Bern University of Applied Sciences
School of Agricultural, Forest
and Food Sciences

Workshop report

Reassessment of NH_3 emission factors for field application of slurry

Final version from 14/03/2013

Date: 12-13/02/2013

Location: Bern University of Applied Sciences, School of Agricultural, Forest and Food Sciences (HAFL), Zollikofen, Switzerland

Organization: Agroscope Reckenholz Tänikon (ART), Zurich, Switzerland

This workshop was held within the framework of the project “Ammonia emissions after field application of slurry”. This project is carried out by ART and HAFL on behalf of the Federal Office for Agriculture FOAG and the Federal Office for the Environment FOEN

Participants

Martin Hansen, AgroTech, Aarhus, Denmark

Chris Flechard, INRA, Rennes, France

Benjamin Loubet, INRA, Thiverval-Grignon, France

Arjan Hensen, ECN, Petten, The Netherlands

Jan Huijsmans, WUR, Wageningen, The Netherlands

Julio Mosquera, WUR, Wageningen, The Netherlands

Tom Misselbrook, North Wyke Research, Devon EX20 2SB, United Kingdom

Albrecht Neftel, Jörg Sintermann, Christof Amman, ART Zürich, Switzerland

Thomas Kupper, Harald Menzi, Christoph Häni, HAFL Zollikofen, Switzerland

Beat Achermann, Rudolf Weber, Gaston Theis, FOEN, Bern, Switzerland

Christine Zundel, FOAG, Bern, Switzerland

Scope of the workshop

- Exchange of knowledge on the latest developments on measurements of NH_3 emissions from fields after slurry application in the participating countries.
- Further steps towards an understanding of the differences between the results of old and more recent ammonia emission measurements following field application of slurry (as reported in the paper by Sintermann et al. 2012).
- Discussion of suitable experimental set-ups for reliable NH_3 emission measurements.

Presentations

Thomas Kupper, HAFL Zollikofen
Situation in Switzerland and view of the user (emission inventories) of emission factors for modeling ammonia emissions from agricultural sources.

Julio Mosquera, WUR, Wageningen
Dutch measurements on ammonia emissions after field application of slurry: overview of the methodological approach.

Jan Huijsmans, WUR, Wageningen
Dutch measurements on ammonia emissions after field application of slurry: overview of the experimental design and results (overview 20 years of measurements).

Arjan Hensen, ECN Petten
Dutch measurements on ammonia emissions after field application of slurry: intercomparison of different methods.

Tom Misselbrook, North Wyke Research, Devon
Measurements on ammonia emissions after field application of slurry in the UK: overview of the results and comparison of different samplers and techniques (Misselbrook et al., 2005).

Benjamin Loubet, INRA
French measurements on ammonia emissions after field application of slurry: studies at the Grignon field site, application of the FIDES method, CASDAR –Volat NH3 project.

Martin Hansen, AgroTech, Denmark
Danish measurement system and emission factors for field application of slurry

Albrecht Neftel, Jörg Sintermann, ART Zürich, Christoph Häni, HAFL Zollikofen
Reasons for a systematic emission overestimation in the first generation of the Swiss measurements, further outline of the measuring methods used in the ongoing project.

Discussion

The workshop discussed some potential causes of biases in NH_3 flux measurements with a special focus on the z_{inst} method as applied in Switzerland in the past, the backward trajectory footprint dispersion models and the IHF method (integrated horizontal flux). The latter is widely considered as the reference method. The following sources of uncertainties were addressed:

- Meteo/wind speed/turbulence measurements (e.g. the response of cup anemometers to low wind conditions)
  - Interpolation requirements to allow for proper integration of the wind profile.
- Uncertainties in the NH_3 concentration measurements
  - The use of different sampling systems.
  - Potential losses in the air sample inlets.
  - Representativeness of NH_3 concentration.
  - Effect of the correlation between wind and concentration (u'c' term).
- Uncertainties associated with the method coupling wind and concentration data into a flux value
  - Different integration schemes along the IHF tower.
  - Assumptions in turbulence models (for example FIDES, Windtrax).
  - Interferences by nearby sources.

ART/HAFL reevaluated their old Swiss measurement data from 1992-1994 and reported an overestimation of their previous emission factors determined with the z_{inst} method, caused by a combination of at least three factors all leading to a systematic overestimation:

- over-speeding of the cup anemometers used for the wind measurements near the ground.
- Cross-interference of the plots located at distances of 70 m.
- z_{inst} scaling factor.

Additionally, it is possible that the used ammonia sampling device (passive diffusion samplers) overestimated the concentrations in situations with strong temporal fluctuations, due to potential deposition of NH_3 onto internal surfaces during phases with high concentrations, followed by remobilization from the surfaces during phases with cleaner air.

WUR showed the effect (sensibility) of changing the height and number of samplers on the central mast in their experiments. It pointed out why they kept to measuring a whole profile of concentrations to assess a good concentration profile and not measuring at one (Zinst) height (despite the more work and costs involved). The same accounted for measuring wind speed at different heights to assess local wind profile.

The group felt that a reevaluation of old data sets from the different countries could be beneficial to further analyze discrepancies/biases in measurements.

The workshop further discussed the difference in emission factors found in the Netherlands with EF's for splash plate application of on average ca. 70% of applied TAN, versus the lower levels of 25-35% of applied TAN found in Switzerland and the United Kingdom. Denmark has no recent measurement on splash plate application, as the use of this technology has been banned for almost 30 years. However, the historical emission factors for the technology are at the same levels as the emission factors found in the Netherlands.

Possible reasons were put forward for the observed differences (e.g. slurry properties, large differences in dry matter contents, weather conditions and length of total sampling period between e.g. Switzerland and the Netherlands), but the workshop members were not able to quantitatively assess the influence of differences in experimental set-ups and measurement methods. The participants identified a number of potential pitfalls in the implementation and interpretation of the different methods.

Conclusions and recommendations

I) Reassessment of measurements of ammonia emissions after field application of slurry

1. The participants decided to exchange from each group full data sets of 2 experiments which will allow each group full insight in the experiments carried out by other groups. ART/HAFL will distribute a template for data exchange by 15 March 2013.
2. Participants are invited to return their example data by 15 April 2013.
3. ART/HAFL will compile the datasets and redistribute the entire dataset to all participants by 30 April 2013.
4. Each group is invited to analyze the data of the other groups as far as possible and report back to the participants by end of May 2013.

II) Extension of the data base on ammonia emissions after field application of slurry used in the Sintermann et al. paper by inclusion of hitherto unpublished data

1. ART/HAFL will prepare a data file containing all data included in Figure 1 of the paper of Sintermann et al. (2012) and disseminate it among the participants by 15 March 2013.
2. The participants are requested to complete the file with their data not yet considered in the existing dataset.
3. The completed file shall be re-distributed to the participating groups by 15 April 2013 for the purpose of re-analysis. A special focus should be given on the stratification of the data, e.g. with respect to slurry properties, measurement techniques, soil conditions, etc.

It must be investigated whether this task can/should be coordinated with Sven Sommers activities (revision of the ALFAM database). ART/HAFL will ensure the contacts.

III) Measurement methods and dispersion modeling

The group discussed requirements regarding measuring ammonia emissions after field application of slurry and dispersion modeling

1. The group recognizes that micrometeorological methods are the only reliable measurement techniques for the determination of ammonia losses after field application of manure.
2. The IHF method can be considered as the reference method, provided that sufficient attention is paid to critical parameters such as: integration height, background concentration, shape of profile (fitting), calibration of sensors.
3. A careful design of the ammonia sampling inlet is essential for a reliable concentration measurement.
4. The use of several short range dispersion models is a useful tool to assess the consistency and plausibility of the calculated emissions and the measured vertical concentration profiles.

IV) Recommendations for international methodological intercomparison field studies

An international coordinated field intercomparison experiment is recommended to investigate the potential discrepancies between emission measurement methods. This should take advantage of recent advances in instrumentation (e.g. open path DOAS sensors, LIDAR) and dispersion modeling in combination with the established reference methodology (e.g. IHF method). The inclusion of an artificial ammonia source is recommended to validate all methods used to quantitatively determine emissions from field applied slurry. The intercomparison experiments should include measurements to assess if results from different emission modeling methods differ with respect to the plot size. Specific experiments should be carried out to allow a differentiation in emissions between manures with low and high DM/TAN contents in interaction with application rates.

V) Use of mechanistic models (e.g. Volt'Air)

The participants felt that the application and further development of mechanistic models such as Volt'Air would strengthen process understanding and might reveal the influence of soil processes and other influencing factors on the observed emission rates. This issue has potential links with the FP 7 ECLAIRE project.

This report can be disseminated
1. within the participants and to national ministries
2. to recipients as decided by the participants

References

Misselbrook, T.H., Nicholson, F.A., Chambers, B.J., Johnson, R.A. 2005. Measuring ammonia emissions from land applied manure: an intercomparison of commonly used samplers and techniques. Environ. Pollut. 135(3): 389-397.

Sintermann, J., Neftel, A., Ammann, C., Häni, C., Hensen, A., Loubet, B., Flechard, C.R. 2012. Are ammonia emissions from field-applied slurry substantially over-estimated in European emission inventories? Biogeosciences 9: 1611–1632.

Acknowledgements

This workshop was sponsored by the Swiss Federal Office for the Environment FOEN.