



Productive potential and environmental impact of livestock production

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Agenda

- Definition to performance
- The Best
- Environmental impact
 - Feed conversion
- Limitations to animal performance and productivity
 - Education
 - Breeding
 - Diseases
 - Nutritional limitations
 - Nutrient and nutrition
 - Protein digestibility
 - Gut
 - Regulation of feed intake
- Questions



Definition of performance

- What is performance?
 - Animal level
 - Daily gain
 - Feed conversion
 - Protein gain
 - Milk yield per cow
 - Farm level
 - CO2 neutral
 - Milk yield per hectare
 - Kg meat per square meter

Limitation can only be found after performance parameters has been defined!





The best



Variation among dairy cows

- In high yielding dairy herds the best cow will yield +22.0k kg of milk – the average for the herd is 13.7k kg of milk

- Main reason is difference in feed intake

+50%

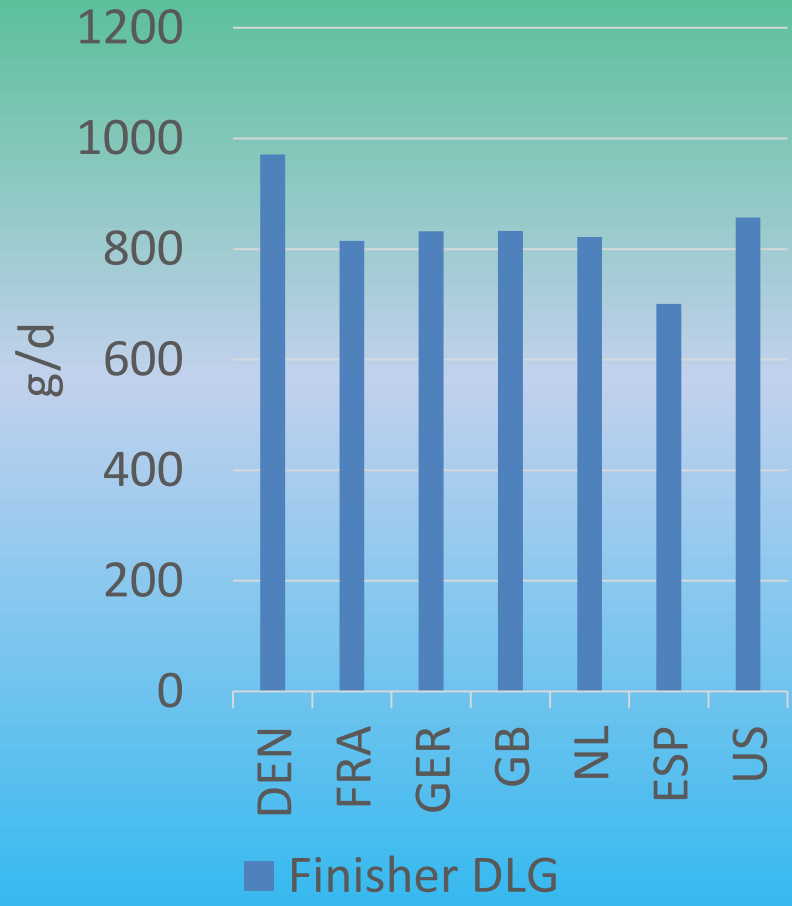
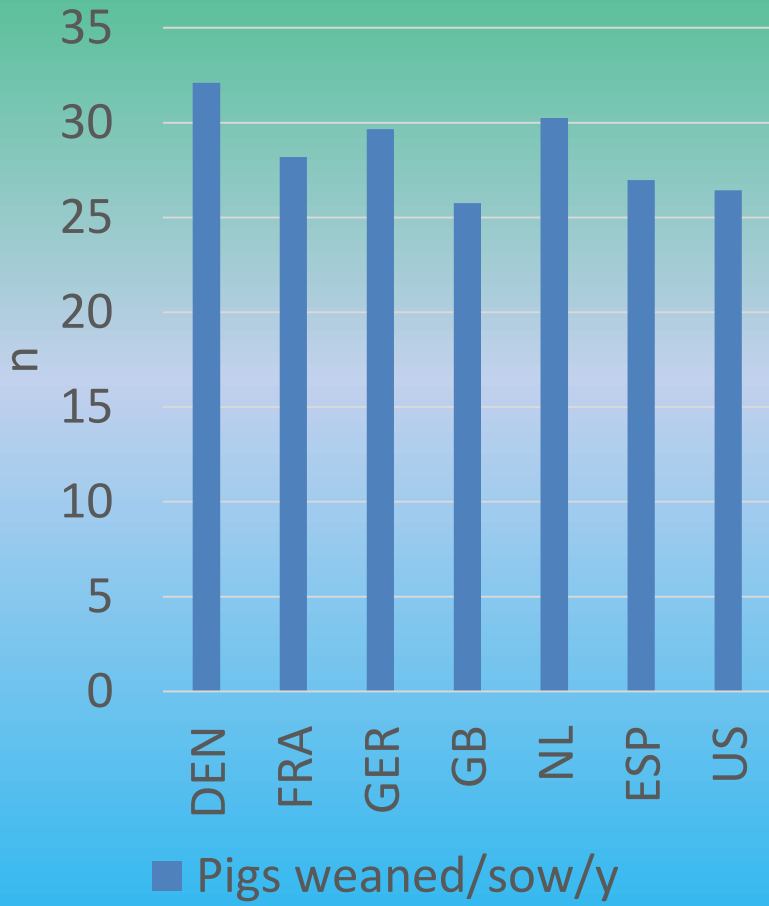
– Other reasons

- Genetic
- Health
- Utilization of nutrients
- Microbiome
- Nutrient balance is likely more optimal for that specific cow than the average cow





Average pig performance in selected countries





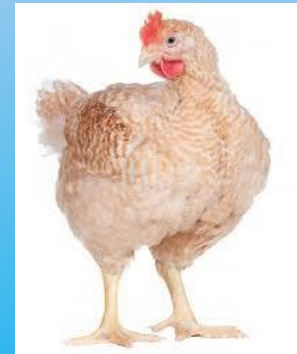
Best producing swine herds

- Best producing swine herds have +42 weaned piglets per sow per year
- A client of my, using same pig breed produce only 20 weaned piglets per sow per year at current time
- Best producing swine herds have +1,200g in average daily gain for finishing pigs



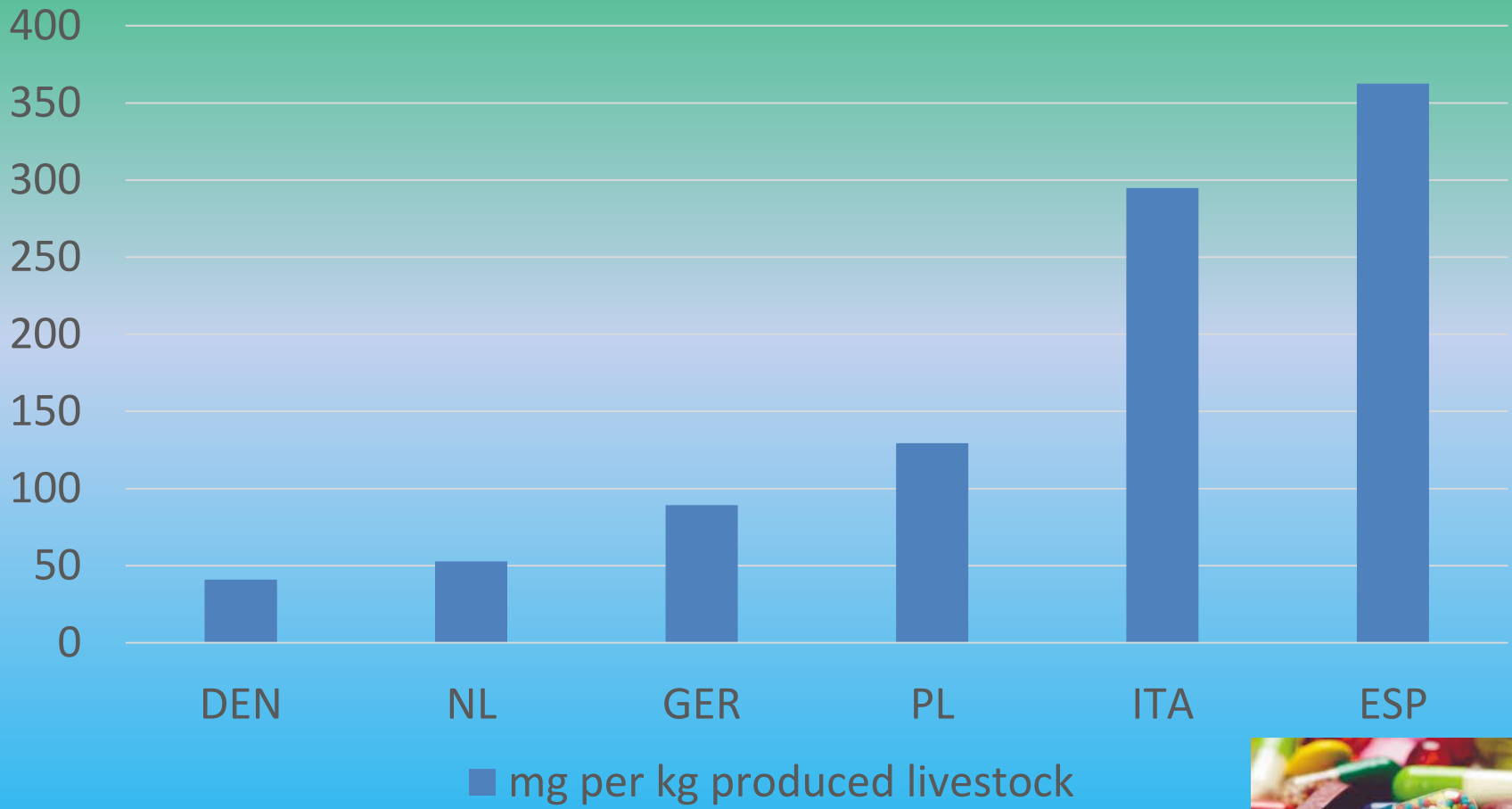
Best producing broiler flocks

- Aviagen have recently moved the target from 400 to 420 for EPEF (European Production Efficiency Factor) to be in elite club
- A response to too many reach the target of 400





Antibiotic use





Environmental impact



Food waste in China

China wastes enough food to feed 100 million people

Operation Empty Plate: China's food waste campaigner



Xu Zhijun's campaign has gained wide support online

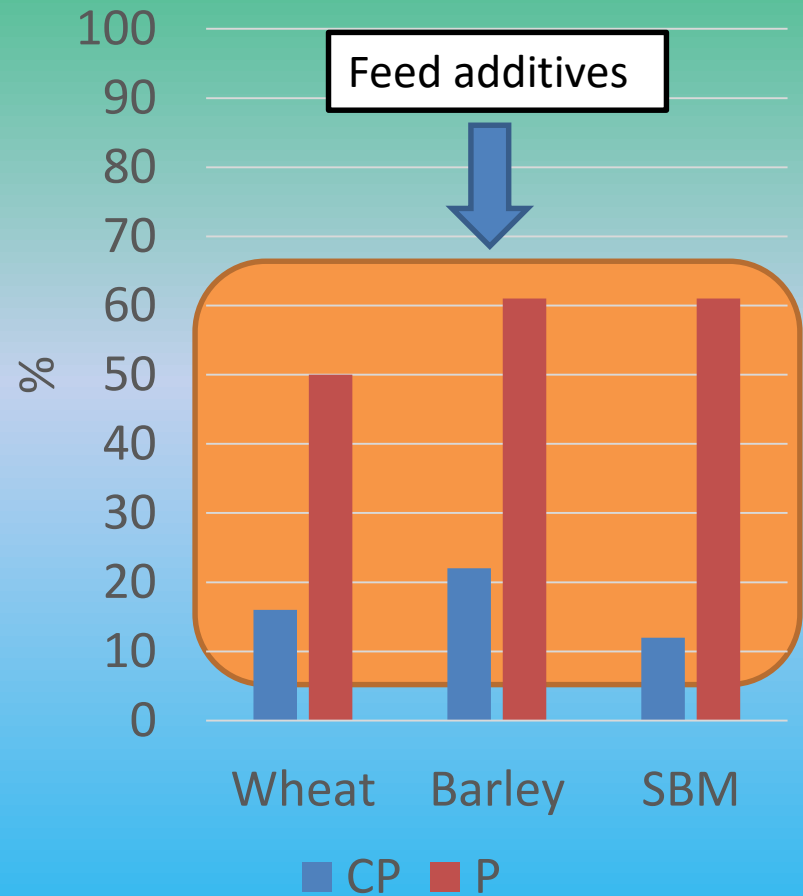
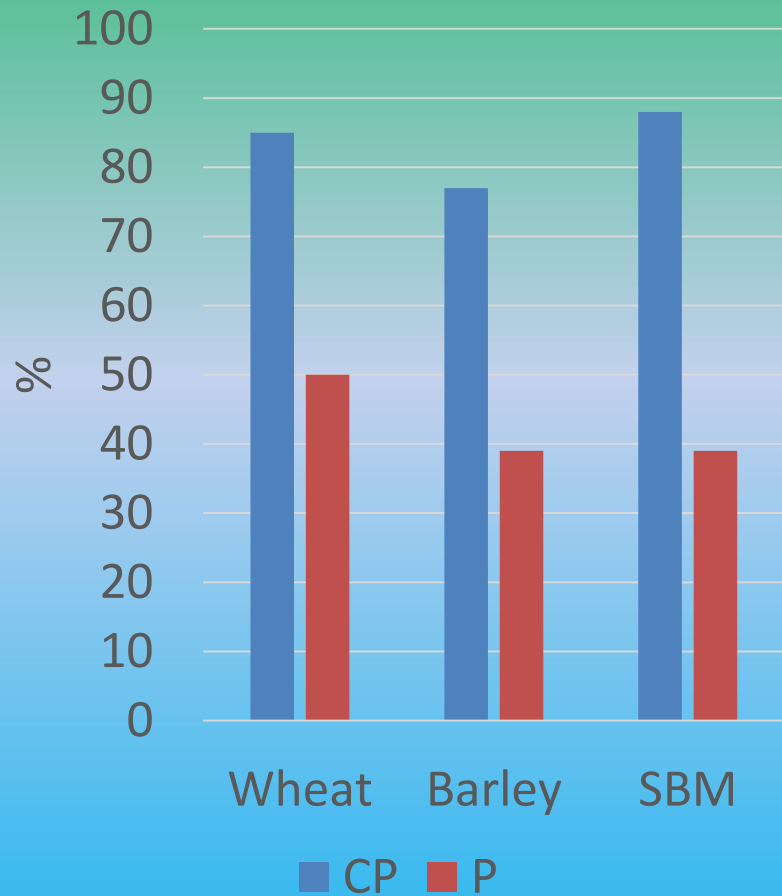


Environmental impact of livestock production

- Can largely be linked to feed conversion
- How much of single nutrients are converted to milk, egg or meat
- The conversion of single nutrients are highly variable
 - For starch to energy is very efficient across animal species
 - For protein it depends on several factors like animal species, type of ingredient, age, processing...



Digestibility and non-digestibility of CP and P in selected ingredients fed to pigs





Feed additives

- Plays a role in lowering environmental impact of animal performance by reduced the amount of non-digestible nutrients
- There is still a great potential to tap into
 - Matrix value is a most
 - Way to understand environmental impact





Feed Conversion



Feed conversion for different species

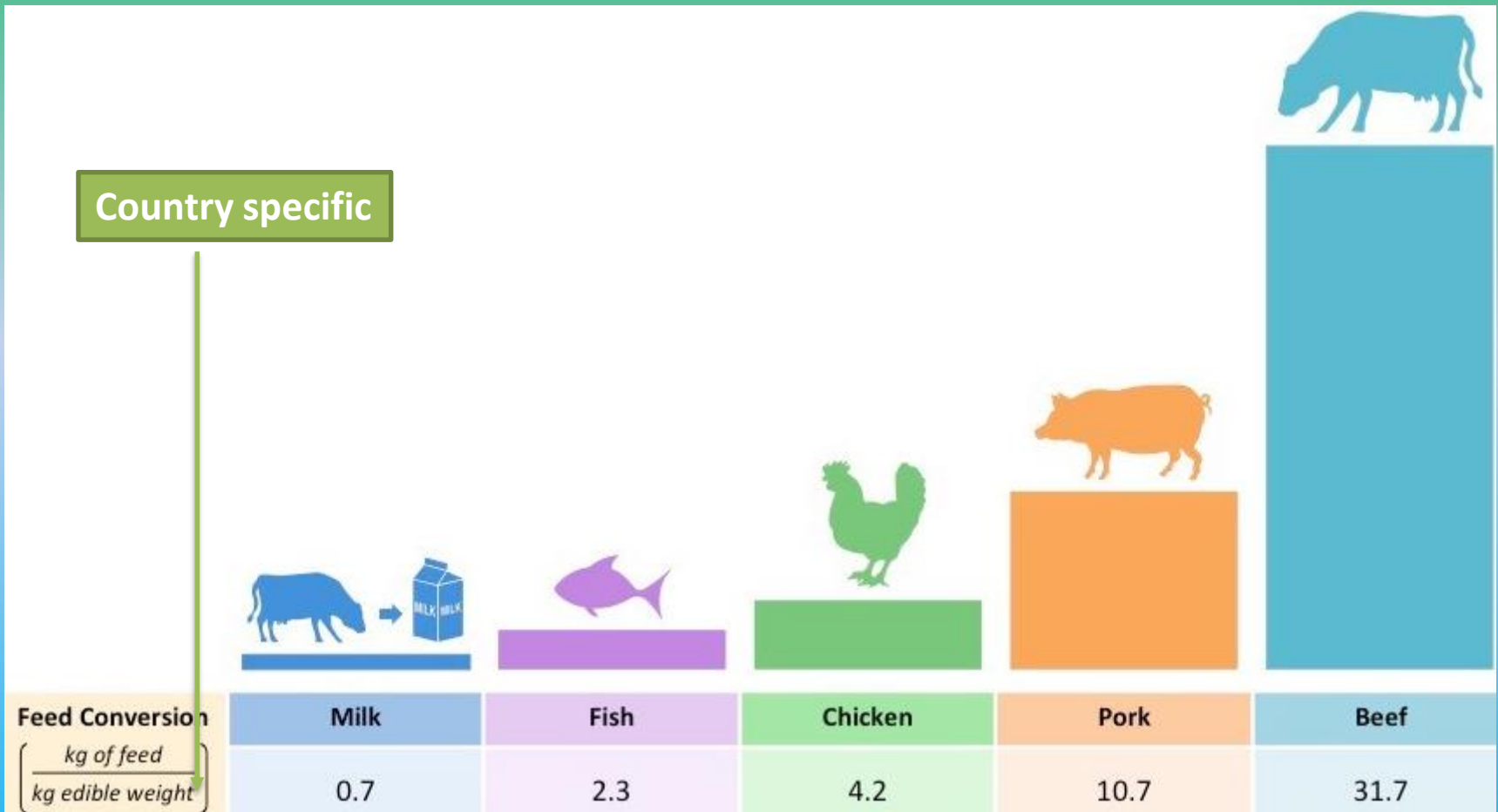
- Kg feed per kg gain
- Aqua: 1.1
- Poultry: 1.7
- Pigs: 2.9
- Beef: 6.8



- There is a large variation to the above values



Feed conversion in relation to food





Typical chemical composition of diets, g/kg DM

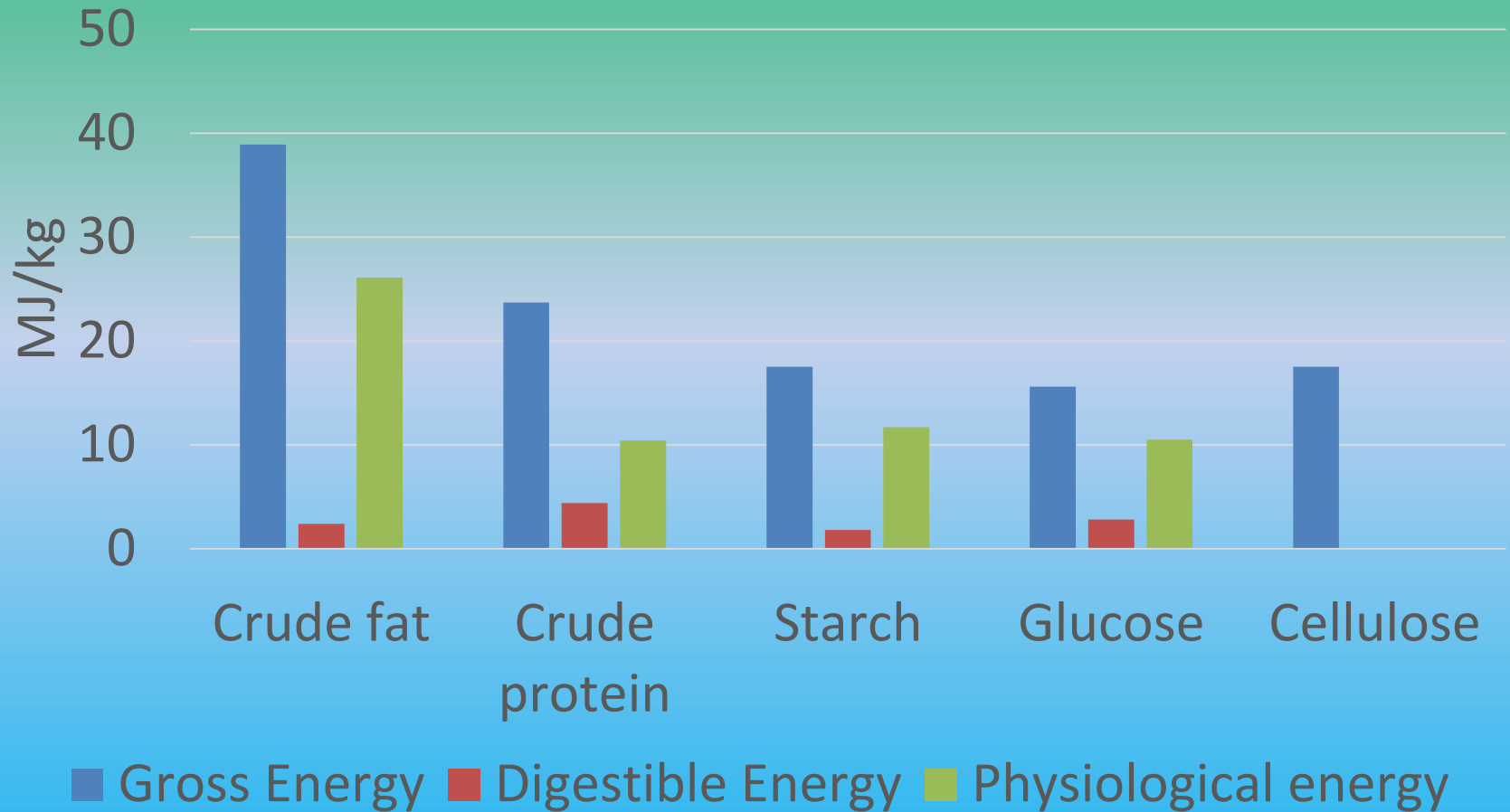
Item	Fattening pig	Broiler	Salmon
Crude fat	65	73	266
Crude protein	190	230	493
Starch	400	447	110
Sugar	40	40	10
Rest ¹	248	137	41
Ash	57	62	85

¹ mainly hemicellulos and cellulose

What does the data show: very different amounts of nutrients and therefore potential very different energy concentration as well



Energy values for different nutrients (monogastric)





Physiology energy in different diets

Species	Crude fat	Crude protein	Starch	Ash
Salmon	19.0	50.0	14.0	9.5
Broiler	3.5	20.0	58.0	5.0

Species	Feed conversion	PPE in diet, MJ	PPE intake per kg gain, MJ	Difference
Salmon	1.1	11.8	13.0	-
Broiler	1.7 (+55%)	9.8	16.7	+28%



Limitations to animal performance and productivity



Education

Research

- Evaluation of new feed additive

Education

- Presentation of new feed additive

Implementation of knowledge

- Use new feed additive by customer





Weaning age of piglets

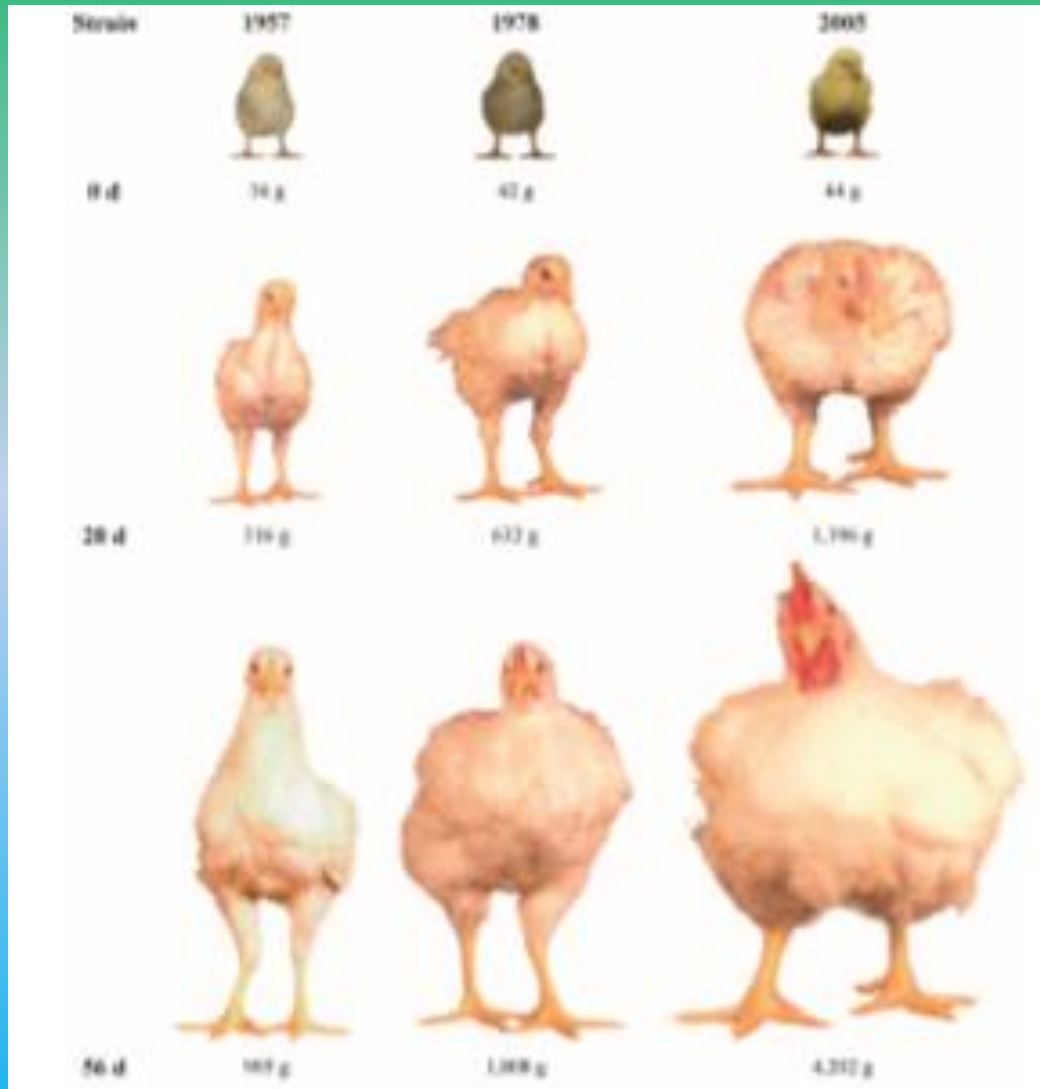
- Weaning age = litter size!
- Weaning at 19-21 days = litter size up 15-17 piglets
- Weaning at 24-25 days = litter size up to 20-22 piglets
- Mainly do to weight losses of sow during lactation, weaning later results in lower weight losses at end of lactation
- Losses of muscle is critical



Breeding



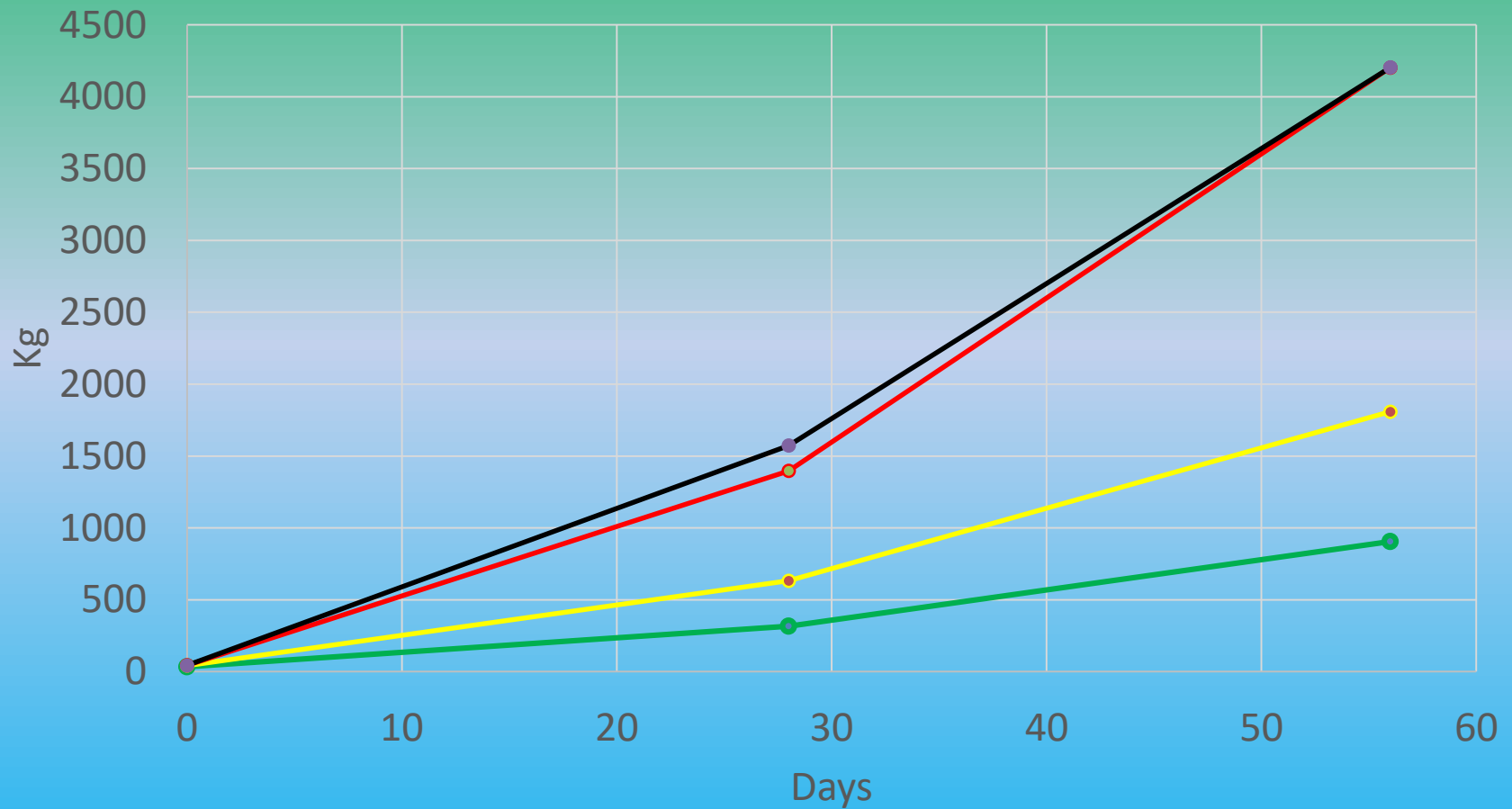
Broiler growth - 1957-2005



Fed same diet!



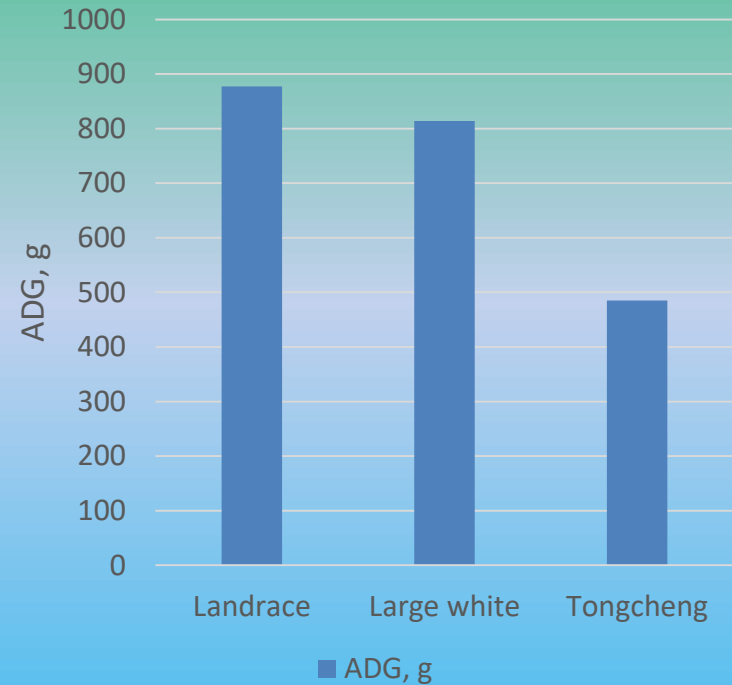
Broiler growth





Effect of breed on performance

- Comparison of three different pig breeds on performance
 - Fed same diet
- Questions?
 - Is the same diet the optimal for all three breeds?

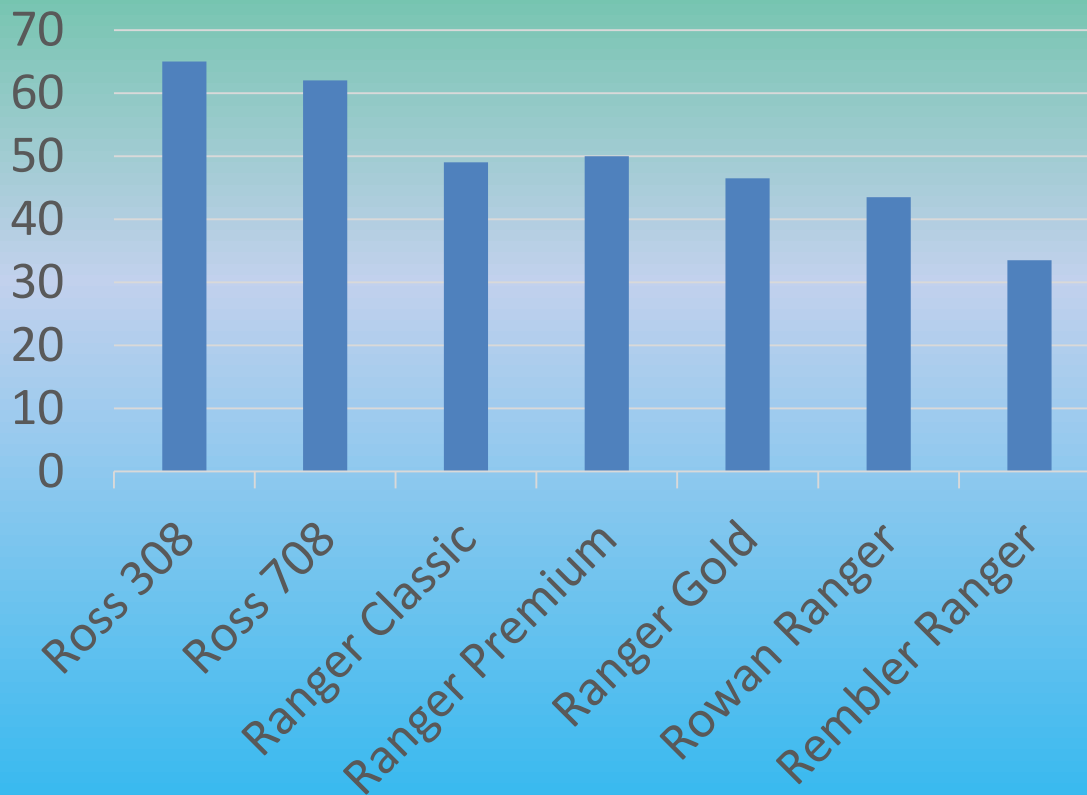


Tang et al., 2008. Frontiers of Agriculture in China



Potential broiler growth

Average Daily Gain (g/d)



- 1) Genetic plays a major role in animal performance.
- 2) Consumer have a choice to make



Current breeding progress

- The genetic progress for DanBred boars was last year at -0.041 kg feed/kg gain
 - Value of £0.65 per pig





Diseases



ASF in Asia

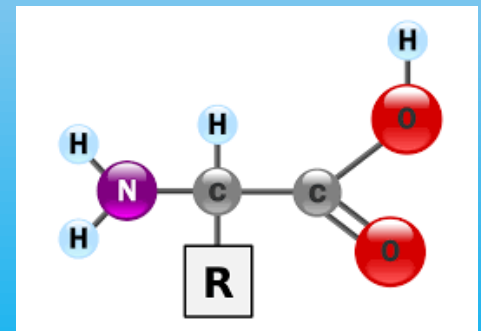


ASF is an e.g. of a very visual diseases, which have an impact on animal performance



Amino acid profile

- Ideal protein concept is used
 - Constant ratio among amino acids
 - Related to Lysine (100)
- The ideal protein is not constant all the time
 - E.g. Methionine increase when animal is challenged (Williams et al., 1997)





Nutritional limitation



Recommendations vs. requirements

- Diets are typically formulated according to recommendations for nutrients
- Animal need for nutrients are requirements
- Recommendations are based on requirements studies
- So is recommendations = requirements
- Only partly
- So why it so?



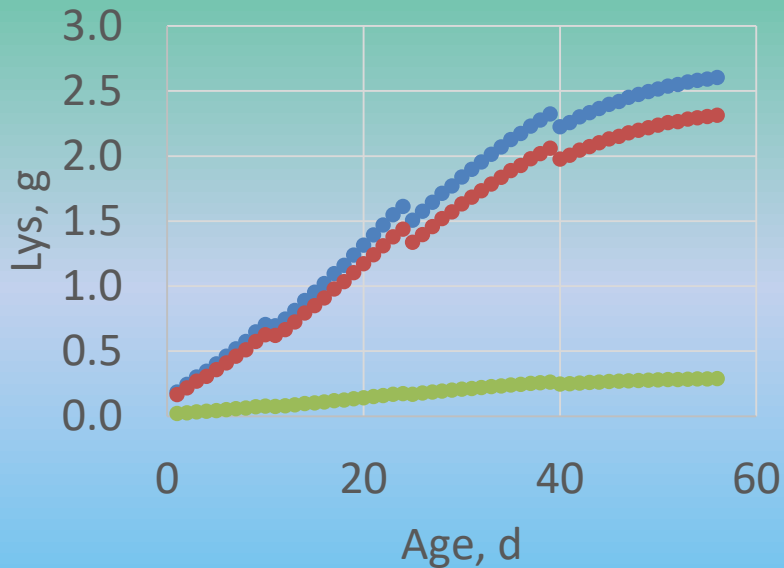
Recommendations

- Recommendations are typically financial recommendations for a group of animals
 - Animals are not fed on individually basis
- Animal requirements for nutrients changes with age
 - Need less amino acids per kg feed
 - The total intake of amino acid increase with age in broilers



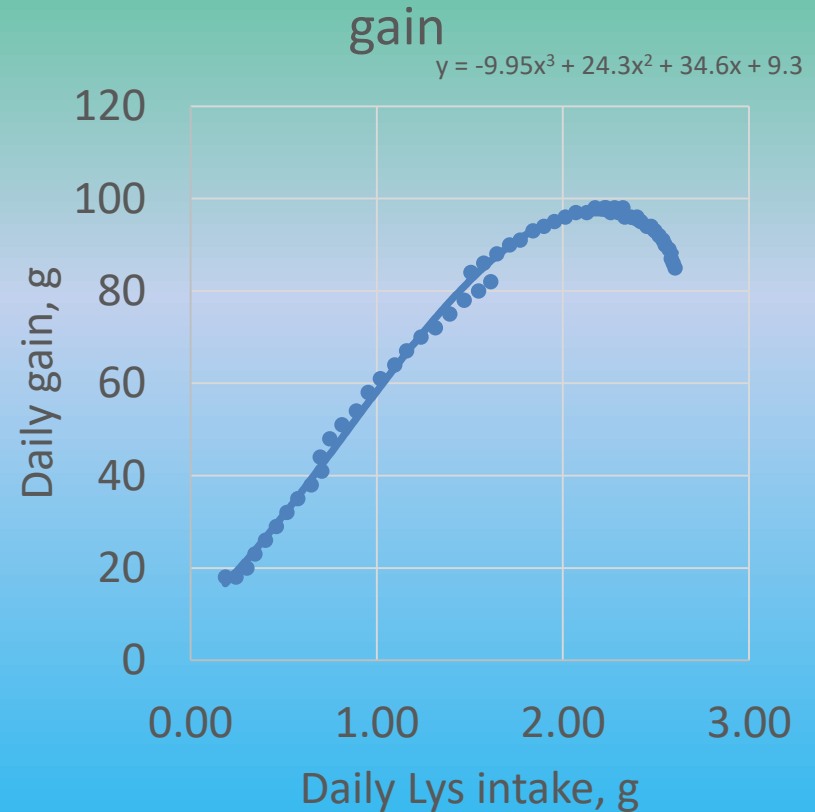
Lysine intake in broilers

Lysine



- Total daily Lys intake, g
- Daily digestible Lys intake, g
- Daily undigested Lys, g

Daily Lysine intake vs. daily





Nutrition and nutrients



Nutrients

- An animal needs a complete diets will all necessary nutrients
- The number of nutrients needed is about 40
 - Animal specific
 - Energy – can be covered by several nutrients, typically starch is the main energy source, not in aqua
 - Amino acids – need all essential amino acids and sufficient of all amino acids to cover the need for non-essential amino acids
 - Minerals
 - Vitamins
 - Fatty acids



Nutrient formulation

- Typically diets are formulated for only some of the nutrients needed
 - Assumed that rest will be covered anyway
 - Not always the true
 - A reason why a lot of data is not interpreted correctly





Over supply of nutrients

- Are diets ever too high in some nutrients
- Yes – all the time
- Do it matter
- Yes – it does
- Oversupply of amino acids (N) cost energy





How to identify energy cost for over supply

- In general terms
 - Energy cost in relation to oversupply – results in higher feed conversion
 - Feed conversion is largely regulated to energy concentration of the feed





Ammoniotelic

- Excretion of ammonia and ammonia ions
- -NH_2 is removed from proteins when they are converted to carbohydrates
- Very toxic substrate
- About 0.5l of water is needed per 1g of nitrogen
- Done by:
 - Protozoans
 - Crustaceans
 - Platyhelminths
 - Cnidarians
 - Poriferans
 - Echinoderms



Ureotelism

- Excretion of urea
- Conversion done in the liver and kidney
- Urea is less toxic than ammonia
- 0.05L water is needed per 1g of nitrogen
- Done by:
 - Amphibians
 - Mammals

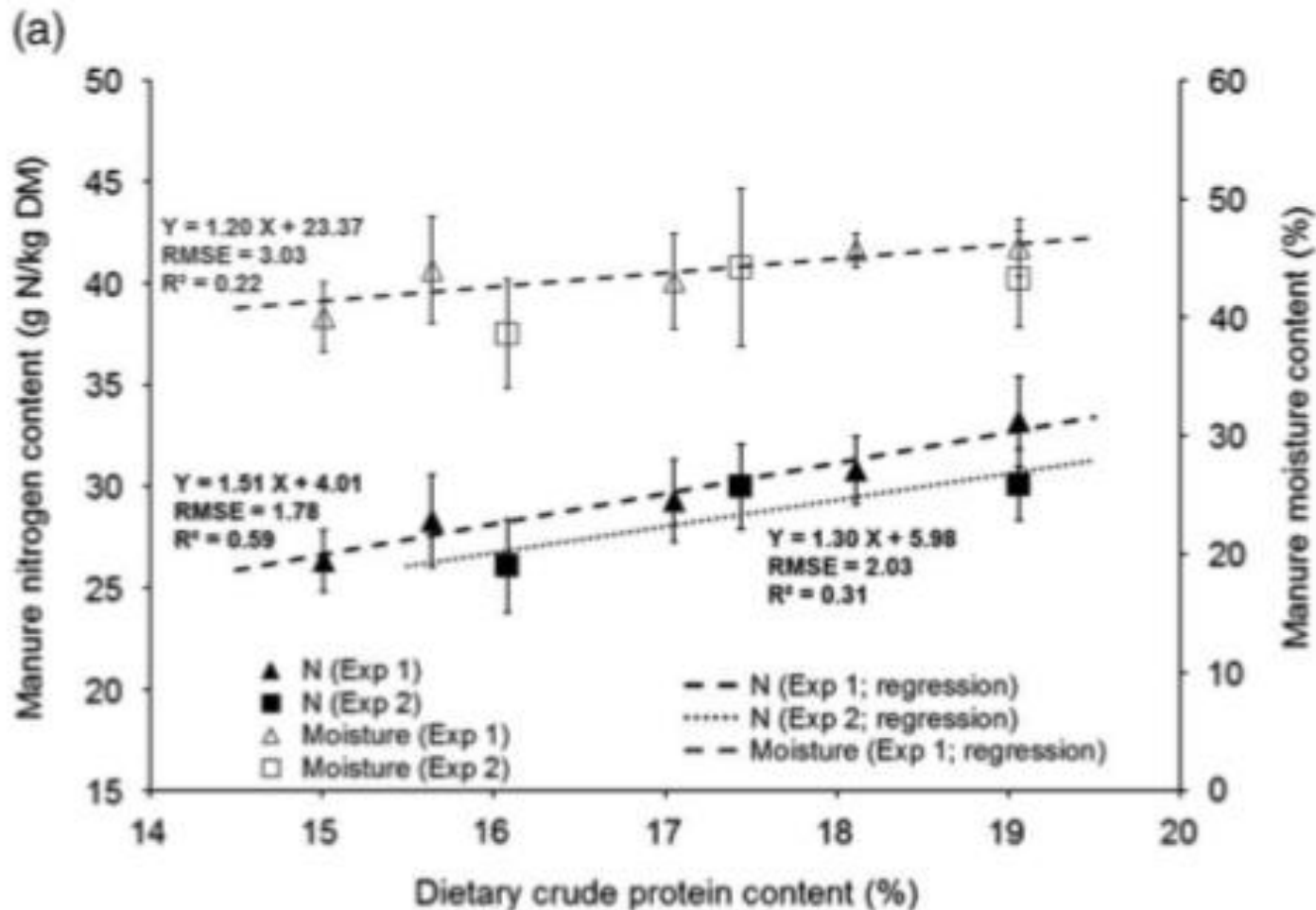


Uricotelism

- Excretion of uric acid
- Cost more metabolic energy $\sim +16\%$ vs. urea
- Uric acid's lower toxicity and low solubility in water allow it to be concentrated into small volume of pasty white suspension
 - Urine is liquid in mammals
- Water consumption is 50ml per 1g of nitrogen
- Done by:
 - Insects
 - Birds
 - Reptiles



Reduced N in feed gives lower water consumption in broilers





Protein digestibility



SBM digestibility in pigs

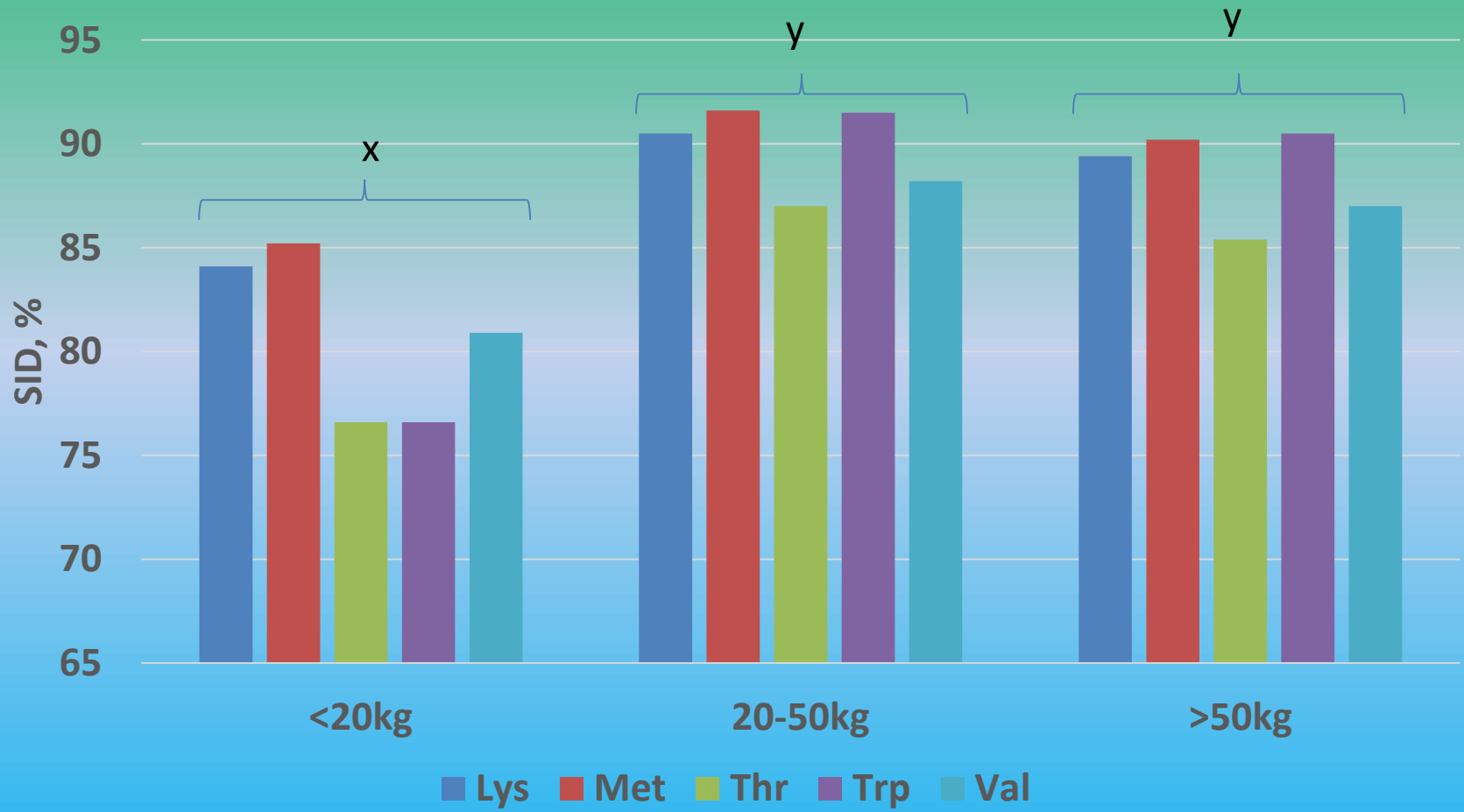
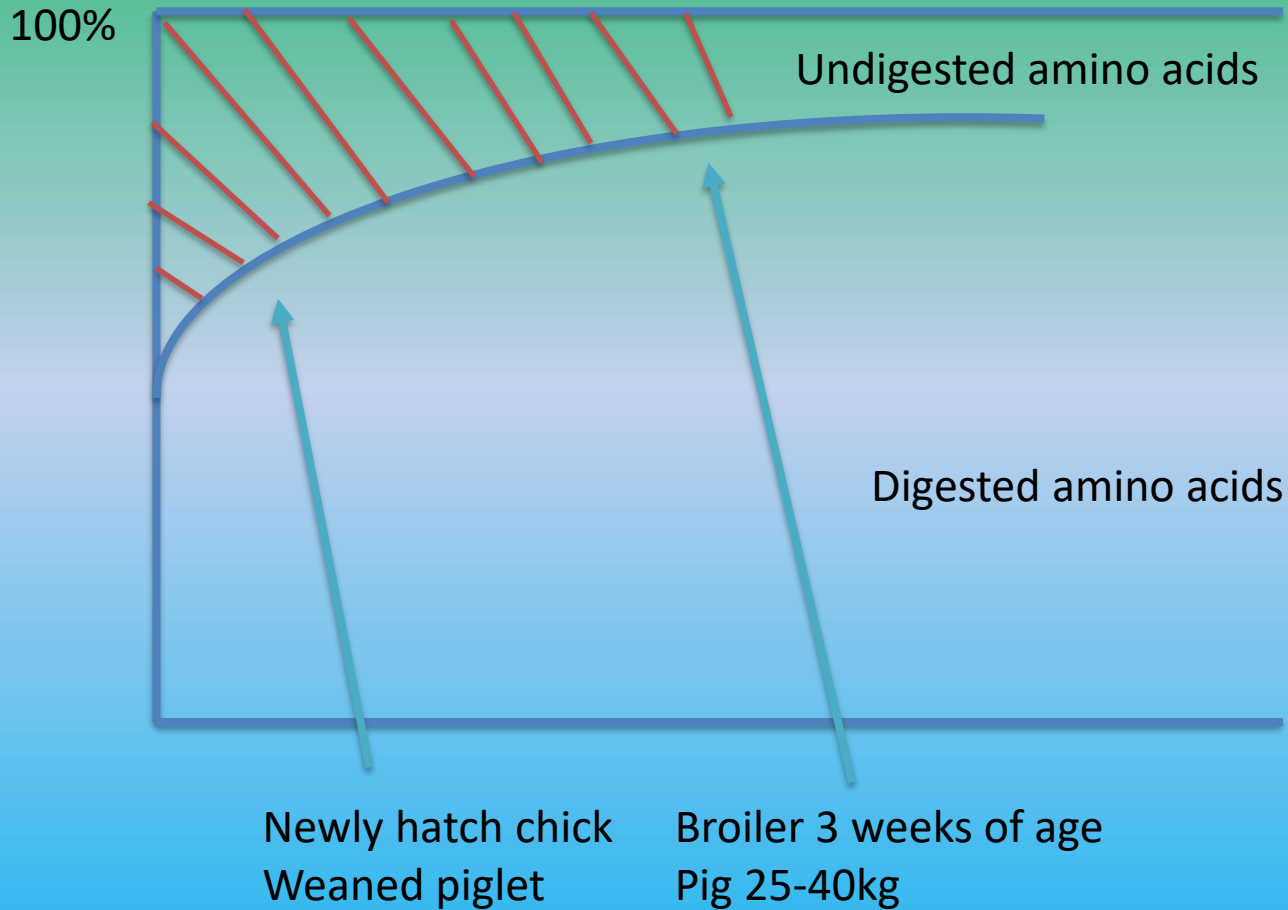




Illustration of amino acid digestibility with age





Limitation to growth in young animal

- Digestible amino acids
 - Maintenance e.g.
 - Organs
 - Gut
 - Growth e.g.
 - Gut
 - Organs
 - Muscle
- Undigestible amino acids
 - Growth of pathogenic bacteria
 - Excretion of nitrogen
 - Liver capacity?
 - Kidney capacity?

Amino acid balance



Gut



Carry-over/delay response (1)

Item	Control	Test	SEM	P-value
Start weight, kg	5.84	5.88	0.21	0.916
Pre-starter phase (19-40 days)				
ADG, g/d	177	191	8.13	0.247
FI, g/d	254	260	12.4	0.722
FCR	1.44	1.36	0.04	0.198
Starter phase (40-73 days)				
ADG, g/d	417	550	27.2	0.001
FI, g/d	883	1,000	42.7	0.057
FCR	2.11	1.82	0.06	0.001

Source: Evonik Nutrition & Care GmbH, Facts & Figures Swine no. 14128 Feeding Fecinor® (*Enterococcus faecium* CECT 4515) improves performance in piglets fed ZnO-free diets.



Carry over/delay response (2)

- Limited effect of test product during phase 1
- Clear effect of test product during phase 2
- It is likely caused by a manipulation of the microbiome in phase 1 and effect seen in phase 2
 - Microbiome is more sensitive to manipulation the younger the animal is
 - Microbiome extract more energy from the feed in test treatment in comparison to control
- Potential differences in animal's amino acids requirements



Regulation of feed intake



Energy concentration impact voluntary feed intake in chicken

	Diet no.				
	1	2	3	4	5
Energy content of diet					
ME, MJ/kg	13.18	11.59	10.21	8.91	7.45
Percentage of number 1	100	88	78	68	57
Performance of chicks to weeks of age (percentage of results for diet No. 1)					
Total feed intake	100	101	113	117	125
Total ME intake	100	90	88	80	71
Liveweight gain	100	99	102	98	98
Fat content of carcass at 11 weeks of age (percentage of dry matter)					
Male chicks only	26.8	23.2	21.1	18.1	16.1



Questions?



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