AGRAMMON: AN INTERNET BASED MODEL FOR THE ESTIMATION OF AMMONIA EMISSIONS

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1 INTRODUCTION

As ammonia emissions from agriculture are increasingly recognized as a serious impact to the environment and a loss of nitrogen for farms, international agreements, new national policies and extension service campaigns aiming at the reduction of emissions have increased in importance in recent years. These depend on reliable estimates of emissions which take into account the relevant farm management and structural parameters that influence emissions. The same is true for emissions reporting obligations under the Gothenburg Protocol.

In most countries of North-western Europe inventories of ammonia emissions from agriculture use empirical models based on the nitrogen (N) flow, taking into account farm and manure management practices. An overview of such models in the UK, Germany, Denmark, Netherlands and Switzerland is given by Reidy et al. (2008a) who compared these models in the framework of the European Agricultural Gaseous Emissions Inventory Researchers Network (EAGER).

Recently, emission calculations for Switzerland have been made at the individual farm, rather than national, level (Reidy et al. 2008b). For this purpose, the model DYNAMO was developed. The results were then compiled to average values for 36 farm classes differentiating between three geographical areas, three altitude levels and four farm types. DYNAMO was never released publicly since it was replaced by the new model AGRAMMON. The aims of the model revision were:

- To revise and update all the emission factors and calculation algorithms in view of new scientific data, especially the conclusions from the EAGER network (Reidy et al. 2008a).
- To put the model on a new programming basis making it more transparent, flexible and reliable, to allow for later modifications and extensions and to make it accessible via the internet.
- To allow development of further applications using the same model base (e.g. calculations for regions).
- To produce a detailed and transparent scientific and technical documentation of the model.

As for DYNAMO, it was an important goal that the new model, AGRAMMON, can not only be used for inventory calculations, but should be implemented as a user-friendly tool that farmers and extension workers could use to evaluate the emission status of individual farms and to perform scenario calculations. Such scenario calculations could be a powerful means for increasing the awareness of farmers, politicians and the general public and for evaluating emission abatement options.

2 MATERIALS AND METHODS

AGRAMMON basically follows the same N flow approach as other European models (Reidy et al., 2008a) to allow for consideration of the complex interactions between different stages of the manure management chain. Following the requirements of the new draft Corinair guidebook for tier 3 emission calculations, emission factors in percent of soluble N (total ammoniacal N – TAN) are used. The model does not calculate the N excretion of the animals but uses the regularly revised official national guide-values (Flisch et al., 2009), which are also the basis of the farm-related nutrient balance regulations. However, for dairy cows the influence of the milk yield level, the amount of concentrate used and special feed rations (e.g. maize silage during summer feeding) on N excretion is considered. For pigs, N excretion is adjusted according to the crude protein content of the ration. As an exception to the general approach, emission factors for slurry storage are not given in percent of the TAN flow but rather per m^2 of storage surface, because the emitting surface remains the same even if the N flow through the storage is reduced due to grazing (except for 24 h grazing for all animals). The major farm and manure management variables considered by the model are:

- Housing systems: higher emission rates are used for loose housing systems for cattle and multi-area pens with littered areas or combined lying and feeding cubicles in combination with outside yards for pigs to account for the higher surface per animal.
- Duration the animals spend outside the housing system (grazing and exercise yard). During the use of the exercise yard and grazing, emissions in animal housing systems are reduced less than proportional to the time that the animals are outside, because it is assumed that the emitting surface remains (except for 24 h grazing).
- Floor type of exercise yards.
- Mitigation techniques in housing.
- Slurry storage system and the existence and type of a cover, the slurry storage surface area and frequency of slurry mixing.
- Slurry spreading techniques, incorporation of solid manure, the proportion of manure that is spread during summer months (June to August).
- Climatic factors and time of day of slurry application.
- Amount and type of mineral N fertilizer and organic fertilizers used.

The basic philosophy for choosing these influencing factors was that variables have to be relevant for the emissions and that the information is readily available on the farm without any special measurements, records or investigations. A more detailed description of the model design is available in Kupper et al. (2010) and Menzi et al. (2008).

3 RESULTS AND DISCUSSION

3.1 Implementation and improvement of the model

Some twenty test users were instructed during a workshop. A test version of the model was uploaded on the internet and activated for the test users. They were asked to check the reliability and applicability of the model. The model was thereafter adapted according to the feedback. After this four month test phase the final version was uploaded in September 2009 (http://model.agrammon.ch/single/). Since then some minor improvements have been implemented.

3.2 Usage of the model

The model is available for unrestricted use on the AGRAMMON website at http://www.agrammon.ch in German, French and English. Users can create their own account with authentication credentials (Figure 1). Users can generate their own datasets using the “File” menu. Optionally, sample datasets for various farm types can be used as a starting point and adapted to the specific needs of the user (Figure 2). Data must be entered for each of the modules housing, storage, application and plant production. For each livestock category and manure store, instances must be created by clicking on the respective category label with the right mouse button. Data entry is complete when the red dots and boxes turn to green (Figure 3). The entered data is immediately stored in a relational database on the AGRAMMON server. The user can access the data later for completion, modification or further processing. They will remain unchanged in the database and can only be viewed, modified or deleted by the authenticated user.

After the dataset is completed (i.e. all instances appear green) the results can be displayed as tables or graphs. A table is produced by clicking on the tab “Tabular Results” (Figure 2). Results can be displayed in different levels of details for each emission stage (housing, storage, application, plant production) as kilograms per year or per animal category or as percentages, respectively (Figure 4). The data can be exported in CSV-format (comma separated values) for further data processing.

4 CONCLUSIONS

To our knowledge, the new model, AGRAMMON,, is the first tool publicly available on the internet for calculating ammonia emissions at the whole farm level. An extensive documentation of input parameters, model algorithms and model design as well as an instructions manual is available from http://www.agrammon.ch. After several months of public use, AGRAMMON has proven to be an appropriate and user-friendly tool. Currently, the model is being extended with a version allowing for regional calculations. In the future, it will be periodically revised according to the state of the science. Future modifications of AGRAMMON will be announced on the website and users are informed about changes during login. User feedback on the model is welcome (see contract addresses on the website) and will help us to further improve the model.

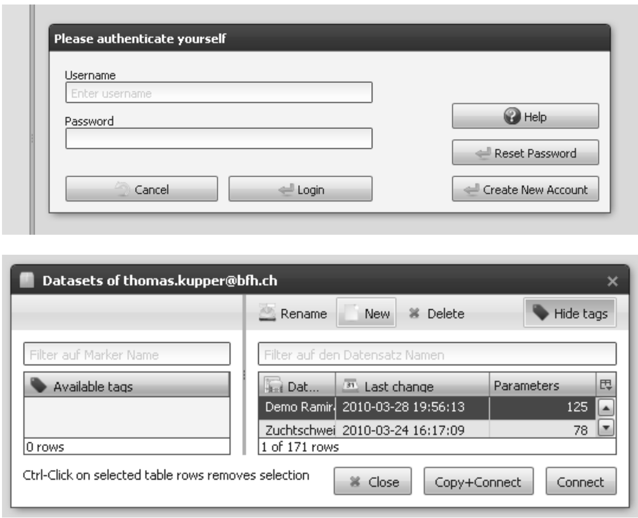


FIGURE 1 **Authentication and creating an account for using AGRAMMON**

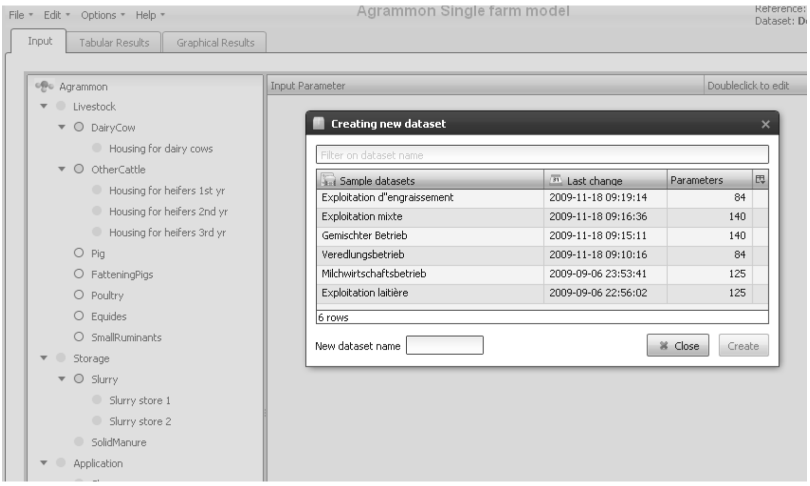


FIGURE 2 **Creating a dataset by using a sample**

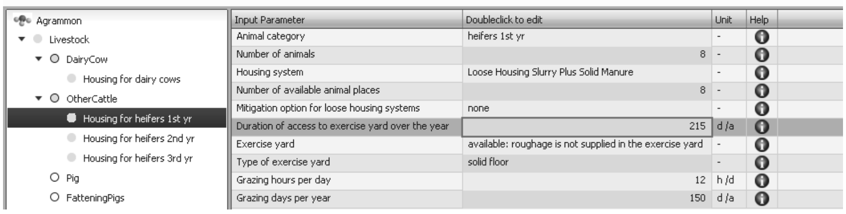
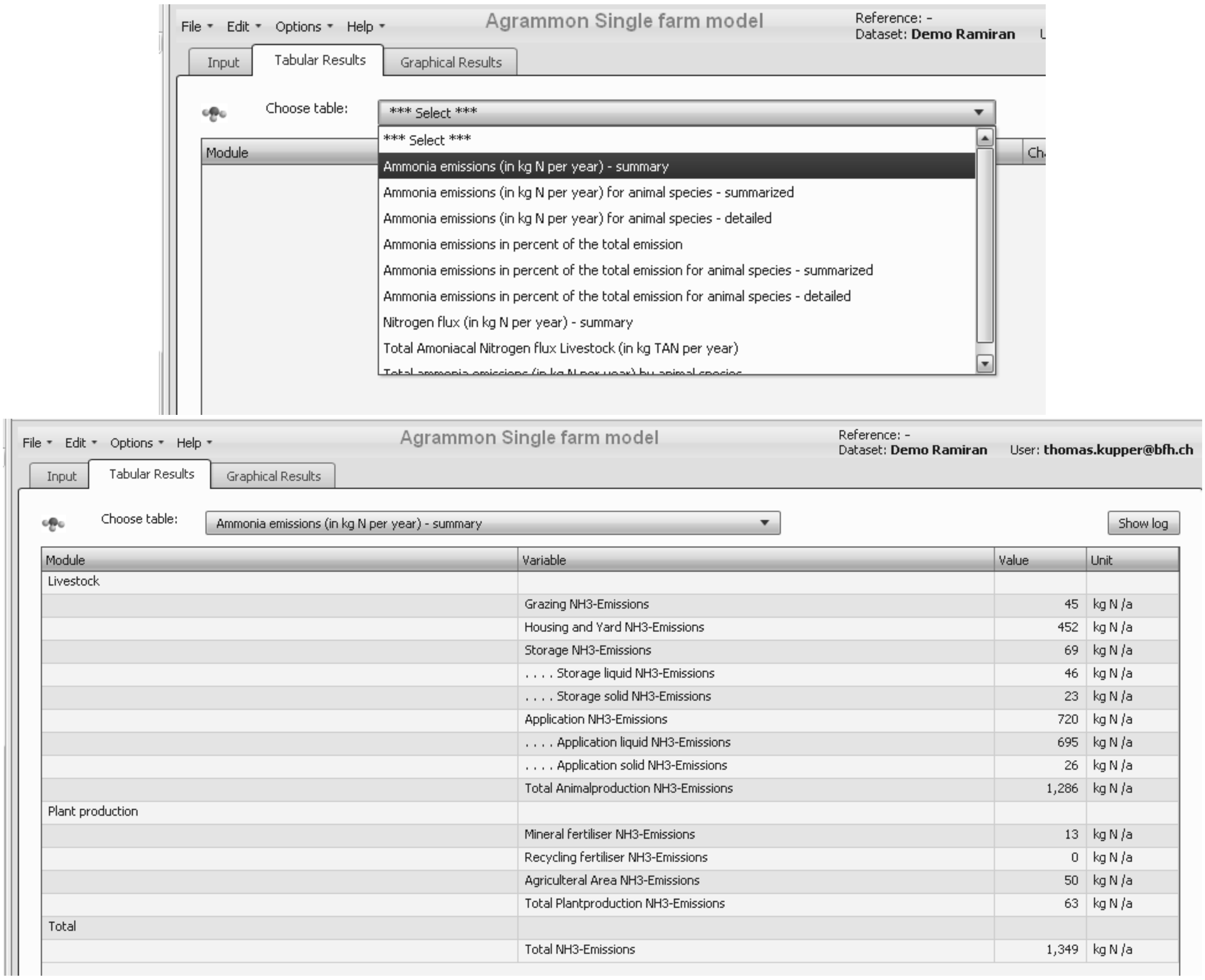


FIGURE 3 **Completion of input parameters**



Module	Variable	Value	Unit
Livestock			
	Grazing NH3-Emissions	45	kg N /a
	Housing and Yard NH3-Emissions	452	kg N /a
	Storage NH3-Emissions	69	kg N /a
	. . . . Storage liquid NH3-Emissions	46	kg N /a
	. . . . Storage solid NH3-Emissions	23	kg N /a
	Application NH3-Emissions	720	kg N /a
	. . . . Application liquid NH3-Emissions	695	kg N /a
	. . . . Application solid NH3-Emissions	26	kg N /a
	Total Animalproduction NH3-Emissions	1,286	kg N /a
Plant production			
	Mineral fertiliser NH3-Emissions	13	kg N /a
	Recycling fertiliser NH3-Emissions	0	kg N /a
	Agriculteral Area NH3-Emissions	50	kg N /a
	Total Plantproduction NH3-Emissions	63	kg N /a
Total			
	Total NH3-Emissions	1,349	kg N /a

FIGURE 4 **Display of the results**

ACKNOWLEDGEMENTS

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