Optimal rumen function is the key to environmentally sustainable cows

The primary functions of the rumen are to break down fibre and synthesise microbial protein. Both of these functions are essential, as much of the energy and protein utilised by the cow comes from the rumen. Good rumen function will ensure optimal feed intake and digestion, while poor rumen function can negatively impact feed intake, health and overall cow performance.

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Formulating the ration correctly and understanding how the individual ingredients in the ration work together can help keep the rumen – and thus the cows – functioning properly. After all, the rumen must be working efficiently and effectively to supply the cow with the nutrients she needs to produce milk and maintain body condition.

The rumen is a large fermentation vat (40-60 gallons in a mature dairy cow) that contains diverse microbial populations (an estimated 150 billion microbes per teaspoon) of bacteria, protozoa and fungi. The warm, moist environment of the rumen is the perfect setting for microbial growth, providing food and excluding oxygen, which is toxic to most rumen microbes.

These microbes, in turn, produce enzymes that digest fibre, starch and protein into many metabolites, primarily glucose, small peptides, ammonia and gas. This enzymatic activity of microbes is especially important for fibre digestion, as the rumen is the only location in the cow's digestive tract where fibre will be digested; the rumen microbes, rather than the cow herself, produce the enzymes responsible for fibre digestion. The rumen and its ability to digest cellulose from fibre are some of the cow's most important evolutionary advantages.

Feed intake and digestibility

If rumen function is impaired, fibre digestion is also impaired. The digestion and passage of fibre through the rumen dictates how 'full' the cow feels and, as a result, how much she eats. Feed intake and digestibility determine how much energy is available to rumen microbes for growth and to the cow for milk production.

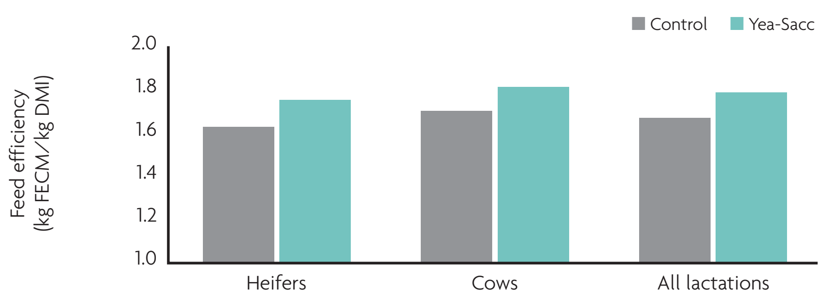
Microbes utilise glucose and ammonia to support growth, with volatile fatty acids (VFAs) and more microbes as the end products. The cow, in turn, uses the VFAs and the microbial protein produced by microbes in the rumen for energy and to support milk production, maintenance, immune function and reproduction. The cow depends on rumen microbes to fulfil many of her energy and protein requirements.

For the rumen to function properly, the conditions of the rumen must be optimal. One of the main causes of rumen upset is acidosis (i.e., rumen pH less than 6), which is often caused by high-starch rations or small-particle feeds. Starch is rapidly digested into organic acids and gas by the rumen microbes.

Excess starch and a build-up of organic acids can lower the rumen pH. Over-processed forages will not provide the cow with sufficient long particles and, as a result, will not stimulate rumination. Rumination produces saliva, which contains sodium bicarbonate and buffers the organic acids produced during fermentation in the rumen, preventing acidosis.

Feed additives, such as live yeast culture, are frequently included in rations to help to stabilise fluctuations in rumen pH. Particle size, along with other aspects of feed delivery and animal housing – such as ration mixing, feeding times and social interactions between animals – can impact feeding and rumination behaviour and rumen function.

Fig. 1. Effect of dietary inclusion of live yeast (Yea-Sacc) on feed efficiency (kg FECM/kg DMI) in Holstein dairy cows (adapted from Steingass et al., 2007).



Poor fibre digestion

Poor fibre digestion due to rumen upset or an imbalanced ration can lead to reduced feed intake and increased amounts of undigested fibre in the faeces.

If the cow eats less feed, and if that feed is less digestible, her energy supply will decrease, subsequently affecting her ability to produce milk. Reduced milk fat and laminitis are two of the most common symptoms of subpar rumen function and can be linked to low rumen pH.

The main driver of rumen function is the ration fed to the cow. Along with the

Continued on page 12

Continued from page 11
forages, grain and protein sources included in the ration, other small inclusion ingredients can have a major impact on rumen function.

Dietary inclusion of live yeast, such as Yea-Sacc (Alltech Inc), can rapidly promote an anaerobic environment, helping desirable, fibre-digesting microbes to proliferate and efficiently colonise feed particles, resulting in improved fibre digestion.

Yea-Sacc also stimulates lactate-utilising bacteria, which helps to reduce the acid load in the rumen and avoid significant drops in rumen pH, creating an optimal rumen environment. Cellulolytic bacteria then thrive and generate more energy for the cow. This creates a more efficient and complete digestion of the ration, particularly the fibre portion, leading to improved feed efficiency (Fig. 1).

Return on investment

Feed additives should be selected for their ability to meet the needs of a particular ration and for their return on investment, usually in the form of improved milk production or reduced feed costs.

Yea-Sacc is a proprietary strain of the live yeast Saccharomyces cerevisiae, with specific rumen activity and its benefits are supported by a plethora of controlled animal performance data (Table 1).

Along with its important role in feed digestion and milk production, rumen function is also a factor in the environmental impact of producing milk. During normal digestion in the rumen, gas – primarily carbon dioxide and methane – is produced by rumen microbes. Methane formed during rumen fermentation can make up to 40% of a dairy farm's carbon footprint.

While there is no denying that livestock production contributes to global greenhouse gas emissions, cattle are not the primary drivers of climate change – but even so, the agricultural industry should continue to take steps to ensure maximum efficiency and production while minimising its environmental impact.

Reducing the emission intensity of animal production, amount of greenhouse gases produced per unit of milk or beef, is a marker of production and environmental efficiency.

Reducing methane emissions

Since the rumen is one of the main sources of methane generation, feeding programmes and ingredient selection are critical to ensuring proper and efficient rumen function.

Programmes for reducing methane emissions and a farm's carbon footprint via nutrition and feed should focus on providing feeds that are digestible and that maximise animal production and efficiency. Higher-production animals are more efficient and have a lower carbon footprint than their lower-producing counterparts.

A 100kg increase in milk production per cow per lactation will result in a 3-7% decrease in emission intensity (per kilogram of milk). Increasing animal production through nutrition, management and/or genetics will decrease maintenance energy requirements, thereby increasing feed efficiency and reducing the carbon footprint per unit of milk.

Methane can be directly reduced by including feed additives in the ration. Feeding rumen modifiers can directly reduce methane emissions by altering the biochemistry of the rumen and/or selectively inhibiting methane-producing microbes in the rumen.

Care should be taken to select feed additives that reduce methane formation in the rumen but not at the expense of proper rumen fermentation or animal production.

When feeding the dairy cow, the rumen must come first. The rumen is responsible for a large portion of the cow's supply of energy and protein, and good rumen function is critical to milk production and feed efficiency.

A high-producing cow is one that is fed a well-balanced ration that supports optimal rumen function and milk production, making her efficient, profitable and environmentally sustainable. ■

Table. 1. Effect of dietary inclusion of live yeast (Yea-Sacc) on milk yield and composition in Holstein dairy cows (adapted from Tristant and Moran, 2015).

	Control	Yea-Sacc	SD	P value
Milk yield (kg/d)	35.9[a]	36.7[b]	0.25	0.003
ECM (4% fat, 3.4% CP) (kg/day)	34.3[a]	35.7[b]	0.35	<0.0001
Fat (g/kg)	39.8[b]	38.7[a]	0.3	0.0002
Protein (g/kg)	32.5[a]	32.8[b]	0.1	0.009
SCC (1,000/ml)	1.95[b]	1.79[a]	0.3	<0.0001
Lactose (g/kg)	49.8[a]	50.6[b]	0.09	<0.0001
Urea (mg/l)	0.248[b]	0.239[a]	0.003	0.004