Dairy Australia

FEED PLANNING

Feeding supplements

MARGINAL MILK RESPONSES AND $ RETURNS

Tactical feeding decisions this spring-summer should be made based on the marginal milk response to supplement fed and the $ returns that you might expect from this investment.

It is critical to understand the difference between marginal and average milk responses.

- **Marginal** milk response is the incremental increase in milk yield obtained from an extra kg of supplement fed
- **Average** milk response is the increase in milk yield averaged across all kgs of supplement fed.

In production economics the principle is to use an input as long as it adds to profit. Therefore, use an input up to the level where the extra income from an extra unit of input just equals the extra cost of that input. All previous units of input add something to total profit.

Marginal thinkers seeking to maximise profit continually ask themselves these questions:

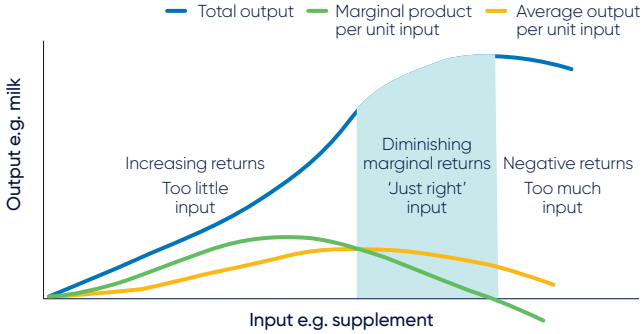
How good an investment is each additional kg of feed?

If I spend another 45 cents per cow per day to feed an extra kg of concentrate, will I get more than 45 cents back in extra milk income?

Seek to maximise profit, not milk production

As is illustrated in Figure 1, as more supplement is fed the milk yield per unit supplement firstly increases, then diminishes in rate, peaks and then declines. This blue curved line is called the 'production function' or production response curve.

Figure 1 Production function



Source: Bill Malcolm, AgVic, 2013

There are no prizes for maximising milk production. What we are seeking to maximise is profit.

The logic of the production function shown in the graph dictates that the most profitable quantity of supplement to feed is somewhere between:

- the level of input (supplement) where the average response is maximized (where the yellow line peaks in the graph), and
- the level of input (supplement) where output (milk) peaks and starts to decline i.e. the point at which the marginal output per unit input becomes negative (where the green line drops below the horizontal axis). Beyond this you get decreasing output with extra input, and can get the same output with less input, so it never makes sense to feed more than this amount.

These two points define the 'just right' input zone (the shaded area in the graph).

The ratio between milk price and supplement cost determines the profit maximising point in the 'just right' zone.

Maximum profit is where

$$\frac{\text{Supplement price}}{\text{Milk price}} = \frac{\text{Extra milk output}}{\text{Extra supplement}}$$

For example, if supplement price is $0.25/kg and milk price is $0.50/kg, profit is maximised when 1kg of extra feed yields 0.5 litres extra milk. (0.25/0.5 = 0.5/1)

So if you can reasonably estimate how much milk will be obtained from an extra kg of supplement, and you know the prices of a kg of supplement and a kg of milk, you can determine the most profitable level of supplement as being where the ratio of supplement price to milk price equals the extra milk output to extra supplement input.

Factors influencing immediate marginal milk responses to supplements

Many factors influence cow productivity at a given time, and therefore the marginal milk response of a particular cow in a herd to each successive kg supplement offered i.e. the shape and position of the production function (production response curve).

Cow factors

- Genetic potential for milk production
- Stage of lactation
- Body condition score
- Lactation number

Grazed forage factors

- Type and species
- Nutritional characteristics
- Pasture allowance

Supplement factors

- Type (conserved forages, concentrates, by-products) and amount offered and consumed
- Nutritional characteristics
- Physical characteristics
- Timing of feeding each day, and how it is fed to cow (in bail, on ground, in a mixed ration)

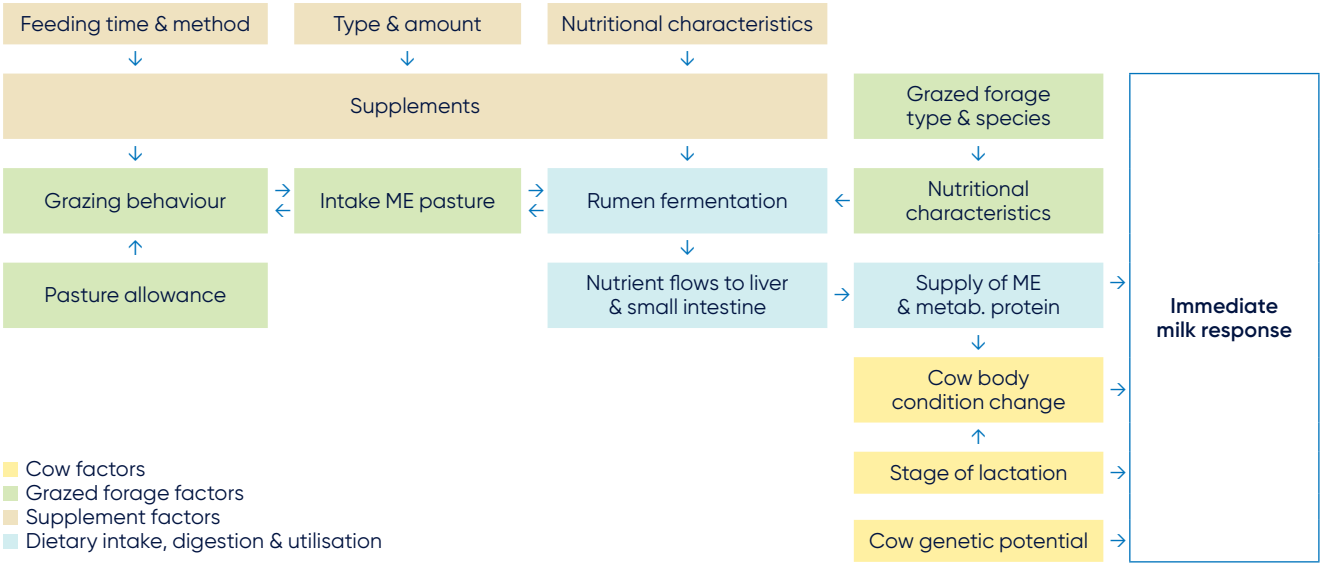
Total diet (grazed forage and supplements) offered to cow, which influence

- Voluntary dry matter intake
- Rumen fermentation of dietary fibre, starch, sugars, protein
- Nutrients flowing to cow's liver and to her intestine for digestion
- Supply of metabolisable energy and metabolisable protein to cow
- Nutrient partitioning to milk vs bodyweight gain

As an example, Figure 3 shows the production functions measured for cows fed grazed pasture and one of two alternative supplements presented as partial mixed rations (PMRs) during one of the feeding experiments conducted at Ellinbank. (Auldist *et al.*, 2013). PMR 1 comprised barley grain, pasture silage, and lucerne hay. PMR 2 comprised barley grain, maize grain, maize silage, and lucerne hay. Both diets were equal in energy density. Cows fed PMR 1 and PMR 2 were offered a daily allowance of 14kg ryegrass pasture.

The production functions for PMR 1 and PMR 2 have very similar shapes to the graph above, with increasing marginal returns followed by diminishing marginal returns and then negative marginal returns. However, they follow different trajectories, diverging from about 7kg supplement DM fed per cow per day.

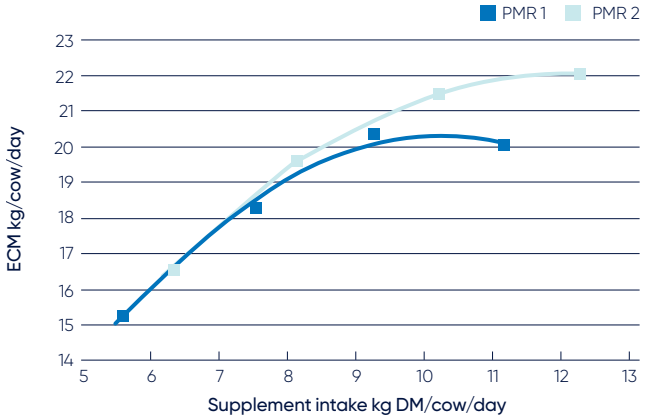
Figure 2 Factors influencing immediate milk response to supplementation are not equal and are not constant



- With PMR 1, marginal milk responses to each additional kg of supplement decline more rapidly than with PMR 2, and at about 10kg supplement, maximum milk yield with PMR 1 is reached. Addition of an 11th and a 12th kg of PMR 1 give negative milk responses (likely due to mild ruminal acidosis).
- With PMR 2, marginal milk responses to the 8th, 9th and 10th kg supplement are greater than with PMR 1 and continue to be positive until 12kg supplement is fed, at which the maximum milk yield is reached.

The better performance of PMR 2 vs PMR 1 is likely to be related to its inclusion of a more slowly digestible starch source (maize) which helped to maintain better rumen function than PMR 1 at higher supplement feeding levels.

Figure 3 Mean daily yields of cows fed supplements



Source: Wales et al, 2013

Assessing marginal milk responses at a herd level

The marginal milk response of a herd to each successive kg supplement offered, as seen in the vat, is a composite of the marginal milk responses of each cow in the herd. It can be challenging to assess responses in a herd comprised of cows which are diverse in terms of their genetics, stage of lactation, body condition score and lactation number without the use of milk meters.

Remember that what we are seeking to maximise is profit. There are no prizes for maximising milk production so an exploration of marginal responses is warranted. This will involve feeding cows an extra kg supplement for several days (holding everything else as constant as possible) and seeing how they respond.

Further reading

If you are looking for some more technical, detailed information on using marginal analysis to make tactical feeding decisions and factors affecting production functions, here are a few items:

- *Farming the business* manual, Section 3. Farm business management (GRDC, 2015)
- *Predicting milk responses to cereal-based supplements in grazing dairy cows*, Heard *et al.* (Animal Production Science, 2016)
- *Feeding concentrates: supplements for dairy cows*, Kelloway and Harrington (Dairy Australia, 2004)
- *Invited review: Production and digestion of supplemented dairy cows on pasture*, Bargo *et al.* (J. Dairy Sci. 86:1–42, 2003)
- *Use of partial mixed rations in pasture-based dairying in temperate regions of Australia*, Wales *et al.* (Animal Production Science, 53:1167–1178, 2013).

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