The Missing Link for Reproduction and Nursery Performance

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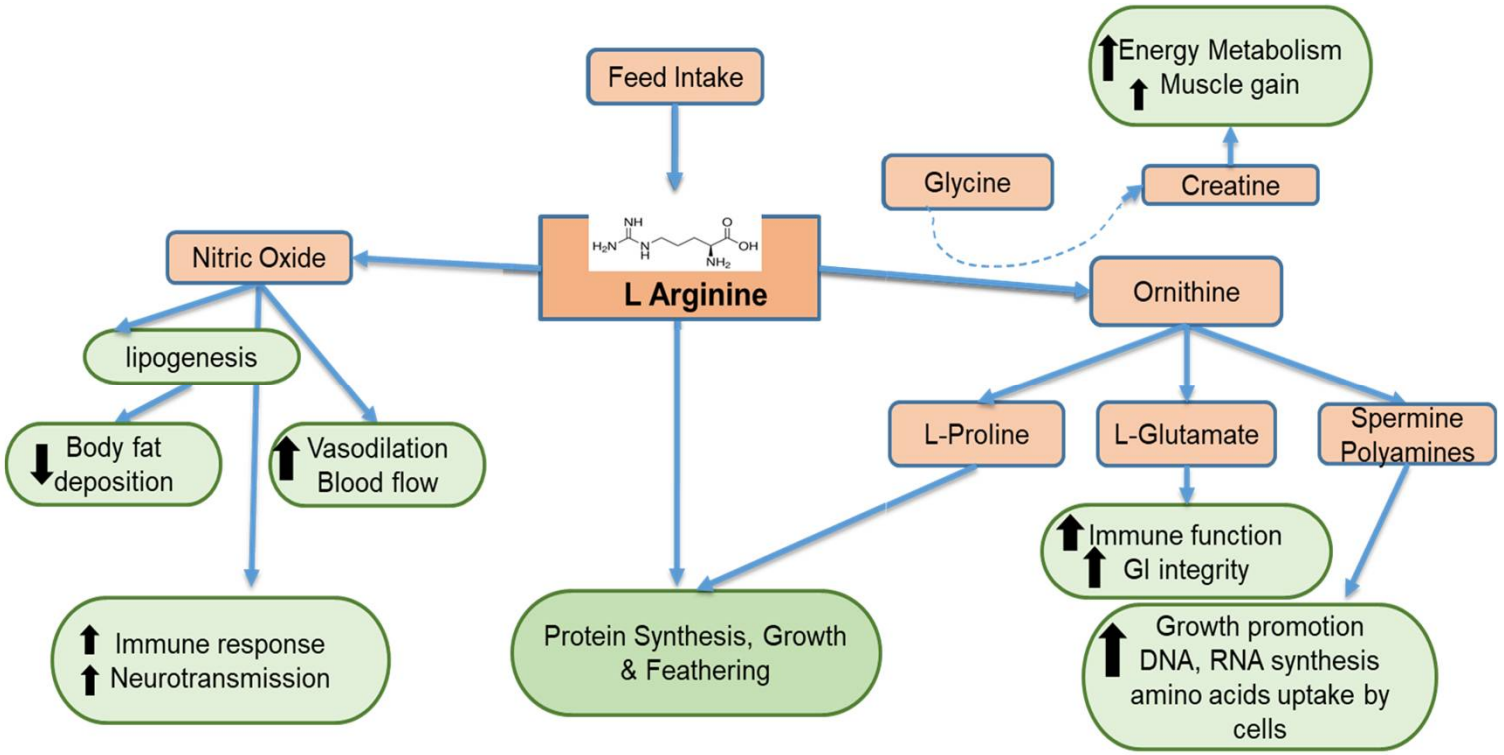
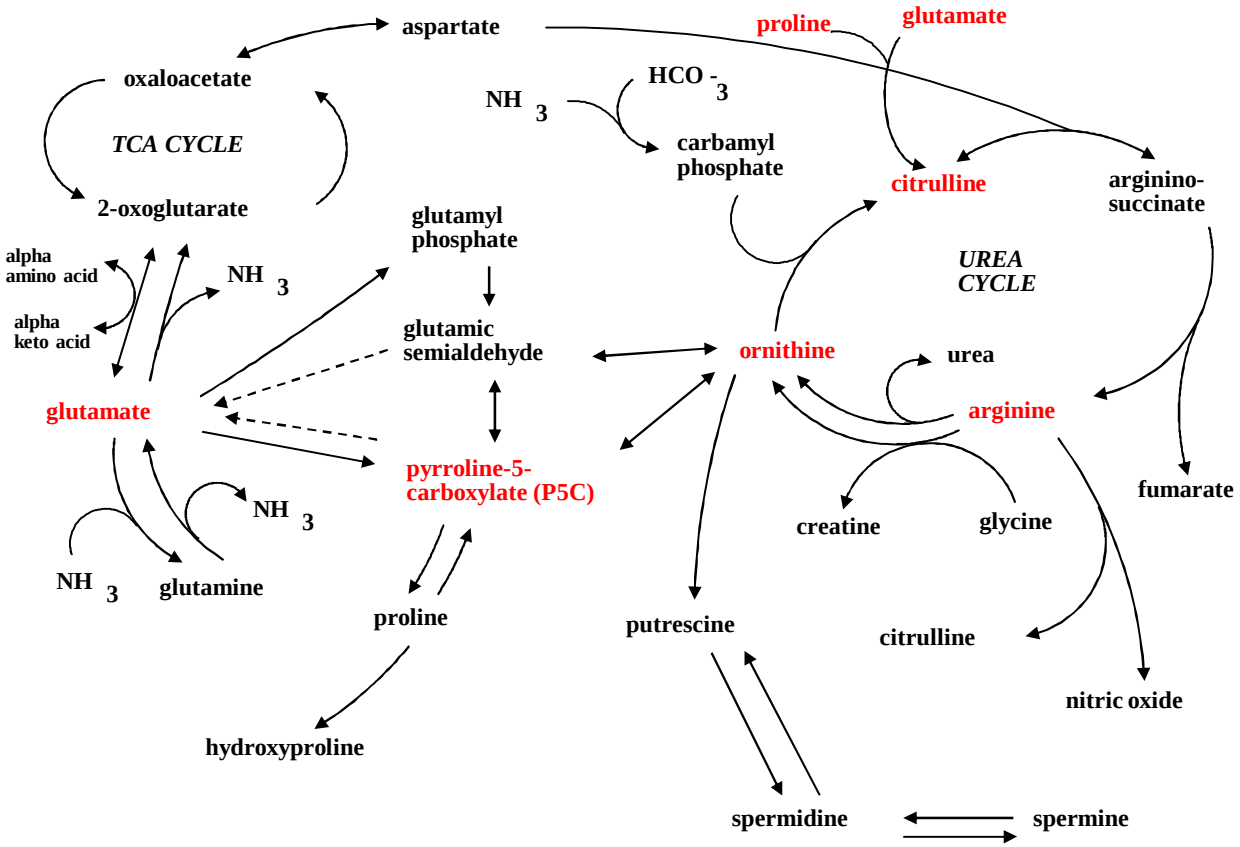
Arginine is the most versatile amino acid: Multifunctional



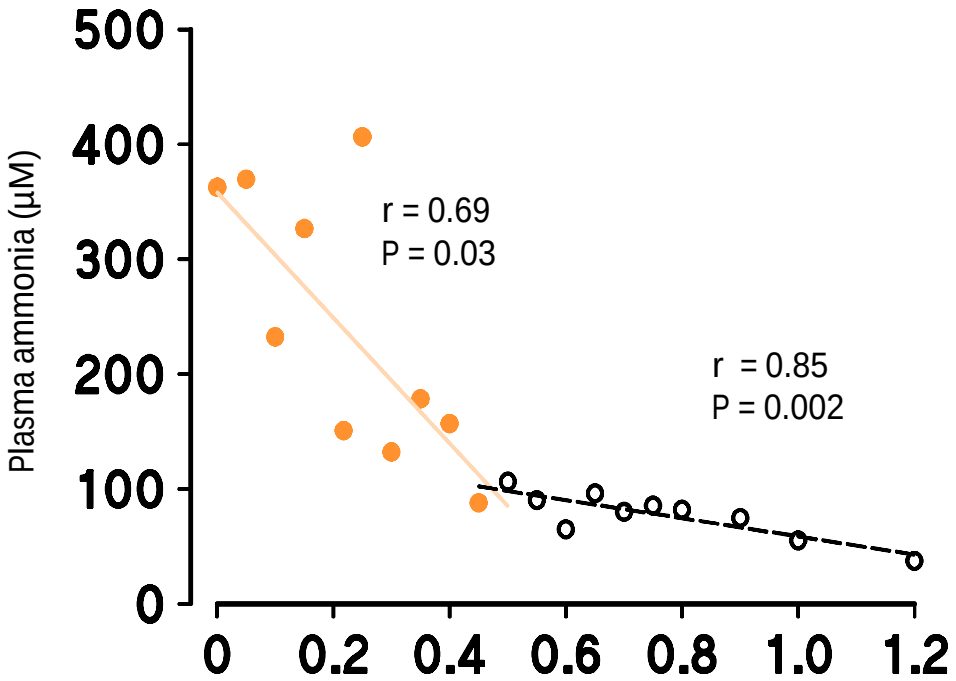


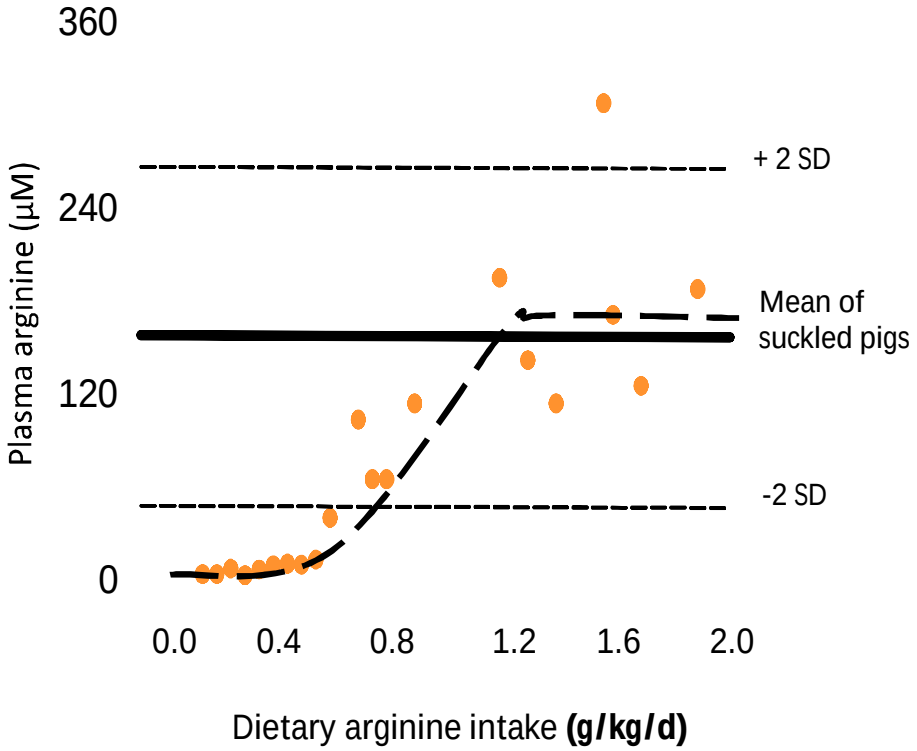
*OAT: Ornithine aminotransferase: Only found in the gut in piglets. Very low activity in other parts of the body

Arginine in piglet nutrition

- Piglets fed intravenously (i.e., mimicking poor gut function) do not synthesize Arg
  - Removal of Arg in the IV-fed diet causes death (Ron Ball, 2014)
  - Arginine synthesis
    - Adult pigs: Gut, Kidney, Liver
    - Young pigs: Gut only (but gut damage is frequent)

Arginine requirement in piglets: 1.2g/kg body weight/day





Ball, 2014

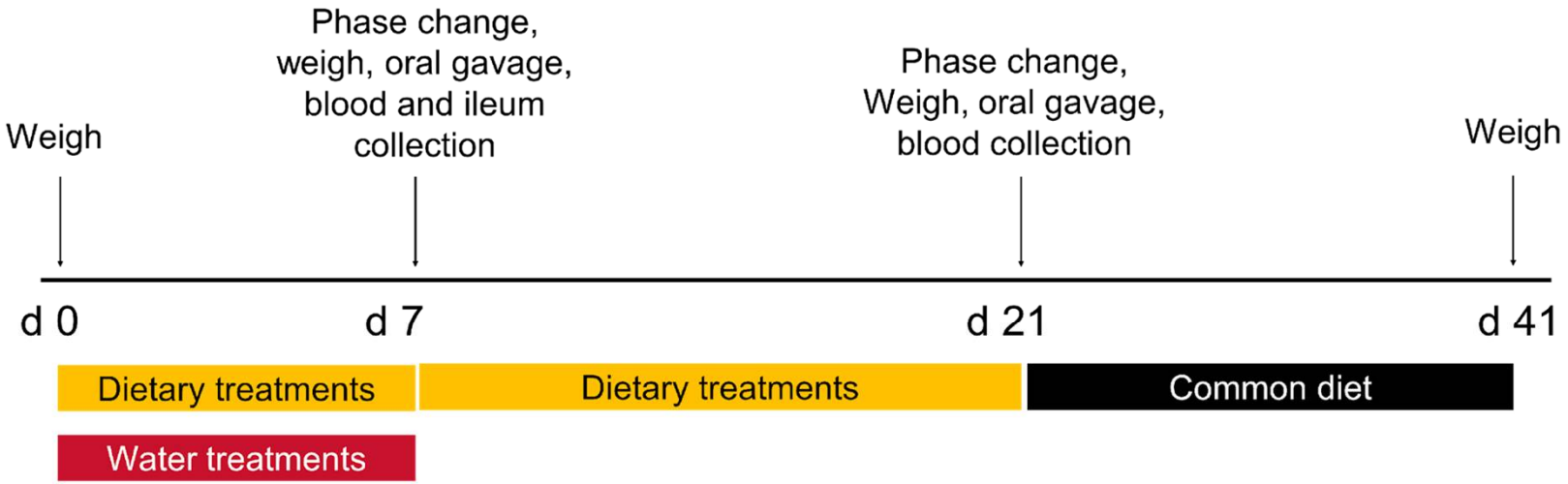
Arginine requirement in pigs (NRC, 2012)

BW, Kg	6	9	18
SID Arg, g/d	1.8	2.9	5.1
SID Arg, g/kg/d	0.30	0.32	0.28
SID Lys, g/kg/d	0.67	0.70	0.62
SID Arg:Lys	0.45	0.46	0.46

- Current NRC recommended intake of SID Lys is 0.3-0.32 g/kg/d
- Piglets require at least **1.2g** total Arg/kg/d (1.08g SID Arg/kg/d) for optimal protein synthesis and minimum plasma ammonia.
- Piglets require a **3.5-fold higher** SID Arg requirement than the current NRC recommendation

A piglet study at Iowa State University

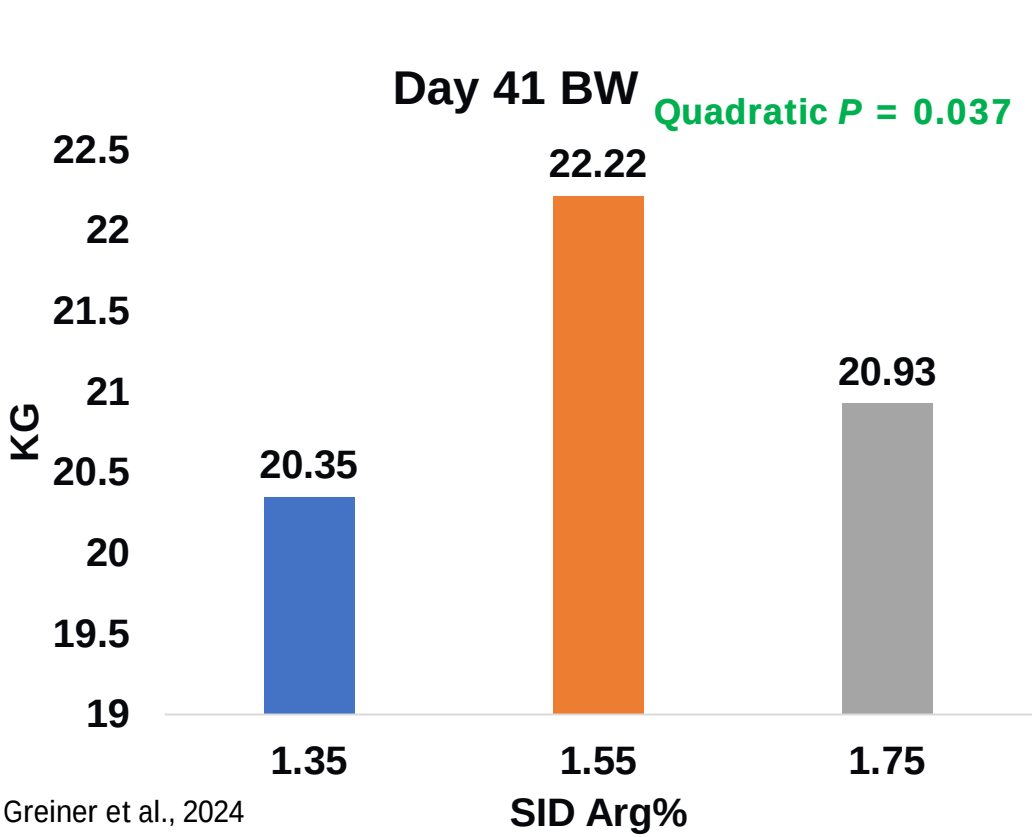
- **Trial timeline**



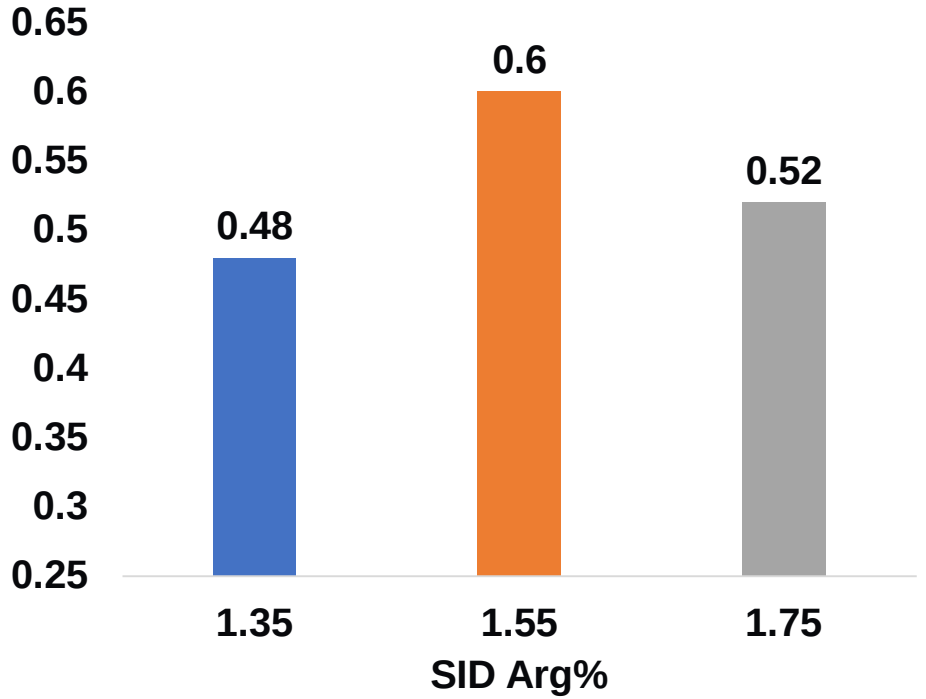
One pig per pen was orally gavaged with a lactulose and mannitol solution, and a serum sample was collected 4 hours post-gavage

Greiner et al., 2024

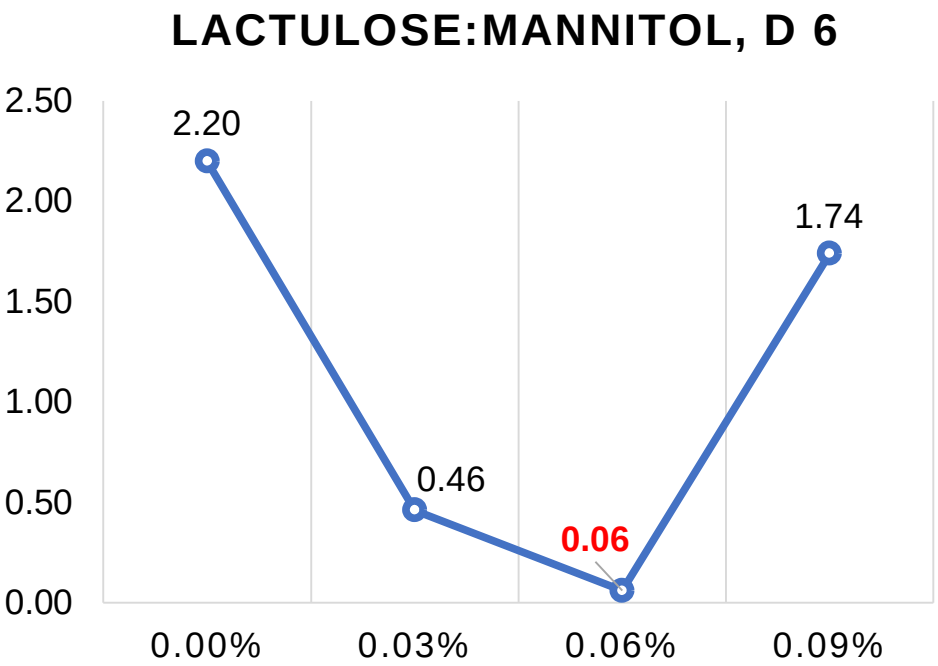
A piglet study at Iowa State University

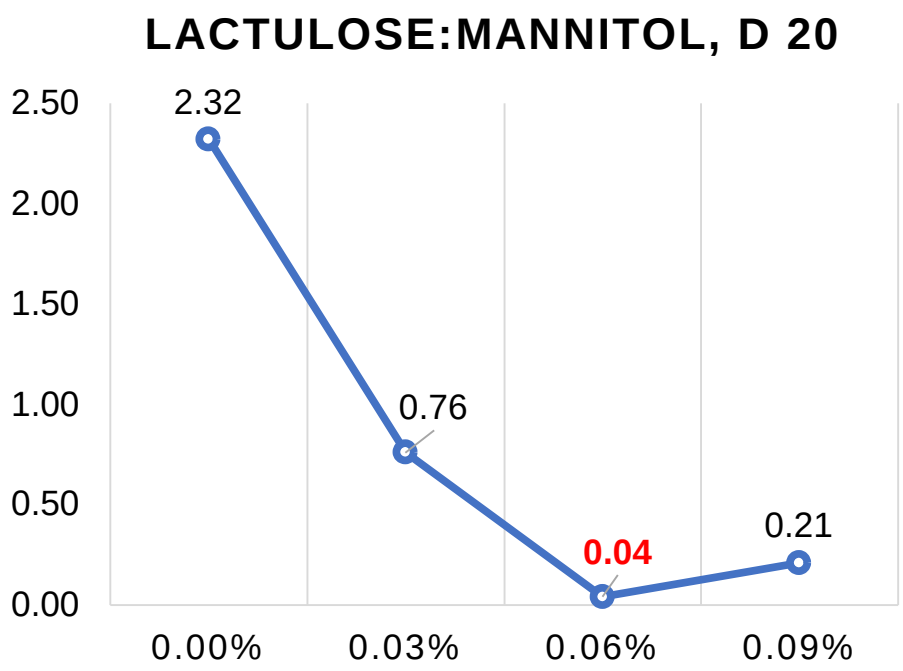


Greiner et al., 2024



A piglet study at Iowa State University





Greiner et al., 2024

A piglet study at South Dakota University

Experiment 1

- 225 pigs at 5.8±0.9 kg
- Basal diet SID Arg 0.66 (NRC recommendation)
- 2 phase feeding (Phase 1 0-7d; Phase 2 8-21d), then commercial diet until market weight
- Arg treatments 0-21 days:

Arg supplementation, %	0	0.3	0.6	0.9	1.2
SID Arg content in feed, %	0.66	0.96	1.26	1.56	1.86

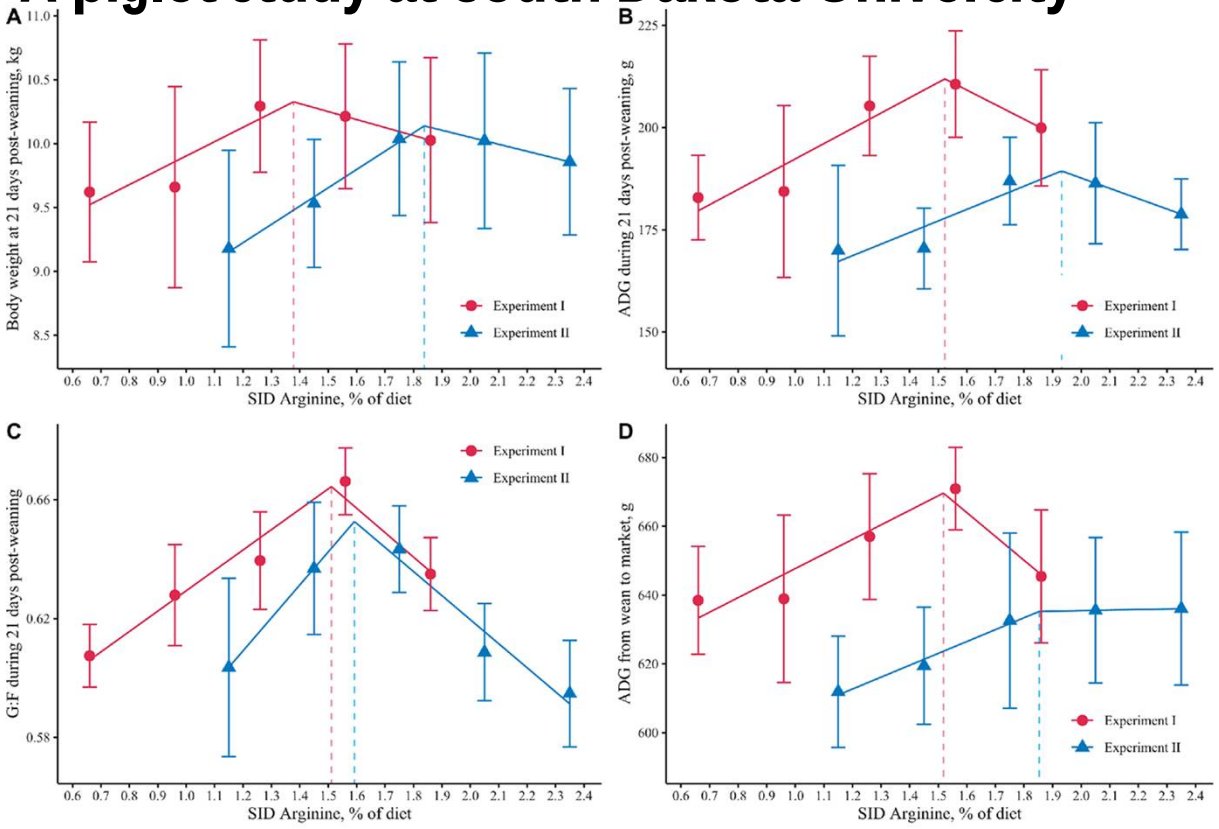
Experiment 2

- 200 pigs at 6.1±1.2 kg
- Basal diet SID Arg 1.15 (Commercial standard)
- 2 phase feeding (Phase 1 0-7d; Phase 2 8-21d), then commercial diet until market weight
- Arg treatments 0-21 days:

Arg supplementation, %	0	0.3	0.6	0.9	1.2
SID Arg content in feed, %	1.15	1.45	1.75	2.05	2.35

Perez-Palencia et al., 2024

A piglet study at South Dakota University



Source: Perez-Palencia et al., 2024

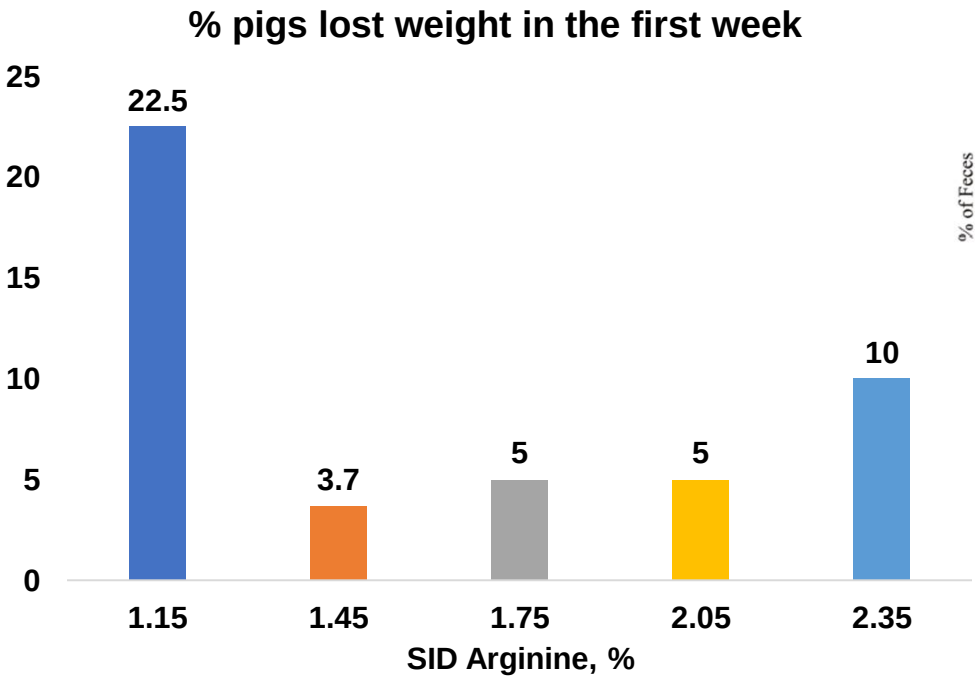
After weaning~43d, piglet

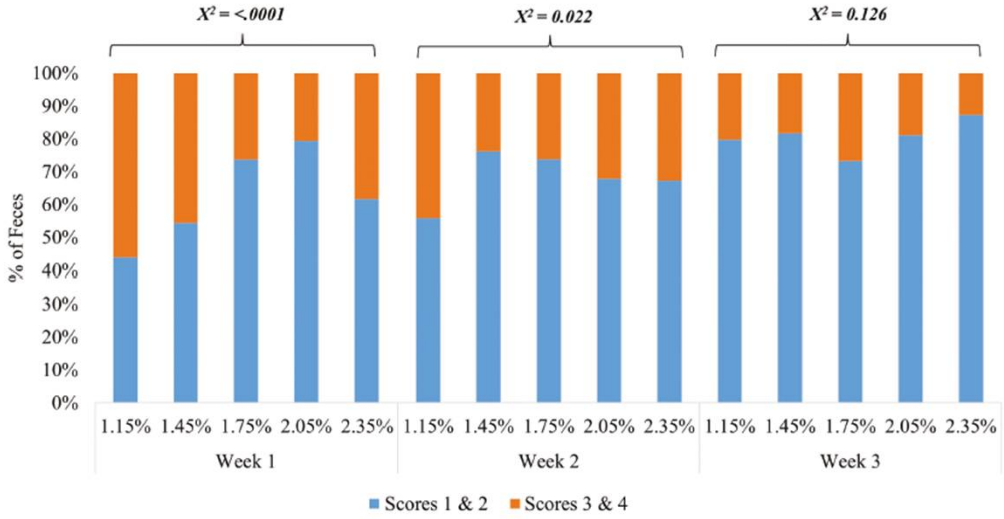
Exp 1. BW 5.8±0.9 kg,
Basal diet SID Arg 0.66 (NRC)

Exp 2. BW 6.1±1.2 kg,
Basal diet SID Arg 1.15 (Commercial)

- Arg requirement in piglet **SID Arg 1.5-1.9%/diet** = **2.3~2.8 times higher** than NRC recommendation

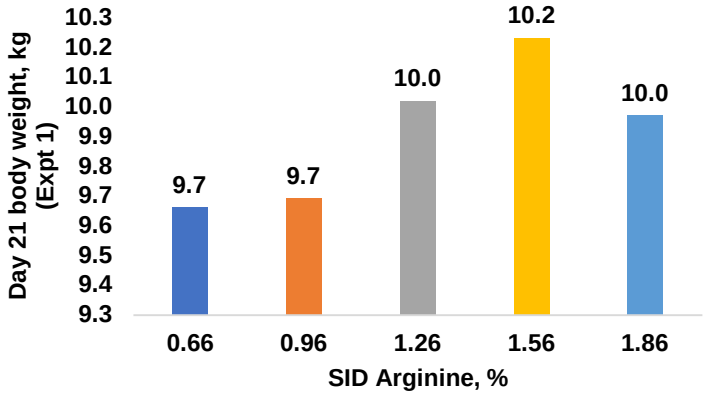
A piglet study at South Dakota University

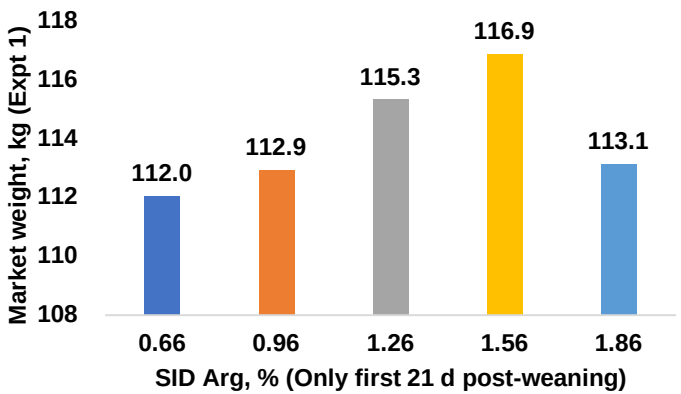


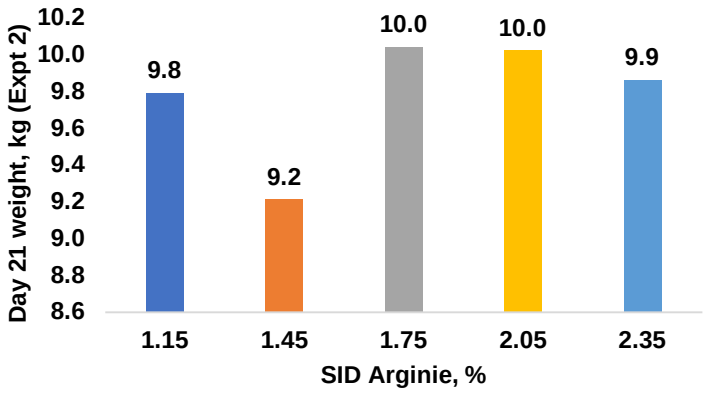


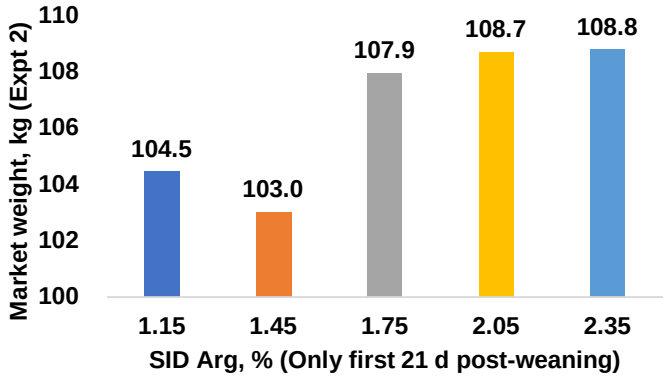
Source: Perez-Palencia et al., 2024

A piglet study at South Dakota University









Source: Perez-Palencia et al., 2024

A piglet study at Kansas State University

Animal

- 480 weaned pigs (6.20 kg)
- 6 treatments * 8 pens * 10 pigs/pen

Diets: Corn, dried whey, oat groat, corn gluten meal diet. 20.3% CP, 1.3% SID Lys, 3400 kcal ME

Treatments

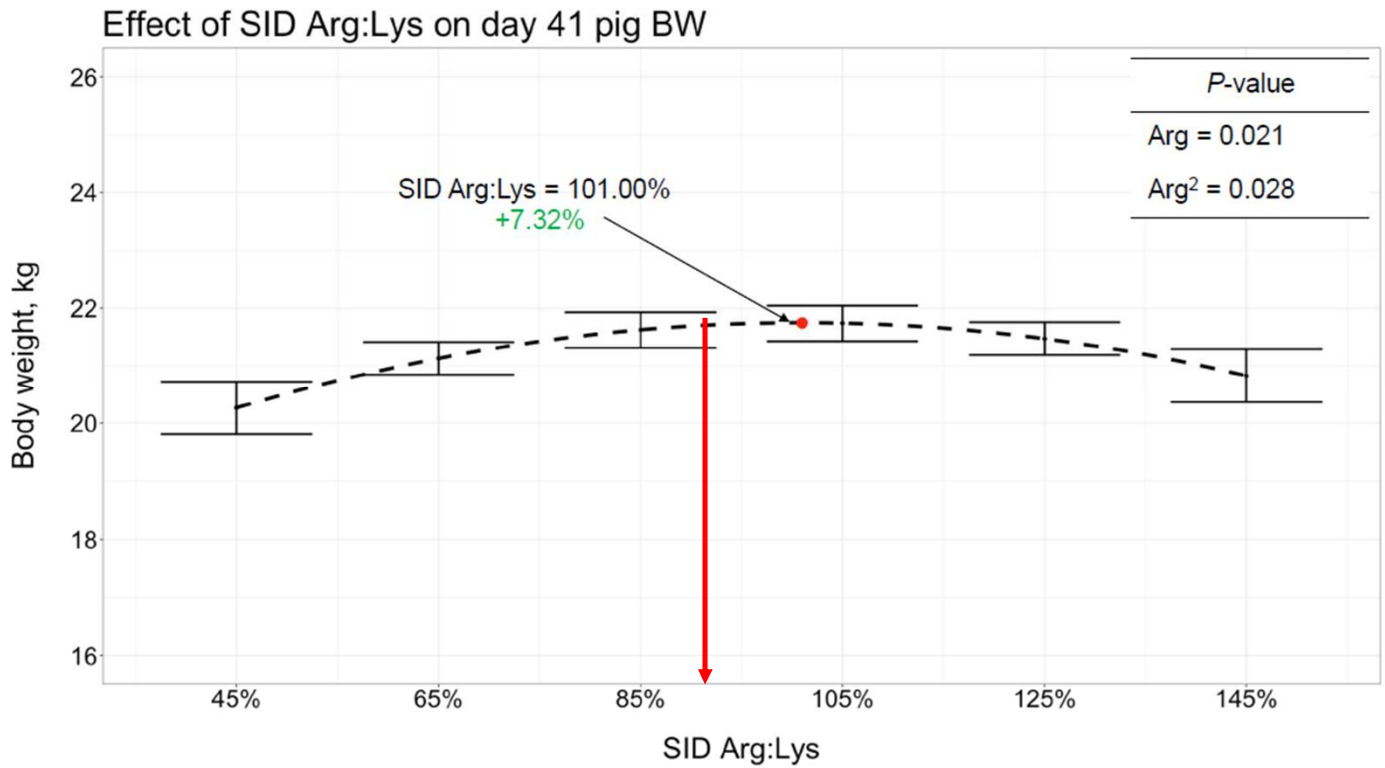
- SID Arg:Lys ratio 45%, 65%, 85%, 105%, 125%, 145%

Feeding phase

- Phase 1: day 0 – 10
- Phase 2: day 10 – 27

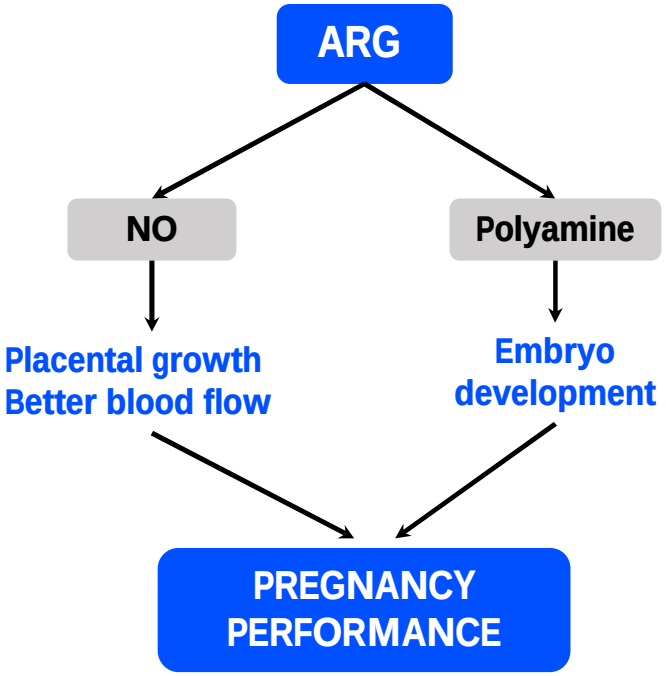
Source: Humphrey et al., 2024

A piglet study at Kansas State University



Source: Humphrey et al., 2024

Arginine in reproduction animal nutrition



Source: Wu., 2018

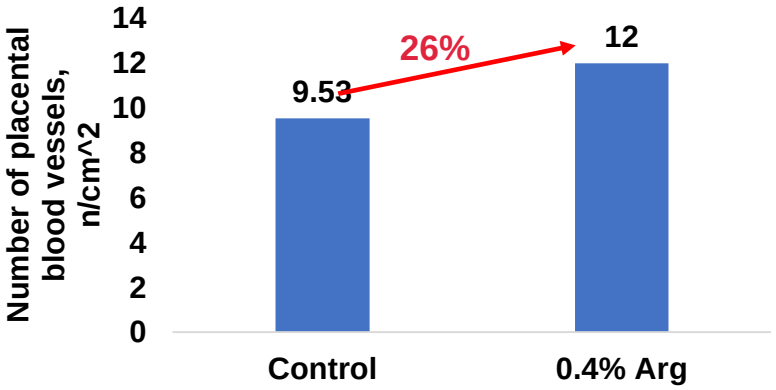
•Substrate for key regulators of pregnancy

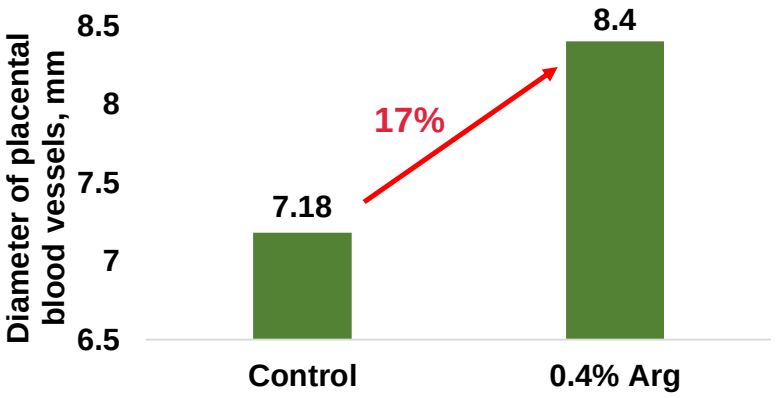
- Arginine is a common substrate for NO and polyamine synthesis (Wu and Morris, 1998)
- Theses are key regulators of embryogenesis, placental and fetal growth (Reynolds and Redmer, 2001; Wu et al., 2004a)

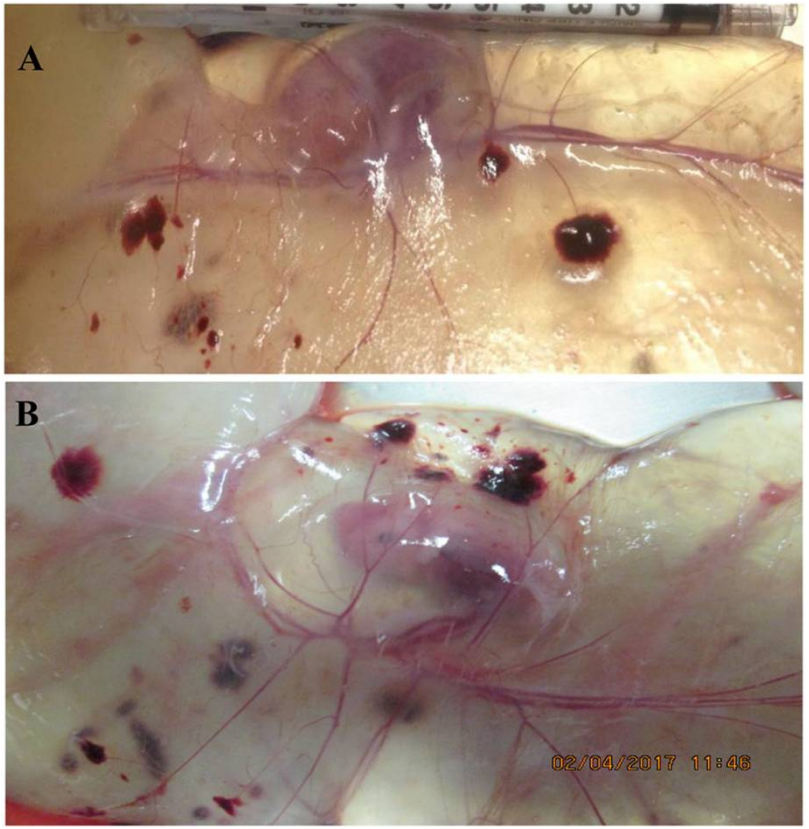
•Improving pregnancy outcomes

- The diet with dietary L-arginine supplementation improves the number of live-born piglets. (Ramaekers et al., 2006)

Arginine improves placental angiogenesis

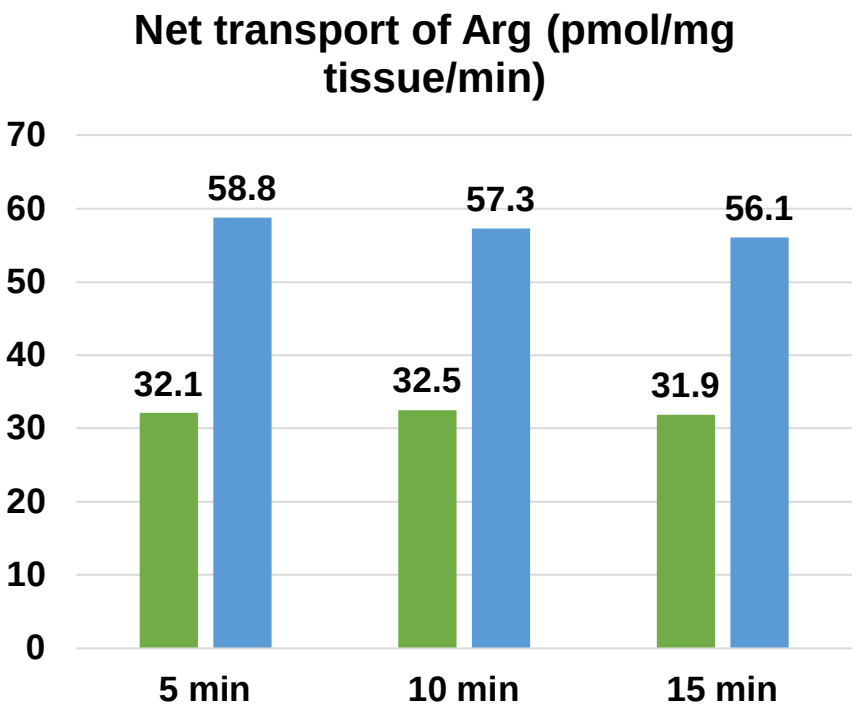


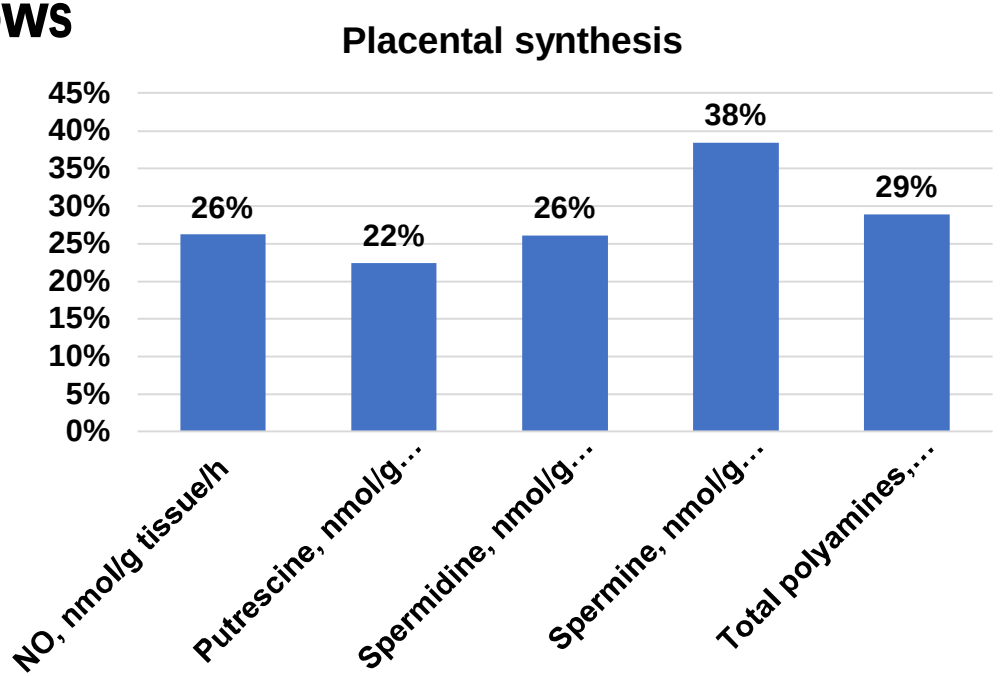




Source: Herring et al., 2022.

Arginine requirement in gestation sows





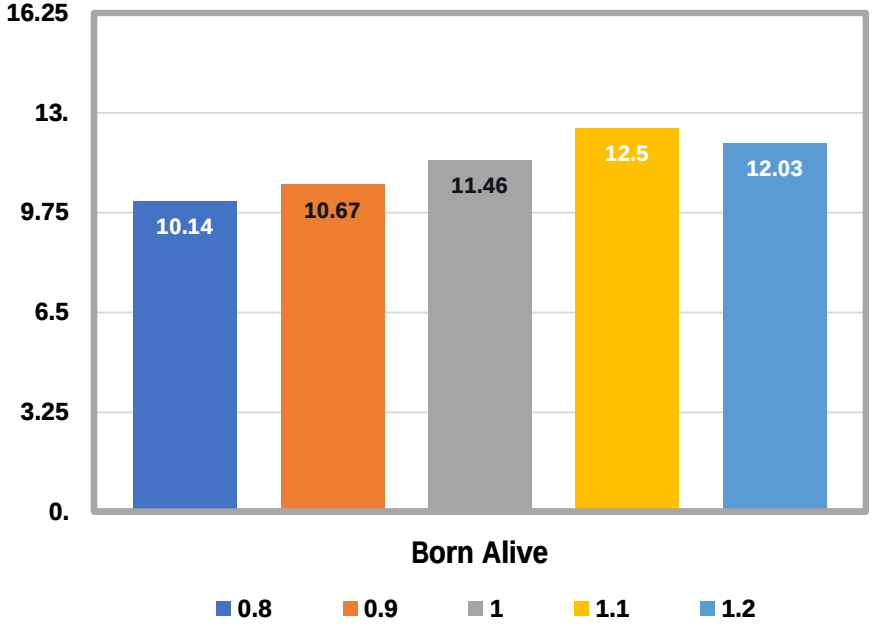
Source: Herring et al., 2022.

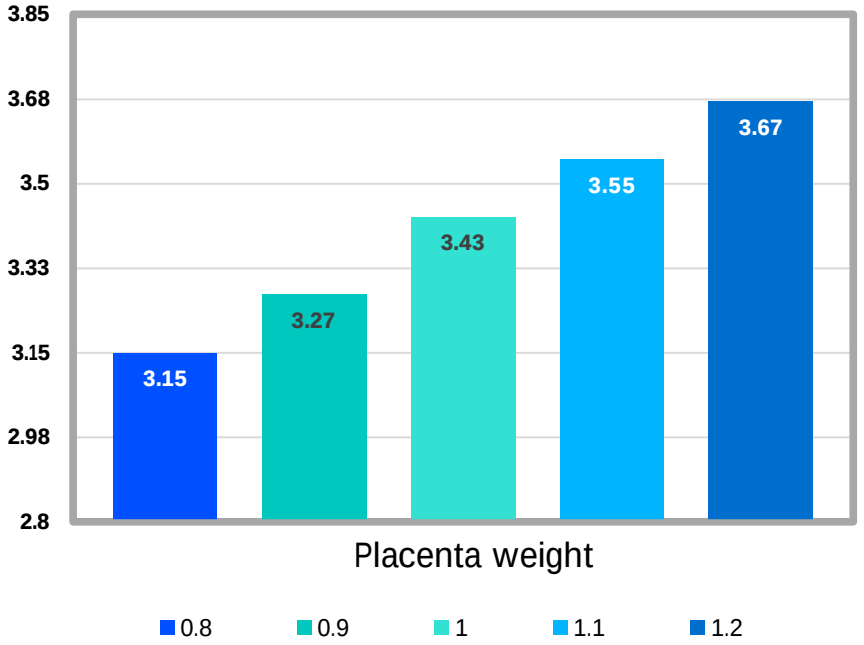
Arginine requirements in sows have not been properly studied

Authors	Parity of sow	Supplemental arginine (% of diet or g/sow per day)	Period of arginine supplementation	Feed intake per day (kg)	CP content in diet (%)	Energy content in diet (ME; MJ/kg)	Arginine content in basal diet (%)	Lysine content in basal diet (%)	Placental weight during early- to mid- gestation[a] or at birth[b]	Litter size of viable fetuses or live-born piglets	Litter weight of viable fetuses or live-born piglets
Bérard and Bee (2010)	1	0.87% 21.7 g	d 14–28	3.0	14.3	11.5	1.07	0.88	No effect[a]	↑ by 3.7 per litter	↑ by 32% per litter
Campbell (2009)	1 and MP	1% 25 g	d 14–28	ND	ND	ND	ND	ND	ND	↑ by 1 per litter	↑ by 6.4% per litter
De Blasio et al. (2009)	1	1% 25 g	d 17–33	2.5	ND	ND	ND	ND	ND	↑ by 1.2	ND
Gao at al. (2012)	1 and MP	0.83% 16.6 g	d 22–114	2.0 (d 22–90) 3.0 (d 90–114)	13.2	13.0	0.88	0.65	↑ by 16%[b]	↑ by 1.1 per litter	↑ by 11% per litter
Li (2014)	1	0.40% 8.0 g	d 14–25	2.0	12.0	12.9	0.70	0.57	↑ by 34%[b]	↑ by 2.2 per litter	No effect
Li (2014)	1	0.80% 16.0 g	d 14–25	2.0	12.0	12.9	0.70	0.57	↑ by 21%[b]	↑ by 1.7 per litter	No effect
Mateo at al. (2007)	1	0.83% 16.6 g	d 30–114	2.0	12.2	13.0	0.70	0.58	ND	↑ by 2.0 per litter	↑ by 24% per litter
Ramaekers (2006)	1 and MP	1% 25 g	d 14–28	ND	ND	ND	ND	ND	ND	↑ by 1 per litter	ND
Wu at al. (2012)	MP	0.83% 16.6 g	d 90–114	2.0	14.7	13.5	0.80	0.78	ND	No effect	↑ by 16% per litter

Arginine requirement in gestation sows

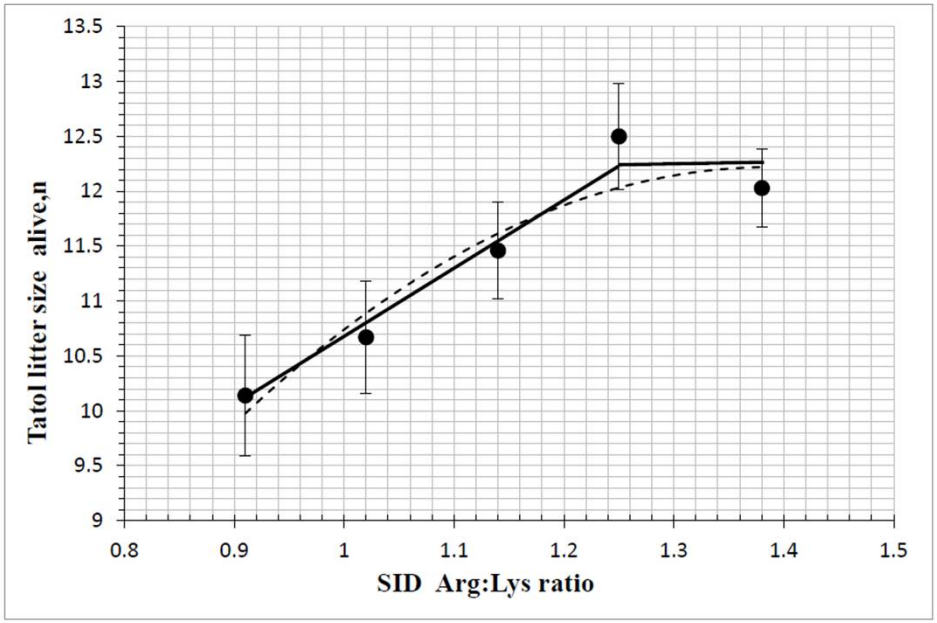
- Control: DE 3.18Mcal/kg, CP 14.25%, Lys 0.80%, Arg 0.64%,
- Feeding: Early pregnancy is 2.5kg, and the later period is 3.0kg.

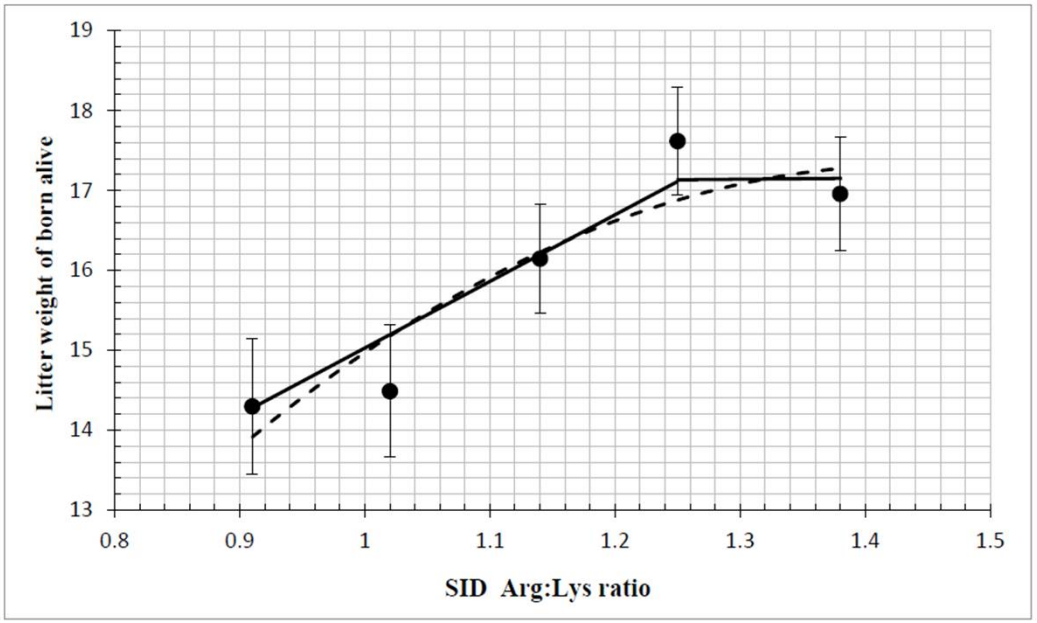




Source: Ko et al., 2018

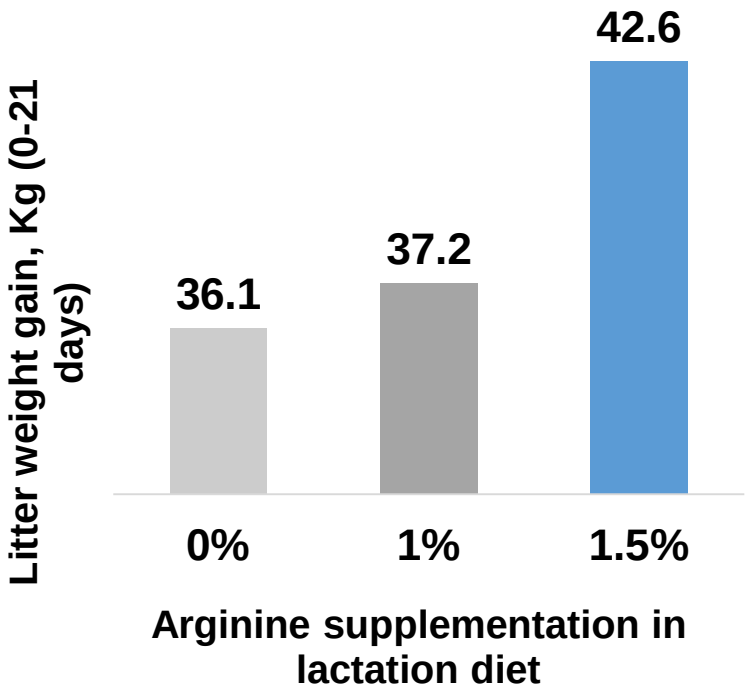
Arginine requirement in gestation sows

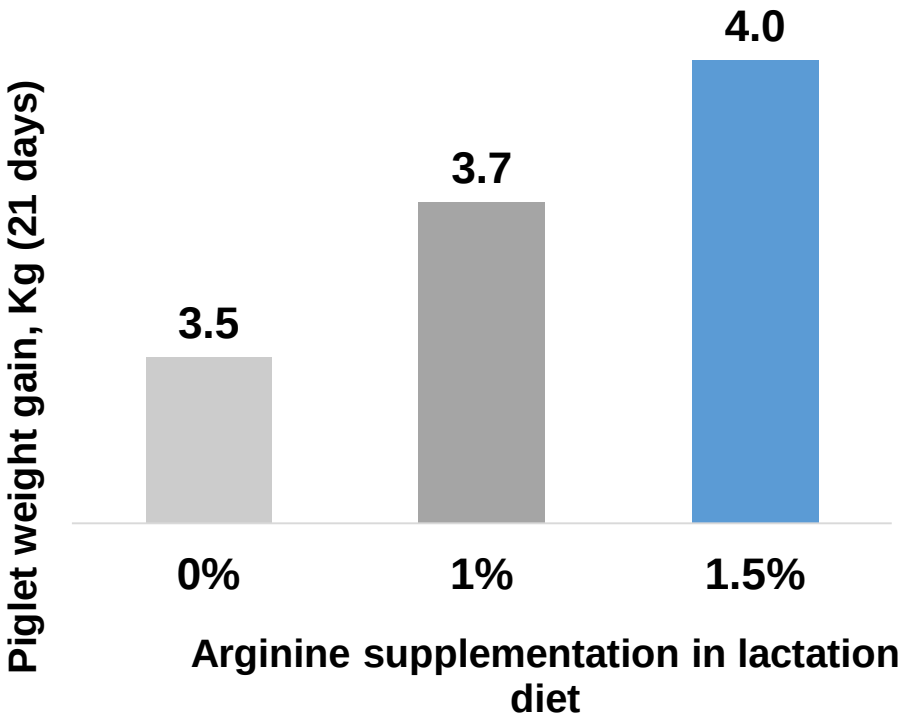




Wen et al., 2024, https://doi.org/10.3390/ani14182688

Arginine requirement in lactation sows



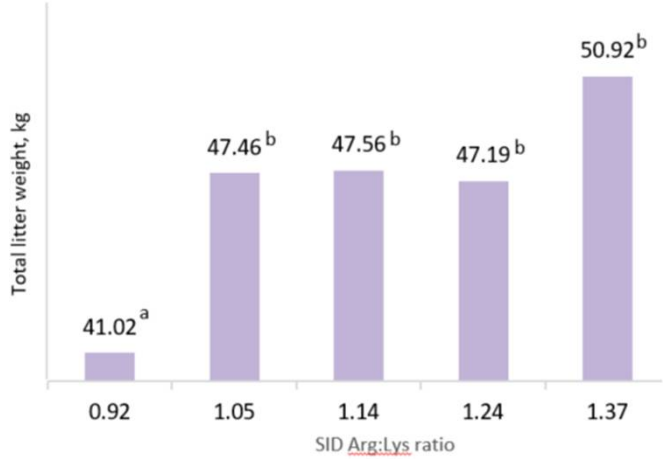


Hong et al., 2020

Arginine requirement in lactation sows

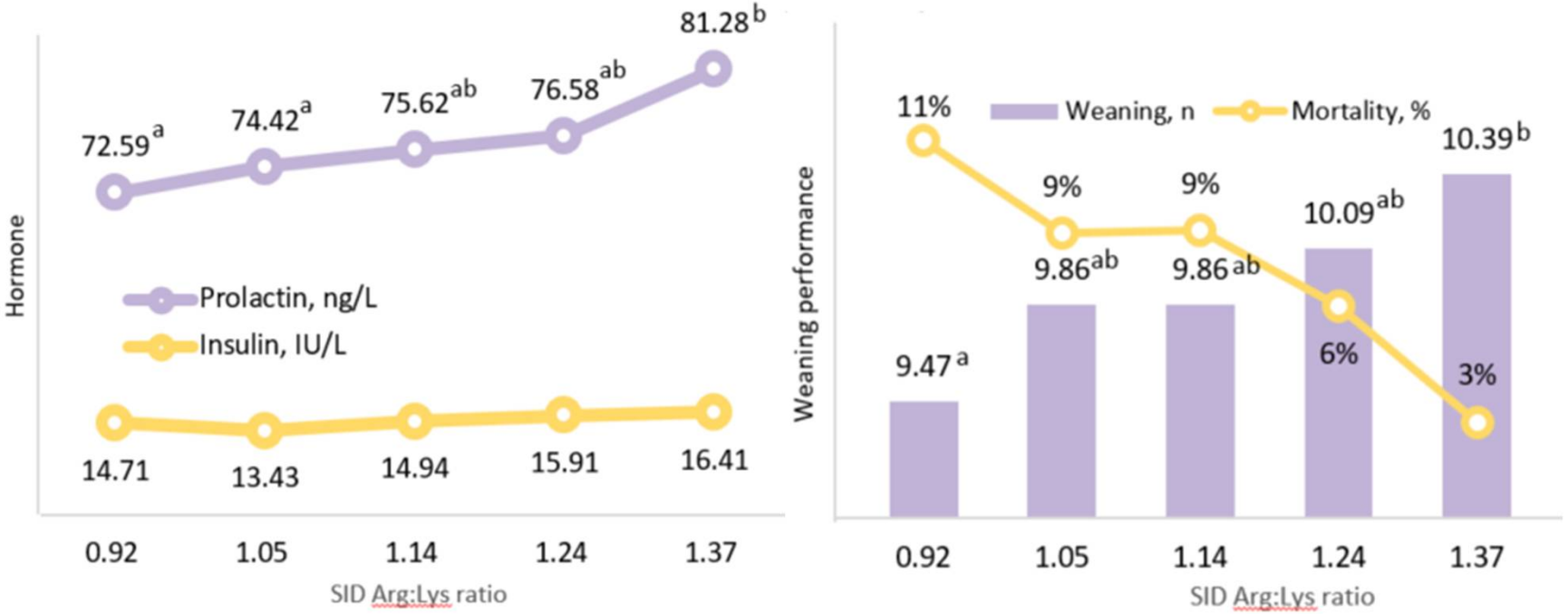
200 multiparous sows (3-6 parities, Yorkshire × Landrace, 40 sows/treatment), 174 completed the study
Period: from day 110 of pregnancy to 20-d lactation

Treatments	Added L-Arg				
	0.0%	0.1%	0.2%	0.3%	0.4%
Arg/Lys (As-fed)	0.9	1.0	1.1	1.2	1.3
Arg/Lys (SID)*	0.92	1.05	1.14	1.24	1.37



Gao et al., 2020_doi:10.1093/jas/skaa261

Arginine requirement in lactation sows



* A hormone that contributes to the development of mammary glands in mammary tissues and milk production

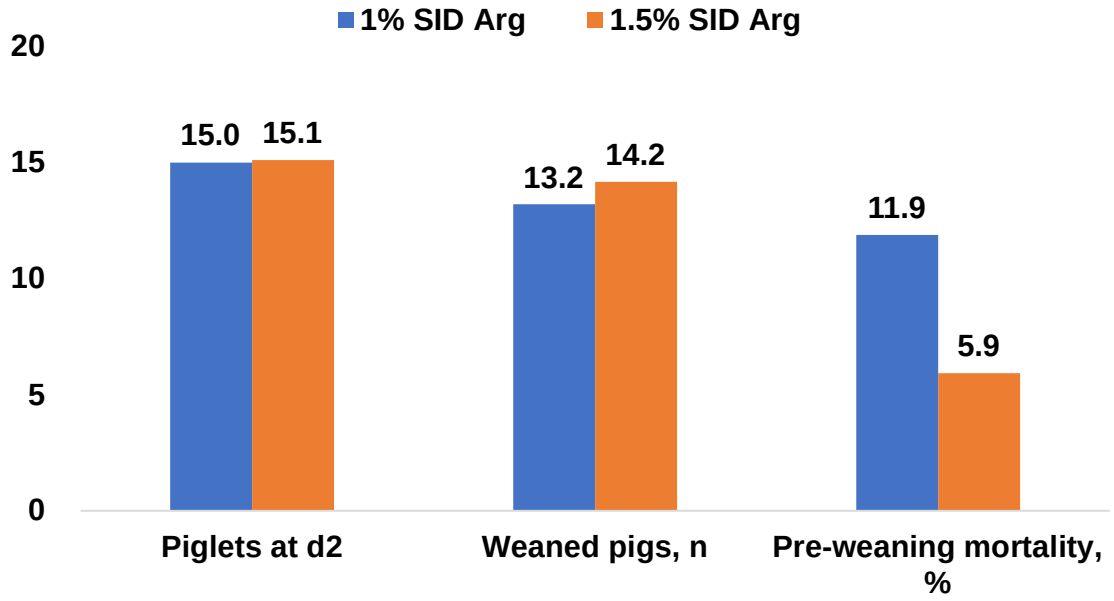
Gao et al., 2020_doi:10.1093/jas/skaa261

Arginine requirement in lactation sows

Criteria	SID Arg/Lys 90	SID Arg/Lys 105	SID Arg/Lys 120
Site #1			
Preweaning Mortality, %	8.06	4.57	4.88
	SID Arg/Lys 100	SID Arg/Lys 150	P value
Site #2			
Pre-weaning Mortality, %	14.49[a]	7.60[b]	0.034

Arginine requirement in lactation sows

- 100 females (238 kg; parity 0-3)
- To evaluate season (winter and summer) X dietary arginine level from day 110 of gestation until weaning
- Control: 1% SID arginine vs. Control + 0.5% L-arginine supplementation



Piglets from Arg supplemented sows had higher (+20%, $P < 0.1$) plasma IgA concentrations at weaning.

Perez-Palencia et al., 2025. National Hog Farmers. (www.nationalhogfarmer.com/livestock-management/arginine-plays-critical-role-in-young-pig-nutrition-for-survivability-lifetime-performance)

Conclusions: Arginine is the missing link for optimum swine production

•Piglet

- The current requirement is set significantly lower than the real requirement.
- **Should meet the minimum 90% of SID Lys and the optimum for 101% of SID Lys**

•Gestating sow

- **125% of SID Lys** supplementation improves the reproductive performance

•Lactating sow

- Arginine has the effect of improving the weaning performance of suckling piglets
- CJ's recommended requirement is >**1.06** SID Arg:Lys (current NRC standard requirement is 0.56)

•Boar

- **Semen quality is improved when 0.8% added**

Acknowledgements

- Technical team at CJ Bio America
- Kansas State University
- Iowa State University
- South Dakota State University