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Alternative feed ingredients for laying hens

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Government of Western Australia
Department of Primary Industries and Regional Development

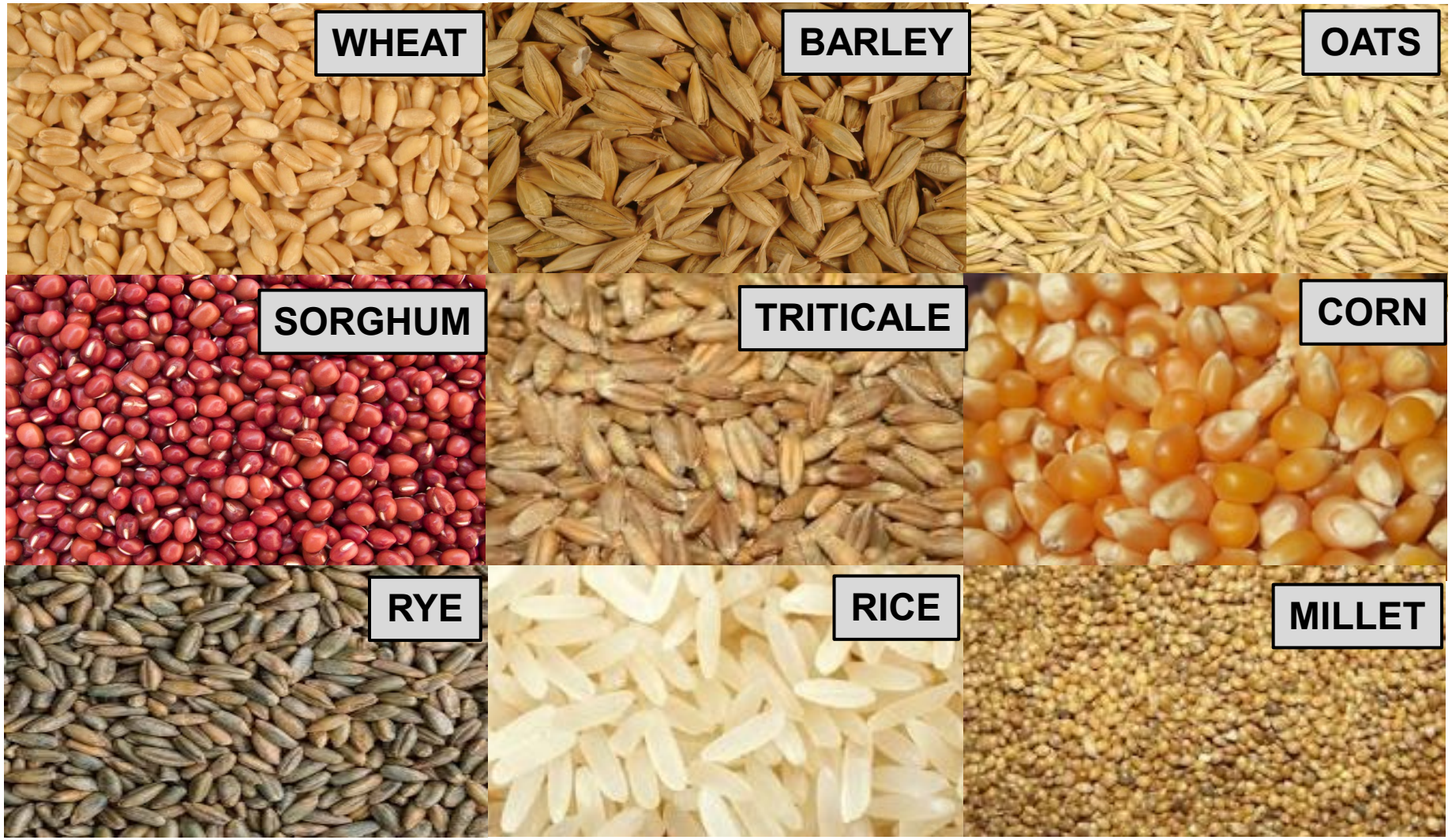
GRDC
Grains Research & Development Corporation

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

Background

- Two main components of layer diets
  - Grain base as the energy platform
  - Protein source to supply amino acids for egg protein synthesis
- In South East Asia (SEA) these have traditionally been met with corn and soybean meal
  - But neither are essential
- With the current pressure on the cost and supply of corn and soybean meal it is timely to broaden our view and consider what alternatives could be utilised

Cereal grains used in layer diets around the world



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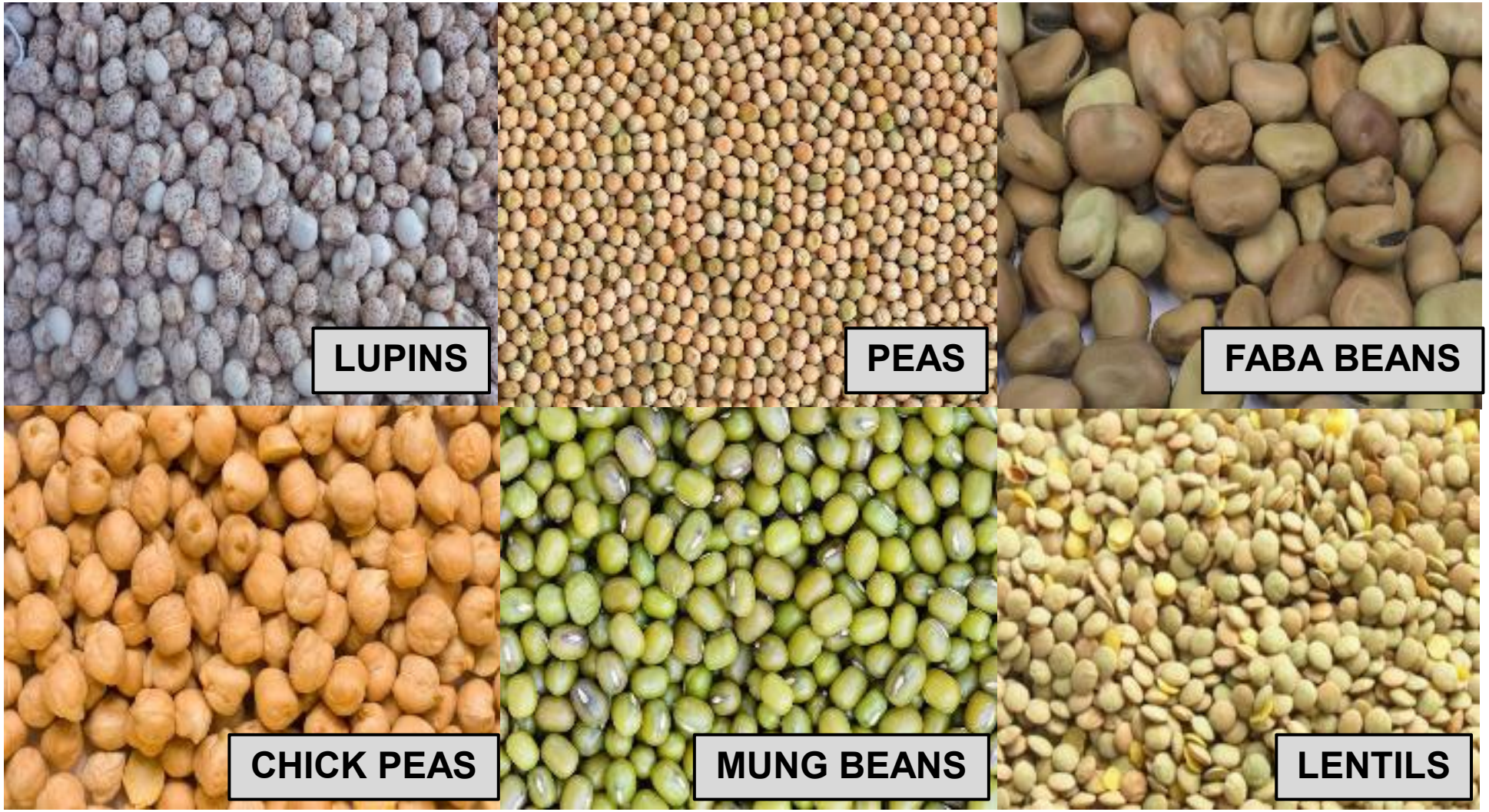
Grain legumes



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Protein meals

ANIMAL

PLANT

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Other potential materials

Grain alternatives:

- Cassava
- Rice bran (full fat & extracted)
- Wheat bran (pollard)
- Copra
- Hominy
- Bakery waste

Protein alternatives:

- Synthetic amino acids
- Cottonseed meal
- Corn gluten meal
- D.D.G.S.
- Peanut meal
- Feather meal
- Algal proteins
- Bacterial biomass products

NB: Each has its own limitation of use which needs to be fully understood for successful use.

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Nutritional principals

- The birds have no requirements for any specific ingredients
- Rather their requirements are in the form of Kcals metabolizable energy and milligrams of digestible amino acids per day
- These can be derived from many different sources with equal efficacy
- There are however secondary nutritional and physical properties in some ingredients which limit their inclusion in diets

The focus of the rest of this talk will be on the alternative grains readily available from Australia because:

1. Limited time precludes exploring all options
2. These grains (wheat, sorghum, barley) are readily available
3. They are not by-products- they are consistent and well characterised
4. They represent the main economic advantage

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Comparative analysis of alternate cereals relative to corn

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
Fibre	Crude (%)	2	2	4.8	2.3
	NDF[1] (%)	9	8.5	16.0	8
	ADF[2] (%)	2.2	2.5	5.5	2.5
Starch + Sugar (%)		64.6	63	53.9	63
Linoleic Acid (%)		1.88	1.0	1.09	1.44
Broiler ME MJ/kg (Kcal/kg)		13.45 (3215	12.56 (3000)	11.2 (2677)	13.21 (3157)
Layer ME MJ/kg (Kcal/kg)		13.75 (3285)	13.0 (3105)	11.8 (2820)	13.5 (3227)
Australian Broiler values (Kcal/kg)[3]		3350	3200*	2900*	3300

NB: typical values only- composition can vary widely with different agronomic conditions
*With Non-Starch Polysaccharides (NSP)
NDF[1] = Neutral detergent fibre ADF[2] = Acid detergent fibre

Source: Premier Atlas (2008)
[3] T. Walker (2018)

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Standardised ileal digestible amino acid composition of grains at typical protein levels

	Corn	Wheat	Sorghum	Barley
Crude protein (%)	8	11	10	10
SID Lys	0.22	0.27	0.20	0.31
SID Met	0.16	0.16	0.16	.015
SID Cys	0.16	0.23	0.14	0.19
SID M+C	0.32	0.39	0.30	0.35
SID Thr	0.25	0.27	0.28	0.25
SID Try	0.05	0.12	0.12	0.09
SID Arg	0.33	0.45	0.34	0.40
SID Ile	0.27	0.35	0.35	0.29
SID Leu	0.89	0.66	1.10	0.57
SID Val	0.35	0.43	0.44	0.40

Source: Evonik AminoDat 5.0

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Typical fibre content of wheat, sorghum & barley relative to corn

		Arabinoxylan	B-Glucan	Cellulose	Other NSP[2]	Lignin	Total fibre
Corn	Soluble	0.1					0.1
	Insoluble	5.1		2.0	0.8	1.1	9.0
	Total	5.2		2.0	0.8	1.1	9.1
Wheat	Soluble	1.8	0.4		0.2		2.4
	Insoluble	6.3	0.4	2.0	0.3	1.8	10.8
	Total	8.1	0.8	2.0	0.5	1.8	13.2
Sorghum	Soluble	0.1	0.1				0.2
	Insoluble	2.0	0.1	2.2	0.25	1.1	5.65
	Total	2.1	0.2	2.2	0.25	1.1	5.85
Barley	Soluble	0.8	3.6		0.1		4.5
	Insoluble	7.1	0.7	3.9	0.5	3.2	15.4
	Total	7.9	4.3	3.9	0.6	3.2	19.9

Source: [1] From Choct (2006) and Bach Knudsen (2014)[2] Mannans + Galactans + Uronic Acid

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Grain alternatives

- Wheat and sorghum can be used to completely replace corn
- Barley has the potential to partially replace corn
- There are real advantages to having a mixture of grains
- Australian grains are harvested dry and held in good storage facilities- hence low mycotoxin risk

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Points of concern

The alternative grains are different to corn and these differences need to be addressed e.g.:

- Fibre levels
- NSP content - need for enzyme support
- Lack of pigment - need to supply pigments from other sources such as synthetic or natural pigments, corn gluten etc
- Energy density - need to balance with added fat/oil
- Linoleic acid - need to balance with added fat/oil
- Milling properties - e.g. pelleting, may need modification to milling parameters such as grind size, steam conditions, throughput rate, etc

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Wheat

- Major grain in Australian poultry diets
- Diets can be successfully based on all wheat though many nutritionists prefer a mixture of grains
- Wheat is classified as a viscous grain due to its soluble arabinoxylan content and hence requires xylanase enzyme support
- Wheat is slightly lower in energy than corn due to a lower fat content and despite similar starch levels

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Wheat cont.

- Wheat is higher in protein and essential amino acids compared to corn
- Wheat starch and protein are highly digestible
- The mycotoxin risk is low
- Wheat starch gelatinises readily and improves pellet quality
- Currently available for export from Australia is a large volume of sprouted wheat (germination initiated but arrested prior to shooting) which has high test weight and normal energy values

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Sorghum

- Used extensively in poultry diets in Australia when priced competitively
- Similar in energy to corn
- Can be used as the sole grain but often used in combination with wheat to improve pellet quality

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Sorghum cont.

- Phenols are present in the pigmented seed coat but the level of condensed tannins is very low and represents no impediment to performance
- These pigments are not xanthophylls and hence do not replace the pigmenting aspects of corn
- Sorghum is low in both soluble and insoluble NSP’s

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Barley

- Barley is higher in fibre, lower in starch and hence lower in energy than corn
- This need not be a negative aspect
- Energy value can be restored with added fat or the lower energy can be used to regulate excessive weight gain in late lay, or in rearing birds
- The fibre in barley promotes gut health via physical stimulation and by the delivery of probiotic oligosaccharides
- Barley is often included in layer diets for this purpose up to 30%

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Reducing soyabean meal dependence

- Use alternative proteins such as canola, sunflower, meat meal, blood meal or legumes
- Exploiting the high amino acid delivery from wheat and barley relative to corn
- Extended use of synthetic amino acids- lysine, methionine, threonine, isoleucine, tryptophan, valine
- Use of protease enzymes

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Example diet - Phase 1 layer (17-32 weeks)

AUD$/T	Raw material	Corn/soy	Wheat (Alt. proteins)	Sorghum (Canola/meat)	Barley (Canola/meat)
$420	Corn 8%	60.88			30.76
$380	Wheat 11.5%		49.18		
$360	Sorghum 9%			60.15	
$320	Barley 10%				30.0
$1,000	Soybean meal 46%	26.8		13.4	13.8
$450	Peas		15.0		
$500	Canola meal (exp) 36%		10.0	10.0	10.0
$400	Sunflower meal 30%		8.0		
$845	Meat meal 50%		3.6	3.9	3.4
$1,200	Blood meal		1.3		
$1,500	Canola Oil	0.5	2.5	2.5	1.8
$220	Salt	0.3	0.2	0.2	0.25
$1,000	Bicarb Soda	0.15	0.22	0.2	0.2
$141	Limestone	4.3	3.8	3.5	3.6
$141	Lime Grits	5.5	5.5	5.5	5.5
$910	Monocalphos	1			
$2,000	Lysine HCl	0.05	0.14	0.17	0.14
$3,520	DL Methionine	0.26	0.25	0.29	0.26
$2,200	Threonine		0.04	0.03	0.02
$12,000	Tryptophan	0.1	0.01	0.01	0.01
$18,000	Isoleucine	0.04	0.14	0.02	1.0
$10,000	Valine	0.03		0.01	0.04
$1,500	Choline Chloride	0.07			
$100,000	Yolk Colour Pigments	0.0065	0.01	0.01	0.01
$20,000	Xylanase/Beta-glucanase		0.005	0.005	0.005
$20,000	Phytase	0.0035	0.0035	0.0035	0.0035
$8,000	Vitamin + Mineral Premix	0.1	0.1	0.1	0.1

	Corn/soy	Wheat	Sorghum	Barley
Analysis				
ME KcaL/kg	2730	2740	2880	2730
Protein (%)	17.5	18.4	17.5	17.5
SID Lysine(%)	0.83	0.83	0.83	0.83
Calcium (%)	4.0	4.1	4.0	4.0
Av. Phos (%)	0.42	0.41	0.41	0.42
Linoleic Acid (%)	1.65	1.40	1.4	1.57
Cost AUD $/Tonne	$594	$484	$525	$539

Take home messages

- Know your materials
- Have confidence that these grains are used extensively in other countries very successfully
- Ensure adequate enzyme support (xylanase, B-glucans, phytase and protease)
- Balance all aspects of the diet (i.e. avoid simple substitutions) e.g. energy, amino acids, Ca, Av. P, Linoleic acid, electrolyte balance, pigment levels
- Transition to new diets in existing flocks in a gradual manner to avoid disruption of the intestinal microbiome.
- Layers generally perform best on a diet prepared as a coarse mash. These alternative grains wheat, barley, sorghum can also be included partly in the diet as whole grains to stimulate gizzard function.

Conclusions

- The economics of livestock production including laying hens is under intense pressure from escalating feed costs
- It is timely that alternative materials be considered. However, any move to alternative materials must involve a thorough understanding of their nutritional value and diets must be formulated to accommodate these differences
- Productivity is the key to profitability. Hence any move to alternative materials that compromises production is unlikely to be cost effective even if it reduces feed cost

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