Optimizing fertiliser use on the dairy farm

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Introduction

The average dairy farmer spends about $35,000 on fertilisers annually. It is the largest item of discretionary expenditure on most dairy farms and hence efficient fertiliser use has a large impact on the overall economic efficiency of the farm. Dexcel economic survey results (2001 to 2004 inclusive) show that the average dairy farmer spends $0.41 on fertiliser per kg MS produced. The top 10%, based on EFS, spend $0.35/kg MS. In other words, the average dairy farmer, producing 85,500 kg MS annually spends about $6,000 more on fertiliser than necessary. If this inefficiency was eliminated it would increase the economic efficiency of the dairy industry by $70-80 m annually.

Possible reasons why the top 10% of dairy farmers are more efficient include: better animal genetics (greater MS production per unit of feed consumed), higher pasture utilisation, and, better soil nutrient management (this includes using the least-cost fertiliser products, farming at not above the economic optimal soil nutrient level and making use of the nutrients in the effluent).

The purpose of this paper is to explore these issues in order to identify those practices which have greatest effect on fertiliser use on the dairy farm.

What does the average dairy farm look like?

Relative to the efficient dairy farm (EDF i.e. the top 10% of farmers based on EFS) the average dairy farm is larger but has a lower stocking rate (Table 1). The EDF produces more MS per cow and per hectare and although the EDF uses about 30% more supplements (made on farm, purchased off farm or grazing off) their total supplement costs are similar. The EFD uses slightly higher inputs of N, P K and S on a per hectare basis, but their total fertiliser costs are lower than the average because of the smaller area. Thus, although their fertiliser costs per hectare are larger, their fertiliser-use efficiency is lower.

This suggests that the EDF is better at converting feed (whether pasture or supplements) into MS and is a better purchaser of supplements. While they use more nutrients

they are not necessarily better purchasers of fertiliser. They have a higher fertilizer use efficiency simply because they have a more efficient biological system.

Table 1: A comparison of the average dairy farm and the 10% dairy farm based on EFS (Data from Dexcel Profit Watch Surveys 2001 to 2004 inclusive)

Measurement	**Average**	**Top 10%**	**Difference (%)**
Area (ha)	97	83	-14
Stocking rate (cows/ha)	2.6	3.1	+15
Total MS (kg/yr)	85,640	95,142	+11
MS/ha	880	1140	+29
MS/cow	333	363	+10
Supplements (kg DM/ha)	2873	3732	+30
Supplements ($)	43,618	44,109	+1.1
Supplements ($/ha)	450	531	+18
Supplements ($/kg MS)	0.51	0.46	-10
Nitrogen (kg/ha)	101	124	+23
Phosphorus (kg/ha)	54	57	+6
Potassium (kg/ha)	54	62	+11
Sulphur (kg/ha)	56	58	+4
Total fertiliser (kg/ha)	265	301	+13
Fertiliser costs ($/ha)	355	398	+12
Total fertiliser costs ($ incl N)	34,505	33,116	-4%
Fertiliser efficiency ($/kg MS)	0.41	0.35	+15

A study of fertiliser use efficiency

To understand this further, a theoretical, 'model' dairy farm was set-up and the theoretical costs of fertiliser per unit MS were calculated for a range in MS production, increasing from 800 kg MS/ha up to 1500 kg MS/ha. The calculations were done for three feed conversion efficiencies: low, medium and high (ie 15, 14 and 13 kg DM/kg MS). One of the important assumptions is that the maximum production from pasture, in the absence of fertiliser N, is 16 t/ha. Once this is exceeded (by the feed demand required to achieve the increasing production targets) then fertiliser N was added into the management (at 10:1 conversion efficiency), but only up to 200 kg N/ha. If further feed was required to achieve the production target, supplements were introduced. All the other assumptions are given in Table 2.

Table 2: Assumptions used to calculate fertiliser use efficiencies

• The maximum pasture production (with no fertiliser N) = 16 t DM/ha
• 14 kg DM is consumed = 1 kg MS produced
• All cows are wintered on
• Supplements are feed on feed pad and nutrients go to effluent block
• Pasture utilization is 80% except for the fertiliser N derived pasture which is assumed to be fully (100%) utilized
• I kg/ha fertiliser N = 10 kg DM/ha and maximum of 200 kg N/ha/yr, applying a cost of $494 urea/tonne on ground
• Soil fertility is at the at economic optimal
• 0.7 kg 20% potassic super per 1 kg MS (at $273/ha on ground) is required to maintain the soil nutrient levels
• 500 kg lime/ha/yr is required to maintain the soil pH at $40/tonne on the ground
• supplements costs at 20 cents/kg DM and assuming no wastage or labour cost.
• 350 kg MS/cow
• One cow produces $11 of nutrients in effluent/yr
• The supplement is maize silage giving $29 of nutrients per tonne DM

With these assumptions, the relationships between fertiliser costs per unit MS and total MS per hectare, for the three levels of feed conversion efficiencies, are shown in Figure 1. Superimposed are the fertiliser efficiencies derived from the Dexcel surveys (see Table 1).

At the most efficient feed conversion ratio (13 kg DM/kg MS — the green line above), it should be possible to get close to 1000 kg MS/ha without fertiliser N or supplements. The fertilizer use efficiency is very high (< $0.20/kg MS). To increase production from this point

it is necessary to include increasing amounts of fertiliser N to meet the feed demand, and accordingly, fertiliser costs per unit MS increases up to about $0.34. Because we have limited the amount of fertiliser N to not more than 200 kg N/ha, further increases in production above 1200 kg MS/ha can only be achieved by adding supplements. This causes the fertilizer use efficiency to decline from about $0.34 to about $0.25 – higher production is being achieved without adding to the fertiliser costs.

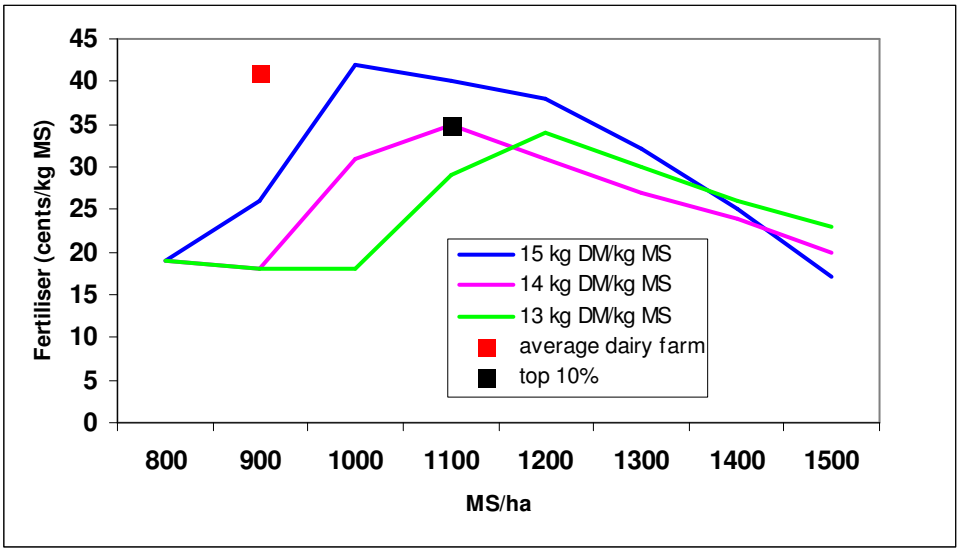

Figure 1: A comparison of the theoretical and actual fertilizer use efficiency on dairy farms

As the feed-use efficiency on the farm declines (in this example from 13 to 14 to 15 kg DM/kg MS), the curve is displaced to the left and the peaks get higher (ie. higher fertiliser costs per unit production at a given production level). A farm with a low feed conversion efficiency (15 kg DM/kg MS), and using 200 kg N/ha, to produce 1000 kg MS/ha has a very low fertiliser conversion efficiency of about $0.43. To summarize: adding fertiliser N decreases the fertilizer use efficiency and this effect is greatest when the feed-use efficiency is low. Adding supplements improves the fertilizer use efficiency.

Comparing these theoretical figures with the fertilizer use efficiencies derived from the Dexcel survey data indicate that there is considerable room for improvement. For example, if the average dairy farmer, producing 85,500 kg MS per annum (880 kg MS/ha) were to improve fertiliser use efficiency to what is theoretically possible, then this would represent a saving of $13,600 annually for a low feed conversion efficiency of 15 kg DM/kg MS, and about $17,000 at the high feed conversion.

Options for improving fertilizer use efficiency

It is obvious from the above that improving animal genetics (ie. more MS produced per unit feed consumed) and pasture management (more kg DM consumed per kg DM produced) will increase the fertiliser use efficiency. These are important improvements that are occurring incrementally over time right across the industry.

There are some more immediate options to improve nutrient use efficiency. These are:

- Using dairy shed effluent as a resource. The average dairy cow produces about $11 worth of nutrients in dairy shed effluent annually. A 500 cow herd represents about $5,500 of effluent nutrients per year! Making efficient use of these nutrients will mean $5,500 less on your fertiliser bill immediately.
- Farm at, not above, the economic optimal nutrients levels. It costs money, and it is bad for the environment, to maintain unnecessarily high soil nutrient levels, for no financial gain.
- Purchase the least-cost fertiliser to supply the nutrients you need and remember old recipes may not work if the soil is out of balance.

Conclusions

Most farmers are spending more, per unit production, than they need to on fertiliser. Improvements in fertiliser use efficiency can be achieved incrementally by improving the feed conversion ratio (kg DM consumed per unit production) and/or by improving pasture management (higher pasture utilisation). In addition there are several immediate and practical means to improve fertiliser efficiency by developing and adopting a comprehensive nutrient management plan for the business.

Acknowledgments

We would like to thank Dr J Roche and Mr Chris Glassey (Dexcel Ltd) for their assistance and input into this paper.