Nitrogen flow modelling: lessons from the EAGER project

Harald Menzi and **Beat Reidy**, Swiss College of Agriculture (SHL), Switzerland

Ulrich Dämmgen, Federal Agric. Res. Cent., Inst. of Agroecology, Germany

Helmut Döhler and **Brigitte Eurich-Menden**, Association for Technology and Structures in Agriculture (KTBL), Germany

Frits van Everts, Plant Research International, Netherlands

Nick Hutchings, Danish Institute of Agricultural Sciences (DIAS), Denmark

Harry Luesink, Agricultural Economics Research Institute (LE), Netherlands

Tom Misselbrook, Inst. of Grassland and Environmental Research (IGER), UK

Gert-Jan Monteny, Wageningen UR, Agrotech. and Food Innovations B.V, Netherlands

Lena Rodhe, Swedish Inst. of Agricultural and Environmental Engineering (JTI), Sweden

J Webb, AEA Energy&Environment, UK

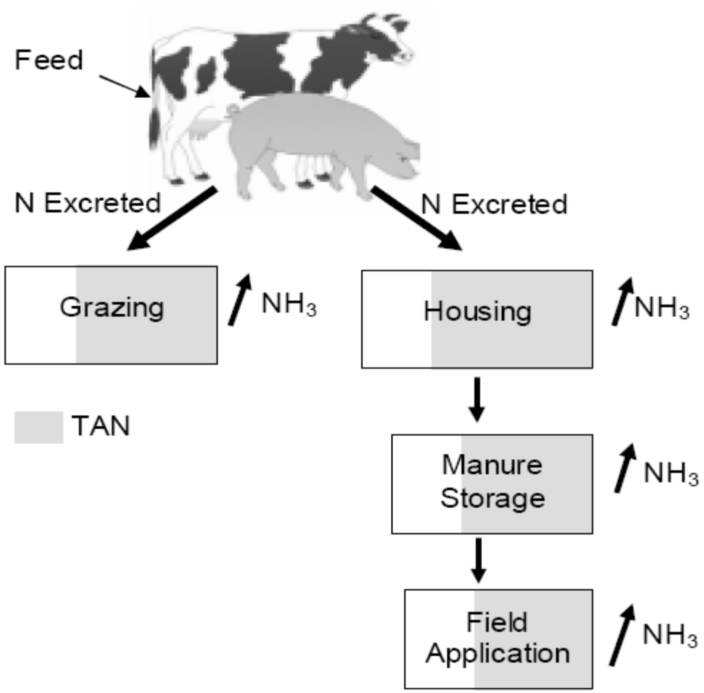
EAGER: European Agricultural Gaseous Emissions Inventory Researchers Network

Background

- Accurate agricultural NH_3 emission inventories are required for reporting within the framework of the Gothenburg Protocol
- to allow a co-ordinated implementation of the Protocol, different national inventories should be comparable
- a core group of emission inventory experts initiated EAGER to
  - achieve a detailed overview of present best available inventory techniques
  - compile and harmonize the available knowledge on emission factors (EFs) for nitrogen (N) flow emission calculation models
- **first key task: comparison of models**
  - how far do results agree; reasons for differences?

Approach for comparison of models

- **Six N-flow models from CH, DE, DK, NL, UK**



Model	Country	Objectives of the model
DYNAMO	Switzerland	Estimation of the magnitude of NH_3 losses at the farm and national level; national emission inventory, evaluation of abatement potential
DanAm	Denmark	Estimation of the magnitude of NH_3 losses at the national level ; national emission inventory
GAS-EM	Germany	Estimation of NH_3 and other N losses at the national level ; national emission inventory
MAM	Netherlands	Manure policy analyses and estimation of NH_3 emissions at the farm and national level
FARMMIN	Netherlands	Ex-ante evaluation of the effect of management on profitability and nutrient losses.
NARSES	United Kingdom	Estimation of the magnitude, spatial distribution and time course of agricultural NH_3 emissions at the national level ; national emission inventory, calculation of cost curves

Reasons for approach taken

- Comparing emission inventories on the basis of EFs and N excretion rates can identify differences among models but not the respective reasons. The reasons can be divided into 4 main types:
  - (1) errors
  - (2) differences in agricultural practice
  - (3) differences in the model structure
  - (4) differences in model parameterisation

Approach to comparison of models (2)

- Three levels of model standardizations

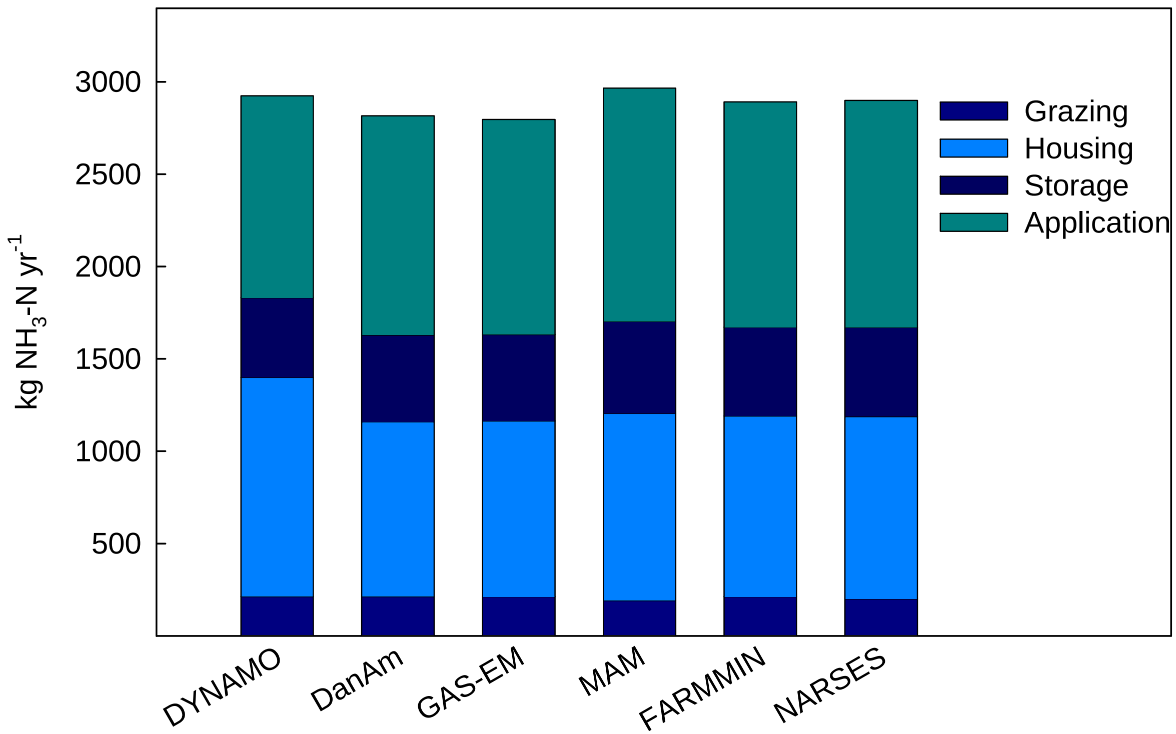
Scenario	Nitrogen excretion [kg yr^{-1} N]	Emission factors
FF	Fixed[a]	Fixed[a]
FN	Fixed[a]	National[b]
NN	National[b]	National[b]

a) Same value used in all models
b) Model-specific values used

- A simplified dairy cow and pig scenario (only dairy scenario presented here)

Results and discussion: FF scenario

- Very similar estimates of the NH_3 emissions for the FF scenario
  → underlying N flows of the different models are highly comparable
- Reasons for differences are clear



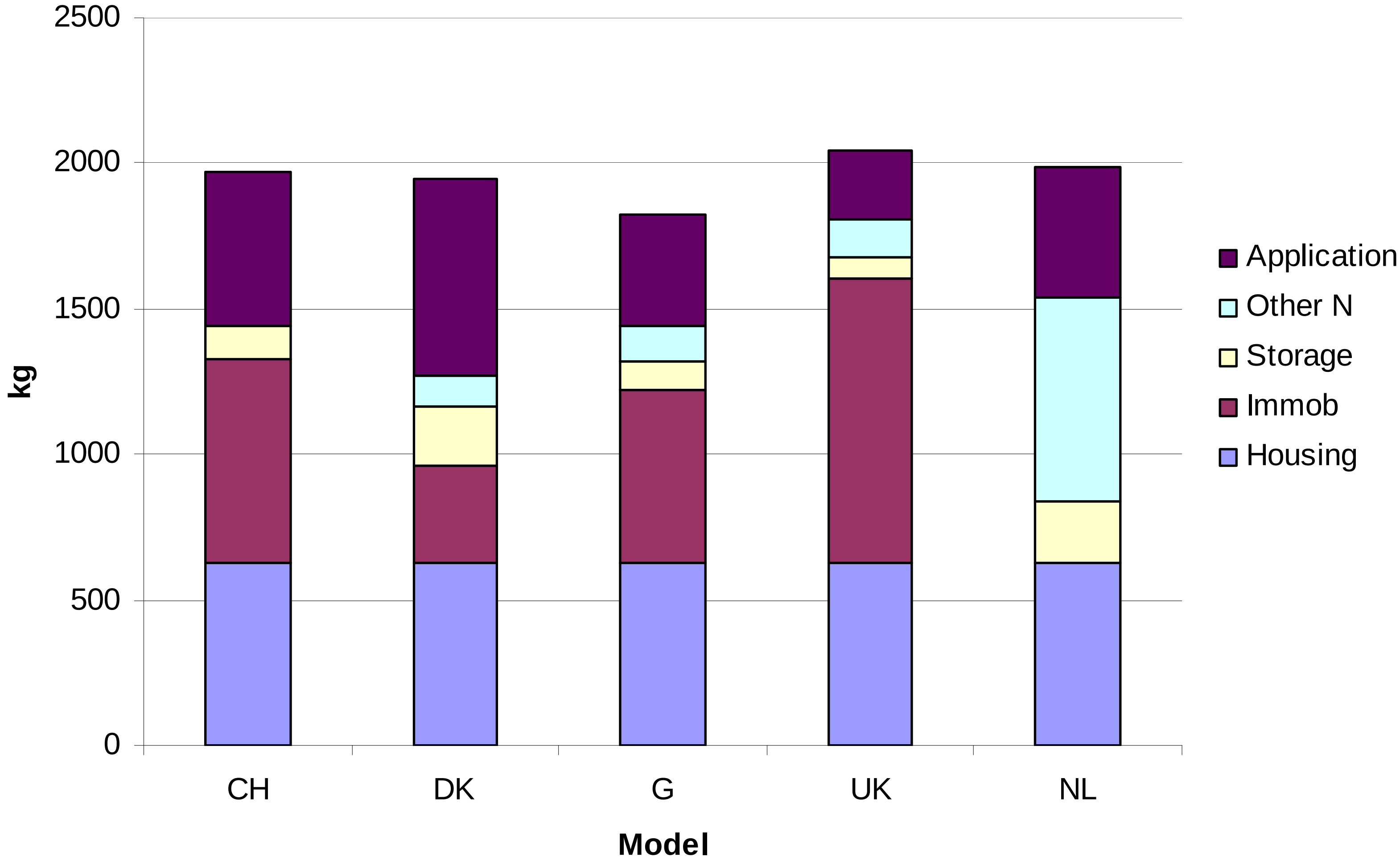
Reasons for differences

- The underlying N flows of the different models are similar.
- the small differences can be explained by
  - slight differences in the assumptions concerning emissions during the grazing period
    - partitioning of excretal N between grazing and animal housing; emissions in houses and manure stores when cattle are largely outside
  - inclusion of additional sources (e.g. hard standings)
  - and by the inclusion of mineralisation and denitrification (GAS-EM)

Comparison of litter-based manures

- Two scenarios for litter-based systems were run
  - for beef cattle and for broilers
- FF, FN and NN scenarios as for slurry comparison

Beef FYM FF scenario



Results of comparison for litter-based manures

- Results of the FF scenario for beef cattle produced large differences in the estimate of NH_3 emissions (±32% of the mean)
- these differences arose from the different approaches to TAN immobilization, other N losses and mineralization in the models
- as a result of those differences estimates of TAN available at spreading differed by a factor of almost 4

Lessons learned

- In the congruency testing some minor weaknesses were identified in all the models tested
- the debate increased awareness and consensus of available data and the importance of some processes (e.g. mineralisation)
- the congruency exercise has led to a better harmonisation of the structure and function of the models tested
- in some cases, the consensus relied on work that was only available in reports to funding bodies or in languages other than English
  - highlighting the need for the collation and publication of information in a form available to an international readership.

Lessons learned

- Complete harmonisation of models was not considered desirable
- the relative importance of the processes involved may vary among countries, due to different agricultural practices and natural conditions
- the modeller is always at the mercy of the statistical data available as model input
- there is therefore little point in creating a model that uses activity data that are likely to remain unavailable for the foreseeable future.

Inferences for future work

- Immob. and denitrif. also depend on the manure C:N ratio
- hence advantages to including C in mass flow models
- this would also provide an integrated model for the estimation of emissions of CH_4, NMVOCs and CO_2
  - estimation of the latter would provide an estimate of mass loss to enable calculation of the N and TAN concentrations in litter-based manures
  - at present output can only be checked by means of the N:TAN ratio prior to storage and spreading
  - checking estimates of concentrations as well as ratios against measurements would enable more thorough output validation

Achievements of EAGER

- Thorough and critical analysis of models and intensive exchange between participants
  - Weaknesses of all models recognized and improved → all partners and models profited from the excercise
  - Starting harmonization between calculation procedures
- Evidence of good comparability between N-flow models
  - Indication that models are following the same general procedure and are based on comparable data and assumptions
  - Inter-country comparisons are possible
  - It is possible to study the effect of different framework conditions and management
- One generalized model across Europe is hardly realistic because of differing framework conditions, structure, management

But further harmonization is possible

Achievements of EAGER (2)

- Inputs for UN/ECE expert groups
  - No overlap thanks to partly common membership
  - Nucleus group for advanced solutions
    - Fast exchange of new knowledge
    - more focused work possible than in large groups with varying membership
- Contribution towards further harmonization of emission inventory calculation procedures and improved emission data
  - Tools for countries only starting with inventory work (long term only)
- Core group of scientists that can also provide inputs to research projects, policy questions, extension service tools etc.

Results and discussion: FF scenario

come to see the poster and have a more detailed discussion

- Differences more pronounced when using national emission factors and/or national N excretion rates (FN and NN scenarios)
- Variation primarily result from distinct national emission factors and N excretion rates which reflect the specific livestock and manure management systems and climatic conditions