EUROPEAN AGRICULTURAL GASEOUS EMISSIONS INVENTORY RESEARCHERS NETWORK (EAGER)

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ABSTRACT

Under the Gothenburg protocol, signatories will have to report NH_3 emissions annually. To satisfy the requirements of the protocol, the emission inventory approach must give a true picture of emissions, reliably and reproducibly show changes over time, recognise relatively small changes and take into account all relevant and measurable variables that influence emissions. To allow a co-ordinated implementation of the Protocol, different national inventories should be comparable. Current inventory approaches do not fulfil these requirements because 1) they are often based on expert assumptions for input data on farm management, 2) the structure and background of models used differs considerably, 3) the number of input variables is very limited and 4) most NH_3 emission inventory models do not account for other N losses. A core group of emission inventory experts has inaugurated a network, with the aim of achieving a detailed overview of the present best available inventory techniques, compiling and harmonizing the available knowledge on emission factors and initiating a new generation of emission inventories that satisfies Protocol requirements. The purpose of the group is to support harmonized emission inventory activities on the European scale (input for UN/ECE expert group, CORINAIR etc.) and to review and coordinate emission model development activities.

Keywords: *Ammonia, emission inventory, network.*

BACKGROUND AND REASONS FOR EAGER

Under the Gothenburg protocol, signatories will have to report NH_3 emissions annually. The emission inventory must give a true picture of emissions, reliably and reproducibly show changes over time, recognise relatively small changes and take into account all relevant and measurable variables that influence emissions. There is also an increasing demand for inventories to give a regional resolution of emissions and different national inventories should be comparable, to allow a co-ordinated implementation of the Protocol. Current emission inventory approaches can not fulfil the above requirements for the following reasons:

1) Most emission inventories rely, at least partly, on expert assumptions for input data on relevant livestock and manure management practice, because statistical data on this topic is not available in most countries (except Sweden and the Netherlands in the EAGER member countries). Even the best expert judgements will have the following limitations:

a) They do not have a good enough resolution to reliably recognise small changes in management practice (e.g. a few percent change in slurry applied with low emission techniques).

Nevertheless, in most countries changes in emissions expected over a few years are small (e.g. ceiling for Switzerland -13% over 20 years) and are usually achieved through the cumulation of a number of changes in manure management and livestock numbers.

b) No expert can reliably know differences in management between different regions and if different experts are consulted for different regions, the comparability of their assumptions can not be guaranteed.

c) If experts have to be changed (job changes etc.), a direct comparability of their perception can not be guaranteed.

d) In most cases, no expert will have experience over the whole range of relevant topics (different livestock categories and manure management systems; feeding, housing, storage, application). As soon as the assumptions of different experts have to be combined, there is a risk that they base their experience on assumptions that might not be fully compatible.

e) Even experts are human and their perception might sometimes not be fully objective because it depends on their background, personal experiences or sometimes recognised or unrecognised considerations about potential consequences of their expertise.

2) As soon as countries do not use the simple CORINAIR methodology only, their inventory approaches differ, the most important differences being:

a) Older models based on emission factors in kg per unit of activity data (e.g. livestock numbers) vs. models based on the nitrogen (N) flow with emission rates in percent of the N flux at different stages (e.g. grazing, housing, storage, application).

b) Differences in livestock categories used and how many different stages of emissions are considered.

c) Differences in scientific data and assumptions used to define emission factors and rates.

d) Differences in input variables considered and in their effect.

3) The number of input variables, on farm management and other influencing conditions (e.g. climatic conditions) considered, varies between models, but is limited in all of them.

4) Even though NH_3 is the major N loss in the manure management chain, it is not the only one. Especially in models based on N flow, the omission of other gaseous losses (e.g. N_2O, NO_x) can cause errors in the emission calculations for NH_3. Most NH_3 emission inventory models do not account for other losses.

AIMS AND OBJECTIVS OF EAGER

To overcome weaknesses of present inventories discussed above, there is an urgent need to modernise and harmonise emission inventories. In January 2003 a group of NH_3 emission inventory specialists from Switzerland, Germany, UK, Denmark, Sweden and later also the Netherlands inaugurated the "**E**uropean **A**gricultural **G**aseous **E**mission inventory **R**esearchers network (EAGER)". The general idea behind this network was that a core group of experienced inventory specialists from different countries should unite their experience and activity with the following aims:

- Gain a detailed overview of the past, present and future emission inventory activities (including background information, personal experiences etc.).
- Initiate a more intensive discussion forum between inventory specialists in different countries and compile and harmonise the available knowledge on emission factors and functions.
- Discuss the terms of reference of emission inventories needed for the reporting under the Gothenburg protocol.
- Assemble a detailed overview of the present best available inventory techniques and per-

form congruency tests between different newer emission inventory models. If such tests could show that the state of the art models give well comparable results, this would contribute to the credibility of emission inventories in general.
- Identify the main weaknesses of the presently used emission inventories of the member countries.
- Initiate a new generation of emission inventories that satisfies the protocol requirements.
- Propose and support harmonised emission inventory activities on the European scale by providing inputs to the UN/ECE ammonia emissions expert group and the expert group responsible for the agricultural chapters of the CORINAIR emission inventory guidebook.

In a later stage the work of EAGER should be extended to emission model development activities because the introduction of new legislation aiming at a reduction of NH_3 emissions will generate an increasing demand for more reliable emission models. To prevent misunderstandings, these models should be harmonised as far as possible with emission inventories. At least for a first phase, EAGER should be a network of nationally-funded activities, because the work is too urgent to wait for an eventual approval of a project or network in the EU framework program and because the calls in the 6th framework program did not cover such topics. For this first phase it was also decided to keep EAGER as a closed group of experienced experts to allow for efficient and fast progress. Later-on it might be necessary to extend the network to achieve a wide dissemination of the results. Nevertheless, it is the aim to continually feed in the results of EAGER to the UN/ECE and CORINAIR expert groups. The fact that the chairmen of both existing groups are members of EAGER will guarantee that activities will not overlap. Details about the models used by the EAGER members are given by the following sources: Switzerland – Menzi et al. (2003); Germany - Daemmgen et al. (2003) UK model traditionally used for the national inventory – Misselbrook et al. (2000); UK NARSES – Webb and Misselbrook (2004); Denmark – Hutchings et al. (2001). The Swiss, German, and Danish model as well as NARSES from the UK are N flux models.

RESULTS OF PAST ACTIVITIES

So far EAGER has organised three workshops. While the first one aimed at reaching a common understanding of the problem and the aims and activities of the network, the following ones started activities to compile and compare N-excretion values and emission factors of the models used in member countries and to perform congruency tests of the existing models. Values on total N excretion of livestock used in the member countries agree quite well for major livestock categories and appear to be reliable. They should therefore not cause errors in the emission calculations. Nevertheless, reliable and up-date excretion information might not always be available in other countries. The direct comparison of N-excretion values is sometimes complicated by different definitions of livestock categories (e.g. weight boundaries between different pig categories). The comparison of emission factors proved to be rather difficult because the basis of the values used often vary:
- Emission factors of emission factor models are given in kg of N while those of N-flux models are in percent of the N flow at a certain stage of the manure chain.
- In some N flux models emission factors are given in percent of total N and in others in percent of total ammoniacal N (TAN).
- In some models different emission factors are used for different conditions (e.g. different seasons of manure application) while others use one standard emission factor and account for varying conditions with variable correction factors.

Nevertheless, if these differences can be sorted out, the emission factors mostly agree quite well and existing differences are often explicable by farming practice. The biggest uncertainties exist for solid manure.

For congruency testing, standard data sets were created and used for calculations with the different models. Two different datasets were used: a) only livestock numbers, b) livestock numbers plus N-excretion values. When only livestock numbers were standardised, the different models gave very comparable results for different livestock categories. Nevertheless, the distribution of emissions to grazing, housing, storage and application sometimes varies. When both livestock numbers and N excretions were standardised, results are more variable and difficult to interpret for the following reasons: a) Each model has its own units which often are difficult to transform, b) interdependencies between N-excretions and emission factors are disturbed, c) national differences in farm management are not sufficiently accounted for.

CONCLUSIONS

A reliable assessment of the development of NH_3 emissions can only be done with models based on the N flux, because changes in farm management could otherwise not reliably and reproducibly be considered. At least for manure storage and application, the emission rates used should be in percent of TAN. The existing N-flux models based on TAN in Switzerland, Germany and UK compare quite well, at least for total emissions. Some differences in the distribution of emissions to grazing, housing, storage and application must be studied in more detail. Thanks to the comparison of models, all participants identified some aspects where their own models could be further improved. It is important to consider not only NH_3 emissions, but also mineralisation, immobilisation and denitrification processes, especially for solid manure. In the future, it would therefore be advisable to develop models which encompass all these processes and correspondingly different forms of nitrogen losses as well as carbon. At present, only the German model has this capacity. Coordination and to a certain extent harmonisation is important for reliable and comparable emission inventories. Nevertheless, at least at present, it does not appear necessary or advisable to aim at one standardised methodology for all countries, because regional differences in farm management and natural conditions might then not be well enough considered.

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