Feed Formulasi – Pabrik

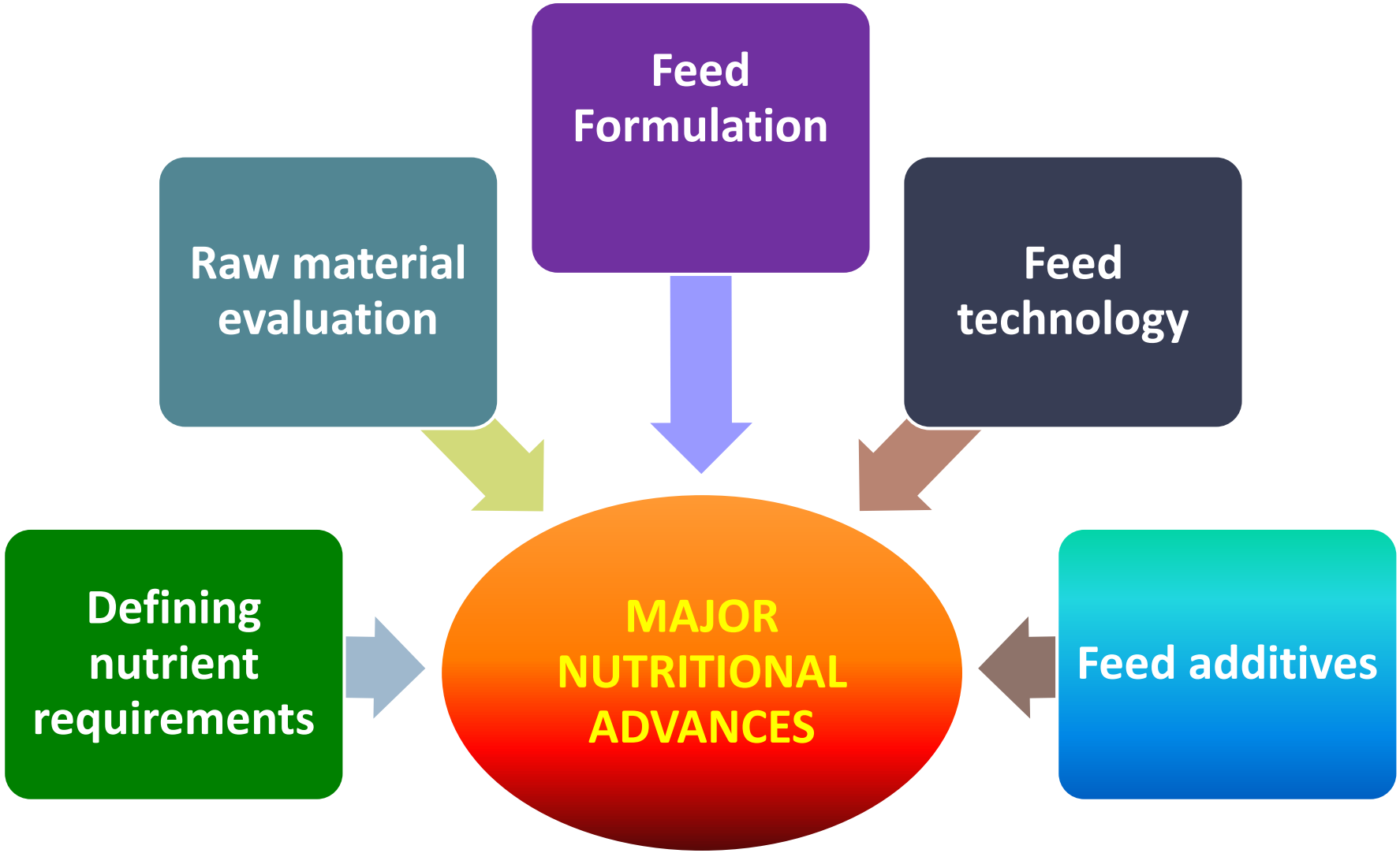
(seri 2)

Lely Delima S, drh, M. Si

The relationship between feed quality and animal performance is important and encompasses not only the quantitative amounts of all feed components, but also the digestibility and metabolism of those components.

Feed Quality

- Good quality of feed is influenced by:
  - Formulation
  - Good quality of the raw materials
  - Production process


Feed Formulation
Raw material evaluation
Feed technology
Defining nutrient requirements
MAJOR NUTRITIONAL ADVANCES
Feed additives

Feed Formulation is the means by which we apply our nutritional and technical knowledge in practice

Klyen, 2019

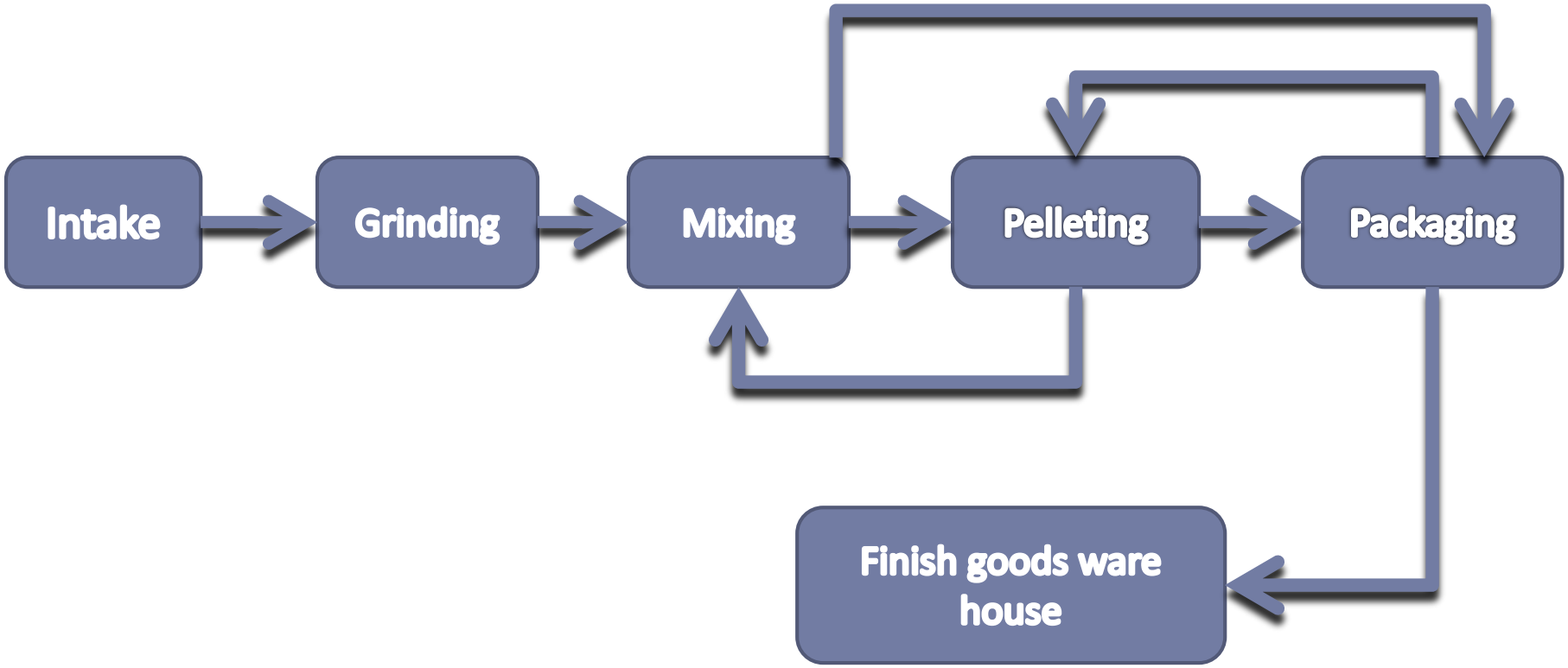
Feed Formulation

- “Advances in feed formulation necessarily follow advances in nutrition” (Pesti and Alhotan, 2014)
- The opposite is probably more accurate:
  - we can now formulate complexity simply and quickly
  - allows us to look at nutritional problem differently
- In many ways – formulation has driven nutrition

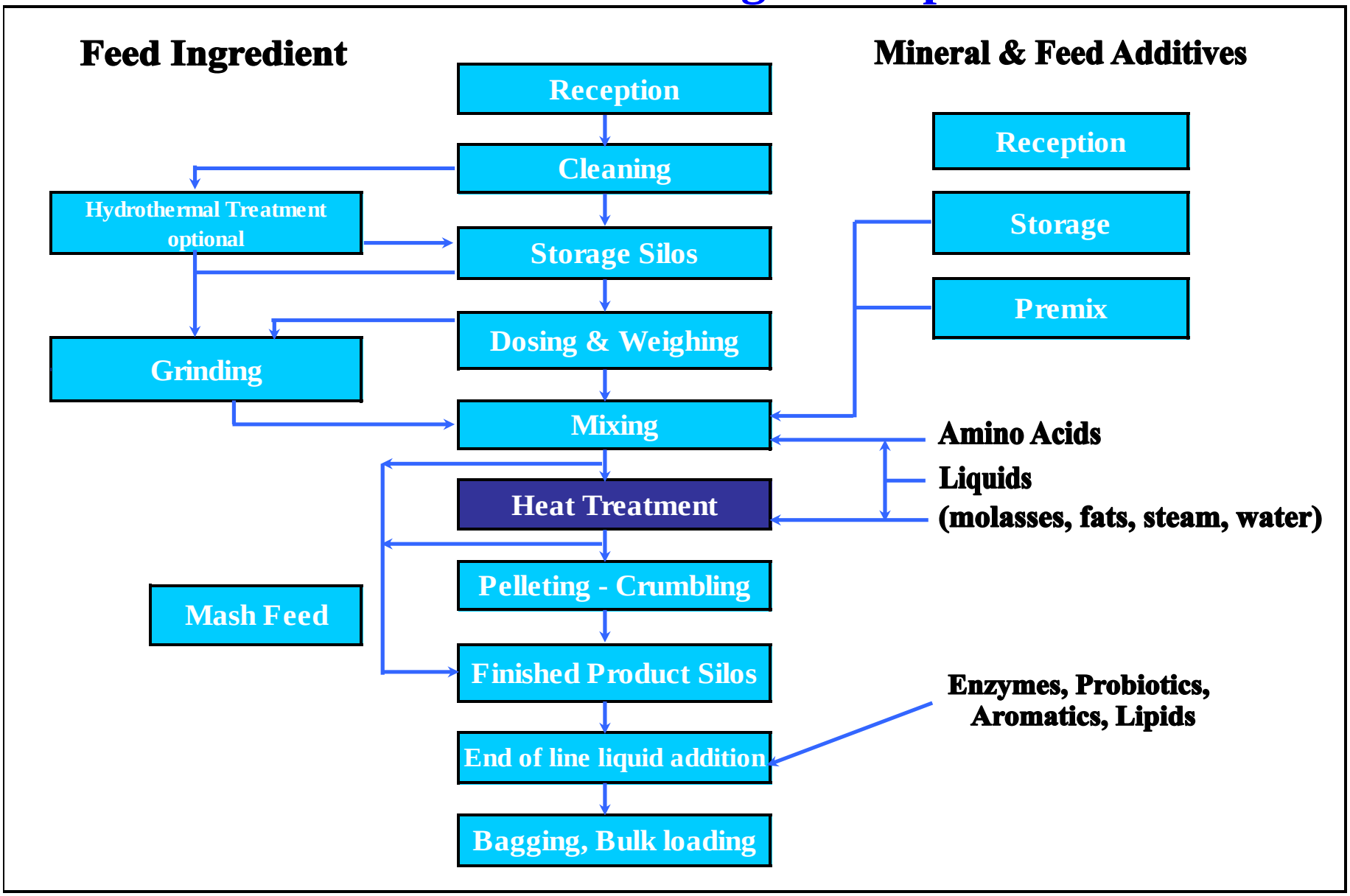
Feed Formulation

- The nutritionist needs to provide:
  - a formulation that is nutritionally adequate
  - that is easy / possible to manufacture
  - with the correct physical characteristics
  - at a nutrient density and price that is profitable

Feed Manufacturing Flow



Process for manufacturing of compound feed



Feed Processing Technology

- Grinding and particle size
- Mash, crumbled or pelleted diets for broilers
- Pelleting and pelleting conditions
- Mash feeds for laying hens and laying duck
- Pelleted feed for swine and ruminantia
- Crumble feed for quail

Grinding

- Grinding is necessary to make good pellets
- Separately or mixed grinding of feed ingredients
- Equipment: hammer mill or roller mill

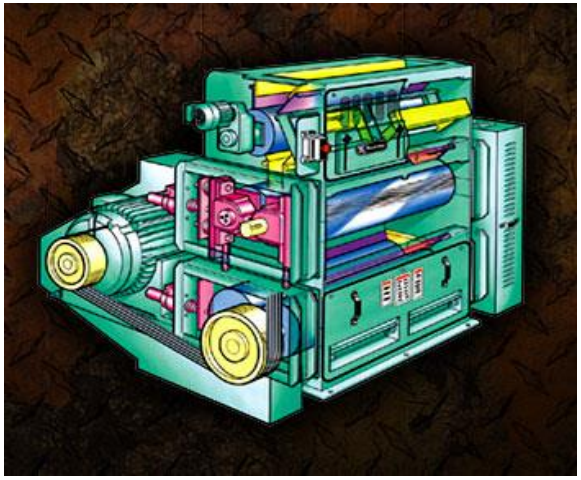
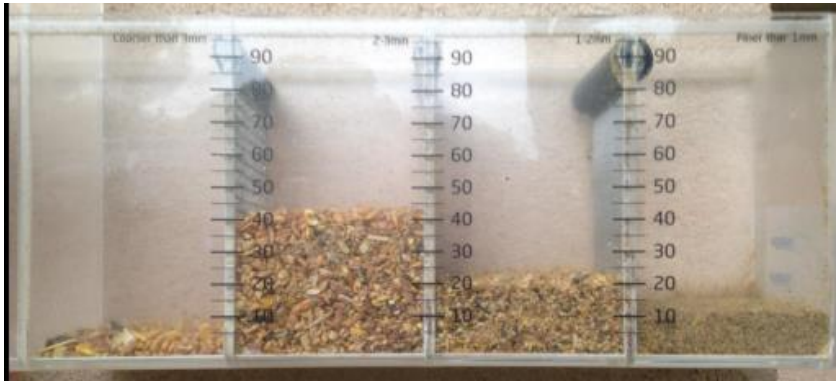


Illustration courtesy California Pellet Mill and Roskamp Champion

Coarse Grinding

- ↑ GIT and gizzard development
  - ↑ peristaltism and digesta refluxes
  - ↓ adherence of the microorganism to the digestive mucosa
- ↑ HCl and endogenous enzyme activity
  - ↑ pepsinogen activation
  - ↑ solubility of the mineral source
  - ↑ phytase activity
- Modify bacteria growth and profile

Coarse Grinding



Hen production, 17-49 wk of age[1]

Particle size of the cereal[2,3]

Screen (mm)	Egg rate (%)	ADFI (g)	Egg mass (g/d)	FCR (g/g)
4	91.7	112.6	56.5	1.99
6	93.0	112.7	57.7	1.95
8	93.0	112.9	57.5	1.96
10	92.9	112.9	58.0	1.95
12	93.1	113.2	58.0	1.95

[1] Average of barley and corn diets

[2] Hammer mill

[3] 5 SEM=10. 10 birds/treatment

[4] $P < 0.05$: 4 mm vs. others

Herrera et al., 2018

Effect particle size cereals in mash diets

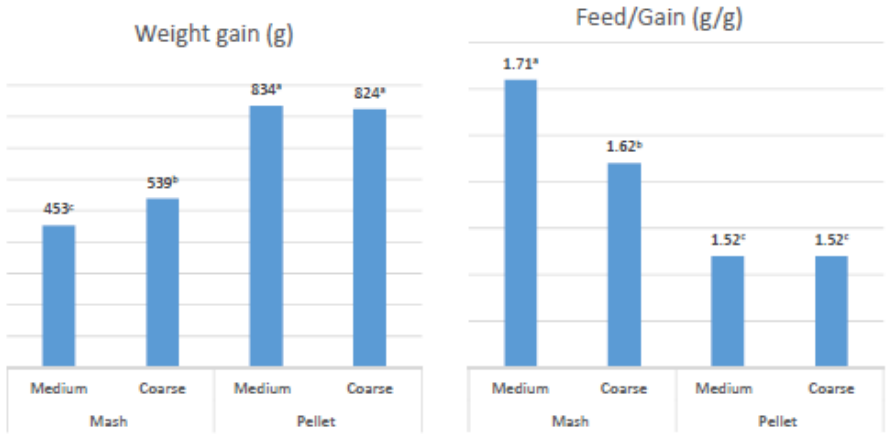
Grain	GMD (mm)	GSD	Feed/gain g/g	Reference
Maize	0.814		1.43[a]	Reece *et al.* (1985)
	1.343	-	1.40[b]	
Maize	0.947		1.49[b]	Douglas *et al.* (1992)
	1.470	-	1.55[a]	
Maize	0.897	1.41	1.51[a]	Nir *et al.* (1994)
	2.010	1.00	1.38[b]	
Wheat	0.839	1.69	1.72[a]	Amerah *et al.* (2007)
	1.164	1.54	1.63[b]	

Coarsely grinding of cereals is preferred, but there is an optimum

Particle size effects in pelleted diets

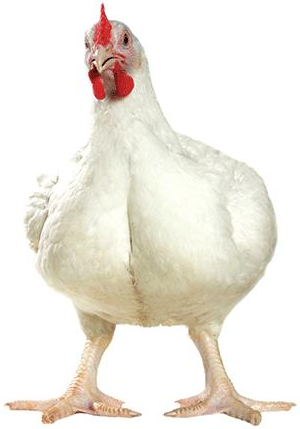
Grain	Av. particle size (mm)	Feed/gain g/g	Reference
Maize	0.68	1.93[a]	Reece *et al.* (1986)
	1.29	1.93[a]	
Wheat	0.60	1.57[a]	Svihus *et al.* (2004)
	1.70	1.58[a]	
Wheat	0.30	1.28[a]	Peron *et al.* (2005)
	0.96	1.25[a]	
Wheat	0.28	1.528[a]	Amerah *et al.* (2008)
	0.89	1.467[b]	
Maize	0.30	1.448[a]	Amerah *et al.* (2008)
	0.53	1.360[b]	

Effect of grinding and pelleting on performance, day 1 - 21

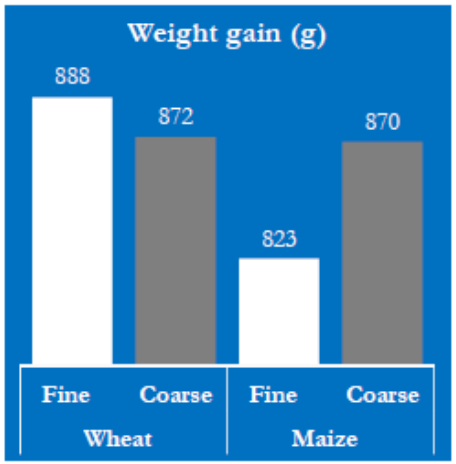


P-Interaction Feed form x Particle size: < 0.05

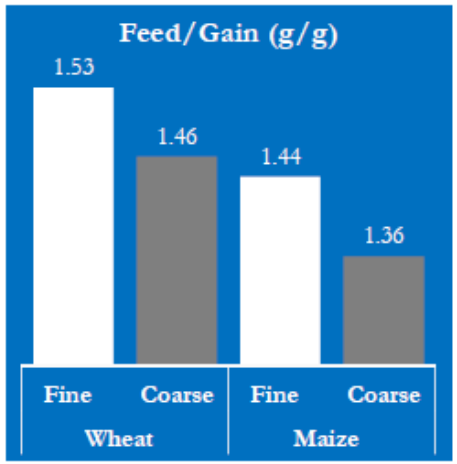
Amerah et al. (2007). Poultry Science. 86: 2615-2623



Effect of grinding and grain type in pelleted diets on performance, day 1 - 21



Grain type x particle size, P=0.07



Grain type, P<0.05
Particle size, P<0.05

Amerah et al. (2008). Poultry Science. 87: 2320-2328

Why Do We Mix Feed ?

- To produce a nutritrious feed, in each and every bite
- To uniformly distribute nutrients throughout the feed
  - macro nutrients
  - minor nutrients
  - micro nutrients
  - nutritional additives
  - Liquids

Image courtesy H.C. Davis Sons Manufacturing Co., Inc.

Mixer Types

- What are you mixing ?
  - the mixing characteristics of ruminant TMR's are different than broiler finisher diet
- How much do you want to spend ?
  - a twin shaft, double paddle mixer is 2.5 – 3.0 x of a single shaft, double ribbon.
- Have you modeled your batching process ?
  - putting in a twin shaft, double paddle mixer (mix time of 30 secs) may not be justified if your batching sequence is 6 minutes.

Pelleting

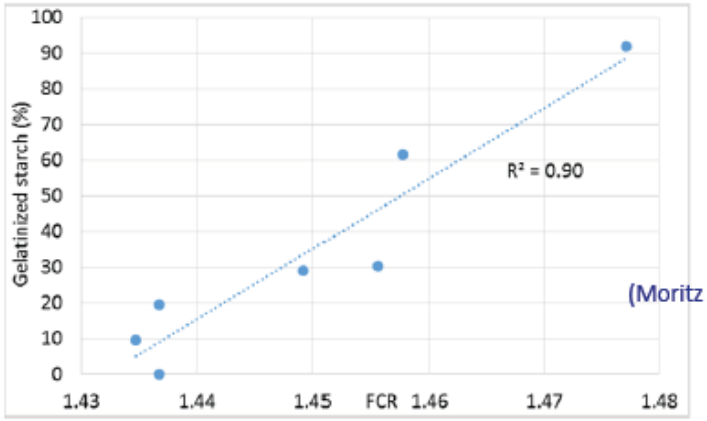
- Improves feed intake, ADG and FCR
- Effect pelleting is partly based on gelatinization of starch and coagulation of protein (Thomas, 1998)
- Gelatinization of starch depends on temperature, water, shear, time, particle size and ingredients
- Reduces bacterial load in feed
- But, birds do not appreciate:
  - Gelatinized starch (Moritz, 2005)
  - Viscous diets (van der Klis, 1993; Bedford, 1996)
  - Rapidly degradable starch (Weurding, 2002)
  - Poorly digestible protein (Smulders, 1999; De Lange, 2003)

Effect of processing corn on animal performance

Treatment	BWG (g)		FCR		Rel. FCR
Unprocessed	579	c	1.437	a	100.0
Pelleted 1/3	624	a	1.435	a	99.9
Pelleted 2/3	613	ab	1.437	a	100.0
Pelleted 3/3	585	bc	1.449	a	100.9
Extruded 1/3	618	a	1.456	ab	101.3
Extruded 2/3	620	a	1.458	ab	101.5
Extruded 3/3	621	a	1.477	b	102.8

Gelatinization degree starch: (Moritz *et al.*, 2005)
Unprocessed: 0%; Pelleted: 29%; Extruded: 92%

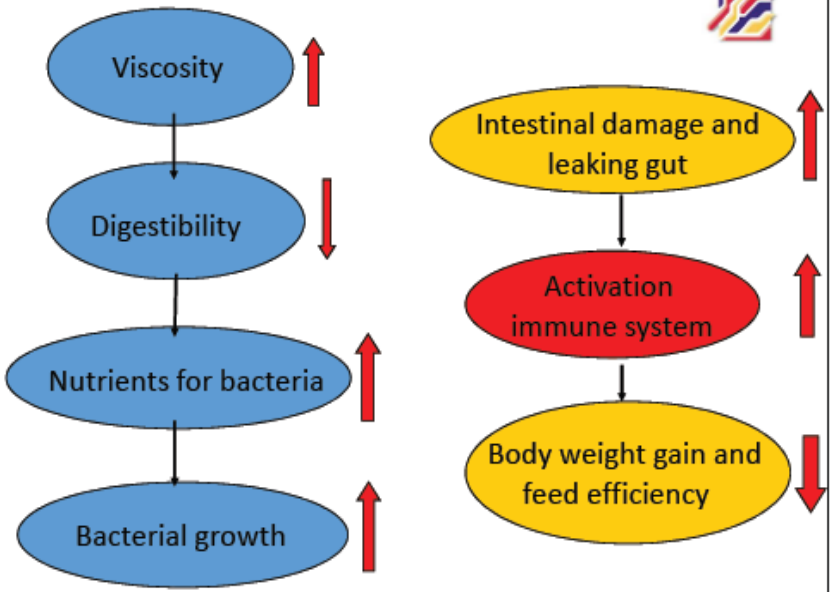
Effect of starch gelatinization on FCR



(Moritz *et al.*, 2005)

More gelatinized starch results in higher FCR. Why?

Viscosity and feed efficiency



Feed Additives

A low-inclusion product used in diet formulations for purposes of improving the nutritional quality of feed or the performance and health of animals

EC Regulation 1831/2003

Feed additives are defined as substances, micro-organisms or preparations, other than feed material and pre-mixtures which are intentionally added to feed or water to favourably influence *inter alia* the

(i) Characteristics of feed or animal products

(ii) Environmental consequences of animal production

(iii) Performance, health or welfare through their influence on gut microflora profile or feed digestibility, or

(iv) To have a coccidiostatic or histomonostatic effect.

Feed Additives

Regulation (EC) No 1831/2003

- Sensory additives
- Technological additives
- Nutritional additives
- Zootechnical additives
- Coccidiostat and Histomonostat
- Potensial new cathegories – welfare addivites, product quality additives

Sensory Additives

- Definition: any substance, the addition of which to feed improves or changes the organoleptic properties of the feed, or the visual characteristics of the food derived from animals
- Colour / pigment: canthaxantin, oro glo, etc
- Flavour: honey vanilla flavour, etc

Technological Additives

- Definition: any substance added to feed for a technological purpose
- Preservatives, antioxidants, emulsifiers, acidity regulators, silage additives

Nutritional Additives

- Vitamins
- Amino acids
- Trace Elements

Zootechnical Additives

- Definition: any additive used to affect favourably the performance of animals in good health or used to affect favourably the environment.
- Excludes additives that favourably affect the characteristics of animal products or animal welfare, unless the welfare benefit (e.g. reduced morbidity) also translates into an economic benefit for the user.
- Digestibility enhancer, gut flora stabilizer, substances which favourably affect the environment, other zootechnical additives
- E.g: enzymes, prebiotics, some organic acids

Coccidiostat

- Definition: an antiprotozoal agent that acts upon Coccidia parasites
  - Ionophores coccidiostat

    e.g: monensin, narasin, salinomycin, etc
  - Chemical coccidiostat

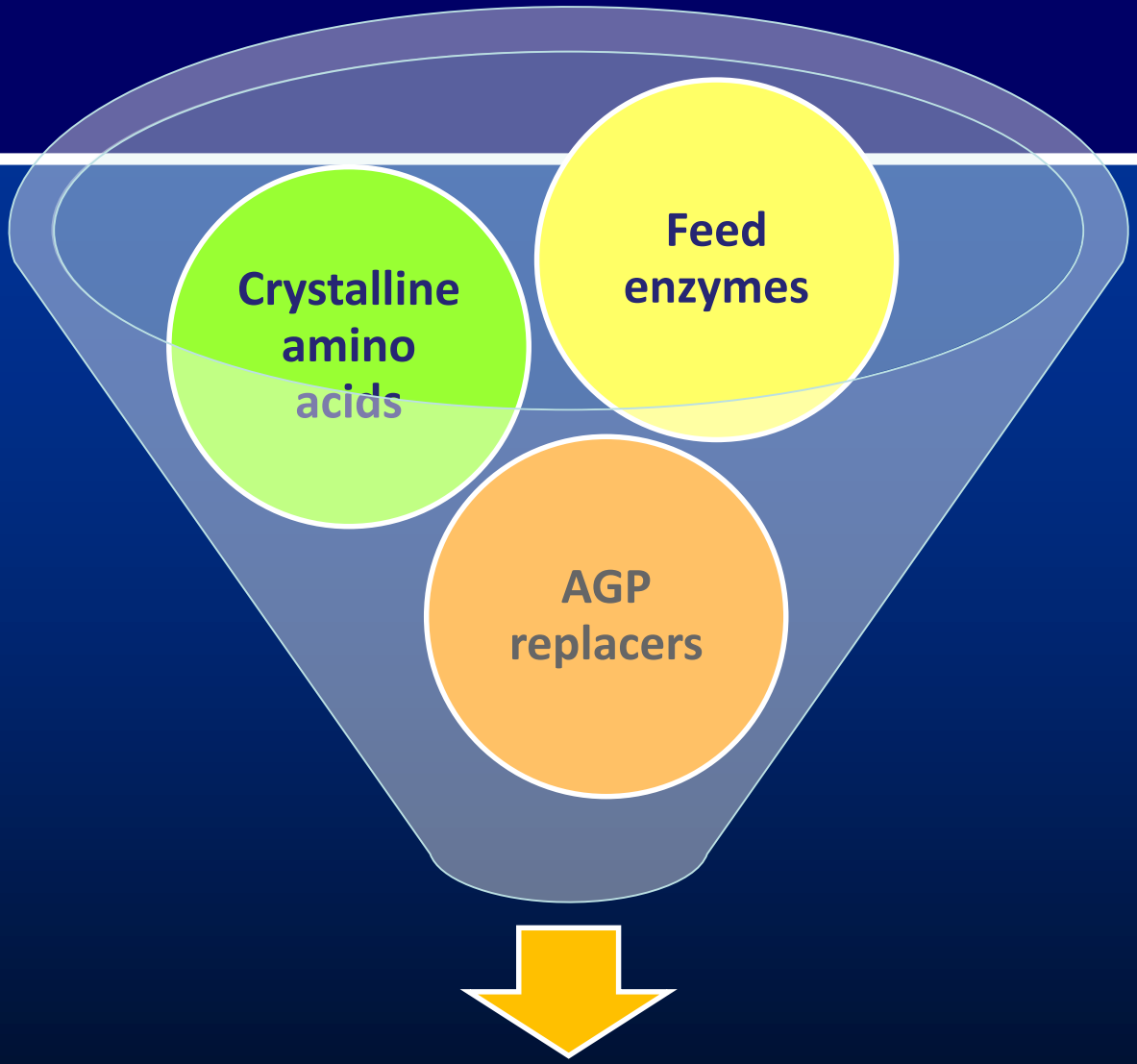
    e.g: diclazuril, decoquinate, nicarbazine, etc

Welfare Additives

- Definition: any additive used to favourably affect the welfare of animals.
  - Metabolic regulators: substances which act within the animal to correct undesired consequences of nutritional origin.
  - Immuno-modulators: agents or substances which influence the immune function to the benefit of the host animal.
  - Detoxifiers: agents or substances which degrade or otherwise reduce the toxicity of contaminants ingested with feedstuffs.
  - Other welfare additives

Product Quality Additives

- Definition: any additive used to favourably affect the sensory (other than visual appearance), nutritional or hygienic properties of products of animal origin.
  - Microbial contamination controllers: additives intended to reduce the numbers of zoonotic pathogens in animal food products;
  - Radionuclide contamination controllers: substances that suppress absorption of radionuclides or promote their excretion;
  - Nutritional value enhancers: additives intended to improve nutritional characteristics of the animal products;
  - Sensory additives: additives intended to improve the sensory characteristics and acceptance of animals or animal products;
  - Other product quality additives.



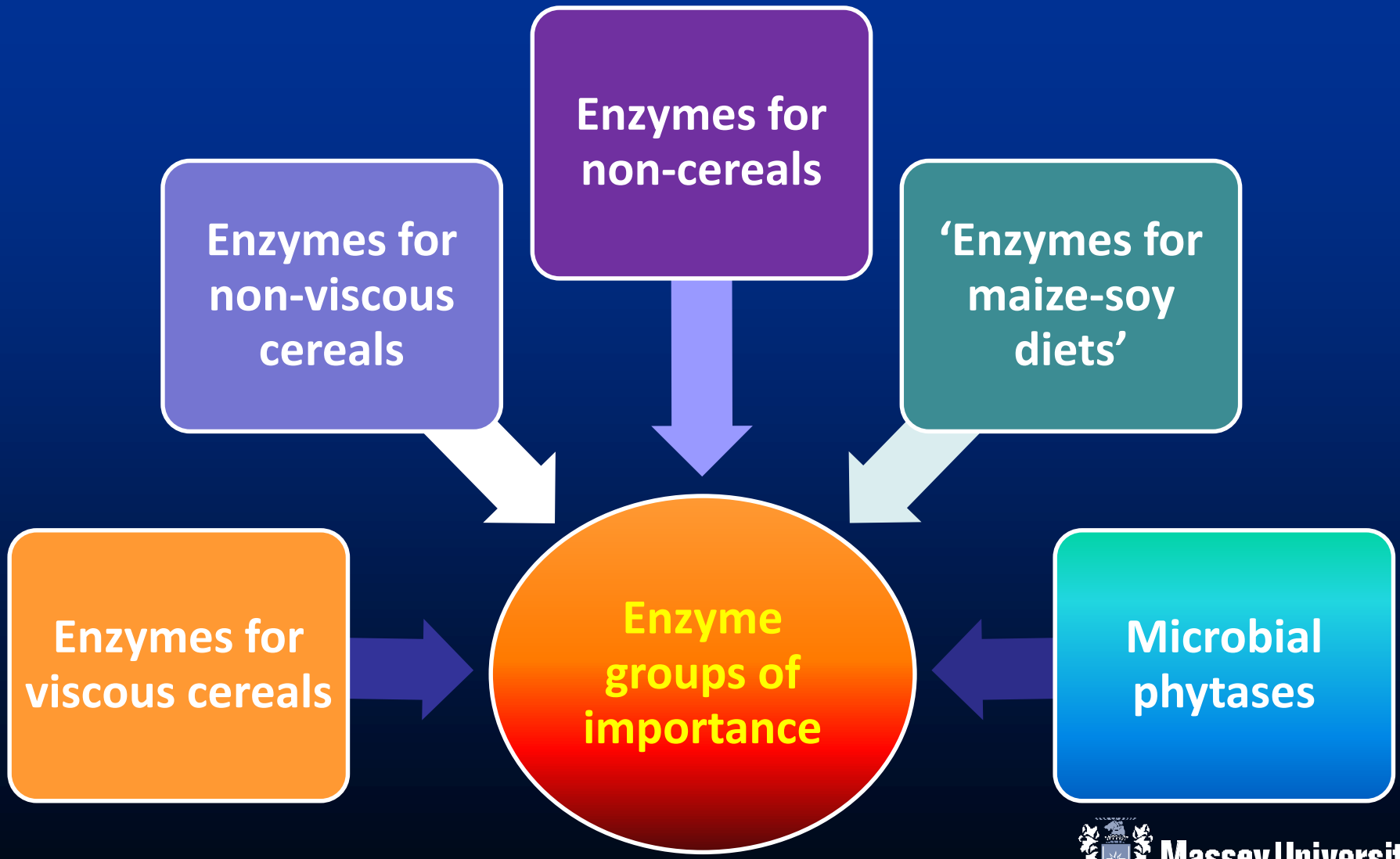
Additives of interest

Enzymes

Why the increased interest and acceptance?

- The enzyme always works
- Environment
- Industries want to be seen as ‘pro-active’
- Inclusion not restricted to specific ingredients
- Ban in the use of animal protein meals
- Soaring inorganic P prices
- Poor quality of locally available inorganic P sources
- Declining phytase inclusion costs
- Recognition of ‘extra-phosphoric’ effects of phytate

MAJOR GROUPS OF ENZYMES



Commercial Feed Enzymes and Substrates

Enzyme	*Action*	*Target*
Amylases	Degrade cereal starch to dextrins and sugars	High starch cereal diets
ß-glucanases	Degrades ß-glucans to oligosaccharides and glucose	Barley, oats and rye
Cellulases	Cellulose to low molecular weight products and glucose	High fiber ingredients containing high proportion of cellulose
Xylanases (pentosans)	Arinoxylans to low molecular weight products and sugars	Rye, barley and wheat
α-galactosidase	Degrades oligosaccharides	Soybean meal and other legumes
Phytases	Increases availability of P from phytic acid	Various vegetable sources
Proteases	Protein to peptides and amino acids	Proteins
Lipases	Fats to fatty acids	Animal and vegetable fats

Crystalline Amino Acids

- 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
- (Also other effects of supplemental amino acids)

Crystalline Amino Acids

- Commonly available amino acids:
  - methionine, lysine, threonine, trypthopan
- Recent addition / future:
  - valine, isoleucine, arginine
- Non essensial amino acids:
  - glycine, serine, glutamic acid, glutamine

Alternative to In-Feed Antibiotic

- Alternatives have been shown to
  - ‘mimic’ the working effects of antibiotics on gut flora
  - improve digestive function
  - enhance immune responses
- But effects on animal performance are variable
- Also more costly than conventional AGP programmes

Alternative to In-Feed Antibiotic

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

Numerous studies and exhaustive reviews are accumulating. None are currently standard inclusion in poultry diets, except enzymes.

General Aspects of Formulation

- **Keep it simple:**
  - additional constraints add cost (nutrients, ratios, bounds)
  - difficult to solve
  - difficult to check
  - data for obscure ingredients / nutrients often limited

General Aspects of Formulation

- **Regular revision:**
  - Ingredient costs and quality
  - Performa vs specification
  - Analytical results of retention samples
  - Pellet quality and through put

General Aspects of Formulation

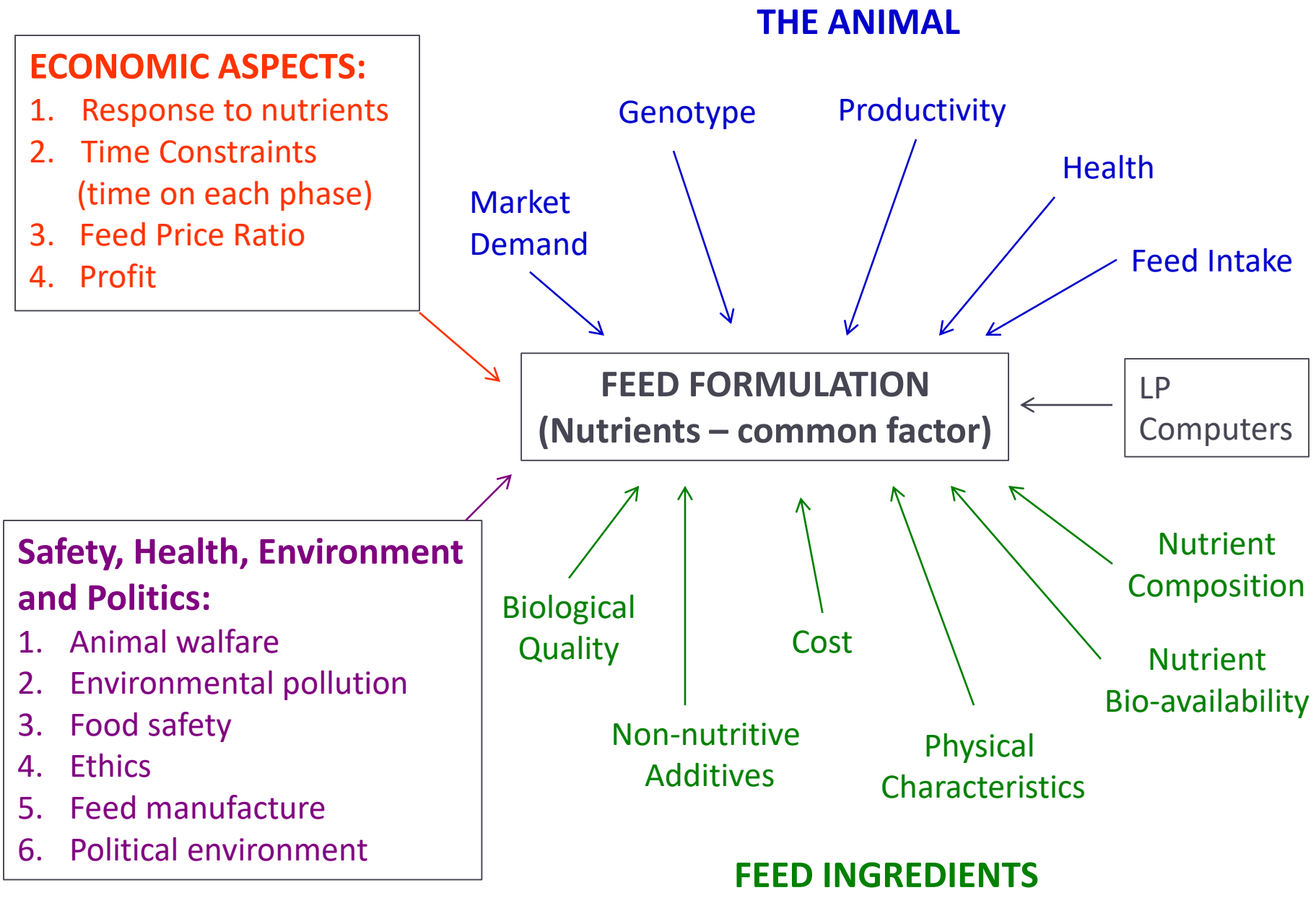
- **Check all formulation:**
  - Compare the current costs with previous
  - Normal nutrient tolerances
  - No harmful ingredients
  - Premix and medication correct ?

General Aspects of Formulation

- **Obtain new perspective:**
  - Easy to get in a rut
  - Secrecy can prevent meaningful exchange
  - Interaction / new ideas are essensial
  - New technologies come along all the time (L Valine)

Check the Additives

- Antibiotics
  - growth promoters
  - therapeutic
- Coccidiostats
  - ionophores
  - chemicals
- Enzymes
- The dosage – Hand Add


THE ANIMAL
ECONOMIC ASPECTS:
1. Response to nutrients
2. Time Constraints
(time on each phase)
3. Feed Price Ratio
4. Profit
Genotype
Productivity
Health
Market Demand
Feed Intake
FEED FORMULATION
(Nutrients – common factor)
LP Computers
Safety, Health, Environment and Politics:
1. Animal walfare
2. Environmental pollution
3. Food safety
4. Ethics
5. Feed manufacture
6. Political environment
Biological Quality
Non-nutritive Additives
Cost
Physical Characteristics
Nutrient Composition
Nutrient Bio-availability
FEED INGREDIENTS

Lesson Summary

- Formulation only provides the ‘seed’
- Require excellent ingredients
- Well controlled production processes
- Good formulation – no guarantee of a perfect product
- Bad formulation ensure non - conformance

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