

Nutrient management efficiency in Ireland – A data envelopment analysis of specialist dairy and tillage farms

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Introduction Within the constraints of the EU Nitrates and Water Framework Directives, controlling and managing nutrient transfers to water from excessive fertiliser use on agricultural land is a significant environmental policy challenge. This paper assesses whether there is room to reduce nitrogen and phosphorus fertiliser application by exploring the extent of their over application using data envelopment analysis methodology.

Materials and methods Data envelopment analysis (DEA) is a deterministic approach to efficiency measurement. It measures the relative efficiency of a decision making unit (DMU) by comparing relative inputs to outputs. DEA establishes the most efficient DMU's and compares all others to the most efficient. The method uses linear programming to place a non-parametric frontier over the data. This frontier consists of the most efficient DMUs and all other DMUs are measured by their relative distance to this frontier as a measure of their level of efficiency. Analysis was undertaken using the software package DEAP (Coelli *et al.*, 1998).

The main data source employed in this analysis is the Teagasc National Farm Survey (NFS) 2008. The NFS is collected annually as part of the Farm Accountancy Data Network requirements of the European Union. A farm accounts book is recorded on a random representative sample of farms throughout the Republic of Ireland. The sample is weighted to be representative of farming nationally across Ireland. In the 2008 NFS survey 1,102 farmers were surveyed representing 104,800 farmers nationally (Connolly *et al.*, 2009).

This paper concentrates on specialist dairy and tillage farms. These agricultural systems are the most intensive and may pose the greatest risk in terms of managing nutrient transfer from agricultural land to water courses. The analysis was undertaken and stratified by land use potential of soils (Gardiner and Radford, 1980). Output for specialist dairy farms was measured in litres of milk per hectare and the inputs examined were nitrogen (N) and phosphate (P) fertiliser usage kg ha^{-1} as well as feedstuffs, labour and other variable costs. Output for specialist tillage farms was measured in the form of gross output in € ha^{-1} and the inputs examined were again nitrogen and phosphate fertiliser usage kg ha^{-1} , labour and other variable costs.

Results Analysis indicates that specialist dairy farmers on good soils tended on average to overuse fertiliser to the greatest extent at 51.2kg N ha^{-1} and 4.1kg P ha^{-1} . Average cost saving on fertilisers of $\text{€}74.25 \text{ ha}^{-1}$ could be achieved by operating at the benchmark standard as set by other cohort farmers in the sub-sample. This figure declined to between $\text{€}33.09 \text{ ha}^{-1}$ and $\text{€}16.83 \text{ ha}^{-1}$ for those on average and poor soils, respectively, as shown in Table 1. Over application of N was 21.4kg ha^{-1} and 9.6kg ha^{-1} and average excess P was 2.3kg ha^{-1} and 1.6kg ha^{-1} for specialist dairy farms of average and poor soils, respectively. Results for specialist tillage farms on good soils indicate over application compared to the benchmark of 20.7kg N ha^{-1} and 3.5kg P ha^{-1} . This declined to 16.3kg N ha^{-1} and 4.5kg P ha^{-1} for average soils. Potential cost savings for specialist tillage farms compared to the benchmark was approximately $\text{€}34 \text{ ha}^{-1}$ to $\text{€}36 \text{ ha}^{-1}$ as illustrated by Table 1.

Table 1 DEA analysis of over application of N and P on specialist dairy and tillage farms.

Farm System	N	N (Kg ha^{-1}) Over application	P (Kg ha^{-1}) Over application	Potential cost saving* (€ ha^{-1})
Specialist Dairy - Good Soils	146	51.2	4.1	74.25
Specialist Dairy - Average Soils	91	21.4	2.3	33.09
Specialist Dairy - Poor Soils	17	9.6	1.6	16.83
Specialist Tillage - Good Soils	88	20.7	3.5	36.47
Specialist Tillage - Average Soils	14	16.3	4.5	34.82

*Average prices from the CSO (CSO, 2009)

Conclusions Results demonstrate considerable inefficiency in the utilisation of N and P fertilisers across specialist dairy and tillage farms. Consequently, there is potentially an opportunity for inefficient producers to reduce costs on N and P fertilisers without affecting output by adopting similar practices to those of the most efficient benchmark farms. Potential cost savings on average ranged from $\text{€}17 \text{ ha}^{-1}$ to $\text{€}74 \text{ ha}^{-1}$. Such reductions have the potential to deliver a win-win situation by reducing the risk of nutrient leaching and diffuse pollution from agricultural land while improving economic margins.

References

- Coelli, T.J., Prasada Rao, D.S., O'Donnell C.J. and Battese G.E., 1998. An introduction to efficiency and productivity analysis, 2nd edition, Springer.
- Connolly, L., Kinsella, A., Quinlan, G. and Moran, B., 2009. National Farm Survey 2008.
- Central Statistics Office, 2009. Fertiliser Prices. Available online at <http://www.cso.ie/px/pxeirestat/Dialog/Saveshow.asp>
- Gardiner, M.J. and Radford, T., 1980. Soil associations of Ireland and their land use potential. Explanatory bulleting to soils map of Ireland 1980. An Foras Taluntais.