

Impacts of low protein formulation on mucosal health and growth of pigs

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Let's talk about protein in pig feed first

Science-driven solutions



1 billion pigs in the world

Science-driven solutions

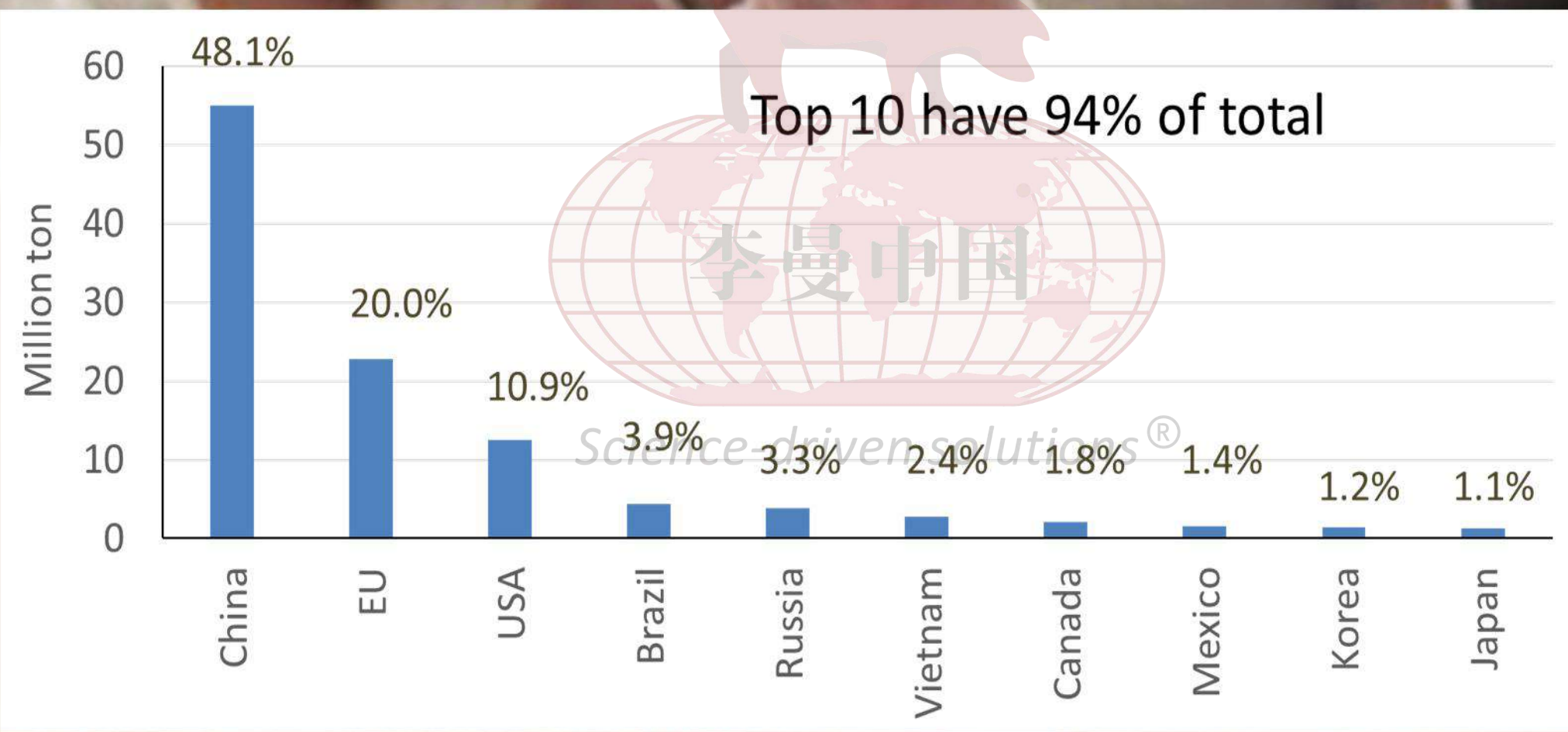
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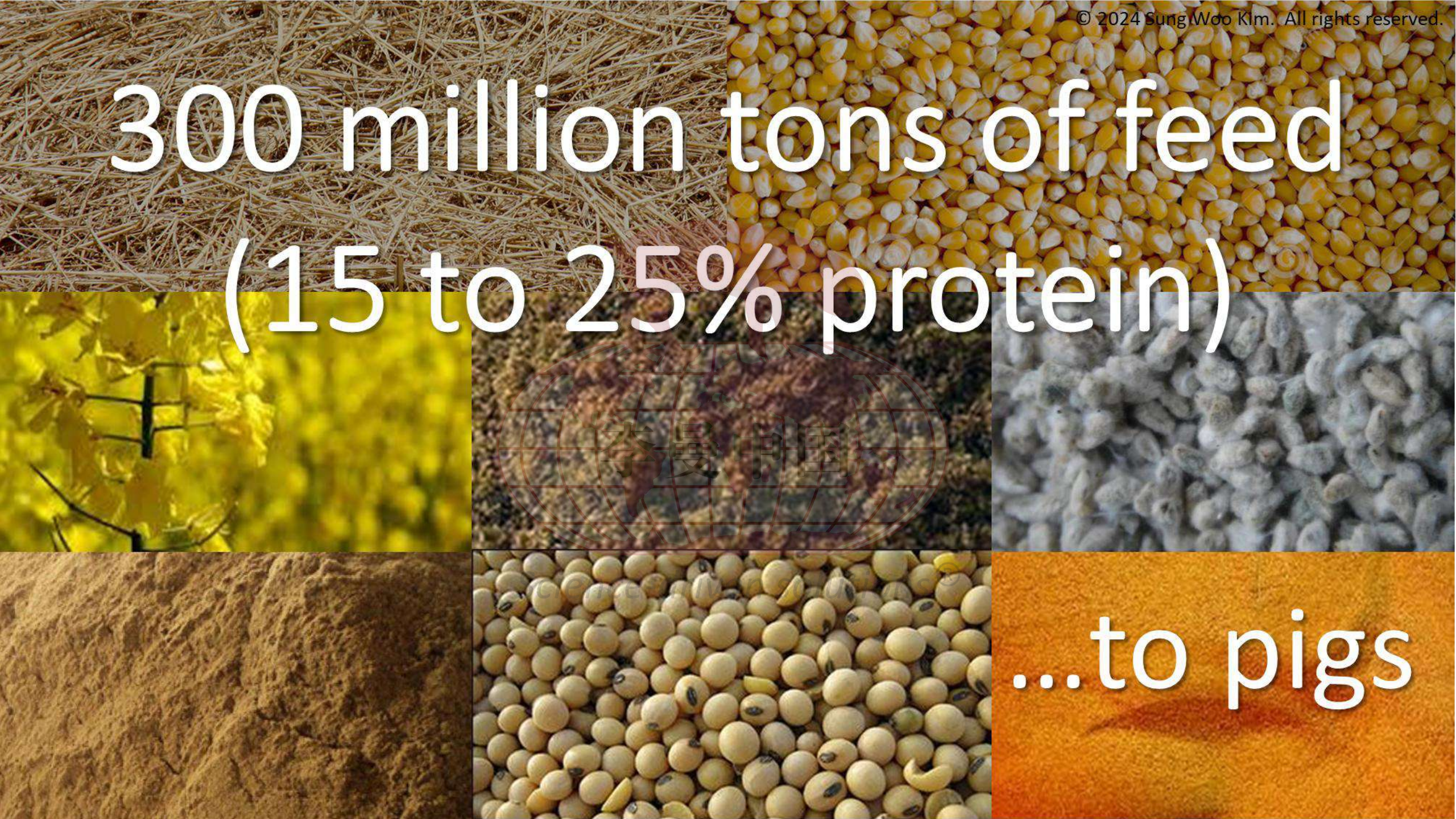
— Invited Review —
**Current status of global pig production:
an overview and research trends**

Sung Woo Kim^{1*}, Alexa Gormley¹, Ki Beom Jang¹, and Marcos Elias Duarte¹

Top 10 countries: pork production



300 million tons of feed
(15 to 25% protein)

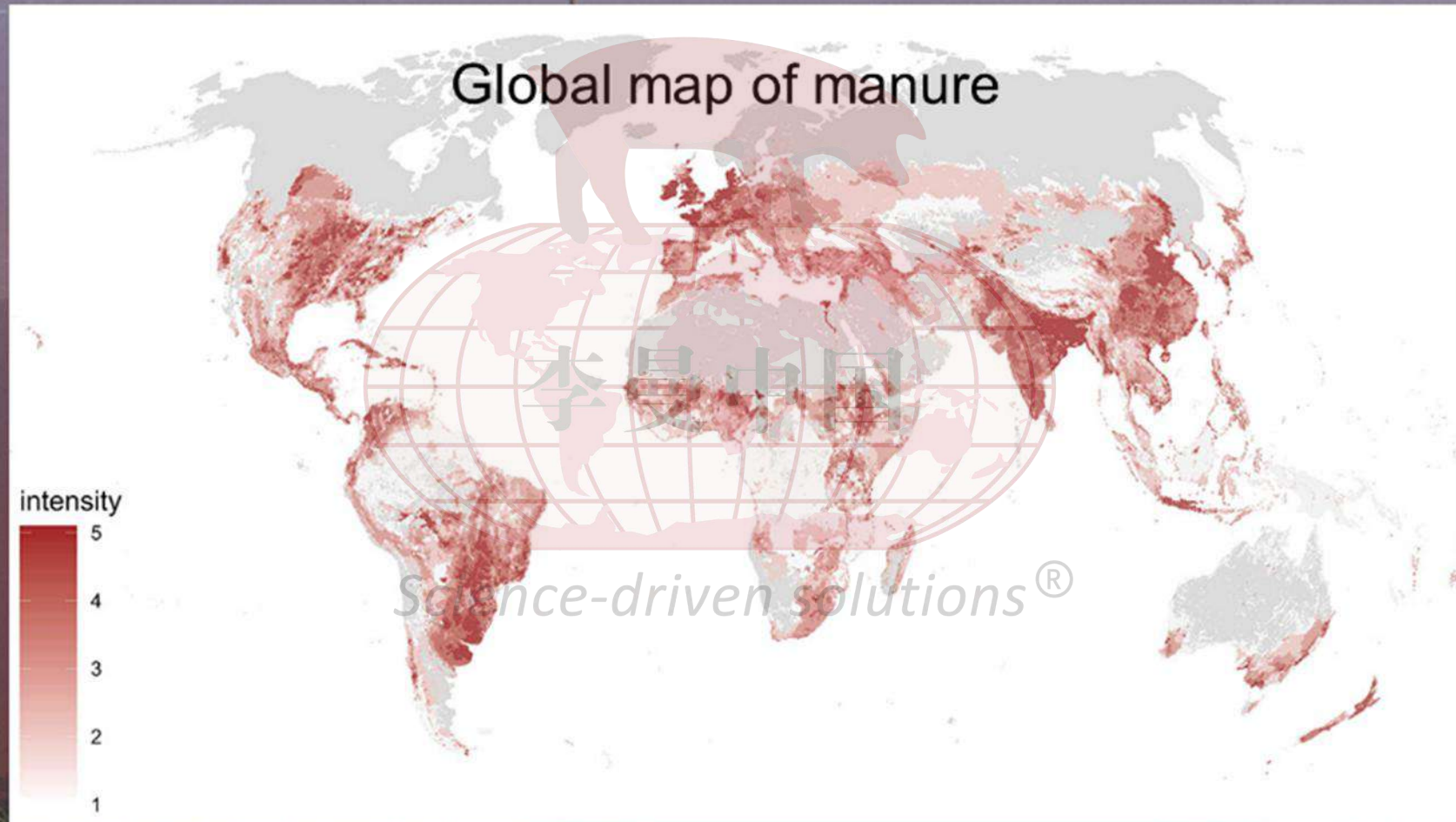


...to pigs

From pigs ...

85% of protein is digested
... excreting 9 mt protein

Consolidated animal agriculture: 'manure map'



Society perspective of animal agriculture

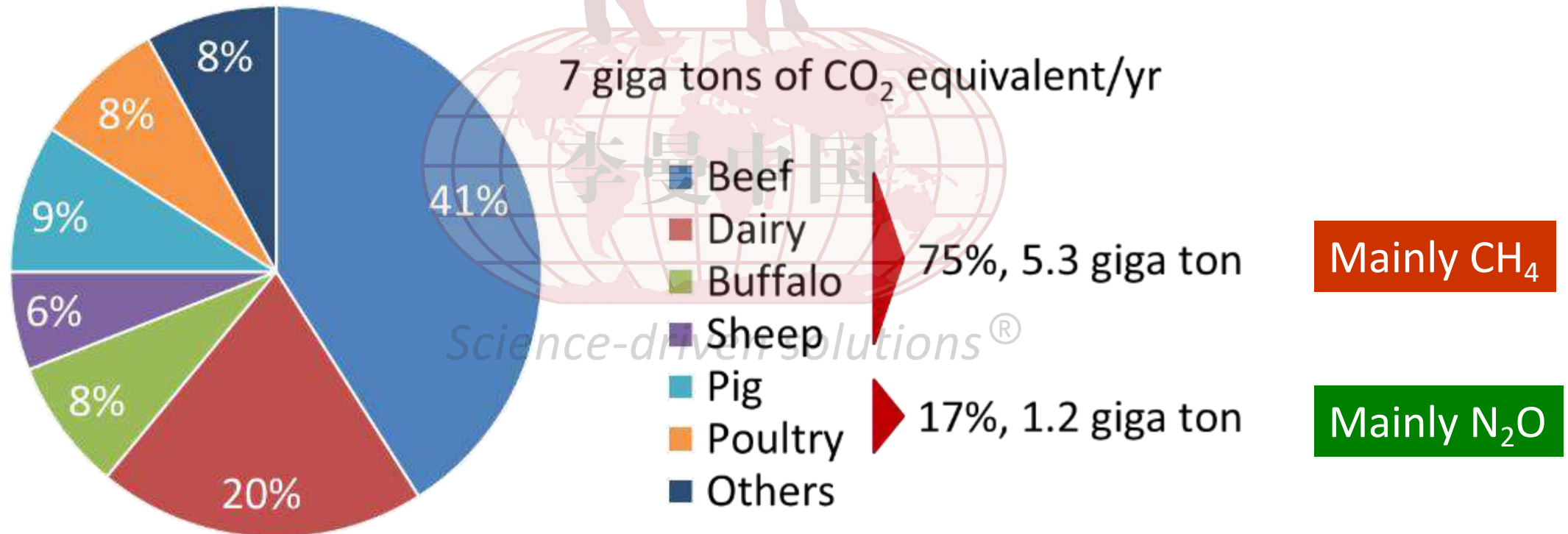
The image displays four browser windows illustrating search results for 'animal agriculture':

- Google:** Shows search results with a red circle around the article 'Animal Agriculture: Negatively Impacting the World Around Us' and another red circle around the article 'How Does Animal Agriculture Affect Global Warming? - This'.
- Yahoo:** Shows search results with a red circle around the article 'Animal Agriculture: Negatively Impacting the World Around Us'.
- YouTube:** Shows video search results with red circles around the video 'How Animal Agriculture is Destroying Our Planet' and 'The End of Animal Farming | Jacy Reese Anthis'.
- Twitter:** Shows search results with a red circle around a tweet from Greenpeace titled 'THE AMAZON IS BEING WIPED OUT'.

A large watermark 'Science-driven YouTube' is overlaid on the center of the collage.

Greenhouse gas emission and animal agriculture

- Greenhouse gas (GHG) emissions from global animal agriculture
 - By species (% of GHG from global animal agriculture)



Nitrogen excretion from pig production

- 1% reduction of CP in swine and poultry feeds
 - Reduce NH_3 loss by 10% (Blair et al., 1995; Sutton et al., 1997)
 - Reduce N excretion by 8% (Ferguson et al., 1998)
- Use of feedstuffs with high protein digestibility
 - Reduce N excretion by 10-20% (Applegate, 2008)

**2% CP ↓ in pig feeds =
1.8 million tons of N excretion**

Do pigs really need protein in their diets?



Probably not!

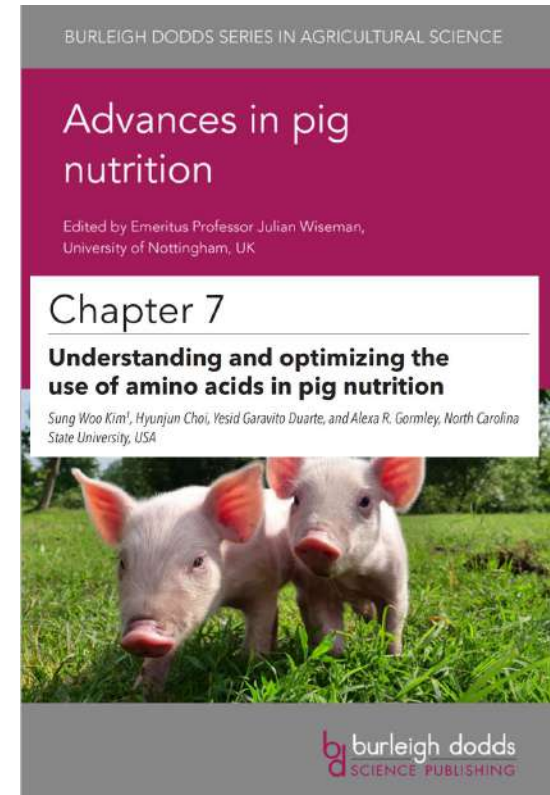
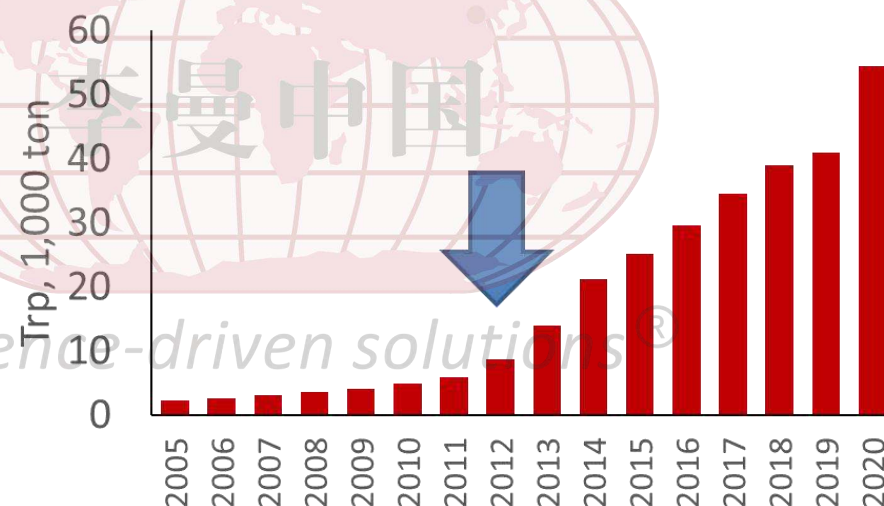
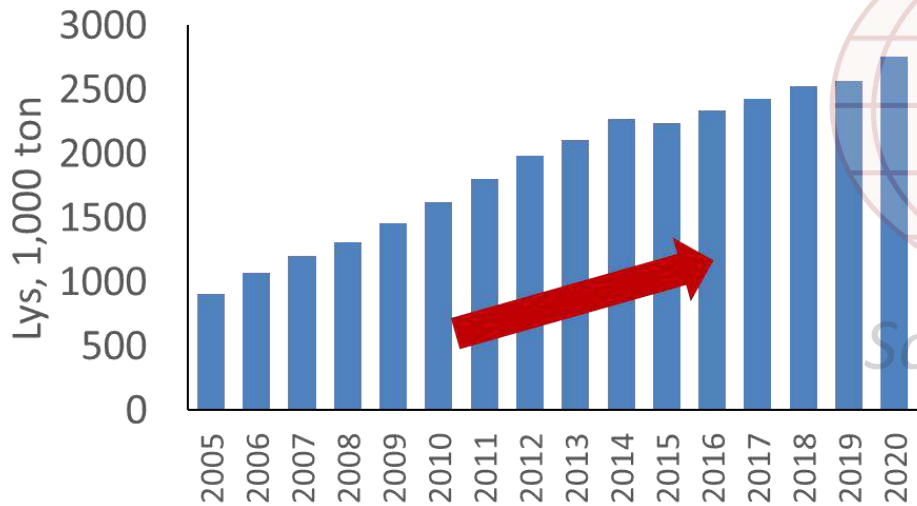
Animals need amino acids but not protein for protein synthesis.

Protein vs. amino acid requirement

- Animals require amino acids but not nitrogen or crude protein.
- High protein is not necessary if amino acids meet the requirement.
 - There is no 'protein requirement' but 'amino acid requirement' for the growth, health, and body maintenance.
- Amino acid profiles and contents are key for feed quality.

Low protein formulation: global trends

- Global use of supplemental AA has been increased dramatically.
 - Trends of low protein formulation (cost, gut health, and environment)



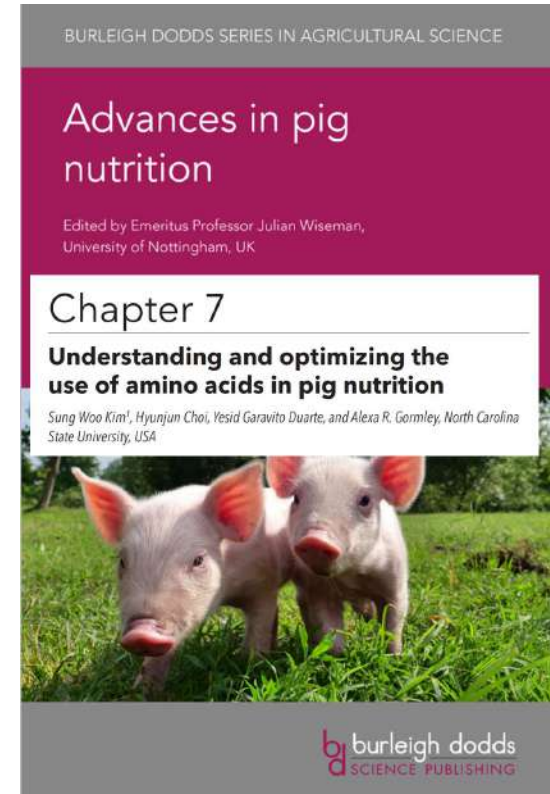
Low protein formulation: global trends

1960' ▶ 1980'-2000' ▶ 2000'-2020'

25 to 50 kg BW	SBM	+ Lys, Thr	+ Met	+ Trp, Val, Ile	+ His, Phe
SBM	38.5	30.0	22.5	15.5	8.9
L-Lys HCl		0.10	0.32	0.54	0.75
L-Thr		0.12	0.22	0.32	0.41
L-Met or DL-Met			0.07	0.13	0.19
L-Trp				0.04	0.08
L-Val / L-Ile				0.10 / 0.04	0.21 / 0.15
L-His / L-Phe					0.07 / 0.12
SID Lys, %	0.98	0.98	0.98	0.98	0.98
CP, %	23.1	19.9	17.2	14.9	12.7

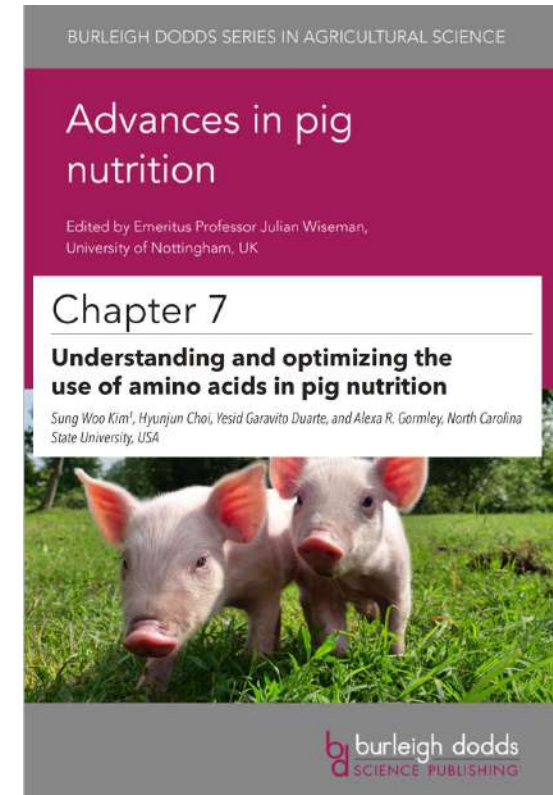
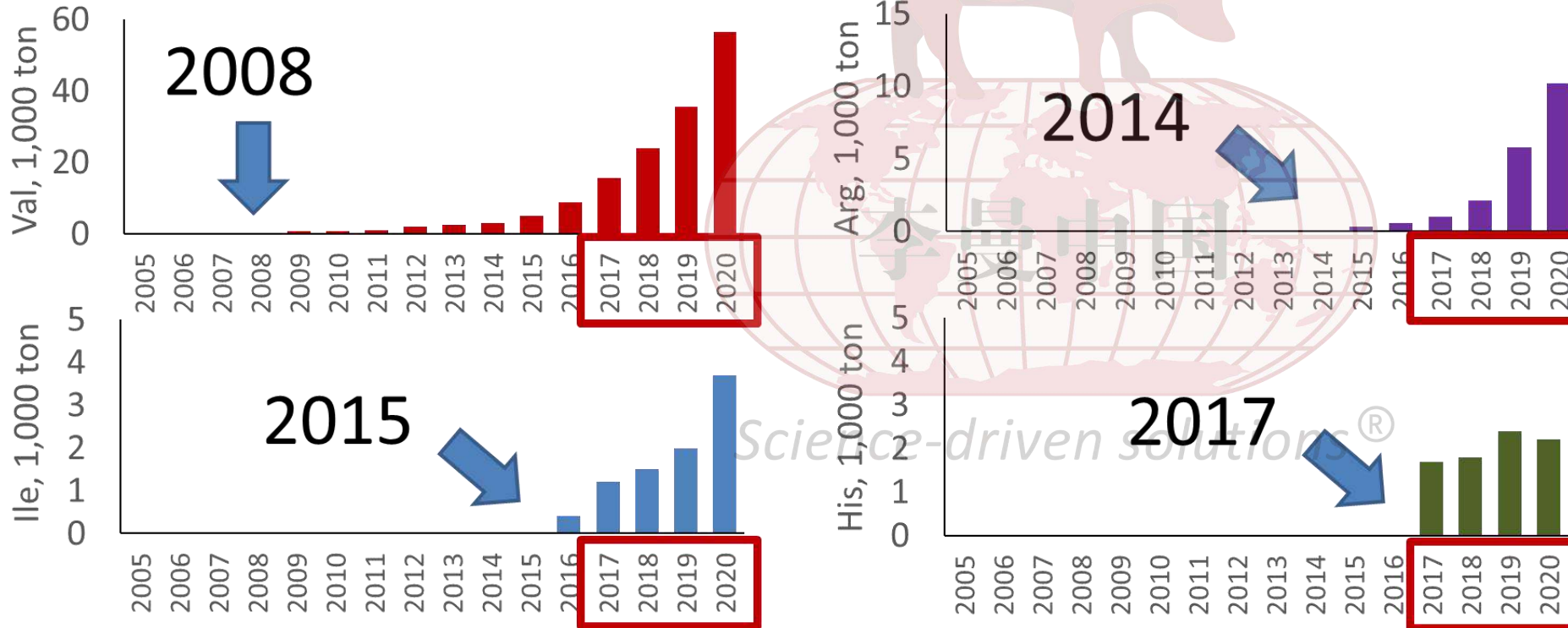
Rule of thumb: 0.15% Lys HCl/t with Met and Thr

Δ3.2% ▶ Δ2.7%



Low protein formulation: recent trends

- Major trend of low protein formulation since 2017 (w/ Val, Arg, Ile, His)



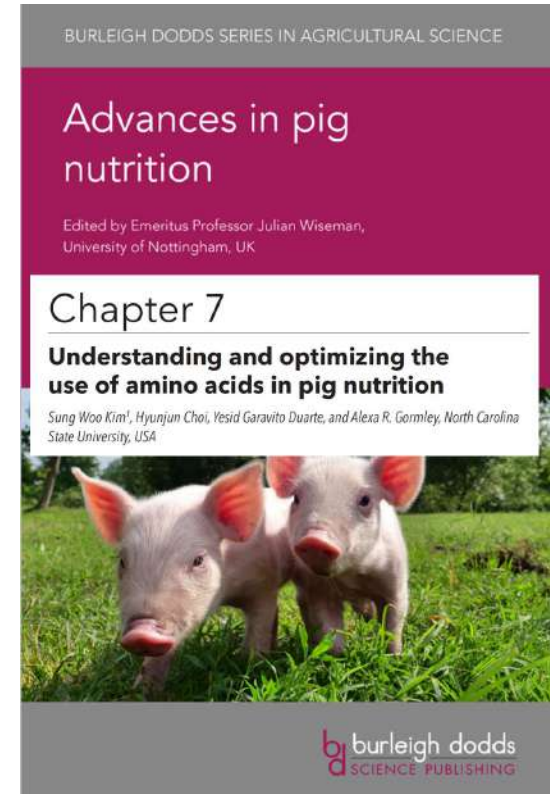
Low protein formulation: recent trends and future

1960' 1980'-2000' 2000'-2020'

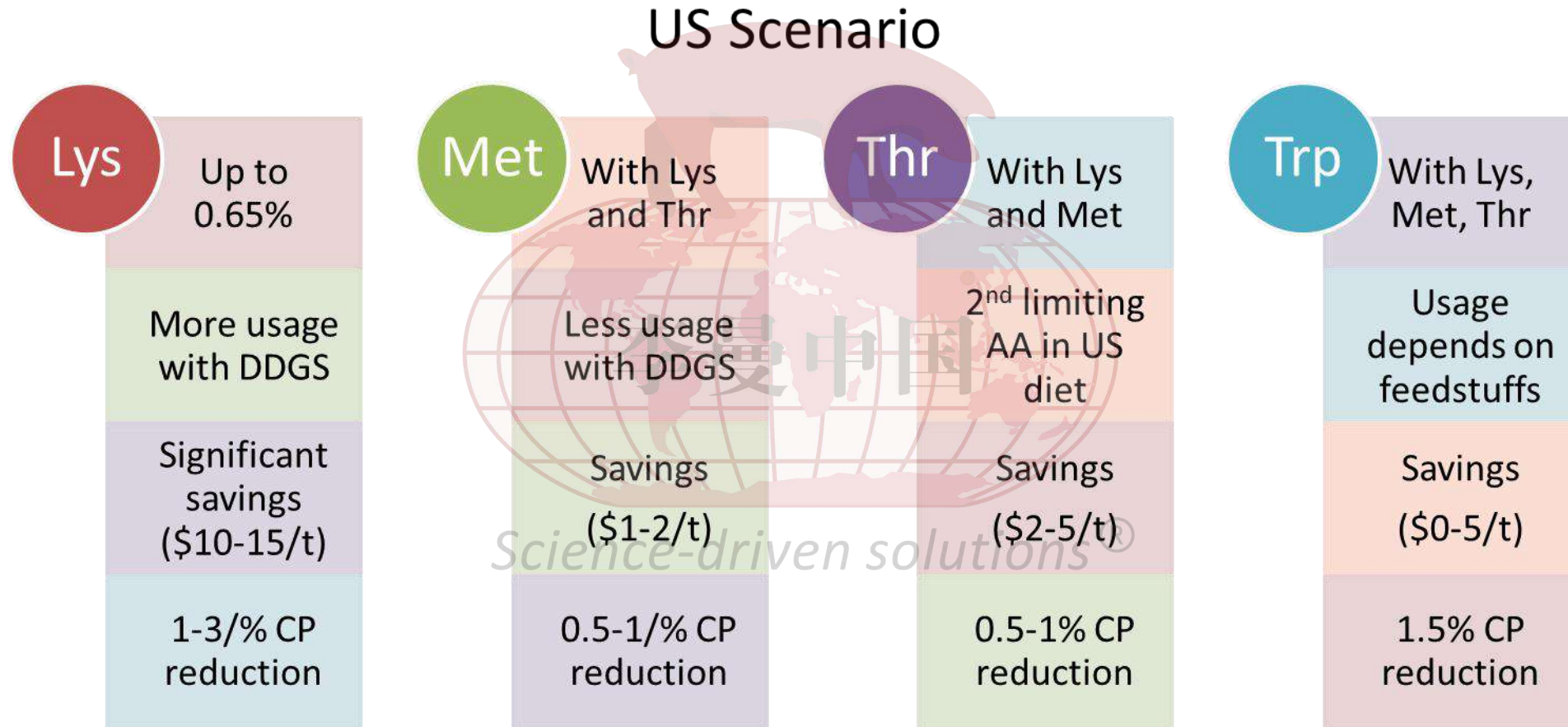
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SID Lys, %	0.98	0.98	0.98	0.98	0.98
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Up to 0.65% Lys HCl for nursery
0.35% Lys HCl for finisher
DDGS needs Trp, Val, Ile

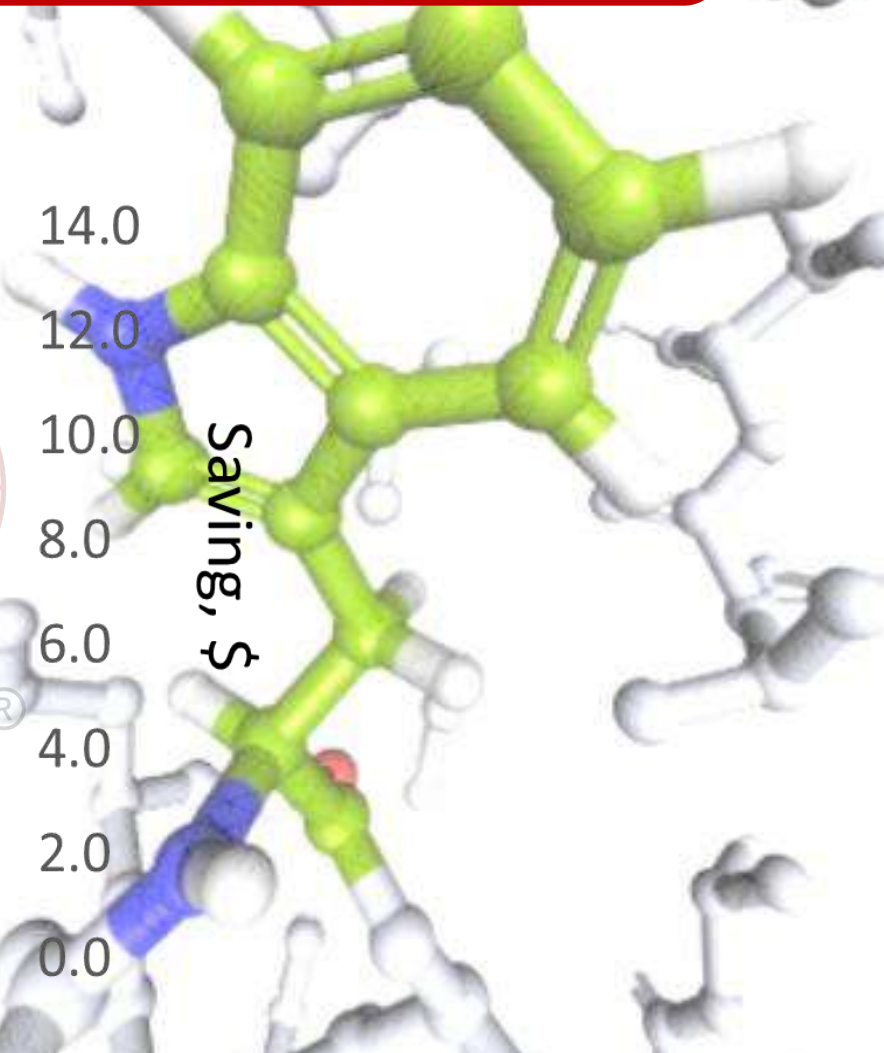
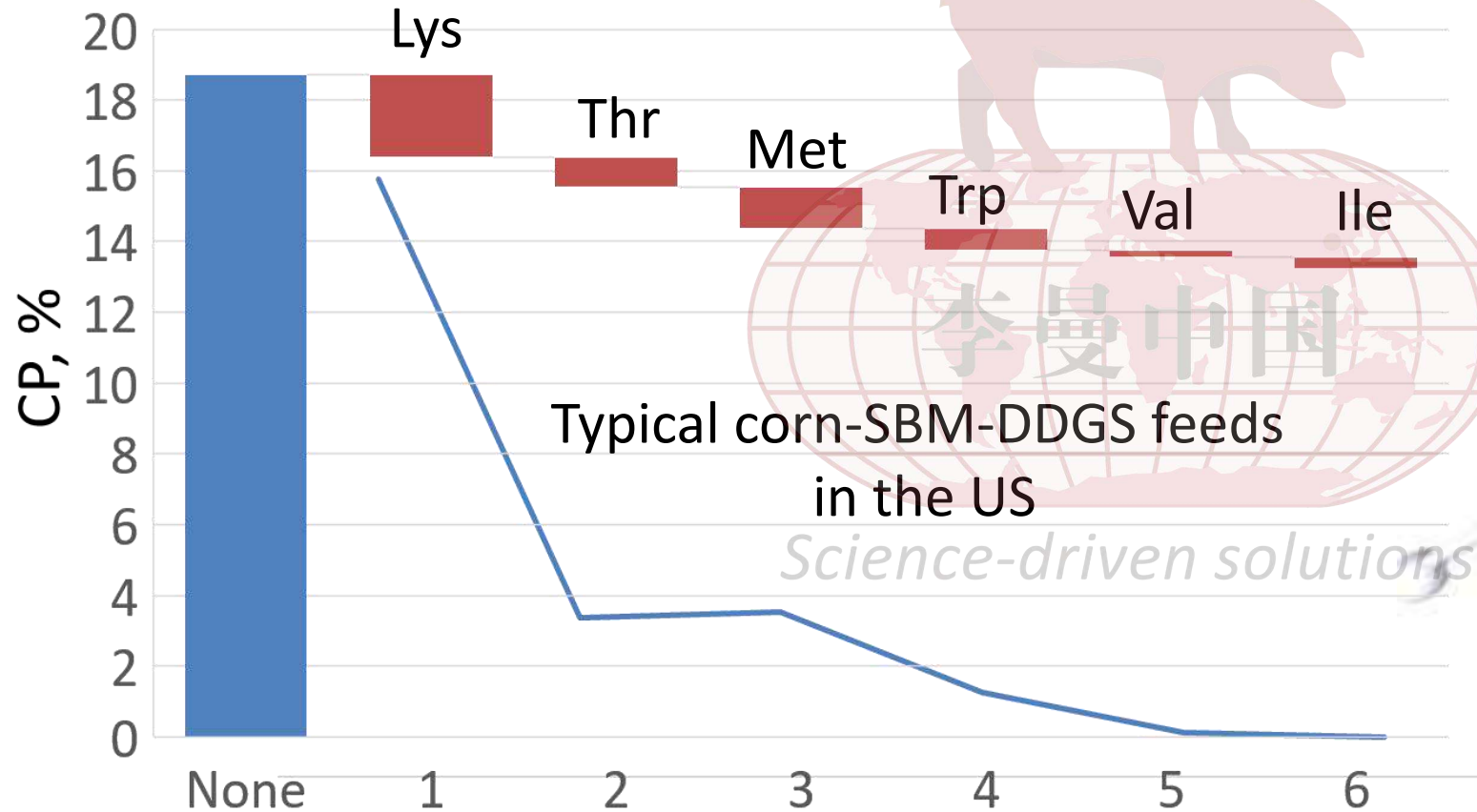
$\Delta 3.2\%$ $\Delta 2.7\%$ $\Delta 2.3\%$ $\Delta 1.2\%$



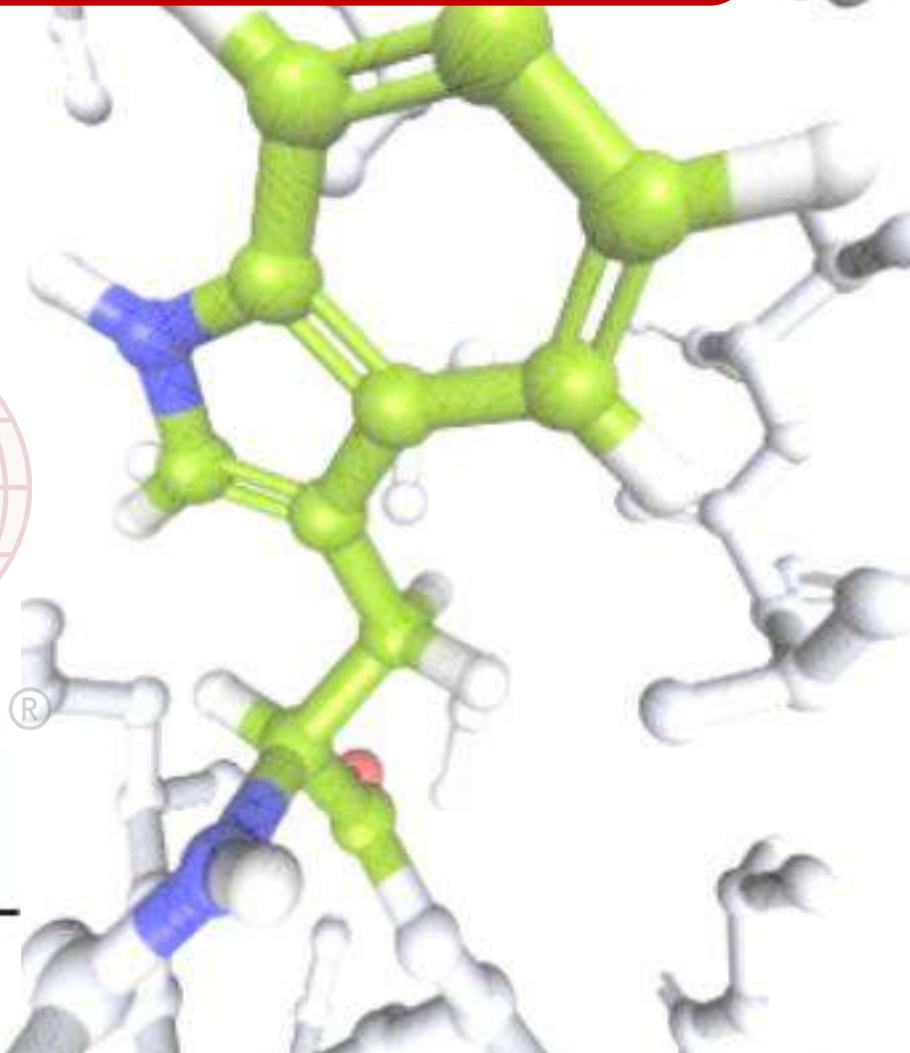
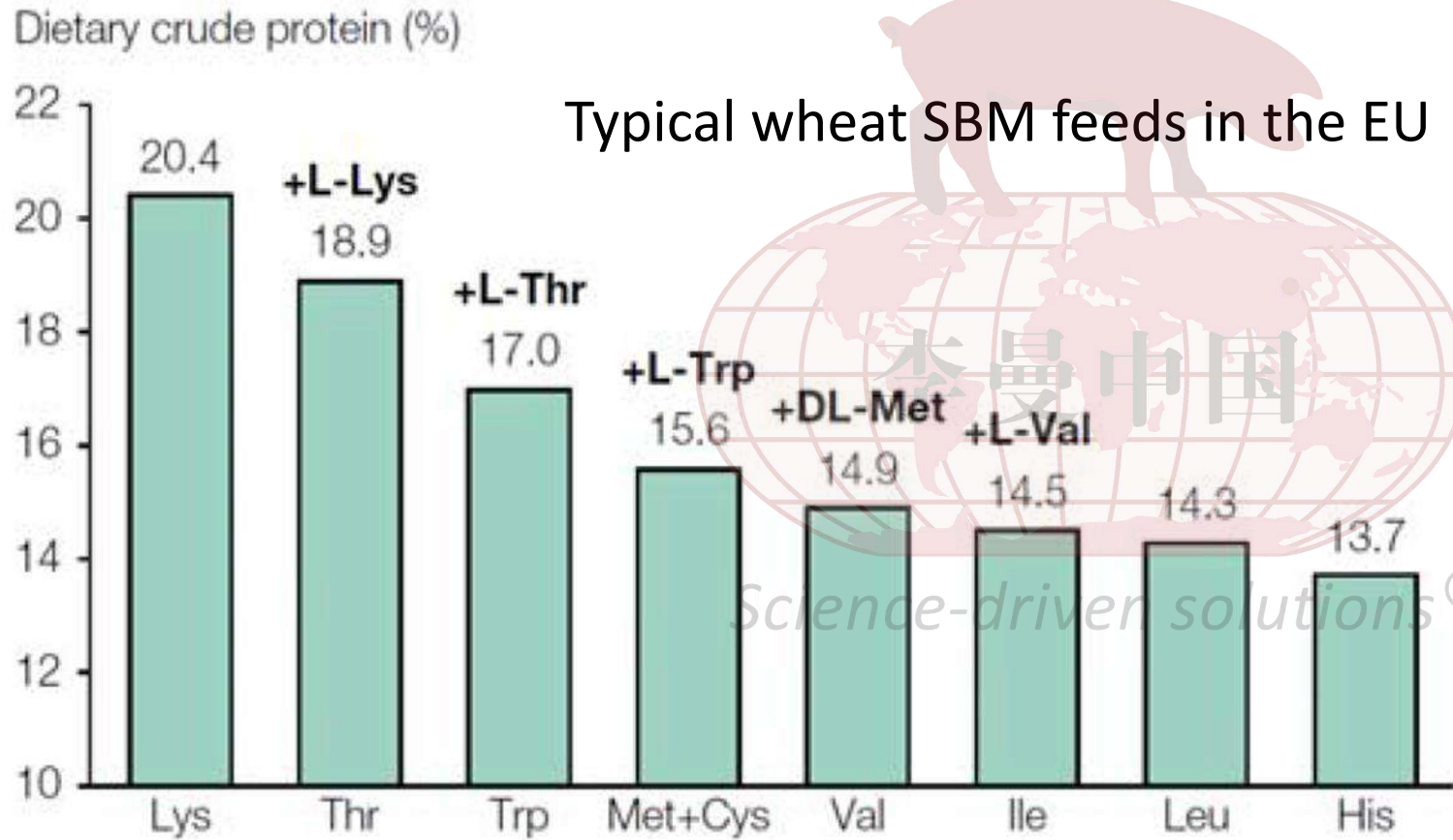
Low protein formulation: supplemental AA



Low protein formulation: supplemental AA

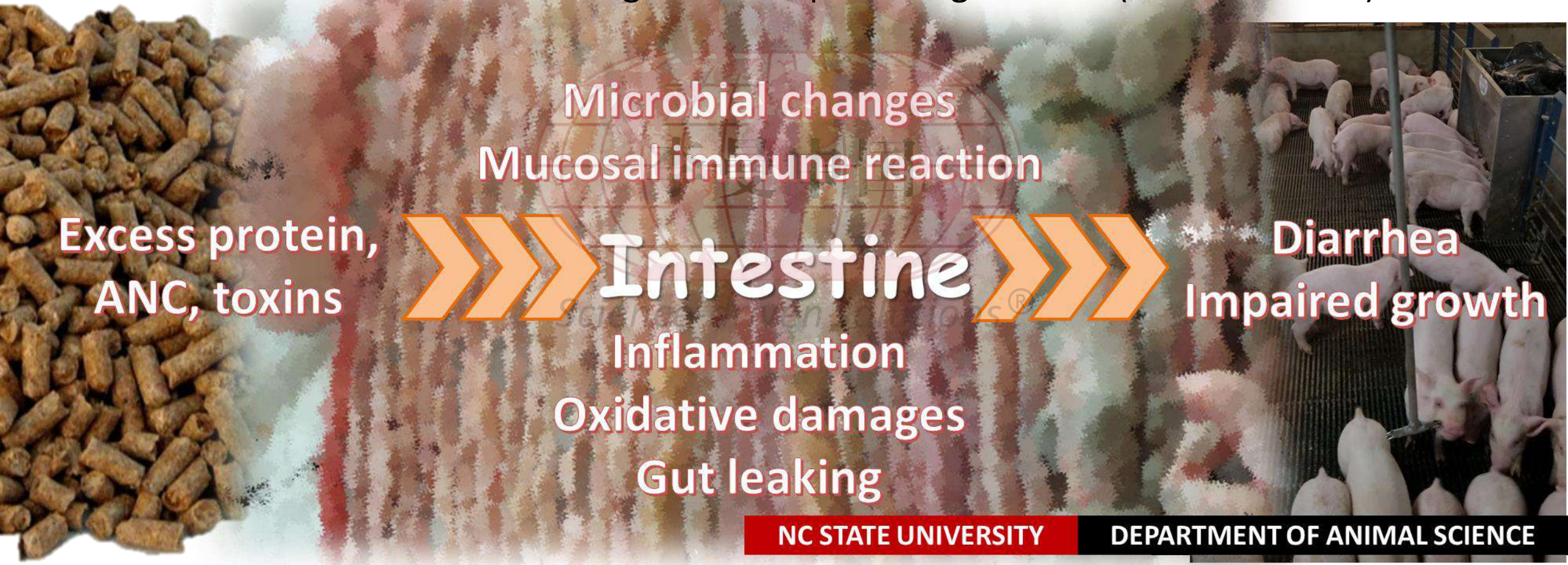


Low protein formulation: supplemental AA



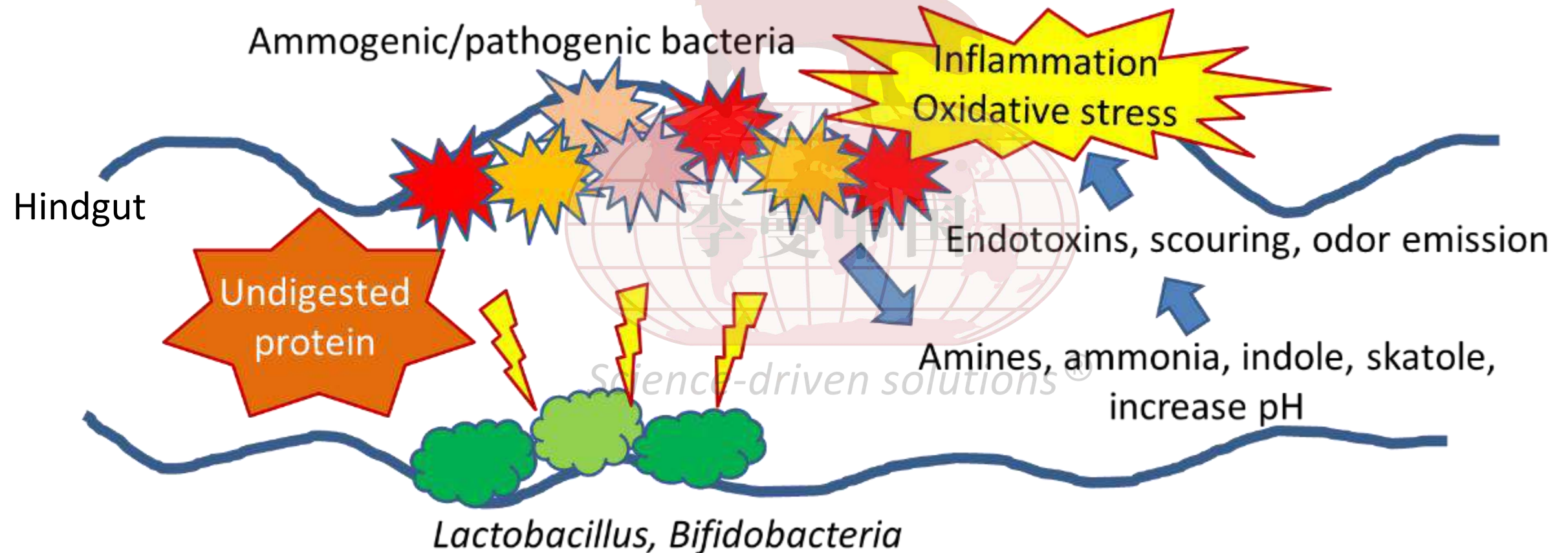
Low protein formulation: intestinal health

- Excess dietary protein increases undigested protein in the intestine.
 - Provides risks of increasing ammonia producing bacteria (Proteobacteria)



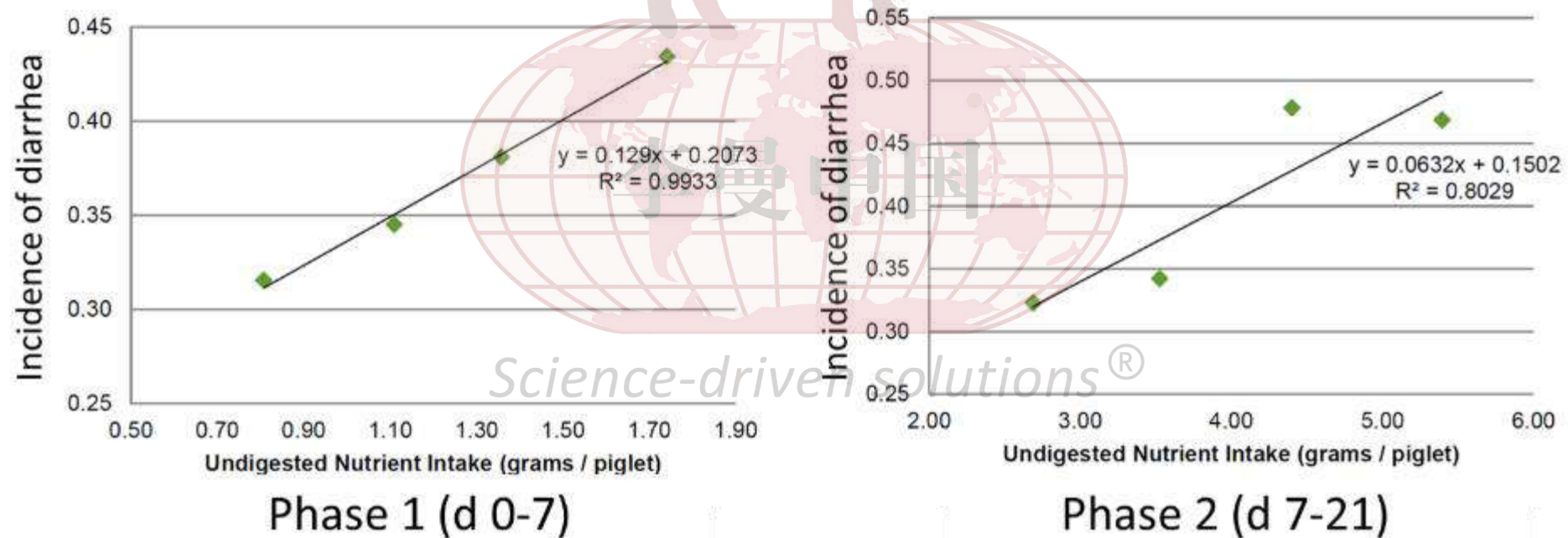
Low protein formulation: intestinal health

- Undigested protein causes microbial imbalance



Low protein formulation: intestinal health

- Undigested protein can cause diarrhea in nursery pigs.



Low protein formulation: intestinal health

- Undigested protein increases abundance of ammnogetic bacteria associated to the jejunal mucosa causing gut mucosal inflammation.

Duarte *et al.*
Journal of Animal Science and Biotechnology (2024) 15:55
<https://doi.org/10.1186/s40104-024-01015-6>

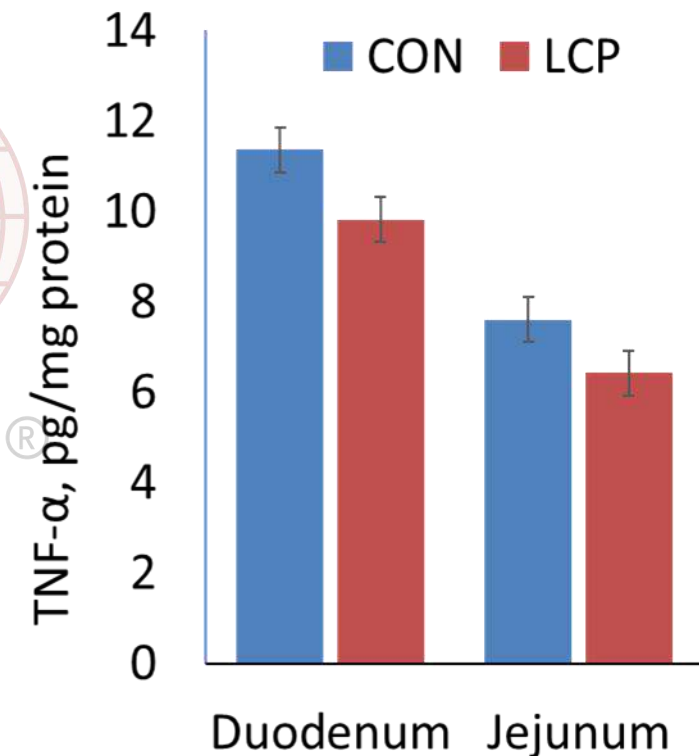
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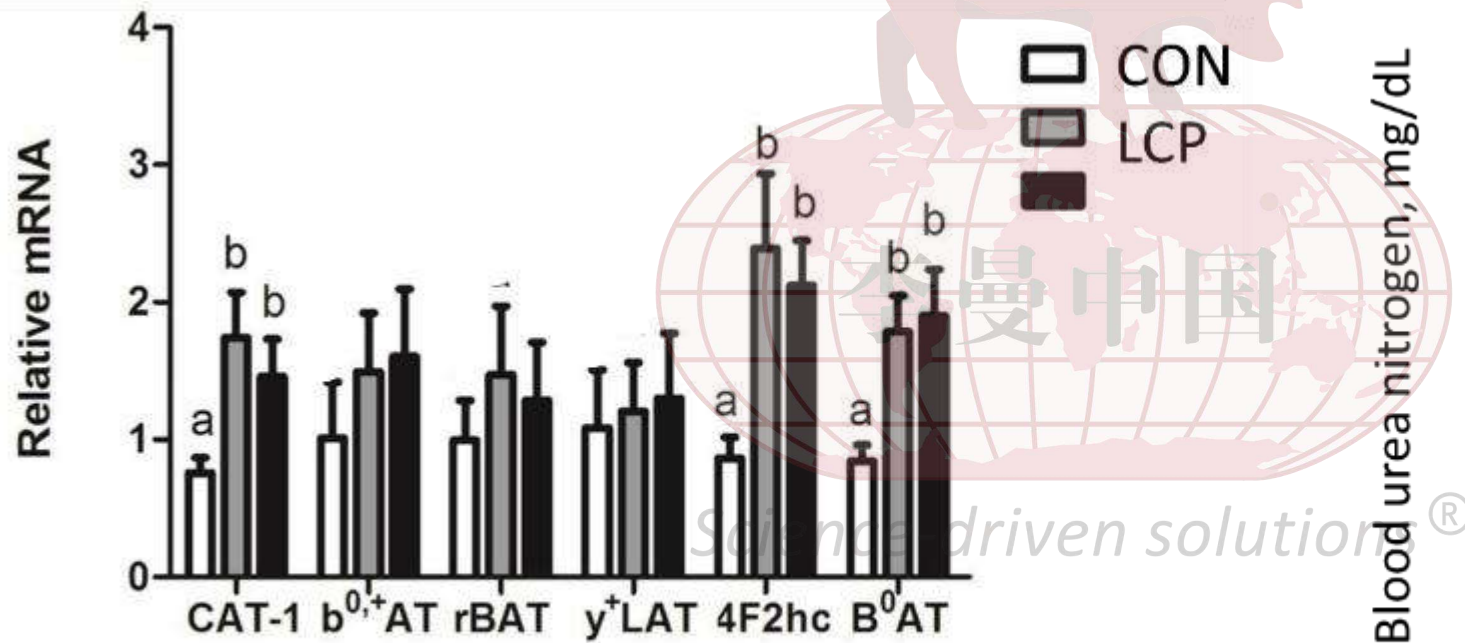
Low crude protein formulation with supplemental amino acids for its impacts on intestinal health and growth performance of growing-finishing pigs

Marcos Elias Duarte¹, Wanpuech Parnsen¹, Shihai Zhang¹, Márvio L. T. Abreu¹ and Sung Woo Kim^{1*}

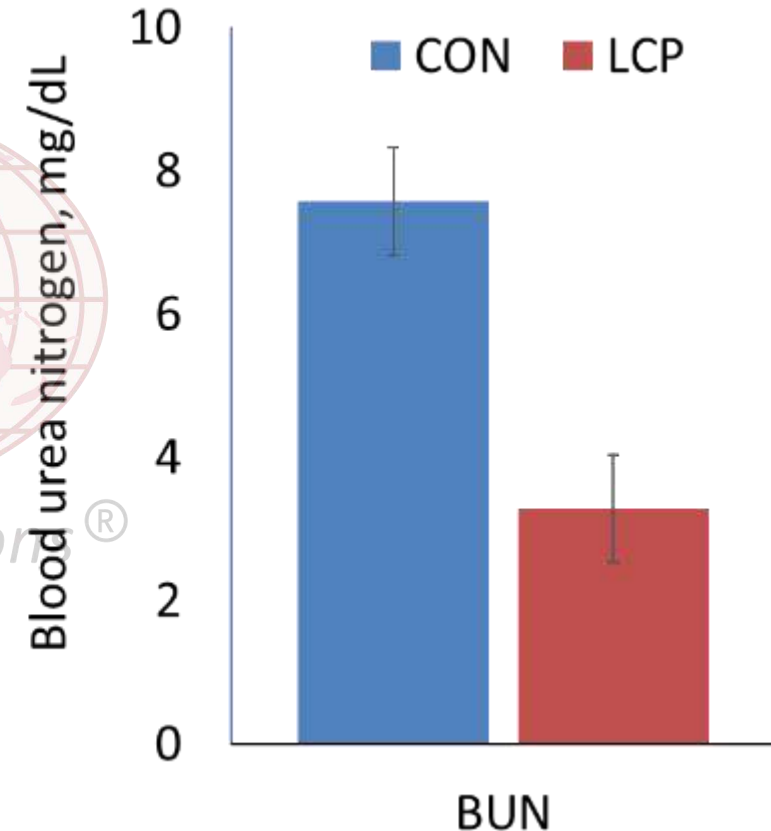


Low protein formulation: intestinal health

- Efficient utilization of amino acids and N



Expression of mRNA related to amino acid transporters in the jejunum of growing pigs



Low protein formulation: intestinal health

- Whey protein concentrate (9.35%) and fish meal (5.00%) were replaced by Lys, Met, Thr, Trp, Val, and Ile when CP was reduced from 22.6 to 18.5%.

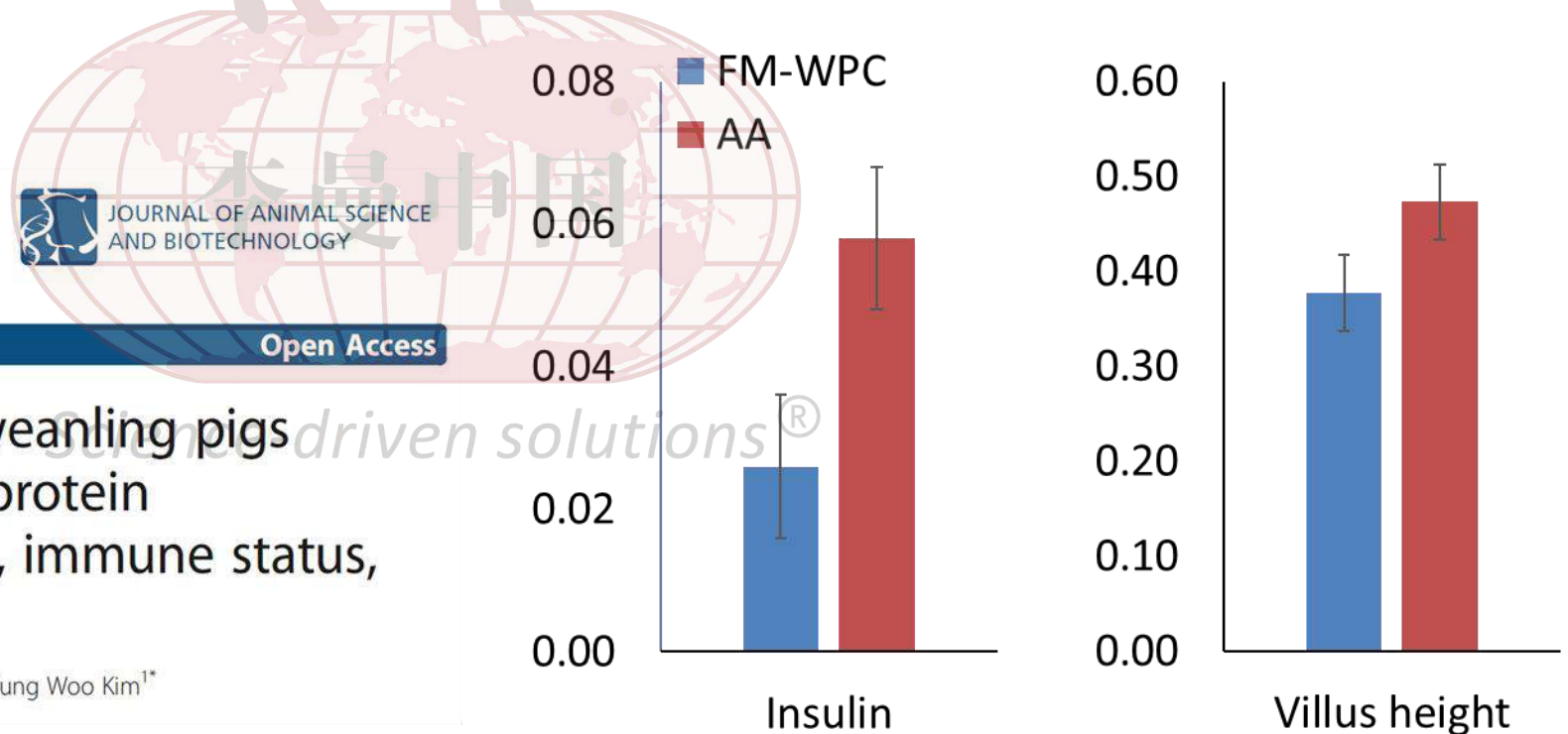
Zhao et al. *Journal of Animal Science and Biotechnology* 2014, 5:57
<http://www.jasbsci.com/content/5/1/57>

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Amino acid fortified diets for weanling pigs replacing fish meal and whey protein concentrate: Effects on growth, immune status, and gut health

Yan Zhao¹, Alexandra C Weaver¹, Vivek Fellner¹, Robert L Payne² and Sung Woo Kim^{1*}



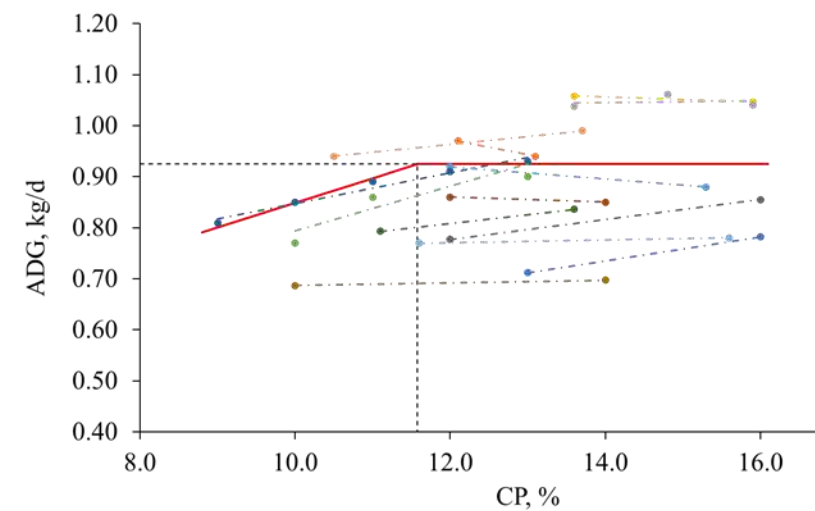
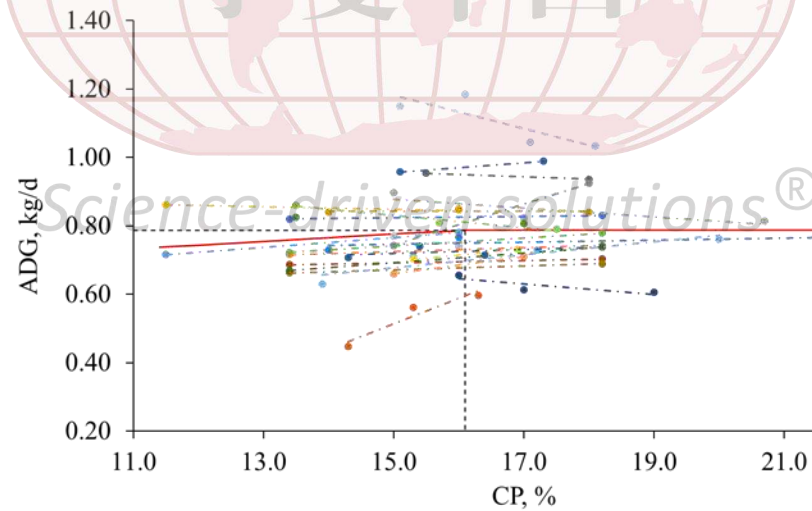
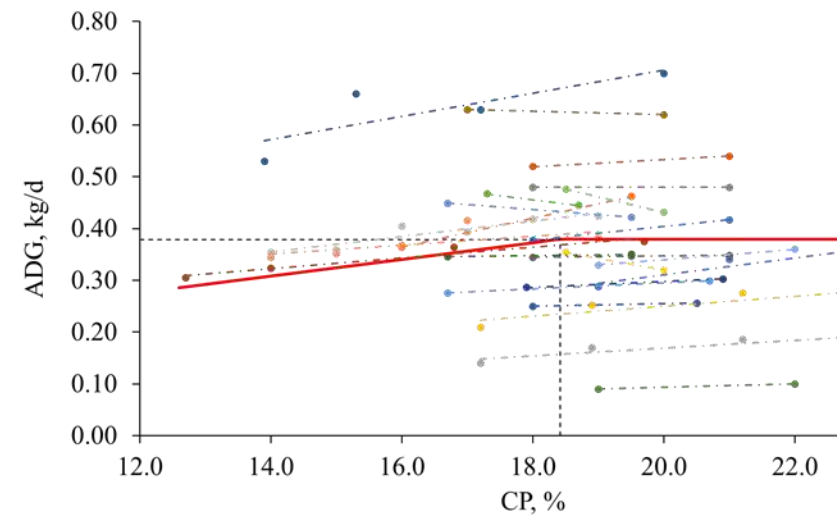
Low protein formulation: implication/limitation

- Meta-analysis, low CP formulation
 - Review of how much supplemental amino acids can be used without negative effects on growth efficiency



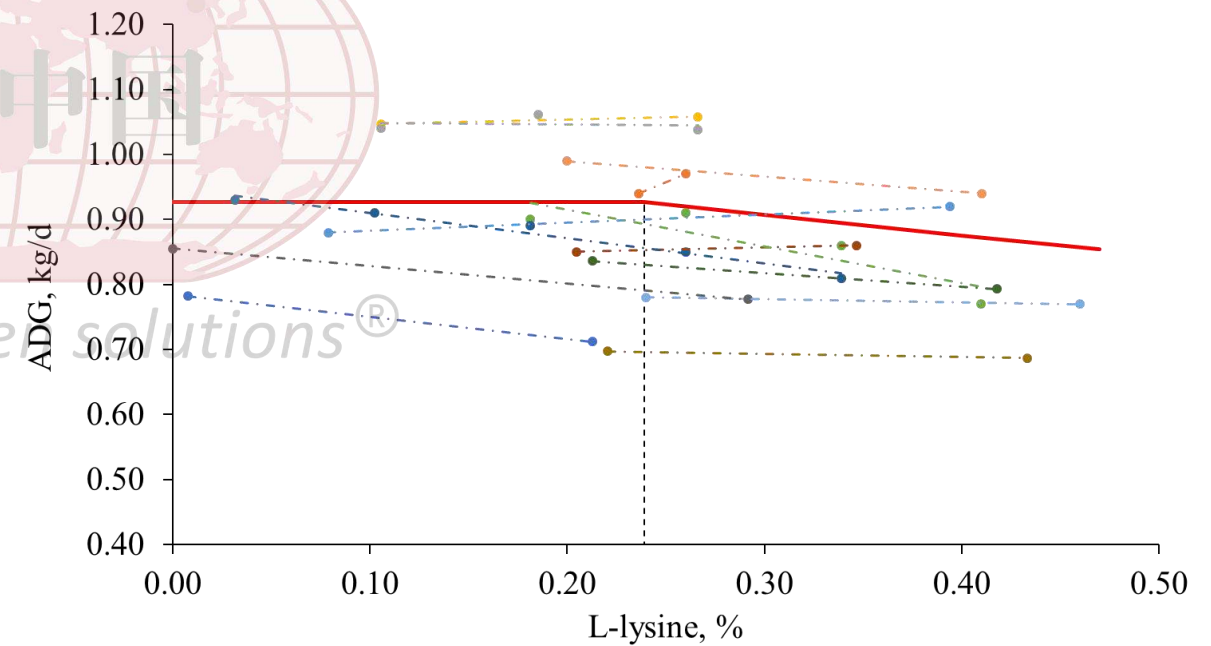
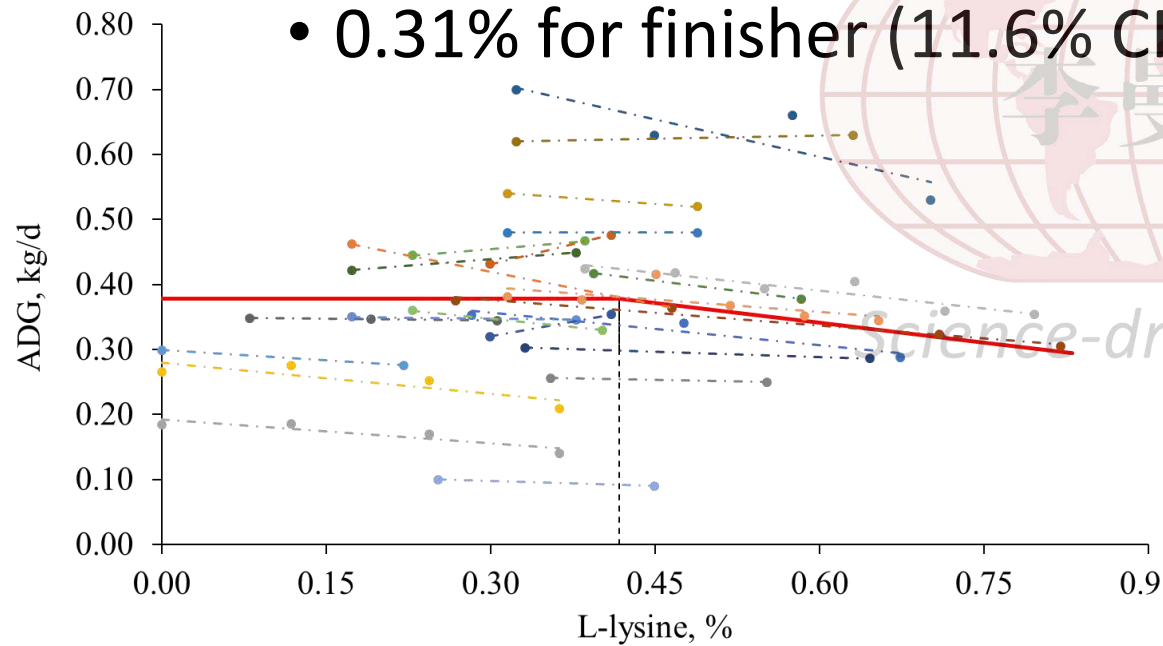
Low protein formulation: implication/limitation

- Meta-analysis, low CP formulation
 - Min CP levels with all EAA balanced without compromising ADG
 - 18.4% for nursery, 16.1% for grower, and 11.6% for finisher
 - Due to limited NEAA, bioactive compounds (?)



Low protein formulation: implication/limitation

- Meta-analysis, low CP formulation
 - Max levels of L-lysine HCl (78% purity) without compromising ADG
 - 0.54% for nursery and grower (18.4 and 16.1% CP)
 - 0.31% for finisher (11.6% CP)



Benefits of using amino acids instead of protein supplements

Almost 100% utilization (absorption)

Provide ideally balanced AA for needs

↑ efficiency of protein synthesis

↓ amino acid oxidation

↑ intestinal health

↓ nitrogen defecation

↑ feed density

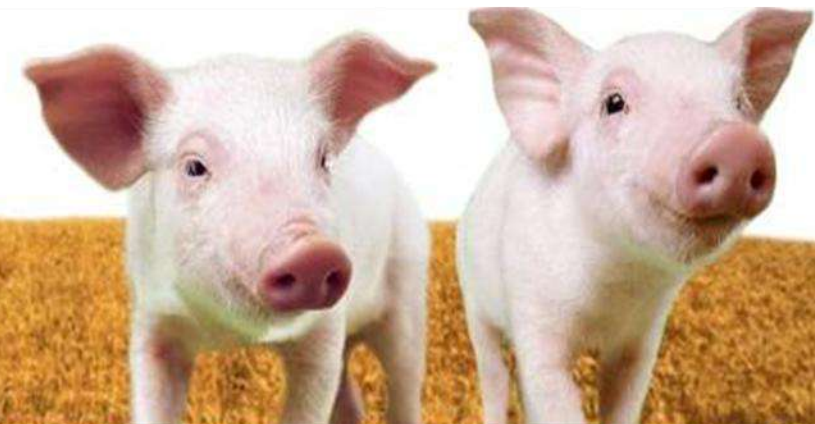
↓ feed storage and transportation

↓ use of plant proteins

↓ land use

↓ use of N fertilizer

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Disadvantages / challenges of using amino acids instead of protein supplements

↓ appetite

Potential deficiency of NEAA (nutritional requirements of NEAA)

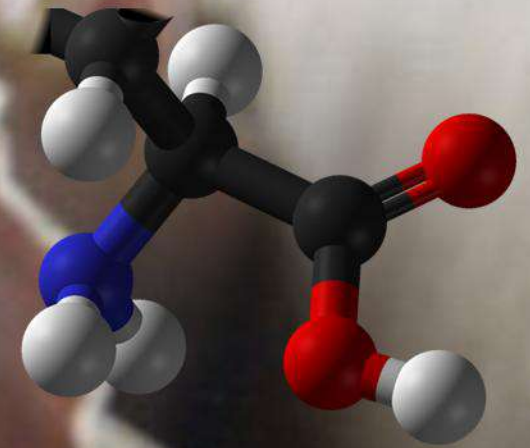
Depletion of bioactive compounds derived from plant proteins

↑ feed cost (currently only 8 AA available): but potentially ↓

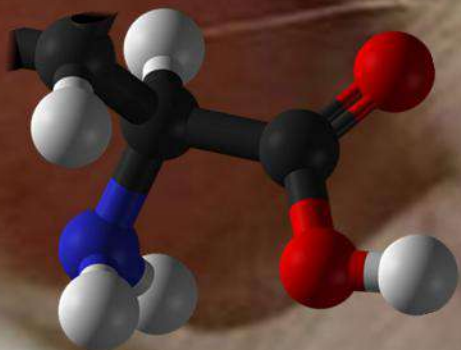
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Finally



the use of crops in feeding pigs
can be reduced significantly.



Science-driven solutions

Thank you!

Thoughts? Questions?



Invitation:



Kim Lab 2024

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