N MANAGEMENT STRATEGIES ON DUTCH DAIRY FARMS IN RELATION TO AMMONIA LOSSES

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Introduction

Losses of N through ammonia volatilization after land application of slurries are a major concern in many countries. For this reason, low emission techniques, such as shallow injection, are compulsory in the Netherlands. Some dairy farmers, however, perceive low emission techniques as damaging soil structure and reducing N use efficiency, and hence dispute this obligation. The alternative strategy proposed by these farmers to reduce ammonia emissions to acceptable levels is to reduce fertilizer-N use, to reduce protein content of rations and increase the proportion of organic N in slurry, combined with aboveground spreading of slurry under weather conditions that minimize emissions. In terms of ammonia emission per ton milk, previous research has shown that such a strategy indeed might be equally effective as conventional management combined with low emission slurry application techniques (Sonneveld et al., 2008).

In 2006, a research project started in the north of the Netherlands to compare the alternative strategy with a conventional N management strategy. The objectives of the research were (1) to quantify differences in farm management characteristics between farms following either strategy and (2) to quantify differences in resulting ammonia emissions between these farms.

Materials and Methods

Twenty nine dairy farms followed the alternative strategy (ALT group), adopting the following objectives to be reached in 2008: (1) mineral N-fertilizer input <100 kg N per ha, (2) N-surplus <140 kg per ha, (3) milk urea content in winter <20 mg per 100 ml and (4) proportion organic N of total N in slurry >57%. Slurry was applied through aboveground spreading. Another twenty nine dairy farms served as reference (REF group). The REF group applied conventional N management and used prescribed low emission techniques to apply slurry.

Farm level data were collected for the years 2005, 2006 and 2007. Data included imports of fertilisers and feeds, exports of milk and animals and C and N contents of slurry and silage. . To calculate ammonia emissions at farm level, a simple N flow model was used (Koei'N; Schröder et al., 2003). Based on farm data and internal N efficiencies according to literature, Koei'N quantifies N flows, including ammonia emissions.

Main determinant of ammonia emission after slurry application is the emission factor (i.e. proportion of total N applied emitting as ammonia). Literature provides a range for emission factors when slurry is applied through aboveground spreading (40-100%, average 74%). Measurements in the study area during three slurry application events hinted at 35%, but it is uncertain to what extent this value is representative for all application events. Below, we use, both emission factors (35% and 74%) to calculate ammonia emissions and assess the efficacy of the alternative strategy.

Results

N management data for both groups of farms are given in Tab. 1 (averages of 2006 and 2007). Farms in the REF group produced more milk per unit of land. A large variation was found in fertilizer N use and N surpluses among farms in both groups, but both were significantly lower in the ALT group. On average, the goals for 2008 for both mineral N fertilizer and N surplus have been met by the ALT group.

Tab. 1. Average farm characteristics based on 2006 and 2007 for the ALT and REF group. Characteristics with an asterisk had been given ambition values for 2008 in the ALT group.

	ALT group	REF group
Intensity (ton milk per ha)	9.3	12.5
Mineral fertilizer-N (kg per ha)*	92	141
N-surplus (kg per ha)*	114	166
Milk urea in winter (mg per 100 ml)*	23.1	25.0
Norg/Ntot ratio in manure (-)*	54	53
Ammonium-N content manure (g per kg)	1.80	2.06
C/Norg ratio in manure (-)	16.0	14.3
Dosage of individual slurry applications (m^3 per ha)	15.4	24.1
Number of slurry applications per field per year	3.0	2.0

Milk urea contents in winter were slightly lower in the ALT group, but this difference was not statistically significant. Ammonium-N content in slurry was significantly lower in the ALT group, and C/Norg ratio significantly higher. Farmers in the ALT group applied their slurry in smaller quantities, with more applications per field per year.

Calculated ammonia emissions for the ALT group strongly depend on the assumed emission factor (Tab. 2). Consequently, this factor is also decisive for the efficacy of the alternative strategy in reducing ammonia emissions. There is a large variation in calculated ammonia emissions at farm level in the ALT and REF group (data not shown). Assuming an emission factor of 35%, some farms in the ALT group succeed in achieving ammonia emissions per ton milk that are comparable to farms in the REF group using conventional management and prescribed low emission slurry application techniques.

Tab. 2. Ammonia emission (kg per ton milk per year) in 2007 using emission factors of 35 and 74% for aboveground spreading in the ALT group. For the REF Group, emission factors of 16% (shallow injection) and 26% (trailing hose) are used.

Emission factor aboveground application	NH_3 emission (kg per ton milk)	Emission factors low emission techniques	NH_3 emission (kg per ton milk)
	ALT		REF
35%	8.0	16% / 26%	6.8
74%	11.2	16% / 26%	6.8

Conclusions

Fertilizer N use and N surpluses were significantly lower for the ALT group in 2006 and 2007. Calculated ammonia losses at farm level in the ALT group for 2007 were found to be strongly dependent on the assumed emission factor for ammonia volatilization during and after aboveground spreading of manure. Consequently, this factor is also decisive for the efficacy of the alternative strategy in reducing ammonia emissions. Given the large variation in calculated ammonia emissions at farm level, and provided the emission factor during aboveground slurry application does not exceed 35%, it is concluded that some farms in the ALT group succeed in achieving emissions that are comparable to conventional farms that use prescribed techniques for manure application.

References

Schröder, J.J. et al. 2003. An evaluation of whole-farm nitrogen balances and related indices for efficient nitrogen use. European journal of Agronomy, 20: 33-44.

Sonneveld, M.P.W. et al. 2008. A Whole-Farm Strategy to Reduce Environmental Impacts of Nitrogen. Journal of Environmental Quality 37, 186-195.