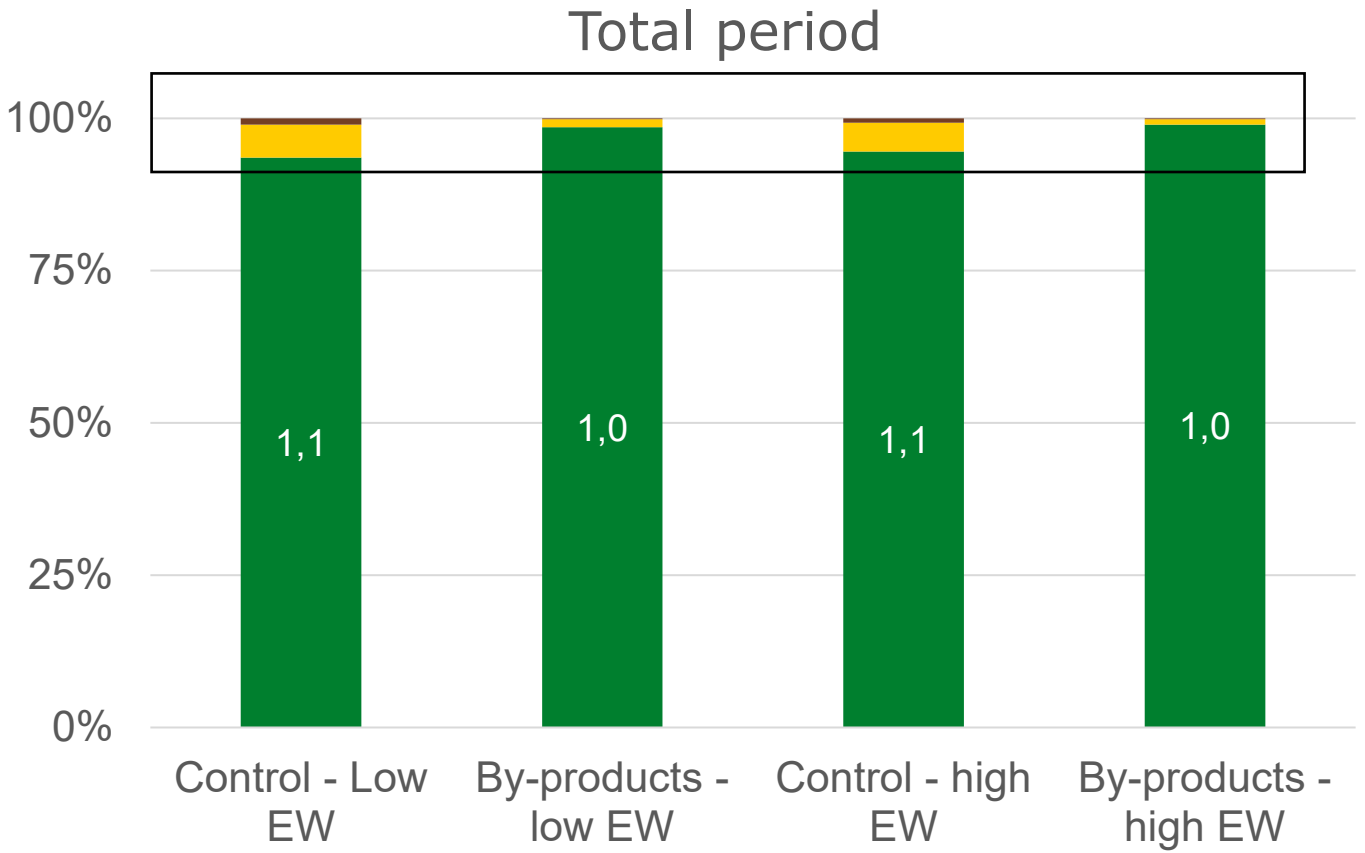
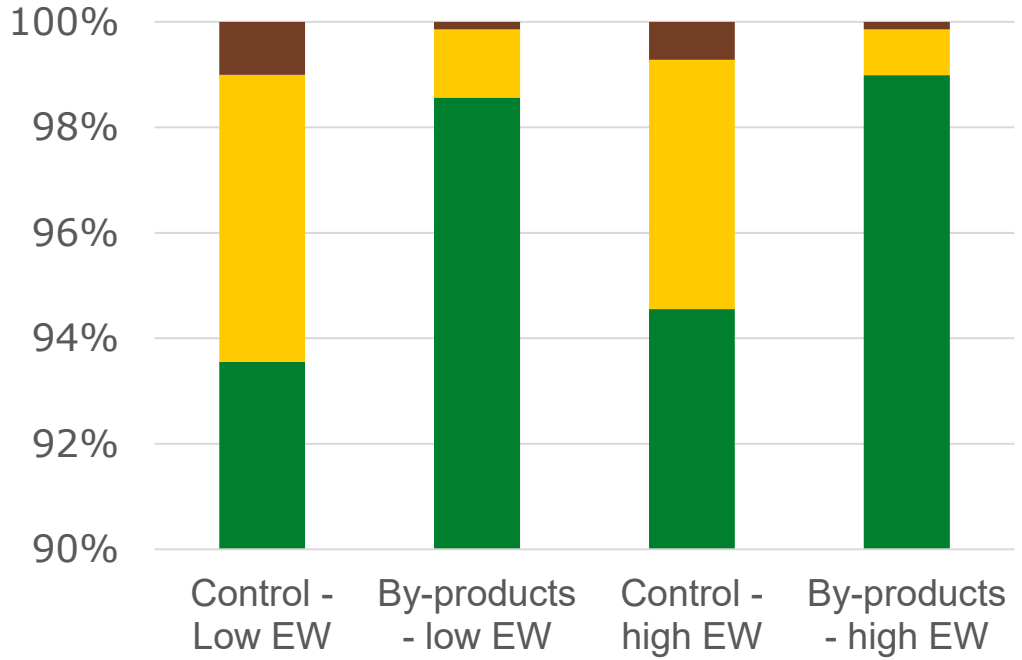
No effect on faecal consistency

Visual: 1 (firm) – 2 (loose) – 3 (severe diarrhoea)





No significant effects, though numerically more firm faeces at high BP inclusion

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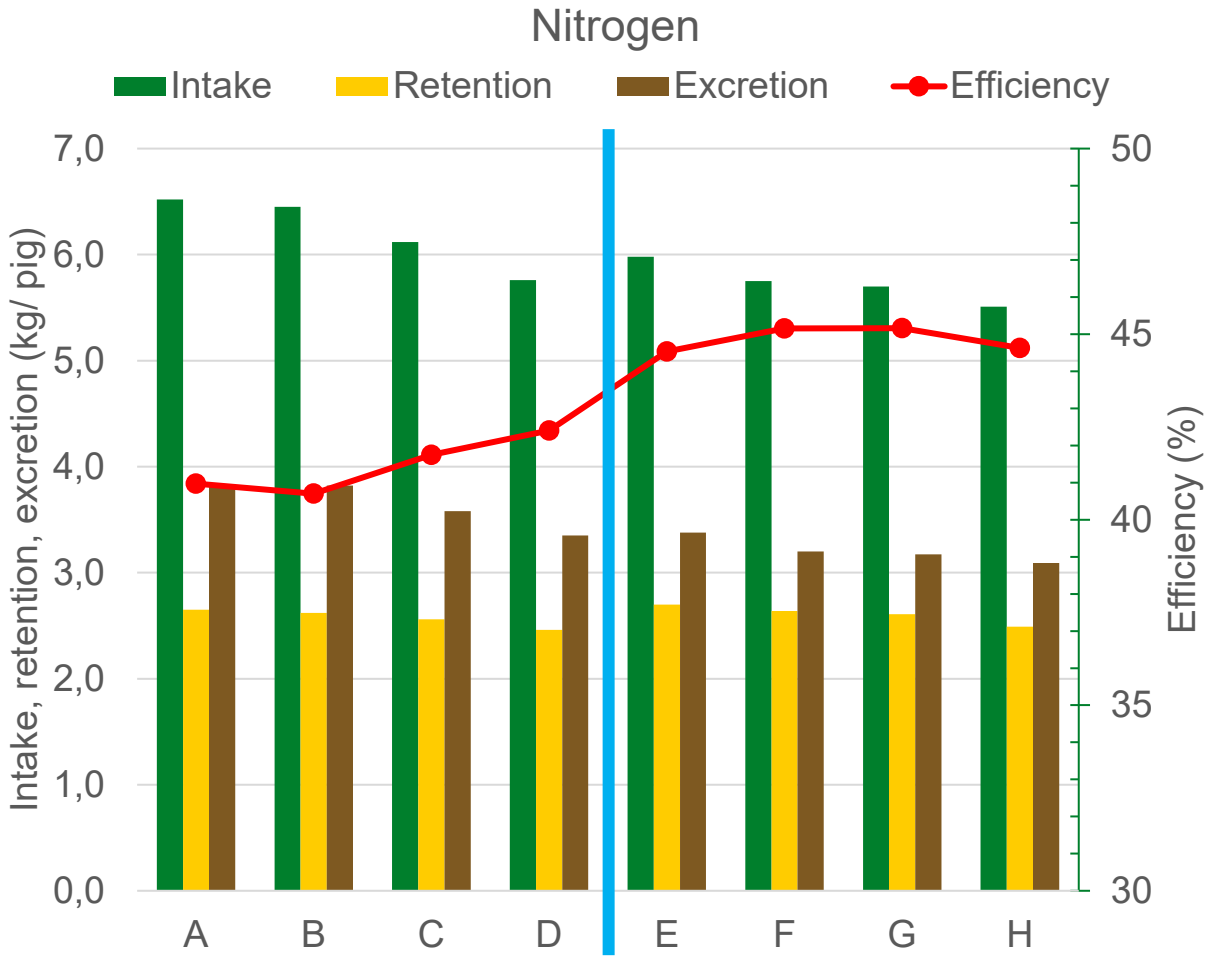
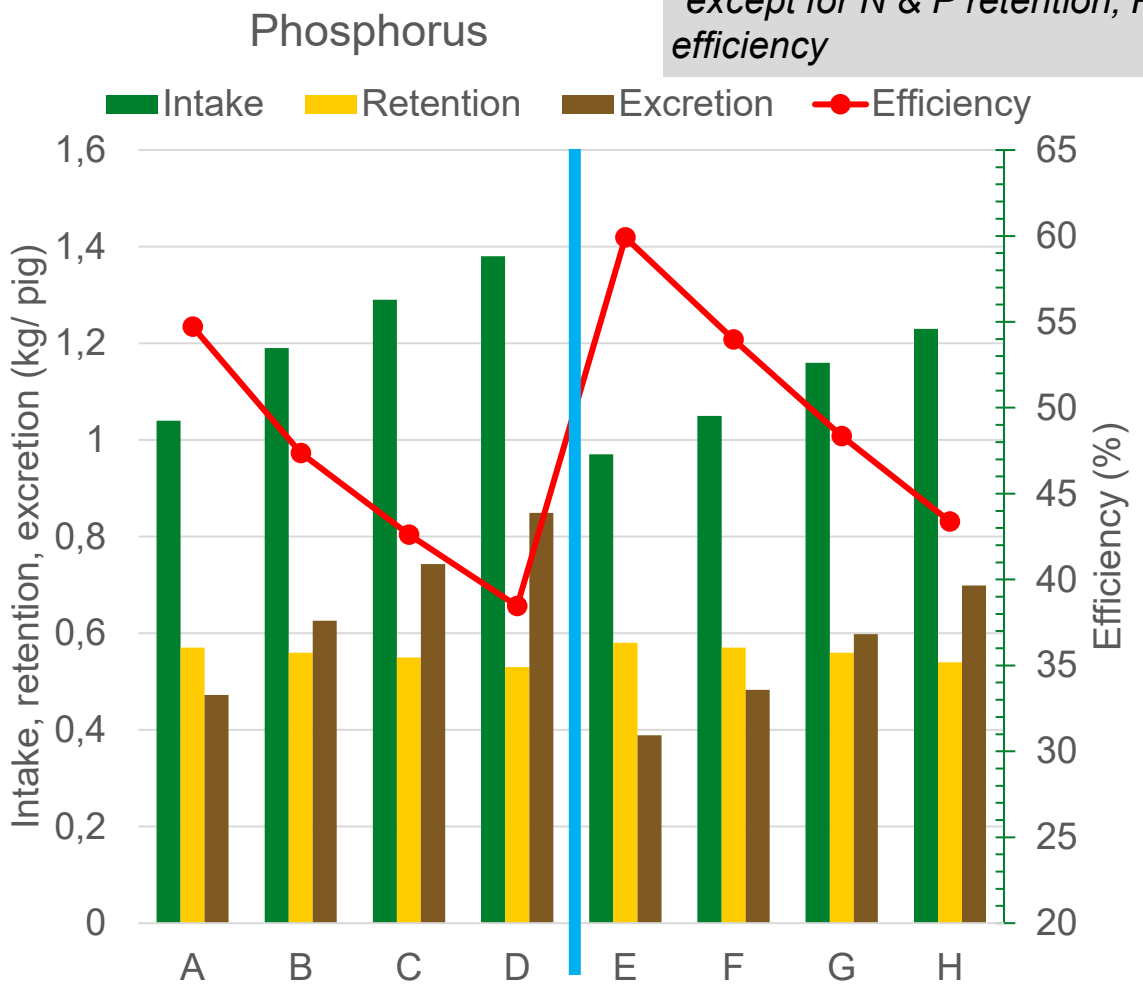
N and P intake and efficiency of utilisation

P-value$_{EW}$: <0.05
P-value$_{BP}$: <0.05

P-value$_{EW*BP}$*: <0.05
**except for N & P retention, P efficiency*



A-D low EW; E-H high EW;
A & E control diets; D & H = 100%BP diets



A-D low EW; E-H high EW;
A & E control diets; D & H = 100% BP diets

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Carbon footprint (g CO2-eq/kg feed) with/without land-use change (LUC)

Treatment	A	D	E	H				
	Control	100% BP	Control	100% BP	SEM[1]	P-value	P-value	P-value
	low EW	low EW	high EW	high EW		EW	BP	EW*BP
Diet CFP								
CO_2 incl. LUC	981	734	955	821				
CO_2 excl. LUC	509	606	538	665				
Diet CFP at animal level								
CO_2 incl. LUC / kg gain	2168	1700	2083	1810	58	0.208	<0.001	<0.001
CO_2 excl. LUC / kg gain	1131	1407	1176	1468	39	<0.001	<0.001	0.065

- Control diets: higher CFP including LUC due to SBM inclusion
- High BP diets: higher CFP excluding LUC due to WGFM, maize DDGS, soybean oil and pure AA
- At animal level BP inclusion reduced CFP with LUC, increased CFP excluding LUC

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Summary and Conclusions

Replacing wheat and SBM by cereal by-products in diets to improve circularity:

- Reduced feed intake and daily gain (and increased FCR mainly at low EW level)
  - Likely caused by increased NSP in high BP diets
- Reduced carcass quality → potential overestimation of digestible AA in by-products
- Did not reduce faecal consistency
- Slightly reduced N excretion, drastically increased P excretion (high P in by-products)
- Reduced CFP with LUC of diets and per kg body gain, but increased CFP w/o LUC
  - Trade-off replacing SBM (high CFP w. LUC) vs DDGS and WGFM (high CFP w/o LUC
- Dietary strategies may have contradictory effects on different sustainability criteria

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Thank you for your kind attention

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