

# Manure management system distribution in Austria and consequences on the ammonia emission inventory

Barbara Amon\*, Stefan Hörtenhuber, Martina Fröhlich, Thomas Amon  
University of Natural Resources and Applied Life Sciences, Department of Sustainable  
Agricultural Systems, Division of Agricultural Engineering, Peter Jordan Strasse 82,  
A-1190 Vienna, Austria; Phone: ++43 1 47654 3502, Fax: ++43 1 47654 3527,  
Email: barbara.amon@boku.ac.at

## Introduction

Under the UNECE Convention on Long-range Transboundary Air Pollution (CLRTAP), the Gothenburg Protocol has been set up to abate acidification, eutrophication, and groundlevel ozone. Austria has a national emission ceiling of 66 Gg NH<sub>3</sub>. The Protocol requires best available techniques to be used to keep emissions down. Emission inventories must provide transparent, consistent, comparable, complete, and accurate data on sources and sinks of national emissions and must evaluate the progress towards meeting the reduction commitments. NH<sub>3</sub> emissions are reported according to the methodologies outlined in the EMEP/CORINAIR Guidebook (EMEP 2002). Emission inventories must not only estimate national emissions as accurately as possible, but as well be able to show the annual trend in emissions, and the effect of mitigation measures.

In Austria, the Umweltbundesamt has a legal responsibility for the preparation of Austrian emission inventories. In order to fulfil various national and international obligations, the Umweltbundesamt annually prepares a comprehensive Austrian Air Emission Inventory ("Österreichische Luftschadstoff-Inventur, OLI"). A quality management system (QMS) has been installed according to the European Standard ISO EN 45004 (ANDERL ET AL. 2005).

In 2002, 96.7 % of national NH<sub>3</sub> emissions in Austria resulted from the agricultural sector. Animal husbandry held the biggest share in agricultural NH<sub>3</sub> emissions (84.8 %) with cattle husbandry contributing 74.8 % to these emissions, followed by the pig sector with 15.3 % (WIESER ET AL. 2004). Agricultural emissions depend largely on the animal housing, and on the manure management system (MMS). Data on MMS are a mandatory prerequisite for accurate emission estimates. The lack of these data in Austria lead to two major disadvantages:

1. Austrian specific values could be integrated in the national emission inventory only to a small extent. Major parts of the inventory had to be set up with default values that did not always represent processes typically found in Austria.
2. Due to the lack in activity data, the effect of mitigation measures could not show up in the national emission inventory.

In 2005, Austria assessed the manure management system distribution via a survey (AMON ET AL. 2007) and will now integrated the survey results into the national emission inventory.

## Materials and Methods

The research project "TIHALO" assessed the MMS distribution (AMON ET AL. 2007). Following the Swiss methodology developed by REIDY ET AL. (2007), 5,000 questionnaires were distributed to Austrian farmers. The project aimed at the following: Detailed overview on Austrian animal husbandry, improvement of the Austrian emission inventory, modelling of typical farms and estimation of their emissions, development of emission scenarios, and

proposal of feasible mitigation measures. The project was a close cooperation between the Division of Agricultural Engineering, the Austrian Chambers of Agriculture, the Austrian Environment Agency, the Federal Research Centre for Agriculture in Alpine Regions, and the Statistics Austria.

### **Questionnaire design**

The questionnaire assesses relevant parameters in all stages of animal husbandry systems: housing and exercise yard, grazing, waste and washing water, manure storage, manure application, animal feeding, and mineral fertiliser application. The sections “animal housing”, “exercise yard” and “grazing” assess details on the housing system, and on the yard and grazing management. The sections “manure storage” and “manure application” ask for manure storage facilities, manure treatment and when and how the manure is applied to agricultural land and/or grassland. Questions on feeding strategies and animal diet composition serve as a basis for estimates of N excretion, manure composition and CH<sub>4</sub> emissions from enteric fermentation. In the last section, data on amount and composition of mineral N fertilisers have to be filled in.

### **Representative sample of Austrian farms**

The sample design and the subsequent drawing of the sample were done in close cooperation with the Statistics Austria. For the sample design, the Statistics Austria proposed the following criteria:

- NUTS<sup>1</sup> region: 1 Eastern Austria (Burgenland, Lower Austria, Vienna), 2 Southern Austria (Carinthia, Styria), 3 Western Austria (Upper Austria, Salzburg, Tirol, Vorarlberg)
- Weighing factor “hv”: weighted sum from arable area and the number of livestock units scaled with 1.21.

Farms with animal husbandry play a greater role in the emission inventory than farms without animal husbandry and should be represented more often in the survey sample. Thus, the Statistics Austria weighed arable land with the factor 0.2 and livestock number with the factor 0.8.

The returned questionnaires were manually fed a data template and a database was created that contained the questionnaire information. The database was checked for representativeness and plausibility prior to the emission calculations. From the questionnaire information, the frequency distribution of manure management systems in Austria was estimated. This frequency distribution will now be used to update the Austrian ammonia emission inventory.

### **Results**

This section gives some preliminary results on the first steps of the update of the Austrian ammonia emission inventory. The update will be completed by the end of June 2008.

Knowledge on animal husbandry in Austria and on manure management systems was mainly based on a survey carried out by KONRAD (1995) in 1992. The Austrian emission inventory used data from that survey. Animal husbandry has undergone a major change since 1992 and it was thus necessary to survey manure management systems again. The following tables compare results from the 1992 survey (KONRAD 1995) with the new data collected in course of the TIHALO project (AMON ET AL. 2007).

1 NUTS: Nomenclature des unites territoriales statistiques”.

## Housing systems for cattle

Table 1 gives an overview on cattle housing in Austria. It differentiates tied systems and loose housing systems and within them liquid and solid manure based systems

Table 1: Housing systems for cattle in Austria as assessed by a survey in 1992 (KONRAD 1995) and by the TIHALO project in 2005

animal category	KONRAD (1995) – survey 1992				TIHALO – survey 2005			
	tied systems		loose houses		tied systems		loose houses	
	liquid [%]	solid [%]	liquid [%]	solid [%]	liquid [%]	solid [%]	liquid [%]	solid [%]
dairy cattle	21	77	2	0	14	53	25	8
suckling cows	21	77	2	0	7	54	13	26
cattle < 1 year	29	71	-	-	5	32	14	49
cattle 1-2 years	13	87	-	-	12	35	31	22
cattle > 2 years	49	51	-	-	14	47	23	16

## Grazing, cattle

Grazing has substantial influence on the amount of ammonia emissions. The TIHALO survey assessed a) the number of days cattle were grazed and b) the time they spent grazing on each grazing day. From these the hours of grazing and the proportion of grazing time per year could be calculated (table 2).

Table 2: Grazing of cattle in Austria as assessed by a survey in 1992 (KONRAD 1995) and by the TIHALO project in 2005

animal category	TIHALO – survey 2005				KONRAD (1995) – survey 1992
	length of grazing per day [h]	grazing days per year [d]	grazing hours per year [h]	proportion of grazing [%]	proportion of grazing [%]
dairy cattle	4.4	83	370	4.2	10.6
suckling cows	9.0	133	1202	13.7	10.6
cattle < 1 year	4.1	53	214	2.4	0
cattle 1-2 years	4.6	65.3	301	3.4	10.6
cattle > 2 years	7.7	101.6	782	8.9	0

## Exercise yard, cattle

The use of exercise yards has to be considered when setting up an accurate ammonia emission inventory. The TIHALO survey asked if cattle had access to an exercise yard and how big the exercise yard was. The results are shown in table 3.

Table 3: Exercise yards for cattle in Austria as assessed by the TIHALO project in 2005

animal category	proportion of animals that have access to an exercise yard [%]	mean exercise yard area per animal [m <sup>2</sup> ]
dairy cattle	45.8	5.6
suckling cows	59.1	16.7
cattle < 1 year	28.9	11.8
cattle 1-2 years	28.0	19.8
cattle > 2 years	41.5	11.9

## Housing systems for pigs

Table 4 gives the distribution of housing systems for pigs in Austria as assessed in 1992 (Konrad 1995) and by the TIHALO project in 2005. Housing systems for pig are differentiated in solid and liquid manure based systems.

Table 4: Housing systems for pigs in Austria as assessed by a survey in 1992 (Konrad 1995) and by the TIHALO project in 2005

animal category	TIHALO – survey 2005		KONRAD (1995) – survey 1992	
	solid [%]	liquid [%]	solid [%]	liquid [%]
piglets (< 20 kg)	34.5	65.5	30.0 <sup>1</sup>	70.0 <sup>1</sup>
young pigs (20-50 kg)	12.8	87.2	28.1 <sup>2</sup>	71.9 <sup>2</sup>
fattening pigs (> 50 kg)	10.2	89.8	28.1 <sup>2</sup>	71.9 <sup>2</sup>
breeding sows	36.9	63.1	30.0 <sup>1</sup>	70.0 <sup>1</sup>
lactating sows	44.4	55.6	30.0 <sup>1</sup>	70.0 <sup>1</sup>
boars	74.5	25.5	-	-

<sup>1</sup> one value for breeding sows and their litters

<sup>2</sup> one value for young pigs and fattening pigs

## Liquid manure treatment

Liquid manure treatment may be an option to reduce ammonia emissions. The TIHALO survey asked for the treatment options aeration, separation and anaerobic digestion. The feedback on the aeration question delivered reliable results that may be used in assessing the inventory (table 5). The answers on the question on separation and anaerobic digestion appear to be unrealistically high. Probably farmers did not understand correctly, what separation or anaerobic digestion meant. This is why these two treatment options will not be included in the inventory.

Table 5: Treatment of liquid manure in Austria as assessed by the TIHALO project in 2005

manure treatment	proportion of treated liquid manure [%]
aeration	8.9
separation	5.0 *
biogas	27.1 *

## Outlook

Within TIHALO, representative data on animal husbandry and manure management systems all over Austria were collected. TIHALO created a solid basis for future improvements of the accuracy and transparency of Austrian emission inventories. Abatement measures can be evaluated according to their practicality, applicability, economics and efficiency. On the basis of the TIHALO results, the Austrian Ammonia Emission inventory is currently being updated. The results of the update will be available at the conference.

## References

Amon, B., Fröhlich, M., Weißensteiner, R., Zablatnik, B., Amon, T. (2007): *Tierhaltung und Wirtschaftsdüngermanagement in Österreich. Endbericht Projekt Nr. 1441 Auftraggeber: Bundesministerium für Land- und Forstwirtschaft, Umwelt- und Wasserwirtschaft.* [http://www.dafne.at/dafne\\_plus\\_homepage/index.php?section=dafneplus&content=result&come\\_from=&&project\\_id=680](http://www.dafne.at/dafne_plus_homepage/index.php?section=dafneplus&content=result&come_from=&&project_id=680)

- Anderl, M., Edelmann, A., Freudenschuß, A., Halper, D., Kurzweil, A., Poupa, S., Wappel, D., Weiss, P., Wieser, M. (2005). *Austria's annual national greenhouse gas inventory 1990 – 2003. Submission under Decision 280/2004/EC series.* Umweltbundesamt GmbH (Hrsg.), UBA-Bericht 262, Wien 2005.
- EMEP/CORINAIR Atmospheric Emission Inventory Guidebook (Third edition 2002). <http://reports.eea.eu.int/EMEP/CORINAIR/en>.
- Konrad, S. (1995): *Die Rinder-, Schweine- und Legehennenhaltung in Österreich aus ethologischer Sicht*, WUV Universitätsverlag, Wien.
- Reidy, B., Rihm, B., Menzi, H. (2007): *A new Swiss inventory of ammonia emissions from agriculture based on a survey on farm and manure management and farm-specific model calculations*, Reference: AEA7495, IN *Journal: Atmospheric Environment*, In Press (corrected proof available online)
- Wieser M., Poupa S., Anderl M., Wappel D., Kurzweil A. (2004) *Austria's informative inventory report 2004. Submission under the UNECE Convention on Long-range Transboundary Air Pollution.* Umweltbundesamt GmbH (Hrsg.), UBA-Bericht 257. Wien, 2004.