

Using lupins and barley in Asian dairy diets

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Increasing value for users of Australian grain

Providing technical training, information and in-market support for international customers

Gathering, analysing and sharing market insights with the Australian industry



Increasing value for users of Australian grain

Technical support

We help you get the most out of Australian grain

Empowering you with technical training, information and in-market support

Market insight

We understand what you need

Identifying the grain quality attributes you need to make the best possible products for your customers

Innovation

We think outside the box

Developing new products, processing methods and technologies to help you meet your customers' changing demands



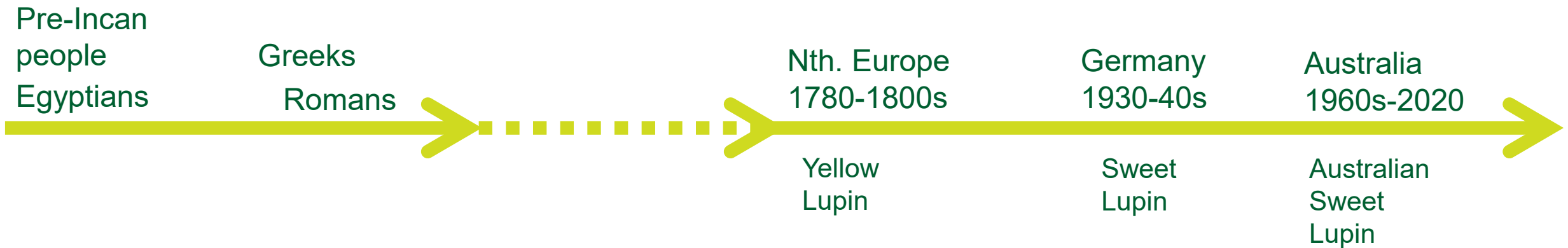
In this presentation

1. Lupins through the centuries
2. Australian lupins as an animal feed
3. Opportunities to use lupins in Asian dairy diets
4. Opportunities to use barley in Asian dairy diets



Lupins through the centuries

- Lupins, peas, beans, lentils, chickpeas, peanuts, alfalfa and soybeans are pulses (seeds of legumes)
- For centuries, lupins have been valued as human and animal foods and useful in grain crop rotation cycles to control weeds and pests and improve soil fertility and crop yields by fixing nitrogen



Lupins today

- Lupins continue to be an important human food in developing countries where protein sources are limited
- Lupins are used in bakery products, pastas and noodles and as a meat additive and dairy food substitute in Australia, Asia and Europe



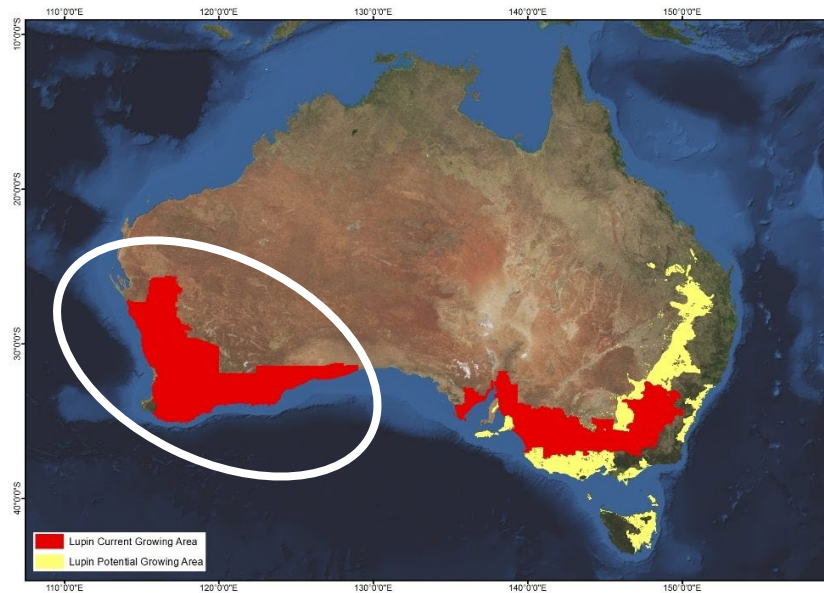
Lupins today

- Lupins continue to be an important human food in developing countries where protein sources are limited
- Lupins are used in bakery products, pastas and noodles, and as a meat additive and dairy food substitute in Australia, Asia and Europe
- Lupins have potential as a human nutraceutical

Characteristic	May assist in control of
Very low Glycaemic Index	<ul style="list-style-type: none">• Diabetes• Heart disease• Obesity
High in soluble fibre	
High in polyunsat. fatty acids	
Gluten free	<ul style="list-style-type: none">• Gluten intolerance, coeliac disease
High in arginine	<ul style="list-style-type: none">• High blood pressure
Lutein, zeaxanthin	<ul style="list-style-type: none">• Macular degeneration of eye(?)

Australian lupins

- Australia produces 80-85% of the world's lupins
 - Approx. 730,000 t per year (ABARES 5-year average to 2018-19)
- Lupins = 30-40% of annual Australian pulse crop
- 80% of lupins are produced in Western Australian grain belt



(AgriFutures Australia, 2020)

Australian lupins

- 70% of the lupin crop is exported to Asia, North Africa and the Middle East for animal feeding
 - Dairy and beef cattle (40%), pigs (40%), poultry, sheep and goats (20%) (White *et al.*, 2007)

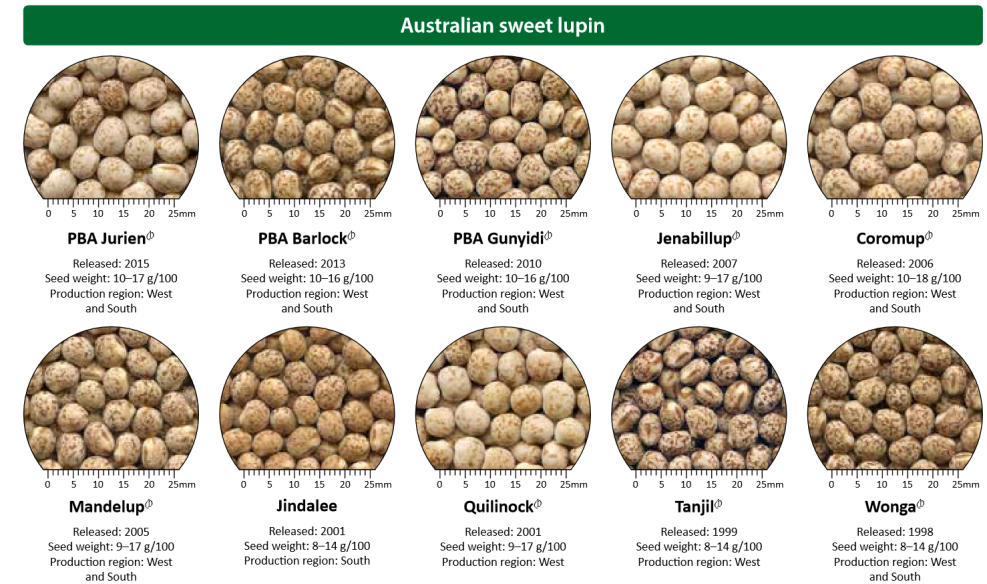


Australian lupins

Narrow-leaved lupin (*Lupinus angustifolius*)

Wild-type	Australian sweet lupin
Bitter seeds	Neutral tasting seeds
Shattering pods	Non-shattering pods
Late flowering	Earlier flowering
Impermeable seed coat	Permeable seed coat

Australia has a very active pulse breeding program. Many varieties of Australian sweet lupin are available to suit different growing conditions.



(Aust. Pulse Variety Guide, 2017)

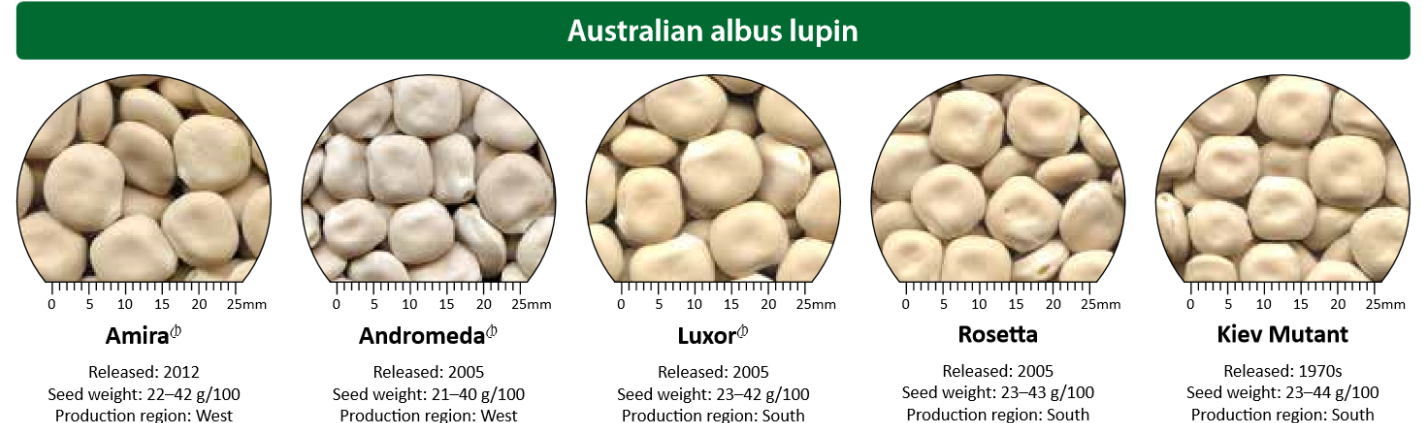
Australian lupins

Albus lupin (*Lupinus albus*)

Compared to Australian sweet lupin:

- Larger, softer seed
- Thinner seed coat
- Slightly higher in protein and fat

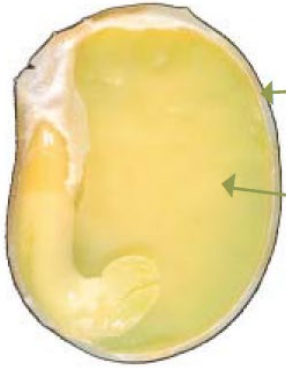
Australia has a very active pulse breeding program. Many varieties of Australian albus lupin are available to suit different growing conditions .



(Aust. Pulse Variety Guide, 2017)

Lupins – an exceptional ruminant feed ingredient

Australian sweet lupin (*L. angustifolius*)



Australian Sweet Lupin
L. angustifolius

Seed coat (hull) - 25%

- Cellulose fibres (bran)

Kernel (cotyledons) - 75%

- Cell wall material - (30%) pectin-like dietary fibres
- Inside cells -
 - Protein bodies (40%)
 - Fat bodies (7%)
 - Oligosaccharides (6%)
 - Starch (<2%)
 - Phytic acid (1%)
 - H₂O (12%)

Each seed weighs 144mg

- 25% seed coat
- 75% kernel

Bulk density: 0.78kg/dl
(similar to that of wheat)

Lupins – an exceptional ruminant feed ingredient

Nutritional value

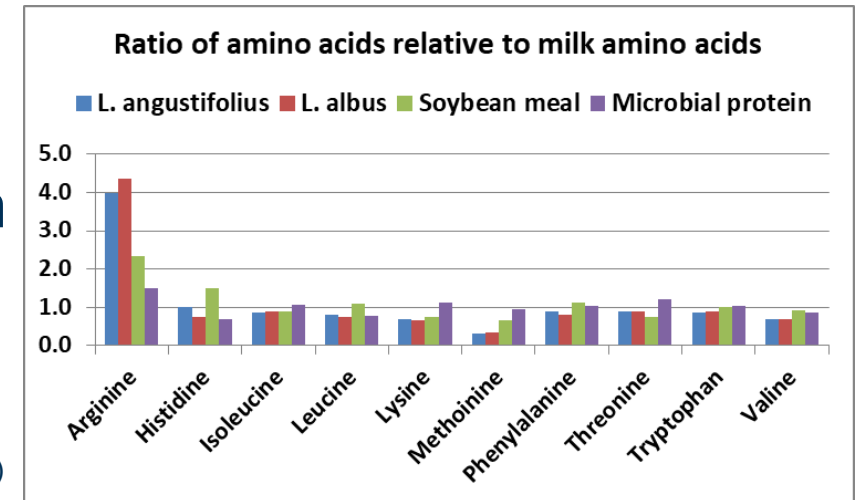
- ✓ Highly digestible feed ingredient
- ✓ High Metabolisable Energy value
- ✓ Very good source of rumen degradable protein (RDP) for synthesis of microbial protein
- ✓ Low in starch and moderately high in neutral detergent fibre (NDF) (unlike other legumes and cereal grains), so they don't depress fibre digestion or voluntary feed intake
- ✓ 6-10% oil which is 75% unsaturated

Lupins – an exceptional ruminant feed ingredient

Nutritional value

- ✓ Good source of minerals, especially P, Mg and S
- ✓ Low dietary cation-anion difference (DCAD) value
- ✓ 10% of nitrogen is non-protein nitrogen (NPN)
- ✓ High in arginine (but low in methionine)

Microbial protein is a highly digestible protein source for the cow with a pattern of essential amino acids very similar to milk



(White *et al.*, 2007)

Lupins – an exceptional ruminant feed ingredient

Nutritional value



Very low levels of anti-nutritional factors in Australian varieties of *L. angustifolius* and *L. albus*

- Alkaloids (<0.2 g/kg DM vs >5,000 - 40,000 g/kg DM in bitter wild types of lupins grown in other countries)
- Tannins
- Saponins
- Protease inhibitors
- Lectins
- Phytate
- Mycotoxins (phomopsins)

Much lower levels than
in soybeans and peas

Lupins – an exceptional ruminant feed ingredient

Typical nutrient specifications

Lupins: 2-feeds-in-1, with high protein & high energy contents

Feed	Crude Protein (% DM)	Starch (% DM)	NDF (% DM)	Metab. Energy (MJ ME/kg DM)
Lupins	34.5	3.1	25.9	13.8
Barley	12.2	56.8	20	12.8
Wheat	12.9	66.9	13.1	13.3
Corn	9.3	72.5	10.7	13.5
Dried tapioca	3	73	11.8	12.3
Soybean meal	48	2.7	13.4	12.1
Peas	25	46.3	16.4	13.3
Beans	28.8	38.3	18	13.2

Lupins – an exceptional ruminant feed ingredient

Storage and processing

- ✓ Easy to handle and store due to low moisture level and a robust seed coat which is impervious to insects
- ✓ For cattle, only need to coarsely roll to reduce particle size to 2-4.2mm. (Lupins require more energy than grain to mill due to harder seed coat). Heat treatment is not necessary
- ✓ Sheep can be fed whole lupins as pasture supplement



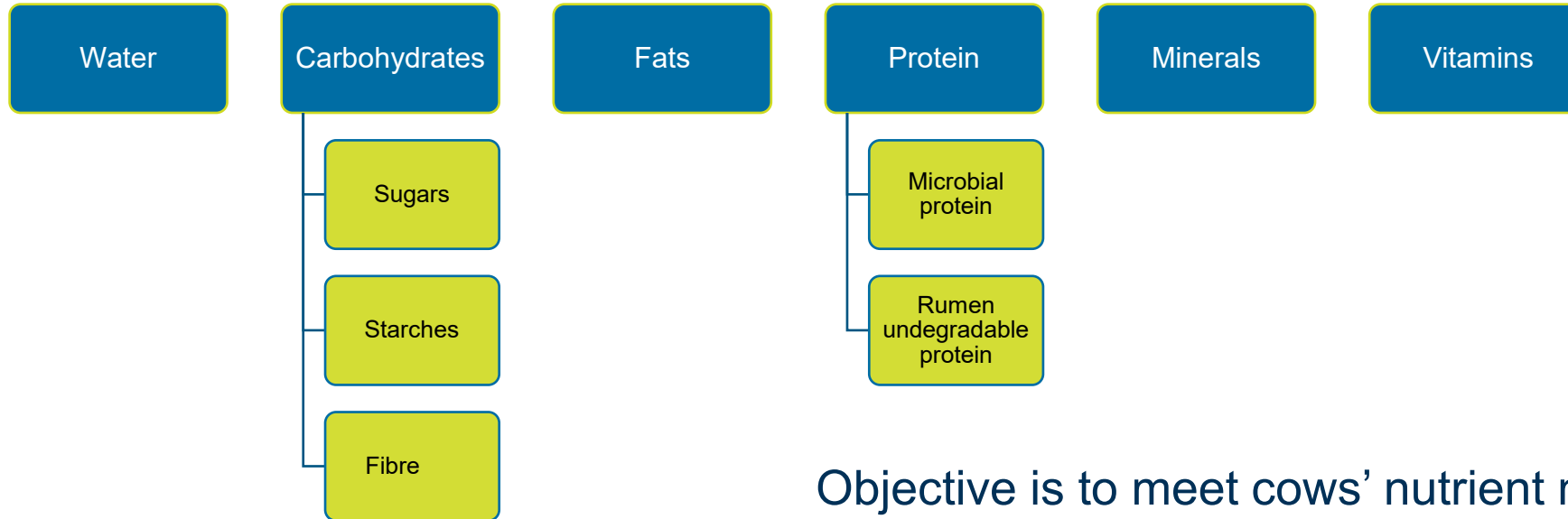
Lupins – an exceptional ruminant feed ingredient

Production responses

- Most dairy studies comparing cows fed lupins vs grains in the milking parlour have found that lupins produced more milk, fat and protein. (Milk protein concentrations tended to be reduced slightly)
- Dairy studies have found that substituting oilseed meals with lupins did not alter milk, fat and protein yields. (Milk protein concentration was reduced slightly)
- Sheep studies have shown that feeding lupins to ewes stimulates ovulation rates



Dairy cows require nutrients, not specific ingredients



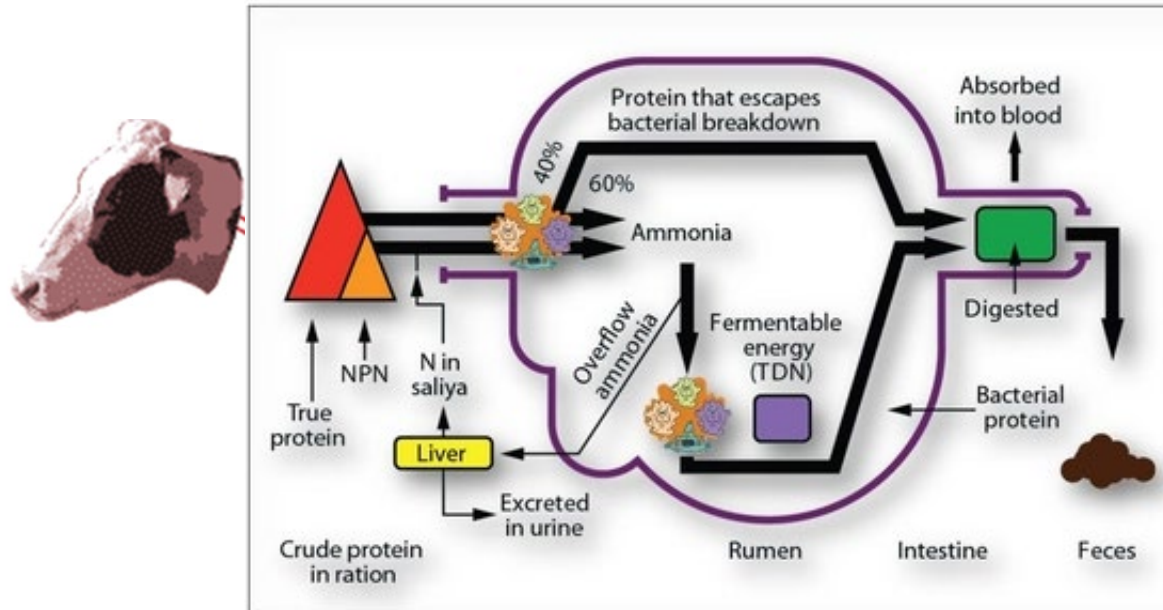
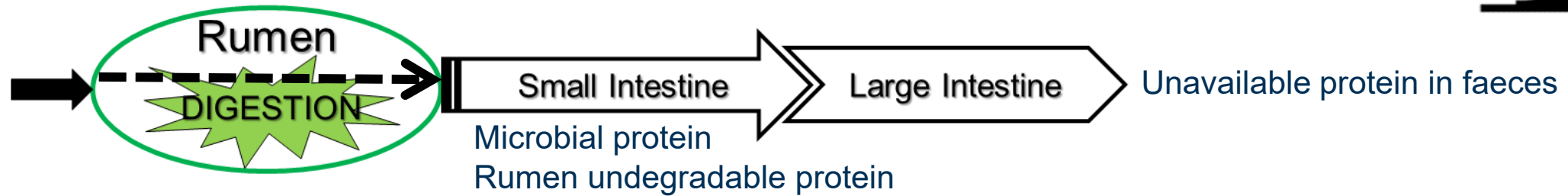
Objective is to meet cows' nutrient needs:

- without excesses
- within cows' intake limit
- with good feed efficiency
- with optimal diet cost and milk income minus feed cost

Feeding dairy cows is all about balance



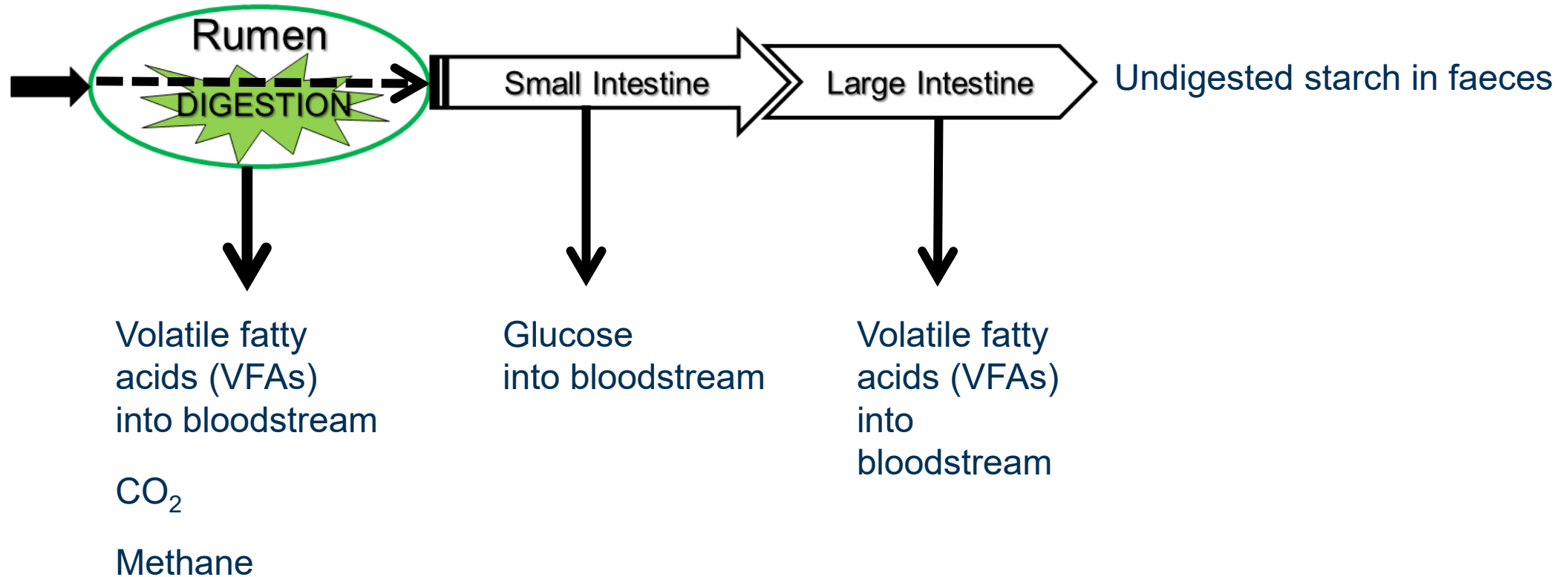
Balancing ruminal and intestinal digestion of dietary **protein**



Feeding dairy cows is all about balance



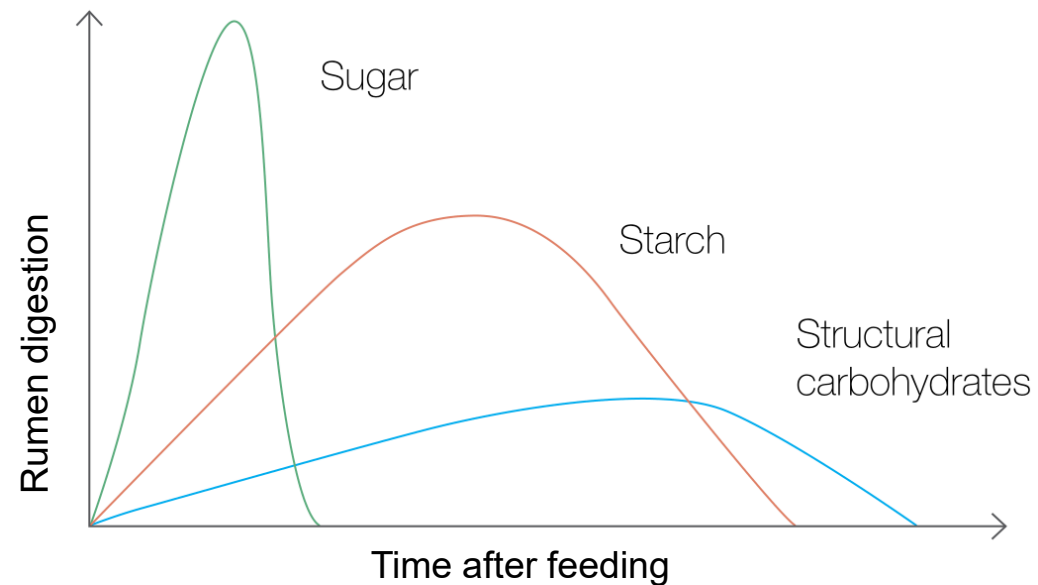
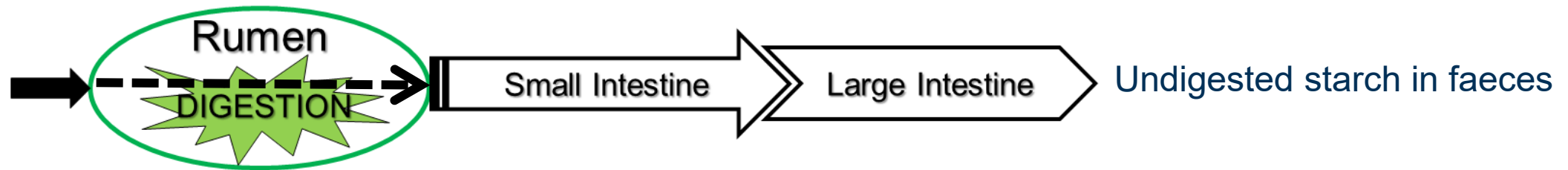
Balancing ruminal and intestinal digestion of dietary **protein**



Feeding dairy cows is all about balance



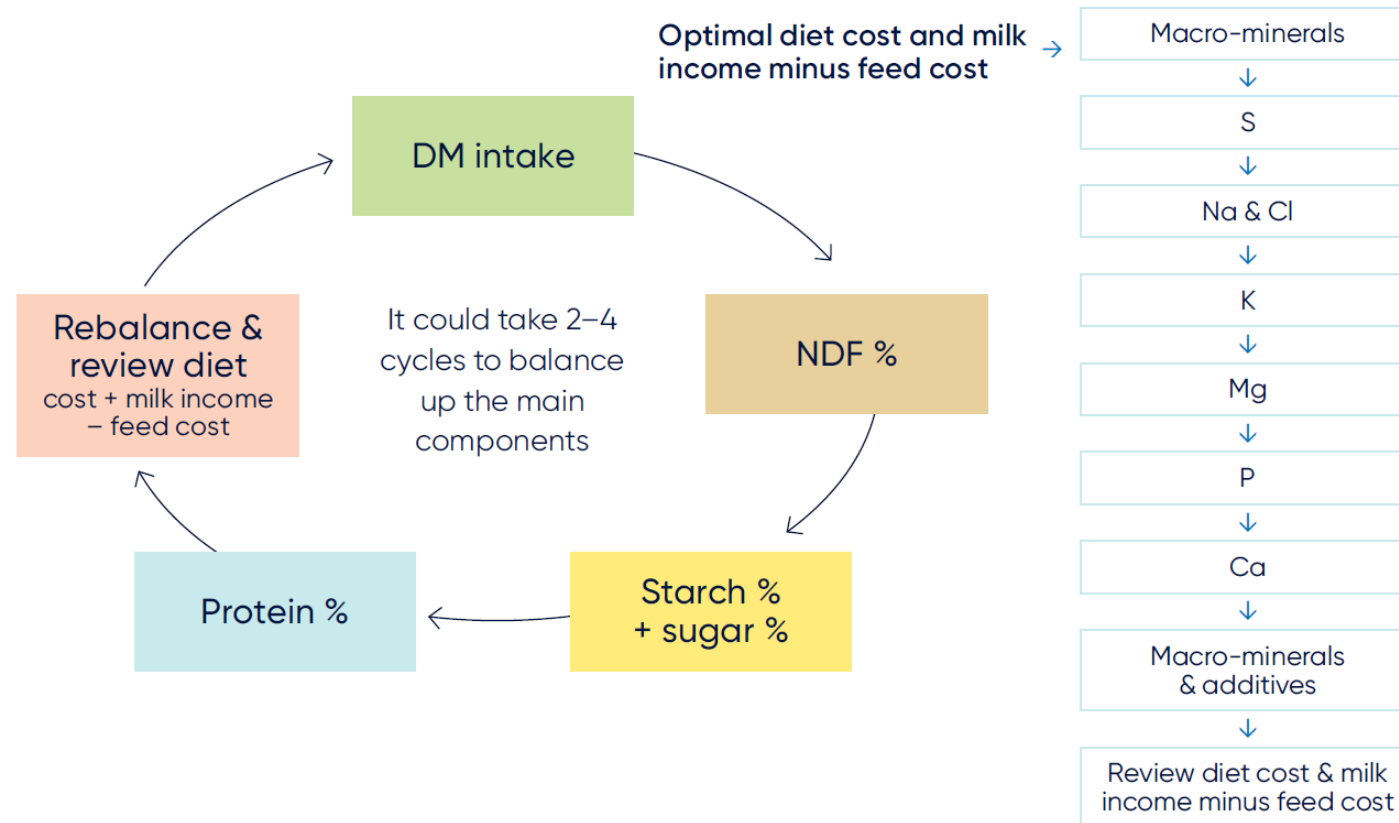
Balancing ruminal and intestinal digestion of dietary **protein**



Feeding dairy cows is all about balance



Designing well balanced dairy diets:



'Adapted from Hannah and Barber, 2007'

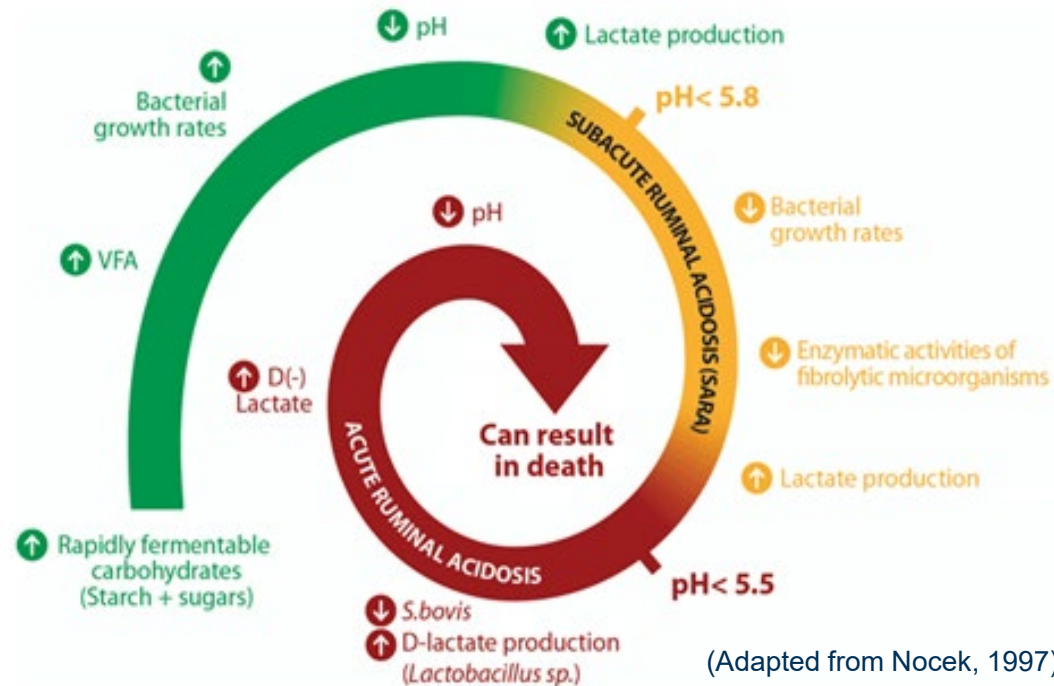
Feeding dairy cows is all about balance



Stable, healthy rumens = Healthy, productive animals

Rumen dysfunction leads to many problems

Descent from healthy rumen function into ruminal acidosis



(Adapted from Nocek, 1997)

- Reduced feed intake and feed efficiency
- Diarrhea
- Rumenitis
- Liver abscess
- Polioencephalomalacia
- Laminitis

Opportunities to use lupins in Asian dairy diets

- 1 As a safe, easy-to-use feed ingredient to increase the energy and protein inputs of cows and young stock fed diets based on low quality forages
 - ☒ Increase diet's metabolisable energy density
 - ☒ Increase dietary protein supply
 - ☒ Synthesise more microbial protein
 - ☒ Increase daily milk yield/growth
 - ☒ Increase cows' daily milk income minus feed cost

Opportunities to use lupins in Asian dairy diets

2 As an alternative protein source, replacing some/all soybean meal/other oilseed meal/peas/beans

- ☒ Maintain dietary protein supply
- ☒ Increase diet's metabolisable energy density

Opportunities to use lupins in Asian dairy diets

- 3 As a safe alternative (low starch) source of energy, replacing some of the starch-dense energy sources in the diet such as corn, cassava/tapioca
 - ☒ Limit starch level of diet to reduce risk of ruminal dysfunction / acidosis
 - ☒ Maintain diet energy density
 - ☒ Reduce inputs of costly protein sources

Opportunities to use lupins in Asian dairy diets

- 3 As a safe alternative (low starch) source of energy, replacing some of the starch-dense energy sources in diet such as corn, cassava/tapioca

Nutrient:	Corn grain	Corn & Lupins (65:35 blend)	Lupins
Dry matter (%)	88	88	89
Metab. Energy (MJ/kg DM)	13.5	13.6	13.8
Crude Protein (% DM)	9.3	18.2	34.5
Starch (% DM)	72.5	48	3.1
Sugar (% DM)	2	4	7.7
Fat (% DM)	4.2	5.2	7.1
Neutral Detergent Fibre (% DM)	10.7	16.1	25.9
Ash (% DM)	1.6	2.2	3.4
DCAD (mEq/kg DM)	-18	18	83

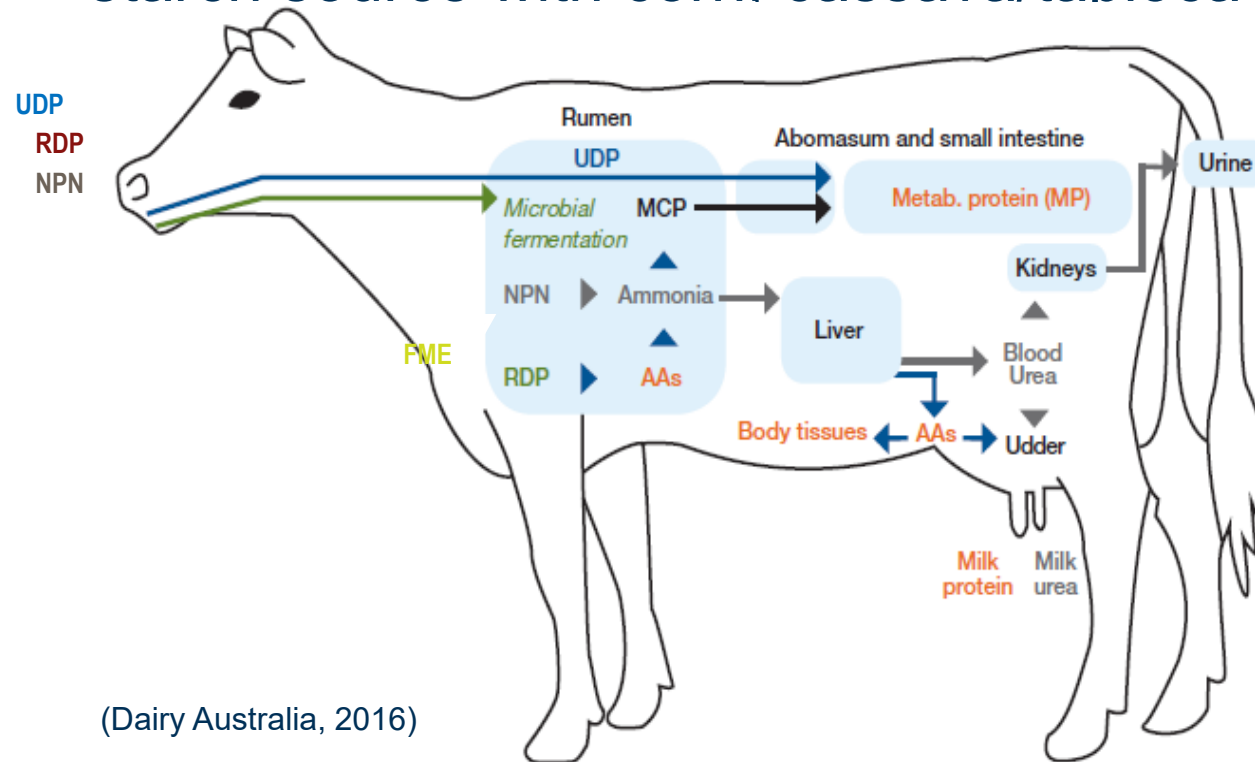
Opportunities to use lupins in Asian dairy diets

- 3 As a safe alternative (low starch) source of energy, replacing some of starch-dense energy sources in diet such as corn, cassava/tapioca

Nutrient:	Barley grain	Barley & Lupins (70:30 blend)	Lupins
Dry matter (%)	88	88	89
Metab. Energy (MJ/kg DM)	12.8	13.1	13.8
Crude Protein (% DM)	12.2	19	34.5
Starch (% DM)	56.8	40.5	3.1
Sugar (% DM)	3.4	4.7	7.7
Fat (% DM)	2.1	3.6	7.1
Neutral Detergent Fibre (% DM)	20	21.8	25.9
Ash (% DM)	2.5	2.8	3.4
DCAD (mEq/kg DM)	10	32	83

Opportunities to use barley in Asian dairy diets

- 1 As the primary starch source or as a complementary starch source with corn, cassava/tapioca etc.



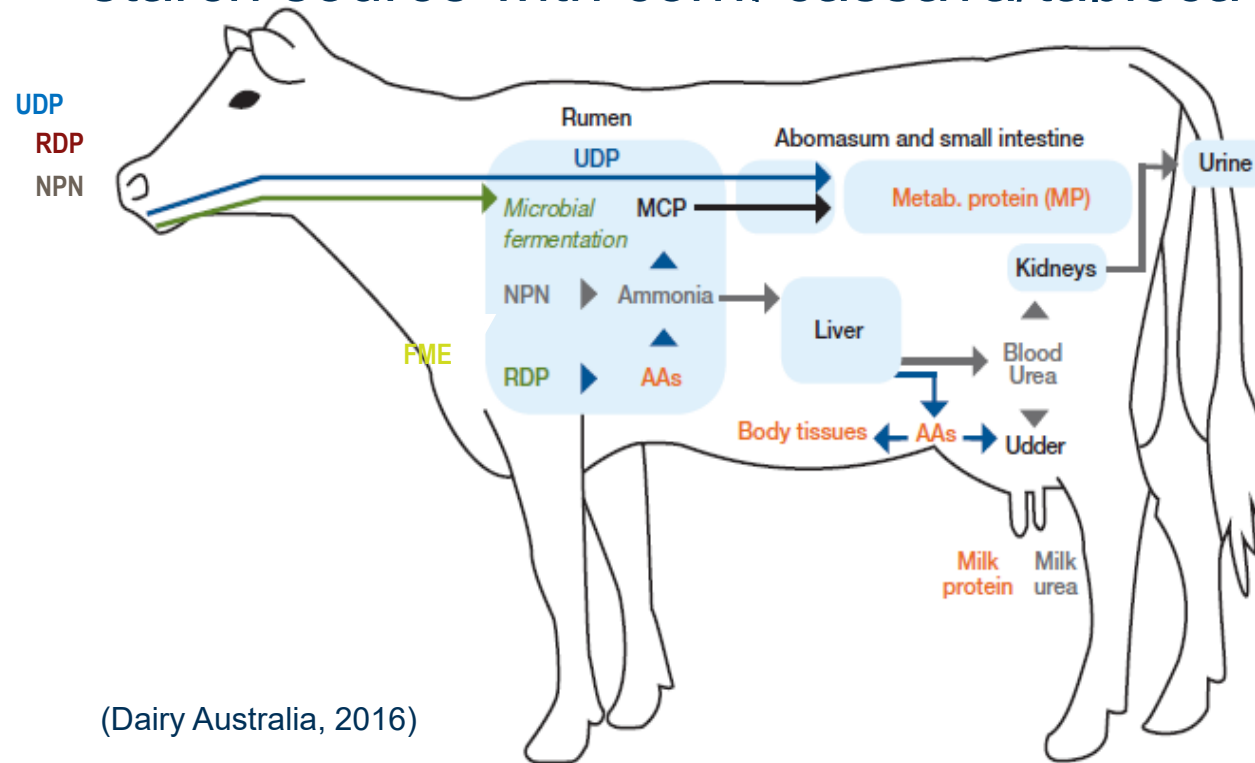
(Dairy Australia, 2016)

! If fermentable ME supply is restricted, →

- Less microbial protein produced in rumen
- More ammonia absorbed across rumen wall and converted to urea in liver
- Most of this urea is excreted in the urine. Some is recycled into rumen as NPN in saliva
 - This process requires energy

Opportunities to use barley in Asian dairy diets

- 1 As the primary starch source or as a complementary starch source with corn, cassava/tapioca etc.



(Dairy Australia, 2016)

- ✓ Achieve a better balance of rapidly, moderately and slowly degrading starch sources in rumen
- ✓ Increase assimilation of RDP as microbial protein
- ✓ Reduce inputs of costly protein sources

Opportunities to use barley in Asian dairy diets

② To help improve cow fertility

Research has shown that dairy cows fed a diet with a higher starch level and low-fat level post calving have increased plasma insulin levels which increases follicular development in the ovary which leads to increased ovulation rate

3 key studies:

- Gong *et al.*, 2002. Effect of dietary-induced increases in circulating insulin concentrations during the early postpartum period on reproductive function in dairy cows
- Garnsworthy *et al.*, 2009. Effect of dietary-induced changes in plasma insulin concentrations during the early post partum period on pregnancy rate in dairy cows
- Burke *et al.*, 2010. Effects of dietary nonstructural carbohydrates pre- and postpartum on reproduction of grazing dairy cows

Key take-home messages

- Australian lupins and barley are proven, reliable, high quality dairy feeds
- Lupins are 2-feeds-in-1, with high protein & high energy contents
- Barley is a great complementary grain to corn
- Consider these opportunities:
 - Use lupins to increase the energy and protein inputs of cows and young stock fed diets based on low quality forages
 - Use lupins as an alternative protein source, replacing some / all soybean meal / other oilseed meal / peas / beans
 - Use lupins as a safe alternative (low starch) energy source, replacing some of starch-dense energy sources in diet such as corn, cassava/tapioca
 - Use barley to the primary starch source or as a complementary starch source with corn, cassava/tapioca etc.
 - Use barley to help improve cow fertility

