Grain feeding for ruminants

Key points

- Barley, oats, triticale, maize and wheat grains are high energy, highly palatable feeds that can provide a valuable source of nutrients for ruminant animals (sheep, cattle, deer and goats).
- Grains provide an excellent source of nutrients, however economic benefits from grain feeding will be maximised by careful feeding and an understanding of the nutrient requirements of the stock class being fed. Grains can be successfully fed to ruminants provided the grain feeding principles in this handbook are followed.
- Maximising profits from grain feeding requires a thorough understanding of how ruminants digest grains, because grains are very different to other feeds such as pasture, silage or hay.
- We must take *extreme care* when feeding grain to ruminants to avoid major animal health problems or stock deaths. Feeding high rates of grain inappropriately to hungry animals increases risk of ruminal acidosis or "grain overload". Guidelines of how to avoid ruminal acidosis are provided in this section.

1. Basic nutrition for grain-fed ruminant animals

a) Gastrointestinal tract ("gut") types for different animals

- Sheep, cattle, goats and deer are ruminant animals which means that they have a series of four stomachs within which they process fibrous feed.
- "Rumen" is the generic term used to collectively describe the first and second stomachs (reticulum and rumen) in ruminant animals.
- Pigs, poultry, horses and humans have one stomach = monogastrics.

- Horses and rabbits are "hind gut fermenters", meaning that they utilise poorly digestible feed by fermenting fibre in the caecum (an enlarged area of the hind gut).

b) Basic Rumen function

Rumen = an enlarged portion of the front part of the gastrointestinal tract of sheep, cattle, goats and deer.

- Functions as an equivalent of a 'brewers vat', or fermentation chamber, housing billions of rumen microbes – bacteria, protozoa and fungi – kept constantly warm at 39°C.
- Feeds (pasture or supplements) are added to the rumen (or 'vat') as an animal ingests and swallows feed.
- Rumen microbes ferment the *feed* to produce

Volatile fatty acids
*(Used by animal for **energy**)*

Rumen microbial protein
*(Digested in intestines, supplies **amino acids** to animal)*

<u>The aim of optimising ruminant nutrition is to feed rumen microbes well</u>

= *Correct amounts of* ***Protein*** + ***Energy*** + ***Fibre***
+ ***Minerals / Trace elements*** + ***Fat***

An *incorrect* balance of feed nutrients may contribute to:

- Sub-optimal rumen microbial growth
- Inefficient rumen fermentation with poor yields of microbial protein
- The wrong mix of volatile fatty acids (VFA)
- Decreased liveweight gain, wool, milk or velvet production
- Increased risk of animal health challenges

2. Grain as a feed for ruminants

The nutritional profile of grains is summarised in the table found in Appendix 1.

a) An excellent source of fermentable energy

- Grains contain high concentrations of starch, a rich source of energy for rumen microbes and, indirectly, for the animal.
- The types of volatile fatty acids (VFA) produced in the rumen of grain-fed animals are slightly different to those found in the rumen of non-grain fed animals. Greater concentrations of one VFA, **propionate**, supports more efficient conversion of feed to meat, milk, wool and velvet for grain-fed animals.

b) Moderate to low crude protein (CP) source (depending on requirements of the stock class)

- Crude protein (CP) concentrations in grains are relatively low compared with forages, with concentrations ranging between 9-16% DM.
- Low concentration of CP in grains is ideal for balancing high crude protein (CP) levels found in pastures during spring and autumn, also in high quality grass or lucerne silage.
- Different stock classes need different amounts of protein, with pregnant and lactating animals, and those growing at rapid rates of liveweight gain requiring more protein (and energy) than other classes of animals. If grains are fed as a relatively small proportion of the total diet, with the balance as good quality leafy forage, for most stock classes a protein deficit is unlikely to limit production. Exceptions include high producing dairy cows during early lactation or when grain is fed together with other low protein feeds such as maize or cereal silage, or poor quality forage during a drought.

c) Low to moderate concentrations of neutral detergent fibre (NDF)

- Grains contain lower concentrations of neutral detergent fibre (NDF) than those found in forages. Ruminant animals require a source of fibre to maintain effective rumen function. Low concentrations of NDF can reduce efficiency of rumen function and may increase risk of ruminal acidosis (grain overload). Grains must ***always*** be fed together with a source of fibre, e.g. relatively mature pasture, hay, straw or silage to optimise production responses and minimise risk of animal health problems. Oat grain provides the highest levels of NDF and maize the least NDF in every kilogram of dry matter.

  Concentrations of NDF required to support optimal rumen function are generally greater for cattle than for sheep.

d) High concentrations of phosphorus, low concentrations of calcium and sodium

- Grain-fed stock classes with an above average requirement for calcium and sodium may require mineral supplementation. Dietary calcium requirements are increased by rapid skeletal growth (young stock growing rapidly), by lactation and during the latter stages of pregnancy.
- Supplemental calcium is delivered usually as limeflour (calcium carbonate) blended with grain. Salt or sodium bicarbonate are common sources of sodium blended with grain.

  Contact one of the PGG Wrightson nutritionists for further nutritional advice to ensure appropriate integration of grains into the diet of different stock classes.

Grain fill influences the nutritional profile of grains:

Plumper grains

- More starch = more fermentable energy (higher metabolisable energy), lower NDF and greater nutrient density and value.
- Good energy density, suited to balancing high crude protein pastures or crops.

- Lower crude protein percentage due to a greater content of endosperm (starch) relative to outer husk (fibre and protein).
- Increased risk of ruminal acidosis problems if not managed correctly.

'Skinny', poorly filled grains

- Less starch = less fermentable energy (lower metabolisable energy), more fibre.
- Relatively poorer source of fermentable and metabolisable energy.
- Typically higher CP%

Grain feeding rates for different stock classes

It is difficult to apply a set figure to each stock class, because utilisation of grain and appropriate type of grain is determined by a wide range of animal, management and farm factors that will differ markedly between businesses. Grains may be sought either as an emergency feed in times of feed shortage (drought etc.) or strategically to complement a pasture based diet of, for example, dairy cows. Each situation must be judged on its own merits therefore the advice from one of the PGG Wrightson nutritionists should be sought before recommending feeding rates.

Processed vs unprocessed grains

For cattle, grain will almost always require processing before feeding, with the exception of oats that can be fed unprocessed.

Sheep and deer don't generally need their grain to be processed, however processing may in some situations slightly improve the utilisation of nutrients within the grain.

Processing grains can increase the risk of acidosis
– **undertake with care!**

Grain processing for sheep and deer

- Maize wheat, triticale, oats and barley grains do not generally require processing before feeding. Animal productivity has been reported as potentially better when these grains are processed for sheep under feedlot conditions.
- Sheep are better at utilising whole grains than cattle (sheep chew their feed well before swallowing, cracking the outer layer of grain, and re-chew grain during cud chewing).
- For sheep, whole grain is better than processed for rumen health because whole grain stimulates more chewing (meaning saliva is added). Whole grains are more easily picked up from the ground than processed grain, enhancing utilisation rates of grain.
- Whole grain breaks down more slowly in the rumen, reducing the risk of rumen acidosis in sheep

Grain processing for cattle

- Unlike sheep and deer, cattle **DO** require wheat, triticale, barley, and maize to be processed to optimise grain utilisation.
- Oats generally do not need processing for cattle but a light roll can improve nutrient utilisation

Methods of processing

- For cattle, aim for methods that crack, crimp or break grains into fewer than 4 fragments. Fragments of grain should just fall apart when handled. 'Flour' should not be present.
- Overprocessing increases risk of ruminal acidosis and variable rates of intake. Processing methods that produce ***very fine particles*** (e.g. hammermilling) can ***increase the risk of ruminal acidosis*** (and sometimes reduce palatability also). Dusty, overprocessed grain will reduce the acceptance and consumption of grain by dairy cows, as well as making the milking shed an unpleasant environment for staff.
- Underprocessing increases risk of loss of grain fragments in the dung of cattle.

- Other methods such as soda grain treatment (e.g. through Keenan mixer wagons) are a good way to process grain but not a practical option for most producers.

Additives for grain

For some stock classes and in some (but not all) circumstances, grains may require the addition of some nutrients or minerals.

Reasons for adding minerals or additives to grain may include:

- Nutritional balancing (e.g. extra calcium or sodium)
- To reduce risk of ruminal acidosis (grain overload). Some grain additives will potentially reduce risk but won't prevent ruminal acidosis from occurring if risk of ruminal acidosis is high – e.g. if stock are offered high rates of grain and/or the total diet is deficient in NDF. This is an extremely important point to remember; **no additive will fully protect animals against the effects of ruminal acidosis**.

Requirements for additives will depend on the type of stock class, how much grain is being offered and other types of feed in the diet. A PGG Wrightson nutritionist can advise regarding the need for additives based on the specific requirements for your clients' stock class.

Additives commonly associated with the feeding of grains

Contact one of the PGG Wrightson nutritionists for specific, quantitative additive recommendations for different stock classes.

- **Sodium Bicarbonate**

  Sodium bicarbonate is added to grain for two key reasons:

  - As a rumen buffer
  - As a source of sodium to balance the relatively low levels of sodium in grains.

  Sodium bicarbonate must be well mixed with grain to be effective. *DON'T* feed bicarbonate to dry dairy cows before calving because this can increase problems with milk fever and other metabolic disease around calving time.

- **Salt**

  Salt (sodium chloride) is added to grains mainly as a source of sodium to balance the low levels of sodium in grains. It is a cheaper source of sodium than sodium bicarbonate however salt does not act as a rumen buffer. Salt encourages stock to drink more water and indirectly may slightly reduce risk of ruminal acidosis by this process.

  Salt can sometimes help to make grain more attractive to shy feeders.

  Note: salt should never be included with grain destined for feeding to springer dairy cows before calving. Salt increases risk of a condition called udder oedema which makes the udders of calving cows (especially maiden heifers) swollen and hard.

- **Magnesium oxide**

  Magnesium oxide can reduce risk of rumen acidosis, working particularly well when fed in conjunction with sodium bicarbonate.

  Magnesium oxide is also a source of magnesium when stock require supplementation to prevent metabolic disease.

- **Limeflour**

  Limeflour is finely ground limestone (calcium carbonate) added to grain as a source of calcium, balancing the relatively low concentrations of calcium found in grains.

  Limeflour is not a buffer and will not help prevent ruminal acidosis.

  Note: Unless specifically advised to do so by a veterinarian or nutritionist, don't blend limeflour with grain destined for feeding to springer dairy cows before calving.

- **Rumensin and Bovatec**

  Rumensin and Bovatec are both ionophore rumen modifiers registered for use in cattle. Ionophores slightly alter the profile of rumen microbes and change proportions of volatile fatty acids

(VFA) present. Ruminal changes can improve feed conversion efficiency, as well as *potentially* reducing risk of ruminal acidosis.

NOTE: Neither Rumensin nor Bovatec have a registered claim to reduce risk of rumen acidosis.

Rumensin and Bovatec require careful and thorough blending with grain – if this cannot be achieved, it is better not to use Rumensin or Bovatec at all as **these products can be potentially toxic to ruminant animals if recommended dose rates are exceeded.**

- Seek guidance from a PGG Wrightson nutritionist for rates and appropriate circumstances for use for each of these products.

3. Preventing ruminal acidosis when feeding grains

GRAIN FEEDING AND RUMINAL ACIDOSIS (GRAIN OVERLOAD)

Grains are characterised by low concentrations of neutral detergent fibre (NDF) and high concentrations of starch. Well managed, these attributes favour exceptional animal performance.

As for any feed, "too much of a good thing" can reduce animal productivity and possibly cause animal health problems.

a) Grains and risk of acidosis

Ruminal acidosis (grain overload) means that the pH of the rumen drops from the normal range of 6.2 to 6.7 to less than 5.8. The low pH is caused by too much acid accumulating in the rumen.

Abnormally low rumen pH can cause:

- Rumen microbes to no longer effectively digest fibre, reducing appetite and lowering feed conversion efficiency.
- Fewer rumen contractions and movements, which further reduces appetite.
- Damage to the wall of the rumen (rumenitis). If microbes grow into and through the rumen wall, microbes can enter the bloodstream and pass to the liver and lungs where abscesses can form.

- Diarrhoea (scouring) and fluid loss from the animal. If animals can't drink enough to compensate for fluid loss they become dehydrated. Dehydration causes the eyes to sink inwards and animals appear weak and wobbly.
- Laminitis (a form of lameness caused by damage to the blood vessels that supply nutrients to the hoof).
- Systemic acidosis. As the rumen pH drops below 5.0, the pH of the blood and vital organs also starts to drop. Death occurs at rumen pH 4.5, due to systemic acidosis.
- Death can occur without any pre-emptive clinical signs if stock have sudden access to large quantities of grains.

b) Gradual adaptation by animals to grain feeding

- The types of rumen microbes required to effectively digest grains are very different to those found in the rumen of pasture or forage-fed ruminant animals.
- Given time, typically 7 to 10 days, the types of rumen microbes will gradually change from those able to ferment forage to those able to ferment starch.
- Until the adaptation is complete, ruminant animals are at greater risk of ruminal acidosis.

  NOTE: Wheat will generally require a longer adaptation period than other grains, up to 3 weeks in some cases.

- **Lactating dairy cows**
  - *Open trough or trailer, 'free choice' feeding of grain.* This is an unsuitable way to feed grains on their own to dairy cows. For open trough feeding, grains must be blended with other less palatable feeds (e.g. PKE) to reduce rate of consumption and risk of ruminal acidosis. Contact a PGG Wrightson nutritionist regarding suitable ratios of PKE to grain to best suit your clients stock class and feeding situation.

- *In-shed feeding systems.* Feeding grains through an in-shed feeding system is managed by gradually increasing rates of grain on a daily basis. For calving cows, grain feeding rates can be increased as cows transition from the springer mob to colostrum mob and finally to milking cows.
- *Partial mixed or total mixed ration (PMR or TMR).* This is the ideal way to feed grain, with processed grains blended with other feeds such as silage, PKE or hay or straw. As part of a mixed ration, cattle can't sift or sort grains out from other feeds, reducing the risk of ruminal acidosis and improving the sustained and balanced delivery of nutrients to the rumen microbes

- **Dry stock**

  For dry stock, where grains are fed on the ground or on top of conserved silages, key steps include:

  - **DO feed grain out as a long narrow line,** allowing all animals to feed simultaneously
  - **DO feed out grain** in the absence of animals THEN introduce animals to the paddock. Avoid feeding grain in the middle of a mob of hungry stock.
  - **DO feed out grain every day.** Feeding every other day, or three times a week will increase risk of ruminal acidosis.
  - **DO make sure stock have access to an adequate supply of good quality water.** Sporadic access to water causes a variable appetite, increasing risk of ruminal acidosis.
  - **DON'T** allow very hungry animals to access grains, even when per head rates of grain feeding are low. Hungry, dominant animals will compete for grain, eating grain at substantially greater rates than the 'average' daily allocation while submissive animals miss out.
  - **DON'T** feed grain as a sole feed in the diet. Provide access to *pasture, crop stubble, hay* or *straw* just before or at the ***same time*** as grain feeding.

Saliva is produced when animals harvest fibrous feed and chew cud. Saliva contains buffers including sodium bicarbonate, helping to neutralise acids in the rumen.

- Feeding fibrous feeds together with grain helps prevent hungry animals gorging on grain.
- Sheep are typically able to cope with grain fed as a higher proportion of their total diet than cattle. One of the PGG Wrightson nutritionists can advise further information regarding ratios of grain to forage for different stock classes.

c) Grain processing and ruminal acidosis

When grains need to be processed before feeding – e.g. for feeding to cattle, the type and extent of processing can alter the risk of ruminal acidosis.

Overprocessing of grain where a flour-like consistency is reached increases risk of ruminal acidosis by increasing surface area of grain exposed to rumen microbes.

The ideal target for processed grain is to see grain cracked into four pieces, with the pieces just separating apart when the grain is handled.

d) Types of grain and risk of ruminal acidosis

Some grain types are more likely to cause ruminal acidosis than others. *ALL grain types can cause ruminal acidosis under some conditions.*

Hulled oats	**(*least* likely to cause grain overload)**
Barley, maize, triticale	↓
Wheat	**(*more* likely to cause grain overload)**

- Sheep or cattle that are fed wheat are at greater risk of grain overload - wheat contains more starch and less fibre than other grains and the starch is more rapidly degraded in the rumen than the other grains.

Note: Grain overload can still occur on the 'safer' grains.

Mycotoxins - Toxic chemicals reducing performance

Mycotoxins are potentially harmful chemicals produced by fungi which can be present in grain.

Two groups of fungi that potentially cause animal health problems may be present in grain:

1. Field Fungi (e.g. *Fusarium spp*). These fungi grow on the grain before harvest, being more likely to be an issue when harvest has been delayed as a result of wet weather.
2. Storage Fungi: (e.g. *Aspergillus spp*). These fungi generally grow on grain in storage, and occur if grain is stored at moisture contents above 14% and/or if water has leaked into the silo.

Animal species vary in their susceptibility to mycotoxins with greater care required when feeding mouldy grain to pigs than to cattle. Cattle and sheep can to some extent tolerate mycotoxins because the rumen can partially detoxify the toxins. Low levels of mycotoxin-infested grain can be fed provided the grain is a small proportion of the diet.

Types of mycotoxins most commonly found in dairy feeds and their potential effects on the cow

TYPE	EFFECTS
Fusarium* species** (grain, pasture, hay) • ***Zearalenone • **T-2 Toxin** • ***Deoxynivalenol (DON)***	• Infertility, oestrogenic effects reported for heifers • Decreased feed intake and milk production • Gastroenteritis, intestinal haemorrhage and death • Significantly reduced immune response in calves
Aspergillus species (*grain, silage*) Aflatoxin	• Reduced growth, feed efficiency and liver damage • Risk of transfer to milk for lactating dairy cows

The presence of mould is not a reliable indicator of the presence of mycotoxin. Fungi can be present without associated high levels of mycotoxins. Mycotoxins can be present without visible evidence of fungi.

Key points are as follows:

- The presence of mycotoxins is difficult to demonstrate and to quantify. There are hundreds of mycotoxins already identified and it is thought many more are yet to be discovered.
- Often several species of fungi and several types of mycotoxins are present, working together to collectively cause greater damage to animal tissues and organs.
- As yet there is no on-farm test for mycotoxins. Laboratory analysis to identify mycotoxins is difficult, takes time and is expensive.
- Symptoms of mycotoxin toxicosis can be varied and non-specific, making it difficult to diagnose yet have a significant impact on income.

Symptoms of mycotoxin toxicosis include:

- Rumen dysfunction
- Scouring and ruminal acidosis type symptoms
- Poor immunity
- Reduced milk production
- Increased somatic cell count
- Reduced reproductive performance
- Variable feed intake
- Skin lesions

Low levels of fungi-contaminated grain can be fed, provided the infested grain is a small proportion of the diet. To further minimise potential health risks that can be associated with feeding at-risk grain, a mycotoxin adsorbent such as Mycosorb® can be added to the diet. Mycosorb® works by binding with mycotoxins preventing them from being absorbed. The mycotoxin is then excreted in the manure. Discuss the feeding options for mould infested grain with one of PGG Wrightson nutritionists.