Does management effects agronomic efficiency of nitrogen fertilisation?

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Background

Analysis of data derived from the LMM Programme (Minerals Policy Monitoring Programme) showed that the amount of nitrogen (N) surplus in the soil is an important factor of N leaching (Fraters et al., 2015). N surplus is mainly the result of N input (fertilisation) and N output (N uptake by crop). LMM data show also an important variation in nitrogen input on grass land (Figure 1) while there is little relation with the realized yield. This accounts also for maize land. This fact suggests that there must be options to reduce the amount of N surplus without loss of income and thus improving water quality. If the production circumstances are similar, differences in output level given the input level must be the result of differences in management practices.

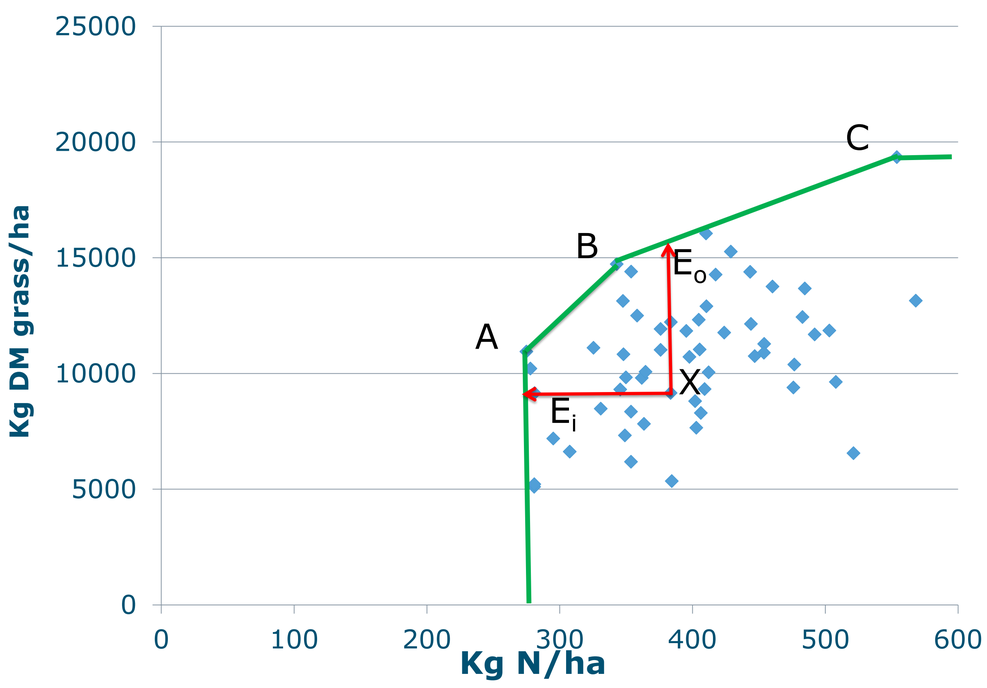

Figure 1. The efficiency curve of dairy farmers on sandy soil in the Netherlands for 2012 and the input saving efficiency (E_i) and output increasing efficiency (E_o) of farm X

Objective

Identification of management as a significant factor for realised nitrogen surplus.

Data and method

Figure 1 shows the variation in N input for dairy farmers (N=57) on sandy soil (>90% sand) based on data from LMM. It shows that assuming similar conditions and given the output level most farmers should be able to reduce their input (input saving efficiency E_i) as is the case for farmer X. Also, given the input level most farmers, like farmer X, should be able to improve their output level (output increasing efficiency E_o). Farmers (A, B and C) are the most efficient farmers. Given the output level there are no farmers who are able to produce this level with lower nitrogen levels. On the other hand there are also no farmers who, given the input level, can produce more.
For each farm the input saving- and the output increasing efficiency is calculated per year for the period 2007-2012. As farms differ in the ratio of grass- and maize land on their farm, DEA (Data Envelopment Analysis) is used to calculate the efficiency of a farm based on comparable farms (De Koeijer et al., 2002).

Results

Each year the input saving efficiency is higher than the output increasing efficiency (Figure 2). This might be expected as the variation in fertilisation might vary less between years compared to the variation in yield. Fertilisation is a pure management decision while yield level is not only the result of management decisions but also from the weather.

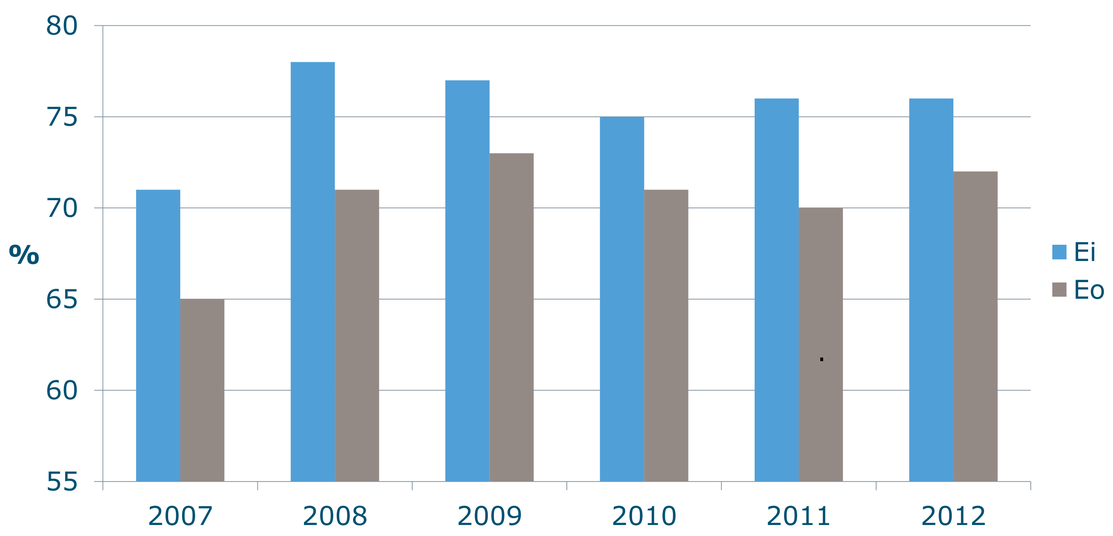

Figure 2. The input saving (E_i) and the output increasing efficiency (E_o) (%) of fodder production of dairy farms on sandy soils for 2007-2012.

Results

The persistence of farmers' performance over time is assessed with Spearman rank correlation. The rank correlation shows significant correlations ($P < 0,05$) except for:

- 2009 versus 2012
- 2007 versus 2011 and 2008 versus 2009 (significant at $P < 0,1$)

This means that management is a significant factor for the realised efficiency. As a higher efficiency results in lower N surpluses and therefore also in improved water quality, improvement of management is crucial for the improvement of water quality.
Further research is focused on the identification of the aspects of management that have a significant impact on the calculated efficiency.

Conclusions

- The average input saving efficiency of 76% shows that there is scope for the reduction of nitrogen surplus and therefore improvement of the water quality without loss of income.
- There is a persistent 'farmer's management influence' on efficiency.
- Given the assumption that all farmers operate under similar conditions, differences in efficiency are the result of differences in management.

References

Fraters, D. T. van Leeuwen, L. Boumans and J. Reijs (2015) Use of long-term monitoring data to derive a relationship between nitrogen surplus and nitrate leaching for grassland and arable land on well-drained sandy soils in the Netherlands, Acta Agriculture Scandinavica, Section B – Soil & Plant Science, 65, Supplement 2, 144-154.
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