Response Rates to Supplements

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Responses to supplements fed to dairy cows are quite variable. For instance, DairyNZ quotes a range from minus 30 grams MS/kg DM of feed to positive 90 grams MS/kg DM of feed for autumn fed supplements. We'll go through some of the reasons for this variability, supplying some practical guidelines around substitution, milk and condition score (CS) responses.

The answers to variability in responses are in the feeds themselves, the rumen flora, the cows, the way the feeds are handled, and the pasture supply versus demand.

Feeds and rumen flora

Feeding cows really means feeding the rumen micro-organisms. These "bugs" will break down the feeds, extracting energy from the feed while doing that and using this energy for their own growth. There is only one way bacteria can grow, and that is by splitting themselves into two new individuals, each of which splits again etc. To do this, they need both energy and protein first and foremost, and then a whole raft of other (micro) nutrients as well. Cows benefit from this in two ways:

1. The exhaust gasses from the active bacteria (volatile fatty acids) are absorbed through the rumen wall and used as fuel for the cow.
2. The bugs themselves are funneled down into the abomasum and gut, to be digested and absorbed by the cow.

So it follows that different feeds may grow different amounts of bacteria, even different kinds of bacteria, resulting in different amounts of fuel for the cow.

Easily digested feeds with high amounts of energy and low fibre content like grain or potato, allow bacteria to extract a lot of energy in a short period of time, resulting in a high amount of exhaust gasses and large numbers of bacteria. These feeds promote the growth of sugar/starch digesting populations. Sugar/starch digesters need true (long-chain) protein to live and multiply.

Compare this to high fibre feeds like low-quality pasture. These feeds break down slowly because of the time it takes to break down the cellulose component of the cell walls, and they contain less energy. The result is less gasses released and lower numbers of bacteria grown. Different bacteria, specializing in fibre break-down rather than starch break-down grow under these conditions. These bacteria need short-chain protein (Non protein nitrogen (NPN), ammonia and the likes) rather than true protein to thrive.

The cow herself needs protein as well, which she mainly gets by digesting the bacteria grown in the rumen, although some dietary protein escapes the rumen and is digested in the small intestine. Supplying high energy feeds without sufficient protein (and of the right type) may result in low bacterial growth rates which make the feed less efficient in releasing energy to the animal than it could be. At peak lactation, the diet needs to contain 18-20% crude protein (CP); late lactation 14-15% and dry cows need around 12% CP.

Whatever feeds are supplied to the cow, most of these feeds need to be broken down to a small particle size (both by cud-chewing and by bacterial action), small enough to escape from the rumen and down to the lower tract. The critical particle size is around 0.7 mm; any larger and the particle will be held back in the rumen for further size reduction; any smaller and it will pass through.

This is the one of the essential factors governing substitution rates and feed intakes. The longer it takes a feed to be broken down to 0.7 mm sized particles, the longer it stays in the rumen, the less the cow will feel the need to re-fill her rumen, so the lower her feed intake and the higher the substitution rates for that feed.

Feed intake is driven largely by Neutral Detergent Fibre (NDF) content - the more NDF, the longer the break-down process takes and the lower the intake. As a rule of thumb, cows will eat no more than 1.28% of body weight as (rumen-effective) NDF at peak lactation.

Example:

A 500kg cow will at peak eat 1.28% x 500 = 6.4 kg NDF.

At 38% NDF, her pasture intake will be around 6.4 ÷ 0.38 = 17kg DM.

Reduce the NDF to 34% and the intake lifts to 6.4 ÷ 0.34 = 19 kg DM.

A well known “exception” is Palm Kernel Expeller (PKE); at 74% NDF, one would expect low intakes of this feed on the basis of the high NDF content. However there are records of cows eating 12kg PKE plus 12kg DM Pasture. This is possible because of the small particle size of the PKE; most of the PKE escapes rumen digestion altogether, it is “ineffective”, and shoots straight through to the lower tract for digestion there. As far as the rumen is concerned, it was never there, so the cow will happily keep filling up the rumen with other feeds.

Concentrate type feeds are generally characterized by low NDF levels, small particle size and high energy content, all aimed at low substitution rates and increasing intakes over and above those that can be achieved with pasture and forages, without much impact on pasture intakes. Forage supplements on the other hand are mostly higher NDF, and their purpose is usually a high substitution rate, causing a reduction in pasture intake (pasture-saving effect) in times of pasture deficit.

To recap this section: Feeds need to be broken down to 0.7 mm particles before they can leave the rumen. The more fibre in a feed, the longer this will take, the lower the response rate that can be expected. The higher the energy content of the feed, the more energy that can be released to the cow and usually the faster the feed breaks down in the rumen, to produce a higher response rate. However without the right amount, and the right type of protein, the break-down process will slow down, regardless of fibre content, and the response rates will reduce.

The cows

Bodyweight, condition score (CS), stage of lactation and genetic merit (BW) are the main cow factors determining intake and response rates to feeds.

- The larger the cow, the more she can generally eat, because intake is determined by both bodyweight and feed NDF%.
- The skinnier the cow, the more she'll be driven to partition feed to body fat rather than milk production and vice versa (a fatter cow is more likely to divert energy to milk). This drive to partition to body fat away from milk increases with increasing lactation length, so it'll be harder to get a milk response in late lactation than in a fresh cow.
- Genetic merit is the fine-tune switch: the higher the genetic merit of the animal, the higher the levels of circulating growth hormone, and the more she'll be inclined to partition available energy to milk production at the cost of body weight, even in late lactation.

Feed handling

Response rates to feeds can look low if wastage is high. It is not always easy to spot, however it would be quite common to lose 20%, even up to 40% of fine chopped silages (grass, maize and especially whole crop) by trampling into the ground if fed on wet pastures in the spring.

Secondary fermentation in the stack by poor compaction, poor covering or poor face management, leads to large amounts of energy vented off as heat before the cow can even get near it. Secondary fermentation also reduces feed palatability, which in turn leads to wastage and lower feed intakes and again lower response rates.

Grains are going to be poorly utilized by the animal if they are milled either too fine (feed refusal because of dust) or too coarse (incomplete digestion). Grain stored in damp conditions can go mouldy, which reduces palatability and can result in mycotoxin contamination.

Sudden dietary changes are not well tolerated by the rumen population. Rumen bacteria are specialists; one strain is only able to digest a certain type of feed. Changing abruptly from say a high fibre forage diet to a diet containing a high amount of grain isn't going to work. The bacteria required to break down grain simply aren't present in large enough numbers; they have to breed up and this takes time, at least a few days. The same even goes for a switch from one forage to another, say from a pasture diet to a lucerne silage or grass silage diet. Rapid changes will result in a large percentage of the feed passing through the cow undigested. Only a gradual transition from one diet is going to allow proper adjustment of bacterial populations and hence maximize response rates.

Pasture supply vs demand

In a pasture based system, forage supplements are usually aimed at filling a temporary pasture deficit. Concentrates can be used to increase cow intakes without affecting pasture/forage intakes by much and so do not help much in increasing pasture covers. On some farms, stocking rates are set so high the pasture can never keep up with feed demand, and some form of supplement is continuously fed. As long as there is a pasture deficit, reasonable responses should be expected. However, if there is already a pasture surplus, offering more forage is only going to result in high wastage of supplement, pasture or both and the response rates will be very low or negative. This effect may be less severe in the case of feeding concentrates, but nevertheless it is still there.

Rules of thumb

Knowing there are numerous ways for responses to supplements to be downgraded, it is still possible to give a few general rules of thumb for intakes and substitution, and so get at least a reasonable feel for possible responses.

- Most forages substitute 1 for 1 if there is no pasture deficit. In other words, feed 1kg DM of (palatable) forage to a fully fed pasture fed cow, and she'll reduce her pasture intake by 1 kg DM. Quite often pasture energy content is higher than conserved forages, so the cow will end up with a lower overall energy intake and the response rate will be negative.
- In a pasture-deficit situation the substitution rate will be lower. In theory it can go down to zero if there is very little pasture available. In times of a smaller but still significant shortage of pasture, one could assume a substitution rate of 0.7:1. In this case, 1kg DM forage displaces 0.7kg pasture, so the overall intake ends up 0.3kg DM higher than before. (The high substitution is helpful in this case, as cows eating less pasture is exactly what's needed in a pasture-deficit situation.)
- Concentrates work differently. Assuming good energy and protein content, the first 3kg of concentrate may displace 0.3 kg DM forage per kg concentrate fed. The second 3kg of concentrate displaces 0.5kg DM forage each, and anything over 6kg concentrate reduces forage intake by 0.7 kg DM.
  An example: (and forgetting for a moment that concentrate has to be introduced gradually)
  Feed 8kg concentrate to a peak-lactation, 500kg forage-fed cow eating 18kg DM pasture. The substitution will be approx
  3kg x 0.3kg DM + 3kg x 0.5kg DM + 2kg x 0.7kg DM = 3.8kg DM forages displaced.
  This cow will now eat: 18 – 3.8 + 8 = 22.2 kg DM.

The NDF intake rule still applies (1.28% of bodyweight eaten as NDF), so the total NDF intake still has to be below 6.4 kg NDF, or she won't eat as much as predicted. NDF intakes will be around 1.1 % bodyweight in the first 6 weeks of lactation, 1.28% bodyweight around peak, 1.15% in the last 3 months lactation and 0.8-0.9% in the dry period.

Using the above rules, DM intakes and energy intakes can be predicted reasonably accurately. It is then a matter of calculating the amount of energy available for milk-production after maintenance, pregnancy and weight changes to work out possible response rates in kg MS production and in dollars. A judgement call will have to be made on partitioning; excess energy will go mainly to milk in a high BW, fat cow around peak lactation, but mostly to weight gain if she's low BW, skinny and near end lactation.

Given all of the variables, it is no wonder that reported response rates vary. This is also one of the reasons for our use of Udder software. Udder "knows" most or all of these factors and is able to predict physical and financial likely outcomes faster and more reliably than can be done by hand. This enables your Intelact consultant to look at these variables and determine the most profitable scenario.