Ammonia volatilization from cattle and pig slurry applied to grassland

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Contents

Summary

Wide ranges of ammonium-N fractions of different types of slurry volatilize as ammonia after application of slurry to grassland under different environmental conditions. The ammonia emissions from different types of slurry have been determined repeatedly during the season to obtain information on factors influencing ammonia volatilization.

Windtunnels have been used to measure the ammonia emission from slurry applied to especially prepared plots on grassland.

The variation in ammonia emission for a single type of slurry after application under different meteorological conditions to soils with a different moisture content exceeds the difference in ammonia emission between types of slurry within a single experiment. Therefore the ammonia emission from slurries of equal dry matter contents depends more on environmental conditions than on other structural characteristics of the slurry.

The results indicated that the ammonia emission can be restricted to 10 % of the ammonium content of the slurry by dilution of the slurry prior to application on dry soil. Research on the influence of soil moisture content and slurry dilution on the emission rate will be continued.

Samenvatting

De ammoniakemissie uit drijfmest na het uitbrengen op grasland blijkt sterk afhankelijk te zijn van de soort drijfmest en de omgevingsomstandigheden. Gedurende een seizoen is de ammoniakemissie van eèn aantal soorten drijfmest herhaaldelijk bepaald om meer inzicht te krijgen in de factoren die de ammoniakemissie beïnvloeden.

Het onderzoek is uitgevoerd met windtunnels die geplaatst werden over proefplekken in grasland waarop drijfmest werd uitgebracht.

De variatie in de ammoniakemissie van een enkele soort drijfmest onder verschillende omgevingsomstandigheden uitgebracht op gronden met een verschillend bodemvochtgehalte overtreft de verschillen in emissie uit verschillende mestsoorten binnen een experiment. De ammoniakemissie uit op grasland uitgebrachte drijfmest blijkt meer afhankelijk te zijn van de omgevingsomstandigheden dan van de structuur van de mest, indien mestsoorten van eenzelfde drogestofgehalte worden vergeleken.

De ammoniakemissie na oppervlakkig uitbrengen van drijfmest op grasland kan worden beperkt tot 10 % van het ammoniumgehalte van de mest als de mest na verdunnen wordt uitgebracht op droge grond. Het onderzoek naar de invloed van het bodemvochtgehalte en het verdunnen van mest op de omvang van de ammoniakemissie zal worden voortgezet.

1. Introduction

Data in literature on the ammonia volatilization rate after surface application of cattle and pig slurry to grassland are highly different. Reported values for the fraction of ammonium-N volatilizing as NH_3 vary from 0,13 [Pain et al, 1988] to 0.93 [Christensen, 1988]. The emission rate appears to be influenced by weather conditions and the dry matter content of the slurries. The variation in the ammonia volatilization is not determined by a single factor. Several authors mention ammonia volatilization exceeding 60 % of the ammonium-N application.These high volatilization rates are observed at a wide range of dry matter contents, 4-18 % [Thompson et al, 1986]. Somewhat lower volatilization values, about 50 %, are reported by Hall and Ryden [1986] and van den Abbeel [1989].

In preceeding experiments [Vertregt & Rutgers, 1988] on ammonia volatilization from urine and dung in grassland, approximately 10 % of the N voided in urine patches and 100 % of the N in dung pats volatilized. The application rate of the fresh dung was 35 kg/m^2, the dry matter content was 13,8 %.

These results suggested that the ammonia volatilization rate depends on the physical structure of the slurry determining the degree of penetration in the soil. The physical structure of the slurry is determined by the crude fibre and solid particle content.

In experiments on the utilization of nitrogen from cattle and pig slurry following application to grassland, the apparent recovery of N from cattle slurry was repeatedly found to be lower than the recovery from pig slurry [Geurink, 1990].

These results suggested higher ammonia losses from cattle slurry than from pig slurry.

Therefore, in this project a number of experiments were carried out to investigate the influence of the chemical composition and physical structure of cattle and pig slurry on the ammonia volatilization rate. Different types of slurry were used, some of which were fractionated by a slurry separator, or diluted prior to application. During the experiments the effects of soil and weather conditions were observed.

The experiments were carried out on grassland on a sandy soil from mid March up to November 1989. Ammonia volatilization was measured by means of windtunnels.

2. Material and methods

The experiments were carried out on grassland on a sandy soil at the experimental farm "Droevendaal", Wageningen.
Soil characteristics are given in table 1.

Table 1. Soil characteristics at "Droevendaal".

depth (cm)	pH	P	K
		mg/kg dry soil	
0-5	5.0	300	125
0-20	5.3	290	75

The grass was cut to a height of 4 cm three or four days before the start of an experiment. The grass was monthly fertilized with 40 kg N per hectare.

The cattle and pig slurries, used in the experiments, were obtained from farms. Slurries were obtained from cattle, fed with maize silage (RM) and grass silage (RG), and from pigs (V) and sows (Z). RM and V were fractionated into a relatively fibrous and a relatively liquid fraction. The liquid fractions, RME and VE, respectively, were used for the experiments. A partly digested pig slurry (P) was obtained from a slurry processing plant.

The slurries were stored at a temperature of 2 °C. The composition remained unchanged during the season, the composition of the slurries is tabulated in Table 2.

Table 2. Composition of the different slurries (g/kg).

Slurry	Dry matter	Ash	Ntot	NH4-N
Cattle, fed maize silage (RM)	96.4	21.8	5.4	2.5
Cattle, fed maize silage liquid fraction (RME)	80.9	22.3	5.4	2.7
Cattle, grass silage (RG)	100.5	23.9	5.2	2.4
Pig (V)	121.5	34.7	9.8	5.4
Pig liquid fraction (VE)	115.4	38.5	9.9	5.7
Sow (Z)	41.0	13.5	4.7	3.4
Pig partly digested (P)	41.8	18.4	7.5	4.8

The chemical composition of RME and VE was very similar to the composition of RM and V, respectively, whereas the physical structure was highly different.

Ammonia volatilization was measured by means of windtunnels. An experimental plot of 2m * 0.55 m was covered by a clear polycarbonate tunnel with a height of 0.6 m, mounted on an iron frame that was driven into the soil to a depth of 12 cm to avoid leakage at the soil surface.

Ammonia-free filtered air was blown through the tunnel by a centrifugal fan at an airspeed of 1.0 m/s, that is 1200 m^3/h. The air was filtered through a polypropylene airconditioning filter with a filter area of 3,6 m^2, that was impregnated with phosphoric acid. The air flow rate through the tunnel was measured with a turbine gas meter. The outflowing air was sampled with a membrane pump drawing the air at 13 l/min through a gas washing bottle filled with 0.3 M phosphoric acid. The volume was determined by a bellows gas meter. The ammonia captured in the phosphoric acid solution was analyzed by an automated continuous flow analysis system, based on the Berthelot reaction.

The detection limit of the method is 0.001 kg N/ha/hr for a sampling period of 24 hours.

The gas washing bottles were changed every 24 hours at 8 A.M. The sampling was continued during a period of 10 days after slurry application. The temperature of the topsoil layer, to a depth of 3 cm, was measured with thermocouples at 8 A.M. and 4 P.M.

During a period of three days before the start of each experiment the outflowing air from the tunnel was sampled and analyzed.

The emission values were corrected for the ammonia background values, determined in this preliminary sampling period. Background values are listed in table 5.

Four tunnels were simultaneously used in the experiments.
In nearly all the experiments equal amounts of slurry were applied, equivalent to 30 tons per hectare. The ammonium-N applications were different for the various types of slurry used.

3. Experiments

The purpose of the experiments was to determine the ammonia volatilization rate from equal applications of several types of slurry under various ambient conditions throughout the year. As four windtunnels were available, different slurries were compared in the experiments. Pig slurry (V) was applied in nearly all the experiments. In most of the experiments cattle slurry (RM) was included. Details of the experiments are summarized in table 3.

The ambient conditions during the initial period of each experiment are tabulated in table 4. The corresponding daily ammonia emissions are specified in table 5.

Table 3. Outline of the experiments. See Table 2 for abbreviations.

Exp. nr.	Date	Type of slurry				Remarks
		plot 1	plot 2	plot 3	plot 4	
1	20-Mar-89	RM	RME	V	VE	
2	3-Apr-89	RM	RG	V	Z	
3	17-Apr-89	RM	V	P	RM	dry matter content equalized to 4.2 g/kg (except RM on plot 4)
4	1-May-89	V	RM	P	RG	NH4-N content equalized to 5.4 g N /kg
5	16-May-89	RM	V	RM	V	wet soil in plots 1 and 2
6	29-May-89	RM	V	RM	V	wet soil in plots 1 and 2 1:3 diluted slurries
7	13-Jun-89	RM	RME	VE	V	
8	26-Jun-89	RM	V	RG	Z	
9	10-Jul-89	RM	RME	VE	P	
10	24-Jul-89	RM	V	RG	Z	
11	28-Aug-89	V	RG	RG	RG	
12	11-Sep-89	V	VE	P	Z	
13	25-Sep-89	V	V	VE	VE	V and VE on plot 1 and 3 applied in wedge-shaped slots
14	9-Oct-89	V	V	V	V	Time of application on plot 1 and 2: 9 A.M., 3 and 4: 3 P.M.
15	30-Oct-89	V	RG	RM	RME	

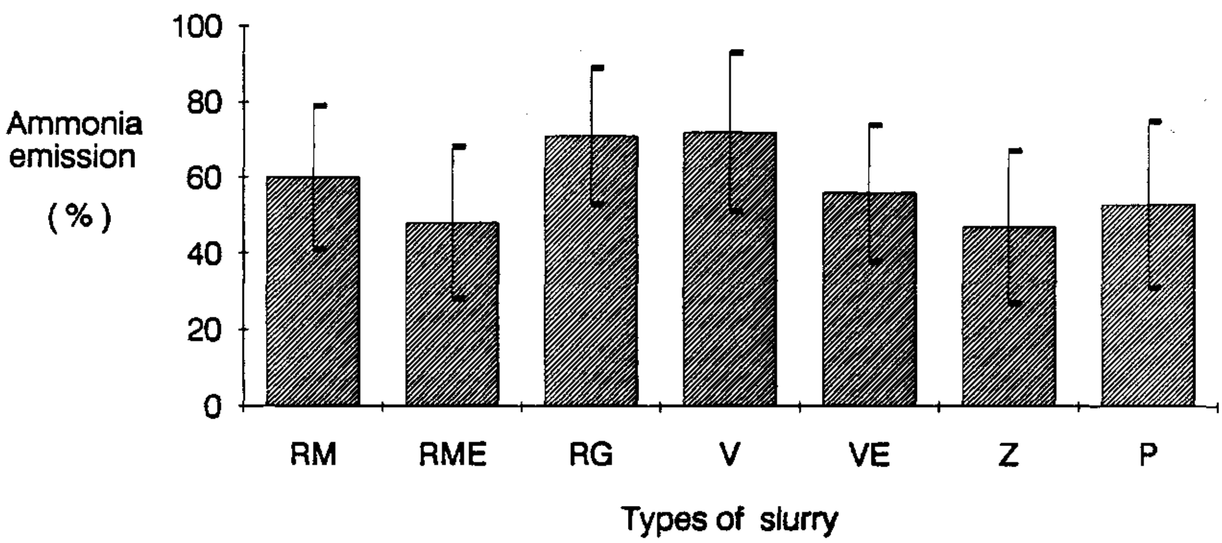
4. Results

Various aspects of the results in relation to the experimental design are discussed below. A number of experiments was carried out to answer questions proceeded from foregoing experiments.

4.1 Total ammonia emission from the various slurries

The total ammonium-N emission is calculated for each single experiment as a fraction of the amount of ammonium-N applied. The results are tabulated in table 6. For each type of slurry mean values and standard deviations of the volatilized fraction of the ammonium-N (%) are calculated. The results of these calculations are presented in figure 1.

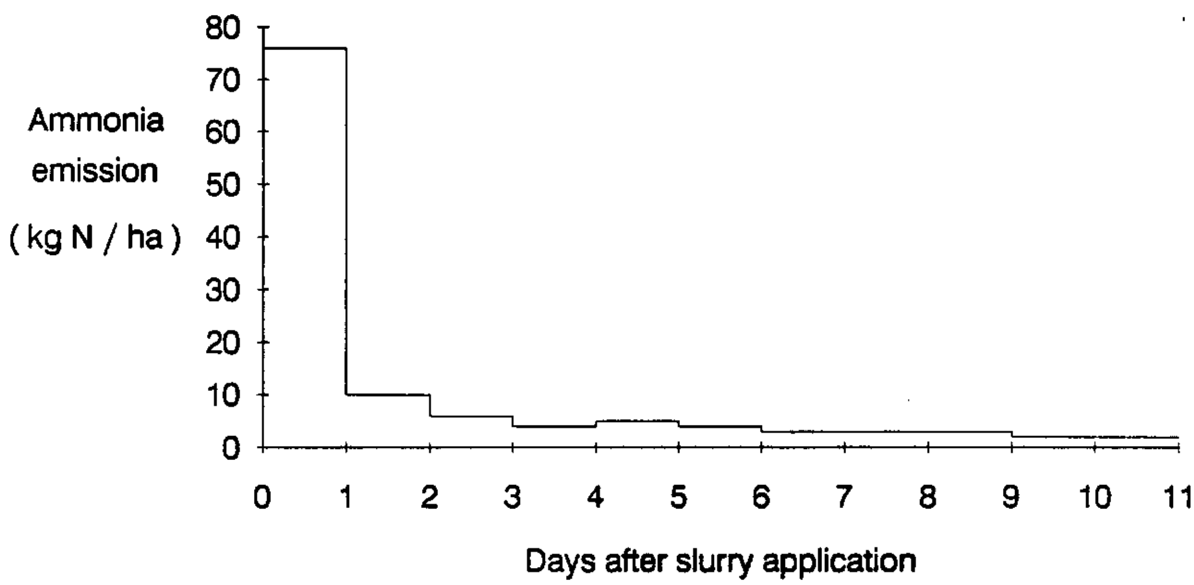
Figure 1. Mean values and standard deviations of ammonia emission from different types of slurry. Presented as percentage of the rate of ammonium-N applied.



From the results in table 6 and figure 1 it can be concluded that the variation in ammonia emission for a single type of slurry under various ambient conditions during the year substantially exceeds the difference in ammonia emission between types of slurries in a single experiment. As a consequence some experiments were especially designed to study the relation between the ambient conditions and ammonia emission from slurries.

In figure 2 daily emission values are plotted for a representative experiment with pig slurry. A substantial part of the total ammonia emission takes place during the first day after application. This first day emission varies between 50 and 85 % of the total emission, depending on the ambient conditions. Within single experiments the first day emission rate relative to the total emission is always higher for the cattle slurry (RM) than for the pig slurry (V), see table 3, 5 and 6. Possibly this phenomenon originates from the high fibre content of the cattle slurry, as water evaporation and ammonia volatilisation could be enhanced by the coarse surface of the fibrous cattle slurry. In contrast to this first day phenomenon the cumulative ammonia emission from cattle slurry is commonly lower than the total ammonia emmision from the pig slurry.

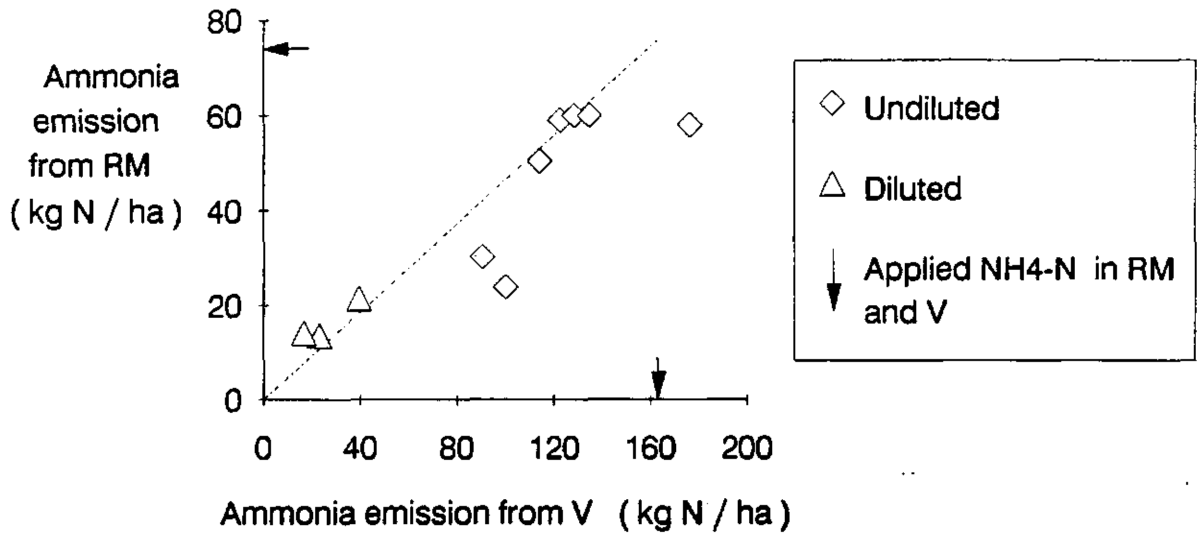
Figure 2. Daily values of the ammonia emission after surface application to grassland of 30 tons pig slurry per ha.



4.2 Comparison of ammonia emission from cattle and pig slurry

In each of the experiments 1, 2, 5, 7, 8, 10 and 15 RM and V were applied under varying, but for each single experiment identical ambient conditions. In the experiments 3 and 6 diluted RM and V were applied in a corresponding way. The fractions of volatilized ammonium-N from RM and V (%) are plotted in figure 3 for each of the experiments. A fairly good linear relation can be observed between the emission values of the two types of slurries.

Figure 3. Ammonia volatilization from cattle and pig slurry. For both types of slurry the application rate was 30 ton/ha, the applied ammonium-N in RM was 76 kg/ha and in V 163 kg/ha.



This means that cattle slurry and pig slurry have similar emission characteristics. Differences between single experiments are mainly caused by differences in ambient conditions as aliquots of a single stock of slurry are applied throughout the year. Obviously the ammonia emission can be reduced by diluting the slurry.

The small influence of physical characteristics of undiluted slurries on the level of ammonia volatilization is proven in experiment 4 in which the ammonium contents of RM, RG, V and P were equalized to study the influence of the viscosity and fibre content on the emission. The results are presented in table 6. As is mentioned before, difference in ammonia emission between the four types of slurries were unexpectedly small.

4.3 Influence of soil moisture content and dilution of slurry on ammonia emission

In experiment 3 RM and V were diluted with water to attain the dry matter content of P (41,8 g/kg). For comparison reasons undiluted RM was applied on plot 4.

The ammonia emission from the diluted RM and V is distinctly lower than the emission from the undiluted RM. The ammonia emission rate from P is high in according with the higher ammonium concentration (table 6).

In experiments 5 and 6 the effect of soil moisture content and dilution of the slurry on the ammonia emission level was investigated. In experiment 5 RM and V were applied to grassland irrigated with 60 mm of water and to dry grassland. In experiment 6 three parts of water were mixed with the normal supply of RM and V before application on wet and dry grassland.

The cumulated values of the ammonia emission for the eight objects are presented in the figures 4 and 5. For both cattle and pig slurries it can be concluded that the ammonia emission is highest after application of undiluted slurry to a wet soil, and lowest after application of a diluted slurry to a dry soil. The total emission of diluted and undiluted RM and V on wet and dry soils are plotted in figure 6.

Figure 6. Ammonia volatilization from cattle and pig slurry. Undiluted and diluted slurry was applied to grassland with high and low soil moisture content (wet and dry, respectively).

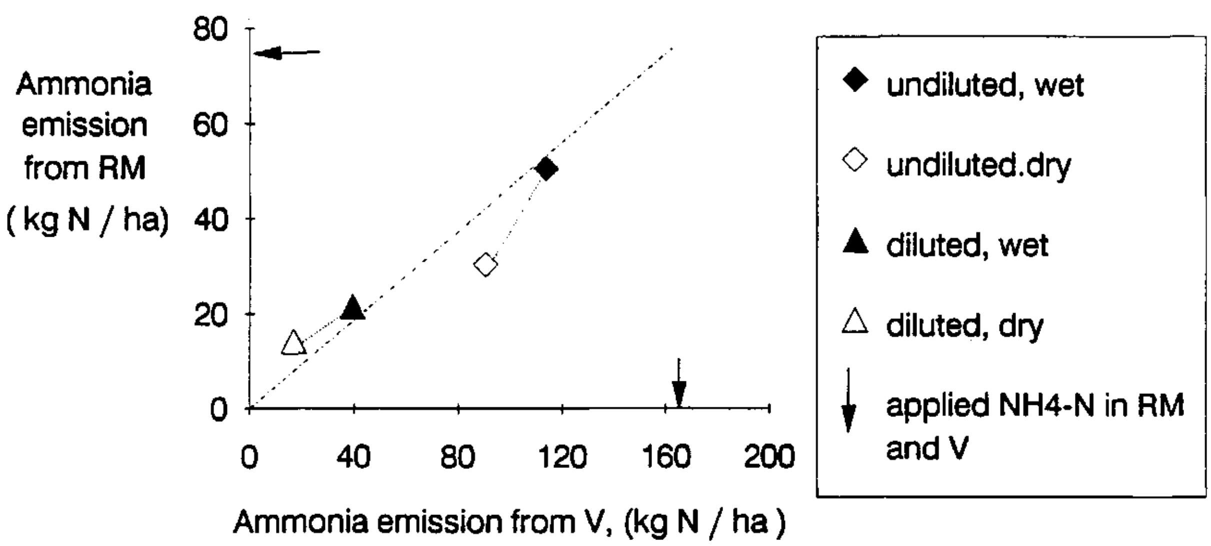


Figure 4. Ammonia emission from undiluted and diluted cattle slurry applied to grassland with high and low soil moisture content (wet and dry, respectively).

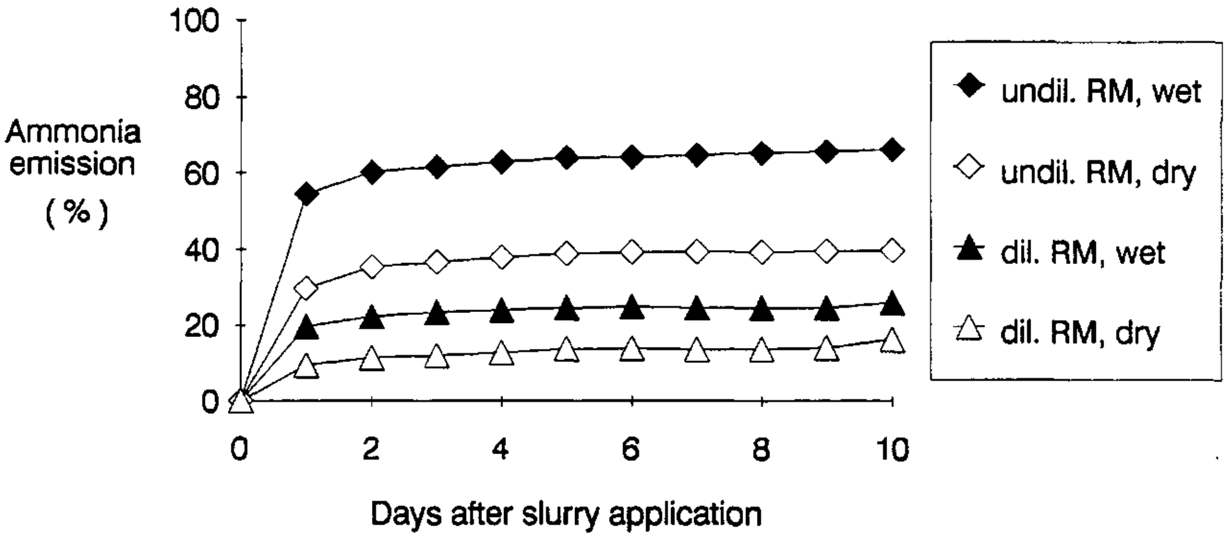
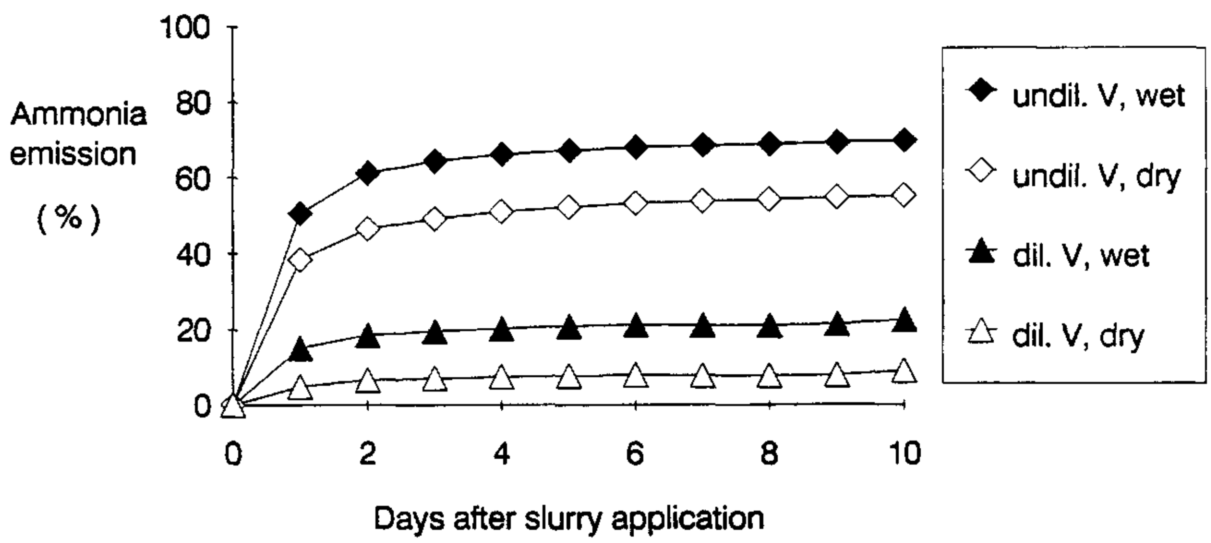


Figure 5. Ammonia emission from undiluted and diluted pig slurry to grassland with high and low soil moisture content (wet and dry, respectively).



4.4 Applications of slurry by sod injection

In experiment 13 V and VE were normally applied on the grassland surface and in wedge-shaped slots made by a disc-plough. In this experiment the application rate was 20 ton per ha. The emission rates are given in table 6. As the slots have a width of 3 cm at the soilsurface and the distance between the slots is 20 cm, the exposed area of the slurry in the furrows was about 15 % of the field area. The ammonia emission from the slurry applied in the slots is approximately 20-30 % of the emission after slurry application. The initial ammonia volatilization is relativily low after slurry application in slots, but, probably as a result of slower drying, the ammonia emission continues over a longer period.

4.5 The effect of fractionation of cattle and pig slurry

Ammonia emissions from both RM and RME are determined in the experiments 1, 7, 9 and 15, emissions from V and VE are determined in the experiments 1, 7, 12 and 13. The emission values (% of NH_4) are tabulated in table 6. The mean volatilization can be read from figure 1. On the average the ammonia emission from RME and VE is only slightly lower as compared to RM and V respectively. Therefore fractionation of cattle and pig slurry does not seem to be a very promising technique for reduction of ammonia emission.

5. Conclusion

The ammonium-N emission from undiluted cattle and pig slurry (dry matter content approximately 10 %) varies between 30 and 100 % of the ammonium-N content, depending on ambient conditions. The emission rate could not be easily predicted. The original hypothesis that ammonia emission depends on the physical structure of the slurry could not be proven.

The ammonia emissions from simultaneously measured slurries from different origins but with equal dry matter contents are rather similar.

The principal factor governing the level of ammonia emission of a specific slurry seems to be the soil water content. The emission rate is highest after the application of the slurry to a water saturated soil. The ammonia emission can be reduced by dilution of the slurry. Dilution with three volumes of water decreases the ammonia volatilization with 50 to 80 %, depending on the soil water content.

Research on the influence of soil water content and slurry dilution on the emission rate will be continued.

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Table 4. Ambient conditions during the first days of the experiments

Exp. nr.	Date	Average airtemp.(C) at + 10 cm	Average rel. air humidity	Sum of glob. rad. (J/cm^2)	Sum of the rain fall (mm) 3 d. before appl	after appl.	Average soiltemp.(C) at - 3 cm	soil moisture
1	20-Mar-89	6.3	78	750	8.4	0.3	8.1	with water
	21-Mar-89	5.6	79	1147		2.5	7.7	with water
2	3-Apr-89	4.2	52	1038	0.0	0.0	6.7	normal
	4-Apr-89	2.4	72	357		1.5	5.3	normal
3	17-Apr-89	7.5	74	1704	18.0	2.4	10.2	with water
	18-Apr-89	6.0	83	878		0.1	8.8	with water
4	1-May-89	10.8	62	2223	0.0	0.0	15.0	normal
	2-May-89	12.1	83	1676		0.0	15.5	normal
5	15-May-89	15.4	61	2494	2.7	0.0	18.8	normal
	16-May-89	16.7	63	2183		0.0	18.6	dry
6	29-May-89	15.3	59	2659	0.0	0.0	20.6	dry
	30-May-89	12.4	70	1691		0.0	17.8	dry
7	13-Jun-89	20.7	46	2777	0.3	0.0	21.3	normal
	14-Jun-89	19.8	52	2656		0.0	20.1	dry
8	26-Jun-89	20.4	56	2657	0.0	5.3	23.8	dry
	27-Jun-89		76	1143		3.0	19.8	dry
9	10-Jul-89	15.3	74	1080	35.1	0.0	20.4	normal
	11-Jul-89	17.1	74	1800		0.0	22.0	normal
10	24-Jul-89	20.4	74	2373	10.4	0.0	24.3	dry
	25-Jul-89	18.6	83	908		0.1	21.8	dry
11	28-Aug-89	13.4	74	1487	23.9	2.1	17.8	dry
	29-Aug-89	15.1	69	1330		0.0	17.5	dry
12	11-Sep-89	17.7	76	1308	0.0	0.0	19.2	dry
	12-Sep-89	17.7	74	1308		9.5	19.1	dry
13	25-Sep-89		87	680	5.9	0.3	17.1	normal
	26-Sep-89		81	703		0.0	15.9	normal
14	9-Oct-89	10.1	89	551	17.4	3.2	12.9	normal
	10-Oct-89	10.1	80	720		0.0	13.7	normal
15	30-Oct-89	13.1	87	186	8.2	12.0	12.6	wet
	31-Oct-89		95	133		8.5	12.0	wet

Table 5. Daily ammonia volatilization at the first three days after application and the background values for the experiments.

Exp. nr.	Sampling period(h)	Background emission (kg N/ha)	Day 1 Sampling period(h)	Day 1 Emission (kg N/ha)	Day 2 Sampling period(h)	Day 2 Emission (kg N/ha)	Day 3 Sampling period(h)	Day 3 Emission (kg N/ha)
1.1	70.0	0.4	21.5	39.5	24.1	12.6	23.9	2.9
1.2	70.0	0.6	22.5	26.0	24.1	10.2	23.9	4.8
1.3	70.0	0.1	22.5	64.2	24.2	21.4	23.8	12.7
1.4	69.9	0.4	22.5	59.2	24.2	18.4	23.8	10.8
2.1	65.8	0.6	22.3	31.3	23.9	6.8	24.1	4.0
2.2	66.0	1.1	22.5	33.9	23.9	7.8	24.1	3.9
2.3	66.2	0.6	22.7	21.6	24.4	4.3	24.1	3.2
2.4	66.4	1.4	22.8	12.8	23.9	3.4	24.1	1.7
3.1	66.5	0.6	22.1	10.1	24.3	2.3	23.8	1.0
3.2	66.7	0.7	22.0	16.4	24.3	3.2	23.8	2.2
3.3	67.0	0.6	22.0	51.3	24.4	7.9	23.8	4.0
3.4	67.2	0.8	22.0	25.4	24.2	4.8	23.8	1.2
4.1	67.5	0.1	23.5	55.2	24.0	11.5	24.0	4.9
4.2	68.7	0.2	23.4	63.2	24.0	6.4	23.9	2.2
4.3	68.9	0.4	23.4	38.8	24.0	5.0	23.9	2.9
4.4	69.2	0.2	23.3	45.8	24.0	5.1	23.9	1.6
5.1	89.1	1.2	23.1	41.6	23.8	4.2	24.3	1.3
5.2	89.1	1.6	23.1	82.8	23.9	17.2	24.3	5.3
5.3	89.1	1.4	23.0	22.7	23.9	4.2	24.3	1.2
5.4	89.1	1.5	23.0	62.9	23.9	13.2	24.3	4.4
6.1	63.8	1.2	22.7	15.0	24.0	2.1	24.1	0.9
6.2	63.7	2.1	22.9	25.0	24.0	5.3	24.1	1.8
6.3	63.7	1.0	23.1	7.4	24.0	1.4	24.1	0.5
6.4	63.6	2.2	23.3	8.5	24.0	2.8	24.1	0.8
7.1	19.2	0.5	22.2	47.7	23.5	4.5	24.4	1.6
7.2	18.2	1.2	22.1	6.5	23.7	4.6	24.4	1.5
7.3	19.2	0.6	22.1	44.3	23.5	9.9	24.2	3.4
7.4	18.1	0.6	22.1	74.2	23.5	34.2	24.4	6.3
8.1	66.2	0.9	22.0	52.8	24.2	4.7	24.4	1.3
8.2	67.2	1.7	22.0	109.5	24.1	11.2	24.5	6.1
8.3	67.3	1.3	21.9	30.0	24.1	4.4	24.4	1.8
8.4	67.3	1.5	22.7	33.3	24.1	4.2	24.4	2.4

Table 5. (Continued).

Exp. nr.	Sampling period(h)	Background emission (kg N/ha)	Day 1 Sampling period(h)	Day 1 Emission (kg N/ha)	Day 2 Sampling period(h)	Day 2 Emission (kg N/ha)	Day 3 Sampling period(h)	Day 3 Emission (kg N/ha)
9.1	67.3	0.7	22.3	32.3	23.8	2.7	24.1	0.9
9.2	67.4	1.2	22.3	35.9	23.8	9.6	24.1	2.9
9.3	67.4	0.8	22.4	43.8	23.8	12.0	24.1	3.6
9.4	67.4	1.1	22.3	89.8	23.8	13.8	24.1	6.8
10.1	67.0	0.9	21.9	48.4	24.0	4.0	24.0	1.8
10.2	67.0	1.6	21.9	135.4	24.0	17.4	24.0	10.9
10.3	67.1	1.0	21.8	37.3	24.0	6.5	24.0	2.5
10.4	67.1	1.3	21.3	43.7	24.0	5.5	24.0	4.1
11.1	20.6	0.4	21.8	58.8	23.9	12.5	24.5	4.3
11.2	20.6	0.8	21.8	54.1	24.0	9.1	24.5	2.0
11.3	20.6	0.4	21.7	30.0	24.0	3.8	24.4	1.2
11.4	20.6	0.6	21.6	54.3	24.0	7.2	24.4	1.8
12.1	66.2	2.4	21.7	50.6	23.1	10.5	24.9	1.9
12.2	66.3	2.2	21.7	60.5	23.1	16.6	24.9	3.1
12.3	66.2	1.8	21.7	46.8	23.1	6.5	24.9	1.7
12.4	66.2	2.0	21.7	47.6	24.1	7.4	24.9	1.7
13.1	67.4	2.3	23.7	11.6	23.9	3.4	24.0	2.8
13.2	67.4	2.3	23.6	75.9	23.9	9.2	24.0	5.0
13.3	67.4	2.1	23.6	2.1	23.9	1.5	24.0	2.0
13.4	66.4	2.1	23.5	55.2	23.9	9.9	24.0	5.6
14.1	67.1	3.2	23.7	88.9	24.1	18.4	23.9	4.8
14.2	67.2	3.0	23.7	123.7	24.1	20.0	23.9	7.9
14.3	73.1	3.6	18.2	62.5	24.0	26.3	20.9	5.9
14.4	73.1	2.9	18.1	77.9	24.0	24.3	23.9	4.3
15.1	71.8	4.7	21.5	71.9	24.1	13.1	23.8	5.3
15.2	71.8	6.5	21.4	34.3	24.1	12.5	23.8	4.0
15.3	71.8	4.7	21.4	23.7	24.1	1.5	23.8	0.9
15.4	71.8	5.3	21.4	22.8	24.1	8.8	23.8	3.2

Table 6. Total net ammonia volatilization (net, kg N/ha) and ammonia volatilization relative to the rate of ammonium-N application (rel, %).

Exp.		RM		RME		RG		V		VE		Z		P	
nr.	Period	net	rel	net	rel	net	rel	net	rel	net	rel	net	rel	net	rel
1	20/3-31/3	59	78	52	64			122	75	118	69				
2	3/4-14/4	48	63			49	67	42	26			20	20		
3	17/4-27/4	14	18					23	14					67	47
		32	42												
4	1/5-12/5	75	54			55	40	79	48					51	36
5	16/5-27/5	50	67					114	70						
		30	40					90	55						
6	29/5-11/6	21	28					39	24						
		14	19					17	10						
7	13/6-24/6	60	79	16	20			128	79	68	40				
8	26/6-7/7	60	79			35	49	135	83			45	44		
9	10/7-21/7	36	48	50	62					62	37			120	84
10	24/7-4/8	58	77			50	69	176	108			60	59		
11	30/8-8/9					69	95	83	51						
						40	55								
						68	94								
12	11/9-22/9							69	42	90	53	65	65	64	44
13	25/9-6/10							32	29	20	18				
								109	100	92	79				
14	9/10-16/10							117	72						
								160	98						
								99	61						
								114	70						
15	30/10-7/11	24	31	36	44	48	66	100	61						