Nitrogen Turnover on Organic and Conventional Mixed Farms

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Abstract Separate focus on crop fertilization or feeding practices inadequately describes nitrogen (N) loss from mixed dairy farms because of (1) interaction between animal and crop production and between the production system and the manager, and (2) uncertainties of herd N production and crop N utilization. Therefore a systems approach was used to study N turnover and N efficiency on 16 conventional and 14 organic private Danish farms with mixed animal (dairy) and crop production. There were significant differences in N surplus at the farm level (242 kg. N/ha. vs. 124 kg. N/ha. on conventional and organic dairy farms respectively) with a correlation between stocking rate and N surplus. N efficiency was calculated as the output of N in animal products divided by the net N import in fodder, manure and fertilizer. N turnover in herd and individual crops calculated on selected farms showed differences in organic and conventional crop N utilization. This is explained via a discussion of the rationality behind the current way of planning the "optimum fertilizer application" in conventional agriculture. The concept of marginal N efficiency is insufficient for correcting problems of N loss from dairy farms. Substantial reductions in N loss from conventional mixed dairy farms is probably unlikely without lower production intensity. The concept of mean farm unit N efficiency might be a way to describe the relation between production and N loss to facilitate regulation. This concept is linked to differing goals of agricultural development—i.e. intensification and separation vs. extensification and integration. It is discussed how studies in private farms—using organic farms as selected critical cases—can demonstrate possibilities for balancing production and environmental concern.

Keywords: nitrogen balance, nitrogen loss, efficiency, fertilization, environment, dairy farms, intensity, system modelling.
Introduction

The environmental consequences of agricultural Nitrogen (N) loss have been intensively studied in both Europe and North America. Some countries have made legislative attempts to limit farm N loss by regulation of manure storage capacity and use in crop rotations. It has been thought that N leaching could be limited sufficiently by educating farmers about the use of fertilizer and manure in crop production (Smith and Chambers, 1993; Michelsen, 1994). This and similar approaches focusing on feeding practice have had little success in reducing fertilizer use and N loss sufficiently (Korevaar, 1992; Michelsen, 1994).

Problems with N loss from mixed farms having both animal and crop production may not be solved if only focusing separately on single activities like fertilization or feeding practice. The interactions between the farmer, the herd and crop production must all be considered to understand agricultural N loss (Conway 1987; Bacon, Lanyon and Schlauder, 1990; Sørensen and Kristensen, 1992; Edwards et al., 1993).

The purpose of this paper is to:
- explain variation in N surplus and N use efficiency on organic and conventional private mixed farms;
- demonstrate the importance of interactions between management, production and pollution;
- discuss the link between production intensity and N loss; and
- suggest different concepts of N efficiency to facilitate regulation of mixed dairy farming N losses.

Materials and Methods

Study Farms

The data were obtained from 30 private dairy farms affiliated with the National Institute of Animal Science. The registration period occurred during the two-year period May 1, 1989 to April 30, 1991 but data from some farms represent only one working year. While the farms had dairy production as the main enterprise, all had grain production. Fourteen of the farms met the Danish organic regulation prohibiting the use of chemically-produced fertilizers and pesticides. Non-organic fodder, only of Danish production, was limited to 15% and organic animal manure was applied only from 1.4 livestock units (LU) per hectare (ha.)/year.

There were some differences as regarding the type of land, crops and cattle within the two main groups (i.e. organic and conventional farming systems) in Table 1. While the average number of cows/year was nearly identical, the organic farms had slightly more land, more Jersey cows, and little fattening calf production, thus the number of livestock units per hectare was 40% greater on the conventional compared to organic farms. The acreage of permanent pasture and grass-clover in rotation was nearly identical for the two farming systems (11–12%). The acreage of alfalfa was 9% on organic farms compared to none on the conventional farms. Acreage with fodder beets and whole crop silage from small grains was twice as much on con-