Indoor breeding or full-grazing dairy management? A farm system analysis of Nitrogen Use Efficiency

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Abstract

This paper investigates nitrogen (N) balance and nitrogen use efficiency (NUE) as a function of grazing intensity on dairy farms in Northwest Germany. 30 farms were analyzed in four groups according to their pasture management systems. Based on the farm data, a substance flow analysis was carried out. Results show that the average annual N surplus tends to increase while NUE decreases from zero-grazing towards full grazing. Considerable differences were highlighted between the mandatory nutrient balances reported by farmers and the N balances calculated in this study.

Keywords: Farm gate balance, Substance flow analysis, NUE, N indicators

1. Introduction

Oversupply of nitrogen (N) fertilizers has led to various environmental problems, e.g. nitrate pollution in ground water (FAO, 2018). Political targets for improving water quality and reducing ammonia emissions have not been adequately accomplished in Germany as defined by the Nitrates and the National Emission Ceilings Directive and, thus, national legislation has been further tightened. The present study compares specialised dairy farms in Northwest Germany with different grazing intensities related to the N use efficiency (NUE) and identifies N mitigation potentials in livestock management.

2. Methodology

A substance flow analysis was carried out to assess the efficiency of N supply following Schüler et al. (2016) and Powell et al. (2010). Input and output flows at the farm gate level of the year 2014 were analyzed for 30 farms in four management groups from full-grazing system (group 1) to year-round stable management (group 4). N surplus and NUE were calculated at three levels (field, feed and farm) and compared between farm groups (Löw et al., 2020). By comparing the inputs (organic and mineral fertilizers, atmospheric deposition, and biological N fixation) and outputs (milk, meat, and cash crops) of the dairy farms, inefficiencies in the N flows were identified.

3. Results

Results indicate an increase of the N surplus from zero-grazing to intensive pasture systems. Zero-grazing farms (group 4) have on average 179 kg N/ha surplus, while the average surplus of full-grazing systems (group 1) is considerably higher, 256 kg N/ha. Zero-grazing farms indicate the highest farm-NUE (50±23%), while farms with full-grazing systems show lower values (40±15%). Also, the variance of farm N surplus and NUE within each of the groups is high. Substantial N inefficiencies in the N flows were identified between organic N fertilizer supply and roughage production, as well as between feed intake and milk produced. Furthermore, the substance flow analysis allows to identify inplausible data in the obligatory N balances reported by farmers according to the German Fertilizer Application Ordinance (2017).

4. Conclusion

The findings of this study suggest that low to zero-pasture systems can reach higher overall NUE mainly by controlling feed intake more efficiently compared to full-grazing farms. The high variance of farm-NUE between farms of the same farm group show high scope for improvements. Substance flow analysis allows to provide reliable data for farm system analysis. Further efforts are needed to increase NUE at farm level to achieve emission reduction targets, especially in intensive grazing systems.

References

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