



Australian barley for pigs: value and opportunity

Brenton Hosking
Consultant to AEGIC



Australian barley

World grain

Australian grain industry

Value and opportunity:
applications in pig feeds





Barley as a world grain

Barley (*Hordeum vulgare L.*)

Ancient grain, many types, grown on all continents except Antarctica

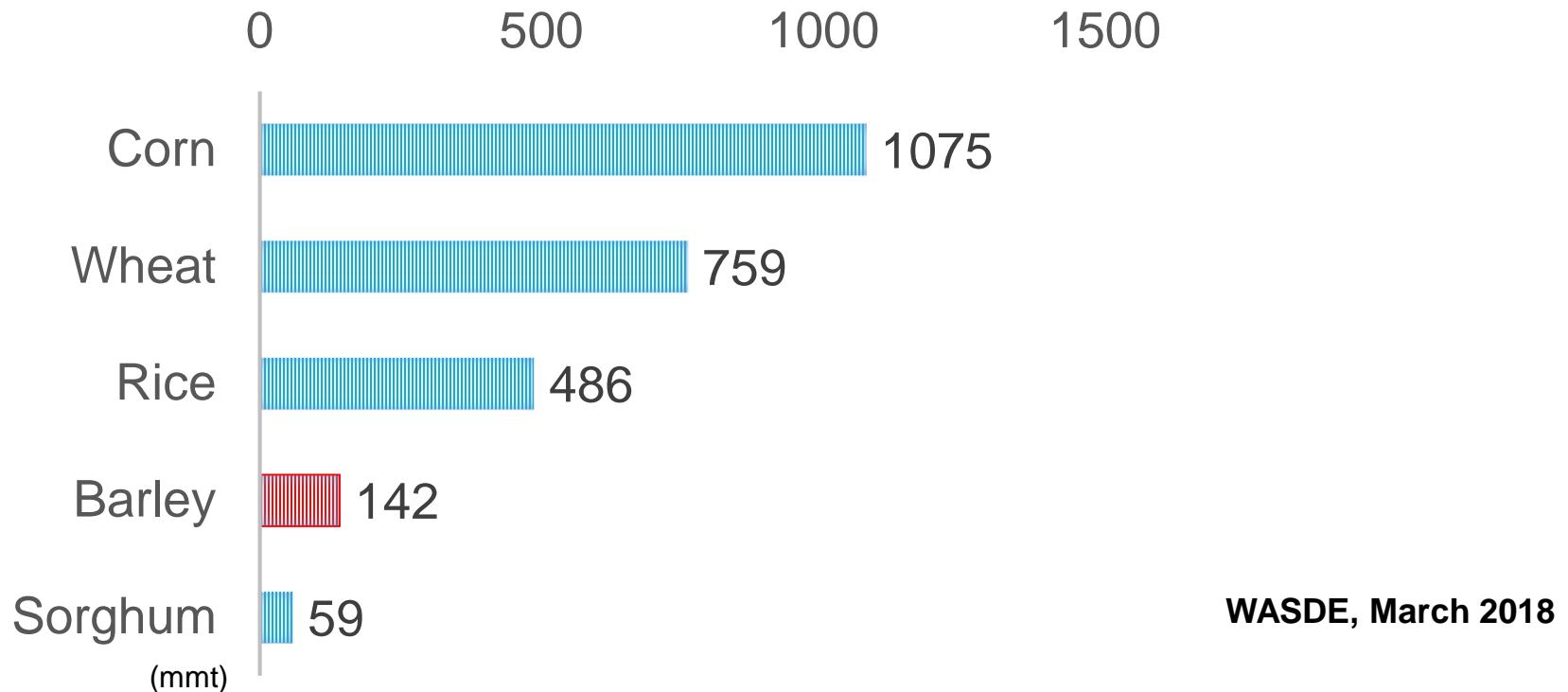
Differs in:

- Number of seeds on the head (2- and 6- row)
- Presence or absence of hull
- Spring or winter (vernalisation)
- Starch type (normal or waxy)
- Aleurone (seed) colour
- Feed, forage and food applications



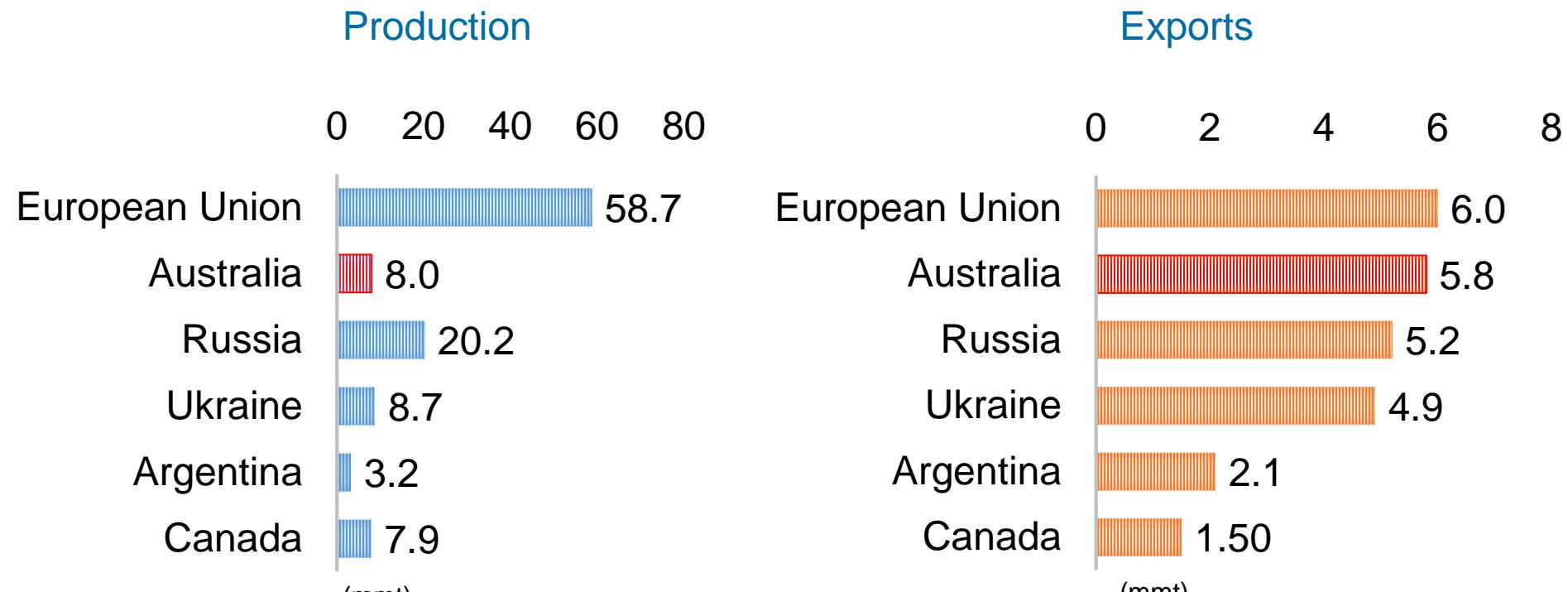
World grain production 2017/18

mmt (million metric tonnes)





World barley production and exports



Predominantly 2-row, spring type barley
– malting characteristics

High quality storage facilities and management

Robust and reliable grading systems for grain trade from paddock to end-user

Generally harvested under low moisture conditions - low risk for mycotoxins and contaminants



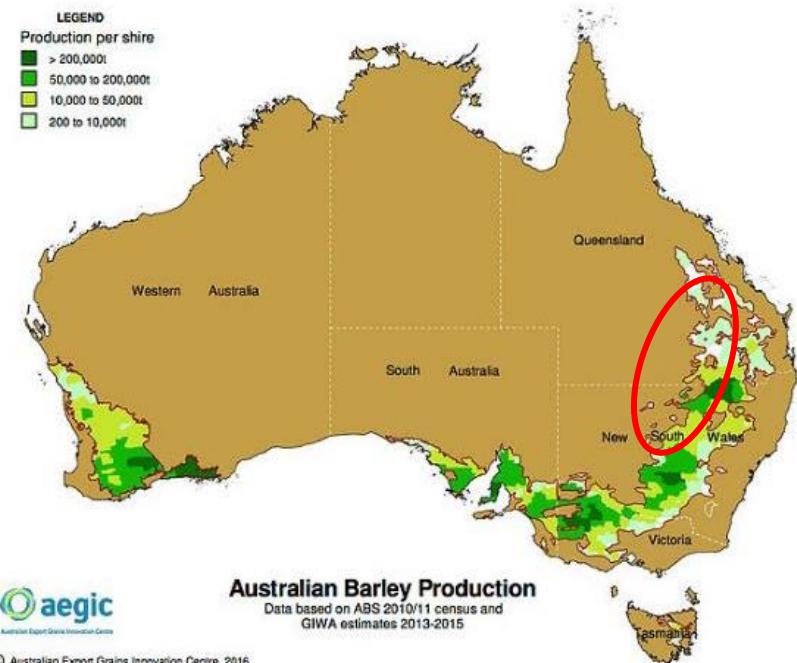


Australian barley

Domestic feed use and applications

Production typically about 8 Mmt/year

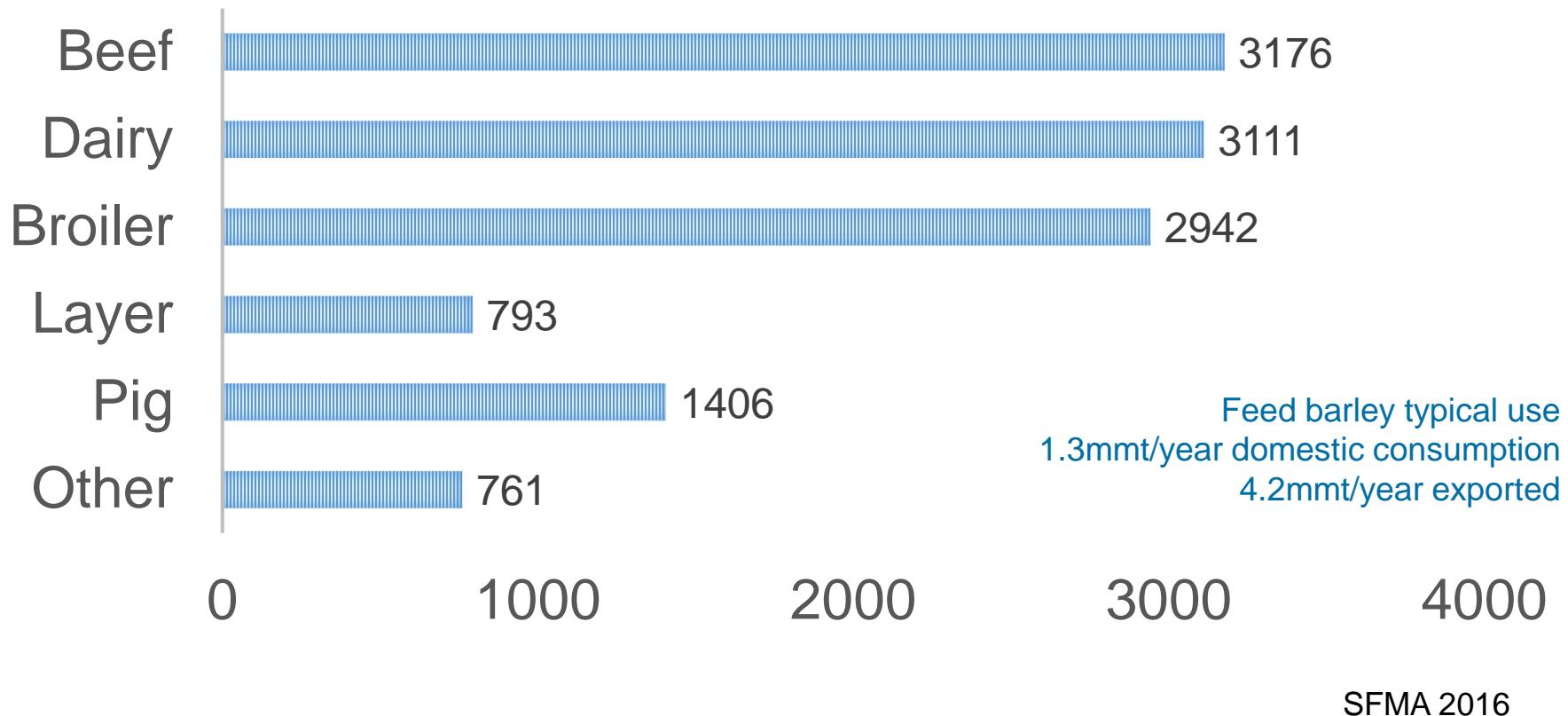
- 5.5 Mmt/year feed grade
- 2.5 Mmt/year malt grade
- Grown in same regions as wheat and sorghum
- Generally used in combination with wheat and/or sorghum





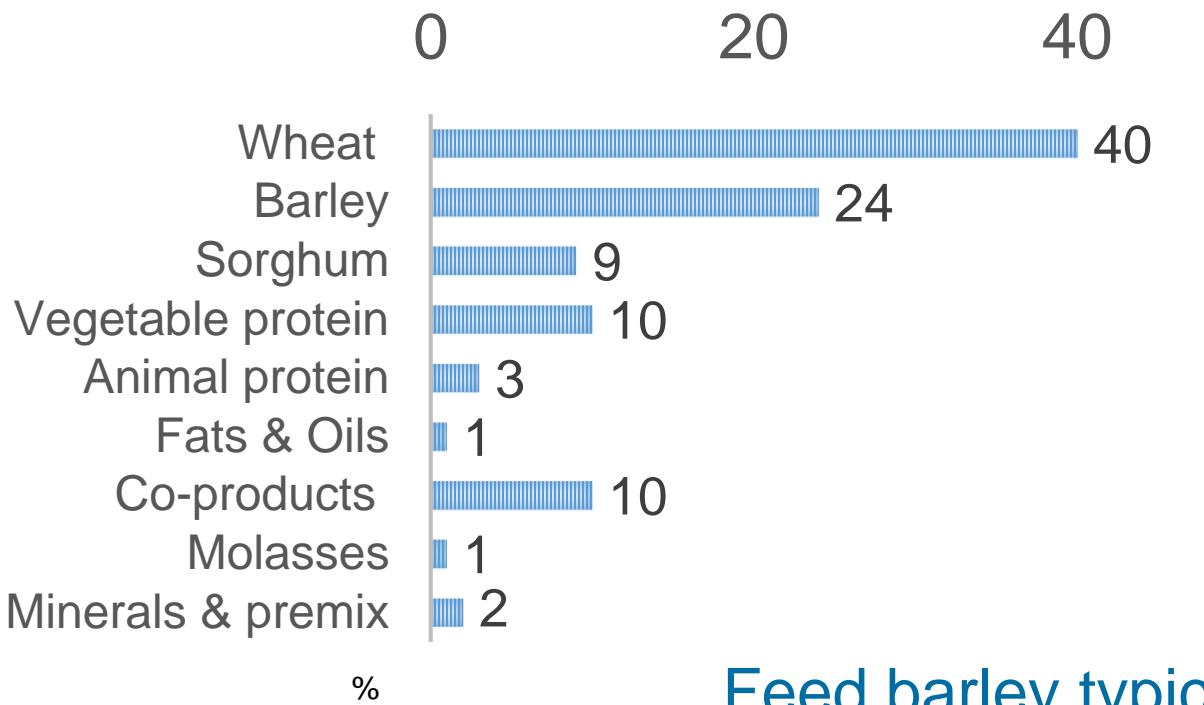
Australian stockfeed production

(thousand metric tonnes)





Raw material use in Australian livestock feeds %



SFMCA 2016

Feed barley typical use in pig feeds
c.150-200 ktonnes per year



Barley is a useful grain for pigs – but it is not wheat and it is not corn



Chemical and physical differences –
Composition, grain size, bulk density and hardness
contribute to differences in formulation, handling and
milling



Concentrations of key nutrients for pigs

	Barley ^a	Corn ^a	Wheat ^a	AusBarley ^b	AusWheat ^b
Moisture	13.3	13.6	11.8	10.7	10.1
Protein %	10.1	8.2	12.7	10.8	12.1
Fat %	1.8	3.7	2.4	1.9	2.0
Fibre %	4.6	2.2	1.5	3.6	1.8
Starch %	52.2	64.1	59.6	57.6	67.6
Choline mg/kg	1027	1100	800	nd	nd
DE swine MJ/kg	12.8	14.2	15.0	13.2	14.2

^a Evapig, 2018; ^b TSS Grain intake report, 2017



Digestible (SID) amino acid and selected mineral contents of corn, barley and wheat at typical protein content

	Barley	Corn	Wheat
Protein %	10.1	8.2	12.7
SID essential amino acid ¹			
Lysine %	0.42	0.19	0.29
Methionine %	0.18	0.16	0.16
M+C %	0.42	0.33	0.34
Threonine %	0.34	0.25	0.26
Arginine %	0.65	0.35	0.40
Isoleucine %	0.37	0.27	0.29
Valine %	0.52	0.35	0.42
Calcium %	0.09	0.04	0.07
Av. phosphorus %	0.36	0.26	0.34

¹ Evapig 2018



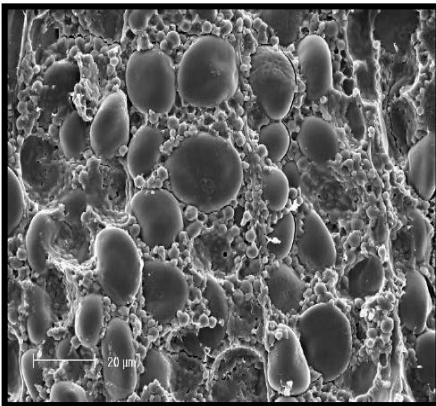
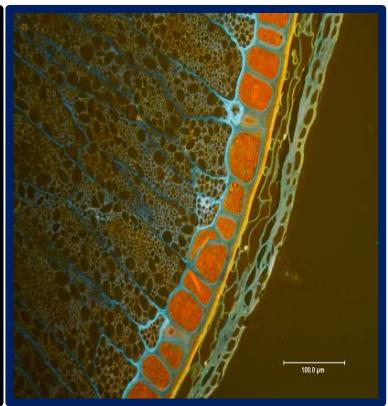
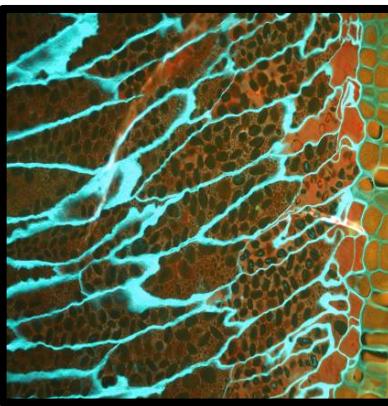
Physical differences between barley, corn and wheat

Constituent		Barley	Corn	Wheat
100 Grain Weight (g)		4.2	35	4.8
Bulk Density (kgm ⁻³)	Raw	620	720	750
Bulk Density (kgm ⁻³)	Milled	630	720	820
Particle size (mm) ^a		0.617	0.894	0.544
Gelatinization temperature (°C)		52-59	62-72	58-64

^a hammered through 3.2 mm screen



Starch Granules are imbedded
in a matrix of protein bodies
and cell walls...
淀粉颗粒嵌入在蛋白和细胞壁基质内



- Digestion only commences when cell walls are disrupted
- Cell walls are the fibrous/structural components of grain - non-starch polysaccharides (NSP)

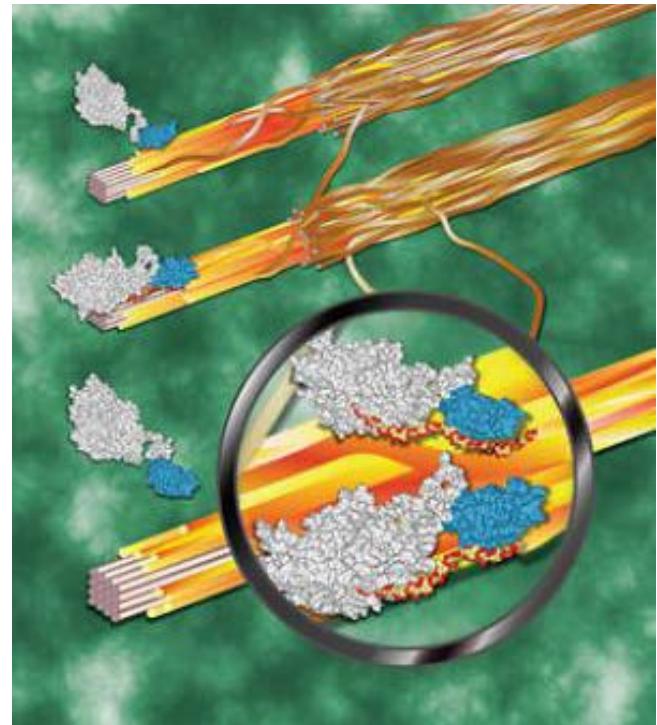
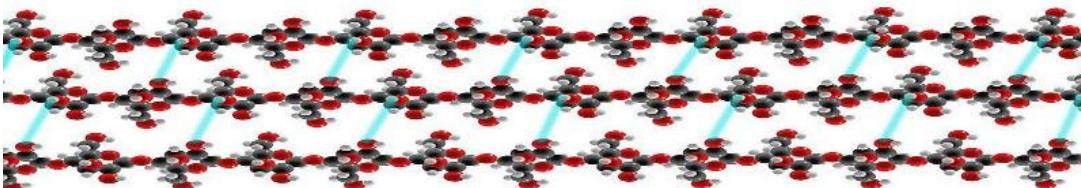
Figures, after Black et al., 2010, Svhuis, 2010



Non-starch polysaccharides (NSP) affect hydration, enzymolysis and digestion

In corn - insoluble NSP pose a physical barrier to hydration and enzymolysis

In barley and wheat - the presence of soluble NSP alter viscosity in the gut





Non-starch polysaccharide (NSP) content of common feedstuffs

Feedstuffs	Ax	β -glucan	Cellulose	Mannan	Pectin	Total NSP
Corn	5.2	-	2.0	0.2	0.6	8.0
Wheat	8.1	0.8	2.0	0.1	0.5	11.5
Barley	7.9	4.3	3.9	0.2	0.5	16.8
Soybean meal	6.0	6.7	6.0	1.6	11.0	31.3
Canola meal	4.0	5.8	8.0	0.5	11.0	29.3
Palm Kernel meal	1.3	0.1	5.0	32.8	0.1	42.0

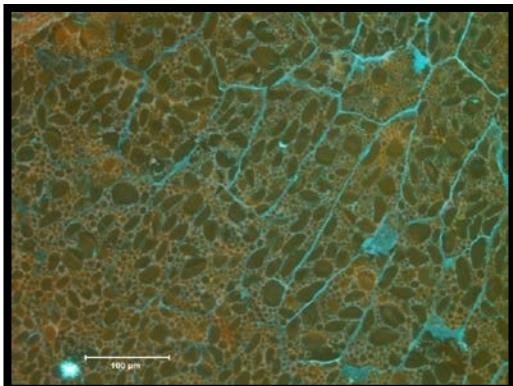
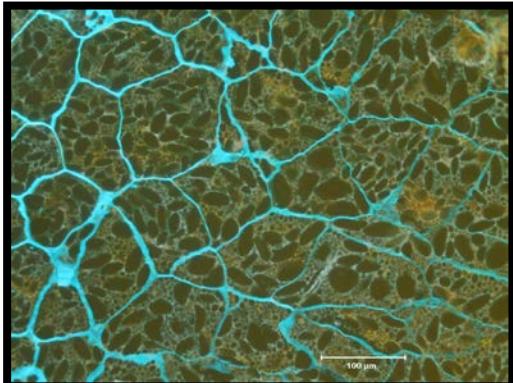
NSP are found in all feedstuffs

after Choct et al., 2006



Typical non-starch polysaccharide (NSP) content of barley, wheat and corn

NSP-Type	Barley	Corn	Wheat
Soluble	4.5	0.1	2.4
Insoluble	15.4	9.0	10.8
Total	19.9	9.1	13.2



NSP are associated with the cell walls of grains

Same cultivar – different years; blue colour indicates effects of season and environment on cell wall content

after Black 2010



Enzyme addition can reduce variability in performance

NSP enzyme Ug.g ⁻¹	0	4	8	16
Intake gd ⁻¹	1270	1253	1352	1314
Daily gain gd ⁻¹	552	580	704	722
Feed:Gain ratio	2.3	2.2	1.9	1.8
Feed:Gain SEM	0.25	0.21	0.07	0.06



after Hosking, 2014; laboratory study, n=8 pigs



Applications of barley grain in pig feeds

The ideal amino acid pattern of dietary protein for growers and breeders

Amino acids	Weaners 5-20 kg	Growers 20-50 kg	Finishers 50-100 kg	Lactating sows	Pregnant sows
Lysine	100	100	100	100	100
Methionine	30	30	30	30	30
Methionine + cystine	55	60	65	55	55
Threonine	63	67	70	60	60
Tryptophan	18	18	18	18	18
DE MJkg ⁻¹	15.0	14.0	13.2	14.0	13.0
Available lysine:DE	0.75	0.65	0.55	0.55	0.4

Australian barley can be used in any type of pig feed if attention given to SID formulation

after www.daf.qld.gov.au



Applications of barley grain in pig feeds

Indicative composition (%) and analysis of Australian pig feeds

Composition	Grower	Finisher	Analysis	Grower	Finisher
Wheat 10%	40.07	36.16	DE MJ/kg	14.2	14
Barley 11%	25	35	Protein %	18.4	15.8
Vegetable proteins	26.1	22	Fat %	5.2	5.0
Animal proteins	5.1	2.6	Fibre %	4.53	4.72
Tallow	2	2	Calcium %	0.94	0.91
Macro minerals	1.15	1.65	Av. Phos %	0.43	0.39
Synthetic AA	0.426	0.39	Av. Lysine %	1.0	0.85
Grower Premix ¹	0.2	0.2	Av. Lys: DE gm/MJ	0.7	0.6

¹ includes NSP and phytase enzymes

Key features: more than one grain; formulated to SID amino acids; use of NSP and phytase enzymes; only 4% soy bean meal; no corn

after Edwards, 2014



Influence of processing

Grain-type	Screen size (mm)		
	3.2	2.0	1.6
Barley ¹	0.617	-	-
Corn ²	0.894	-	-
Wheat ¹	0.544	0.529	-
Wheat ³	0.614	-	0.39
Ulceration ³	2%		21%

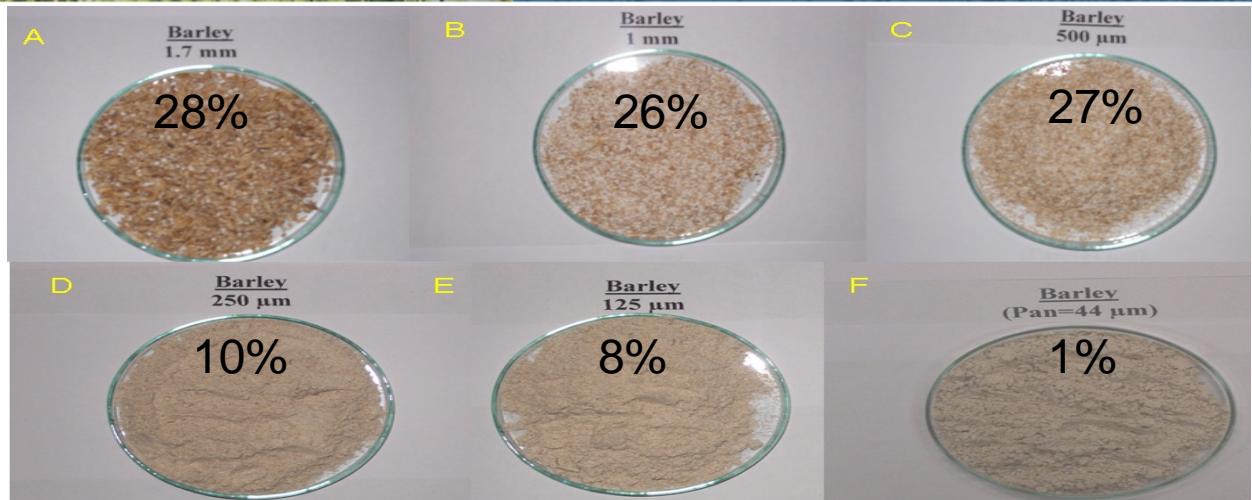
Gidley et al., 2010¹, Briggs et al., 1999²; Hansen et al., 2005³

Particle size differs with grain-type and hammermill screen size



Barley particle size distribution after milling

Milling increases the surface area available for hydration and digestion



Particle Size (mm)	Starch (g/100 g)	NDF (g/100 g)	WSI (%)
0.25	30.9 ^{cd} ± 1.9	35.1 ^a ± 0.6	8.0 ^b ± 0.19
2.8	51.1 ^a ± 1.0	14.0 ^d ± 0.01	0.7 ^g ± 0.11
Unsieved	49.9 ^a ± 0.25	20.1 ^c ± 0.03	4.2 ^d ± 0.16

Barley milled through 3.8mm screen; mean particle size 1.03 mm

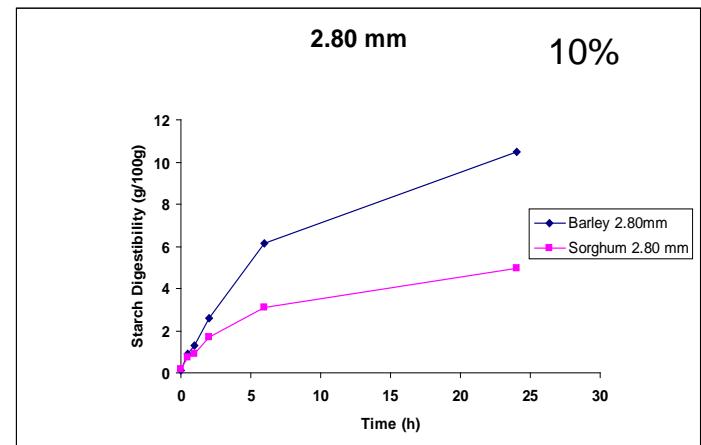
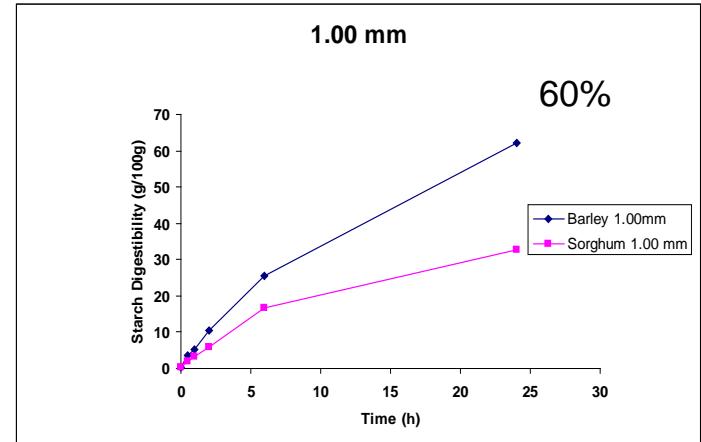
after Gidley, 2010

Barley vs sorghum - particle size

Large particles – contain more starch

- digested more slowly & less completely than small particles
- show big differences between grains

after Gidley et al., 2010





Particle size effects barley digestion

- Particles >2.8mm were shown to be digested less than particles >1mm
- Wheat-barley diets disc milled at different settings to create “fine” (500 – 600 micron) and “coarse” (1000 – 1100 micron) products. The diets were fed *ad libitum* as pellets.

Disc Setting	Fine (0.5 mm)			Coarse (1.7 mm)		
	Dgw	Sgw	SD	Dgw	Sgw	SD
Average	0.6	0.41	2.0	1.1	0.96	2.3

Dgw = geometric mean diameter; Sgw = geometric standard deviation of particle diameter

SD = standard deviation of the mean diameter

after Edwards, 2014

Particle size matters: disc milled barley

	Fine	Medium	Coarse	P-Value	SEM
Grower Pigs					
ADG gd^{-1}	810	836	839	0.228	7.58
ADFI kgd^{-1}	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 gd^{-1}	961	951	960	0.709	5.38
ADFI kgd^{-1}	2.41a	2.52b	2.56b	0.011	0.021
Feed:Gain	2.51a	2.64b	2.60b	0.001	0.019

after Edwards, 2014

Mortality 1.5%; N>3400 pigs



Key findings: disc mill study

Adjusting grind size from 1100 to 600 micron had no effect on ADG but reduced feed intake

2.6% improvement in Feed:Gain in the grower phase and 5.6% improvement in the finisher phase

Feed saving of \$3.50 per pig or c.AUD20 per tonne



Reminder - processing can have as much effect on feed performance as grain selection – similar outcome to US work with corn-based diets



Barley: value and opportunity

- Barley is a world grain in cultivation and use
- Australian barley is clean, low moisture and low risk
- Barley is relatively high in fibre – with advantages and disadvantages depending on how you use it
- It is suitable for all types of pigs
- Barley provides more amino acids and more P than corn
- It mills easily and generally yields a more favourable particle size than corn (< 1mm)



Take the opportunity!

Buy to a standard	Check what you bought	Use digestible nutrients	Use more than 1 grain	Monitor process conditions	Consider using an enzyme complex
Don't buy a problem	Test for DE & nutrient content – NIRs and adjust formulations if necessary	SID amino acids – think nutrients not ingredients	Manage risk – using 2 or more grains assists to minimize product variation	Target particle size c.500um; minimize particles <400um or >800um	Multiple glucanase and xylanase activities can reduce product variation

