NUTRIENT CONVERSION EFFICIENCY ON FARM – LESSONS FROM OVERSEER® EXAMPLES

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Introduction

OVERSEER® Nutrient Budgets (*Overseer*) is a whole-farm nutrient budgeting tool. A large number of farms already have an *Overseer* analysis. Questioning at *Overseer* courses and meetings, and our analysis of a selection of files indicates an emerging trend regarding nutrient use efficiency: the need for attention to detail in farm management if nutrient use efficiency is to be improved.

A set of *Overseer* files submitted to or generated by the Overseer development group were analysed. There were 4081 files, with 1333 from dairy farms. These files are probably a biased selection of farms and may not represent the 'norm'. In addition, a number of these files were generated where only one or two inputs were changed, and this may also give a bias selection.

This paper presents results from an analysis of nitrogen (N) leaching and N conversion efficiency, and discusses the relationship between N conversion efficiency and some aspects of farm management.

N conversion efficiency

Nitrogen conversion efficiency in *Overseer* is defined as:

N conversion efficiency = product N / N input

where N inputs include fertiliser, supplements and N fixation.

Nitrogen conversion efficiency on dairy farms varied from < 10% to > 45% (Figure 1), with a mean of 35% (see Figure 2). Nitrogen conversion efficiency on non-dairy farms was lower, varying from < 10% to > 40% (Figure 1), with a mean of 17% (see Figure 2). About 93% of files were in the range 15 - 45% for dairy farms, and 5-25% for non-dairy farms.

Over the full range of N leaching values within the dataset, N conversion efficiency was weakly correlated with calculated N leaching (Figure 2); N conversion efficiency decreased as N leaching increased. However, within the normal range of N leaching values typical of the majority of each farm type, there was no relationship between N leaching and N conversion efficiency. In other words, high N conversion efficiency did not always imply lower per ha discharges.

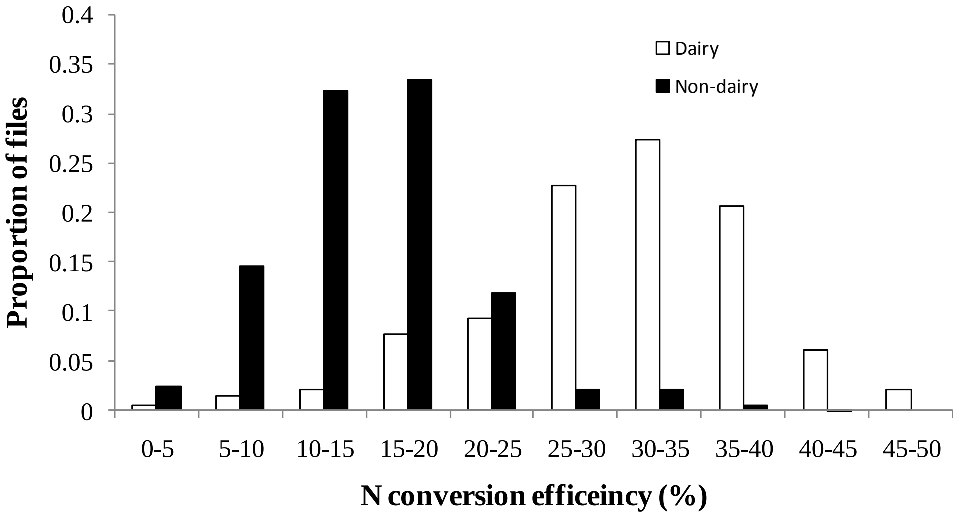

Figure 1. Histogram on N conversion efficiency for dairy and non-dairy farms.

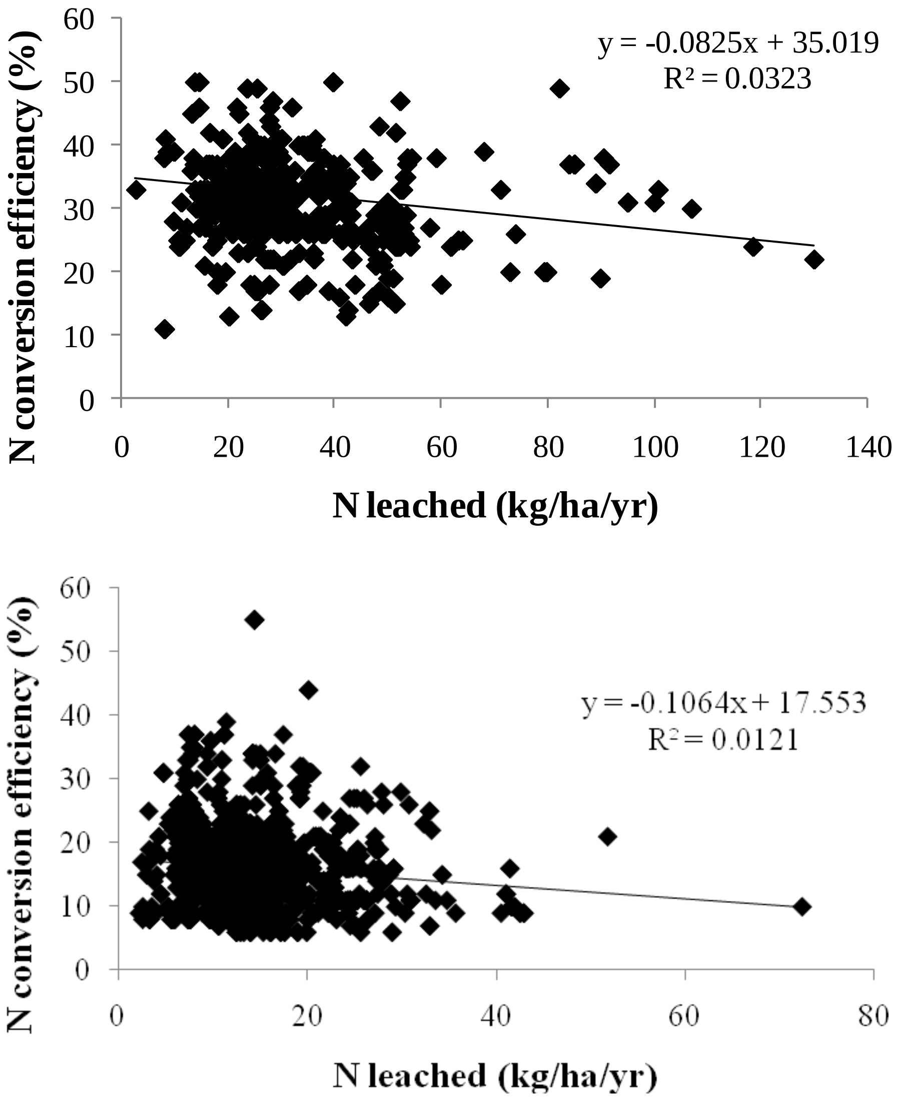

Figure 2. Relationship between N leached and N conversion efficiency for dairy (top graph) and non-dairy (bottom graph) farms.

Examination of random files indicated that high N conversion efficiency was usually associated with high use of low N supplements and high stocking rates whereas low N conversion efficiency was often associated with low producing farms using N fertiliser. High producing farms typically had higher N leaching rates than the low producing farms unless specific mitigation mechanisms were used, such as wintering pads and feed pads, with a fully managed effluent system implemented. On farms with similar production and site characteristics, higher N use efficiency usually equated with lower N discharges per ha. However, the range in data indicates that these are gross generalisations.

Managing N conversion efficiency

By definition, N conversion efficiency can be improved by improving the conversion of N inputs into N sold as product. Optimising the use of effluent and improving timing and application rates of N fertiliser to grow more grass are two of the more obvious solutions, provided any extra production is well utilised. Similarly, any mitigation options that result in lower N losses could result in higher pasture production as there is more N cycling within the system. The use of high energy, low N, feeds also improves N conversion efficiency via the animal metabolic system. Nitrogen conversion efficiency can also be reduced by other factors that reduce animal performance. Hence, optimising animal performance through improved animal health or genetics, and grazing management should not be overlooked.

We receive a number of enquiries around *Overseer* calculating negative pasture production, or under-estimating pasture growth when supplements are fed out. In the newly updated version of *Overseer*, supplement utilisation has been decreased based on survey work (Hedley, pers. comm.) and this has resulted in this issue occurring less frequently. This survey indicated that on some farms, supplement utilisation could be poor (<70% utilisation), particularly when supplements are fed on pastures. Improving supplement utilisation would result in N conversion efficiency increasing – the inputs would be the same but N in products would increase.

Some of the efficiency in nutrient use is associated with inefficient use of N in dung or urine. On dairy farms, N conversion efficiency can be improved by housing animals and then controlling the distribution of effluent back on the paddock. However, this may not always improve N conversion efficiency, as there can be large losses, e.g. volatilisation and denitrification of N from stored manure, with associated potential increase in greenhouse gas emissions. The storage of manure may also increase the risk of loss as either a point source from the storage system, or when effluent is applied to the land.

On dairy farms, there was a tendency for N conversion efficiency to decrease as N leaching per kg milk solids increased (Figure 3), although there was still a wide range in the data. Thus, high N conversion efficiency may indicate a lower N leaching rate per kg product, which is important for a product based emission systems. However, in New Zealand it is the discharge of N (kg N/ha) that is used as a measure of environmental impact, and high N conversion efficiency may not indicate low emissions to water. This suggests that the ideal farm will have both a low N leaching rate and high N conversion efficiency.

Although the focus of this paper has been on N, similar arguments apply to other nutrients.

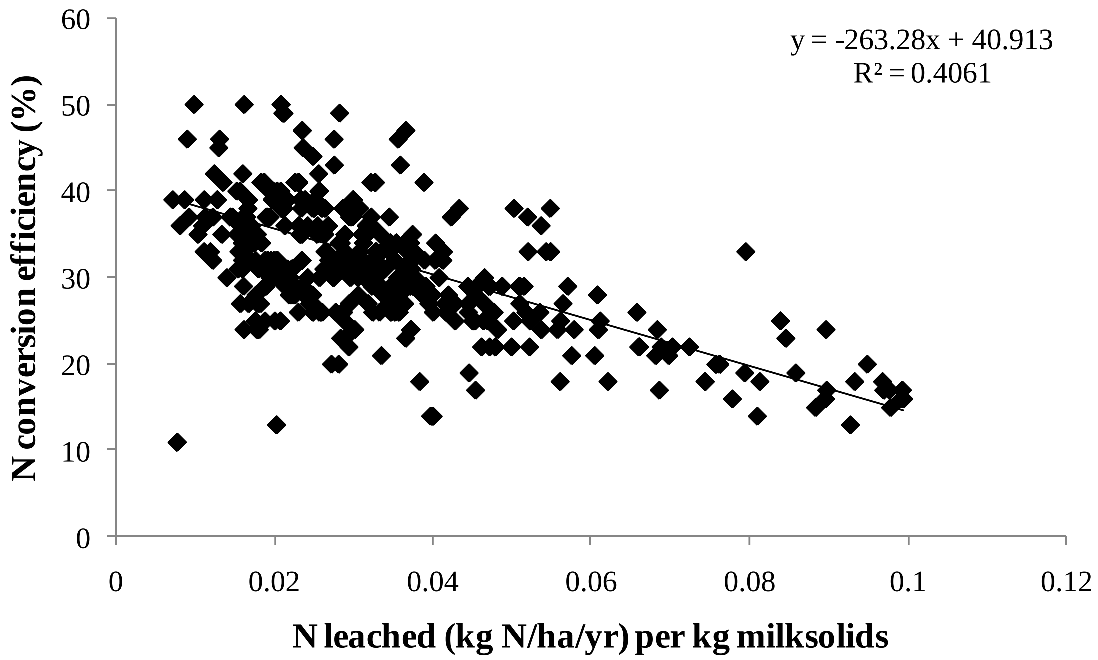

Figure 3. Relationship between N leached per kg milksolids and N conversion efficiency for dairy.

Summary

A survey of a set of *Overseer* data files indicated that:

1 N conversion efficiency was, on average, higher in dairy than non-dairy farms.

2 N conversion efficiency ranged from 15-45% on dairy farms, and 5-255 on non-dairy farms.

3 Within the typical range of N conversion efficiencies, there was no relationship between N conversion efficiency and leaching.

4 On farms with similar productivity and site characteristics, higher N conversion efficiency usually equates with lower discharges per ha.

5 N conversion efficiency decreased as N leached per kg milksolids decreased.

6 Goal should be to have a farm with a low N leaching rate and high N conversion efficiency.

The bias in the sample is unknown, and a more structures analysis should be undertaken to establish these trends.

Acknowledgement

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