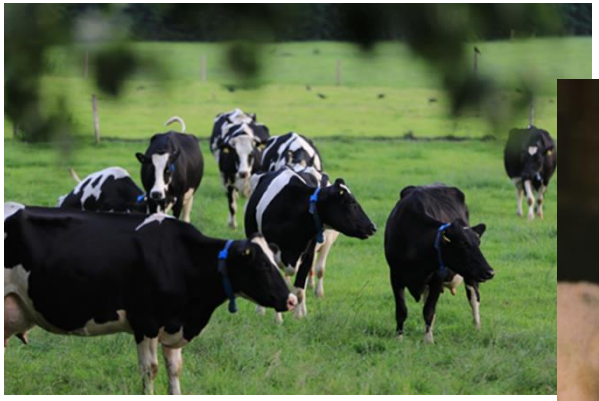
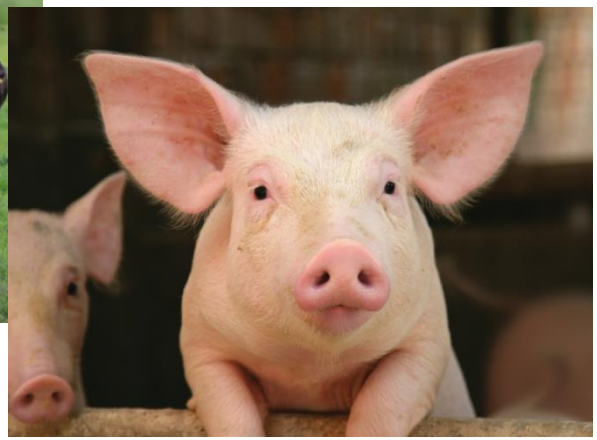
Potential to reduce N excretion through diet formulation for dairy cattle and pigs





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Nitrogen Use Efficiency in Dairy Cows

Background - Dairy

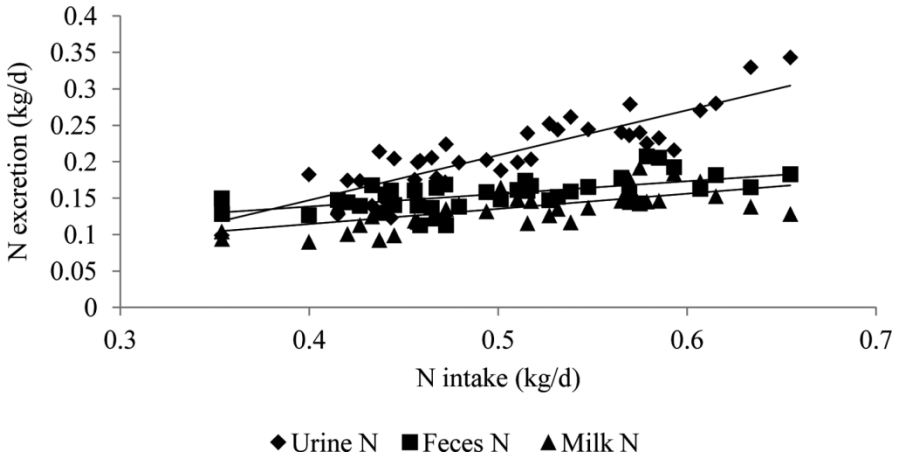
- Current feeding practices opt for high protein (N) diets in an effort to maintain high milk yield and milk protein yields

(Colmenero and Broderick, 2006)

- However…
  - Response of milk yield or milk protein yield to N is limited *(Jenkins and McGuire, 2006)*
  - Response of N excretion to dietary N is significant *(Leonardi et al. 2003)*

Nitrogen use efficiency in the lactating dairy cow

- High N diets are often fed to lactating dairy cows
- However…
  - Only 25-30% of the N fed is recovered in the milk
  - N efficiency at a farm level is often worse (20%)
- N can be lost from the production system as…
  - Ammonia
  - Nitrous Oxide
  - Nitrate Leachate



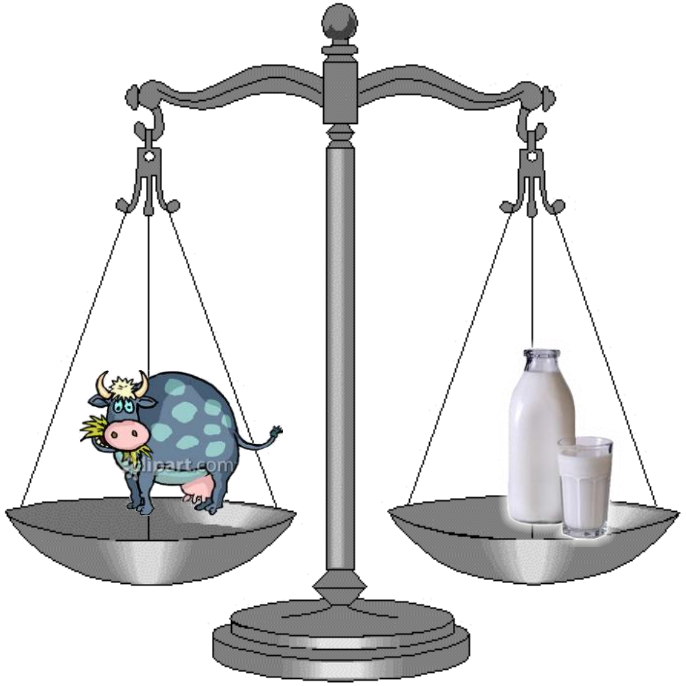
Whelan et al. (2012)

Challenge for Ireland

- Typical perennial ryegrass over supplies protein to grazing dairy cows
- Grass Crude Protein – 16-32%
- With modern protein rationing systems (PDI protein system) it is possible to supply adequate amounts of absorbed amino acids with diets of approximately 15% protein for typical Irish dairy cows

Dietary Strategies to Improve Nitrogen Efficiency

1. Reduce dietary Crude Protein concentration
2. Improve intestinal Amino Acid balance
3. Energy/protein sources in concentrates



Evaluation of Concentrate Type on N Excretion Grazing cows

Research Project 1:

Grazing cows ca 30 kg of milk per day

- High protein concentrate 24% CP 1 kg per day
- High protein concentrate 24% CP 6 kg per day
- Low protein concentrate 9% CP 6 kg per day

What would the greatest theoretical difference be due to compound protein %

Evaluation of Concentrate Type on N Excretion Grazing cows

	HP1[1]	HP6[2]	LP6[3]	SEM
Pasture DMI (kg/d)	15.4[a]	13.9[ab]	13.4[b]	0.96
Total DMI (kg/d)	16.2[a]	18.9[b]	18.4[b]	0.92
Diet DMD[4] (g/kg)	782	792	774	23.6
Milk yield (kg/d)	27.6[a]	32.3[b]	29.6[ab]	1.47
Milk total protein (g/kg)	3.22	3.21	3.17	0.05
Milk protein yield (g/d)	888[a]	1000[b]	934[ab]	40.4
Milk fat (g/kg)	4.06	4.24	4.21	0.26
Milk fat yield (g/d)	1097	1212	1192	84.6

Nutrition and N excretion

Table 4. Least squares means and SEM for nitrogen intake and nitrogen excretion data for dairy cows in Experiment 1.

	HP1[1]	HP6[2]	LP6[3]	SEM
N intake (g/d)	499[a]	618[b]	482[a]	28.5
Milk N (g/d)	144	152	141	9.8
Fecal N excretion (g/d)	132	154	154	16.5
Urine N excretion (g/d)	223[a]	312[b]	186[a]	30.6
Total N excretion (g/d)	355[a]	467[b]	340[a]	26.6
Milk N / N intake (%)	28.9[ab]	25.3[b]	29.5[a]	1.87
N excretion / N intake (%)	71.1[ac]	74.7[ab]	70.5[c]	1.88
Urine N / total N excretion (%)	62.3[a]	66.3[a]	53.7[b]	5.38

[abc], Within a row, means lacking a common superscript differ ($P < 0.05$).

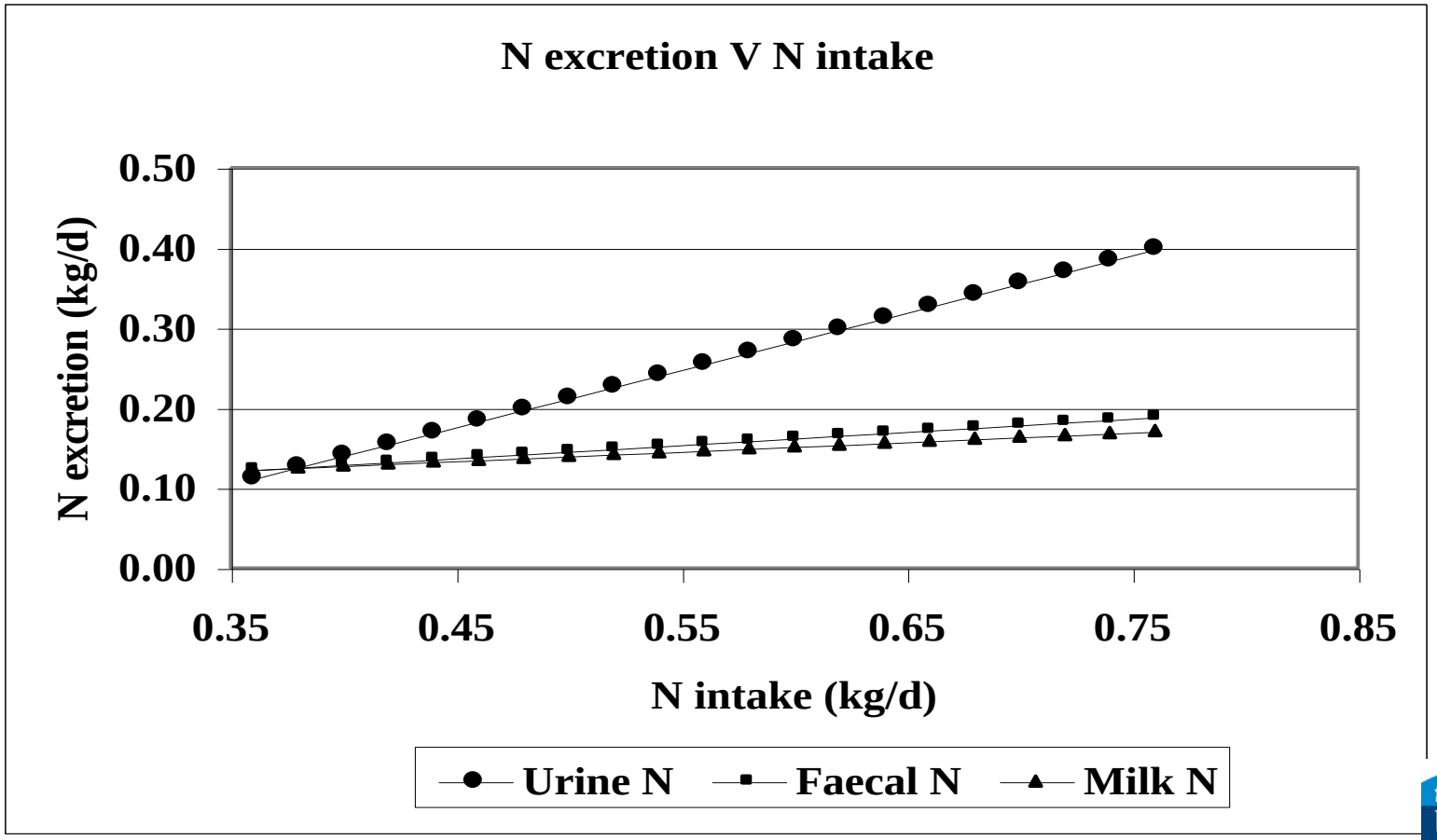
[1]HP1, diet based on grazed pasture plus 1 kg of high protein concentrate.

[2]HP6, diet based on grazed pasture plus 6 kg of high protein concentrate.

[3]LP6, diet based on grazed pasture plus 6 kg of low protein concentrate.

Nutrition and N excretion

Figure 1. Pattern of urinary, fecal, and milk N excretion plotted over the N intake range observed for cows in Experiment 1.



Effect of supplementary concentrate type on nitrogen balance in early lactation dairy cows offered a perennial ryegrass based pasture

Journal of Dairy Science, 2012

Research Project 2

- Grazing Cows (peak milk yield approx 30 kg per day)
- Supplements were fed twice daily during milking (6kg total per day)

- 4 supplementary concentrate treatments
  - HP(18% CP, rolled barley)
  - LP(14% CP, rolled barley)
  - LP+ HMBi (14% CP, rolled barley + methionine)
  - LP Corn (14% CP, ground maize grain)

Supplementary Concentrate Type and Nitrogen Excretion: Milk Output

	HP	LP	LP Met	LP Corn
Milk yield (kg/d)	28.2^{a}	25.2^{c}	26.8^{b}	27.5^{ab}
Fat Yield (kg/d)	0.98^{ab}	0.96^{ab}	1.03^{a}	0.94^{b}
Protein Yield (kg/d)	0.97^{a}	0.88^{b}	0.94^{ab}	0.94^{ab}

Evaluation of Concentrate Type on N Excretion Grazing cows

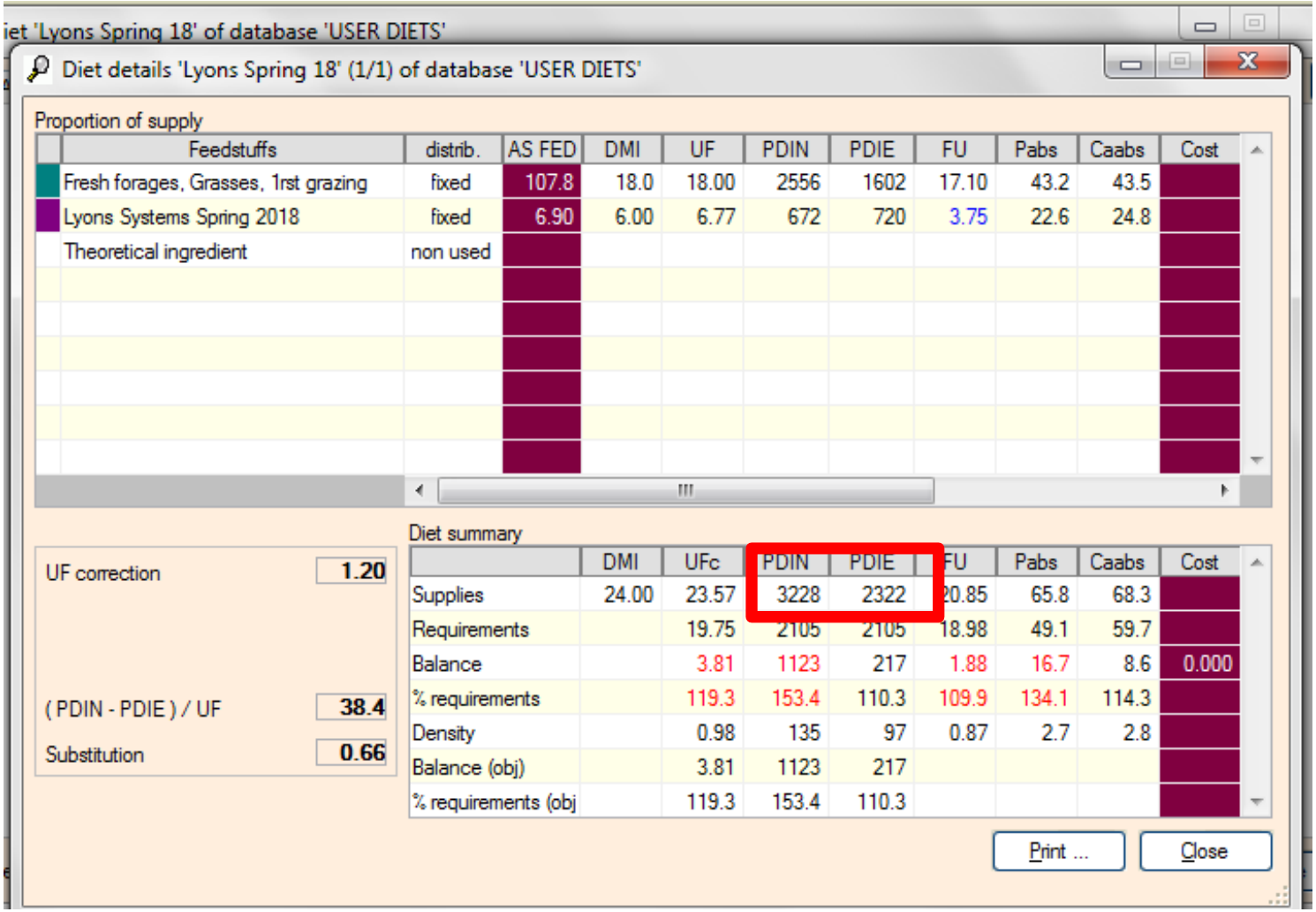
Table 4. Effect of supplementary concentrate type on nitrogen (N) balance

			Lo-Pro +	Lo-Pro	LSM±

Approx 15% Reduction in Urine N Excretion changing from 18 to 14% CP Nut

Approx 20% Reduction in Urine N Excretion if using 14% CP Nut based on corn

Diet Grass 22% CP DM basis
Compound 14% CP as fed
31 kg milk, 4.0 fat, 3.5 protein
630 kg cow
900 g approx of excess rumen degradable protein: Mostly to Urine



Summary

- Most dairy cows in Ireland can have a perfectly adequate diet with 15-16% CP in the total diet on a DM basis

- Grass samples often observed to have 25 – 30% CP and sometimes more than 30% CP

- Dietary formulation for grazing cows allows reductions in Urine N excretion with similar milk and milk solids yield

Current and Future Research

- NutriGen RSF Project 2016
- Evaluating N balances
- Low v high plane of nutrition
- Late lactation supplementation
- Zero grazed grass

- SmartSward Project RSF 2017

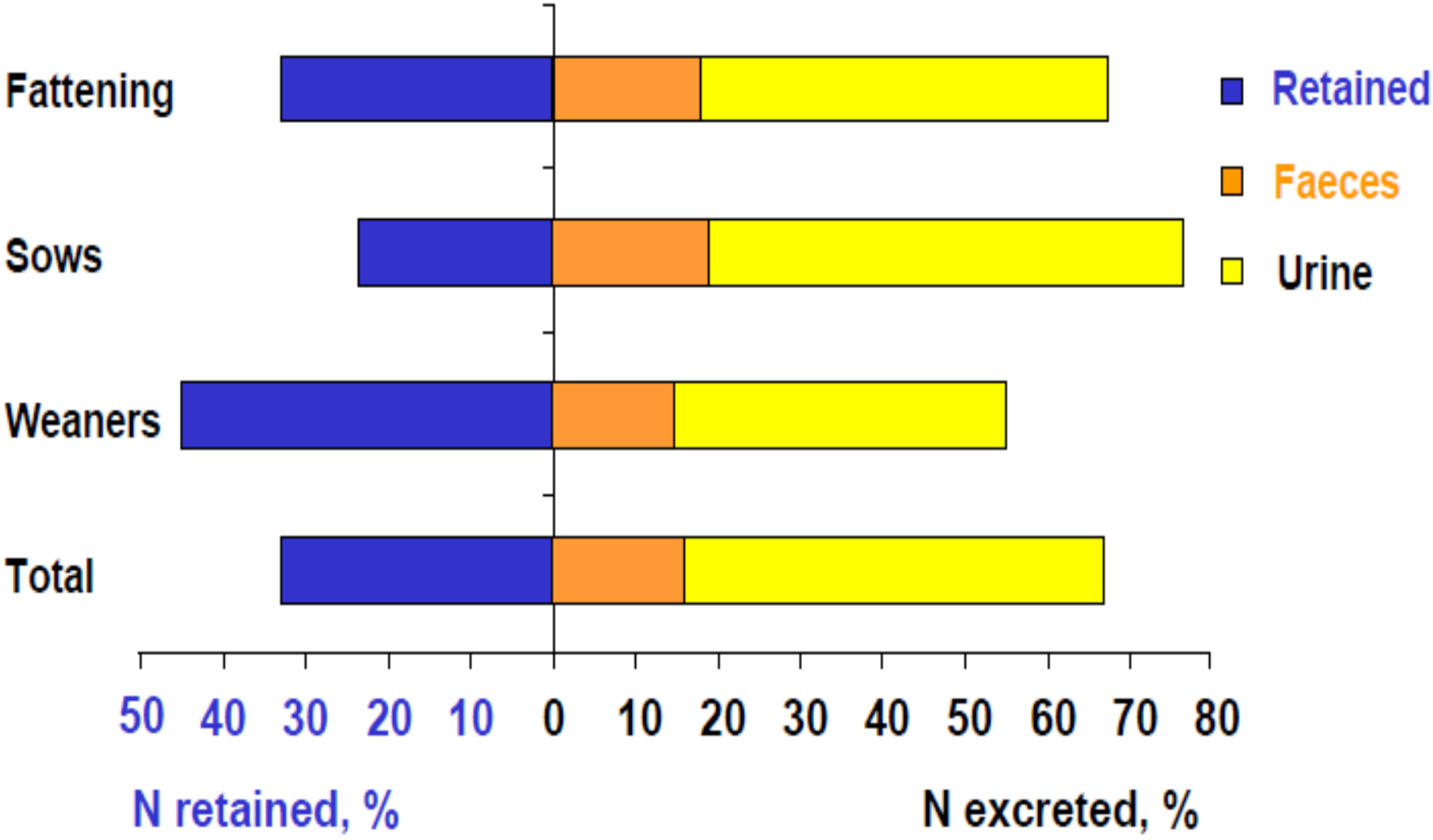
- High N Perennial Ryegrass : 250 kg chemical N per ha
- Perennial Ryegrass White clover: 90 kg chemical N per ha
- Multispecies sward mix: 90 kg chemical N per ha

- Dairy Research Ireland 2019
- 14 v 18 Compound High Output Grazing Cows

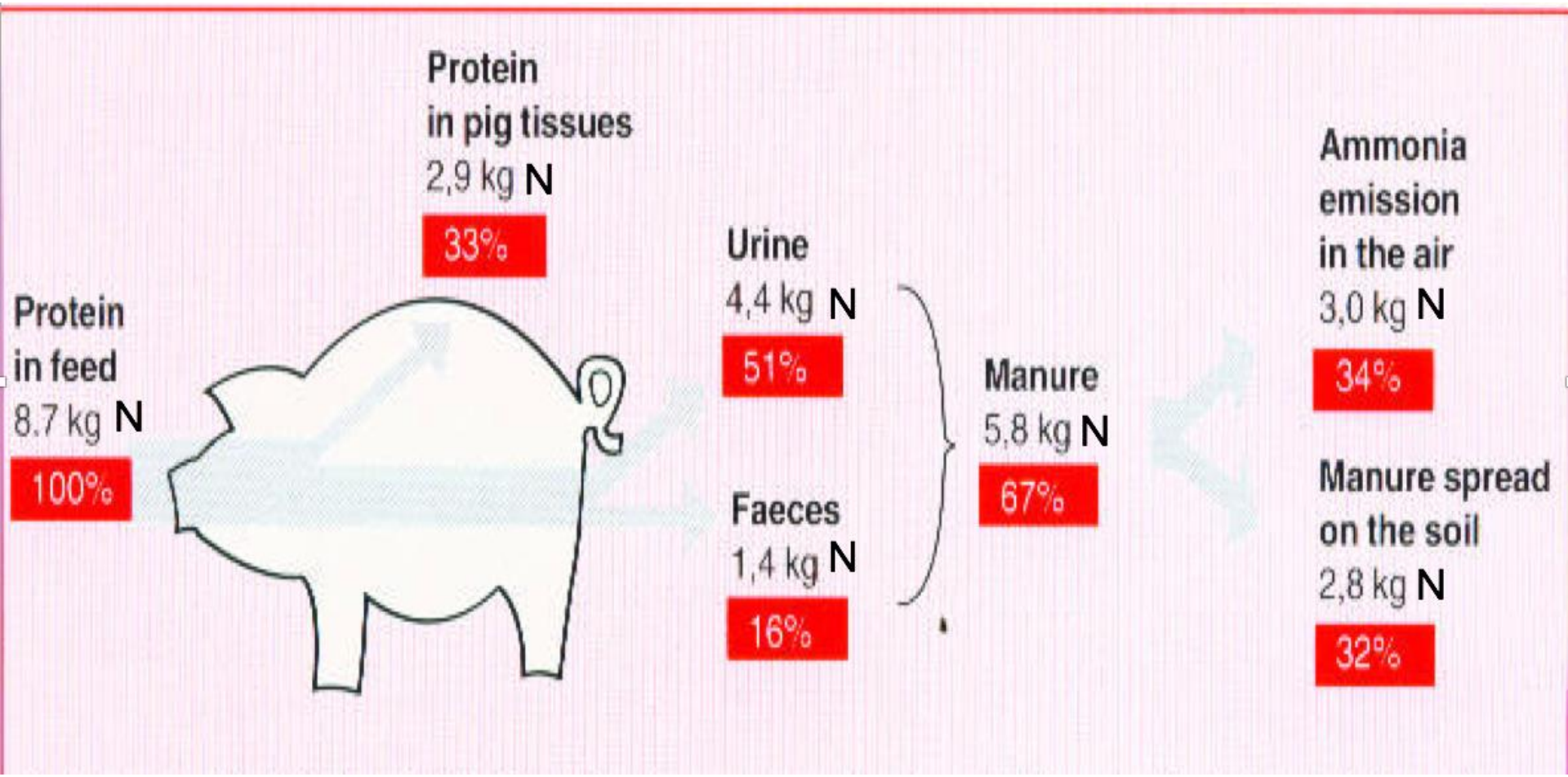
Dietary Strategies to Reduce Nitrogen Excretion in Pig Production

John O Doherty, PhD, DSc.

Efficiency of N utilisations in different types of pigs



Nitrogen consumption, utilisation and losses in the production of a slaughter pig (108 kg)



The relative contribution of the sow is also included

Major strategies to reduce N output

1. Feed Formulation
2. Feed low protein, amino acid supplemented diets
3. Reduce crude protein content of swine diets and fortify these diets with amino acids
4. Feeding management: Split feeding, Phase feeding, Precise feeding

Effect of crude protein on nitrogen intake and output

(Carpenter et al., 2004)

Crude protein % *	21% (1.15 lysine)	17% (1.15 lysine)	15% (1.15 lysine)	12% (1.15 lysine)
N intake (g/day)	71.3	61.5	55.6	49.5
Relative excretion	100	78.5	66.1	62.8
Kg N excretion/sow	74.2	65.0	57.3	58.2

Each 1% decrease in CP decreases N excret by 6%

Leek et al, 2005, Carpenter et al., 2004

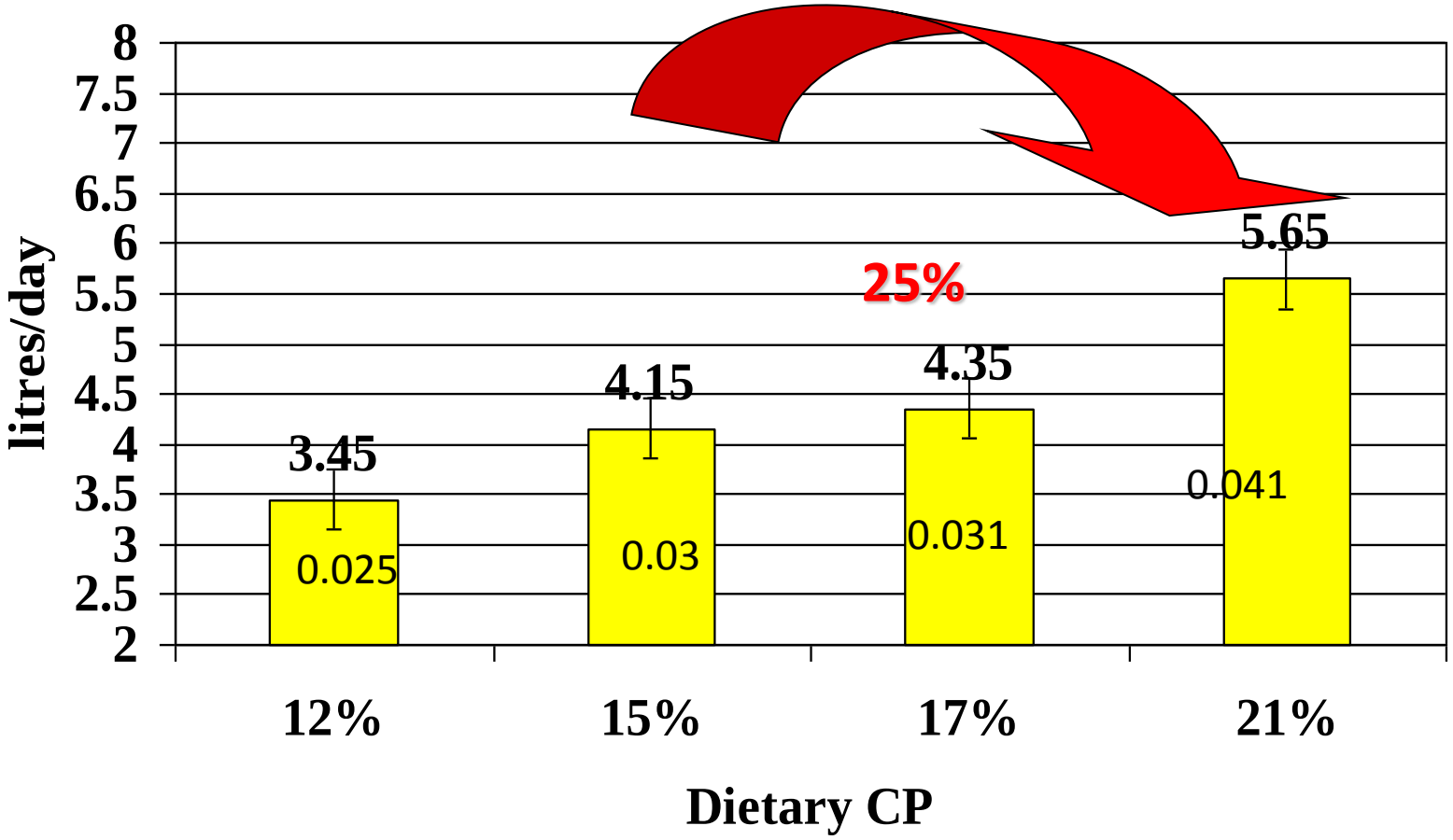
*Added synthetic lysine,methionine, threonine and tryptohan

Effect of crude protein on pig performance, and carcass characteristics

Crude protein %*	21% (1.15 lysine)	17% (1.15 lysine)	15% (1.15 lysine)	12% (1.15 lysine)
Daily gain (kg/d)	0.860	0.861	0.945	0.866
Feed conversion ratio	2.47	2.39	2.38	2.59
Carcass lean %	58.0	58.1	56.6	56.5

*Added synthetic lysine,methionine, threonine and tryptohan

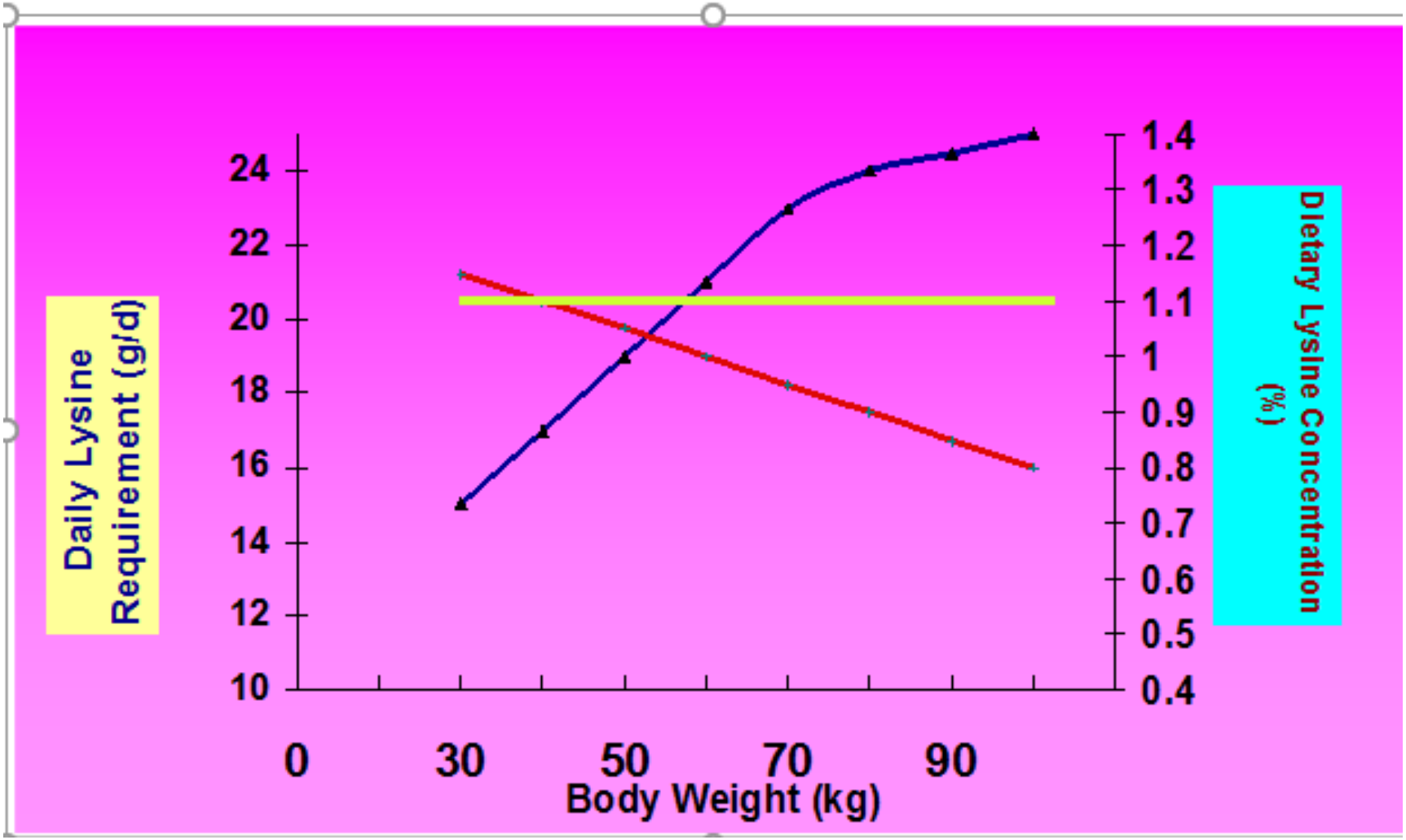
Effect of crude protein and slurry volume (litres/day) and storage capacity (m^3/wk)



Carpenter et al., 2004

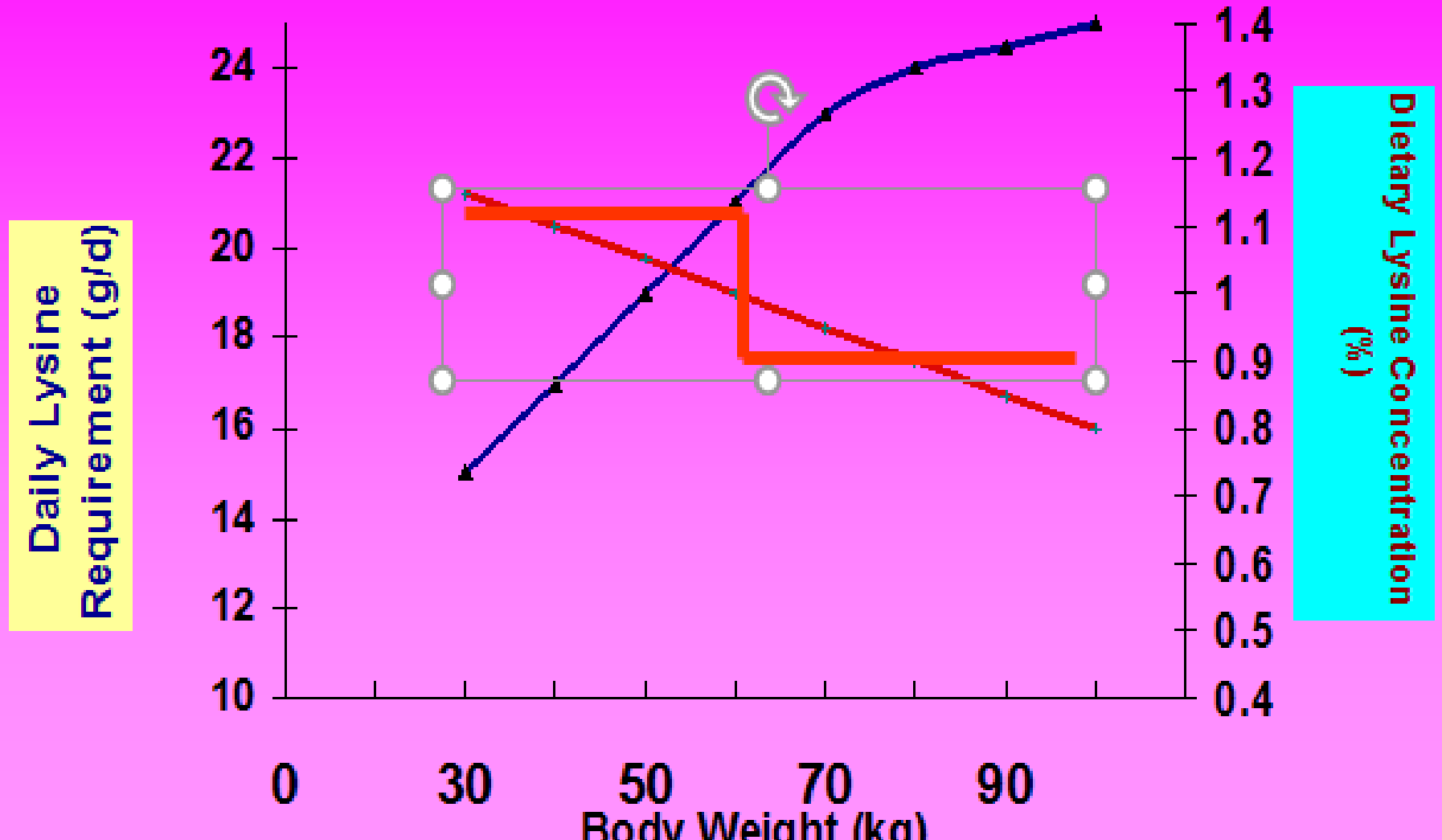
Single Diet Approach

How we feed our pigs



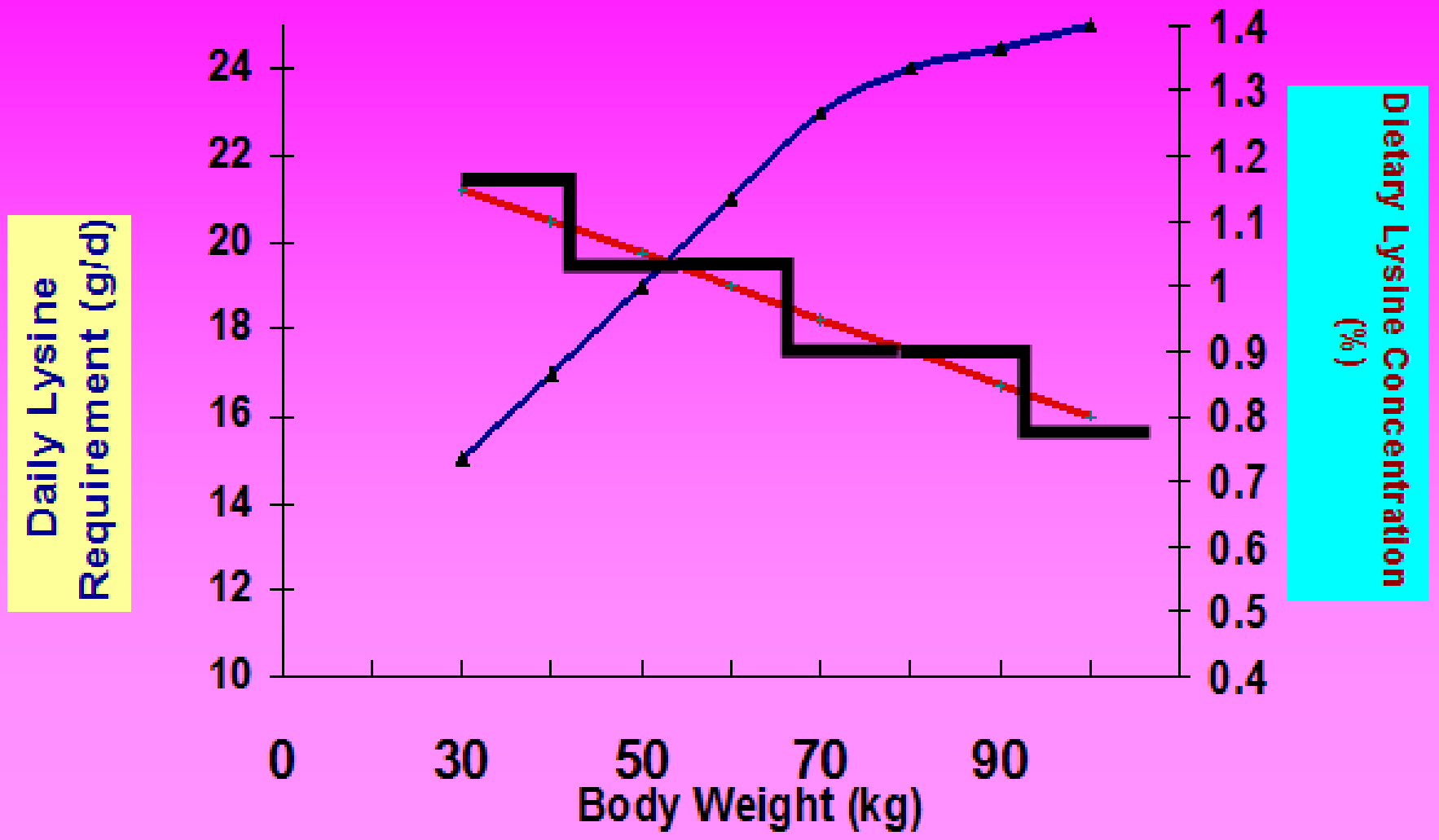
How we feed our pigs

Split Diet Approach



How we feed our pigs

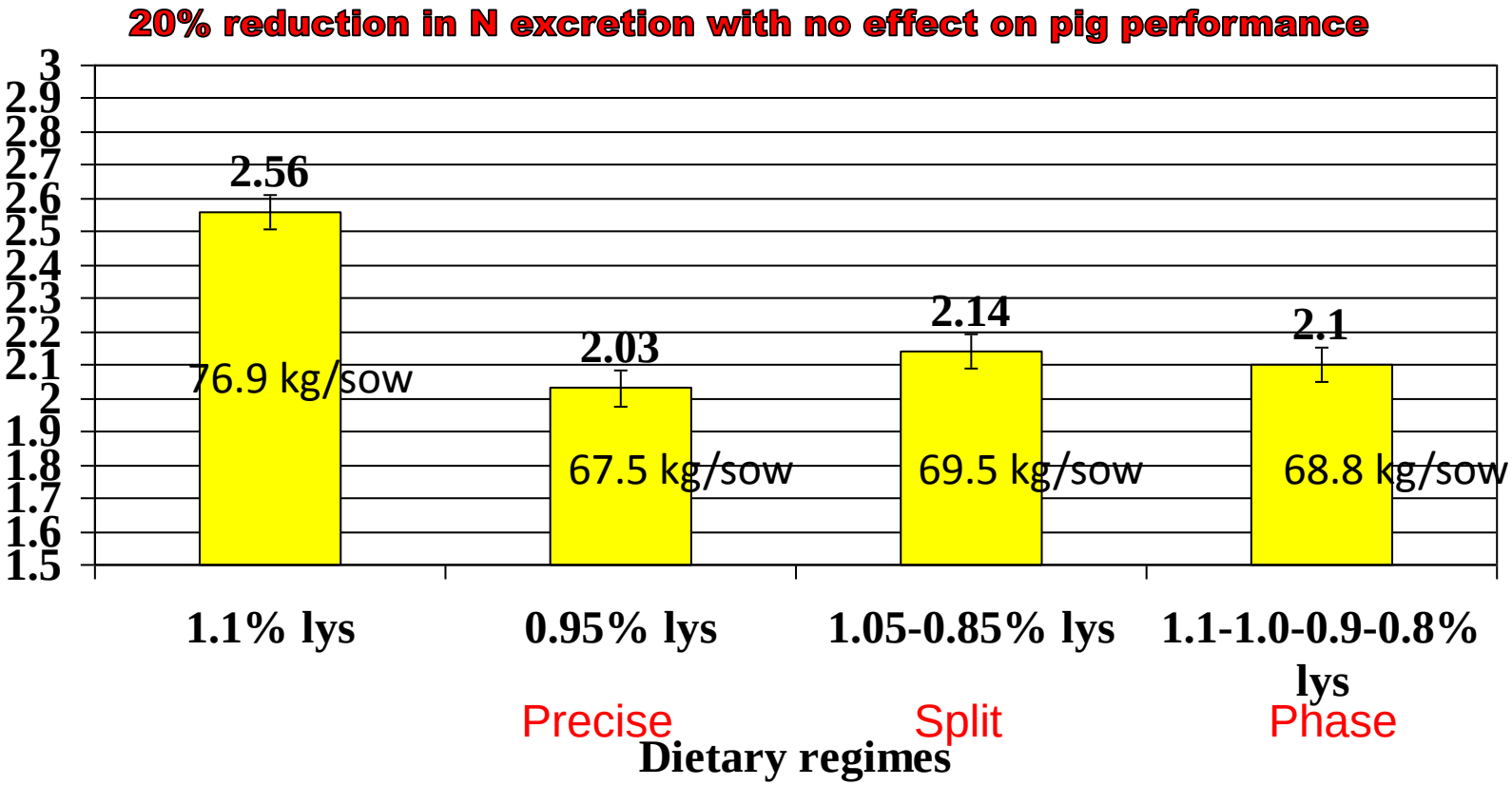
Phase feed Approach



Formulate feed to match nutritional requirements of pigs

- Precise Nutrition
- Need to know actual growth rate of your pigs at various stages at minimum
- Need to know actual protein deposition rates at various stages of growth
- Need to know feed intake
- Formulate diets to match requirements

Effect of treatment on N output in finisher pigs (40-100 kg)

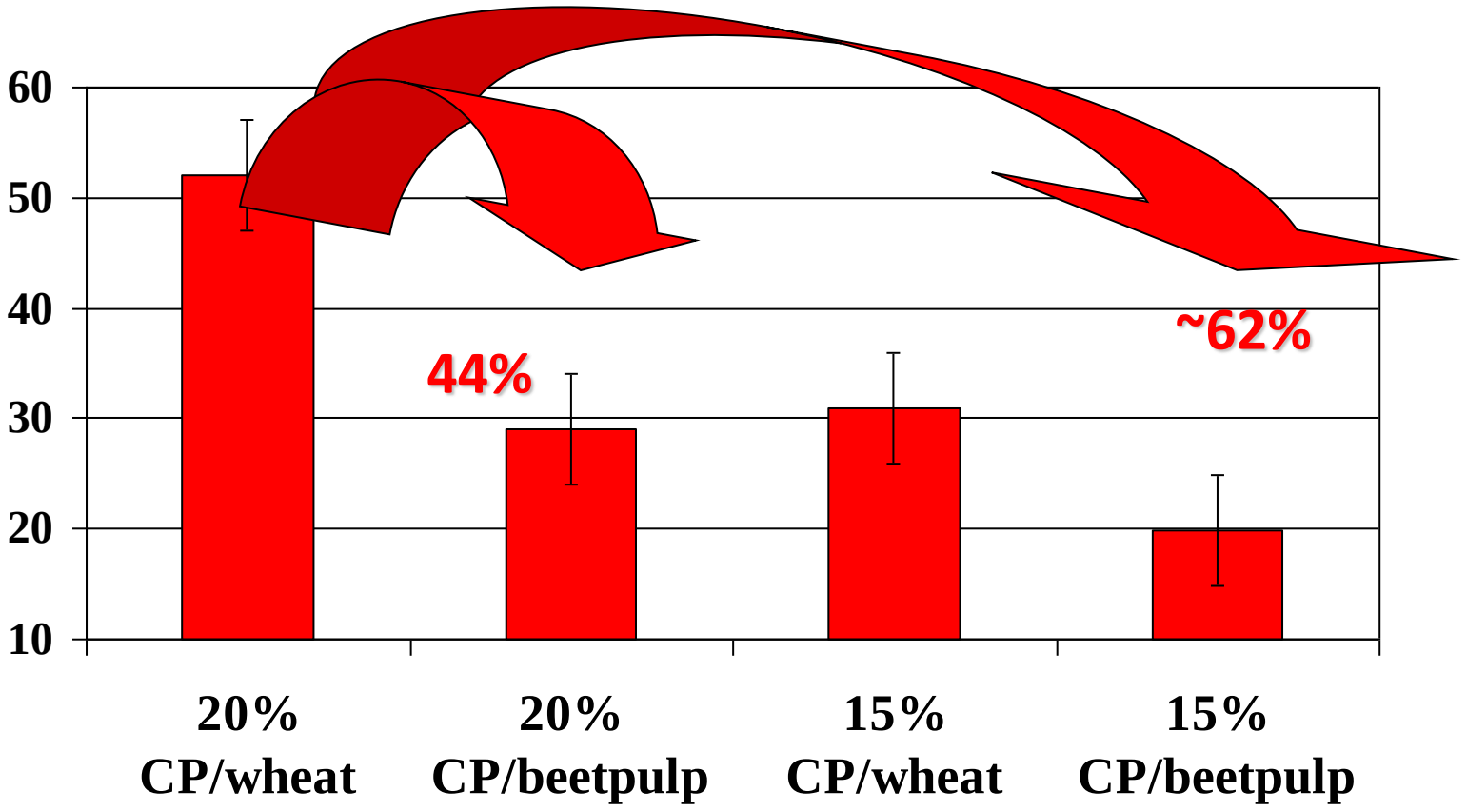


Garry et al., 2005

Strategies to reduce ammonia output by diet

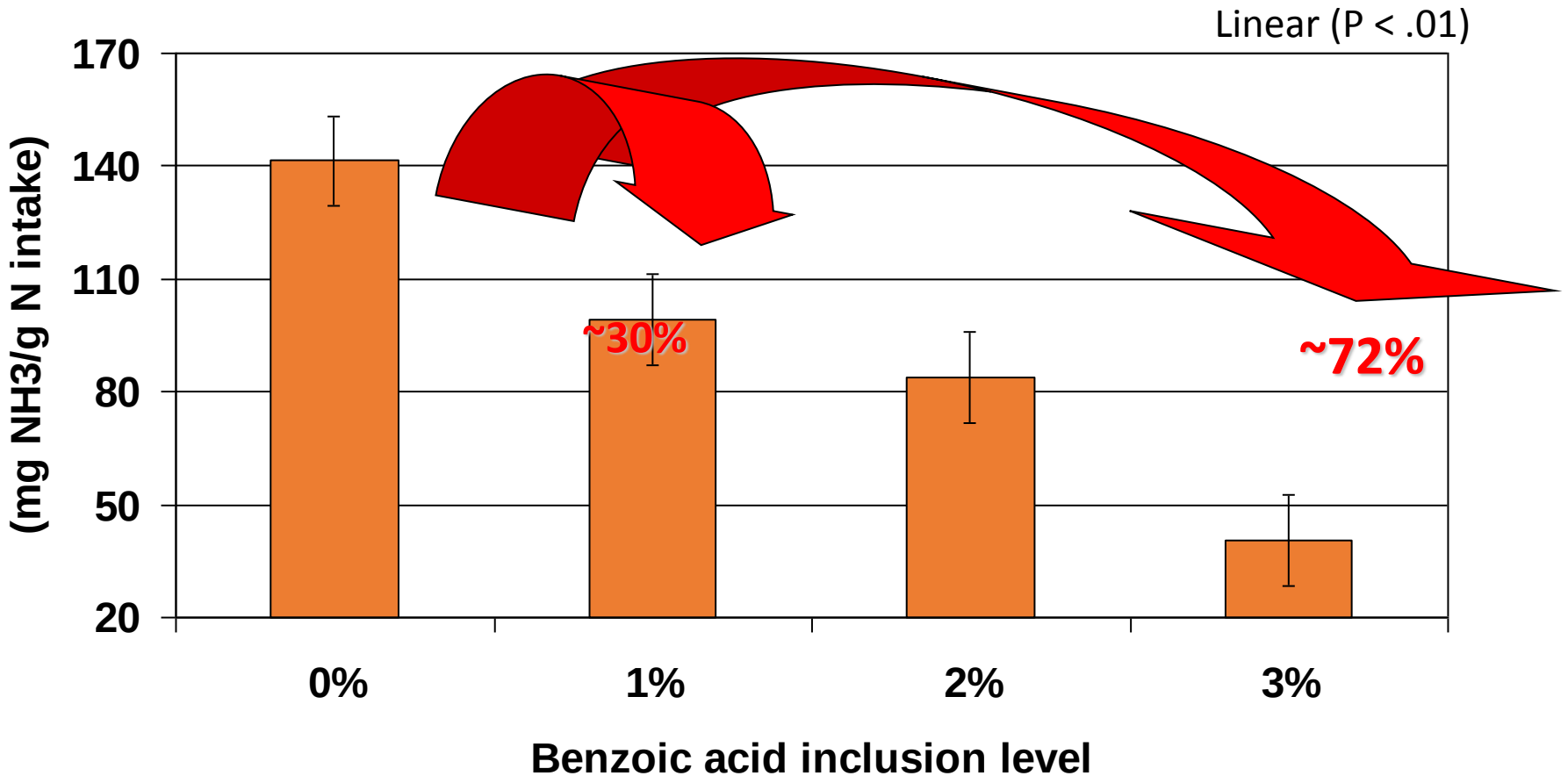
- Feed low protein, amino acid supplemented diets
- Reduce crude protein content of swine diets and fortify these diets with amino acids
- Increase fibre concentration of the diet
- Include dietary acids in the diet

Ammonia output (g/day/LU)



Lynch et al., 2008

Manure NH_3 Emissions (0-240 Hrs)



Murphy et al., 2011

Sensitivity analysis for grower-finisher pigs

Feed efficiency :+10% improvement

	800 g/day	880 g/day
N Excreted kg/finisher	3.15	2.66
Relative N excret (%)	100	84.5

Environmental benefits of lowering the dietary crude protein levels

	Effect of 1 point CP reduction	Maximal effect
Total nitrogen excretion	- 8-10%	- 50%
Ammonia in the slurry	- 11%	- 50%
Ammonia in the air	- 10-13%	- 60%
Slurry volume	- 3-5%	- 30%

Plus health benefits of reduced crude protein diets

Summary

- Many pigs fed too much protein
- Many pigs fed inaccurately with regard to Lysine
- Significant reductions in N excretion and pollutants possible by diet formulation

Thank you for listening!!