

Feeding maize grain to dairy cows

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Key points

- › Grains provide cows with starch for energy.
- › Maize grain is higher in energy density and starch content, and has a slower rate of rumen fermentation.
- › Maize may be useful as a complementary grain to wheat:
 - › When grain is fed at high levels per cow per day,
 - › When cows are freshly calved,
 - › When cows are at increased risk of ruminal acidosis, and
 - › In hot weather.
- › To optimise milk responses from maize grain, processing prior to feeding needs to carefully control particle size.

When maize grain is priced similar to wheat, there is increased interest in including it in dairy cow diets. This fact sheet briefly discusses how grains provide starch for energy, how maize grain compares nutritionally to other grains, and the possible applications for maize grain in dairy cow diets.

As Australian dairy farmers have steadily intensified their operations over the past 30 years by increasing herd numbers and milk production per cow, grain has become a significant component of the diet for most dairy farmers. Today, grain and grain-based concentrates support about 25-30% of all milk produced in Australia, with 95% of dairy farmers feeding grain

at an average of about 1.6 tonnes of grain or grain-based concentrates per cow per year. Larger herds tend to feed higher rates of grain and grain-based concentrates than smaller herds, and some dairying regions tend to feed more than others.

In the 1980s and 1990's, barley and triticale were the pre-dominant

grains fed to Australian dairy cows. However, since the late 1990's, wheat has become more commonly used. Other grains fed to dairy cows, particularly in the more northern dairying regions of Australia, are maize grain and sorghum.

To understand how maize grain might play a greater role in Australian dairy cow diets in future, it is necessary to have a reasonable understanding of how cows consume, digest and absorb nutrients from grain. I will keep this brief!

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Dairy cows are ruminants

Dairy cows are ruminant animals. They have a complex digestive system which enables them to digest fibrous plant material. Their stomach has four compartments (rumen, reticulum, omasum and abomasum), each of which has a specific role to play in the breakdown of feed. Most of the absorption of nutrients in the feed occurs after the rumen when digesta reaches the small and large intestines.

The cow's rumen is a massive fermentation vat (200 litres) which is home to many populations of different microbes which specialise

in breaking down different types of feedstuffs, and provide food for the cow in their own right. Some digest fibre, while others digest sugars and starch. Grains are digested more rapidly by microbes in the rumen than fibrous feeds (but not as rapidly as sugars). The number and proportion of each type of microbe in the rumen varies in response to the cow's diet.

A stable temperature and pH must be maintained in the rumen at all times to maintain thriving populations of microbes and function efficiently. As ruminant nutritionists often say: a happy rumen; a happy cow.

Grains provide starch for energy

When dairy farmers buy and feed grains, they are really buying and feeding starch as a means to increase their cows' daily metabolisable energy (ME) intakes, for milk production or body condition gain.

The starch in grains eaten by cows is digested at three sites: the rumen, small intestine and large intestine.

- > Rumen: Starch digested by the microbes in the cow's rumen is converted into volatile fatty acids (VFAs) and fermentation gases. The VFAs are absorbed through the rumen wall into the blood stream, transported to the liver and used as an energy source.
- > Small Intestine: Starch which escapes microbial digestion in the rumen is washed down undigested into the small intestine. If digested in the small intestine, it yields glucose which the cow can use immediately (releasing more energy than if the starch was fermented in the rumen).
- > Large intestine: Starch not digested and absorbed in the small intestine is subjected to microbial digestion in the large intestine.

Any starch eaten which is not digested is passed out in the cow's manure.

Nutrient value of maize grain compared with other grains

When comparing the nutritional value of maize grain to other grains, the key parameters are energy density, starch content, rate of rumen fermentation and protein content.

Maize grain:

- > has a marginally higher metabolisable energy (ME) density than other grains,
- > is also higher in starch than other grains,
- > ferments at a slower rate per hour in the rumen than other grains, and
- > is generally lower in crude protein (CP) than other grains. See table 1.

Figure 1 Digestive system of a ruminant animal

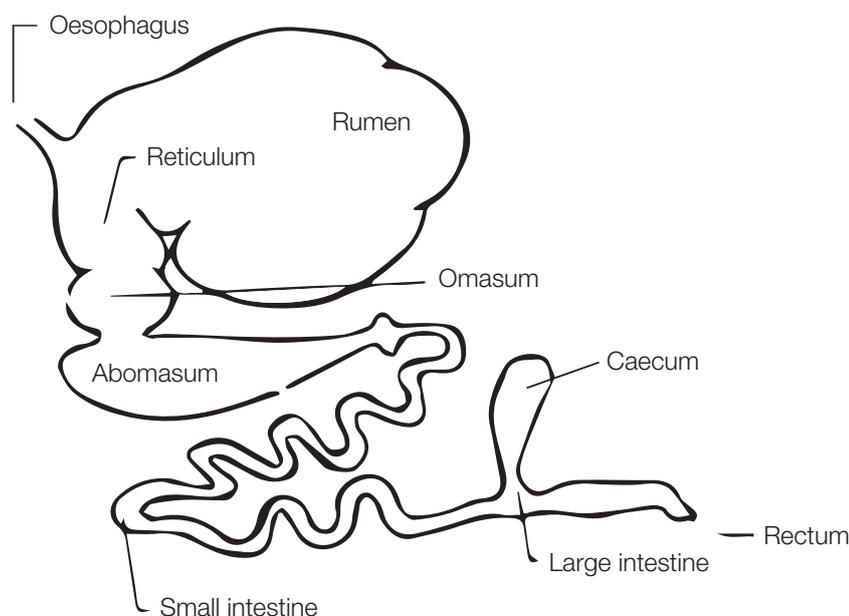


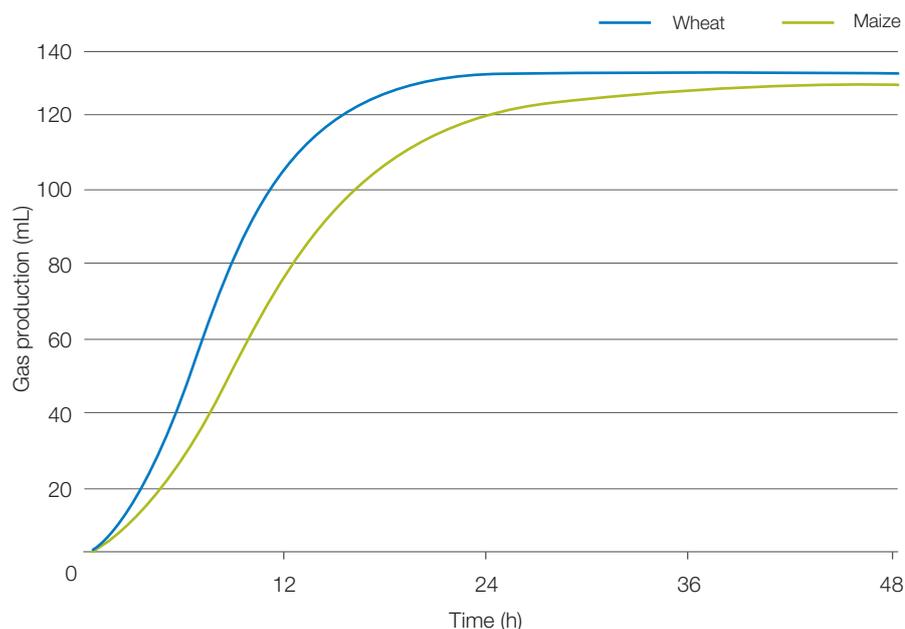
Table 1 Approximate nutrient specifications of grains

Grain type	Energy density (MJ ME/kg DM)	Starch content (% DM)	Rate of rumen fermentation (+ = slow, +++++ = fast)	Crude Protein content (% DM)
Maize	13.5 (12-16)	70-75	+	9.5
Wheat	13 (12-14)	65-70	+++++	12-13
Barley	12 (11.5-13.5)	55-60	+++	12-13.5
Oats	11 (9-13)	45-50	++	11.5-12
Sorghum	11 (7-13)	65-70	+	10.5
Sorghum (steam-flaked)	12 (9-14)	65-70	++	11.5

DM = Dry matter

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Figure 2 Example showing effect of grain type on rate of in vitro rumen digestion



Source: Dunshea et al 2012

Figure 2 illustrates how maize grain ferments in the rumen more slowly than wheat, as measured by the amount of gas produced during microbial digestion.

The rate of fermentation of grains varies with cultivar. For maize grain, it depends on whether the endosperm is vitreous (slower digesting) or floury (faster digesting).

If maize grain is fed at a high rate / cow / day, additional rumen degradable protein and undegradable protein supplementation will be required to meet cow requirements.

Possible applications for maize grain in dairy diets

Incorporating a slower digesting source of starch such as maize grain in milking cow diets may be potentially beneficial in several ways:

As a complementary grain to wheat when grain is fed at high levels per cow per day

Research at Vic - DEDJTR's dairy research centre at Ellinbank has found that at high levels of grain / grain-based concentrate feeding, replacing some of the wheat with a slower digesting

source of starch such as maize grain can, in some situations, help cows maintain a more stable rumen pH, avoid the milk fat depression often seen when diets high in wheat are fed, and produce more milk.

Maize grain is the preferred grain to be fed in combination with wheat. A grain-based concentrate fed to a high production herd at say 8 to 10 kgs per cow per day could, for example, include a mix of two-thirds to three-quarters wheat and one quarter to one third maize grain, plus a protein supplement such as canola meal and other ingredients.

Whenever cows are at increased risk of ruminal acidosis

Whenever a dairy herd has an increased risk of ruminal acidosis, and where a moderate to high level of grain / grain-based concentrate is being fed, replacing some of the wheat with a slower digesting source of starch such as maize grain may help mitigate that risk.

For freshly calved cows

If practical to do so, feeding cows a slower digesting source of starch such as maize grain in their first 3-4 weeks after calving may help them more easily overcome feed intake suppression experienced early in lactation.

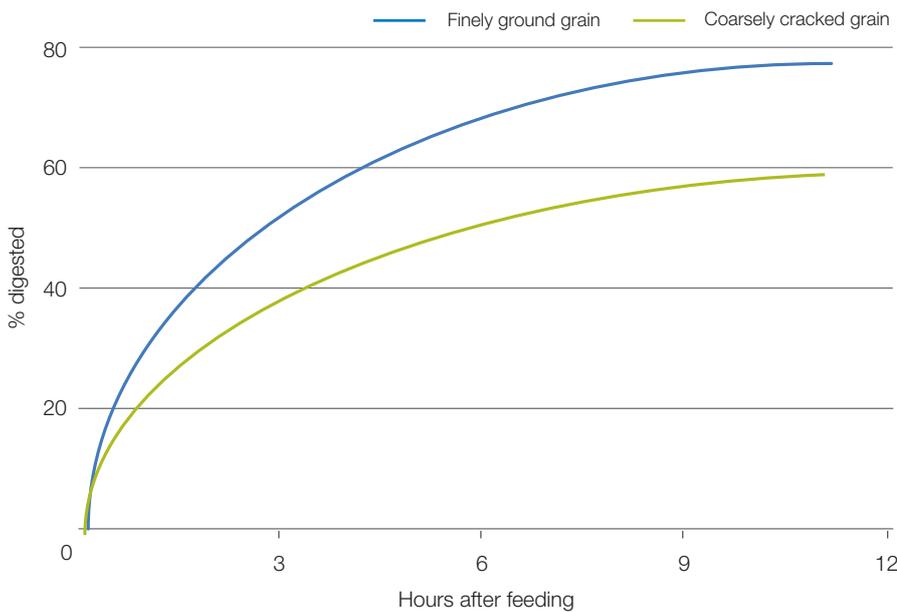
In hot weather

Hot weather reduces a cow's appetite (and energy intake), reduces their ability to digest and absorb feed nutrients and requires them to burn more energy to try to keep cool. With its relatively high energy density and low fibre content, inclusion of some maize in the diet may help to reduce the risk of acidosis, reduce the heat load on the cow and maintain the cow's daily intake of metabolisable energy and other nutrients to support milk production.



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Figure 3 Example showing effect of grain particle size on rate of rumen digest



Processing maize grain prior to feeding to dairy cow diets

With maize grain, as with other types of grain fed to dairy cows, the rate and extent of starch digestion in the rumen versus the intestines, and how much of the starch is lost in the manure, depend on the extent to which its particle size is reduced during processing prior to feeding. See Figure 3.

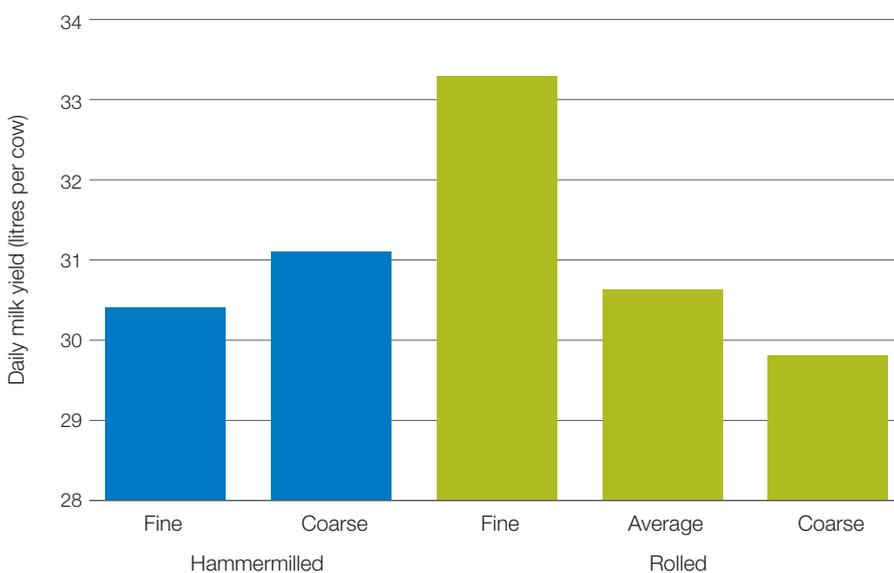
Three types of mills are commonly used to reduce grain particle size in stockfeed mills and on dairy farms which mill their own grain. These are roller mills, disc mills and hammer mills.

The best options for milling maize grain for grazing dairy cows were explored at NSW DPI's Wollongbar Agricultural Institute in 2002. Maize grain was processed in one of five different ways before being fed to early lactation cows at 6 kg / cow / day for several weeks with high quality pasture.

As shown in Figure 4, fine-rolling maize resulted in significantly higher yields of milk and milk protein than other forms of processing but the lowest milk fat concentration. Coarse hammer milling resulted in the highest fat yield. Cows fed coarse-rolled maize had much higher faecal starch levels than cows fed maize processed other ways. Milk protein concentrations, cow liveweights and pasture intakes were similar.

Dairy farmers who choose to process maize grain on farm need to ensure their mill is up to the task, regularly monitor its performance and regularly service it. A disc mill may be a better option for processing maize grain than a roller mill. Alternatively, processed maize could be sourced from a stockfeed mill.

Figure 4 Daily milk yield of cows grazing ryegrass/prairie grass pastures and supplemented with 6 kg of maize-based concentrate



Source: 'Best options for milling maize grain supplements for grazing dairy cows'. B. Granzin. NSW DPI website: www.dpi.nsw.gov.au/agriculture/livestock/dairy-cattle/feed/research/milling-maize

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