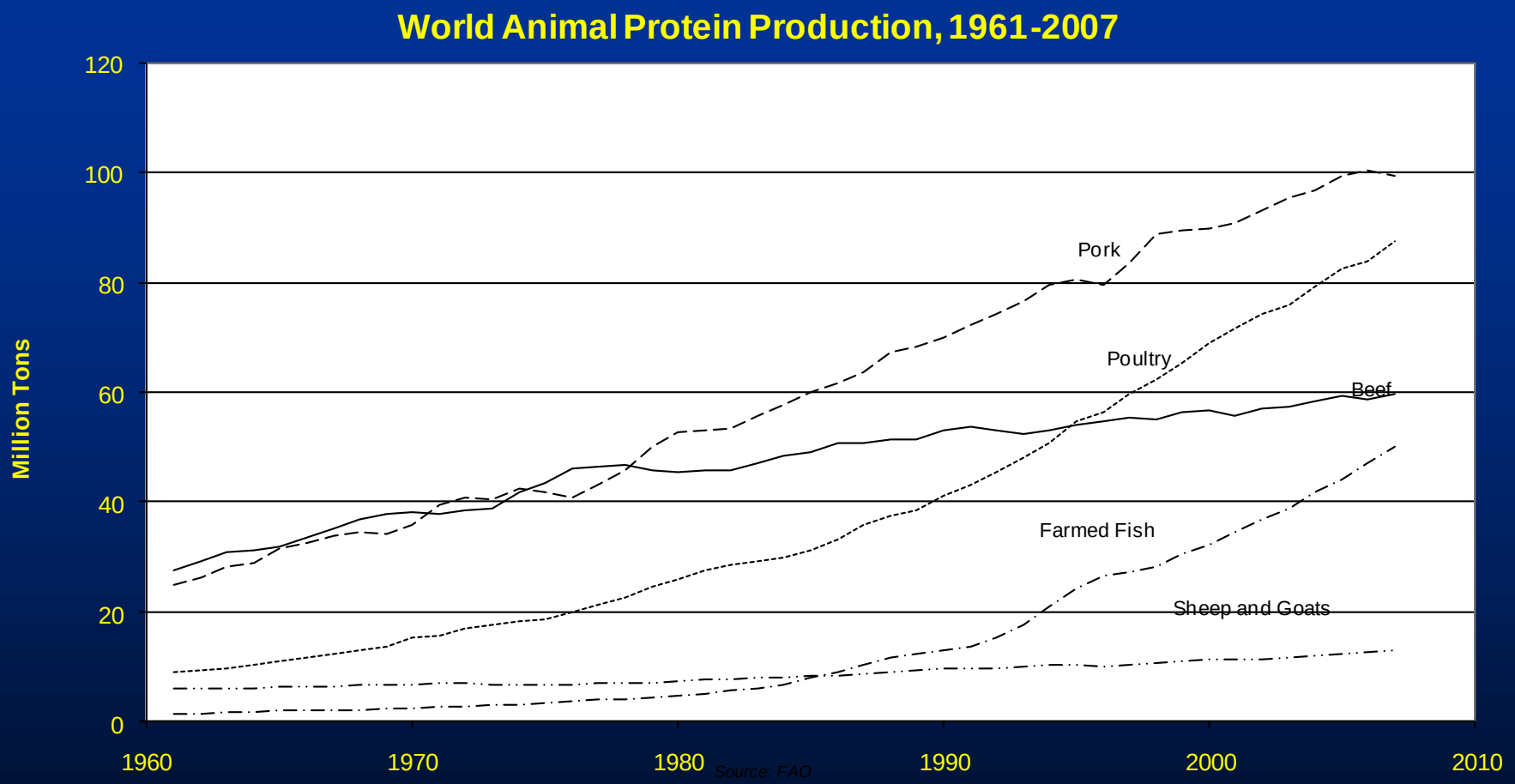
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Advances and Future Directions in Poultry Nutrition

Te Kunenga ki Pūrehuroa

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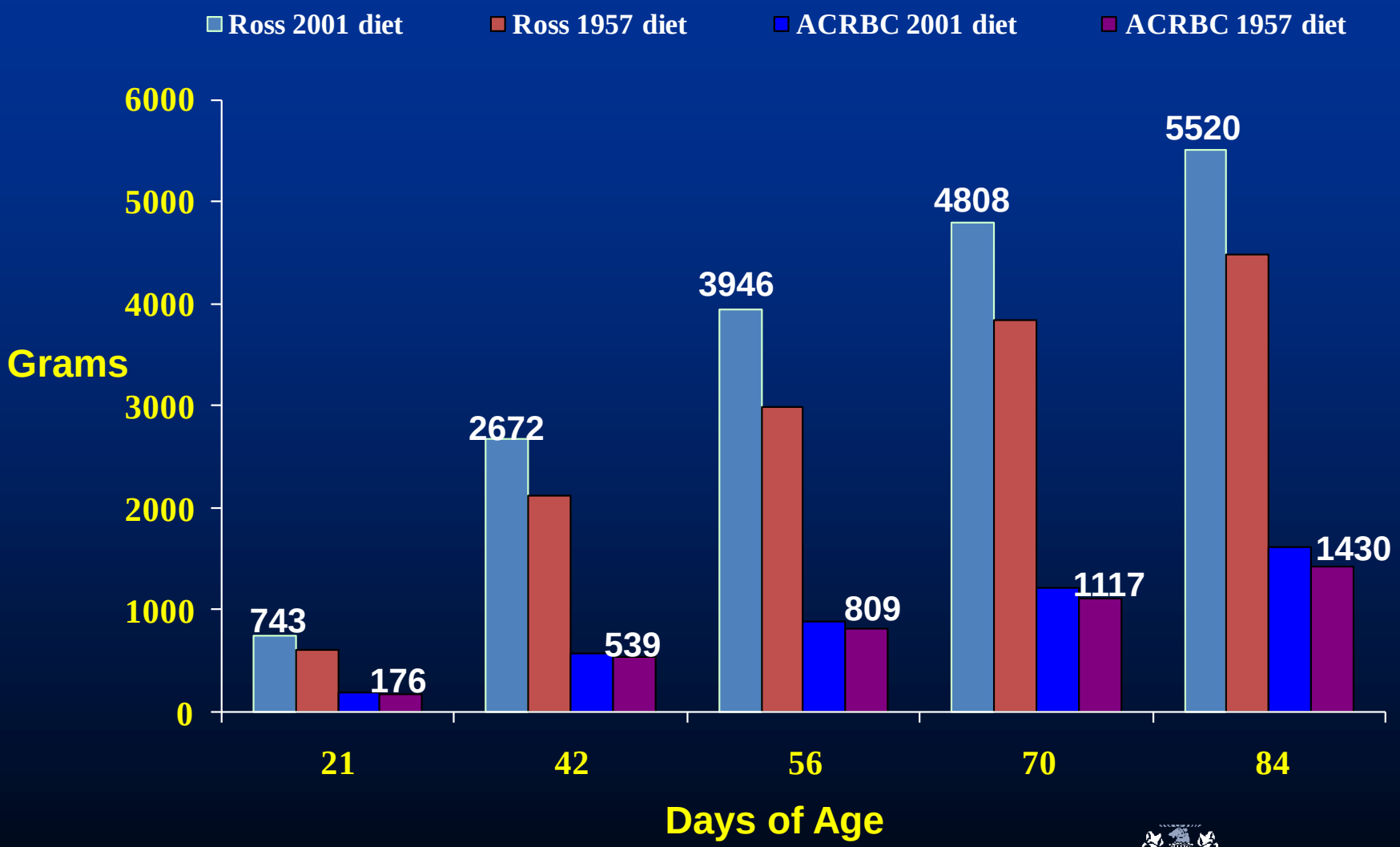
Production standards have continuously increased over this period

Male broilers capable of reaching 2 kg at 30-35 days

White-egg layers capable of producing 330 eggs in 52 weeks of lay

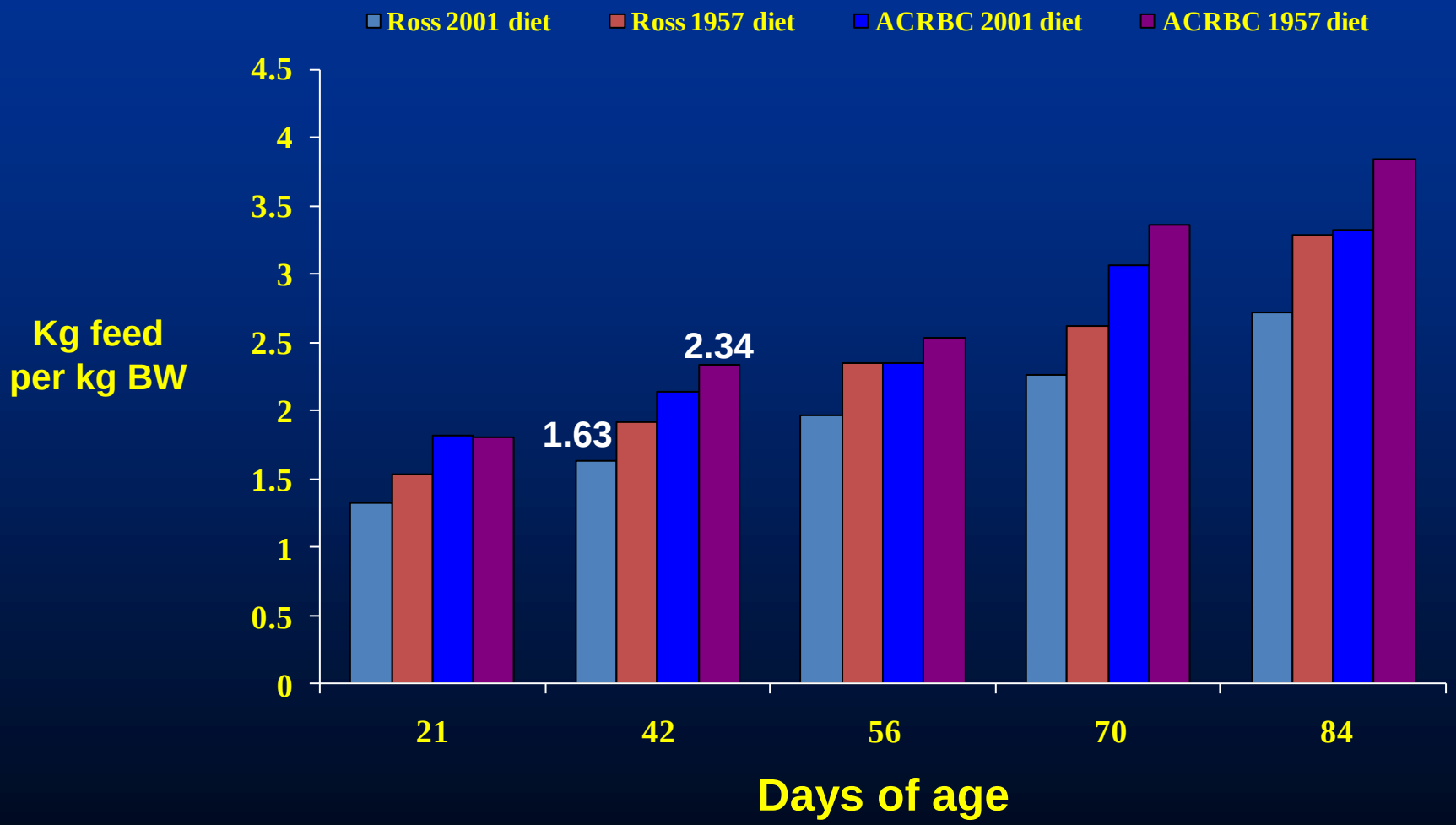
Havenstein GB, Ferket PR and Qureshi MA. 2003. Growth, livability and feed conversion of 1957 versus 2001 broilers when fed representative 1957 and 2001 broiler diets.
Poultry Science. **82**: 1500-1508.

Body Weight



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Cumulative Feed Conversion



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Males on 2001 Ration



1957 ACRBC
Av. 591 g [a]

2001 Ross 308
Av. 2903 g [a]

42 Day Live Weight
Courtesy: NCSU

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Growth of the Poultry Industry is due to:

Improvements in,

- Genetics and Breeding
- **Nutrition and Feed Management**
- Health Care / Disease Prevention
- Poultry Management
- Poultry Equipment and Housing
- Integration of the Industry
- Further Processing
- Fast Food Technologies
- Marketing

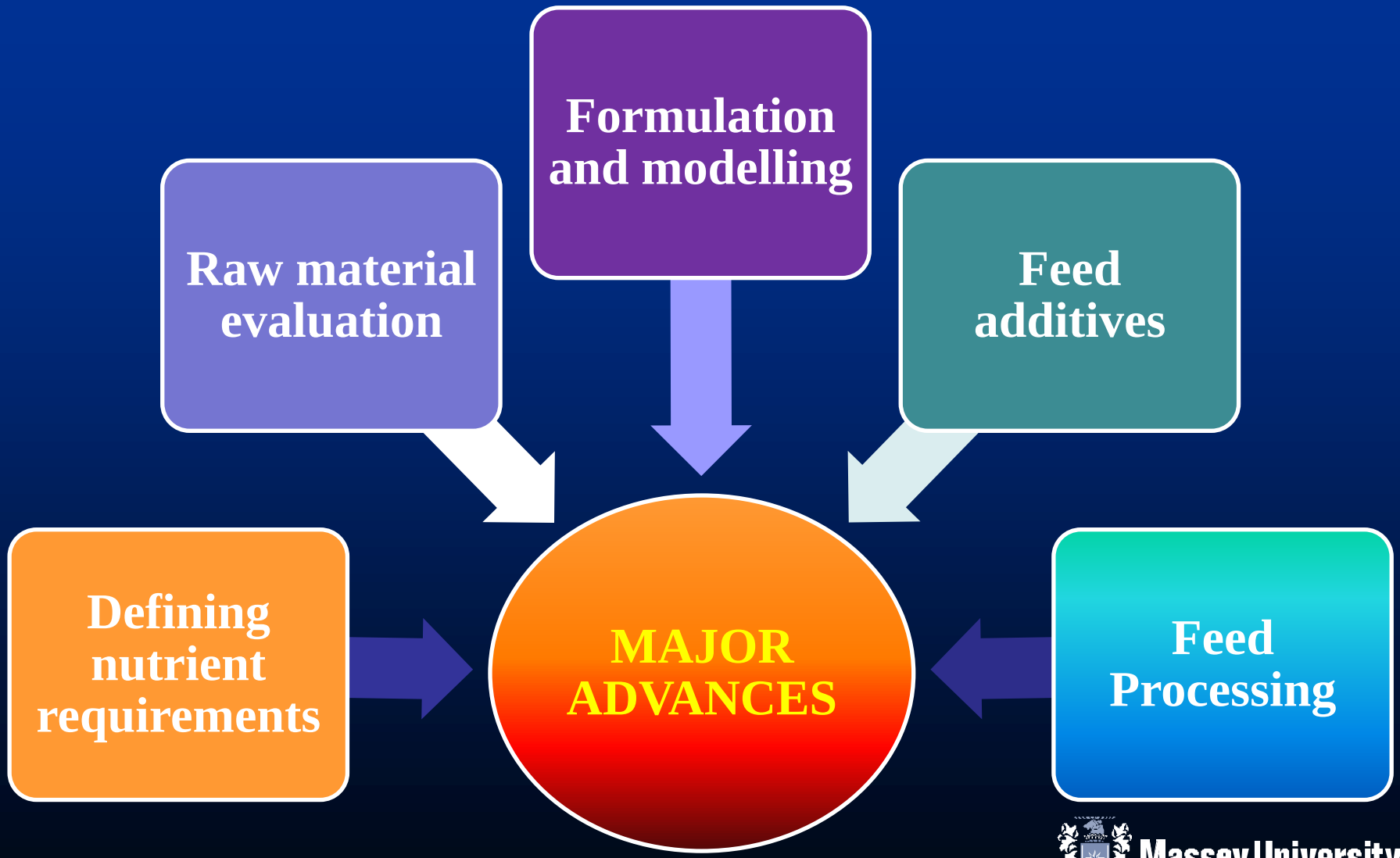
1957-Type Broiler Diets[1]

	Starter	Grower
Ingredients	**1 to 42 d**	**43 to 84 d**
Corn	61.0	66.5
Soybean meal (48% CP)	23.8	13.3
Meat and Bone meal (50% CP)	2.5	3.0
Fish meal	2.5	2.5
Alfalfa meal (17% CP)	2.5	3.0
Wheat middlings	0	10.0
Whey	2.5	0
Distillers dried grains	2.5	0
1957 vitamin premix	0.05	0.05
1957 trace mineral premix	----To 100%	
Nutrient Analysis		
Kcal ME/kg	2895	2930
Crude Protein, %	23.7	19.2
Lysine, %	1.2	0.9
Methionine + Cysteine	0.75	0.65
Calcium, %	1.35	1.20
Non Phytate Phosphorus, %	0.61	0.44

[1] Starter and grower were fed as mash

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- The only feed additive available was antibiotics. The following were not available:
  - Crystalline amino acids
  - Feed enzymes
  - Mycotoxin binders
- Vitamins: A, D, B_{12}, riboflavin, Niacin, Pantothenic acid
- Trace minerals: Zn, Se



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Defining nutrient requirements

- NRC (1950 …1960, 1971, 1977, 1980,1984, 1994), ARC (1975)
- Breeding company recommendations closely match the requirements of modern strains
- Energy and essential AA are the critical components
- Concept of 'ideal protein'
    - Lysine as the reference amino acid
    - Other AA set as a % of lysine requirement

IDEAL AMINO ACIDS RATIOS - BROILERS

	1-21 days	22-42 days	43-56 days
Lysine	100	100	100
Arginine	105	108	108
Histidine	35	35	35
Isoleucine	67	69	69
Leucine	109	109	109
Met + Cysteine	72	72	72
Phe + Tyrosine	105	105	105
Threonine	67	68.5	68.5
Tryptophan	16	17	17
Valine	77	80	80
Digestible lysine requirement, %	1.07	0.865	0.745

IDEAL AMINO ACIDS RATIOS - LAYERS

	CVB (1996)	Coon & Zhang (1999)	Bregendahl et al. (2008)
Lysine	100	100	100
Arginine	-	130	107
Histidine	-	-	-
Isoleucine	79	86	79
Leucine	-	-	-
Met + cysteine	93	81	94
Phe + tyrosine	-	-	-
Threonine	66	73	77
Tryptophan	19	20	22
Valine	86	102	93
Digestible lysine requirement, mg/hen/d	700	636-705	538

Raw material evaluation

- Large volume of data on gross composition, including amino acids
- Rapid tests (NIRS) for gross composition are now available
- But no rapid tests for available energy and amino acids

Energy evaluation

- Fraps (1946) described the concepts of productive energy and net energy
- Hill and Anderson – 1950's – AME system
- Sibbald (1977) – TME system (rooster assay)
  - Ethical issues
- Net energy system is again being researched
  - Costly and time consuming
  - Routine evaluation ?

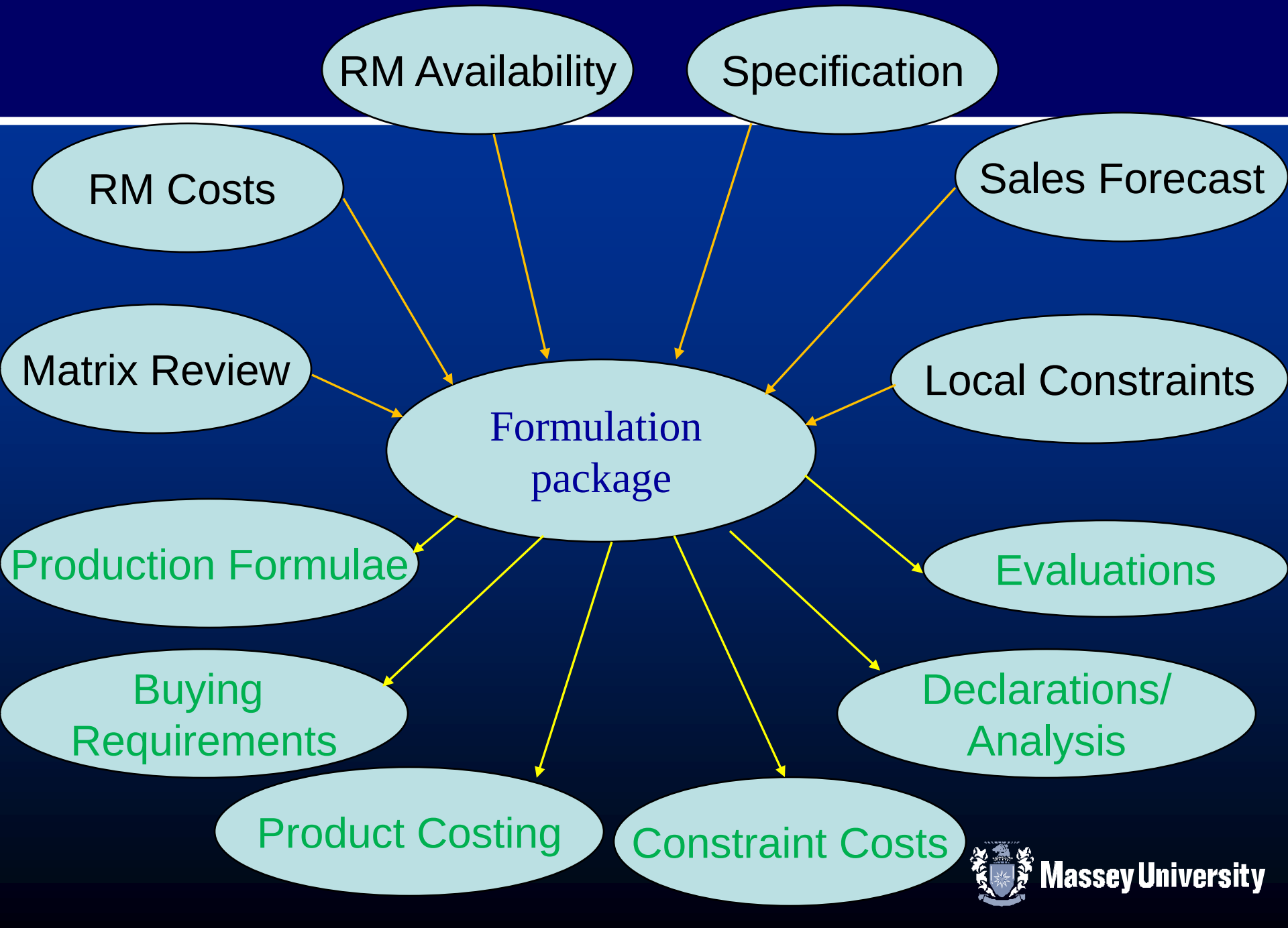
Protein evaluation

- Initially protein
- Then total amino acids
- Excreta-based digestible amino acids
- True digestible amino acids – Rooster assay
  - Excreta-based
  - Relevance to growing birds?
  - Ethical issues
- Ileal digestible amino acids

Better formulation and modelling

Nutrient requirement = Nutrients supplied by combination of raw materials

- Initially simple balancing of few ingredients for limited number of nutrients
- Now computer-aided linear and non-linear programmes for least cost diet formulations
- Nutrient partioning/ growth models



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Advent of feed additives

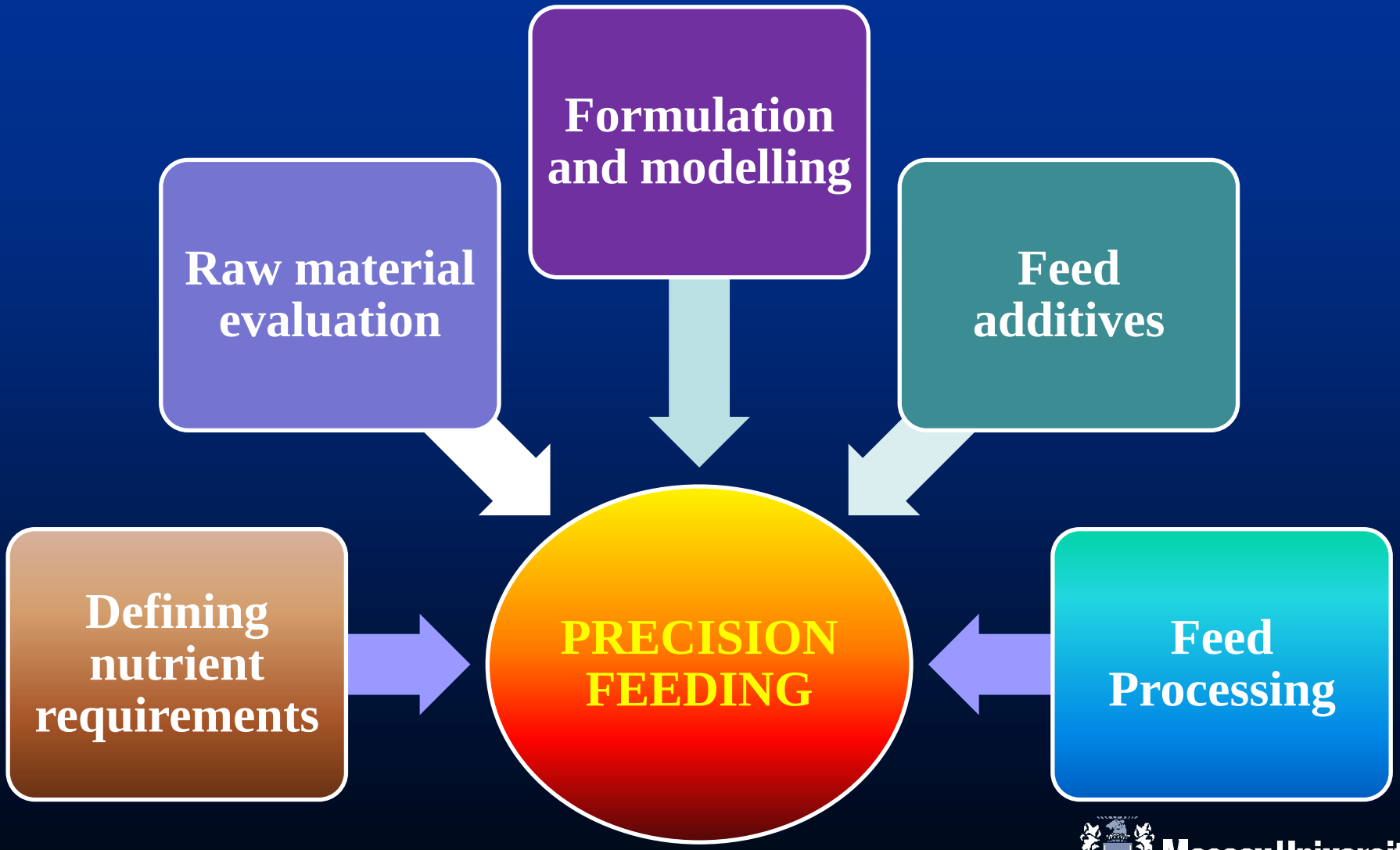
- In-feed antibiotics
- Feed enzymes
  - NSP enzymes
  - Phytases
  - Cocktails with amylases, proteases etc
- Crystalline amino acids
- Mycotoxin binders/ deactivators
- Organic trace mineral chelates
- Emulsifiers

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Feed Processing

- Simple mixing of mash diets - to pelleting or crumbling
- A major contributor to improved bird performance
  - ↓ Feed wastage
  - ↑ nutrient density
  - ↓ Selective feeding
  - ↓ energy spent in eating
  - Destruction of pathogens

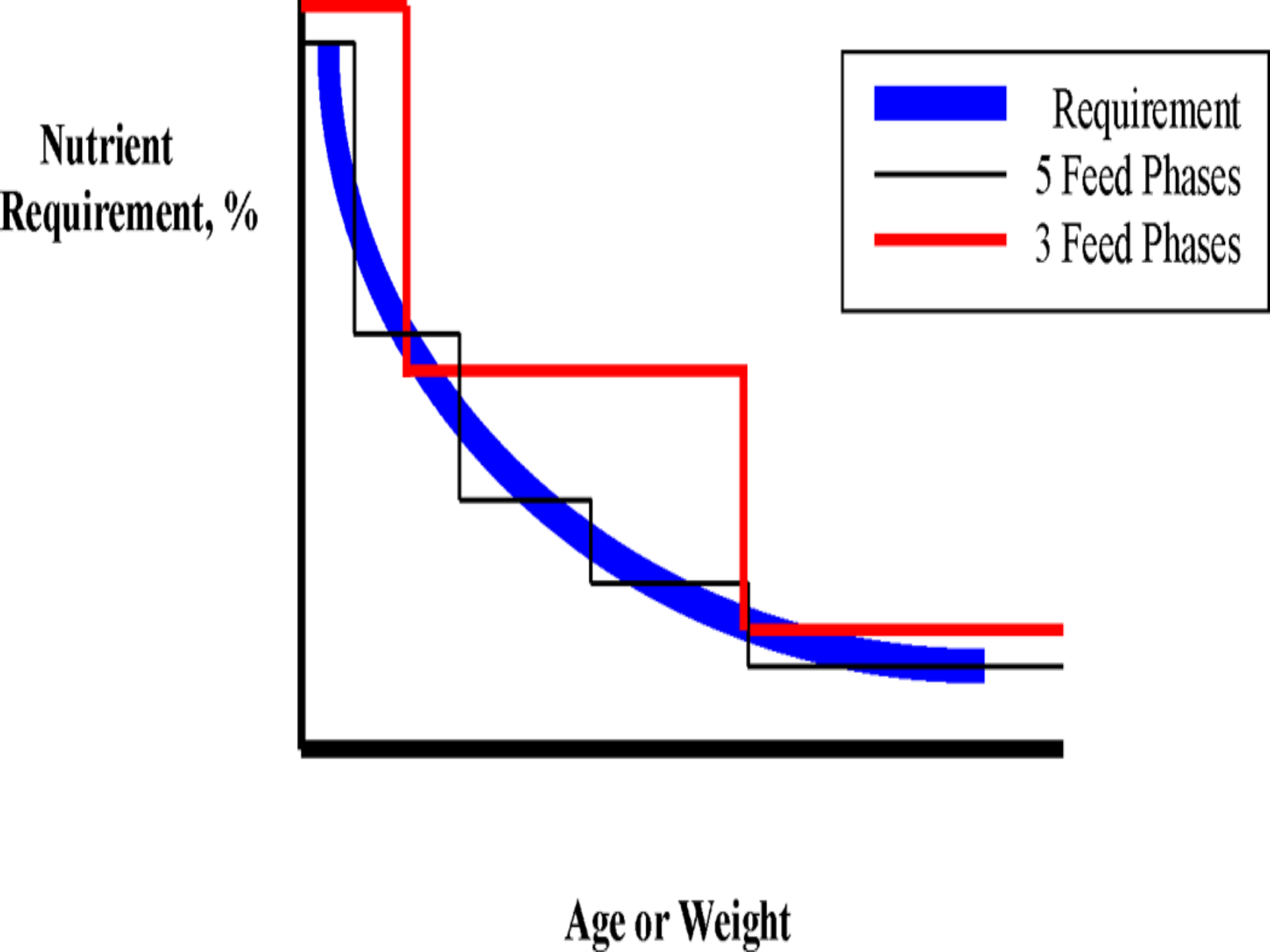
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Phase Feeding

- A form of precision feeding
- Nutrient requirement changes on a daily basis as the bird grows.
- Dietary amino acid levels are steadily reduced over time to closely match the requirements
  - Excess feeding of AA is avoided
  - Lower feed cost
  - Lower N excretion


Nutrient Requirement, %
Requirement
5 Feed Phases
3 Feed Phases
Age or Weight

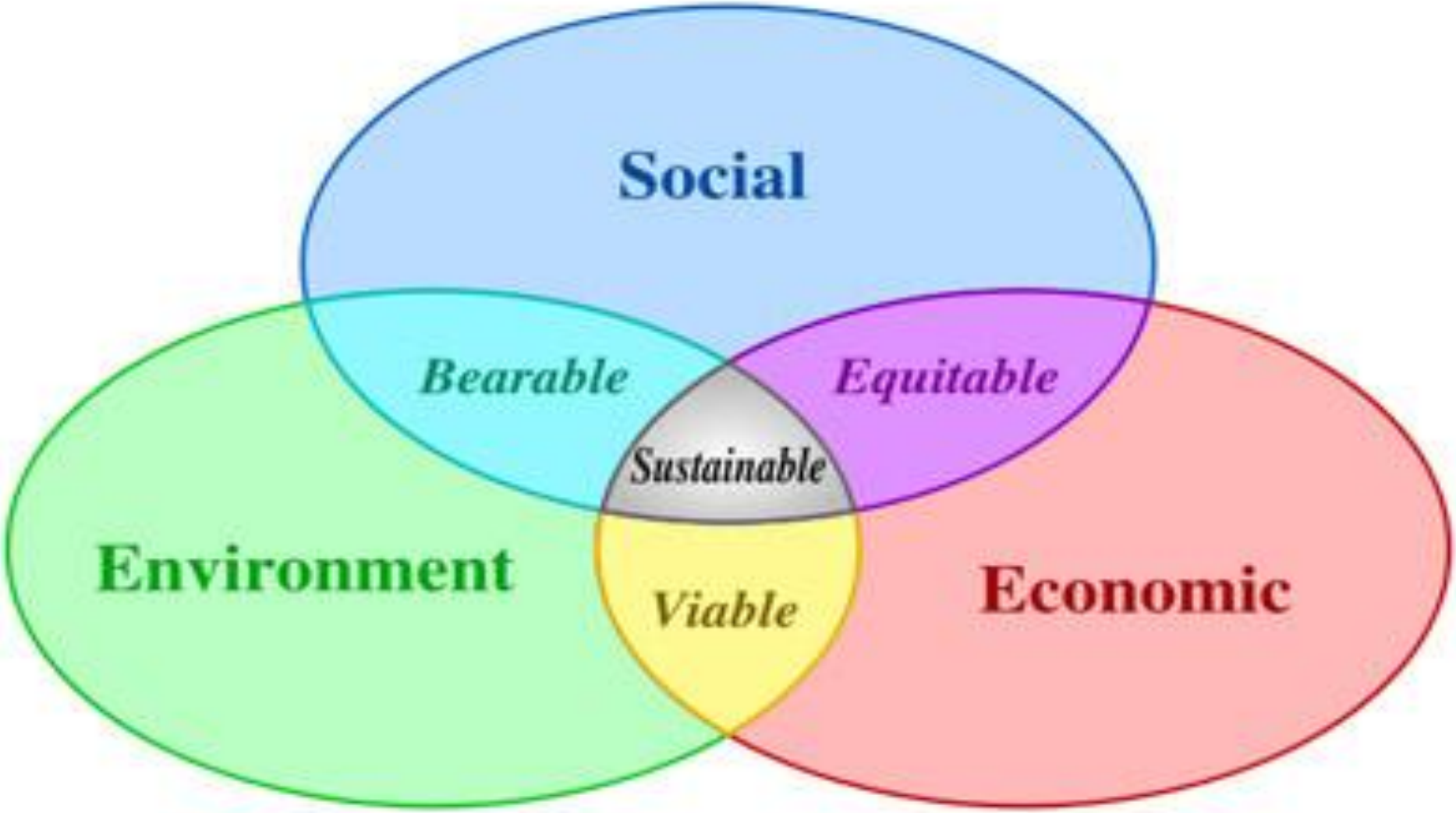
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Future Directions in Poultry Nutrition

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Social
Bearable
Equitable
Sustainable
Environment
Viable
Economic


environment

Algae bloom near La Jolla



Reducing environmental emissions

- Precise nutrition
- Feed formulation techniques
- Improve feed digestibility
  - Reduce anti-nutritional factors
  - Feed enzymes
  - Gut flora stabilisers
- Good feed manufacture – particle size, pellet quality
- Maintain good litter quality

Antibiotic-free nutrition

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- Competitive exclusion
- Probiotics
- Prebiotics
- Anticoccidials
- Acidifiers
- Essential oils
- Plant extracts
- Enzymes

None are currently standard inclusion in poultry diets, except enzymes. But there is increased interest in the use of ‘natural additives’

Alternatives to in-feed antibiotics

- Most have shown to ‘mimic’ the working effects of antibiotics on gut flora
- None, on their own, are capable of fully replacing antibiotics
- But these may way work within combination products
- To be accepted, they must consistently improve bird performance

Raw materials

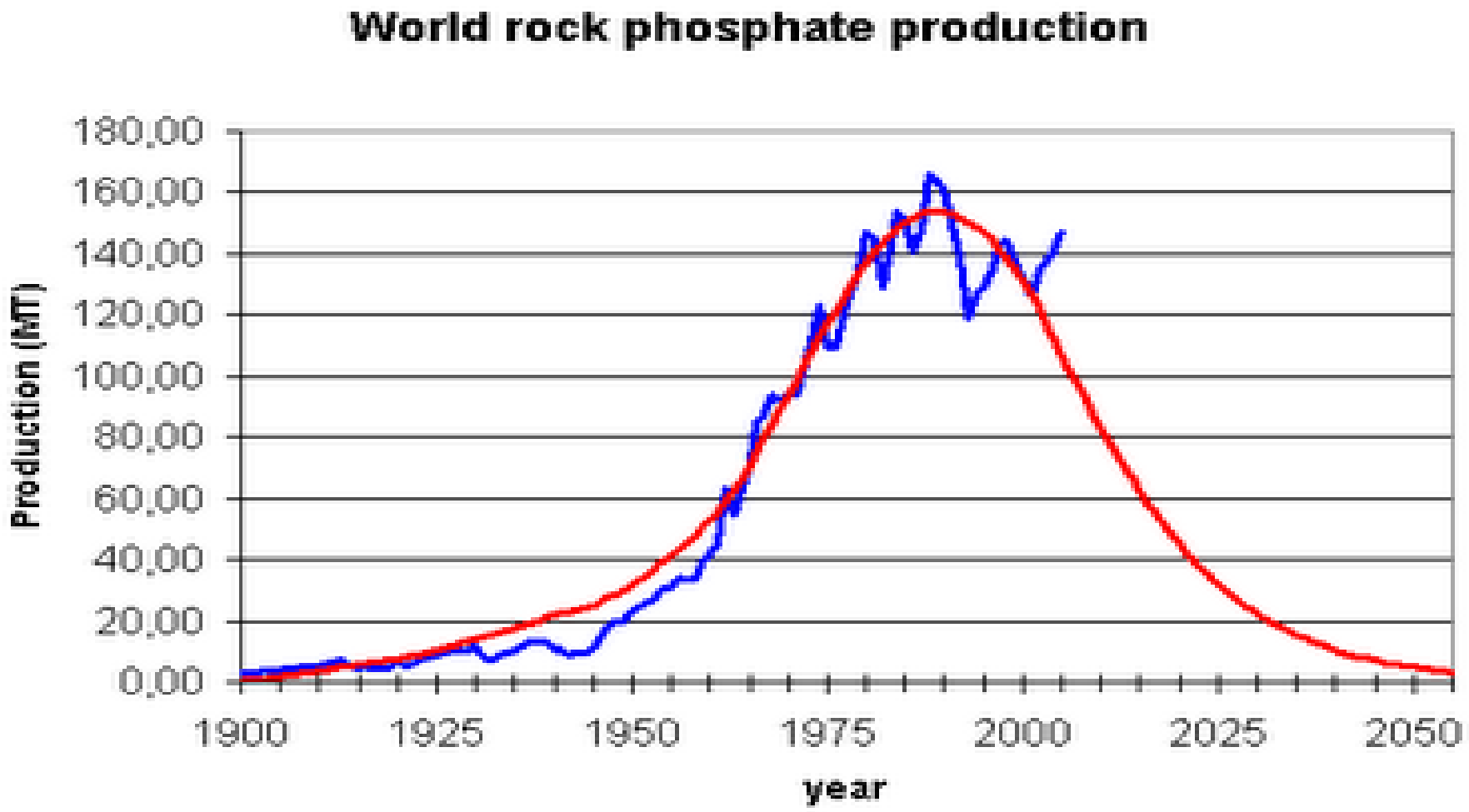
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- Demand for raw materials will continue to increase in the coming decade
- This will be the major challenge
- Test and evaluate new raw materials
- Evaluate ways of maximising nutrient extraction from raw materials
  - Feed processing, additives
- Includes INORGANIC PHOSPHATES

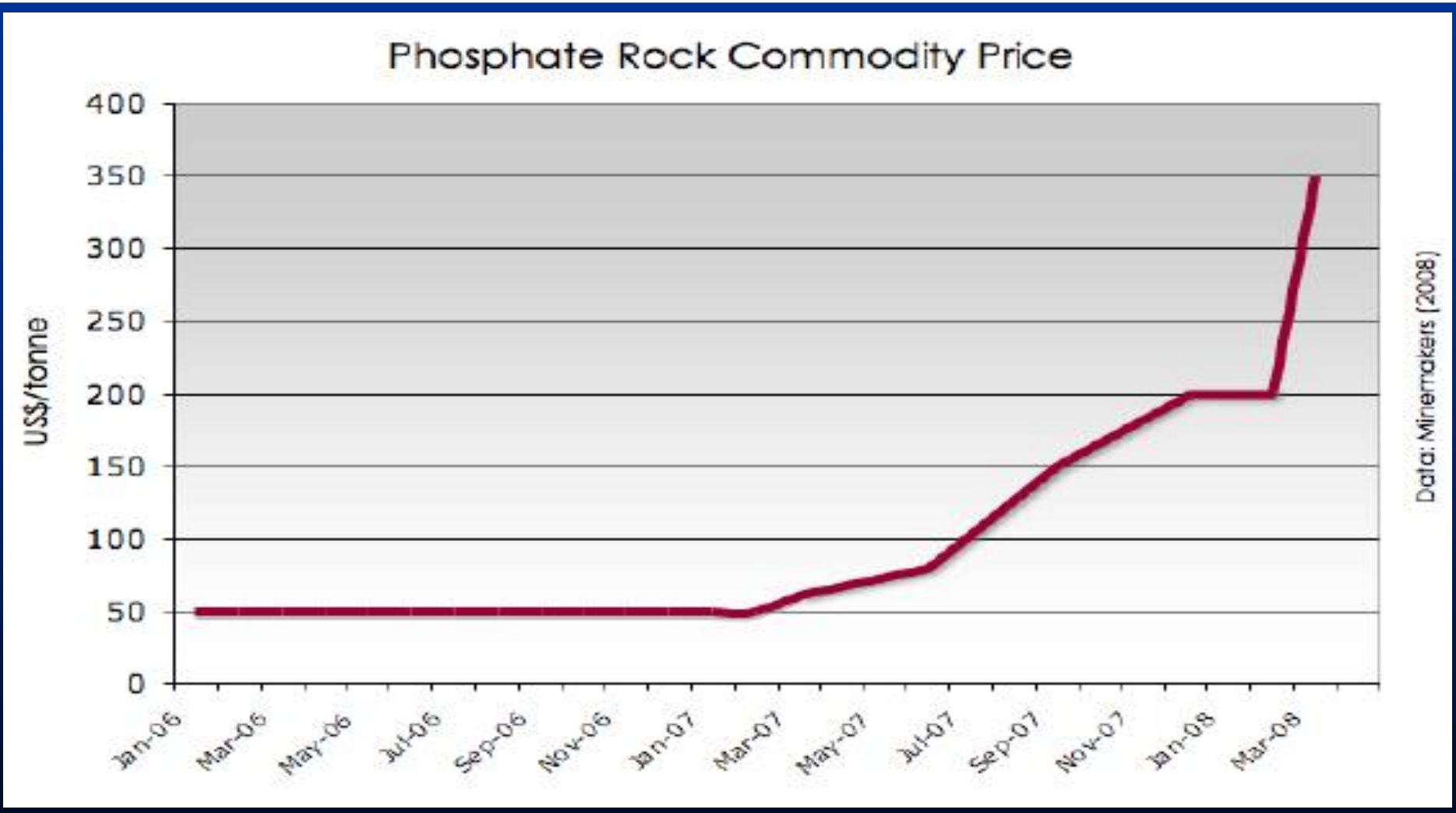
Inorganic Phosphate Supply

Declining and non-renewable

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World rock phosphate production
180,00
160,00
140,00
120,00
100,00
80,00
60,00
40,00
20,00
0,00
Production (MT)
1900
1925
1950
1975
2000
2025
2050
year

Cheap inorganic phosphates – a thing of the past


Phosphate Rock Commodity Price
US$/tonne
400
350
300
250
200
150
100
50
0
Jan-06
Mar-06
May-06
Jul-06
Sep-06
Nov-06
Jan-07
Mar-07
May-07
Jul-07
Sep-07
Nov-07
Jan-08
Mar-08
Data: Minermakers (2008)

And we've used up the good stuff

Quality will decline and price will increase

Feed enzymes

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Where to next?

- Improved enzyme products
- Thermostable enzyme
- Strategic enzyme combinations
- Combining with other additives
- Inclusion of higher enzyme doses

Improved enzymes

- http://www.wipo.int

- An ideal enzyme will have,
  - High specific catalytic activity/ unit of protein
  - High activity over wide range of pH
  - Resistance to proteolysis, especially pepsin
  - Thermostability

Crystalline amino acids

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Maximising protein utilisation

- To precisely meet the ideal amino acid profile
- To formulate diets on the basis of digestible amino acids (and to increase the range and inclusion levels of alternate raw materials)
- To lower dietary crude protein levels (and reduce N excretion in manure)
- To develop phase-feeding systems

Available crystalline AA

Commonly available amino acids:

- Methionine
- Lysine
- Threonine
- Tryptophan

Recent additions/ future:

- Valine
- Isoleucine
- Arginine

End Thoughts

- Major challenges are ahead for nutritionists – especially raw material issues
- Future decisions will be shaped not only by economics and science, but also by societal issues
- Industry and nutritionists need to be ‘pro-active’ to address the public concerns