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Extracting full value of Australian barley (and other grains) for pigs in Vietnam

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Government of Western Australia
Department of Primary Industries and Regional Development

GRDC Grains Research & Development Corporation

AEGIC is an initiative of the Western Australian State Government and Australia's Grains Research and Development Corporation

Key messages

- Pig production is competitive and cost sensitive
- Feed is the single biggest cost - need to be flexible regarding ingredients
- Pigs are adaptable omnivores that can meet their nutrient requirements from a broad range of feedstuffs
- Corn and soy are not essential ingredients for diets
- Australian pigs use mainly barley, wheat, legumes and canola meal with excellent results
- Australia will produce 12mmt of barley in 2020/21
- Australian barley is accessible and attractively priced

Australian Export Grains Innovation Centre (AEGIC)

Independent, not-for-profit company

Funded by the Australian government and Australian grain growers

Established in 2012 to increase value in the Australian grains industry

Facilities include research laboratories, a pilot mill and a pilot bakery

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In this presentation

- Feeding pigs
- Comparing common feed ingredients
- Features of Australian barley
- Raw feed materials: the science
- Factors effecting feed grain processing
- Selecting the preferred feed grain for pigs

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Feeding pigs

- Need to be flexible
- Pigs are remarkably adaptable to a broad range of feedstuffs
- Requires accurate description of nutrient content
- Requires understanding of compatibility with other materials and any peculiar aspects that may limit pig performance if not addressed

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Comparing common feed ingredients

Feed ingredients used in stockfeed manufacturing in Australia

Cereals	Legumes	Animal protein	Vegetable protein	Milling offal	Synthetic amino acids	Food industry by-products	Sundry
Wheat *	Lupins *	Meat meal *	Soybean meal *	Millmix *	Lysine *	Whey *	Minerals *
Barley *	Peas *	Blood meal *	Full fat soya *	Rice pollard *	Methionine *	Brewers yeast	Vitamins *
Oats *	Faba bean	Fishmeal *	Cottonseed meal *	Oat offals	Threonine *	Bread	Tallow *
Sorghum *	Chickpeas	Poultry meal	Canola meal *	Pea offals	Tryptophan *	Biscuits	Vegetable oil *
Triticale	Mung bean	Milk powder	Sunflower meal	Hominy	Isoleucine *	Cereals	Chicken oil
Corn	Lentils	Yeast	Peanut meal		Valine *	Confection waste	Lucerne
Rye	Vetch	Feather meal	Safflower meal		Arginine	Pet food waste	Molasses
Rice		Plasma	Copra			Distillers grain	Cassava

* Major use materials

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Cereal grains

Comparing common feed ingredients

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Protein meals

Comparing common feed ingredients

ANIMAL

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Comparative typical proximate analyses of grains

Specification		Corn	Wheat	Barley	Sorghum
Moisture (%)		13	12	12	13
Protein (%)		8	11	11	9.5
Fat (%)		4	2.3	2.6	3.5
Ash (%)		1.15	1.7	2.2	2.0
Fibre	Crude (%)	2	2	4.8	2.3
	NDF[1] (%)	9	8.5	16.0	8.0
	ADF[2] (%)	2.2	2.5	5.5	2.5
Starch + Sugar		64.6	63	53.9	63
DE[3] MJ/kg (Kcal/kg)		14.5 (3465)	14.0 (3345)	13.0 (3105)	14.25 (3404)
ME[4] MJ/kg (Kcal/kg)		14.0 (3345)	13.6 (3246)	12.6 (3005)	13.9 (3324)
NE[5] MJ/kg (Kcal/kg)		11.18 (2670)	10.61 (2535)	9.66 (2310)	10.97 (2620)

Source: Premier Atlas (2008)

Note: Typical values only - composition can vary widely with different agronomic conditions

NDF[1] = Neutral detergent fibre ADF[2] = Acid detergent fibre DE[3] = Digestible energy

ME[4] = Metabolizable energy NE[5] = Net energy

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Grain SID* Amino acid, Calcium, Phosphorus and Phytate content at typical protein levels

	Corn	Barley	Wheat	Sorghum
PROTEIN (%)	**7.6**	**10.5**	**11.7**	**9.2**
SID Lys	0.18	0.29	0.27	0.15
SID Met	0.14	0.14	0.16	0.13
SID M+C	0.28	0.33	0.40	0.25
SID Thr	0.22	0.28	0.28	0.23
SID Iso	0.22	0.30	0.35	0.28
SID Try	0.05	0.11	0.13	0.09
SID Arg	0.32	0.45	0.52	0.27
SID His	0.19	0.19	0.24	0.15
SID Leu	0.81	0.59	0.69	0.96
SID Val	0.31	0.41	0.44	0.34
SID Phe	0.32	0.43	0.48	0.38
Calcium (%)	0.01	0.05	0.04	0.01
Phosphorus (%)	0.22	0.28	0.26	0.24
Phytate P (%)	0.17	0.16	0.17	0.17

*SID = Standardised ideal digestibility

Source: Evonik AminoDat 5.0

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Variability in faecal digestible energy as detected by AUSSCAN

Grain	Pig Faecal DE MJ/kg		
	Minimum	Median	Maximum
Wheat	12.75	13.89	15.11
Barley	10.80	12.91	14.71
Sorghum	14.08	14.56	15.23

Source: Australian Pork CRC – AUSSCAN calibration (2012)

Raw material variation monitoring

Parameter analysed	Value
Ileal & faecal DE	Site of digestion and yield data allow to define NE-values
Faecal DE intake index	Estimate energy intake (palatability, throughput, density)
Major nutrients	Protein, moisture, fibre, fat, starch, ash
Fibre components	Crude, ADF, NDF
NSP* characterisation	Soluble & Insoluble content, NSP type - arabinoxylan, ß-glucan
Hydration capacity	Pelleting effect, gelatinisation properties and enzyme access

*NSP = Non-Starch Polysaccharides

AusScan

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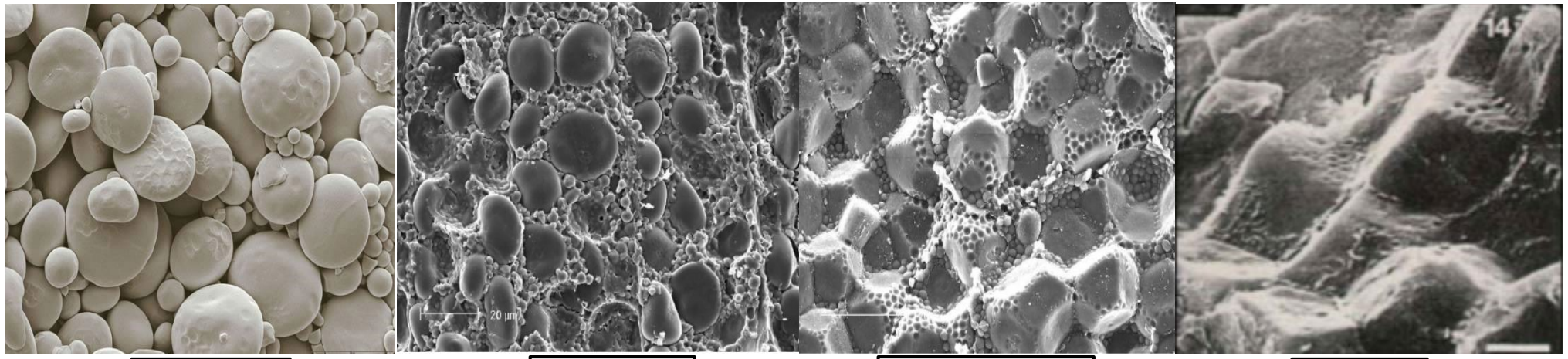
Structure of grain starch

- Starch stored in different ways in grains
- Impact availability of starch for digestion
- Complex structures → less available starch
  - Processing can increase availability



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Features of Australian barley

- Temperate winter crop (harvest October – December)
- Mainly 2–Row varieties, spring type – malting characteristics
- Medium grain size, white with hull
- Low mycotoxin contamination – harvested and stored dry
  - High quality storage facilities and management
- No yellow pigments
- Viscous: contains soluble NSP's = β-glucans + Arabinoxylans
  - But easily managed with supplementary enzymes

Features of Australian barley con't

- Lower in energy than corn, wheat or sorghum due to higher fibre content and lower starch
  - Fibre content considered an asset in regard to gut health
- Protein typically higher than corn but similar or lower than wheat and of higher biological value
- Used extensively in pig diets as a safe and reliable feed component
- Robust and reliable grading system for grain trading

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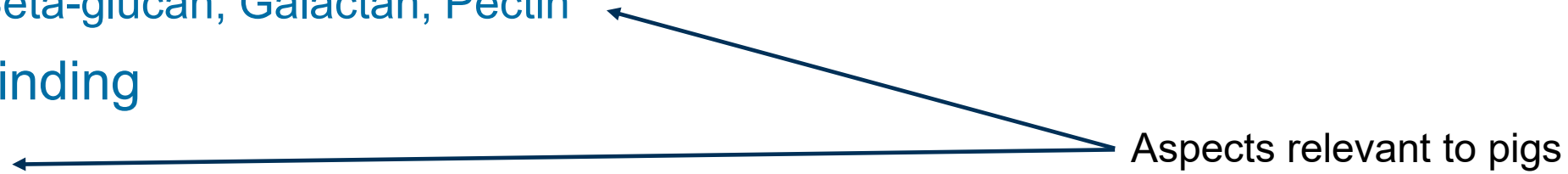
Raw feed materials: the science

Anti-nutritional factors (ANF)

- Compounds limiting the availability of nutrients for digestion
- Structural ANF's
  - Non-Starch Polysaccharides (NSP) – soluble & insoluble
  - Xylan, Beta-glucan, Galactan, Pectin
- Mineral binding
  - Phytate
  - Oxalates
- Reduce protein digestion and utilisation
  - Protease inhibitors
  - Tannins
- Know how to overcome these challenges



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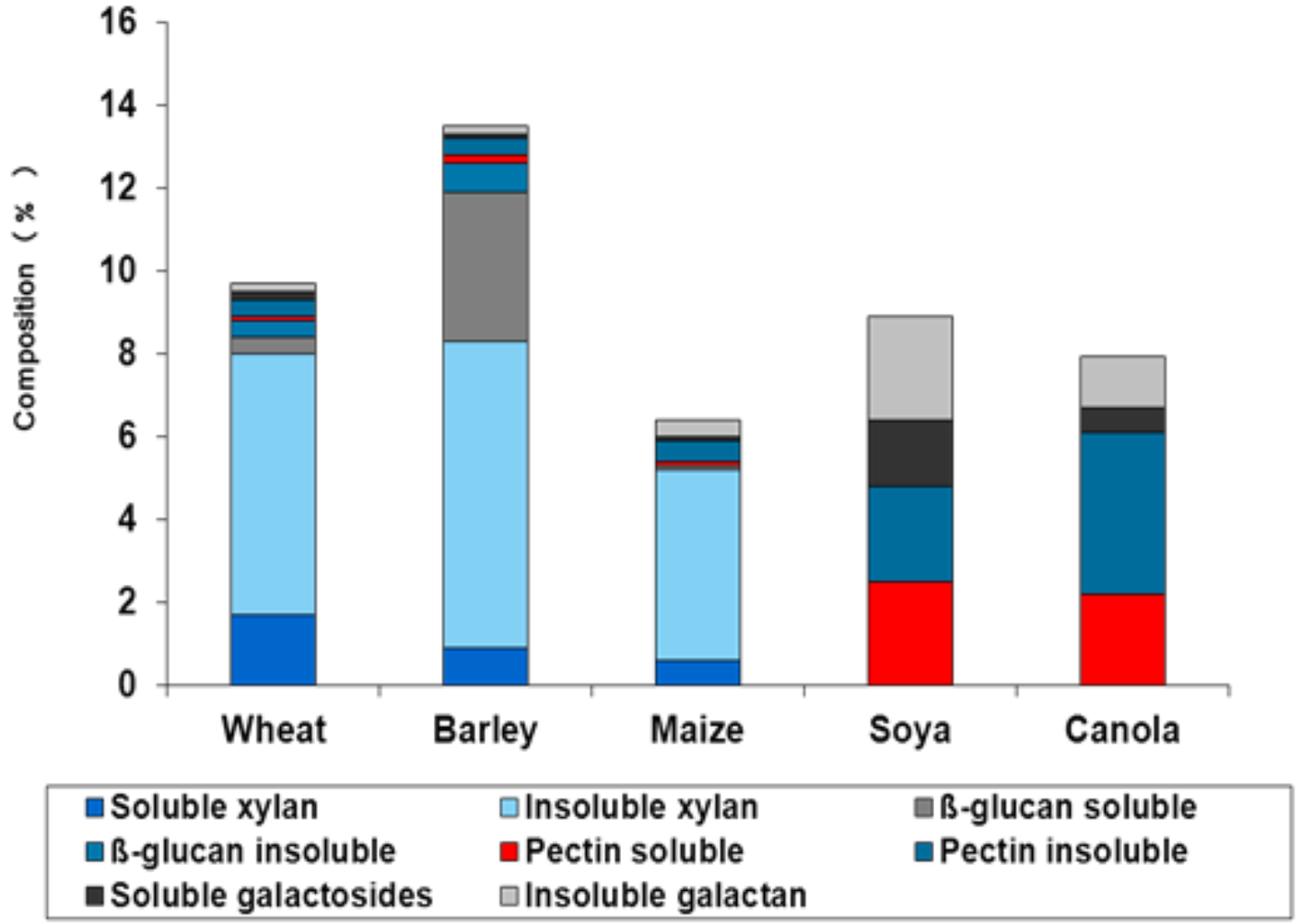
NSP profile of raw materials



Source: Bach Knudsen KE., 1997; Choct. M.,1997

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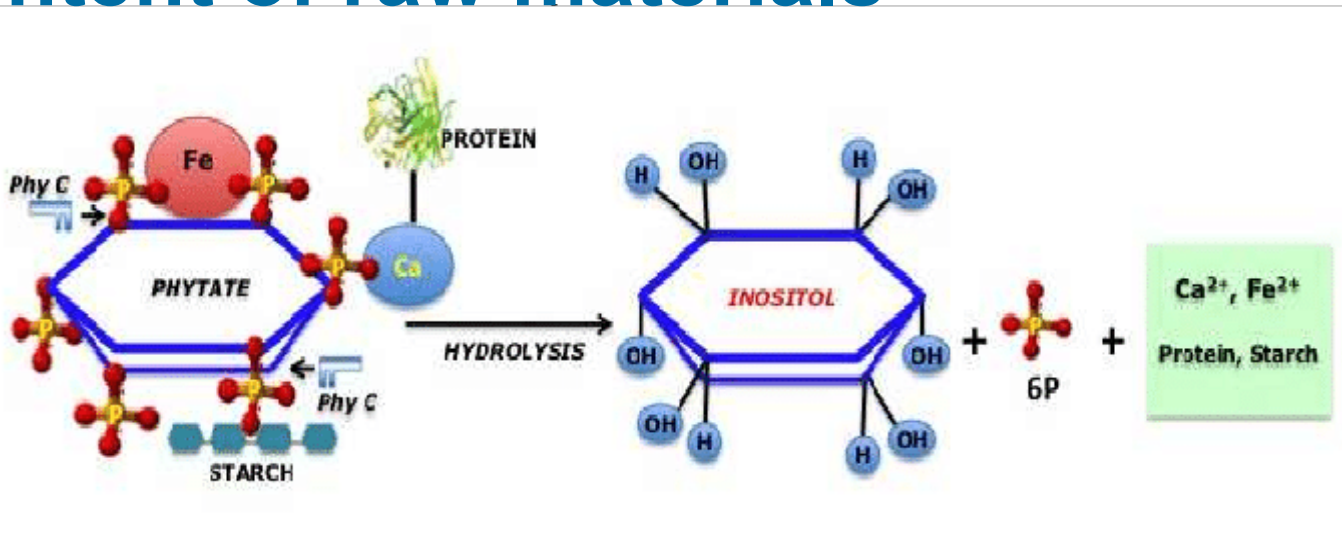
Phytate content of raw materials



Raw material	Total P (g/kg)	Phytate (g/kg)	Phytate-P (g/kg)	Phytate-P / Total P (%)
Barley	3.2	7.0	1.9	61
Corn	2.6	6.7	1.9	72
Wheat	3.1	7.8	2.2	72
Sorghum	3.0	7.7	2.2	73
Soybean meal	6.5	13.8	3.9	60
Canola meal	9.7	22.9	6.5	66

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Managing anti-nutritional factors

Exogenous enzymes

- NSPases: ß-Glucanase, Xylanase
  - Structural NSP's limit endogenous enzymes access to nutrients → animal produce limited quantity
  - Various commercially available products able to address specific NSP challenges
- Phytase
  - Cleaves Phytate-P – increase P availability
- Protease

Heat treatment

- Reduce activity of deleterious compounds:
  - Trysin inhibitor = Soybean meal

Typical formulation limits on grains

Maximum % inclusions

Diet	Wheat	Barley	Sorghum	Corn
Starter	100	10	-	50
Weaner	100	20	15	100
Grower	100	100	60	100
Finisher	100	100	70	100
Lactating sow	45	60	40	100
Dry sow	45	100	60	100

Factors effecting feed grain processing

Raw material processing

- The digestibility of feed components are directly related to particle size
- Optimum particle size of grain is determined by

- **Type**
- **Production stage**
- **Other processes involved**
- **Incidence/risk of GIT disturbances**
- **Milling cost relative to benefits**
- **Affect palatability and feed intake**
- **Physical handling (especially fat)**
- **Levels of respireable dust**

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Grain particle size

- Variability in particle size may be equally as important as average particle size
- Effect of sieving and regrinding large particle grains
  - Barley hammer milled through 4mm screen - mash/pellet

Effect of particle size & diet form on performance of grower pigs

Treatment	ADFI[1] (kg)	ADG[2] (g)	FCR[3]
Barley, ground, mash	1.621	801	2.038
Barley, ground, pelleted	1.660	841	1.959
Barley, reground*, mash	1.597	855	1.880
Barley, reground*, pelleted	1.617	852	1.900

*Particles larger than 1700µ were screened out and reground through a 3.2mm screen and added back

ADFI[1] = Average daily feed intake
ADG[2] =Average daily gain
FCR[3] = Feed conversion ratio

Source: Gidley et al., 2010

Grain particle size

- Australian Pork CRC* – commercial study
- >3000 grower-finisher pigs
- Diet = wheat + barley + pea + canola
- Diets ground (disk mill) and pelleted
- Treatments = average particle size of diet
  - 600 or 1200 µm

Description		Fine	Medium	Coarse	P-value	SEM
Grower pigs	ADG g/d	810	836	839	0.228	7.58
	ADFI kg/d	1.71	1.77	1.81	0.116	0.02
	Feed:gain	2.09	2.11	2.15	0.154	0.012
Finisher pigs	ADG g/d	961	951	960	0.709	5.38
	ADFI kg/d	2.41[a]	2.52[b]	2.56[b]	0.011	0.021
	Feed:gain	2.51[a]	2.64	2.60[b]	0.001	0.019
Mortality 1.5%; N > 3400 pigs						

Source: A.C. Edwards., 2014

Results

Finer grind improved FCR:

- **3.1 % in Grower phase (30 – 60 kg)**
- **5.6 % in Finisher phase (60 – 100 kg)**

*CRC = Cooperative Research Centre

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Selecting the preferred feed grain for pigs

Comparison of pig grower diets: Australia (%)

RM cost (USD/t)	Raw material (RM)	Barley base	Wheat base	Sorghum base	Combination
160	Barley	56.4	-	-	32.5
210	Wheat	-	61.88	-	15.0
215	Sorghum	-	-	59.8	10
245	Peas	20	20	20	20
280	Canola solv. 37	15	11.6	15	15
525	Meat meal	2	3.6	2	2
910	Canola oil	4	0.9	0.5	2.8
	Macro minerals	+	+	+	+
	Amino acids	+	+	+	+
3500	Grow Premix*	+	+	+	+
DE MJ/kg		14.1	14.1	14.1	14.1
SID Lys%		0.99	0.99	0.99	0.99
RM Cost/t (USD)		249.43	256.35	256.84	252.75

* Includes Phytase, NSP - enzymes

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Comparison of pig grower diets: Vietnam (%)

RM cost (USD/t)	Raw material	Std Base	+ Wheat	+ Barley	+ Sorghum	Combination
257	Maize	40.08	13.8	19.3	-	-
270	Wheat	-	20.0	-	-	-
250	Barley	-	-	22.8	-	23.0
260	Sorghum	-	-	-	32.0	19.3
157	Cassava	10.0	5.0	5.0	5.0	5.0
266	Wheat Bran	3.6	9.0	-	10.0	-
247	Rice Bran - FF	1.2	10.0	10.0	10.0	10.0
196	Rice Bran - EXT	5.0	5.0	5.0	5.0	5.0
262	DDGS	15.0	15.0	15.0	15.0	15.0
485	Soybean meal	15.0	13.3	13.4	13.7	13.1
177	Palm Kernel Meal	5.0	5.0	5.0	5.0	5.0
434	Meat Meal	2.5	1.5	2.2	1.7	2.4
	Macro Minerals	1.75	1.1	1.45	1.7	1.35
	Amino Acids	0.73	0.69	0.72	0.69	0.7
3500	Grow Premix*	0.15	0.15	0.15	0.15	0.15
	DE MJ/kg	14.1	14.1	14.1	14.1	14.1
	SID Lys%	0.99	0.99	0.99	0.99	0.99
RM Cost/t (USD/t)		**293.85**	**293.21**	**291.22**	**292.98**	**290.63**

* Includes Phytase, NSP - enzymes

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Selecting the preferred grain base for diets

- The pig is a very adaptable omnivore that can utilise a wide range of different feedstuffs most effectively
- A megajoule of energy or a gram of standardised ileal digestible amino acid can come from any source with equal efficacy
- Feed formulation is more about nutrient delivery than ingredient use
- All feedstuffs have their specific properties that we need to be cognisant of when combining with other components to make up a complete diet
- With a full appreciation of the available nutrient content of feedstuffs and any peculiar constraints to use, the prime determinant becomes the relative cost of delivering the necessary nutrients
- To be economically competitive, we need to maintain an open mind to all options
- Corn + soybean meal may be dominant components in much of the world's pig foods but they are not essential

Conclusions

The pig has an ability to utilise a broad range of feedstuffs to meet its nutritional needs

Traditionally in Asia, corn has been the predominant grain employed. However, with increasing international trade other grain alternatives have emerged representing a real economic advantage

Australia is enjoying a very productive barley harvest this year resulting in significant quantities being available for export at competitive prices

The domestic Australian pig industry will take advantage of this situation and utilise barley as the dominant grain

The opportunity also presents itself to near Asian neighbours and is well worth considering

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