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Role of ^{15}N methods for assessing the susceptibility of agricultural N management systems to environmental N losses

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An evaluation of the susceptibility of different N management systems to nitrogen (N) losses into the environment requires either the in-situ determination of the individual components of the nitrogen balance or the determination of the recovery of fertilizer N in plants and soil. For both aspects, ^{15}N methods are essential as the ^{15}N gas flux method (^{15}NGF) is the only widespread in-situ method for the determination of dinitrogen (N_2) emissions, and ^{15}N labelled fertilizers can be used to assess the allocation of fertilizer N to plants and soil.

To evaluate the influence of management history on N losses, we quantified N loss pathways (NH_3, N_2O, N_2, NO_3^- leaching), total N balance and ^{15}N recovery in soil and plants of two adjacent sites over a two-year cropping sequence. One site was under integrated farming (IF) and the other under organic farming (OF) with frequent legume cultivation and occasional fertilizer input.

Though integrated farming had resulted in significantly higher pH, soil organic C and N content, the emissions of ammonia, dinitrogen and nitrous oxide after cattle slurry application as well as nitrate leaching were low and not significantly different. High ^{15}N recovery rates in plants and soil agreed well with the low directly measured N losses. Integrating the directly measured losses into the ^{15}N balance resulted in high overall recoveries of 84 to 100%. Conversely, unrecovered ^{15}N was on a low level, but higher for OF (12%) than for IF (6%).

Our results confirm that ^{15}N labelled fertilizers and their recovery can be used as an indicator for N losses, but the spatial variability is high, complicating statistically significant findings. Consideration of N_2 fluxes using the ^{15}NGF method could not close the ^{15}N balance, indicating that unaccounted N losses have occurred. Since the directly measured N losses were not significantly different, unaccounted losses could be due to N_2 emissions as their quantification was limited to two weeks after fertilizer application.

Overall, integrated farming history reduced the vulnerability towards N loss, but continuous

methods for determination of N^2 emissions, such as isotopomer measurements, need to be tested concomitantly, and uncertainty of ^{15}N recovery in plants and soil needs to be reduced by more sophisticated sample mixing approaches.