NJF Report • Vol 4 • No 2 • Year 2008

Nordic Association of Agricultural Scientists

NJF Seminar 407

Long-term field experiments - a unique research platform

Sønderborg, Denmark, 16-18 June 2008

Nordic Association of Agricultural Scientists

SOLIDUM PETIT IN PROFUNDIS · UNIVERSITAS ARHUSIENSIS

N balance as an indicator of N leaching in long-term leaching fields

Tapio Salo[1*] *and Eila Turtola*[2]
[1] *31600 Jokioinen, MTT-Agrifood Research Finland*
[2] *P.O.Box 27, FI-00014 University of Helsinki, Finland*
*E-mail: tapio.salo@mtt.fi

Introduction

Ideally, N fertilizers, manure, mineralization and biological N fixation provide sufficient N for crop and forage growth by simultaneously avoiding the risk of water and air pollution due to N surpluses. This ideal state is often not achieved, and the calculation of N balances has been identified as a priority agro-environmental indicator of the environmentally harmful N losses from agricultural fields. The aim of this study was to compare relationships between N surface balances and N leaching losses with data obtained from two long-term agricultural runoff fields in Finland.

Material and methods

The Finnish runoff data was retrieved from two experimental fields on clayey and sandy soil, reported in Salo and Turtola (*2006*). The experimental field on clay soil is located in Jokioinen, southern Finland (60°49'N, 23°28'E, 85 m a.s.l.). The soil is a heavy clay (> 60 % clay, 2.6 % organic C) with a mean slope of 2 % (1–4%). The experimental field on sand soil is situated in Toholampi (63°49'N, 24°09'E, 83 m a.s.l.), with a mean slope of 0.5 % (0.3–0.7%). The soil is classified as a fine sand soil (< 10 % clay, 5.0 % organic C).

Annual N balances were calculated for each plot by considering fertiliser N, manure N and estimated N fixation as the input and crop N (yield) and estimated ammonia volatilisation from the manure applications as the output. The annual N balances were then compared with the annual N leaching losses. Annual N leaching was calculated as the sum of N lost via surface and drainage runoff. In addition to the annual balances, N balances were averaged over the years of similar management and compared with the respective averaged N leaching, for accounting the delay in the leaching due to variable climatic variations.

In our previous work (Salo and Turtola, 2006), linear regression model was fitted to the Finnish datasets and now the linear-plateau model (Sieling and Kage, 2006) was used for the same datasets. N balance at the intersection of the plateau and the linear model, leaching at the plateau part of the model and the proportion of N balance leached at the linear part of the model were estimated using the NLIN procedure of SAS.

Results and discussion

In the Finnish conditions, annual N leaching from the experimental plots was not adequately estimated using the respective annual N balances, or supplementing the estimation with annual precipitation, total runoff, or drainage runoff (Salo and Turtola, 2006). Values averaged over the years improved the estimation when management included such environmentally risky managements as bare fallow or off-season application of cow slurry (Salo and Turtola, 2006).

Calculated with the linear regression (Salo and Turtola, 2006), N leaching was 20–57% of the averaged N balance (Table 1). The linear-plateau model produced higher percentage of N leaching (57%) from the averaged N balance at the linear part of the model (100 x slope in Table 1). The linear-plateau model could not directly be fitted to arable dataset since N leaching did not reach the plateau part. Then N leaching at the plateau part was set to the lowest averaged N leaching values observed at the experimental period.

Table 1. Linear and linear-plateau equations of the averaged N balance (Nb) and N leaching. N_0 is the estimate of N leaching at the plateau part of the model. Intersection is the threshold value of N balance where the linear part of the model begins. Slope is the proportion of the balance (N balance – intersection) that is leached.

Crop rotation	linear equation	R^2	N_0, N kg ha^{-1}	Intersection, Nb kg ha^{-1}	Slope	R^2	n
arable	-13+0.57Nb	0.71	6	33	0.57	0.71	8
grass	5+0.20Nb	0.69	10	99	0.57	0.93	16

With its simplicity, N balance is a useful indicator for potential N leaching. The considerable variation between the balance values and the actual N leaching, at least in individual fields and within a few years time-scale, is obviously due to the complex turnover of N in soil resulting in delayed feedbacks of the management practices and N surpluses. The linear–plateau model seems to be a more appropriate way to describe the relationship between N balance and N leaching than the simple linear regression.

References

Salo, T., & Turtola, E. (2006). Nitrogen balance as an indicator of nitrogen leaching in Finland. Agriculture, ecosystems and environment 113, 98-107.

Sieling, K. & Kage, H. (2006). N balance as an indicator of N leaching in an oilseed rape – winter wheat – winter barley rotation. Agriculture, ecosystems and environment 115, 261-269.