Nutrition and sustainable food production

Application of advanced nutritional concepts towards more sustainable animal production

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Outline

- Challenges for commercial pig production
- How low can we go with reducing CP content in pig diets?
- Synergistic effect of low CP diet with probiotics
- Effect of reducing dietary CP content on feed cost
- Application of low CP diet to minimize environmental impact
- Dynamic AA ratio concept
- Take home message

Challenges for commercial pig production

Current challenges for commercial pig production

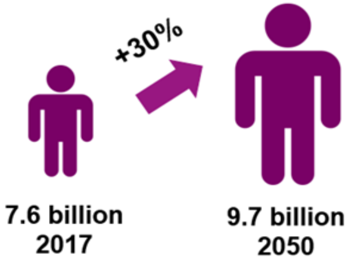
Goal : profitable but in a sustainable way

Climate change

- Environmental pollution

The pollution regulations affecting China's pork producers

20 December 2017



Food demand

- Population growth

Pig production

Food Quality / Safety

- Consumer demand

High feed cost

- Volatility, availability

Animal health

- Poor immune status (AGPs-ban, heat stress)

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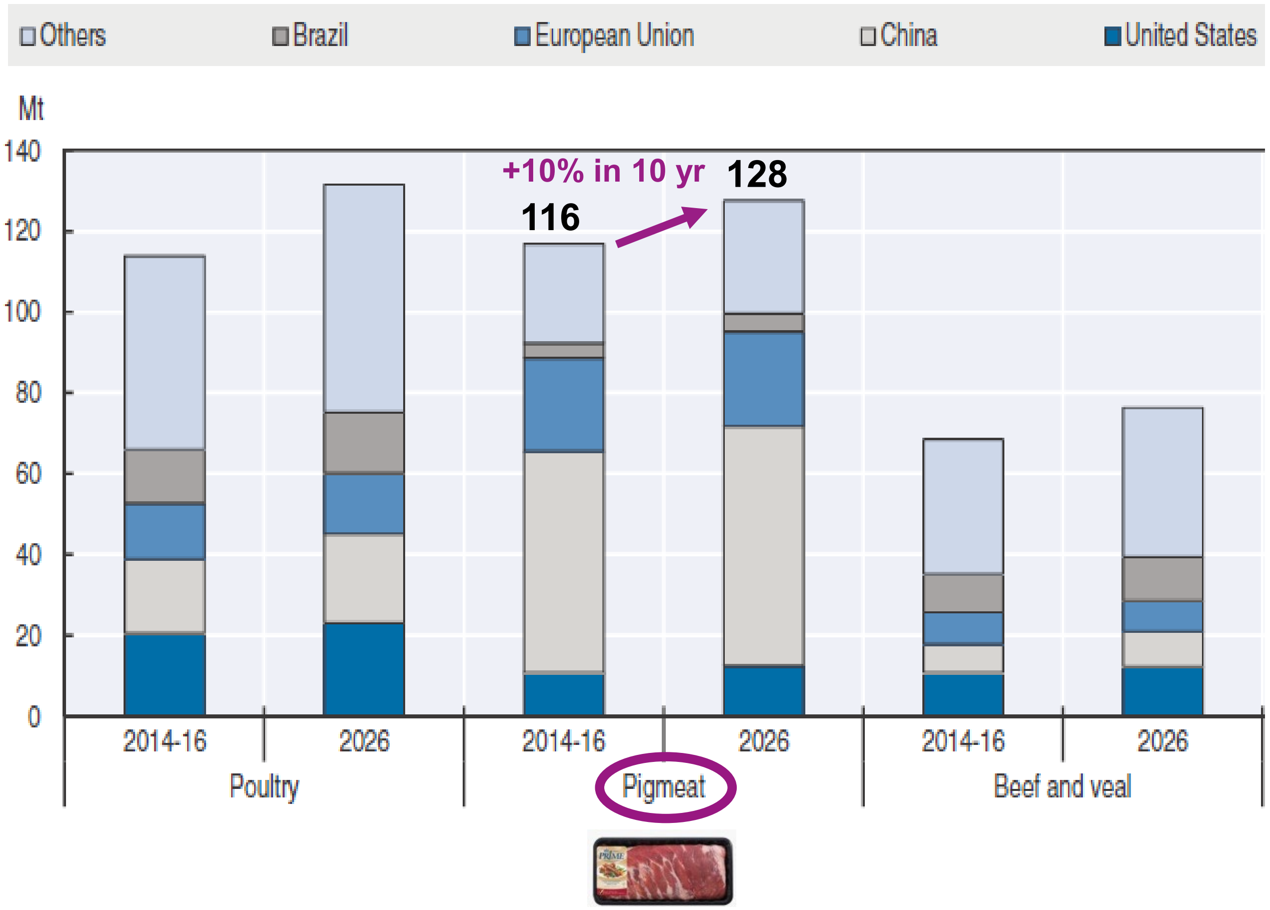
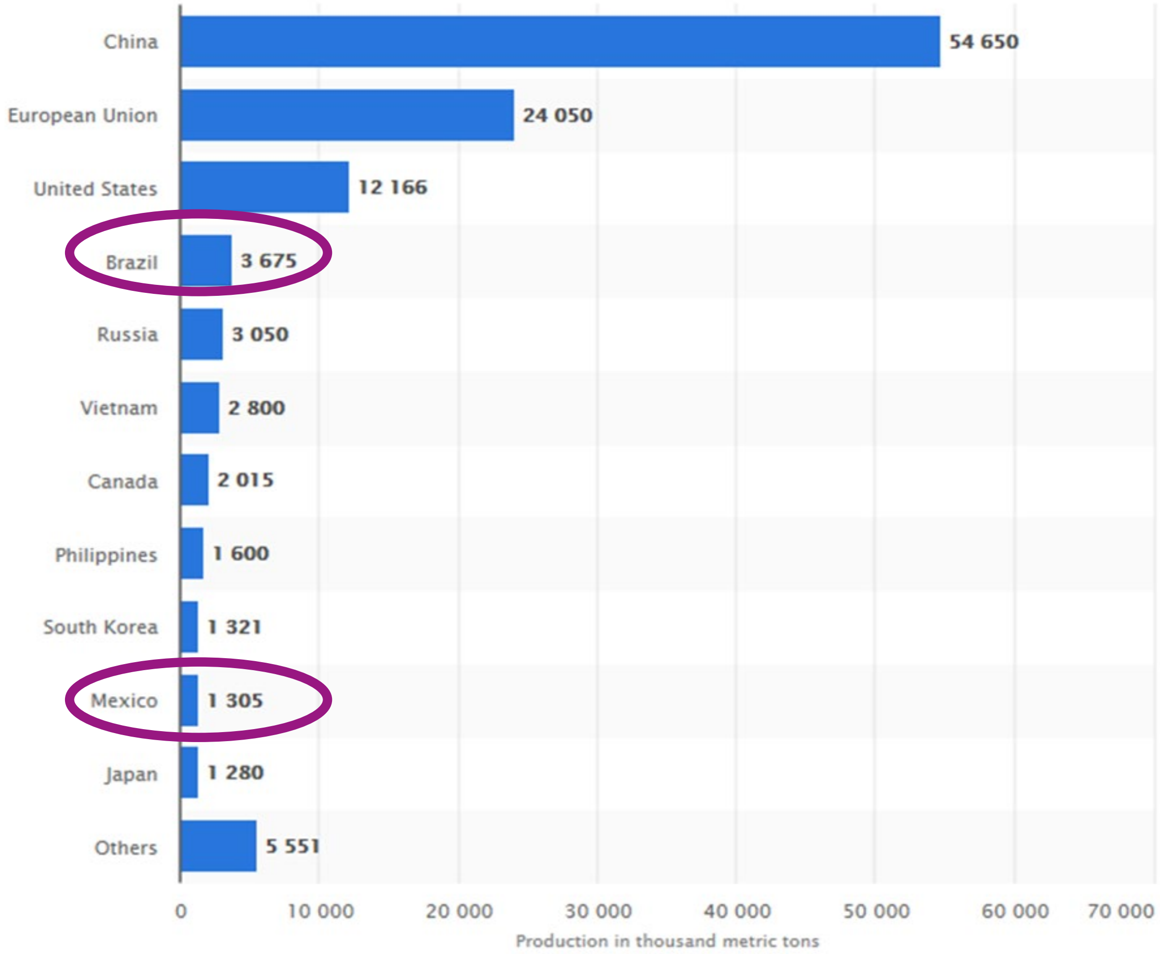
A growing demand for pork and other meat production



OECD-FAO AGRICULTURAL OUTLOOK 2017-2026 © OECD/FAO 2017

Top 11 pork production countries (2018)



US department of Agriculture

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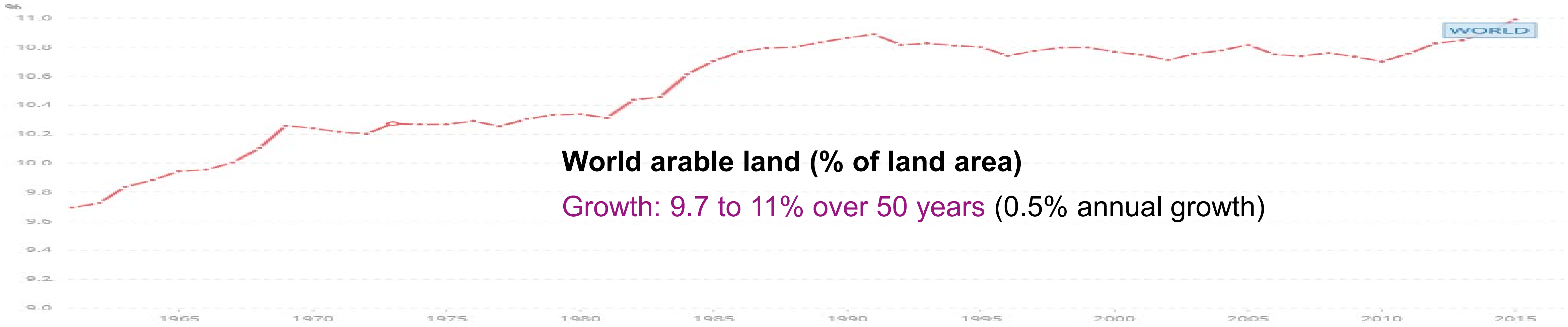
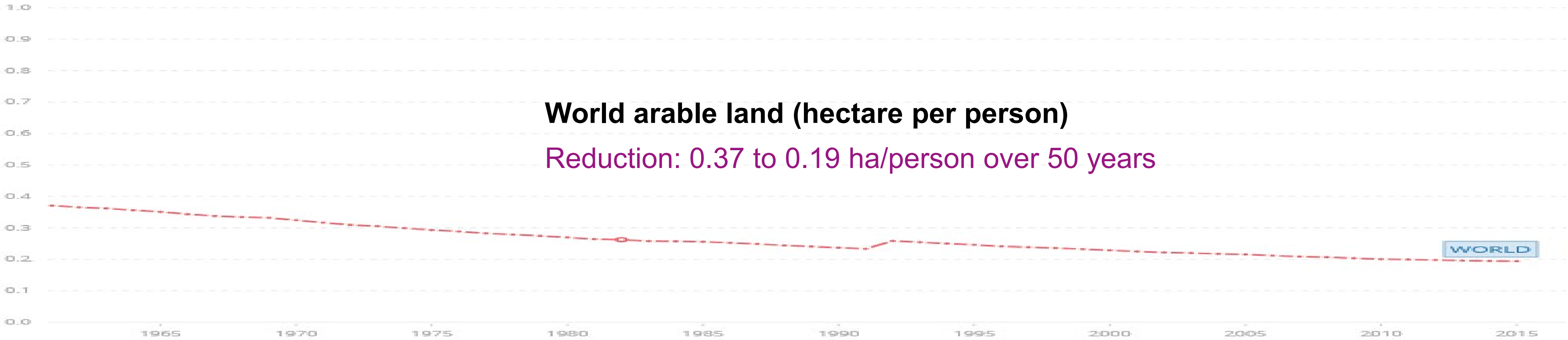
Increased animal feed needs increased amount of arable land and water



World arable land (% of land area)

Growth: 9.7 to 11% over 50 years (0.5% annual growth)

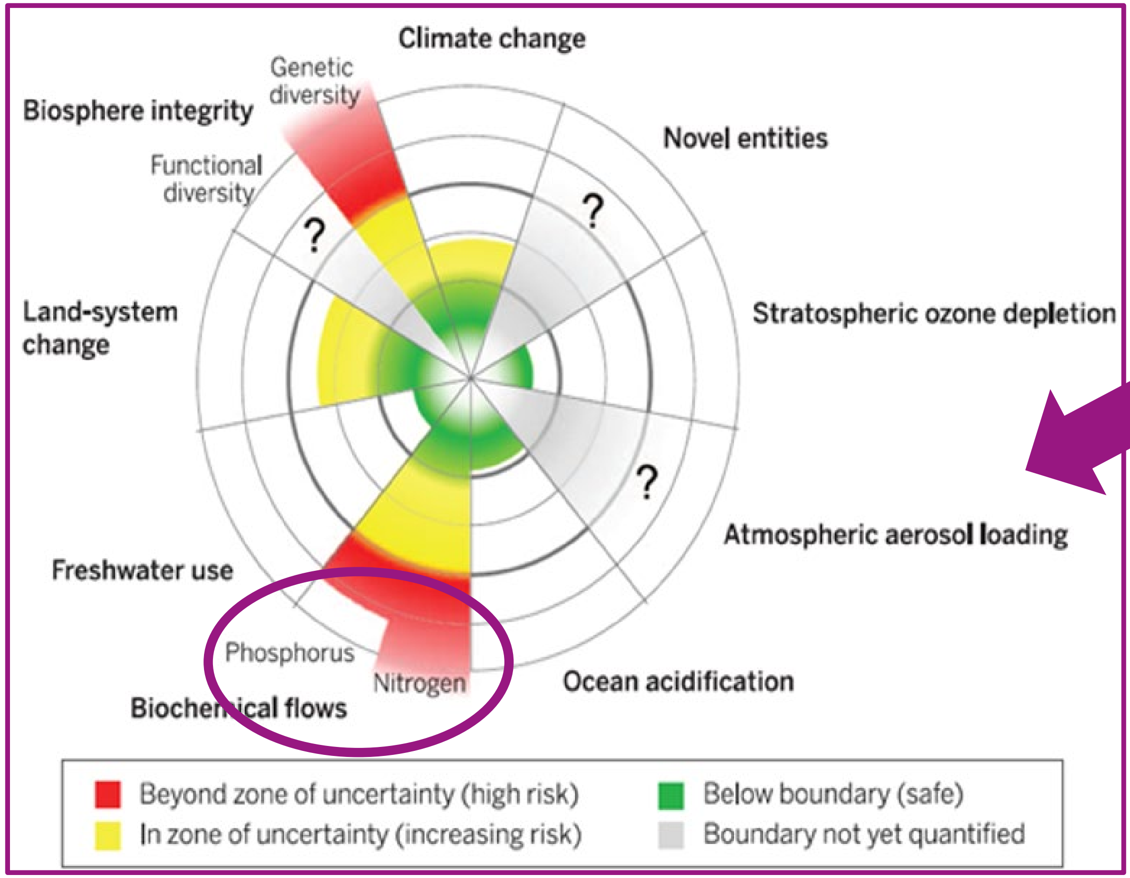


World arable land (hectare per person)

Reduction: 0.37 to 0.19 ha/person over 50 years

FAO (https://data.worldbank.org/indicator/AG.LND.ARBL.ZS)

Current planetary boundaries



Rockstroem et al. (2009)

Contribution from livestock production

- N in manure can turn into NH_3
- NH_3 emission » air pollution (PM2.5)
- Livestock: ~ 2/3 of NH_3 (GHG) from agriculture
- Pig production: 9.4% of total livestock GHG emissions (MacLeod et al., 2013)

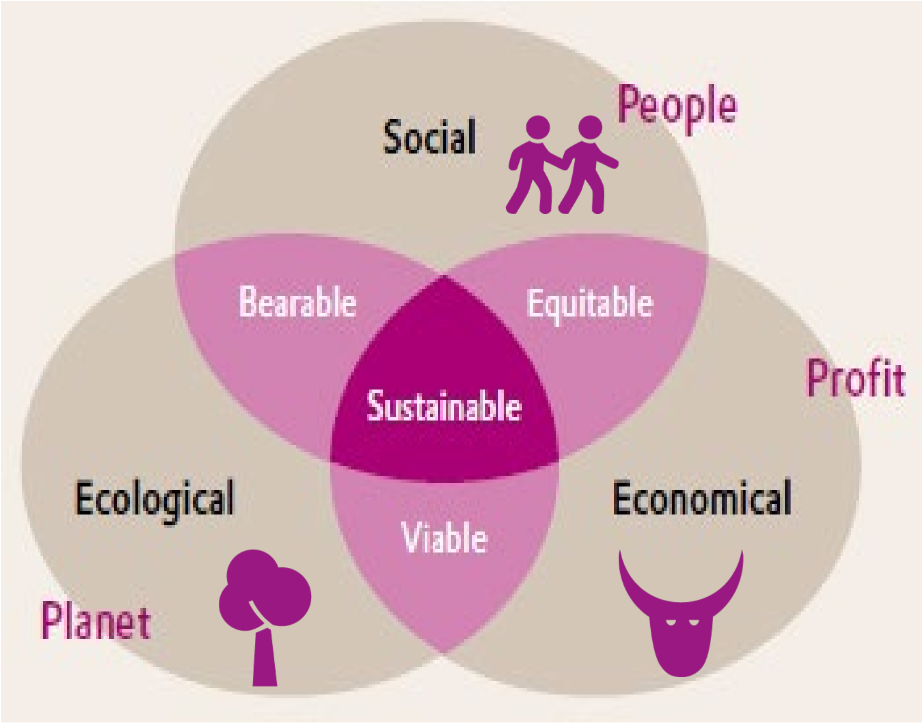
Sustainability

Sustainability

- a new megatrend and a business imperative
- "meeting the needs of the present without compromising the ability of future generations to meet their own needs" (UN commission, 1989).
  - ability to maintain a process or system

UNITED NATIONS

Triple P model



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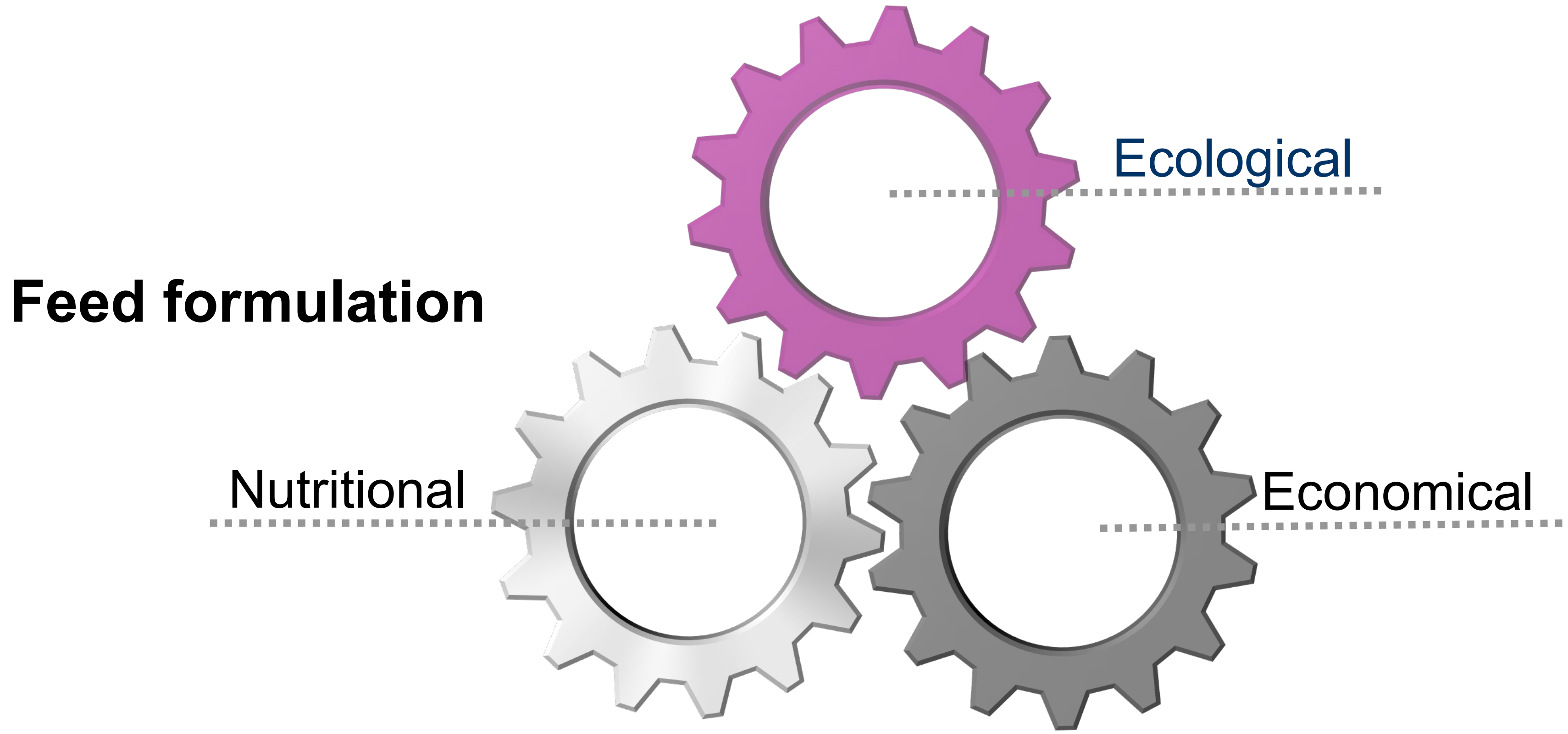
Third dimension in feed formulation

- Optimizing nutritional and economic aspects of feed formulation and feeding concepts
- low consideration for ecological, i.e. 3rd, aspect
- 3rd aspect most likely is going to change in most regions



Life Cycle Assessment (LCA)

- Process of assessing the environmental impact of products (protein sources or levels) in all stages of production, from cradle to grave (creation to disposal).
- LCA, e.g. can be conducted using GaBi software version 6 (PE INTERNATIONAL AG, 2012).
- Calculates global warming potential (GHG emission as CO_2e), eutrophication potential (EP as PO_4e) and the acidification potential (AP as SO_2e).

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- Eco design verified
- LCA verified

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Consequences: increased regulation toward minimizing N/P pollution

With growing demand for food, it is necessary to reduce the global environmental footprint of food production.

GHG emission target (2020 vs. 1990)

- **EU: 20%** reduction
- **Germany: 40%** (1,252 mil. ton CO_2e)

  New fertilizer ordinance (2017)
- **France: 12% reduction** from agri. GHG emissions (2028 vs. 1990)

Solutions to mitigate pollution

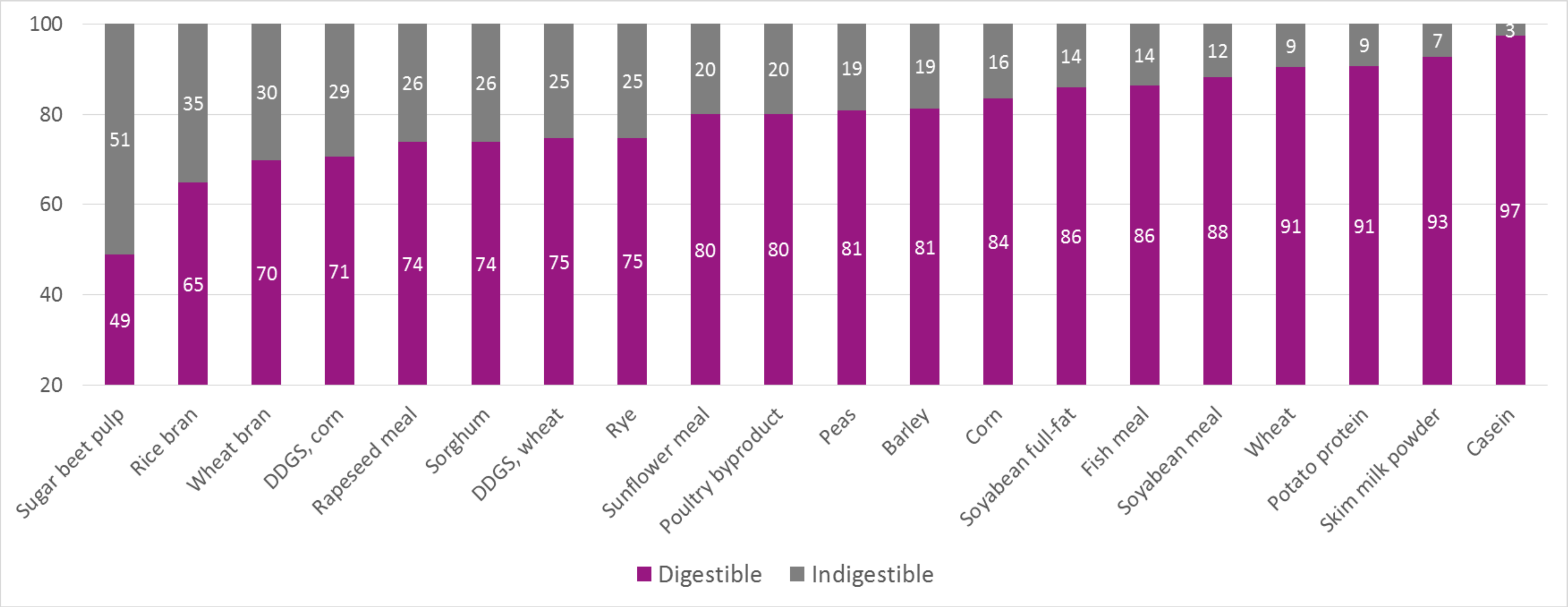
- Low CP-AA diets (minimize N output; improve efficiency)
- Increased use of alternative / local feedstuffs (insect meal, DDGS,…)
- Genetic potentials (breeding)
- Enzymes, probiotics, prebiotics, organic acids

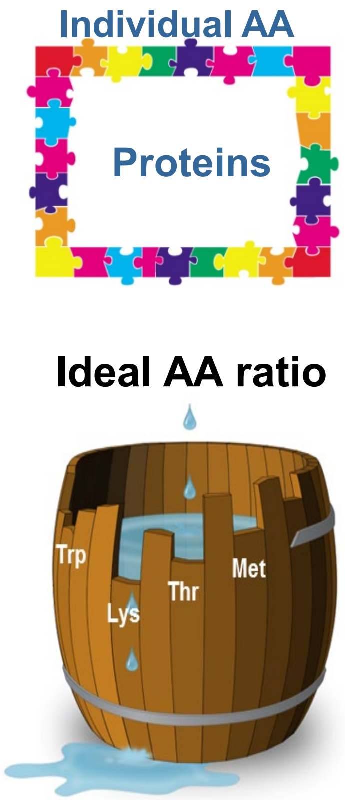
How low can we go with reducing CP content in pig diets?

Not all crude protein and amino acids in ingredients are digestible

Crude Protein = N x 6.25

Animals need amino acids for body protein synthesis





- Protein synthesis is “**all or nothing**”.
- **Lys** is the first limiting AA in typical pig diets (followed by Thr, Met and Trp, Val and Ile)

Source: Evonik review

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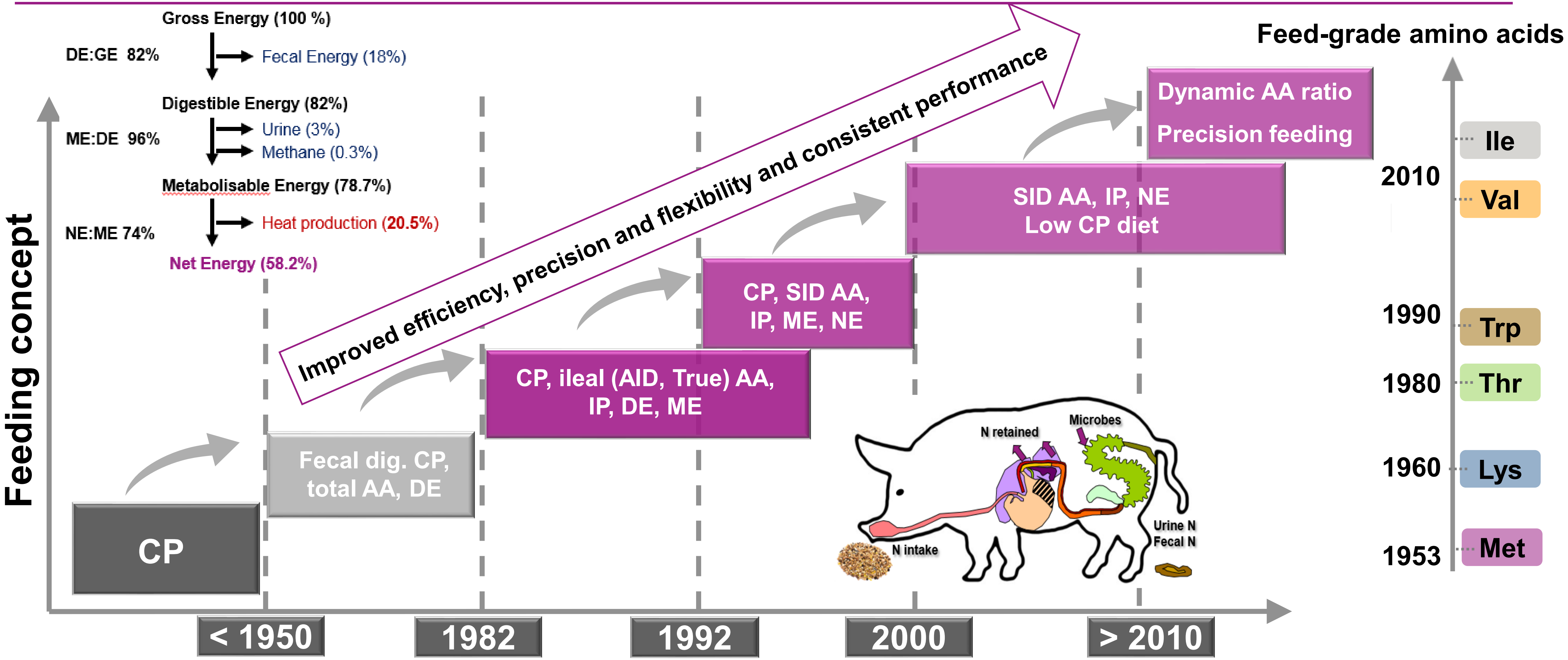
Recommendations for Swine
amino acids and more.

Advancement of feeding concepts for swine



Improving the efficiency of pig production towards sustainability

Factors affecting efficiency

- Over or under supply of nutrients (AA) in the diets
- Poor (gut) health or immune status / AGP-free feeding
- ANFs (fiber)
- Stress (weaning, oxidative, heat)

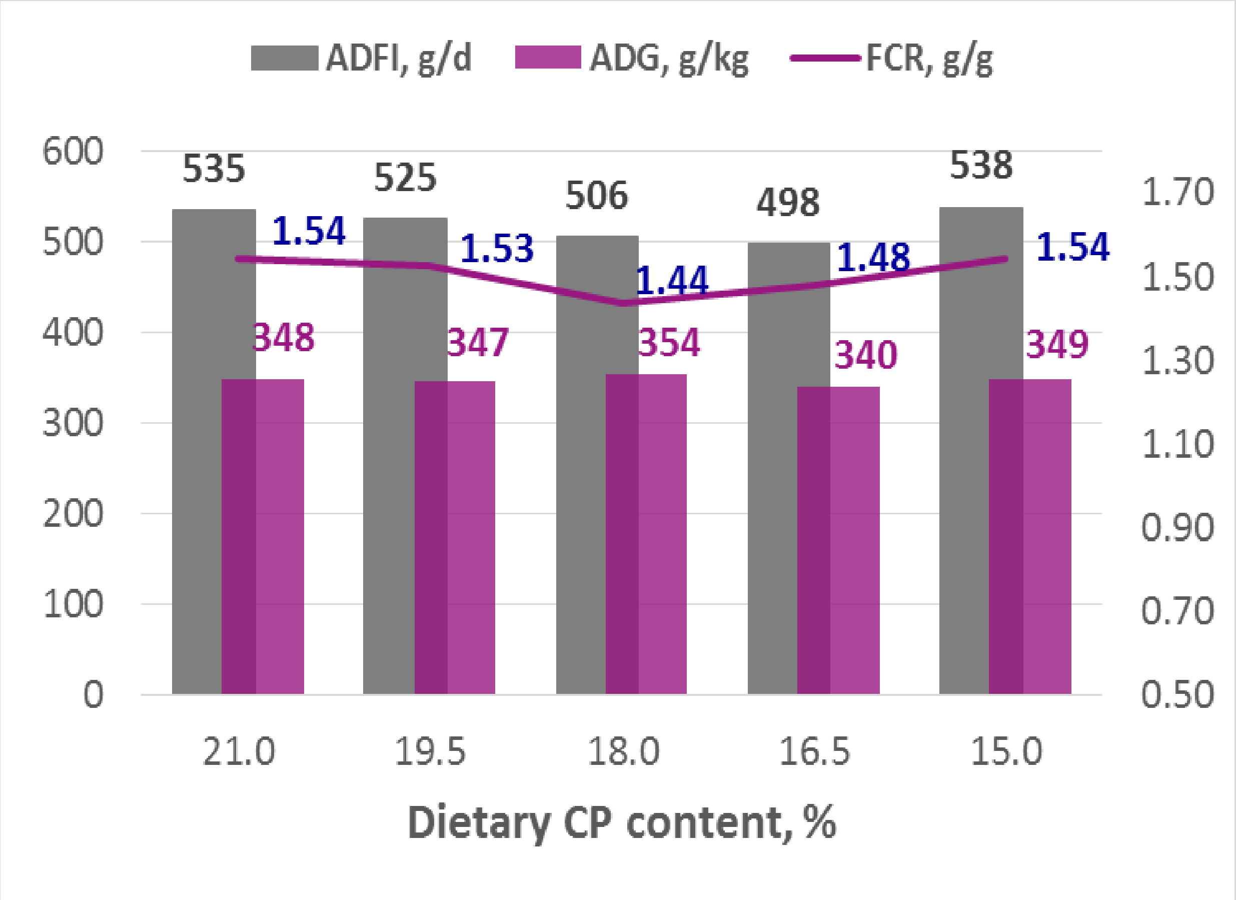
Improving efficiency

- Integrated low CP-AA diets (synergy with pro- & pre-biotics)
- Rapids NIR analysis of nutrients
- Precision nutrition
- Dynamic AA concept

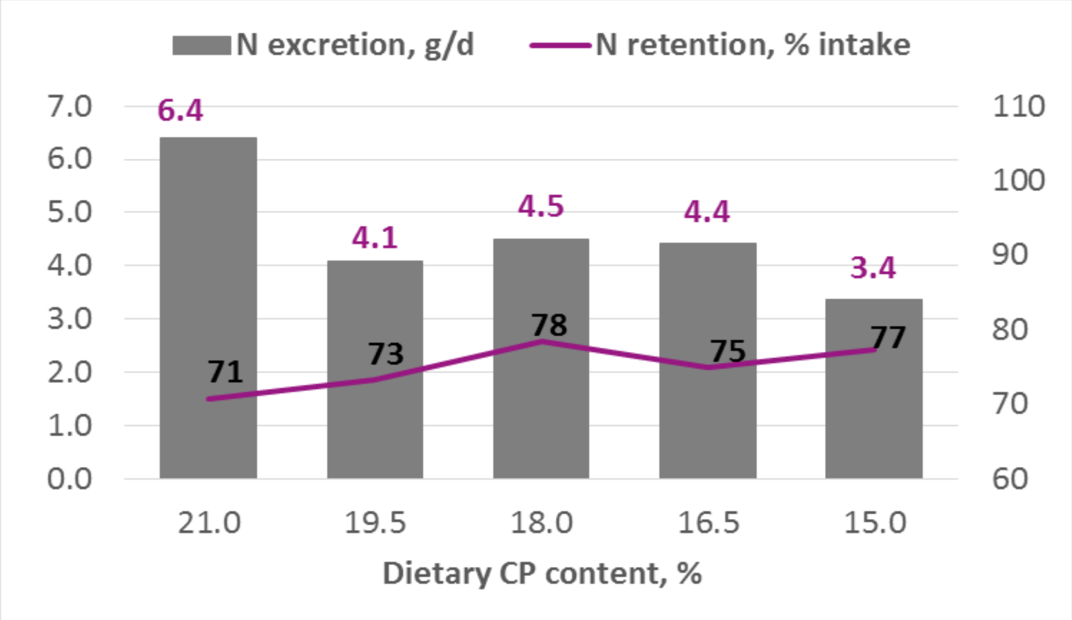
Improving efficiency

Sustainability

Reduction of dietary CP (6%-unit) on performance and N excretion in weaned pigs



Animals	120 pigs for growth trial (initial BW 6 kg; 28 d) 20 barrows for N-balance (initial BW 10.8 kg)
Treatments	5 CP levels (21, 19.5, 18, 16.5, 15%)
Diets	Corn, SBM, skim milk,Lys, Thr, Met, Trp, Val, Ile
Formulation	Same SID AA, ME and electrolyte balance



Toledo et al. (2014)

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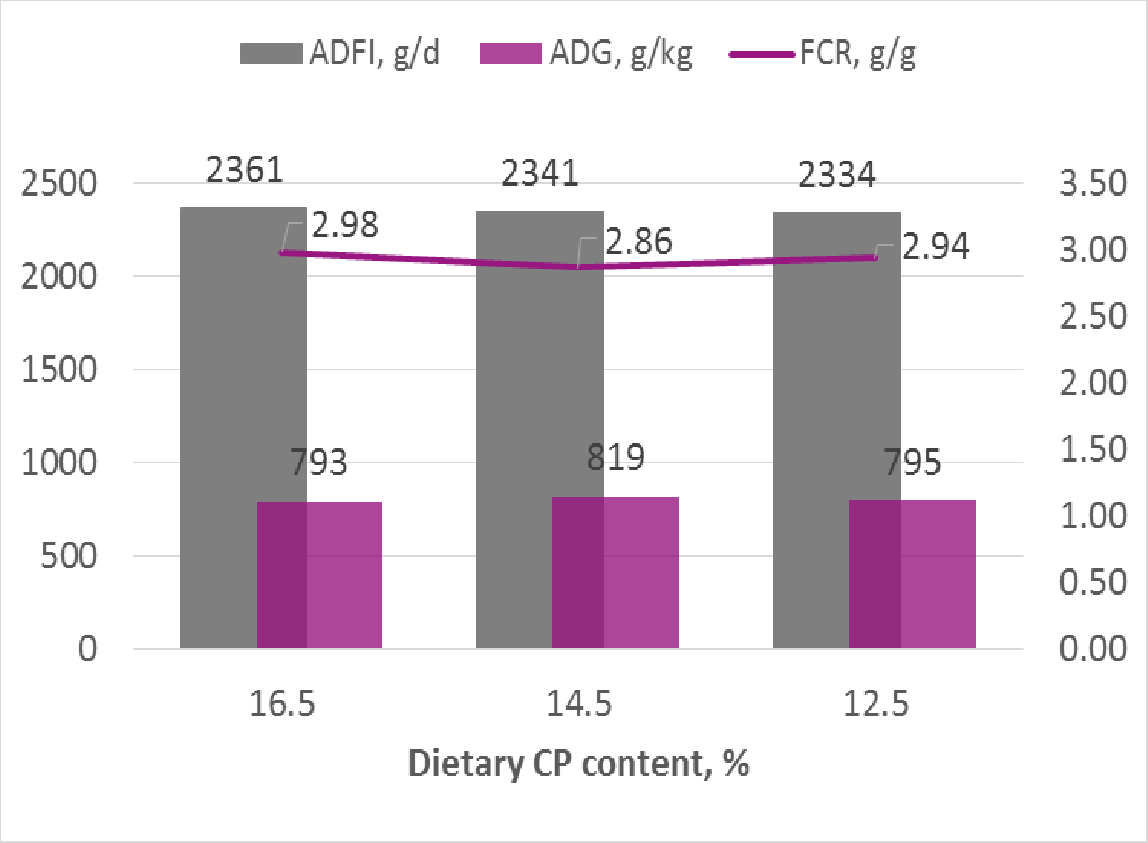
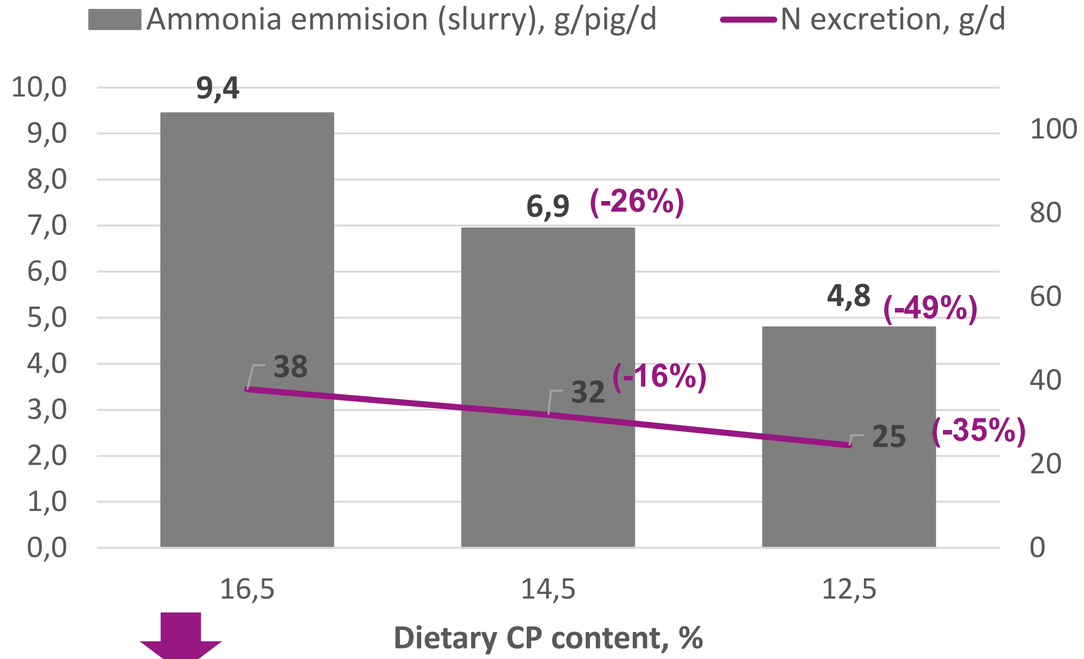
Reduction of dietary CP (4%-unit) on performance and ammonia emission in growing pigs



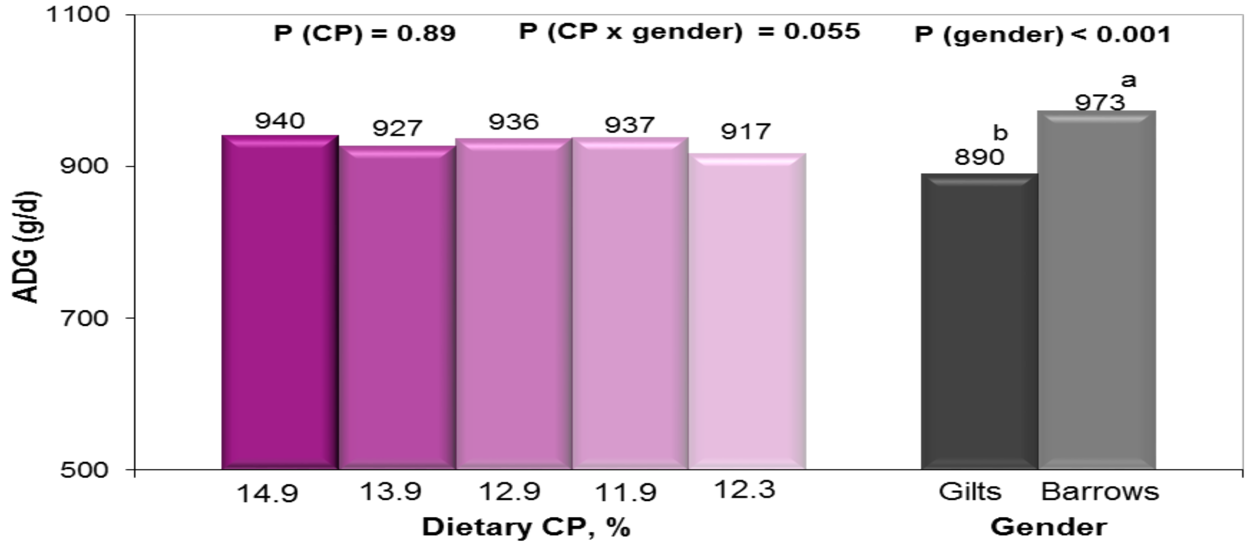
Animals	18 barrows for N-balance (initial BW 55 kg) 216 pigs for growth trial (initial BW 52 kg; 64 d)
Treatments	3 CP levels (16.5, 14.5, 12.5%)
Diets	Barley-wheat-SBM-Lys, Thr, Met, Trp
Formulation	Same SID AA and NE



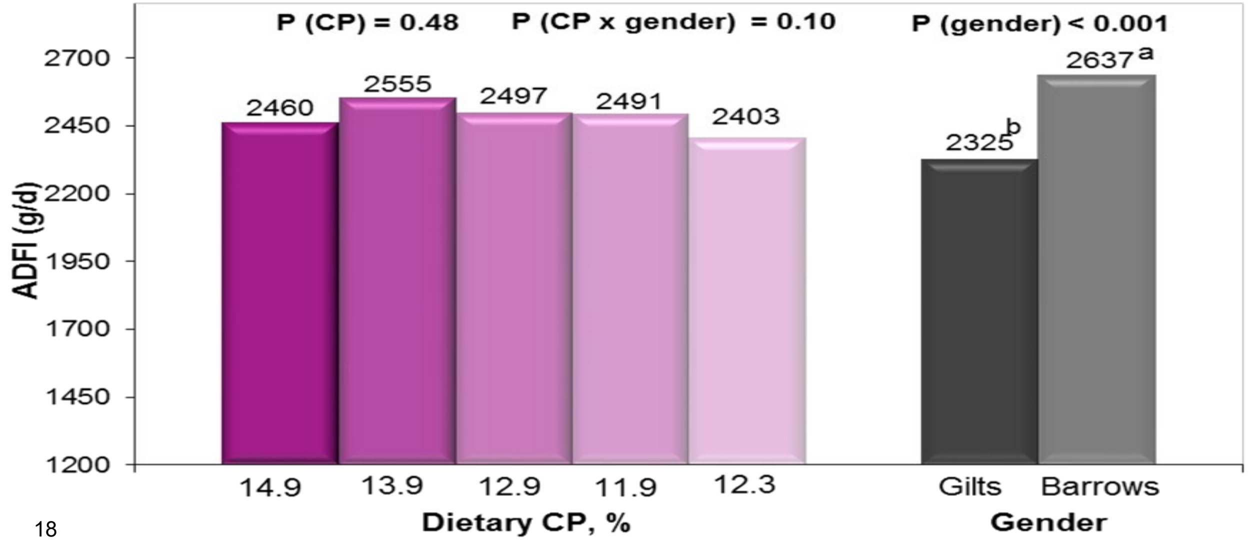
Canh et al. (1998)

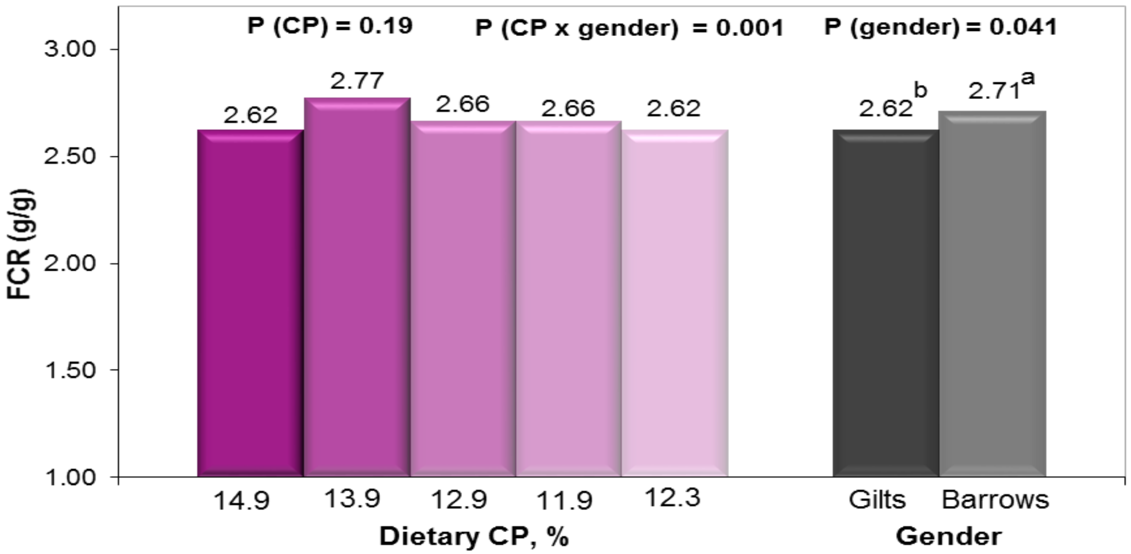
1%-point CP reduction results about 12% reduction in NH_3 emission.

Reduction of dietary CP (3%-unit) on performance of grower-finisher pigs (27-115 kg BW; 3 phases)



14.9% CP	Normal CP diet (Grains + normal SBM + 4 AA)
13.9% CP	Reduced CP diet (Grains + reduced SBM + 5 AA)
12.9% CP	Low CP diet (Grains + very low SBM + 9 AA)
11.9% CP	Extremely low CP diet (Grains + without SBM + 9 AA)
12.3% CP	Extremely low CP diet (Grains + without SBM + 12 AA)





Evonik Trial # 13.62.17001

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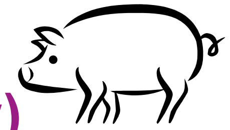
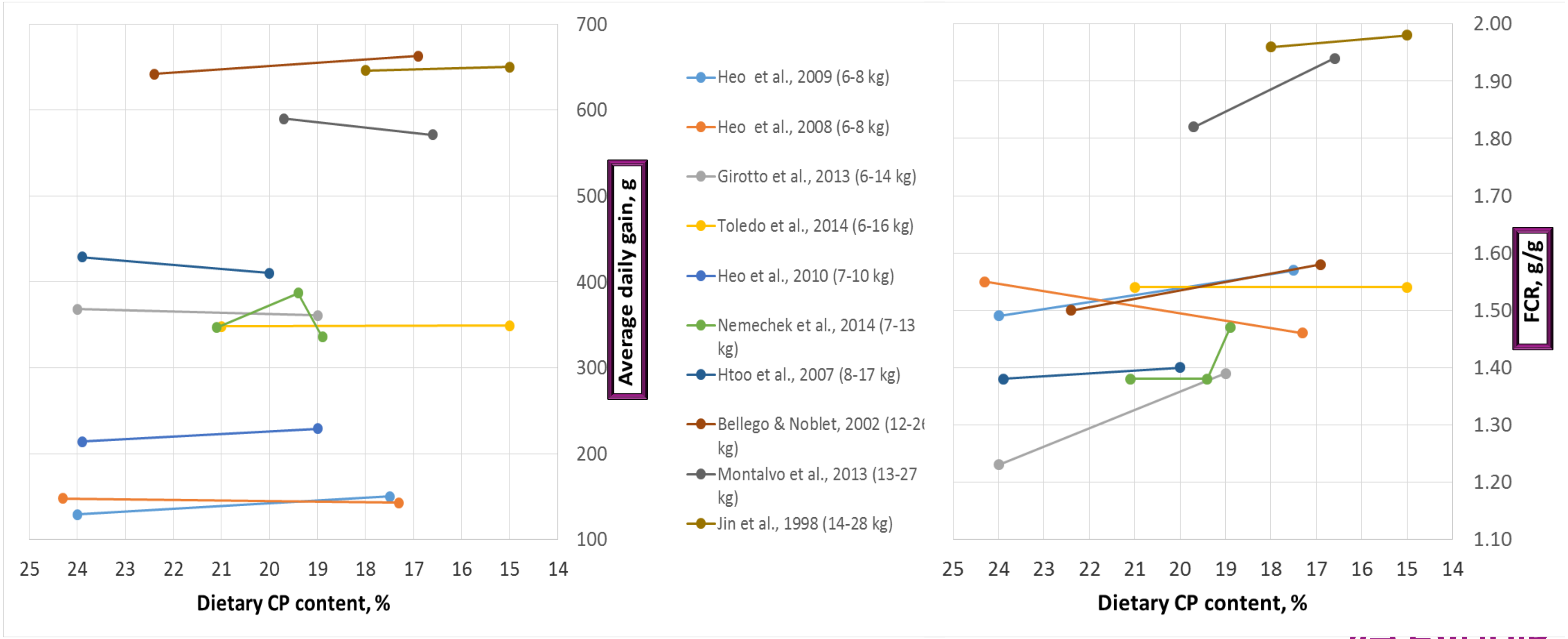
Reducing dietary CP did not compromise ADG and FCR of 6-28 kg pigs (Overview)

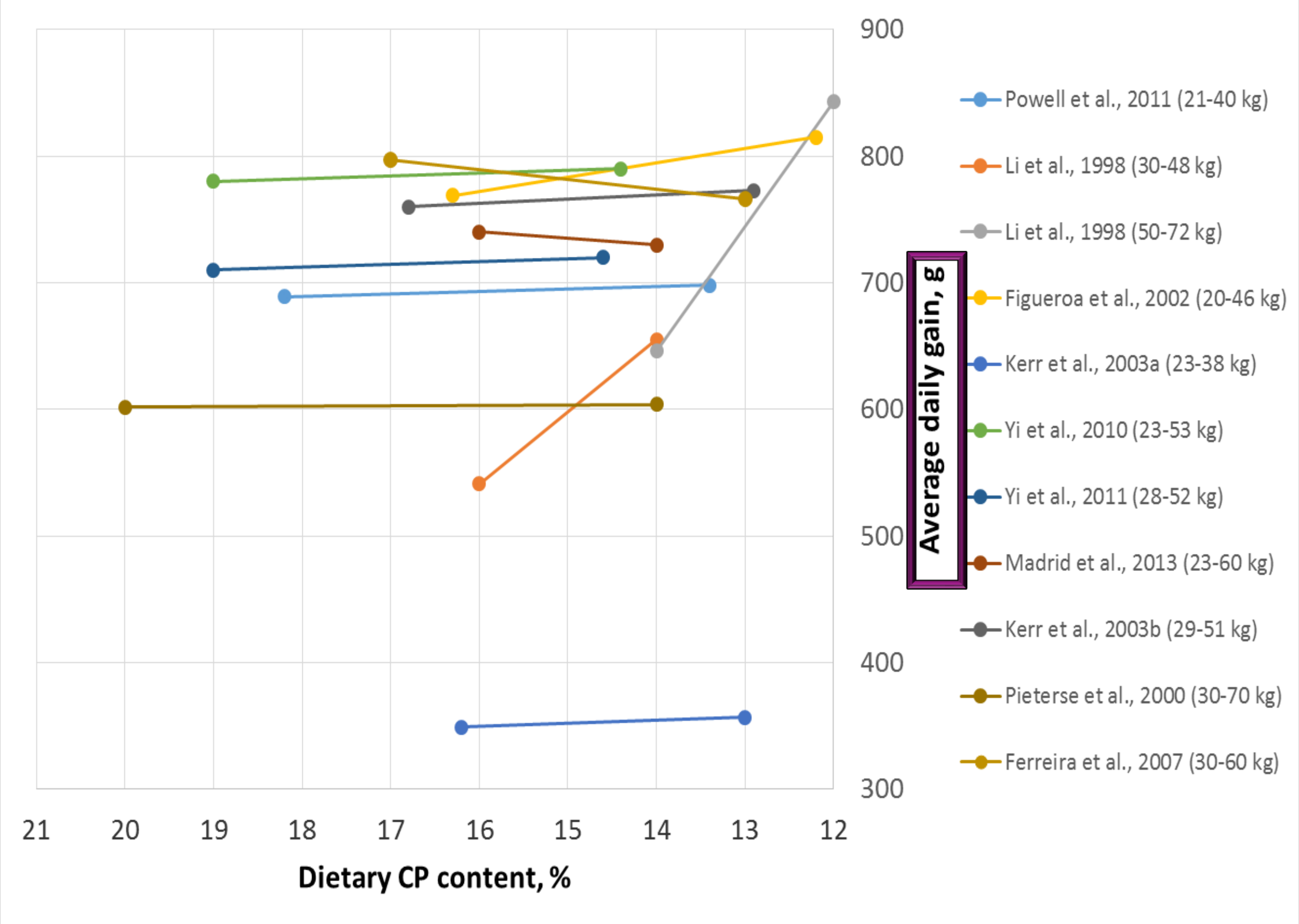


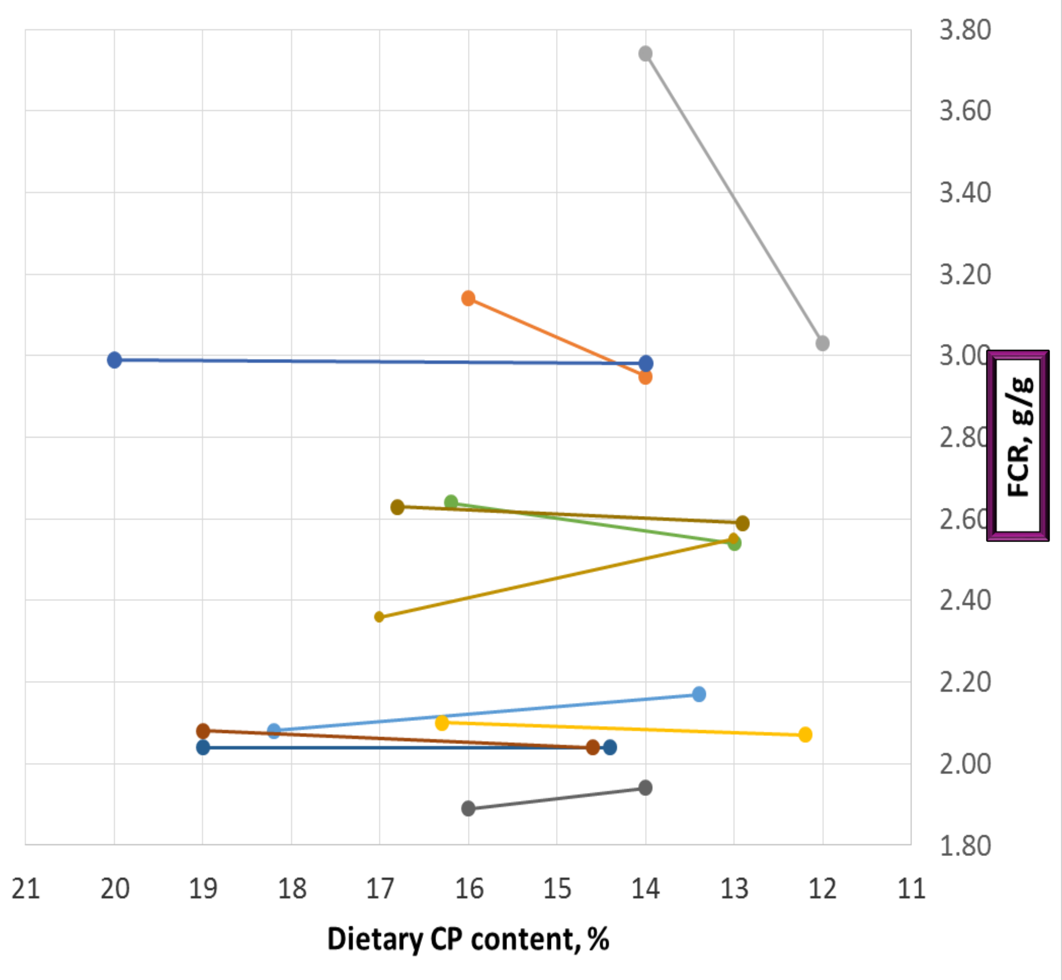
10 trial results (1998-2014); CP reduction: 2 to 7%-points



Reducing dietary CP did not compromise ADG and FCR of 20-72 kg pigs (Overview)

11 trial results (1998-2011); CP reduction: 2 to 6%-points





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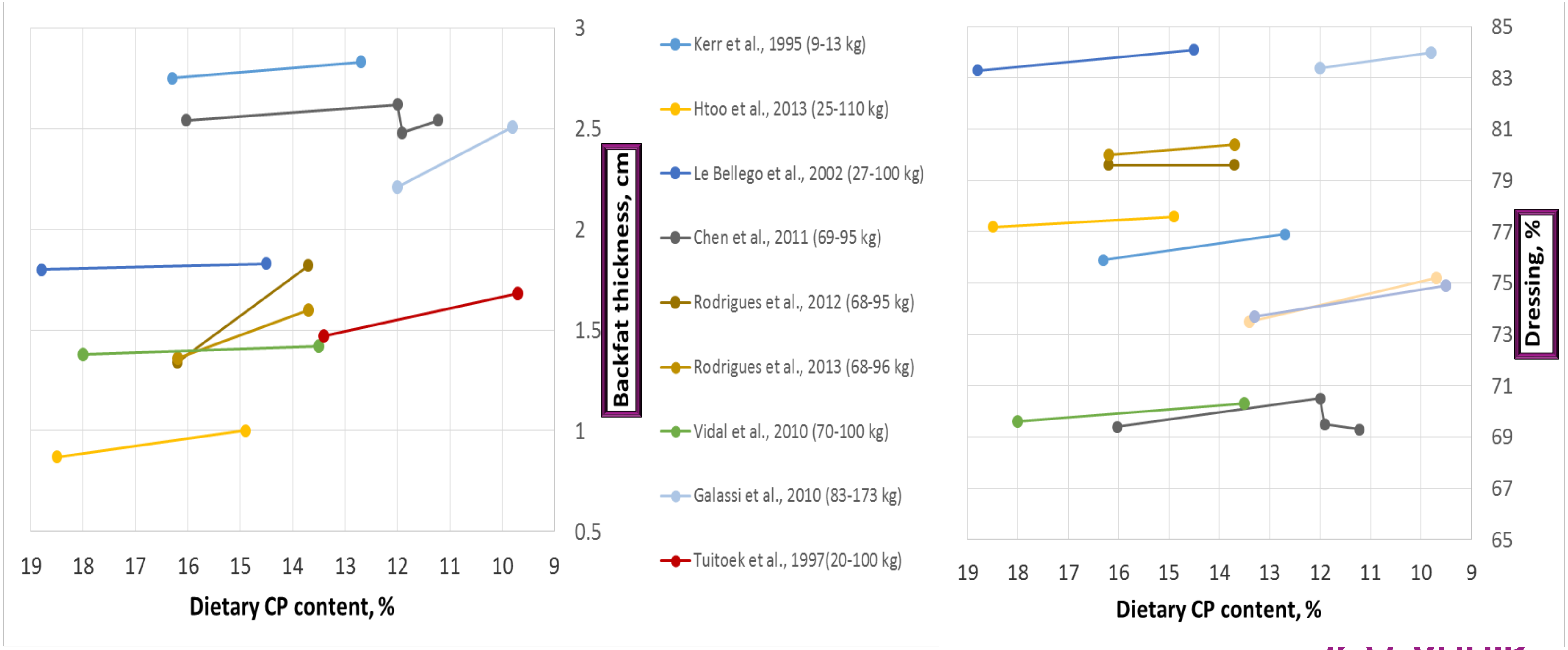
Reducing dietary CP did not compromise backfat and dressing % of finishing pigs

9 trial results (1995-2013); CP reduction: 2 to 4.5%-points

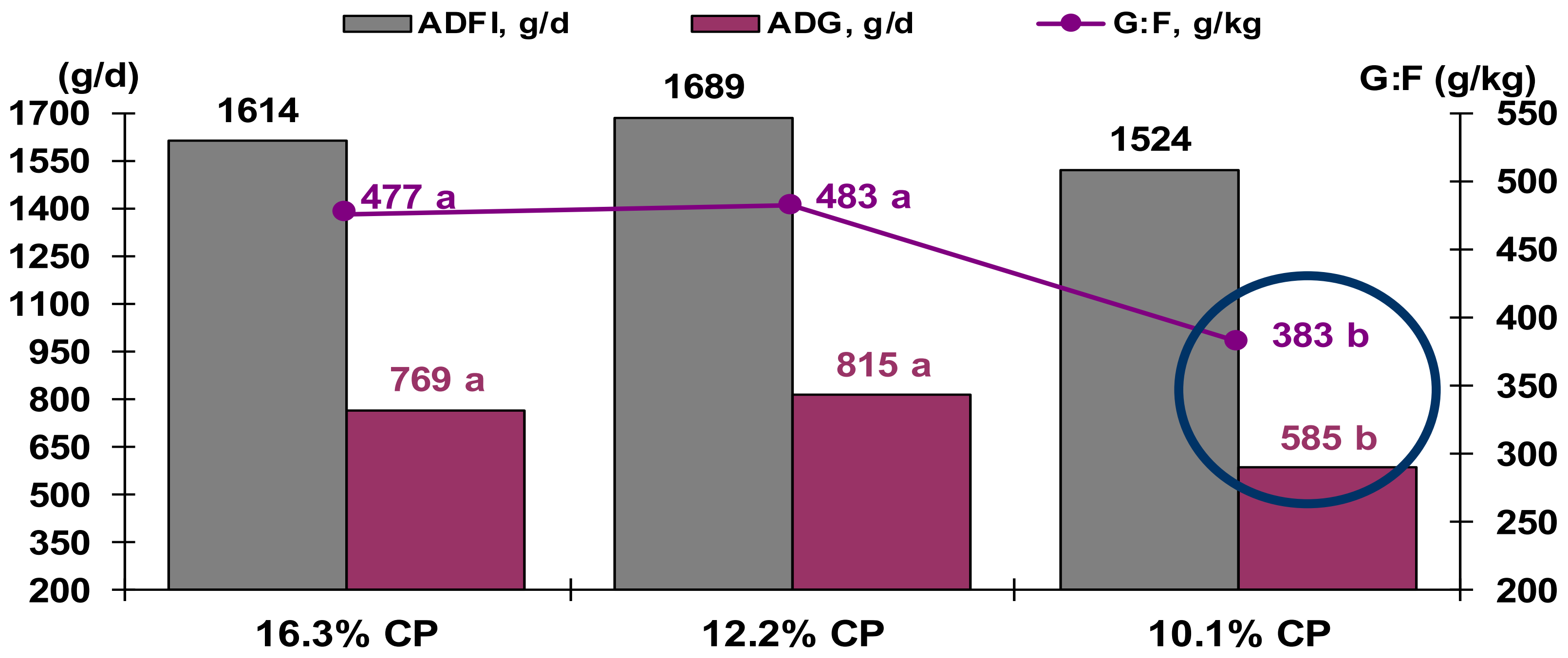


Amino acids deficiency reduced performance of 20-49 kg pigs (35-d)

CP, %*	NE, MJ/kg (kcal/kg)	Total Lys, %	4 EAA level	EAA added	Trp:Lys, %	Val:Lys, %	Ile:Lys, %	Lys:CP, %
16.3	9.81 (2344)	0.79	Adeq.	-	20	89	78	4.8
12.2	9.92 (2370)	0.76	Adeq.	4	18	67	54	6.2
10.1	9.96 (2380)	0.73	Adeq.	4	15	59	44	7.2

* Lowering CP by replacing of SBM with free AA.

[a,b] Sig. different (P<0.05)



Figueroa et al. (2002)

Effect of reducing dietary CP on growth of 12-22 kg pigs (21-d)

CP, %[1]	NE, MJ/kg	SID Lys, %	EAA level	EAA added	NEAA added[2]	EAA:NEAA	SID Lys:CP[3], %	Elec. balance, mEq/kg
17.4	10.25	0.96	Adeq.	**4**	-	46:54	5.5 (6.2)	**180**
15.3	10.30	0.94	Adeq.	**5**	-	46:54	6.1 (6.7)	**180**
13.4	10.30	0.92	Adeq.	**9**	-	49:51	6.9 (7.4)	**180**
11.6	10.33	0.89	Adeq.	**9**	-	53:47	7.7 (8.2)	**180**
12.5	**10.55**	**0.92**	**Adeq.**	**10**	**3**	**46:54**	**7.4 (7.8)**	**180**
13.4	10.77	0.93	Adeq.	**10**	**3**	42:58	6.9 (7.3)	**180**

[1]**Diets 1-4**: Grains-SBM-AA based; **Diets 5-6**: Grains-AA diets; [2]**Glu, Gly, Pro;** [3]Lys:CP in parenthesis.

	Grains-SBM-free AA diets				**Grain-free AA diets**	
CP, %	**17.3**	**15.3**	**13.4**	**11.6**	**12.5**	**13.4**
Final BW, kg	22.2 [a]	22.2 [a]	21.9 [a]	20.1 [b]	21.8 [a]	22.3 [a]
Feed intake, g/d	766	775	779	734	810	782
ADG, g/d	450 [a]	454 [a]	442 [a]	358 [b]	420 [a]	451 [a]
Gain:feed, g/g	0.59 [a]	0.59 [a]	0.57 [a]	0.49 [b]	0.52 [b]	0.58 [a]

[a,b] Within a row, values with different letters are different ($P < 0.05$).

Gloaguen et al. (2014)

Low CP diet is advantageous for pigs raised under hot climatic condition
(68-95 kg pigs; 30-d)

CP, %	Ingredients*	Temp, °C	ME, MJ/kg	SID Lys, %	EAA level	EAA added	SID Lys:CP, %	EB,** mEq/kg
16.2	Corn, SBM	19	**13.6**	0.75	Adeq.	2	4.6	158
13.7	Corn, SBM	19	**13.6**	0.75	Adeq.	4	5.5	158
16.2	Corn, SBM	31	**13.6**	0.75	Adeq.	2	4.6	158
13.7	Corn, SBM	31	**13.6**	0.75	Adeq.	4	5.5	158

*Contained 4.5% oil. **Electrolyte balance** = (**Na + K - Cl**); **SBM contains 2-2.2% of K**.

	Cool room, 19° C		Hot room, 31° C	
	16.2% CP	**13.7% CP**	**16.2% CP**	**13.7% CP**
Feed intake, kg/d	2.771	2.874	2.362[b] ↓	2.594[a]
ADG, kg/d	0.970	0.981	0.838[b]	0.945[a]
FCR, g/g	2.87	2.94	2.82	2.75
Dressing, %	79.6	79.6	80.0	80.4
Carcass lean, %	61.0	57.7	61.4	59.6
Backfat, cm	1.34[b]	1.82[a] ↑	1.36[b]	1.60[a] ↑

[a,b] Within a row, values with different letters are different (*P* < 0.05).

Rodrigues et al. (2012)

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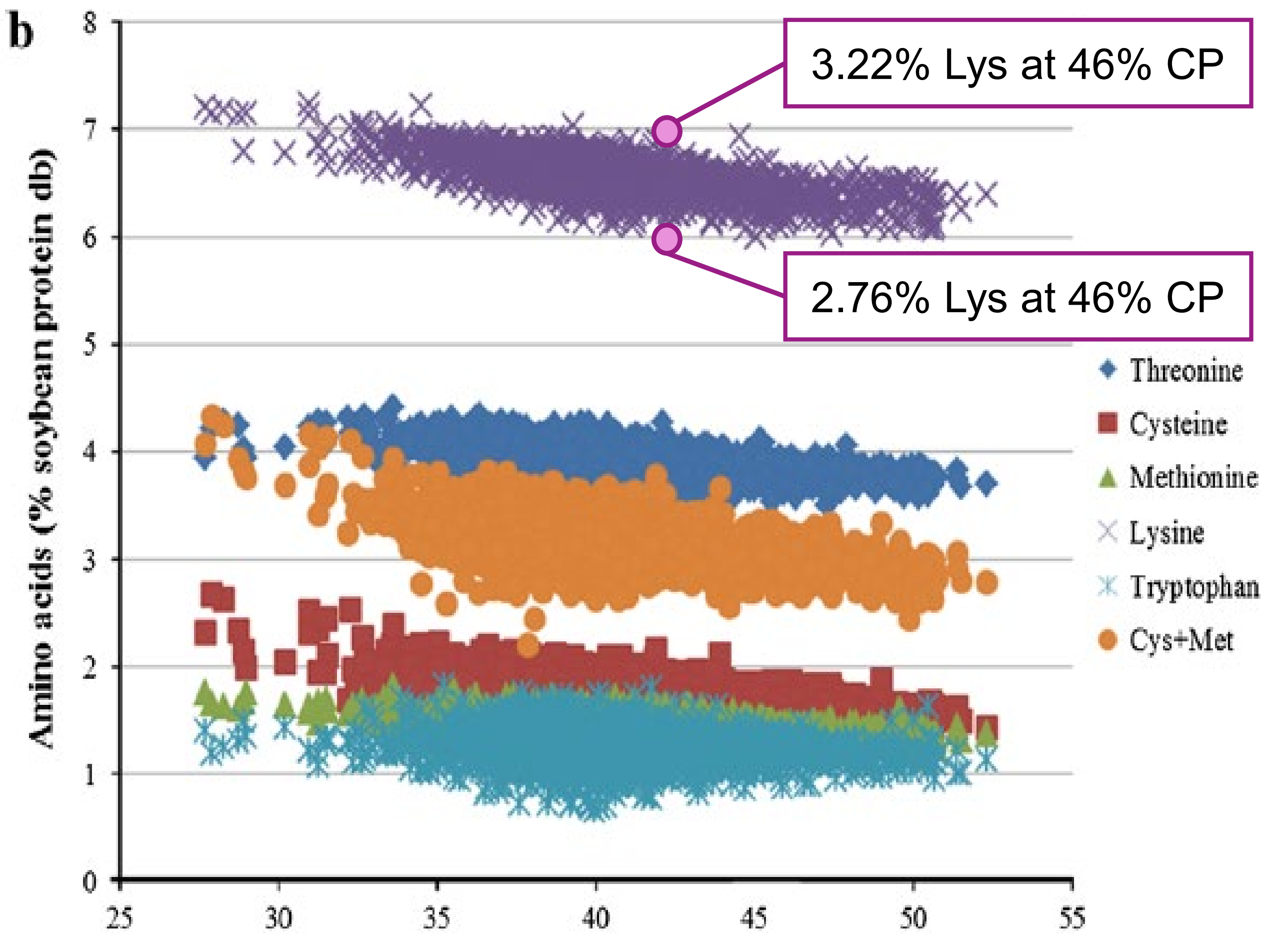
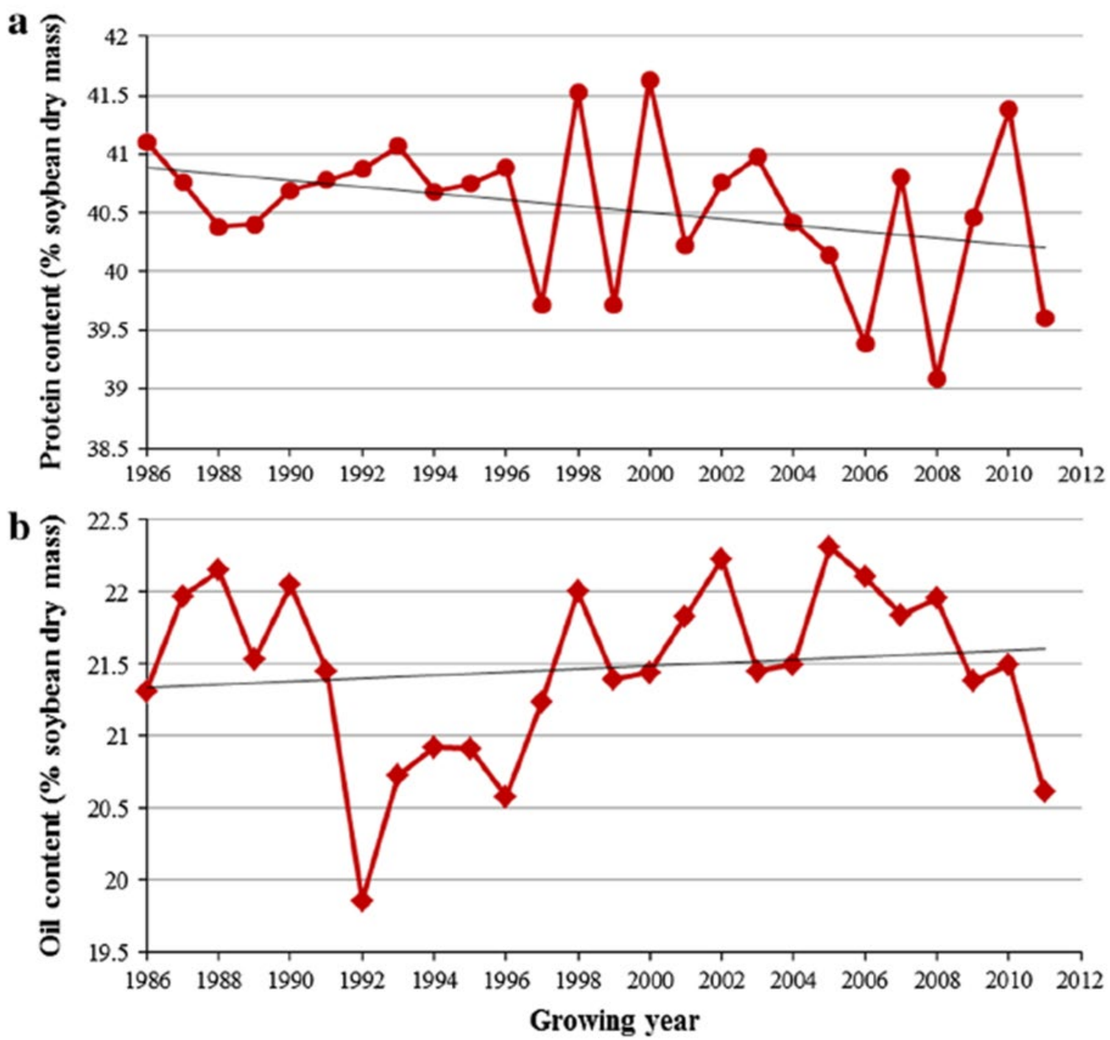
Reasons for the inconsistent results with feeding pig low CP-AA diets and suggested solutions

Reasons	Solutions
Diet formulation on the basis of total AA content	Rapid analysis of ingredients (CP, AA) and convert to SID AA (AMINONIR; AMINODat 5.0)
Deficiency of the next limiting AA (Val and Ile)	Recommendations for SID AA and IP concept (AMINODat 5.0; NRC, 2012; Brazilian Table)
Deficiency of NEAA or N (> 5 %-pt CP)	SID Lys:CP <**6.9%** (7.4% total Lys:CP) essential N:total N **48:100** (Heger et al. 1998)
DE or ME often lead to a greater backfat thickness	NE based feed formulation Rapid analysis of energy (AMINONRG; Brazilian Table)

Essential AA:CP decreases with increasing CP in Soybeans → there is a trend of decreasing CP and increasing oil contents





Medic et al. (2014)

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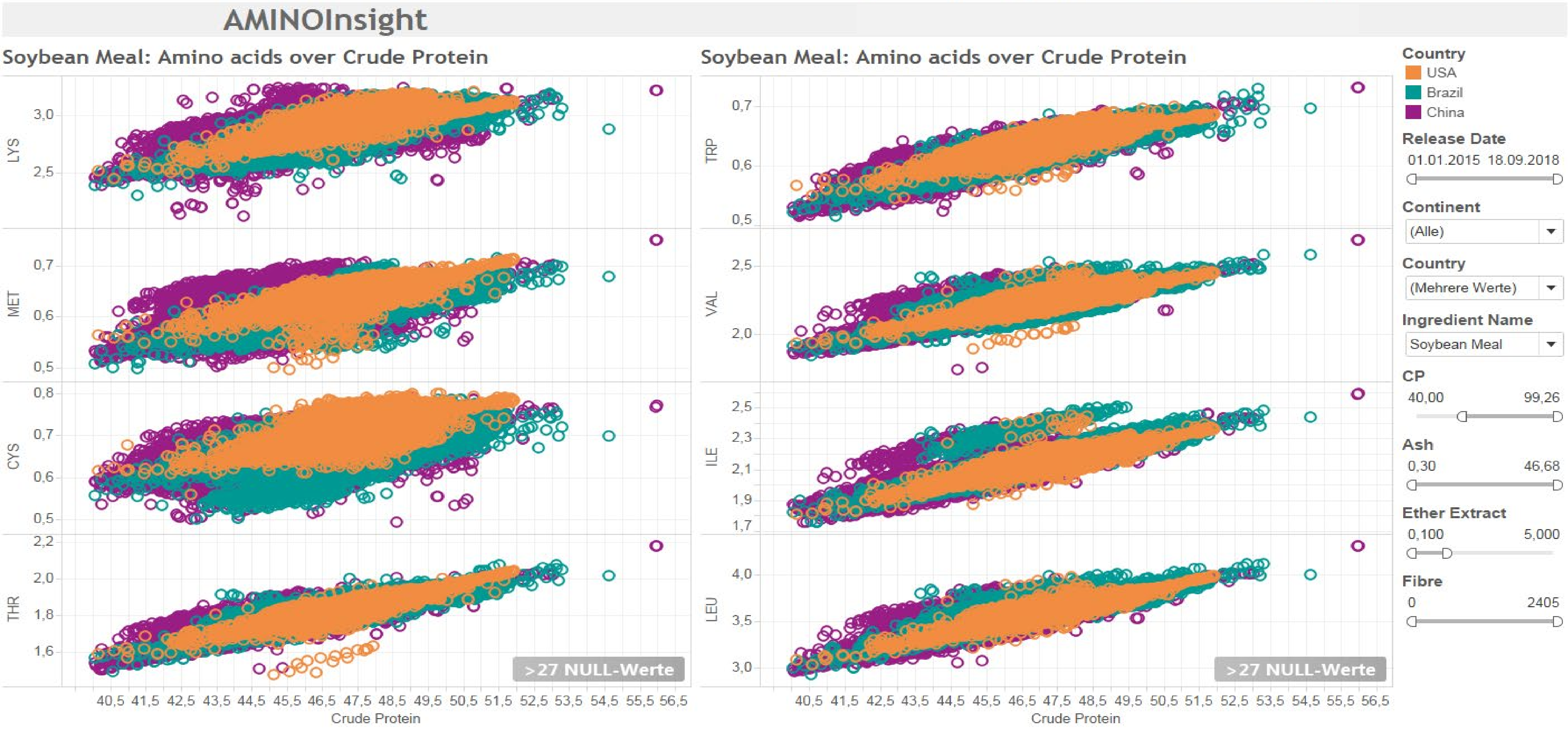
NIR - AA to CP ratios: higher variation in Chinese soybean meal samples



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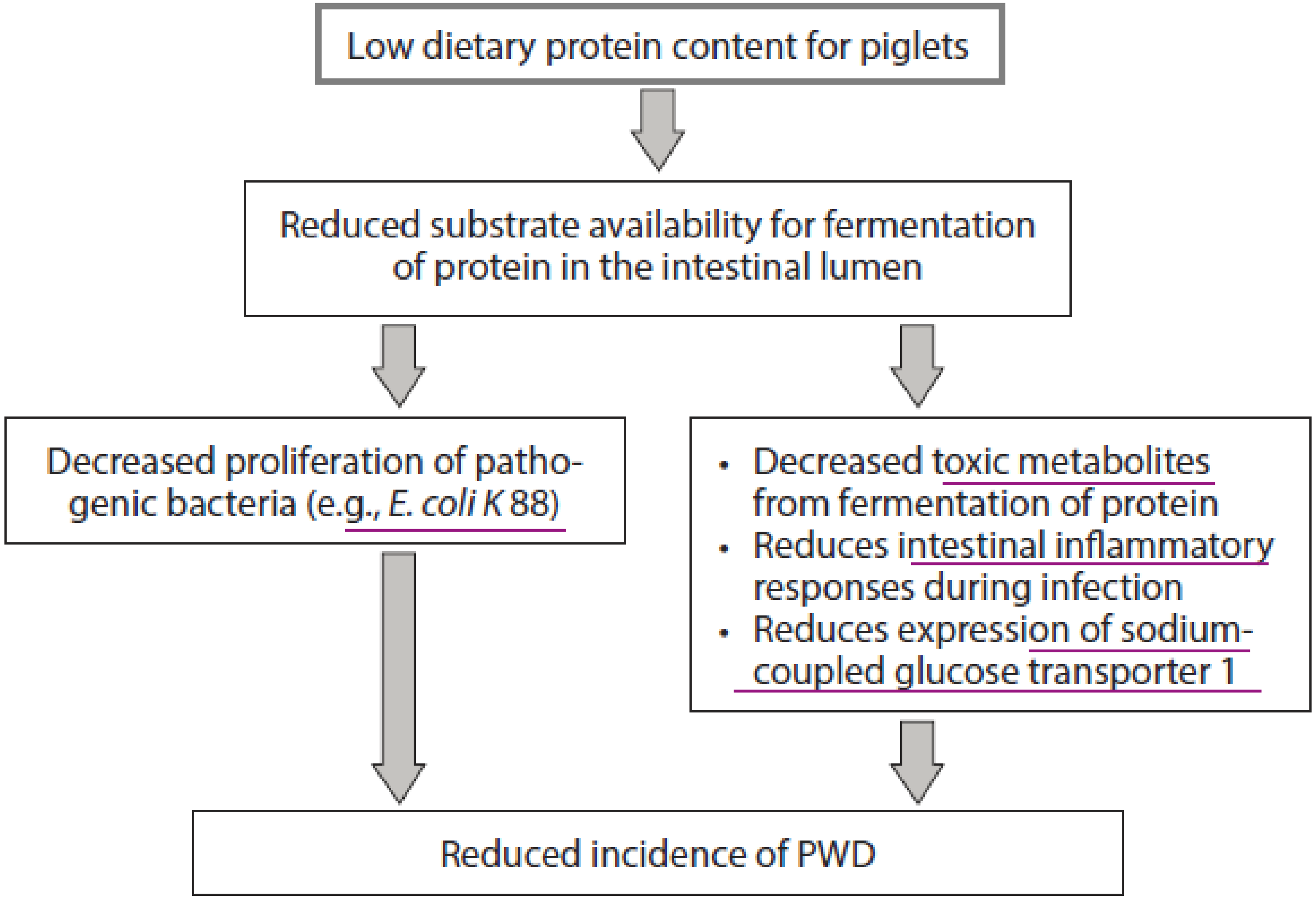
Synergistic effect of low CP diet with probiotics to improve gut health

Proposed mechanism of low CP level as a means to control post-weaning diarrhea (PDW)



Nyachoti and Jayaraman (2016)

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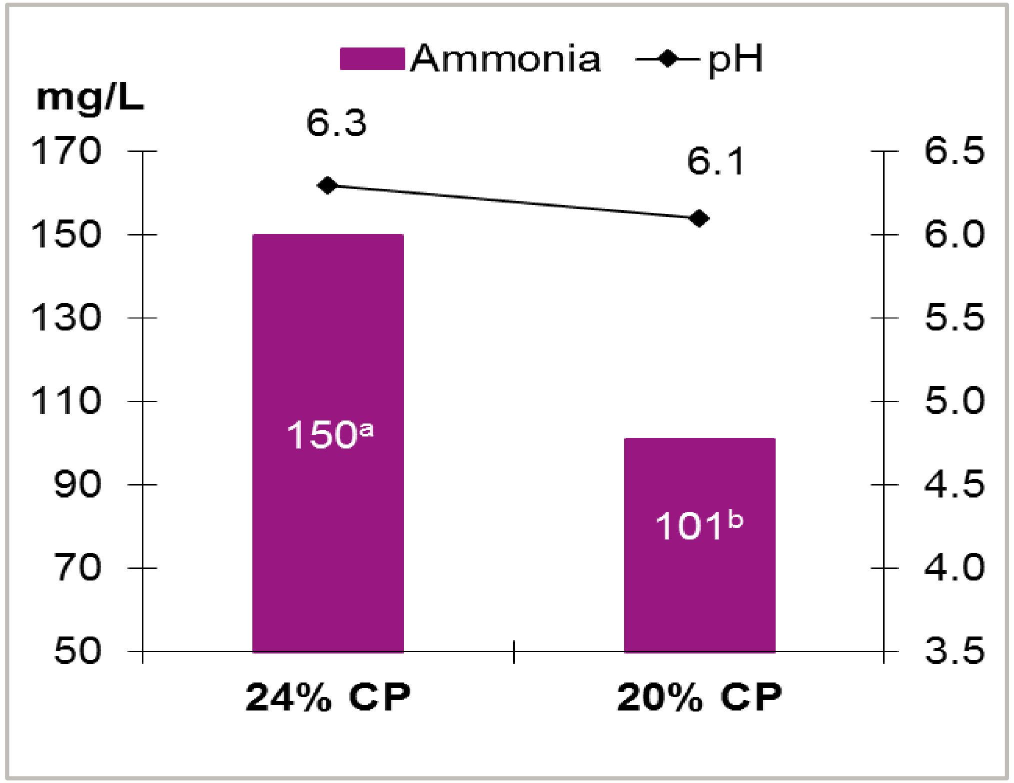
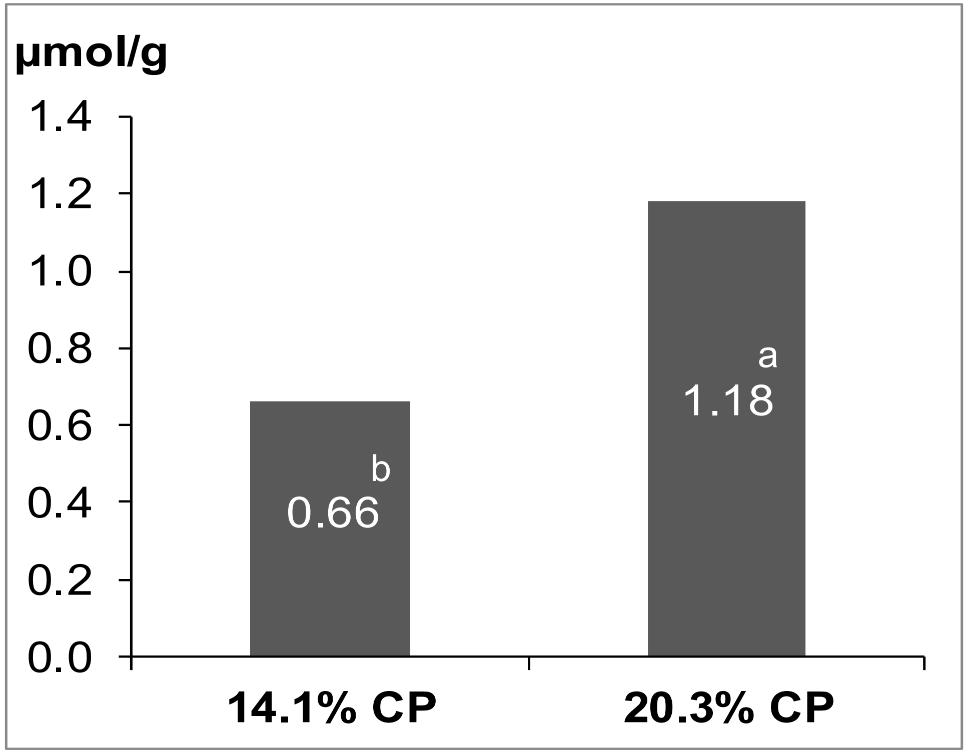
Lowering dietary CP reduces hindgut ammonia and biogenic amine concentration in piglets

Effect of diet CP content on ammonia and pH in cecum



Htoo et al. (2007)

Effect of diet CP content on cadaverine content in cecum



Luo et al. (2015)

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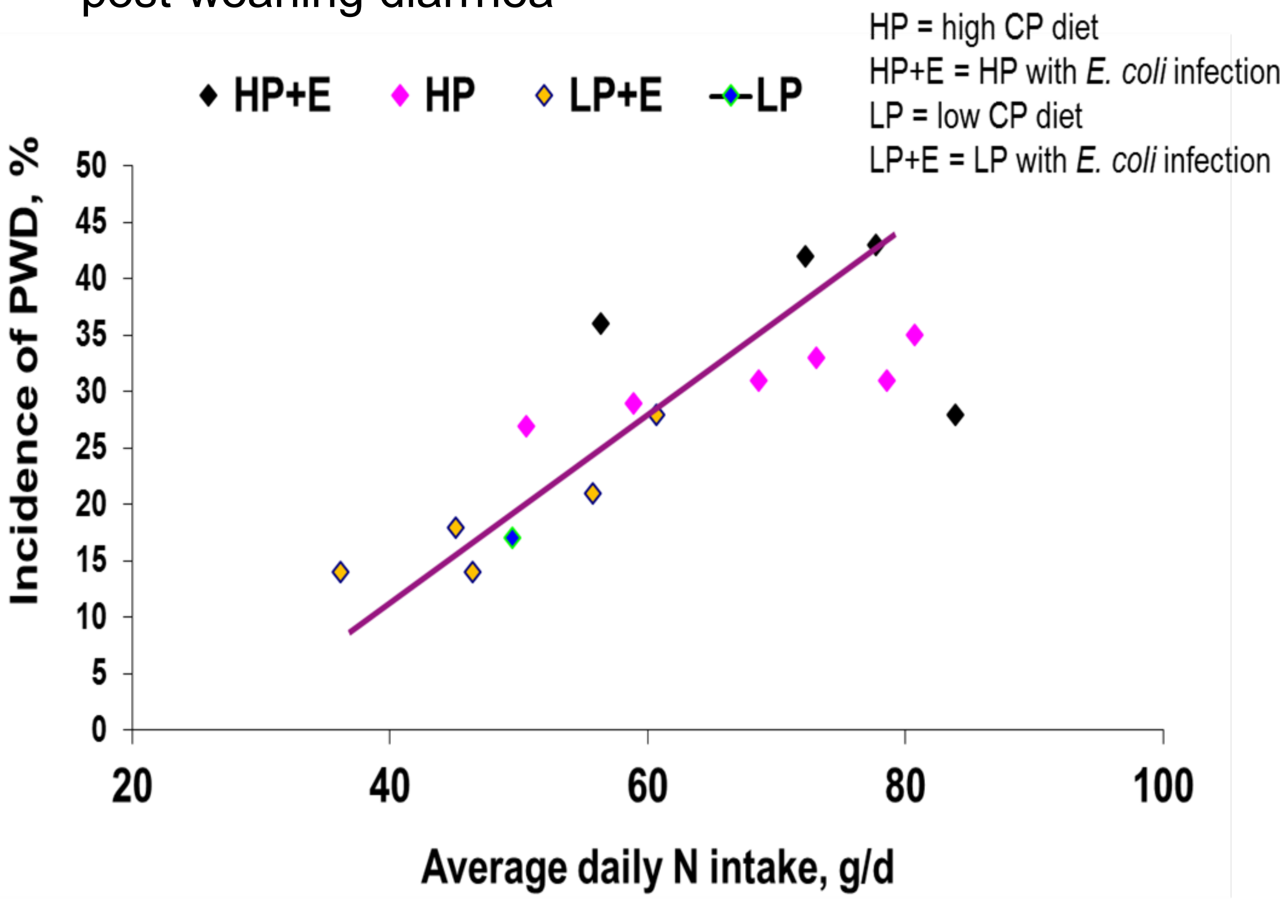
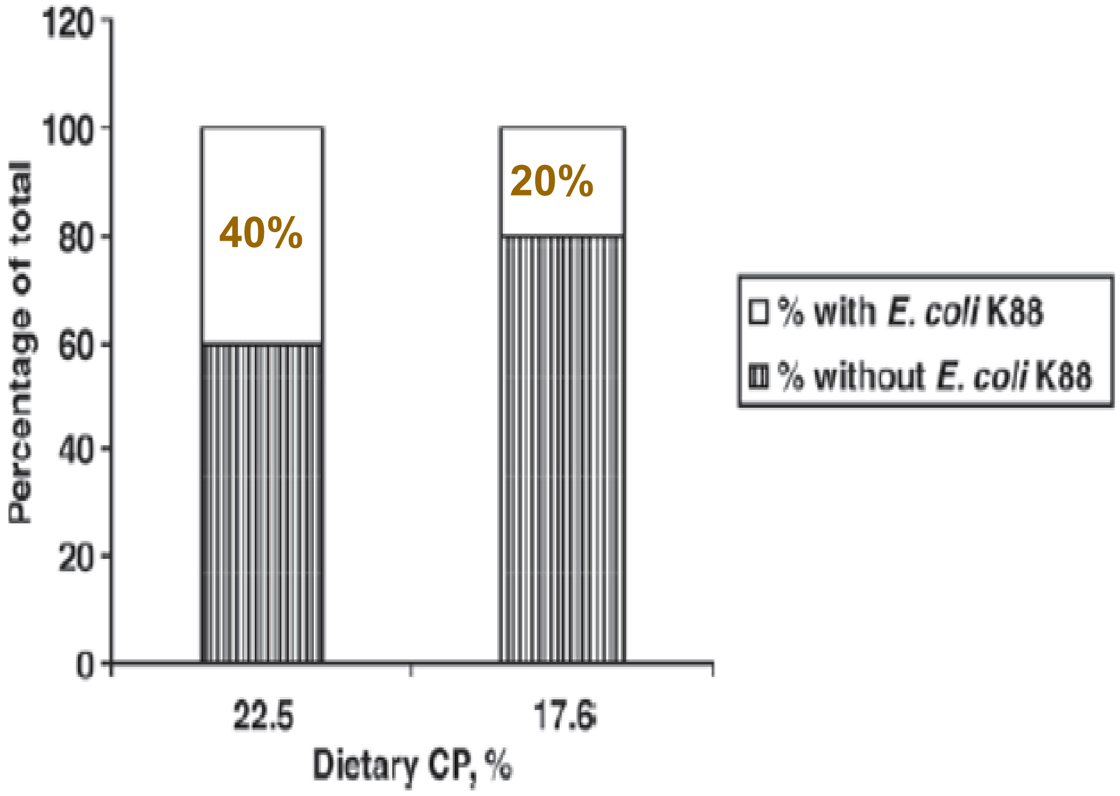
Lowering dietary CP reduces hindgut ammonia concentration and diarrhea incidence in piglets

Increased N intake increases the incidence of post-weaning diarrhea



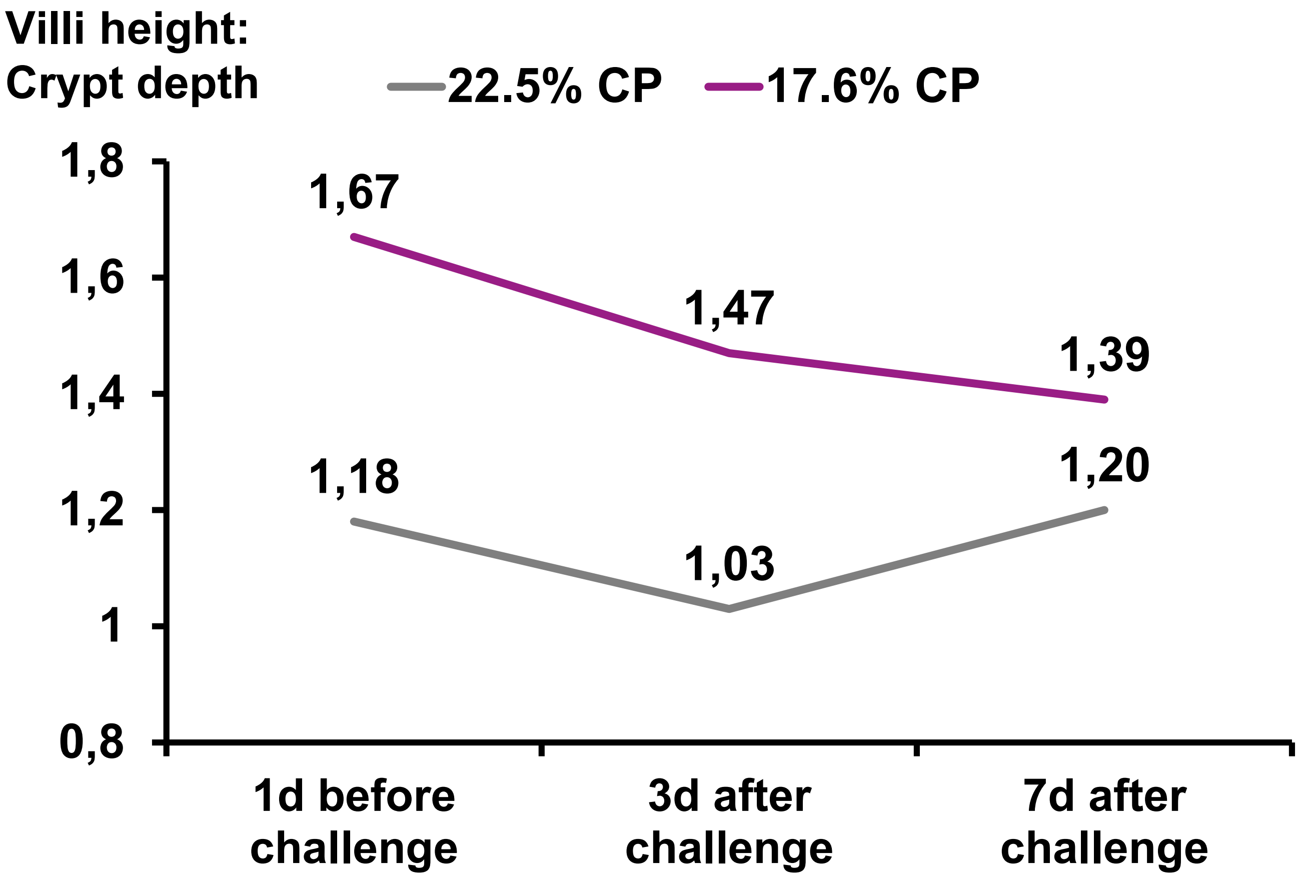
Heo et al. (2010)

E. coli K88 population was lower in ileal digesta of piglets fed a low CP diet 7 d after challenge with E. coli K88



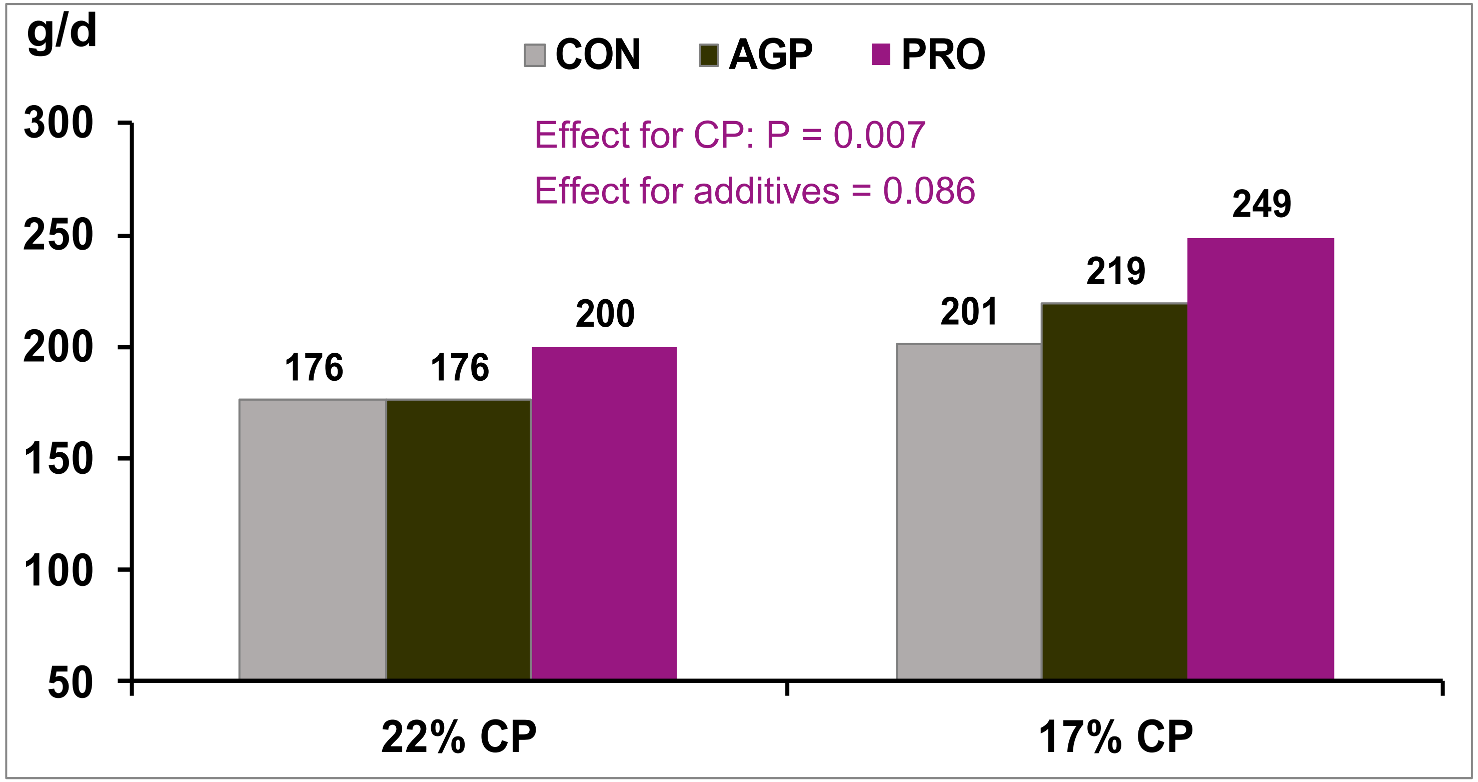
Opapeju et al. (2009)

Reduction of dietary CP improved gut health (VH:CD) of weaned pigs challenged with E. coli K88



Opapeju et al. (2009)

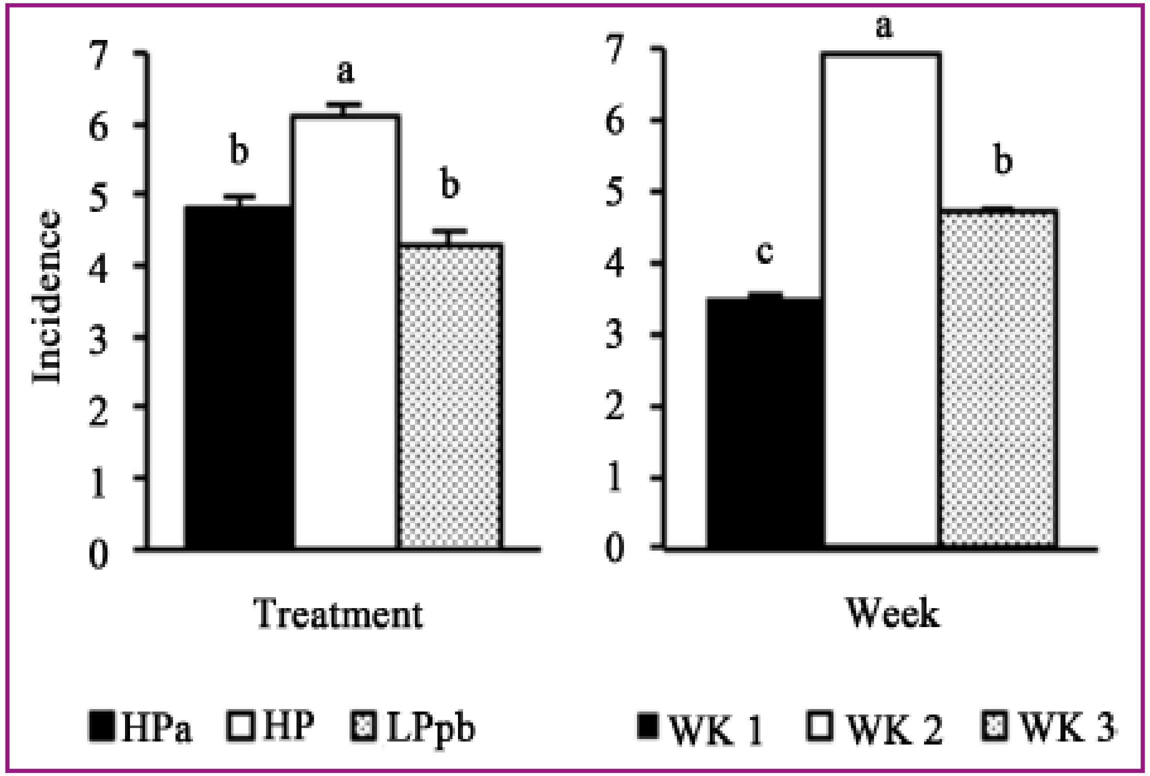
Synergy of LCP diet with a probiotic on ADG of *E. coli* challenged piglets (d 7-12 post-weaning)

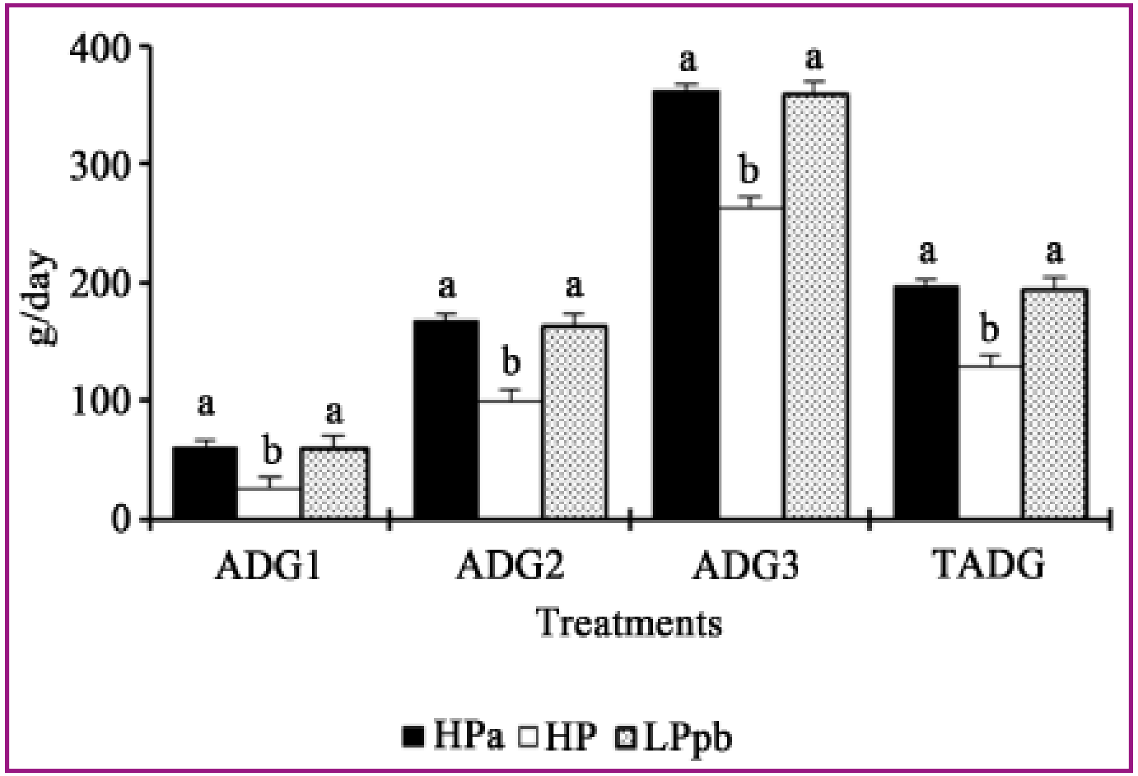


CON = no additive; **AGP** = in-feed antibiotics; **PRO** = probiotics (*E. coli* strains)

Bhandari et al. (2010)

A low CP diet with probiotics had positive effects on diarrhea incidence and ADG of weaned pigs (d 0-21 post-weaning)





HPa = 20% CP+ antibiotic (l*incomycin* + *spectinomycin; Zoetis*)
HP = 20% CP without any additives
LPpb = 16% CP+ probiotic (*Bioplus 2B: B. subtilis and B. licheniformis)*

Garcia et al. (2014)

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Effect of reducing dietary CP content on feed cost

Effect of reducing dietary protein on the cost of 9-15 kg piglet diets (Brazilian Table, 2017)

Ingredients, %	24.3% CP	23.1% CP	20.6% CP
Corn	40.98	44.75	52.60
Soybean meal	40.81	37.33	30.01
Whey powder	5.00	5.00	5.00
Wheat bran	5.00	5.00	5.00
Soybean oil	4.30	3.77	2.63
L-Lys.HCl	0.22	0.33	0.55
L-Thr	0.12	0.17	0.27
DL-Met	0.14	0.17	0.14
L-Trp	0.00	0.02	0.06
L-Val	0.00	0.00	0.12
Others[a]	3.43	3.46	3.55
NE (kcal/kg)	2486	2486	2486
CP, %	24.26	23.06	24.26
SID Lys, %	1.35	1.35	1.35
SID Met + Cys	0.74	0.74	0.74
SID Thr, %	0.90	0.90	0.90
SID Trp, %	0.26	0.26	0.26
SID Val, %	0.99	0.93	0.93
Cost ($/MT)[b]	**304.78**	**301.45**	**300.83**
Saving ($/MT)		**3.33**	**3.95**

Met requirements (Brazilian Table, 2017)

[a] Includes di-Ca-phosphate, limestone, salt and min-vit premix,.

[b] Based on ingredients prices (Sep, 2018).

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Effect of reducing dietary protein on the cost of 70-102 kg finisher pig diets (Vidal et al., 2010)

	Dietary CP, %			
Ingredients, %	17.95	16.45	14.95	13.45
Corn	70.844	70.844	70.844	70.844
Soybean meal	26.696	22.897	18.915	14.905
Soy oil	0.263	0.263	0.263	0.263
Corn starch	0.000	2.847	5.779	7.963
Soy hulls	0.000	0.623	1.276	1.933
L-Lys.HCl	0.00	0.120	0.246	0.372
L-Thr	0.00	0.002	0.068	0.134
DL-Met	0.00	0.009	0.054	0.099
L-Trp	0.00	0.00	0.007	0.030
L-Val	0.00	0.00	0.00	0.018
Others[a]	2.197	2.395	2.550	3.355
ME (kcal/kg)	3230	3230	3230	3230
CP, %	17.95	16.45	14.95	13.45
SID Lys, %	0.81	0.81	0.81	0.81
SID Met + Cys	0.54	0.54	0.54	0.54
SID Thr, %	0.60	0.60	0.60	0.60
SID Trp, %	0.19	0.19	0.19	0.19
SID Val, %	0.76	0.76	0.76	0.76
Cost ($/MT)[b]	209.91	205.95	204.57	205.45
Saving ($/MT)		**3.96**	**5.34**	**4.46**

} 13.5 MJ/kg

[a] Includes di-Ca-phosphate, limestone, salt and min-vit premix, inert and antibiotics.

[b] Based in ingredients prices (FeedInfo; July 2018) and L-Val price of 5.9 US$/kg.

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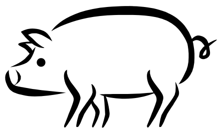
Effect of reducing dietary CP level on income over feed cost and N excretion (70-102 kg pigs; Vidal et al. 2010)

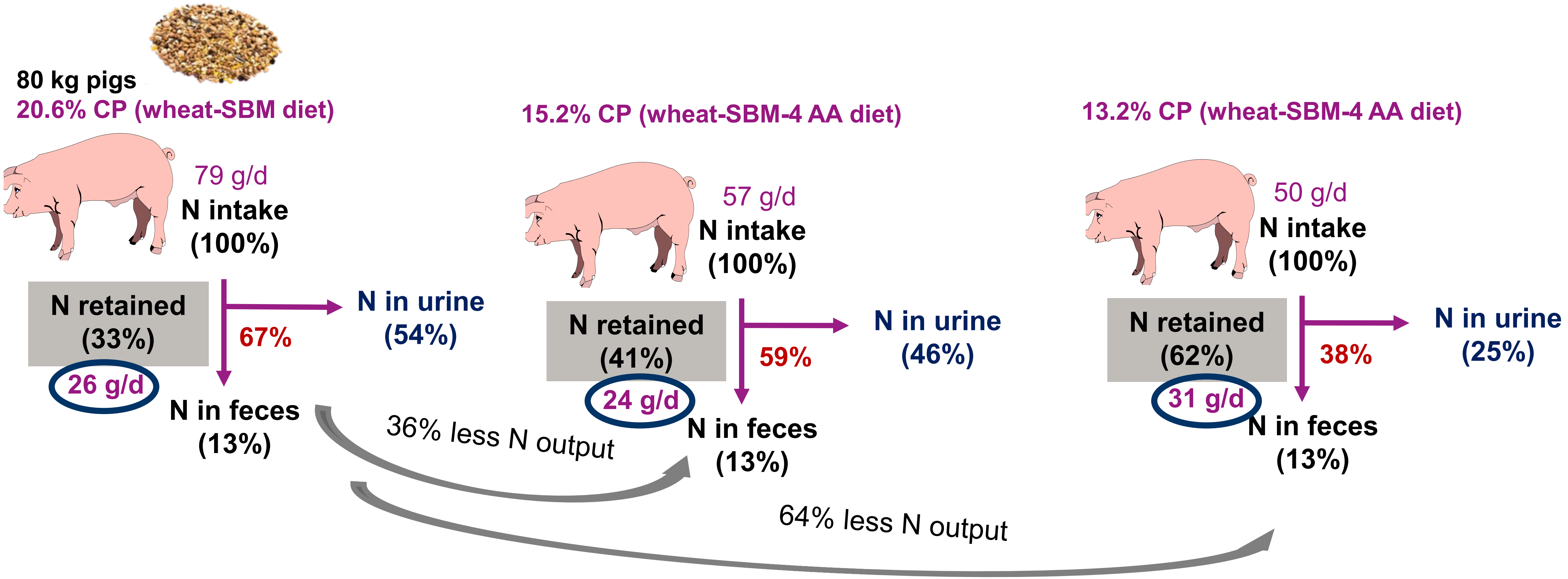


	Dietary CP, %			
	17.95	16.45	14.95	13.45
Performance				
Final BW, kg	102.1	102.0	104.7	101.4
ADG, kg/d[NS]	1.05	1.04	1.12	1.02
ADFI, kg/d[NS]	3.13	2.82	3.09	3.01
FCR[NS]	3.01	2.72	2.76	2.99
Carcass traits				
Carcass yield, %[NS]	69.59	70.19	69.57	70.25
Lean meat, %[NS]	57.01	56.9	57.13	56.93
Backfat, mm[NS]	14.24	13.5	13.37	13.78
Feed cost/pig, $ (70-100 kg)	22.22	17.85	19.54	19.22
Feed cost/kg BW gain	0.63	0.56	0.56	0.61
Pig (LW) value, $ (70-102 kg)[a]	27.20	27.08	29.42	26.59
Income over feed cost/pig, $	6.98	9.23	9.88	7.37
N-balance				
N intake, kg/pig	2.77	2.28	2.28	2.01
N excretion, kg/pig[b]	1.85	1.60	1.35	1.10
N excretion, MT (1000 place[c])	5.19	4.49	3.79	3.09

[NS] The effect of dietary CP level was not significant (P<0.05); [a] Pig prices (https://www.pig333.com/markets_and_prices/, 03.10.2018).
[B] Based on 33% N retention in 80 kg pigs (Leek et al., 2005); 9%-pt less N output by 1% CP reduction; [c] 2.8 rotations/year.

Application of low CP diet to minimize environmental impact from pig production

Excess dietary of CP is the main cause for N pollution



- Partial replacing of protein sources with AA improves N utilization.
- Ammonia emission mainly originates from urinary N excretion.

Leek et al. (2005)

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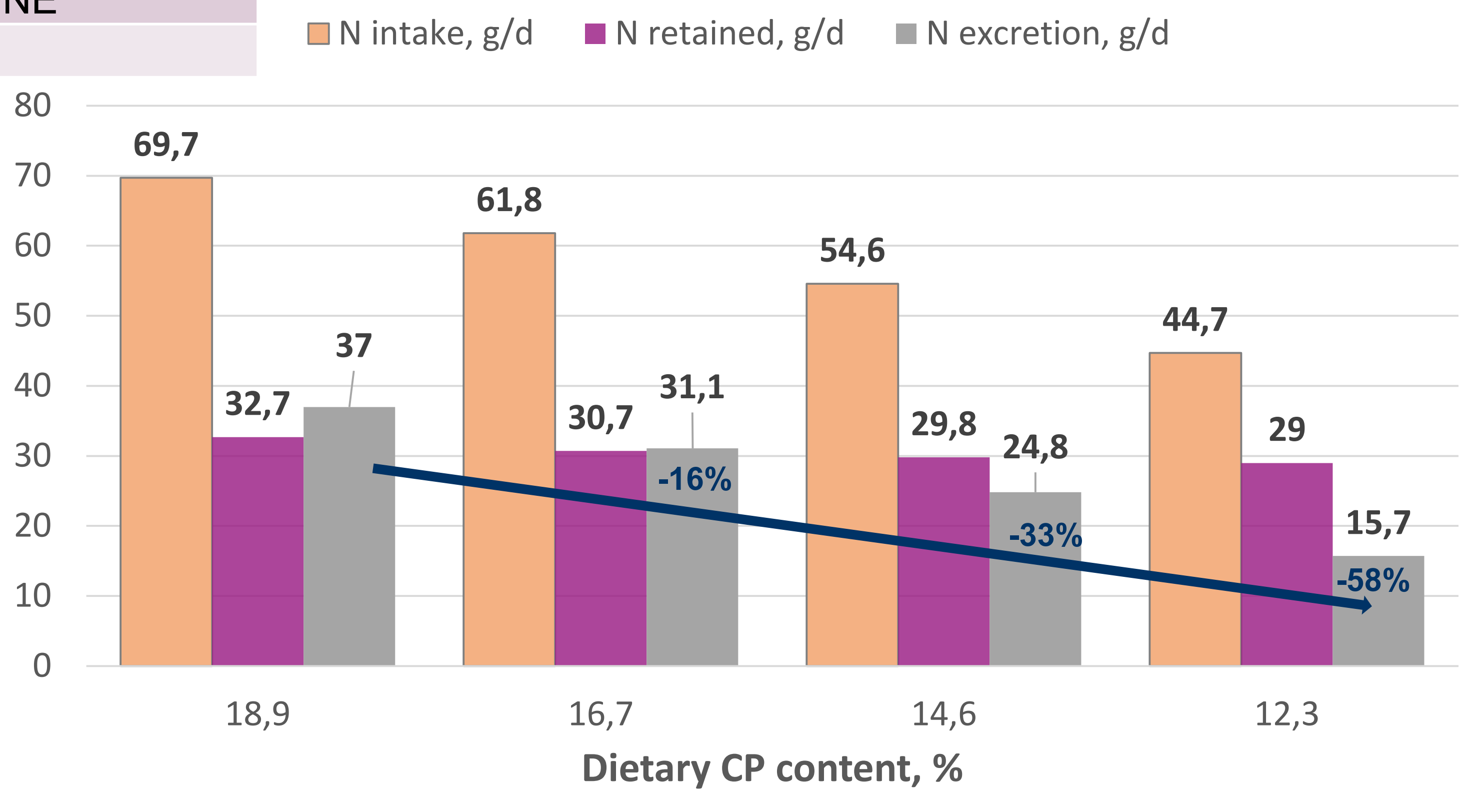
Effect of reducing CP on N-balance of 65-kg growing pigs

Animals	Growing pigs in N-balance (initial BW 65 kg)
Treatments	4 CP levels (18.9, 16.7, 14.6, 12.3%)
Diets	Corn, wheat, SBM, SPI-6 AA
Formulation	Same adequate SID AA and NE
Lys:CP, %	4.8, 5.4, 6.1, 7.2



Le Bellego et al. (2001)

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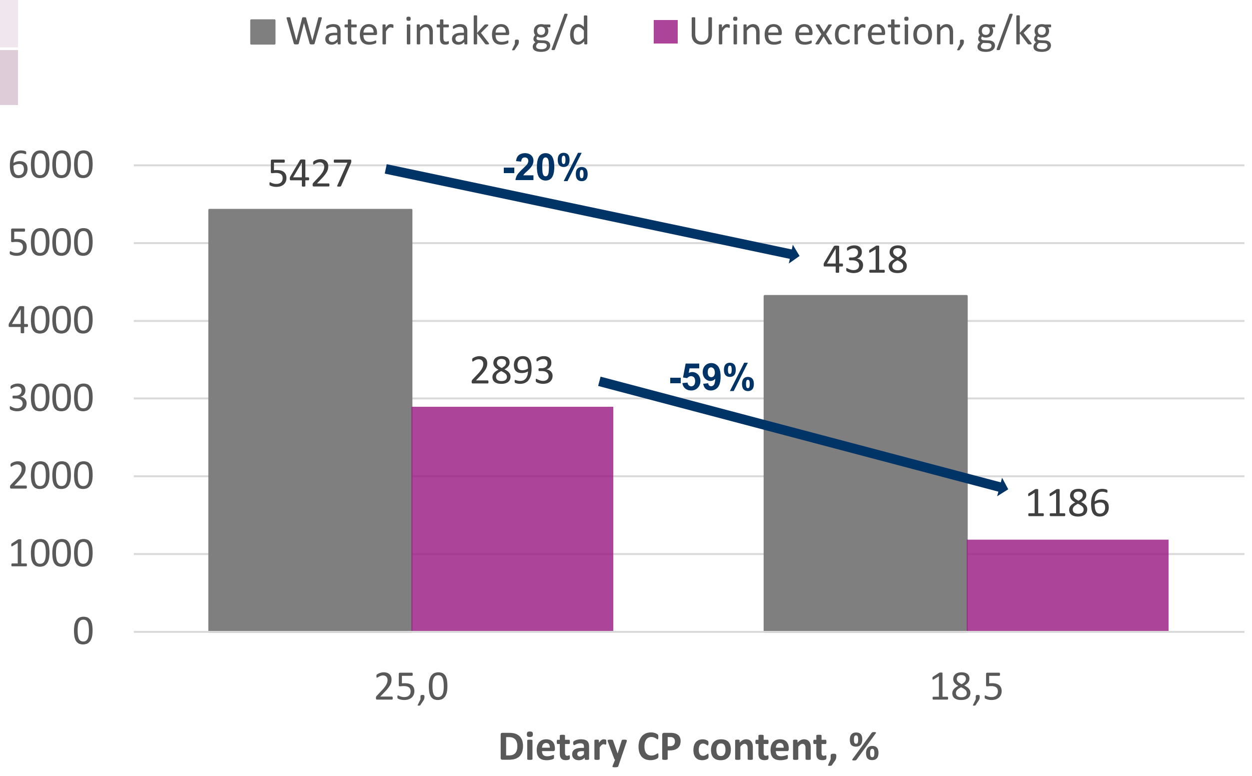
Effect of dietary CP level on water consumption and urine excretion

Animals	8 growing pigs (46 kg BW); N-balance
Treatments	2 CP levels (25 or 18.5%)
Diets	Barley-SBM-4 AA
Formulation	Same AA and ME



	25,0	18,5
Protein intake g/d	479	311
Dry matter intake g/d	1910	1917

Pfeiffer & Henkel (1991)

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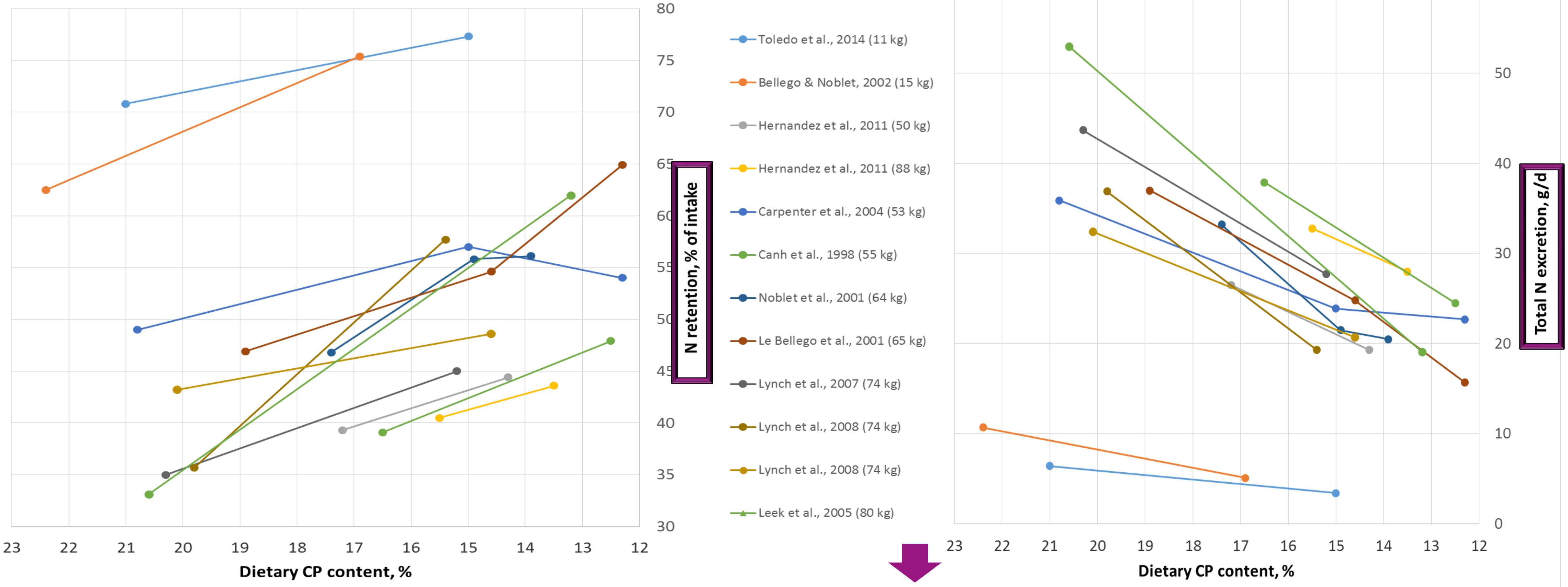
Reducing dietary CP increases N retention and reduces N excretion (11 to 88 kg initial BW)

12 N-balance trial results (1998-2014); CP reduction: 2 to 8.5%-points



On average, 1%-point CP reduction results about 9% reduction in N output.

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Potential to decrease N excretion for pig production in Brazil (25 to 115 kg BW; 2017)

Scenario:

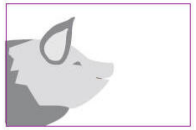
BW: 25 to 115 kg

Produced: **37 million pigs**

(3.7 million MT pork)

Feeding: 3 phases

Dietary CP: **15.6, 14.5, 13.3%**



Diets:	**Normal CP**	**Low CP**	**Low CP**
Added AA:	Lys, Thr, Met	Lys, Thr, Met, Trp	Lys, Thr, Met, Trp, Val
Average CP, %:	**15.6**	**14.5**	**13.3**
Total N excretion (thousand ton)[2]	**107**	**90**	**71**
Reduction in N excretion (thousand ton)		**16 (-15%)**	**35 (-33%)**
Reduction in slurry (million ton)[3]		**2.3**	**5.0**
Reduction in land for manure (thousand ha)[3]		**96**	**208**

[1] Assumed average FCR of 2.60 from 25-115 kg grow-out phase.
[2] Assumed N retained of 53% for normal CP diet; 1%-point CP reduction = 9% N output reduction.
[3]Based on 7.1 kg N/ton of pig slurry.
[3]Based on 170 kg N/ha (fertilizer ordinance, 2017).

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Potential to decrease N excretion for pig production in Mexico (25 to 115 kg BW; 2017)

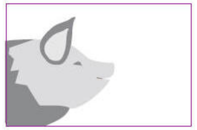
Scenario:

BW: 25 to 115 kg

Produced: **13 million pigs**
(1.3 million MT pork)

Feeding: 3 phases

Dietary CP: **15.6, 14.5, 13.3%**



Diets:	**Normal CP**	**Low CP**	**Low CP**
Added AA:	Lys, Thr, Met	Lys, Thr, Met, Trp	Lys, Thr, Met, Trp, Val
Average CP, %:	**15.6**	**14.5**	**13.3**
Total N excretion (thousand ton)[2]	**37**	**32**	**25**
Reduction in N excretion (thousand ton)		**6 (-15%)**	**12 (-33%)**
Reduction in slurry (million ton)[3]		**0.8**	**1.8**
Reduction in land for manure (thousand ha)[3]		**34**	**73**

[1] Assumed average FCR of 2.60 from 25-115 kg grow-out phase.
[2] Assumed N retained of 53% for normal CP diet; 1%-point CP reduction = 9% N output reduction.
[3]Based on 7.1 kg N/ton of pig slurry.
[3]Based on 170 kg N/ha (fertilizer ordinance, 2017).

Precision feeding

- Use of feeding techniques providing the right amount of feed with the right nutrient composition to each pig in the herd on daily basis (Pomar et al., 2009).
- Precision feeding improves nutrient utilization and reduces N excretion

Performance of pigs in a 3-phase feeding (3P) or in daily-phase feeding programs provided individually to meet 110% (MP110),100% (MP100), 90% (MP90) or 80% (MP80) of the estimated nutritional requirements

	Treatments[1]					Sex			
	3P	MP110	MP100	MP90	MP80	Barrows	Gilts	RSD	*P*-value[2]
Overall performance									
ADFI (kg/day)	2.44	2.43	2.53	2.57	2.33	2.69	2.26	0.33	0.52
ADG (kg/day)	1.05[a]	1.05[a]	1.03[a]	1.00[ab]	0.93[b]	1.07	0.96	0.08	<0.01
G : F (kg/kg)	0.43	0.43	0.41	0.39	0.40	0.40	0.42	0.01	0.05
Feeding costs ($/pig)	80.5[a]	74.8[ab]	72.8[b]	72.8[b]	68.0[c]	79.9	66.8	1.8	0.01
Adjusted feeding costs (¢/kg of weight gain)	89.7[a]	84.4[b]	84.6[b]	84.8[b]	86.3[ab]	89.1	84.5	0.1	0.04

Andretta et al. (2016)

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Effect of grain production location and feeding program on climate change of producing **1 ton pigs** (during growing-finishing) in South Brazil (Santa Catarina)

	Feeding program		
		Precision daily feeding	
	Conventional phase feeding by group	By group	Individual pigs
Climate change (kg CO_2-equivalence)			
SO-SO scenario	1840	1811	1783
CW-SO scenario	2160	2079	2030
CW-CW scenario	2361	2300	2252

SO-SO: SBM and corn produced in South Brazil;
CW-SO: SBM produced in Central-West and corn produced in South Brazil;
CW-CW: SBM and corn produced in Central-West Brazil.

Life-cycle assessment (SimaPro software (v. 8.0.3.14)

Andretta et al. (2018)

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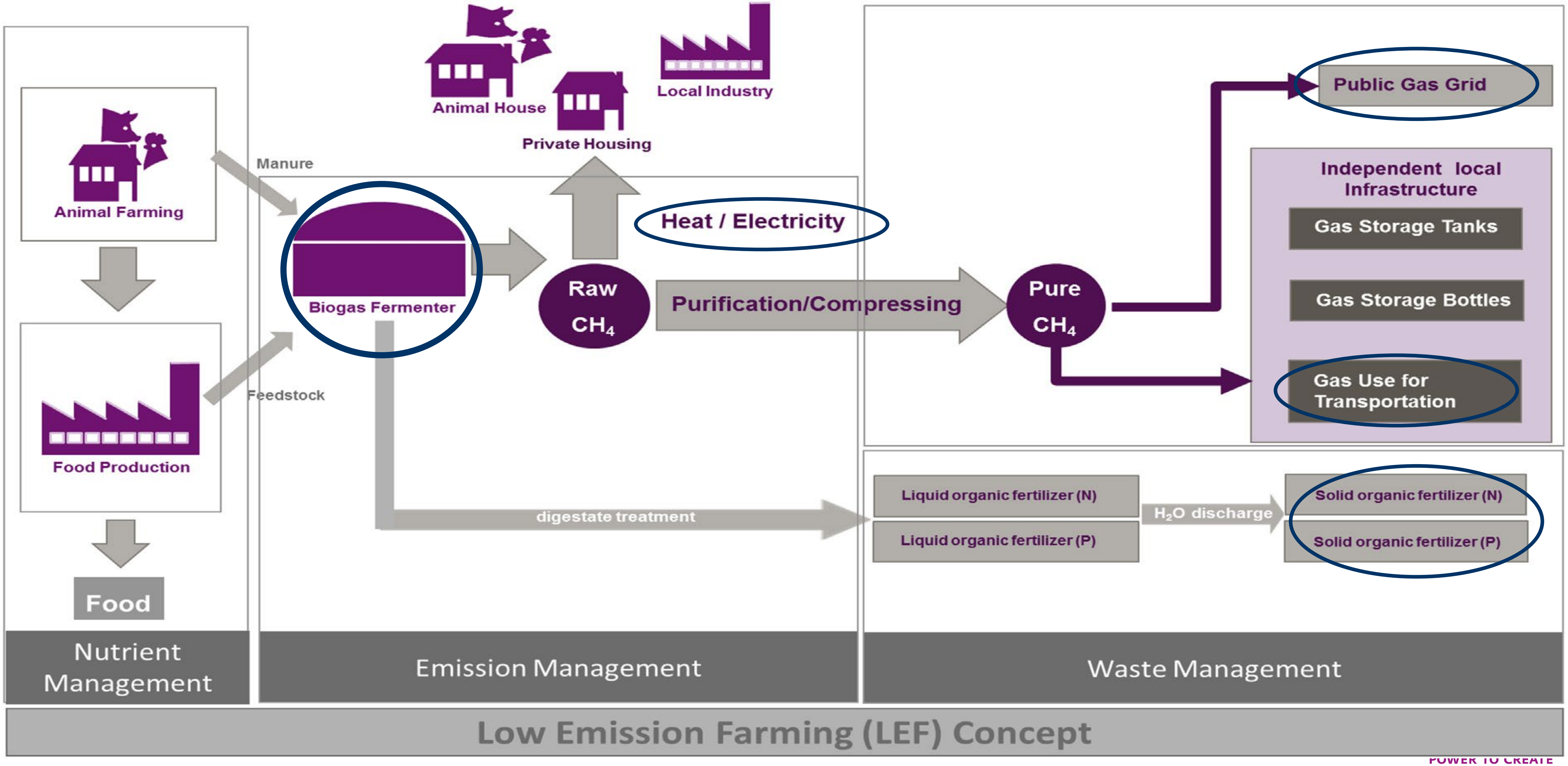
Elements of the integrated low emission farm (LEF) concept

Kaufmann (2015)

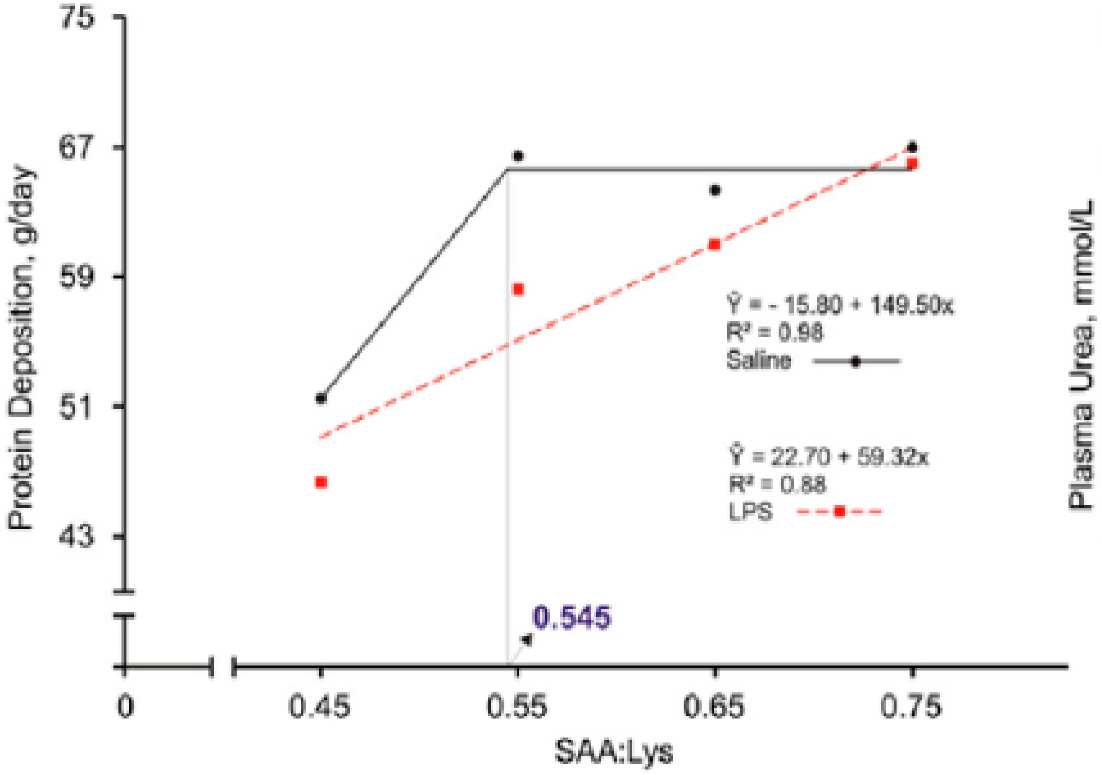


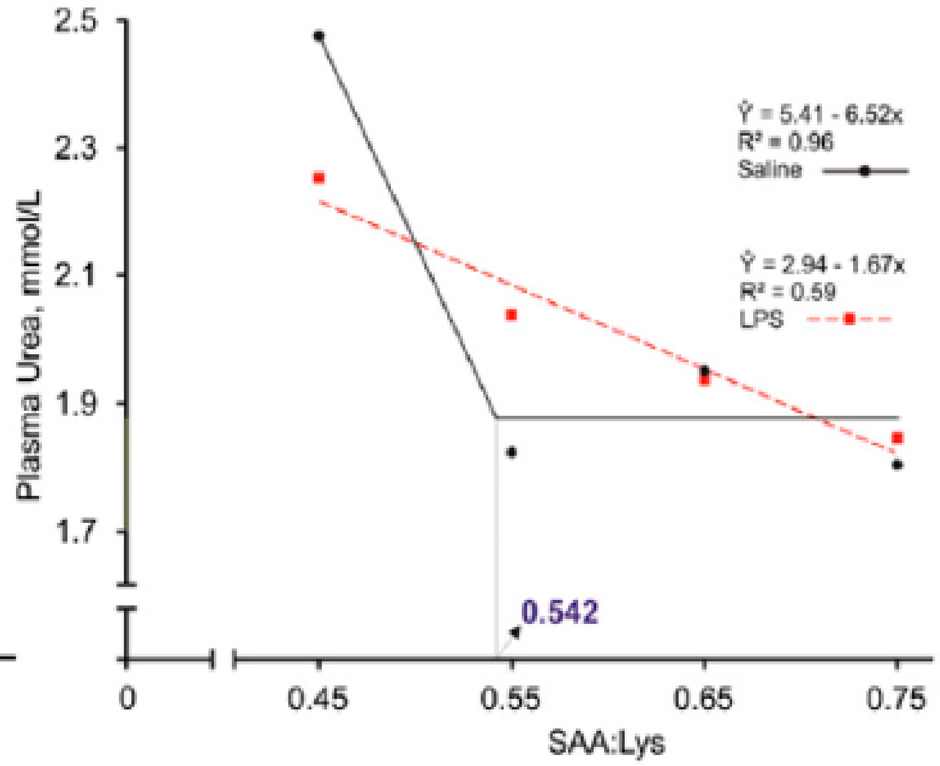
Dynamic AA ratio concept to increase efficiency

Immune challenged pigs need more SAA to support max. performance (53-95 kg)

- 64 individually housed barrows (6 wk trial)
- Split plot design [without or with ISS (E. coli LPS injection on Mon and Thu)]
- 4 SID SAA:Lys ratios (0.45, 0.55, 0.65, 0.75)
- SID Lys: 0.81% (50-75 kg) and 0.74% (75-100 kg)

Kim et al. (2012)





- Optimal SID SAA:Lys increased to 75% for growing pigs challenged with LPS.

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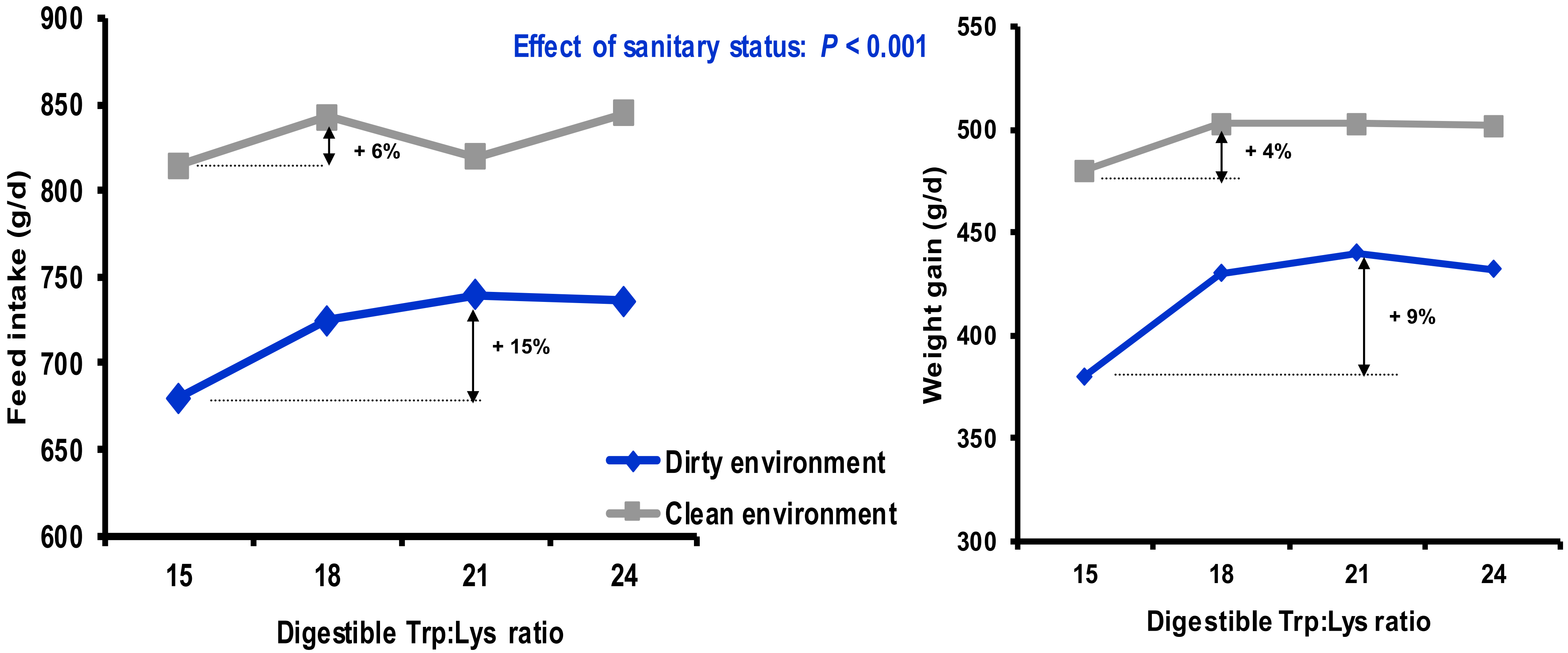
Poor sanitation increases dietary Trp:Lys ratio in weaned pigs

Le Floc'h et al. (2007)

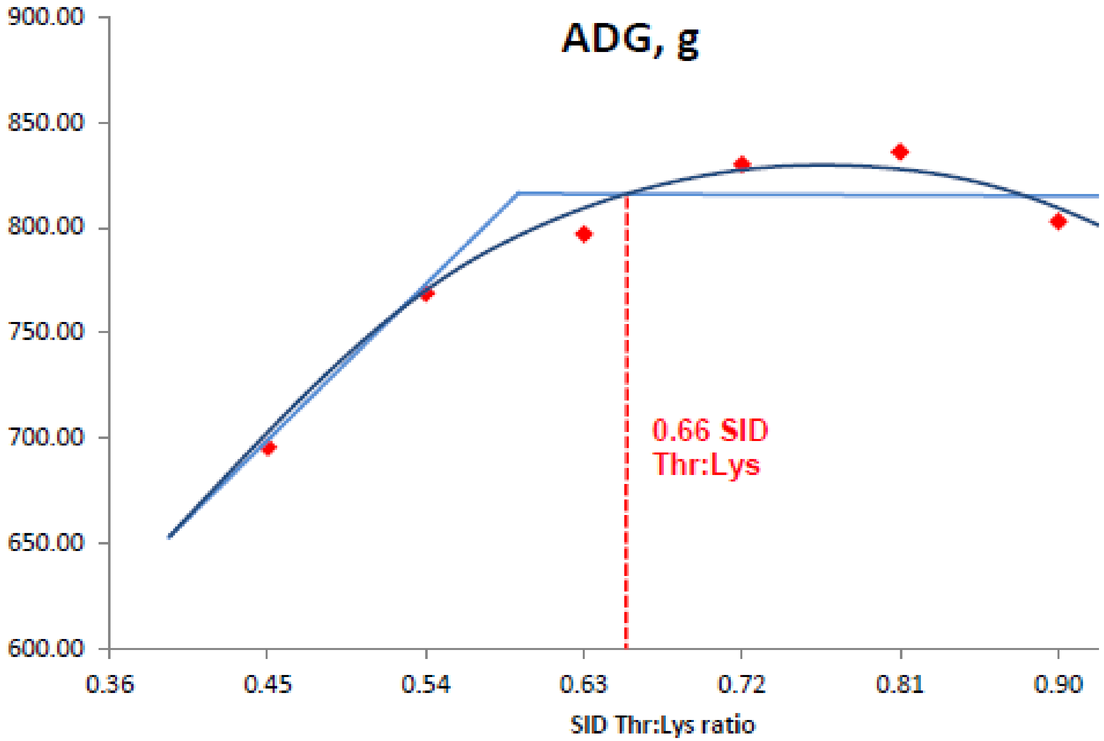


- Responses to increasing levels of Trp were greater in pigs with poor sanitary status.

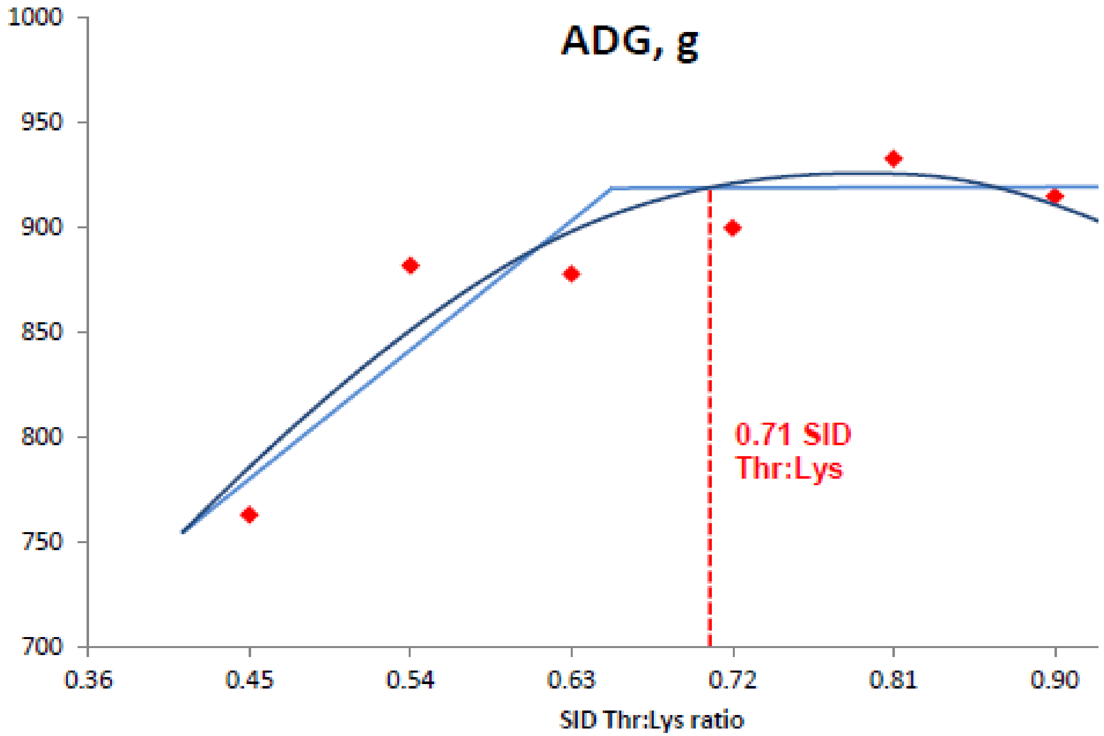
Effect of fiber on optimum Thr:Lys ratio for 25 to 50 kg gilts

25 - 50 kg pigs; 2 x 6 factorial design [low vs. high fiber (15% soy hulls) x 6 SID Thr:Lys]

Mathai et al. (2015)



Effect of SID Thr:Lys on ADG of pigs fed low fiber diets



Effect of SID Thr:Lys on ADG of pigs fed high fiber diets

- Dietary fiber level affects Thr requirement of pigs.
- High Thr in pigs fed high fiber diets may be due to increased mucin production.

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Take home message

Take home message

- CP level in pig diets can be reduced by at least **2 %-points** without affecting performance and carcass quality when balanced AA on SID basis and NE.
- Formulation of low CP diets using supplemental AA allows to be **cost effective** and **environmentally more sustainable**.
- On average, **1%-unit** dietary CP ↓ » **~ 9%** ↓ N excretion
  » **~ 12%** ↓ NH_3 emission
- Saving potential for reducing the dietary CP by 2 %-points for:
  - **Brazil** (37 million pigs): 35 thousand ton N output (33% reduction)
  - **Mexico** (13 million pigs): 12 thousand ton N output (33% reduction)
- Integrated approach of using low CP pig diets with probiotics **further improves gut health and nutrient efficiency** of pigs.
- Advanced concepts (precision feeding, low emission farming, dynamic AA ratio) help towards more **sustainable pig production**.

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Thank you.

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