Dairy Cow Nutrition

Dr. Mike Tame

Introduction

Organic standards require that diets for dairy cows must derive a minimum of 60% of the DMI (dry matter intake) from forage and that the diet must be balanced to provide a high quality product rather than maximising output. As a result, the quality of forage on the organic dairy farm is even more important than on a conventional dairy farm. Consequently, the organic dairy farmer cannot afford to run out of forage. Replacing forage with concentrates is not an option if it means less than 60% of the dry matter is derived from forage. The result is that many organic farmers wait for the grass to "bulk up" before cutting. Unfortunately this often results in conserved forage with both a low digestible energy and low protein content. While it is relatively easy to balance either a low energy or a low protein it is often impossible to balance a deficit of both.

Despite the organic standards requiring a minimum of 60% of the DMI to be derived from forage (on most dairy farms the DMI derived from forage is significantly higher than this), the level of milk derived from forage in organic dairy systems is low at 49.0% and 49.3% (Axient 1999 and OMSCO 2001). There is also a positive correlation between increasing forage quality and higher milk production per cow. There are a number of studies that have looked at the effect of dietary energy on milk quality and animal health. These studies show that high milk fat to protein ratios, particularly in early lactation, indicate an energy deficit, a degree of ketosis and reduced reproductive performance, including calving interval (Tame 2007, Dairy Cow Nutrition review). In order to optimise production and health it is important to feed the rumen rather than the cow.

Effect of forage quality on energy intake and milk production

It has been well established that as the grass plant ages beyond heading date, the D value declines at a rate of approximately three units per week and that this is accompanied by a decrease in DMI of approximately 0.5kg/day. It has also been well established that a new grass plant will initially produce up to five viable green leaves. As new leaves are produced beyond this number, the oldest leaves start to senesce. Older grass plants may only produce three viable leaves before senescence begins.

This Technical Leaflet is one of a series commissioned and prepared by the Institute of Organic Training & Advice (IOTA) as part of its Defra-funded PACARes (Providing Access, Collation and Analysis of Defra Research in the organic sector) project. The PACARes project aims to improve awareness and uptake of organic research by farmers. For more information go to www.organicadvice.org.uk/pacares.htm

The Leaflets aim to provide a summary of the key practical recommendations for organic farming, drawing on the findings of research including IOTA's own Research Reviews commissioned for the PACARes project. Other Leaflets in the series include: Composting, Financial Management for Organic Farms, Nutrient Budgeting, Organic Beef and Sheep Nutrition and Soil Analysis.

defra
Department for Environment Food and Rural Affairs

Clearly, once the required number of viable green leaves has been produced there is little point in waiting for any significant length of time for the crop to "bulk up" as the additional material will comprise leaves in an increasingly advanced state of senescence with a decreasing nutritional value. Furthermore, once the plant is past its heading date it will be producing a flower and stem that becomes increasingly lignified and indigestible. Equivalent data do not appear to exist for clover but it is well established that the D value of clover declines much more slowly than for grass.

Beever and Reynolds (1994) state that the principal sources of energy in forage are derived from water soluble non-structural carbohydrates and the structural carbohydrates in the cell wall (hemi-celluloses and celluloses). These materials are extensively digested within the rumen but as the plant matures and the synthesis of lignin increases, both the rate and extent of digestion decreases. Table 1 shows the relationship between "D" value, DMI and milk production.

What this means in practice is that in order to achieve high energy levels with high digestibility, silage cuts should be made no later than the heading date of the earliest components of the sward.

Table 1: *Approximate relationship between "D" value, DMI, energy intake and milk production.*

D	ME	DMI	Intake	Milk
	MJ/Kg	Kg	MJ	Litres
72	11.5	14	157	17
68	11.0	13	143	14
64	10.5	12	126	11
60	10.0	10	100	6
56	9.5	9	86	3

Figures are for a 600kg cow requiring 5.2 MJ per litre of milk. No allowance is made for weight change.

Clearly, there is a very large advantage to be gained by improving forage quality. Waiting for the crop to "bulk up" before cutting will almost certainly result in lower forage intakes, less milk produced from forage and a need for higher levels of expensive concentrates.

Table 2: *Changes in protein content of grass/clover sward through the grazing season.*

Date: 1995	Protein	Date: 1996	Protein
	%		%
24th May	13.3	**23rd May**	16.7
6th June	16.6	**12th June**	16.4
6th July	18.1	**10th July**	18.9
4th Aug	19.6	**2nd Aug**	19.4
1st Sep	20.1	**11th Sep**	24.2
11th Oct	19.6	**9th Oct**	26.2

Changes in protein content of forage

It has been established that an increasing protein intake, within limits, also results in an increase in DMI. Weller & Cooper (2001) looked at the changes in protein content of a grass clover system through the grazing season and Table 2 shows the changes found in two consecutive years. The implications of this are quite profound for organic farmers, because the changes are opposite to those that occur in conventional systems and they explain why most first cut organic grass/clover silages have low, or very low, protein values and are likely to restrict production levels.

The protein content of the first cut will probably be low. A second cut made as soon as possible after the re-growth has achieved the three leaf stage should have a higher protein content. A third cut made at a similar growth stage should have higher protein content again.

What this means in practice is that in order to achieve higher protein levels more than one cut needs to be made. If possible, three cuts should be made. Whilst this may sound expensive, the higher energy and protein content should result in either an increased production or a concentrate saving to offset the cost (see Table 3).

However, there is also evidence that if energy is provided with the optimum balance of rapidly and slowly available components in the right form at the optimum frequency, then it is possible to operate at much lower levels of protein than is normally considered necessary (Bax 2009 and Tame 1998).

Table 3: *Effect of time of year on energy and protein levels in grass clover swards.*

First Cut	High energy, low protein
Second Cut	High energy, moderate protein
Third Cut	High energy, high protein

Effect of additional forages

It has also been shown that adding another forage, whole crop or maize, to the system increases forage intake by between 1-2kg per cow per day. Adding fodder beet in addition is known to increase the DMI by a further 2 or more kg (Tame 1998). Velik (2006) showed that replacing two thirds of the concentrates with maize silage resulted in only a small, non-significant drop in milk yield, but with a much higher proportion of milk derived from forage.

Throughout the dairy industry acidosis is reported to be a widespread problem (up to 22% of newly calved cows) causing clinical and sub-clinical disease, particularly mastitis, infertility, and lameness (Bax 2009 personal communication). It is also recognised that excessively acid silages should be avoided.

These problems can be reduced by stimulating rumen activity through the inclusion of some forage in the form of long fibre, around 5-7cm long. This will encourage cudding with the production of more saliva, which has a buffering effect within the rumen, helping to maintain a more even pH benefiting fibre digestion. In practice, this means that a proportion of the forage, a minimum of 25%, should be in the form of long cut haylage or whole crop.

Effects of self-sufficiency

The organic ethos suggests that as far as possible a farm should operate within a closed system, i.e. be as self sufficient as possible. In practice this presents some problems. A considerable amount of work has been done at Ty Gwyn (Weller and Jackson 2006) to compare a "self-sufficient system" with a system in which all concentrates were bought in as opposed to being produced on-farm.

The self-sufficient system, of necessity, operated at a much lower whole farm stocking rate, 1.28 LU/ha as opposed to 1.69 LU/ha. Concentrate use in the self-sufficient system was 0.4 tonnes of home-produced cereals per cow per year, while in the other system it was 1.4 tonnes compound feed per cow per year. The milk yield from the self-sufficient system was 7,205 litres per hectare per year as opposed to 11,575 litres per hectare per year. The biggest challenge in the self-sufficient system was to produce enough forage.

As would be expected in the favourable grass growing conditions of West Wales on a limited area of land, the system using bought in concentrates gives a much higher "margin over feed costs" even at current (2009) compound prices of around £320 per tonne. The impact on fixed costs was not assessed and there was no opportunity to measure the potential health advantages of operating at lower yields

Self-sufficiency offers the advantages of long-term feed security and resilience to fluctuations in the price and supply of organic feeds. In applying this information on farm, account needs to be taken of the prevailing grass and crop growing conditions, the cow milking and housing capacity and the availability of land to rent. Options for a more self-sufficient system include renting additional land on which to grow crops and maintaining total milk output by maintaining cow numbers and yield, or increasing cow numbers at a lower yield per cow.

A study in Germany looked at the effect of feeding different levels of concentrates in the summer and showed that when cows had access to grazing for half the day the group fed no concentrates showed only a small, non-significant drop in yield compared with the group fed an average of 1.5kg concentrates.

Efficiency of forage use

A theoretical study (Defra project OF0328 in 2004) based on the experience from the Ty Gwyn work cited above, looked at the factors affecting the production and utilisation of forages in different systems, ranging at one extreme from an all grass system with all concentrates and straw bought in, through a range of systems becoming increasingly more complex and/or self-sufficient.

Again, all the systems used the same land area. Milk output per hectare, stocking rate and proportion of milk from forage were calculated. For each system, three different efficiencies of forage (high, medium and low for both grazing and conserved forage) were examined. The outcome was that the greatest benefit could be gained from improving the efficiency of forage use.

This had a greater effect than changing the system. It was also noted that milk production was greatest from the more complex systems, but that the increase in production was unlikely to offset the increasing cost of that complexity.

The element contributing the greatest benefit is the efficiency of forage use. In practice this means optimising grazing management, avoiding soil contamination, minimising losses in the field, avoiding wastage in the clamp and at the clamp face and avoiding waste at feed-out in the feed troughs.

References

IOTA PACARes Research Reviews (Defra project OF0347, 2007) downloadable from http://www.organicadvice.org.uk/reviews.htm

- **Dairy Cow Nutrition**

Axient (1999). Milkminder League Table – Organic Dairying.

Bax, J. (2009). Personal communication.

Beever, D. E. & Reynolds, C. K. (1994). Proceedings of the 15th General Meeting of the European Grassland Federation.

Defra project OF0328 (2004).

OMSCO (2001). Dairy Herd Survey. Organic Milk Suppliers Co-operative. Monthly Newsletter, May 2001.

Tame, M. J. (1998 and 2007). Personal data.

Velik, M. *et al.* (2006). Joint Organic Congress, Odense, Denmark, May 30-31.

Weller, R. F. & Cooper, A. (2001). Grass and Forage Science. 56. pp.92-95.

Weller, R. F. & Jackson, A. (2006). Organic Farming Guide. IGER, Aberystwyth.

Useful sources of further information

- International open-access archive for research papers on organic agriculture: www.orgprints.org

IOTA is an independent, professional body for trainers, advisers and other extension workers involved in organic food and farming.

For more information on IOTA's work and how to become a member, visit our website at www.organicadvice.org.uk or contact us using the details below. If you are looking for an experienced organic adviser we now have a database of accredited organic advisers on our website.

Institute of Organic Training & Advice, Cow Hall, Newcastle, Craven Arms, Shropshire SY7 8PG
www.organicadvice.org.uk / iota@organicadvice.org.uk / office: 01547 528546

[March 2009]