Feeding Supplements & Practical Ration Balancing
Dr Julian Waters
Guide to Presentation

This presentation was designed to give dairy farmers:

- An overview of non-forage feed supplements and their nutritional components,
- Some basic nutritional principles, and
- Provide a brief example of ration balancing principles.

The text is presented on a per slide basis starting after the title slide.

1. Responses to supplements are influenced by many factors, one of which is the nutrient compositions of supplements being fed. Therefore, it is important to review these for some commonly available supplements. One way of assessing supplements value is to consider their Metabolisable Energy (ME) values, as energy intake is usually the 1st limiting factor in many diets. "Energy" supplements are presented in declining ME order from left to right, and "Protein" supplements in ascending ME order to the right. There is no relationship between energy and protein levels e.g. extracted soybean meal has a high ME and protein content. Protected fats have much higher ME values depending on whether they are calcium soaps or pure fats (32 vs. 37 MJ/kg DM respectively). Note oilseed meal by-products may either result from the oil just being expelled (pressed out) or expelled and extracted (using a solvent). The former have higher ME values due their higher oil contents, the latter higher protein.
2. Feeds do not have fixed ME values nor is ME directly measurable in a laboratory, as it is a biological value, determined by: nutrient composition, degradability, digestibility, nature of the diet, animal performance, and rate of passage through the gut. Therefore, we rely on book values, determined from in vivo (animal) or in vitro (laboratory using rumen fluid and acid) trials. Most feed analyses are now determined using near infrared reflectance spectrophotometry (NIR) calibrations of these techniques derived by using sophisticated statistical techniques. It is important to know if ME values in feed tests have been determined using appropriate calibrations, especially "concentrate" ingredients. Likewise, ME figures for feeds differing significantly from standard values should be treated with caution.
3. ME is a measure of the energy available to ruminants, being that remaining after accounting for losses of Gross Energy (GE) through faeces, urine and gases (methane), and is used in many international feed evaluation systems. Net Energy (NE) is a more accurate measure of energy available for maintenance, production etc., as it also accounts for energy lost in digesting and metabolising feed, but is more influenced by diet than ME, so not suited for manual calculation of energy balance in diets.
4. Crude Protein (CP) is the term usually used to signify protein levels in feeds, but is really the nitrogen (N) level multiplied by 6.25, which does not identify availability. Metabolisable Protein (MP) is a measure of the protein available to ruminants for maintenance, production etc. Like ME feeds do not have a fixed MP, as MP yield is affected by the same factors as ME, and the levels in the graph were calculated based on a number of assumptions. It is also important when balancing diets, to know how much of the CP is available (degraded) in the rumen, how much is not (undegraded, UDP) and how much of the UDP is digested (DUP). About ½ the MP in extracted soybean meal is DUP, but much less than that in canola meals and Distillers Dark Grains & Solubles (DDGS). Choice of

ingredient can be made on whether looking to supply more N in the rumen or DUP post ruminally. All the N in Urea is degradable, and very quickly, so it needs to be used with caution.

5. Neutral Detergent Fibre (NDF) is a measure of cell wall/fibre, and the term was derived, as it is measured by digesting ingredients in a neutral detergent solution, and weighing the remaining residue. Hemicellulose and cellulose are potentially completely degradable, but their actual degradability is reduced by being bound to lignin, and the more lignin in a feed, the less degradable the NDF. Hence, why lush spring pastures are more quickly and completely degraded than mature lignified pastures. Similarly, Soya Hulls contain less lignin than Palm Kernel Expeller (PKE), so are more degradable, hence their higher ME.
6. NDF is not a measure of long/effective fibre, as non-forage supplements are ground or milled prior to feeding.
7. It is useful to also know the nutrient composition of supplements, as this impacts on the overall nature of the diet, and responses in terms of production, condition etc.
8. Minerals are also important but were not covered in the presentation.
9. Identifying what supplements are required for influences the choice of which to use, to best achieve specific objectives. It is important to consider both short and long term benefits, when assessing; whether to supplement, which supplement and financial returns.
10. A detailed review of responses to supplements and supplementation is beyond the scope of this presentation. Cows generally respond to increasing plane of nutrition in early lactation by partitioning most of the increase nutrient supply into milk, and little if any to body reserves (condition). The milk yield response declines as lactation progresses, enabling more energy to be stored as body fat, hence why properly fed cows gain condition towards the end of lactation. Many other factors affect responses including level of substitution of pasture by supplements, and body condition at the start of supplementation. Supplements can also alter milk composition, with fibre and protected fat sources increasing fat levels, and starch and sugars increasing protein levels.
11. This slide identifies some of the factors affecting milk responses.
12. The types of milk yield responses to starting and stopping supplementation are identified by the thick blue line. The flat line is a diagrammatic representation of milk yield without supplements. The cumulative and residual effects may be due to either or both increasing body condition (black) or pasture cover (green) while supplements are fed.
13. Energy (as are all nutrients) is required for Maintenance (keeping cows alive), walking, grazing, termed here as compulsory or fixed costs. Only after the fixed costs have been satisfied, is energy available for milk production, gaining body condition and pregnancy, termed optional or variable costs. The more energy available above the requirements for the fixed costs, the more is available for production (which earns money), and dilutes the fixed costs relative to production and income.
14. Balance is a key concept in nutrition, as it affects feed efficiency, and the limits of production. The water barrel analogy illustrates, that energy is 1st limiting, so no amount of extra protein, fibre, minerals etc. will increase production.
15. Energy yielding nutrients and protein need to be in balance both in the rumen, for the rumen microbes, and post ruminally for the cows. ME results from the Volatile Fatty Acids (VFA's) produced by the rumen microbes plus nutrients digested post ruminally. Likewise MP results from digestion of microbial protein and undegraded protein.
16. There has been a lot of interest in using milk urea as a diet balancing tool, since Fonterra included it with farm milk records. It is affected by many factors, so cannot be used as a sensitive measure. It can be used to decide between supplements based on their starch, sugar and protein levels, with

reference to the target range of milk urea levels. Milk urea will be high on lush spring pasture based diets, due to the high degradable protein and low sugars in the pasture.

17. Kolver & Muller designed an experiment to investigate the performance and feed intake of high producing Holstein cows fed either high quality pasture of a balanced total mixed ration (TMR).
18. TMR cows had higher DM & ME intakes, but protein intakes were similar. DM intake was 3.4% and 4% for the cows grazing pasture and fed TMR diet respectively.
19. TMR fed cows had higher milk yields, as kg milk and milk solids (MS), higher protein : fat ratios than pasture grazed cows. The TMR fed cows also lost less weight, and ended up with condition scores (CS). Fat mobilisation indicators, Beta Hydroxybutyrate (BHBA) and Non-Esterified Fatty Acids (NEFA), were higher in pasture fed cows. Nitrogen was used more efficiently in the TMR fed cows.
20. The authors concluded; only 61% of the lower milk yield was accounted for by a lower DMI, ME was limiting their production, and pasture needs to be supplemented with concentrates to enable milk yields higher than 30 kg milk per cow a day.
21. This slide lists the key drivers in feeding dairy cows, and ranks them according their priority for consideration when reviewing diets and formulating rations.
22. Although it is possible to make rough calculations when reviewing cow diets, sophisticated but easy to use feed rationing programs speed up the calculations, and allow more sophisticated and detailed analysis. Computer programs can do the maths, but don't understand farming and feeding, so it is important to apply one own's knowledge and experience as to whether diets on paper are realistic or not, as in this case is an intake of 134 kg wet pasture able to be grazed by 500 kg cow. The example shows energy to be limiting for a high yielding cow fed spring pasture and PKE. There is a big excess of MP sufficient for 11 kg more milk. Cows in early lactation can respond to increases in MP by increasing milk yield, but if energy is limiting, this will be achieved through increased fat mobilisation.
23. We are often presented with alternatives, requiring "what if" scenarios to be evaluated. In this case 3 kg maize has replaced 3 kg PKE, resulting in a slight increase in energy and decrease in protein intakes. If the extra energy is used for milk, then this would amounts to 0.73 kg milk, with slightly lower fat and higher protein contents, due to starch in the maize replacing fat and fibre in PKE. Although, there may be an increase in milk yield of a slightly higher value (higher P:F), the potential immediate and short term response would not result in an increased revenue (Margin Over Purchased Feeds, MOPF) in this case, due to the wide discrepancy in supplement prices. This type of calculation, while useful, does not consider the whole picture.
24. Mineral levels and balance are also important, and it can be seen maize has less major and trace minerals than PKE. It is important to consider mineral levels and balance when changing diets.
25. Nutrient guidelines are useful when assessing whether diets look sensible, but these should not be considered as hard and fast rules. For example, the starch and sugar levels could effectively be transposed on pasture based diets, as pasture can be high in sugars but is low in starch. High milk yields do not require very high protein diets, as long as the protein is used efficiently (balanced diet), and the amino acid balance of the DUP is similar to cow requirements.
26. Finally, planning is a key process when assessing if or when to feed supplements, and requires a number of key steps, starting with objectives. Wastage of home grown and imported feeds is often underestimated. Feeds should be evaluated based on potential value not costs, and returns on investments need to be calculated.