

Australian feed grains: value and opportunities



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Australian Export Grains Innovation Centre

Supporting Australian Grain Across the World

Core activities include:

- National leadership in the identification and coordination of export grain research and development priorities.
- Accelerated improvement of Australian grain's quality and functionality attributes.
- Development of innovative processing technologies and methods.
- Research and development innovation to grow demand for Australia's malting barley varieties.
- State-of-the-art grain quality testing services.



Barley - a world grain

- Botanical name: *Hordeum vulgare*
- Approx. 145 million tonnes/year produced.
- Ranks 4th in global cereal production and area cultivated after corn, wheat and rice.
- Approx. 70% is fed to animals, including poultry, swine and ruminants.

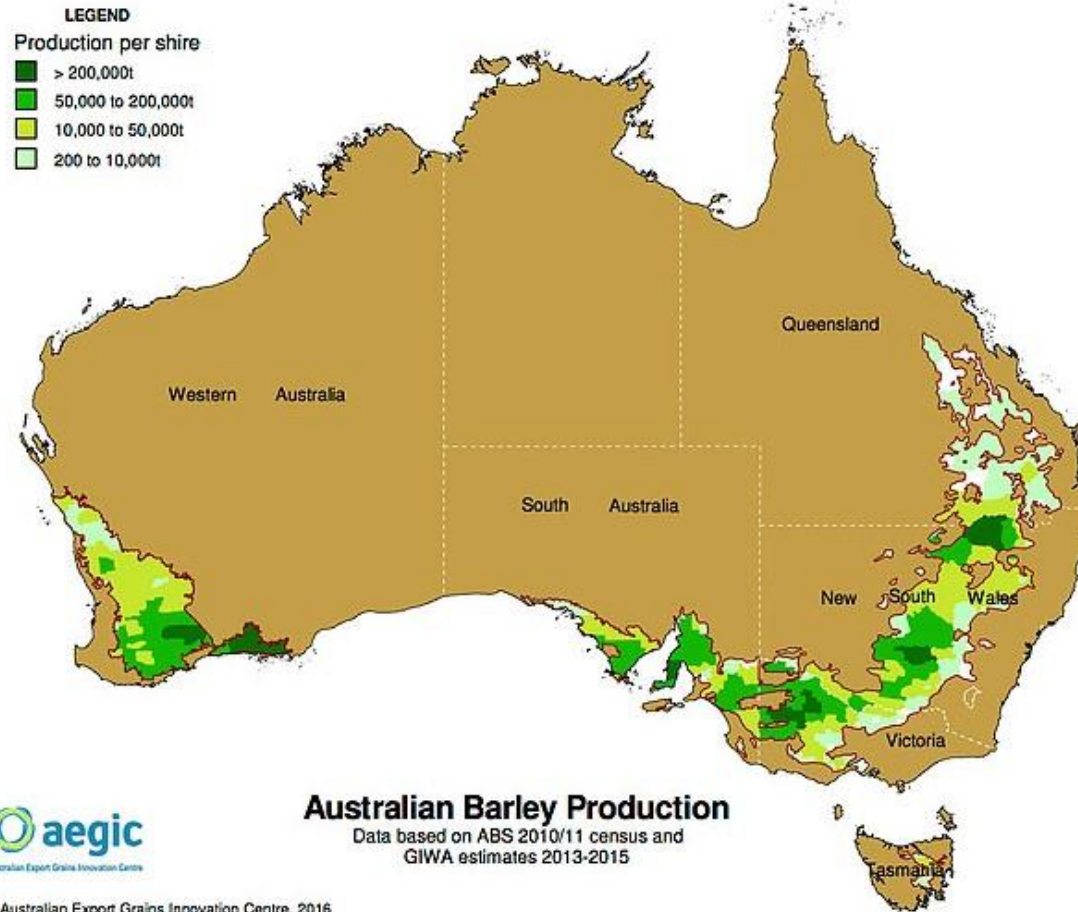


Australian barley

- Predominantly 2-row, spring type (grown in mild Australian winter), white seed with hull.
- Suitable for malting, brewing and animal feed.
- Production typically 8 Mmt/year (top 5 globally).
 - 2.5 Mmt/year malt grade
 - 5.5 Mmt/year feed grade
 - 25% domestic use
 - 75% exported (top 3 globally)
- High quality storage facilities and conditions.
- Robust and reliable testing and grading systems.



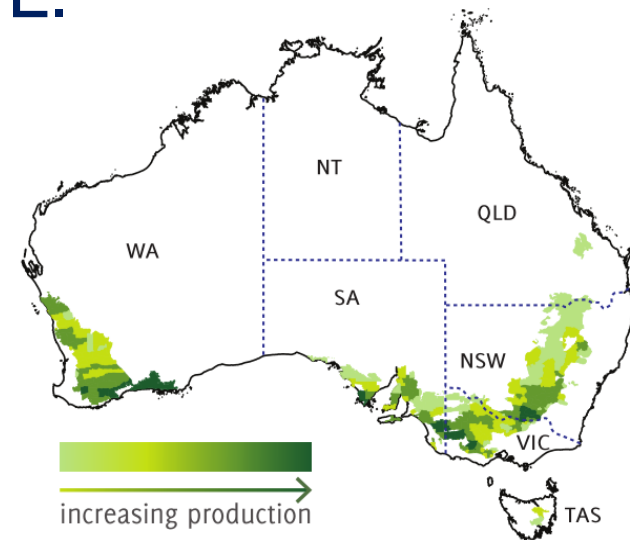
Australian barley



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Australian canola

- Botanical name: *Brassica napus* L.
- Australia's major oilseed crop.
- Canola production is increasing.
 - Now averages 3-4 Mmt/year
 - 85% non-GM, 15% GM
 - 15-20% of world's export trade
- Products: food-grade oil, biofuel and canola meal.
(75% solvent extracted and 25% expeller)
- Canola meal is a primary protein source for dairy in Australia and globally.



Feeding grains – the global view

- Cows are incredibly versatile production animals.
- Around the world, cows eat a wide range of different feeds in each of these categories:
 - Grazed forages
 - Conserved forages
 - Grains
 - Protein supplements
 - Wet and dry co-products from many industries



Feeding grains – the global view

- Around the world, cows produce milk profitably in many feeding systems.
 - Australian dairy farmers use one of 5 main systems:

1.
Low bail



2.
Mod.-high bail



3.
**Partial Mixed
Ration**



4.
Hybrid



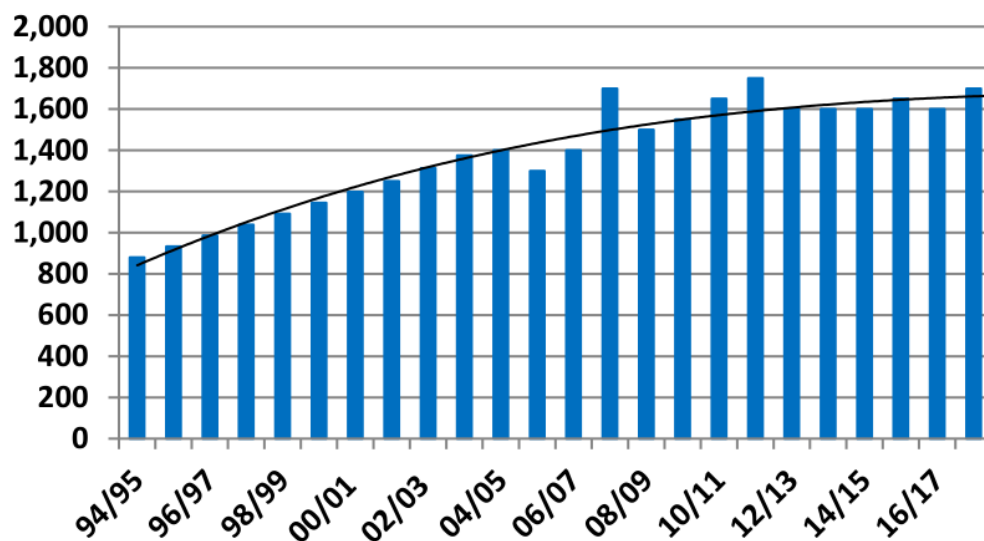
5.
Total Mixed Ration



Feeding grains – the global view

- In Australia, grain intake provides nutrients for 25-30% of all milk produced.
 - Barley and wheat, the main grains, fed to cows since 70s
 - Corn and sorghum also fed in smaller quantities

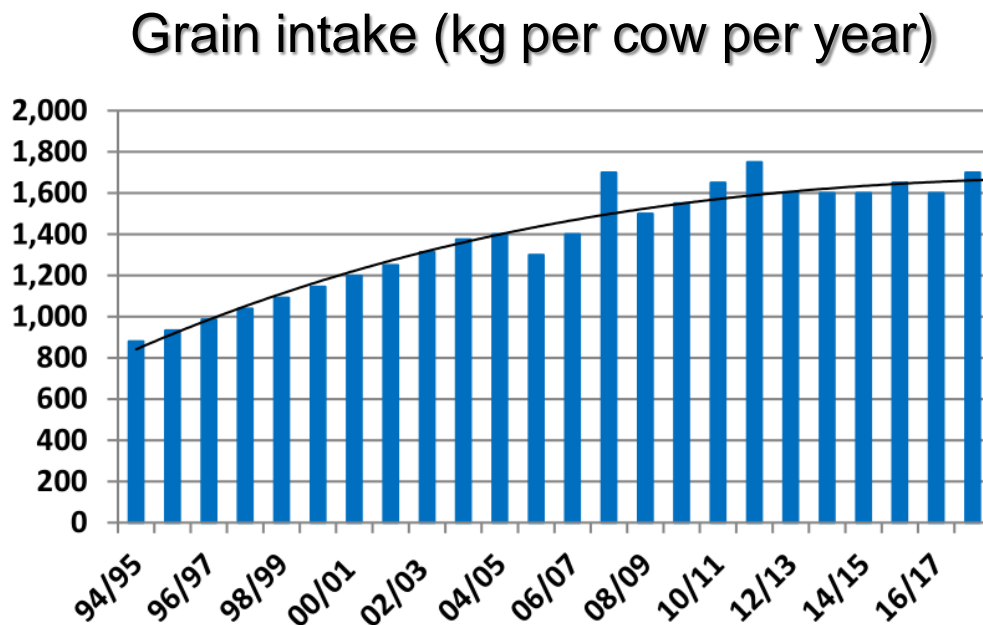
Grain intake (kg per cow per year)



(Dairy Australia, JCS Solutions 2018)

Feeding grains – the global view

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(Dairy Australia, JCS Solutions 2018)



So which grain performs best?

Feeding grains – the global view

- Studies comparing the performance of lactating dairy cows fed diets including different grains and protein supplements have given variable results.
 - This is expected, as responses of lactating cows to different grains depend on many factors, including:
 - Cows' daily feed intake
 - Cows' basal diet
 - Composition of given batch of grain fed
 - How grain was processed
 - Level of inclusion of grain in diet
 - Feeding system used

Five key nutritional principles

- ① Cows require nutrients, not specific ingredients

Five key nutritional principles

① Cows require nutrients, not specific ingredients

■ Designing diets:

From simplistic:

- Formulated on:
 - Metabolisable Energy
 - Crude Protein
 - NDF
- Typically, diet includes a single grain

Five key nutritional principles

① Cows require nutrients, not specific ingredients

■ Designing diets

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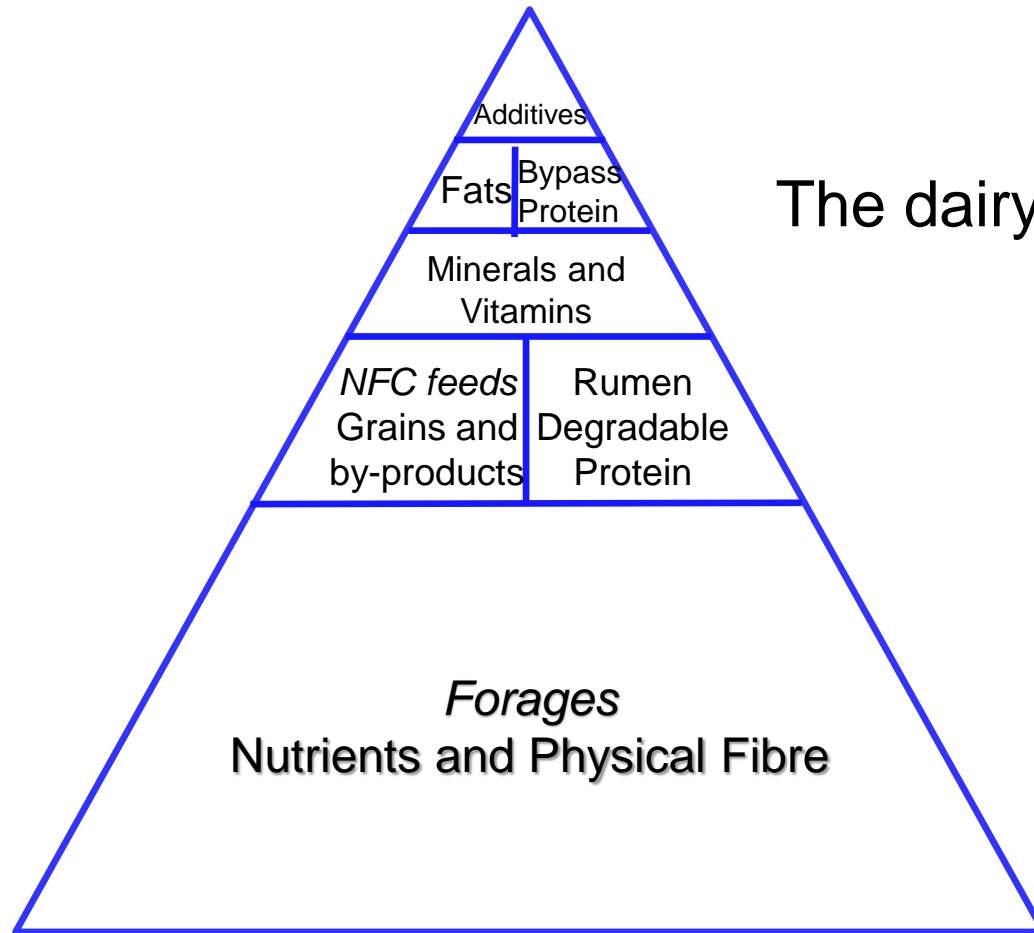
- Typically, diet includes a single grain

To more sophisticated approaches:

- Formulated on:
 - Metabolisable or Net Energy
 - Metabolisable Protein or AAs
 - NDF, peNDF, NDFD
 - Rates and extents of carbohydrate and protein digestion
 - Minerals
- Diets tend to have combinations of grains and protein sources

Five key nutritional principles

2 Forage quality is critical



The dairy feed pyramid

(Paulson, 2007)

Five key nutritional principles

③ Grains are metabolic fuel for rumen bugs and cow

Typical analysis of grains

Grain type	Metabolisable Energy (MJ ME/kg DM)	Starch (% DM)	Neutral Detergent Fibre (% DM)	Crude Protein (% DM)
Corn	13.5	72.5	10.7	9.3
Wheat	13.3	66.9	13.1	12.9
Barley	12.8	56.8	20.0	12.2
Oats	11.6	38.1	30.4	11.9
Sorghum	12.2	65.7	14.8	10.8

(Rumen8 feed library, 2018)

Five key nutritional principles

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Typical analysis of grains

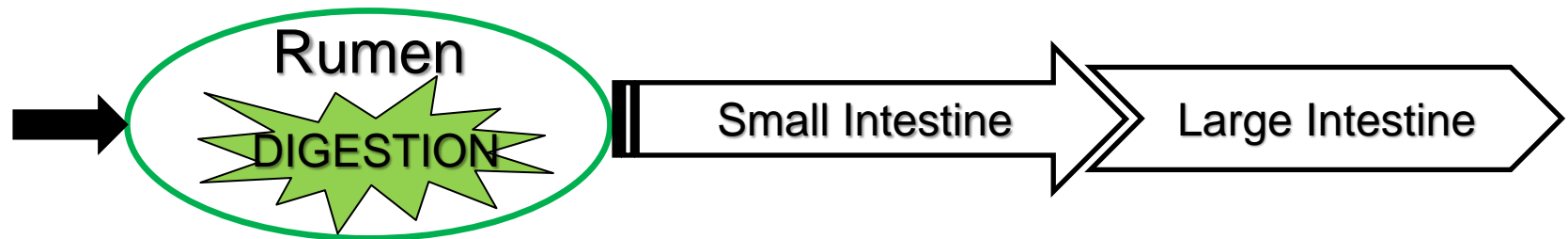
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Sorghum	12.2	65.7	14.8	10.8

(Rumen8 feed library, 2018)

Barley grain has more protein, methionine, cysteine lysine and tryptophan than corn grain. (Nikkhah, 2012)

Five key nutritional principles

4 Starch: Rumen degradation rate vs. passage rate

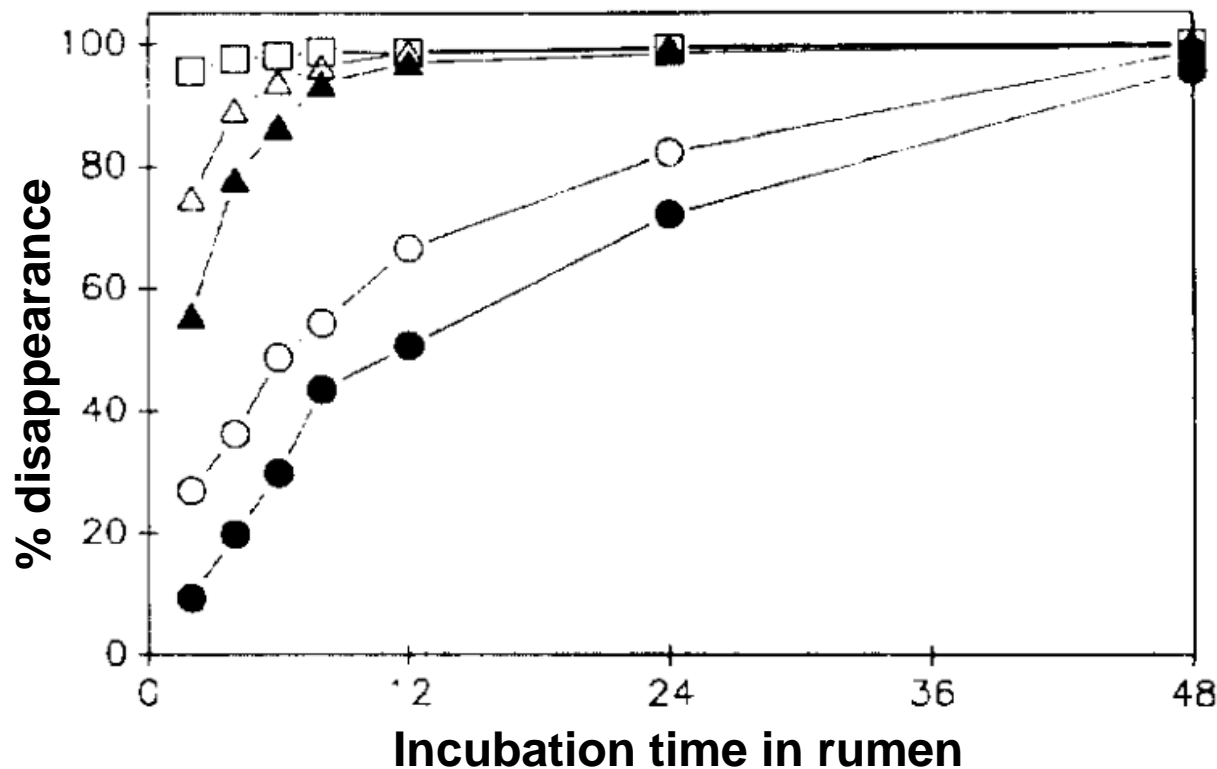


- Aim to optimise microbial protein synthesis in rumen
 - Highly digestible protein source for the cow, with a pattern of essential amino acids that is very similar to milk.

Five key nutritional principles

4 Starch: Rumen degradation rate vs. passage rate

- Grain type



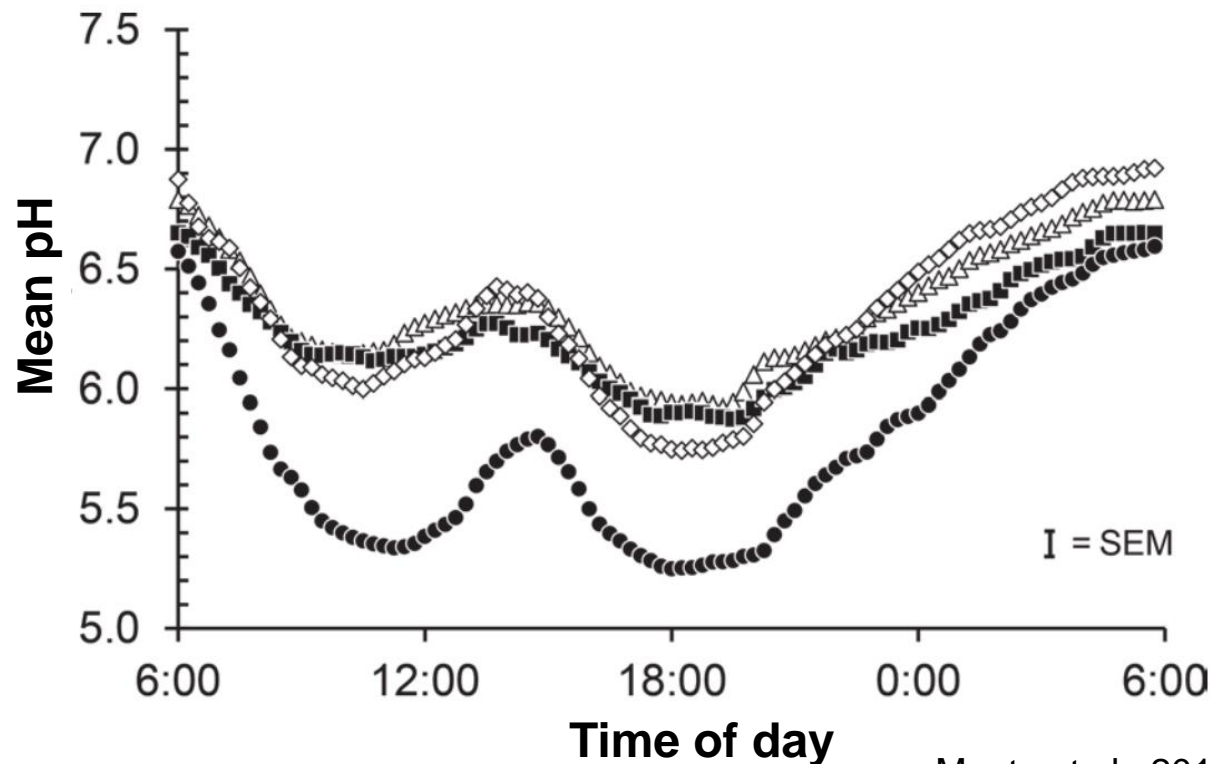
In situ starch disappearance of five grains:

- corn;
- milo;
- △ wheat;
- ▲ barley;
- oats

(Hererra-Saldana et al., 1990)

Five key nutritional principles

- ④ **Starch:** Rumen degradation rate vs. passage rate
- Grain type and processing method



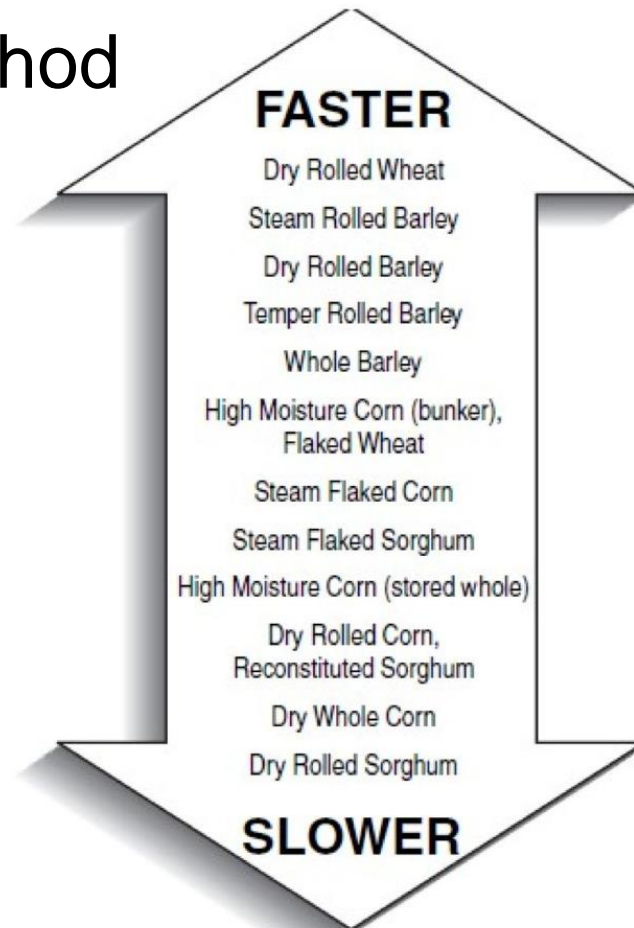
Diurnal ruminal pH of Holstein cows fed:

- Wheat;
- Corn;
- ◇ Barley, single-rolled;
- △ Barley, double-rolled

Moate et al., 2017)

Five key nutritional principles

- ④ **Starch:** Rumen degradation rate vs. passage rate
- Grain processing method



(Nikkhah, 2012)

Five key nutritional principles

- ④ **Starch:** Rumen degradation rate vs. passage rate
- Grain processing method

If grain is *under-processed*:

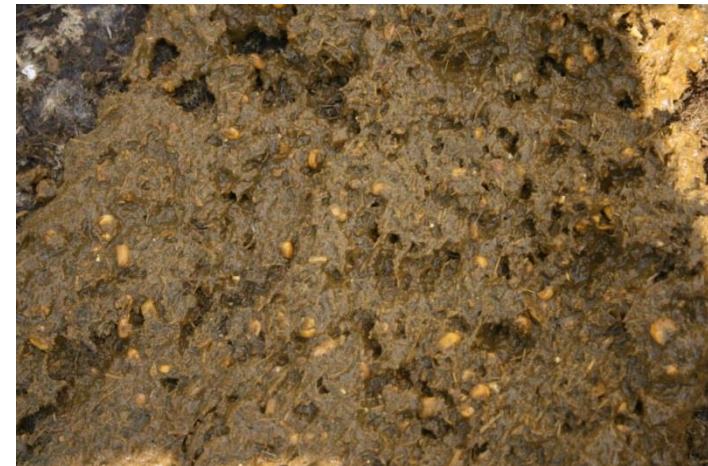
May result in:

- reduced starch digestibility in rumen and total digestive tract
- reduced milk production, feed efficiency and profit

Look for:

- ☐ Undigested grain pieces in manure (visual test)
- ☐ Starch in manure (chemical test by feed laboratory)

“Bypass starch”



Five key nutritional principles

- ④ **Starch:** Rumen degradation rate vs. passage rate
- Grain processing method

If grain is over-processed:

May result in:

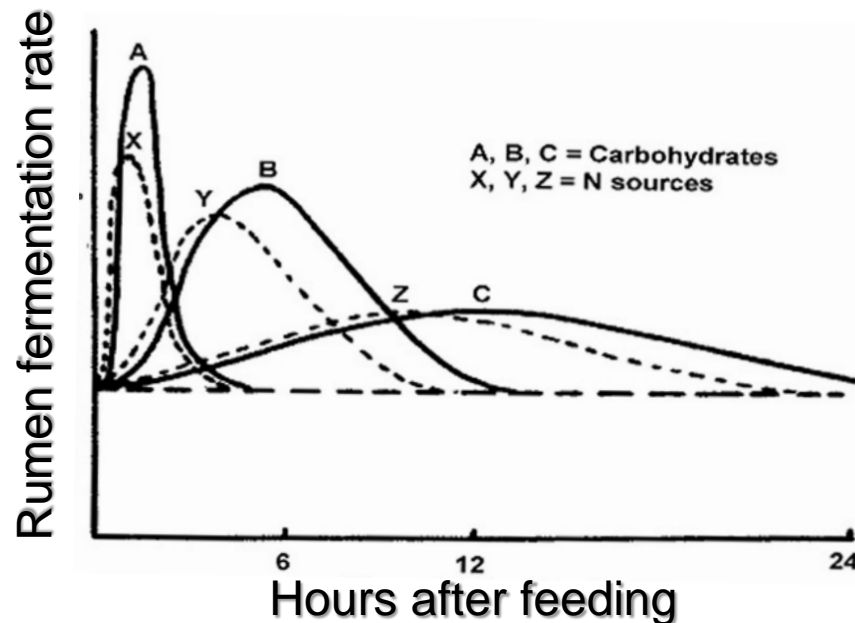
- excessively fast rumen starch degradation
- ruminal acidosis, with reduced milk production, feed efficiency and profit

Look for:

- ☐ Reduced fibre digestion
- ☐ Reduced intake in some cows
- ☐ Mild milk fat suppression
- ☐ Possible diarrhoea and laminitis

Five key nutritional principles

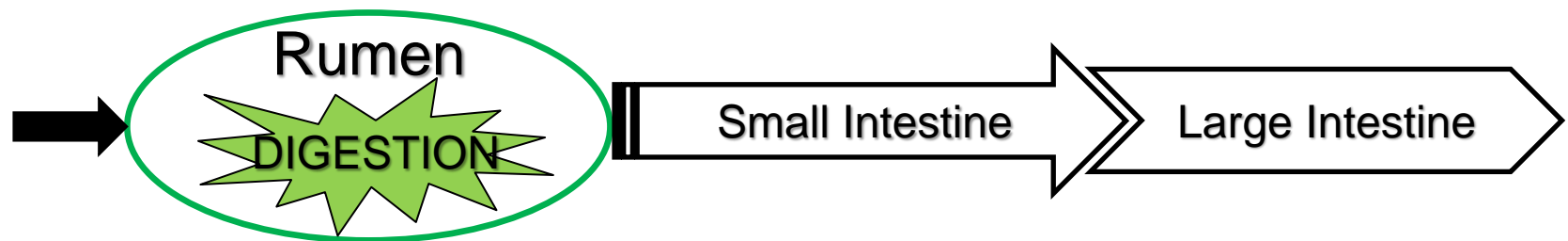
- 4 **Starch:** Rumen degradation rate vs. passage rate
- There is increasing interest in:
 - combining faster and slower fermenting grains in diets
 - varying their ratios in diet at different stages of lactation



(Nikkhah, 2012)

Five key nutritional principles

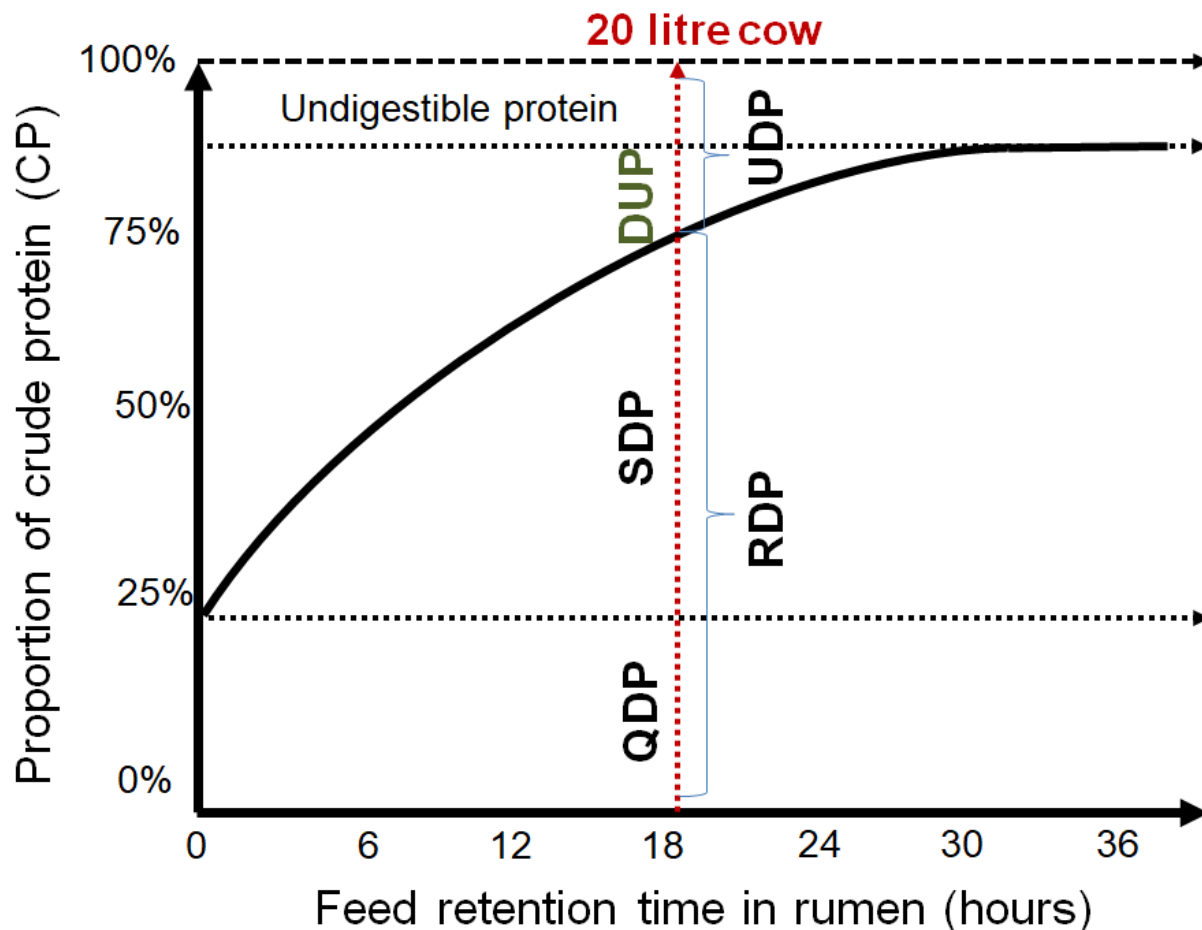
5 Protein: Rumen degradation rate vs. passage rate



- Aim to optimise microbial protein synthesis in rumen
 - A highly digestible protein source for the cow, with a pattern of essential amino acids that is very similar to milk.

Five key nutritional principles

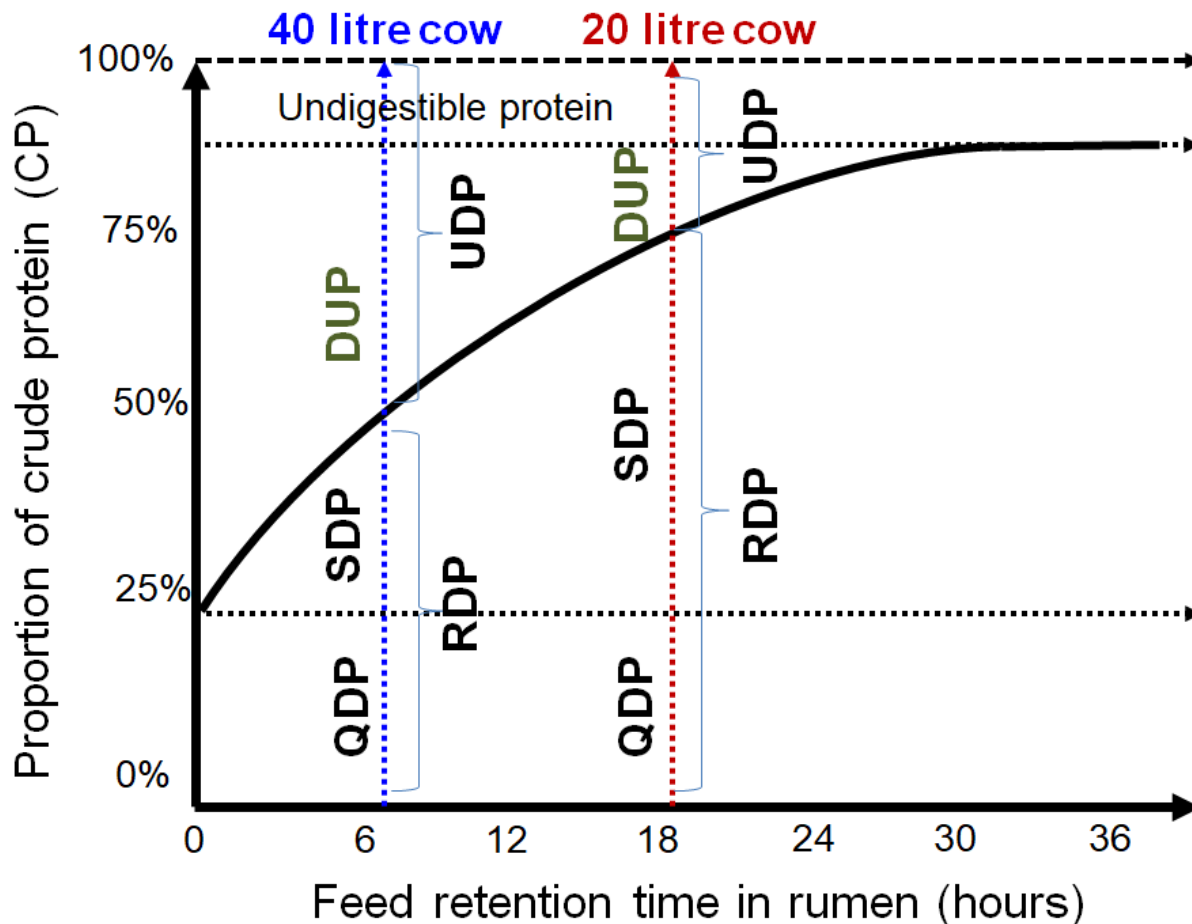
5 Protein: Rumen degradation rate vs. passage rate



(Adapted from Chamberlain and Wilkinson, 1998)

Five key nutritional principles

⑤ Protein: Rumen degradation rate vs. passage rate



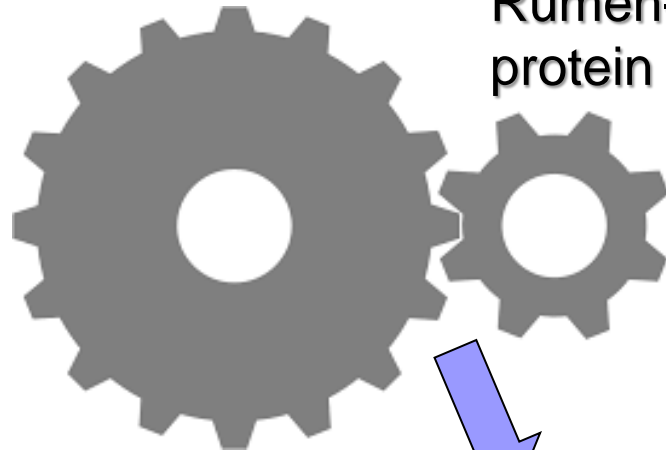
Higher milk yield
↓
Faster feed passage rate
↓
More crude protein bypasses the rumen (UDP)

Five key nutritional principles

- 5 **Protein:** Rumen degradation rate vs. passage rate
- Carbohydrate fermentation and microbial protein synthesis are interlinked

Rumen-degradable
carbohydrates

Rumen-degradable
protein (RDP)



Microbial protein
VFAs

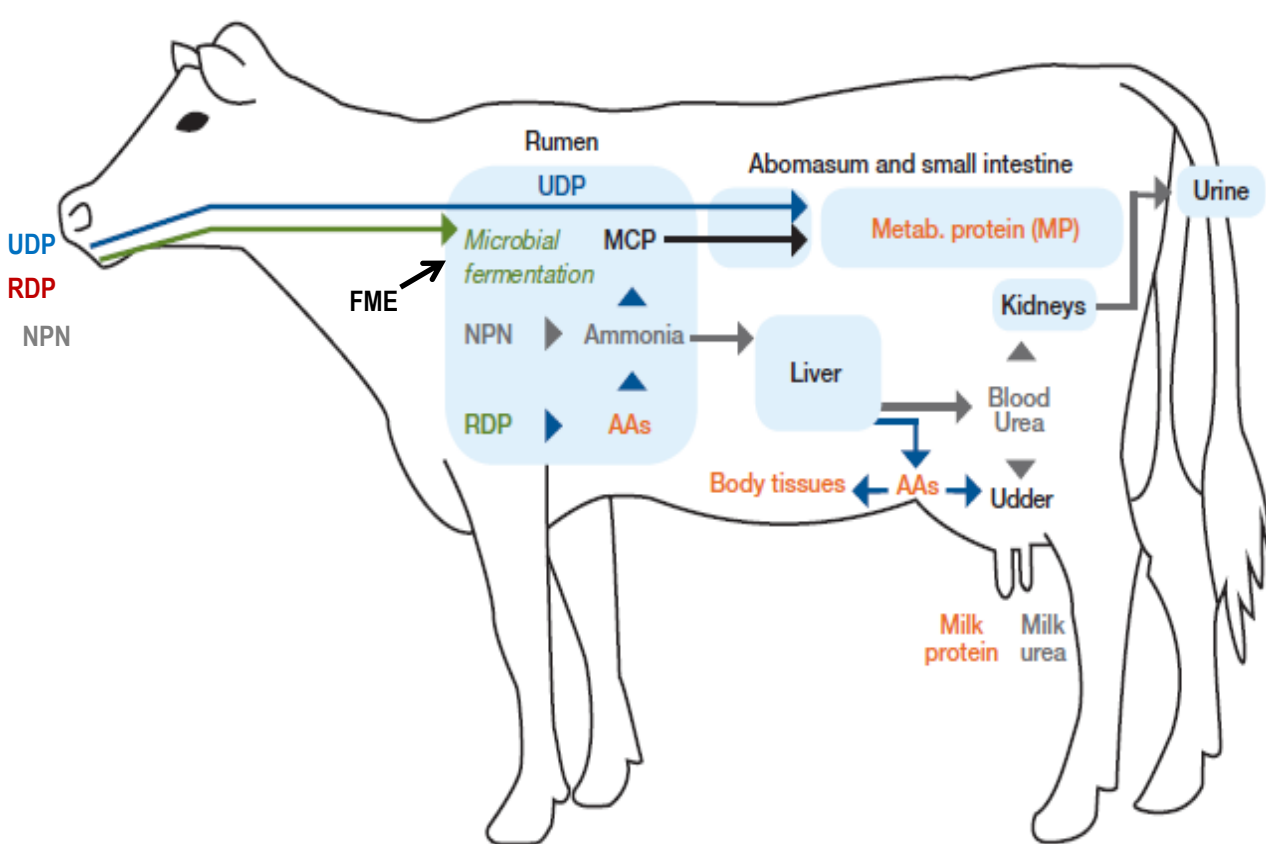
How much RDP is
converted to
microbial protein
depends on:

- supply of fermentable ME
- MCP yield/MJ of fermentable ME

Opportunities to use barley and canola meal in dairy diets

Opportunity 1:

Use barley to help convert more RDP to microbial protein in the rumen

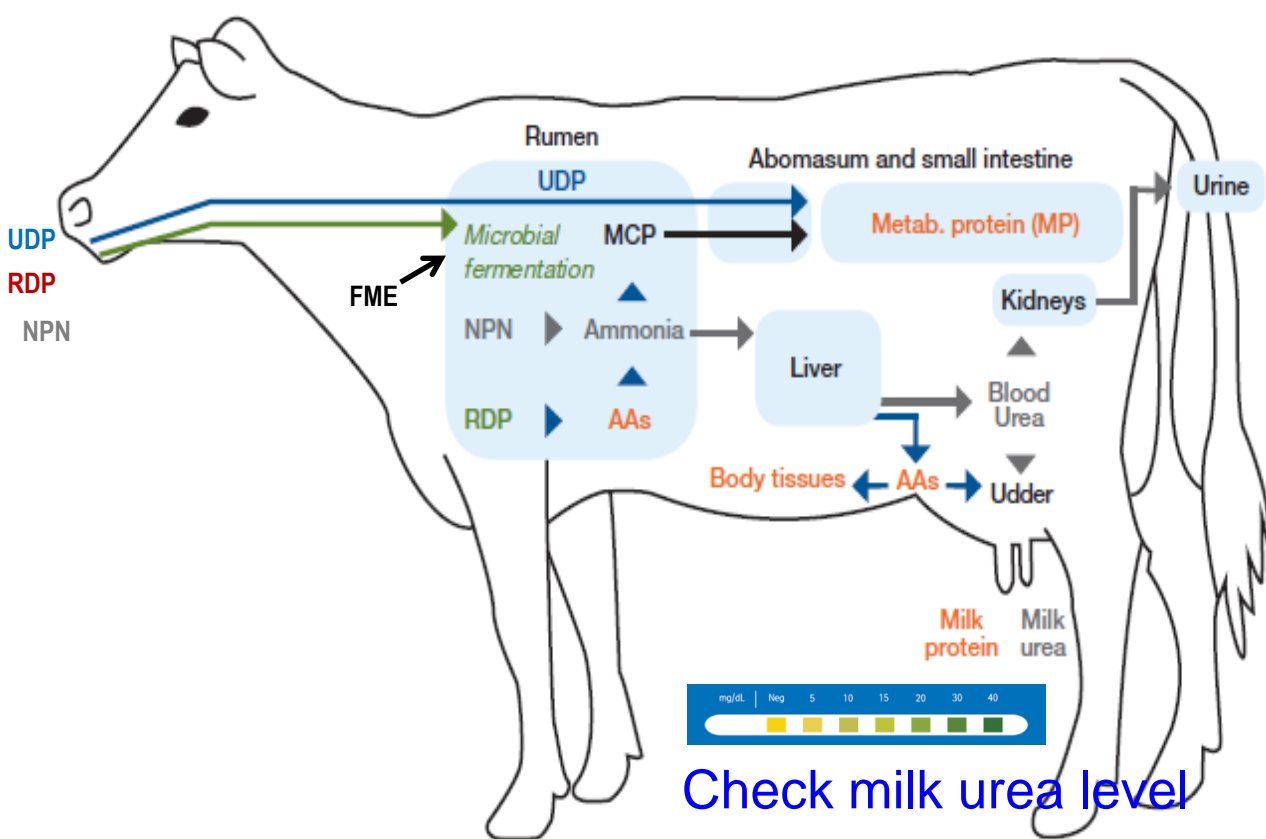


- On its own or as a complimentary grain to corn
- If fermentable ME supply to cow is limiting
- If diet is high in NPN

(Dairy Australia, 2016)

Opportunity 1:

Use barley to help convert more RDP to microbial protein in the rumen



Check milk urea level

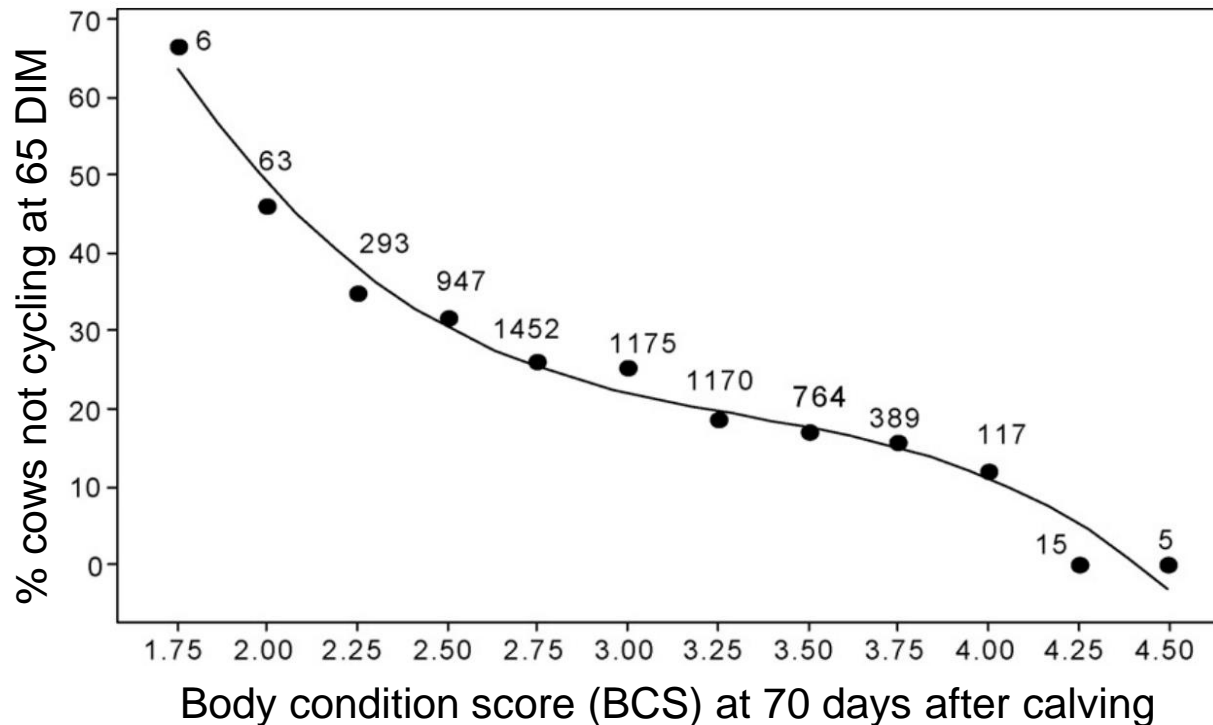
- On its own or as a complimentary grain to corn
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- If diet is high in NPN

(Dairy Australia, 2016)

Opportunity 2:

Use barley to help improve cow fertility

- Reduce body condition loss in early lactation, and achieve a higher body condition score at mating



(Santos et al., 2009)

Opportunity 2:

Use barley to help improve cow fertility

- Reduce body condition loss in early lactation, and achieve a higher body condition score at mating
- Feed a diet after calving with a higher starch level and low fat level post calving, to ↑ plasma insulin level



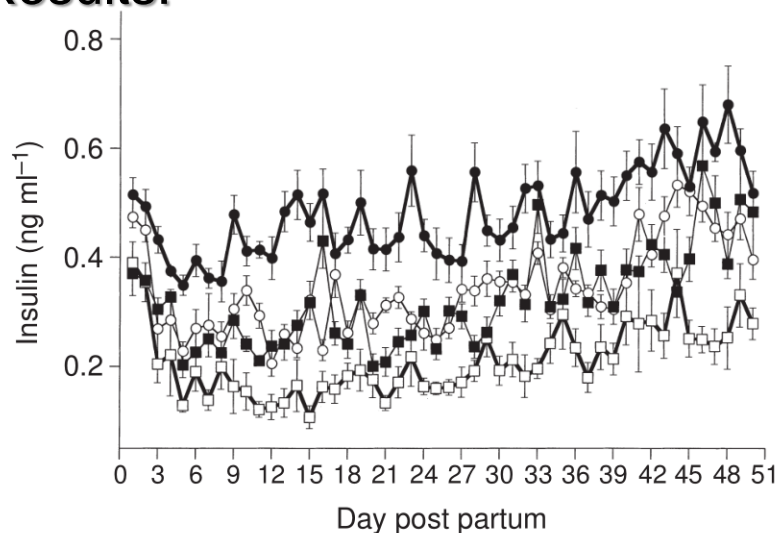
Opportunity 2:

Use barley to help improve cow fertility

Experiment: Gong et al. (2002)

Low and high genetic merit cows were fed isonitrogenous and isoenergetic low or high starch diets (10% and 26% DM) for 50 days post calving.

Results:



- Low merit cow, High starch diet
- High merit cow, High starch diet
- Low merit cow, Low starch diet
- High merit cow, Low starch diet

Days to first ovulation:

	Low starch diet	High starch diet
High merit cows	53.8 +/- 7.7	41.4 +/- 4.9
Low merit cows	43.1 +/- 5.2	27.5 +/- 1.9

Opportunity 2:

Use barley to help improve cow fertility

Experiment: Garnsworthy et al. (2009)

Cows were fed a diet that stimulates low or high plasma insulin until cows resume ovarian cycles, then switched to a low or high plasma insulin diet during the mating period.

4 groups of cows fed these diets:

	Pre-cycling diet	Post-cycling diet*
□ HH	High starch	High starch
■ HL	High starch	Low starch
▲ LH	Low starch	High starch
△ LL	Low starch	Low starch

* fed up to 120 days post calving

Opportunity 2:

Use barley to help improve cow fertility

Experiment: Garnsworthy et al. (2009)

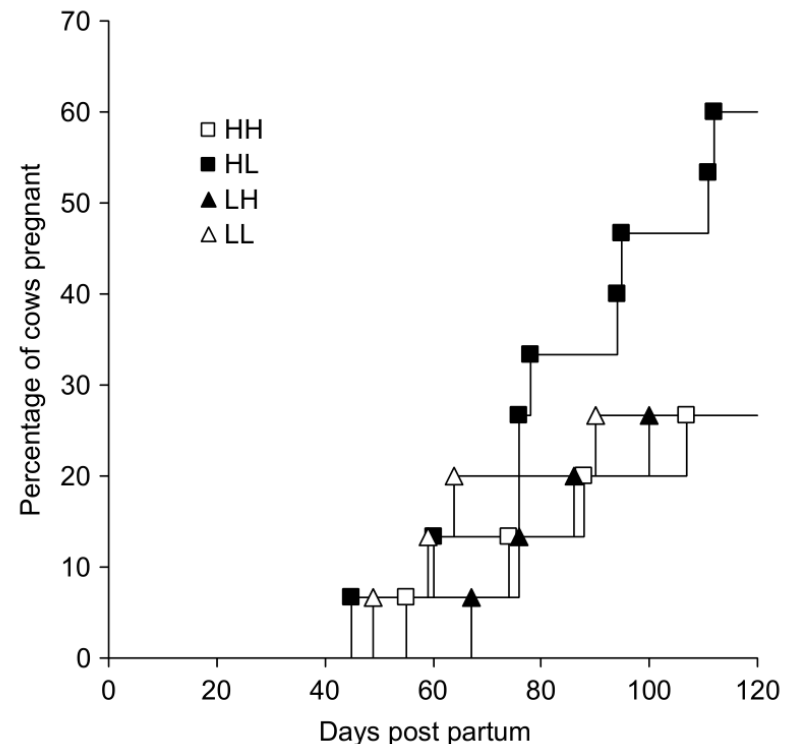
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Results:



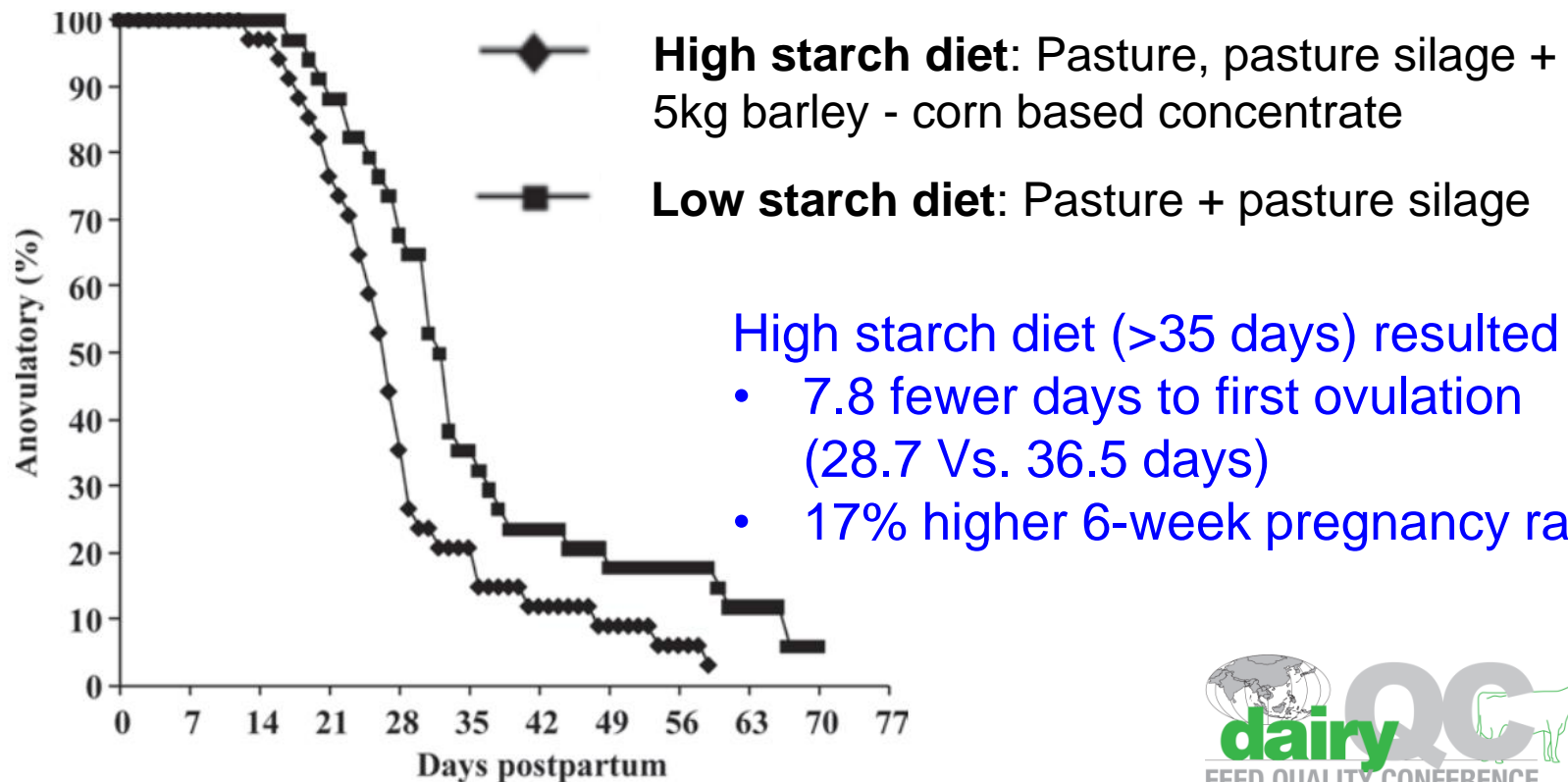
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Experiment: Burke et al. (2010)

To test effect of high starch diet post calving in a seasonal calving system.

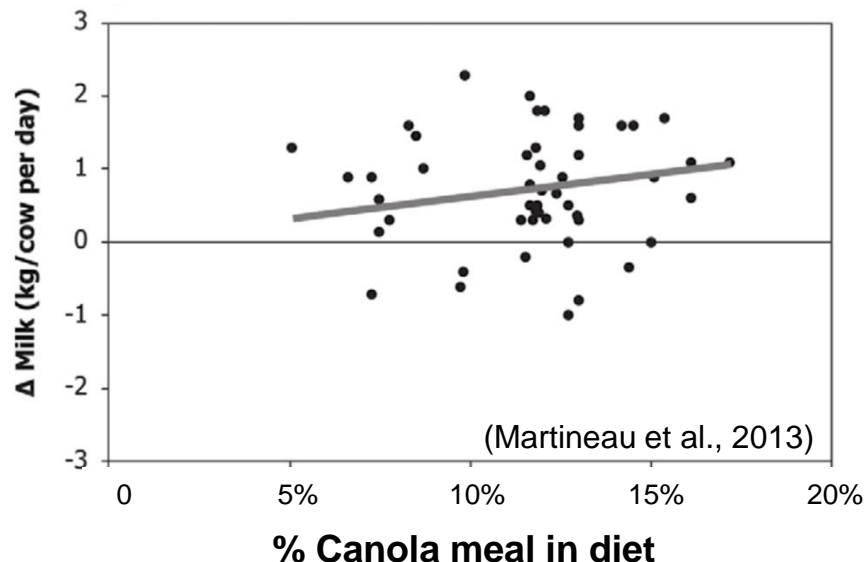
Results:



Opportunity 3:

Use canola meal to help increase performance of lactating cows, transition cows and calves

- Many studies have compared milk responses to canola meal Vs. other protein sources
(Meta-analyses by Huhtanen et al., 2011, Martineau et al., 2013)
- Most milk yield responses positive (42 out of 49 experiments)

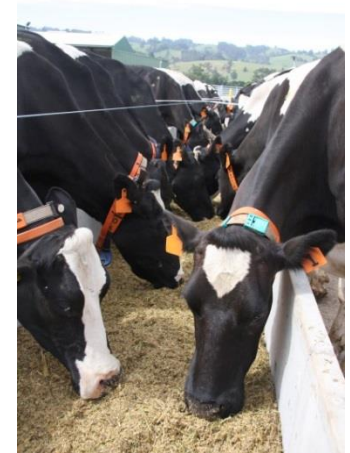
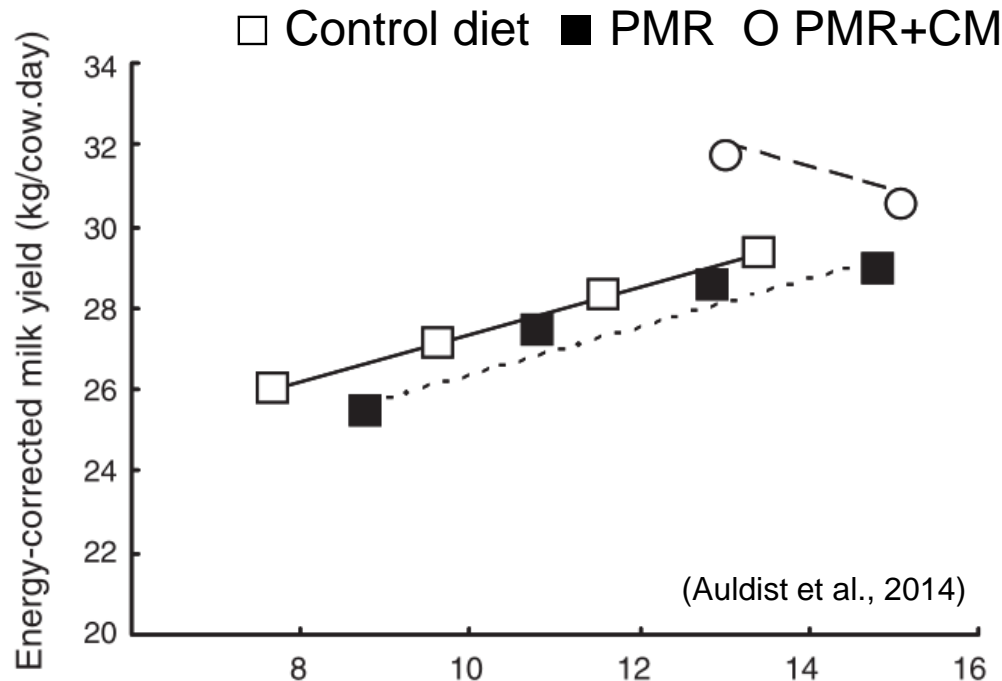


- Feed intake increased in most experiments (35 out of 49)

Opportunity 3:

Use canola meal to help increase performance of lactating cows, transition cows and calves

- Australian study in grazing cows (Auldist et al., 2014)
 - Diet: approx. 8kg DM grazed pasture + 8 to 14kg DM supplement:
 - PMR: 32% maize silage, 9% alfalfa hay, 20% corn, 39% wheat
 - PMR+CM: 32% maize silage, 9% alfalfa hay, 20% corn, 23% wheat, 16% CM



Opportunity 3:

Use canola meal to help increase performance of lactating cows, transition cows and calves

- Canola meal is a well balanced source of RDP and DUP
 - Its RDP stimulates microbial protein synthesis in the rumen (with its Amino Acid profile being very similar to milk).
 - While supplying less DUP than some other protein sources, it contains relatively high concentrations of essential Amino Acids: Lysine, Methionine, Histidine
- Canola meal increases buffering capacity in rumen

Australian study in grazing cows (Auldist et al., 2014):

- Proportion of each day rumen pH less than 6.0

	PMR	PMR+CM
@ 12kg DM supplement	0.45	0.34
@ 14kg DM supplement	0.47	0.39

Opportunity 3:

Use canola meal to help increase performance of lactating cows, transition cows and calves

■ Canola meal stimulates feed intake

Australian study in grazing cows (Auld et al., 2014):

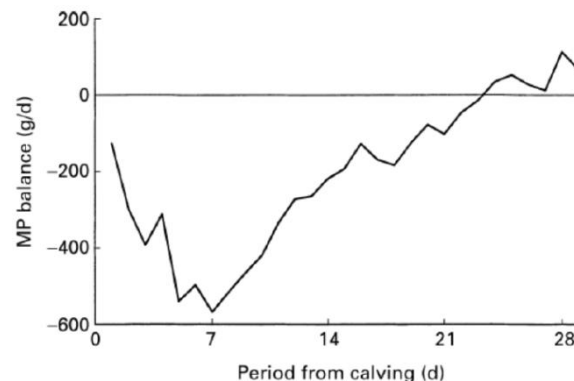
- Pasture intake (kg DM/cow/day)

	PMR	PMR+CM
@ 12kg DM supplement	7.5	8.4
@ 14kg DM supplement	6.2	7.8



■ Canola meal is also very useful as a protein source:

- ☐ in calf diets
- ☐ in transition diets



(Bell et al., 2000)

Key take-home messages

- Australian barley and canola meal are proven, reliable, high quality dairy feeds.
- Barley may be used as the primary grain in dairy cow diets or as a complementary grain in corn-based diets.
- Canola meal is a well balanced source of RDP and DUP which may be used as a primary protein supplement in lactating cow, transition cow and calf diets.
- Consider these three opportunities:
 - Use barley to help convert more RDP to microbial protein in the rumen.
 - Use barley to help improve cow fertility.
 - Use canola meal to help increase performance of lactating cows, transition cows and calves.



Acknowledge support of



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Thank you