

Integrated approach to estimation of nitrogen use efficiency in intensive dairy husbandry at farm level in the North-West Russia

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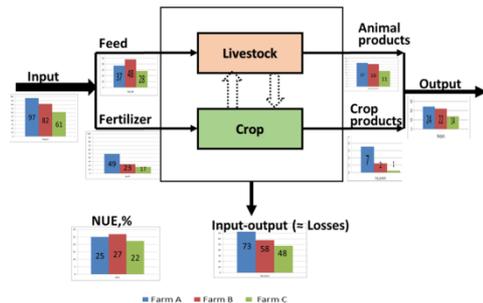
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Introduction

The efficient use of nutrients, nitrogen in particular, is a high-priority task of modern animal husbandry for achieving the United Nations Sustainable Development Goals. The study aimed to explore applicability of nitrogen use efficiency (NUE) as an indicator in estimating the reduction potential of nitrogen losses to the environment on dairy farms in the Leningrad Region. This region is a leader in dairy farming in the North-West Russia. In 2021, the average per cow milk yield was 9022 kg cow⁻¹ yr⁻¹.

Farm Gate Balance for 3 dairy farms

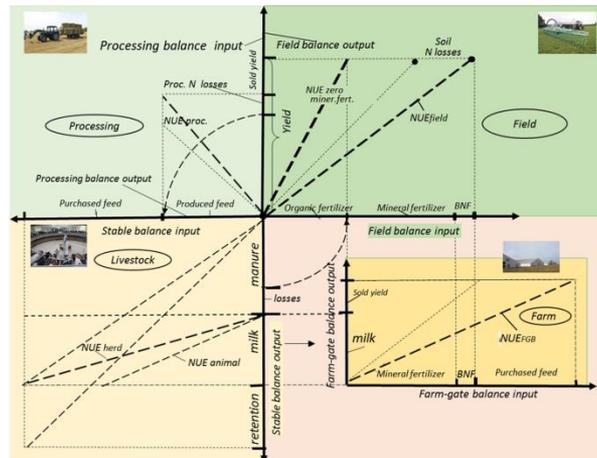
The study considered three pilot farms, which featured high cow performance, zero-grazing, and a share of 40 to 50% of imported feed in the diets. Farm Gate Balance (FGB) was calculated for these farms by the accounting data acquired during the farms surveys.



The farms differed much in the production intensity: N inputs were in the range from 60 to 140 kg ha⁻¹ yr⁻¹, and N outputs – in the range from 25 to 40 kg ha⁻¹ yr⁻¹. The NUE values for these farms, however, were of small difference – 22% to 27%. This fact revealed a certain difficulty in formal application of FGB indicators for comparative environmental farm assessment, as NUE and N surplus were affected by many interrelated factors.

N input–N output diagram for a pilot dairy farm

We assessed the variation pattern of environmental indicators of a pilot dairy farm with 2,200 head of cattle, including 1,000 cows, and 2,276 ha of arable land. The NFGB of the farm was calculated by the data for 2017–2021. While N inputs were in the range of 90.7 to 138.7 kg ha⁻¹ yr⁻¹ and N outputs – of 29.3 to 41.2 kg ha⁻¹ yr⁻¹, NUE was in the range of 26% to 36% and N surplus – of 61 to 103 kg ha⁻¹ yr⁻¹.



The measures for NUE improvement on a particular dairy farm were considered with “N input–N output” diagram, which visualised NFGB of the farm and N balances of its four production sectors: crop sector (NUE_{FIELD} was in the range of 62 to 110%), livestock sector (NUE_{STABLE} was in the range of 15 to 20.5%), processing sector (NUE_{PROCESSING} was in the range of 70 to 90%), and manure handling sector (NUE_{MANURE HANDLING} was in the range of 70 to 75%). High NUE_{FIELD} values indicated the soil depletion risks and the need for optimising the doses of organic and mineral fertilisation of each particular field.

Calculation results showed the essential role of systemic measures for NUE improvement like increasing the own feed production and animal productivity, and reducing mineral fertilisation. In the period under study, the share of purchased feed ranged from 22% to 52%; the milk yield increased from 8770 to 10719 kg yr⁻¹, and the share of livestock products ranged from 50% to 83%.

Conclusion

The applied approach and the estimation results of “N input - N output” balances of the dairy farm production sectors can be used in monitoring, assessing and managing the environmental performance of dairy farming at different levels.

References:

- Oenema, O.; Brentrup, F.; Lammel, J.; Bascou, P.; Billen, G.; Dobermann, A.; Erisman, J.W.; Garnett, T.; Hammel, M.; Haniotis, T.; et al. *Nitrogen Use Efficiency (NUE)—Guidance Document for Assessing NUE at Farm Level*. EU Nitrogen Expert Panel; Wageningen University: Wageningen, The Netherlands, 2016; 49p.
- Aleksandr Briukhanov, Eduard Vasilev*, Natalia Kozlova, Ekaterina Shalavina. Assessment of Nitrogen Flows at Farm and Regional Level When Developing the Manure Management System for Large-Scale Livestock Enterprises in North-West Russia . *Sustainability* 2021, 13(12), 6614; <https://doi.org/10.3390/su13126614> .

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