Simultaneous emissions and dispersion of the ammonia and methane plume inside and around a dairy farm in Segovia (Spain)

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Background

- **Confined animal feeding operations** can **affect air quality** at local, regional and global scales through emissions of trace gases (e.g. NH_3, N_2O, CH_4, and VOCs), particulates (PM2.5 and PM10) and odors.
- **Field measurements are limited**, and there is a need for more accurate quantification of gaseous and particulate emissions from different types of confined animal operations. Quantifying emissions from cattle feedlots is challenging. A few studies have used the mass balance approach for quantifying total feedlot N emissions, but this method cannot distinguish between N species (e.g. N_2O versus NH_3). Various chamber techniques have been used to measure different emissions from either feedlot surfaces or feedlot cattle but these techniques alter the environment and can be unrepresentative of natural conditions.
- So far there are **no emission measurements for dairy farms in Spain**.
- The Spanish Ministry of the Environment and Rural and Marine Affairs (MARM) decided in 2008 to initiate a work **program to evaluate ammonia and GHG emissions** from intensive beef and dairy cattle farms in order to improve the estimations presented by Spain to the National Inventory.

Material and methods

Study farm

- Cubicle house for dairy cattle (250 heads)
- Located in central plateau of Spain
- Straw-bedded system. Once a day removal of solid manure
- Forced ventilation

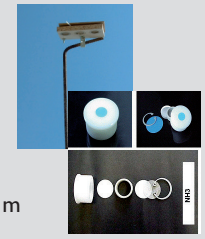
Meteorological variables

Meteorological variables were measured both before and during the experiments (wind speed, wind direction, temperature and radiation at different heights). In addition, during the experiment a sonic anemometer was installed in the centre of the feed lot, and additional anemometers and sample lines connected in the lateral and zenital windows.

Concentrations inside the feed lot and emission estimates

All concentration measurements inside the feed lot were performed using an Innova photoacustic gas analyzer 1412-5 through seven 40 m long sampling lines (3 in the zenital window and 2 on each of the lateral windows). Emissions were estimated via the difference between in- and outside concentrations of the building.

Atmospheric ammonia concentrations (concentration field)



To measure NH_3 concentrations in the atmosphere around the farm, Ferm passive samplers type were used. Ammonia concentration in different points (2 m height) around the farm was measured with passive samplers. Samplers were distributed in a net of 50 x 50 m up to 200 m in the surroundings on the far and in four axes (N-S and E-W) every 50 m up to 600 m. Samplers were exposed for 96 h.

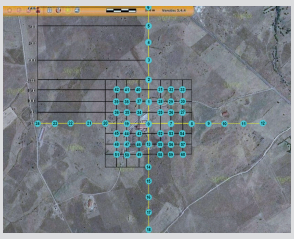
Results (I)

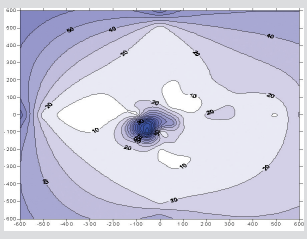
Ammonia concentrations in the farm plume

⇒The maximum averages (96 h) ammonia concentrations were found near the feed lot buildings (154 µg/m³).

⇒Within 300 m the values decreased to 4 µg/m³, values that can be considered as background values for the province (previous measurements by Sanz et al 2007).

⇒Other farms located within 400 to 500 m from the study farm induce an increase in the ammonia concentrations from 300 to 600 m to 79 µg/m³.





Objectives

The objectives of the study were to:

- Determine the concentrations of NH_3 and CH_4 in a dairy farm in Segovia, Spain, using different methods with the aim of estimating the emissions of the farm.
- Determine the concentrations of ammonia around the feed lot with the aim to map the farm plume.

Results (II)

Emissions of ammonia and methane from the feed lot

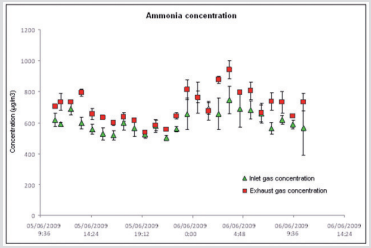


Figure 1. Ammonia concentrations (µg/m³) registered at the ventilation windows of the feed lot on the 5th to 6th of June 2009 at the dairy farm in Segovia, Spain.

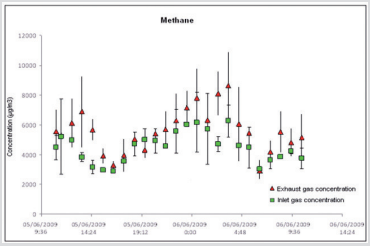


Figure 2. Methane concentrations (µg/m³) registered at the ventilation windows of the feed stock (5th to 6th of June 2009). Dairy farm in Segovia, Spain.

⇒Concentrations for both methane and ammonia measured during the fifth and sixth of June 2009 at the ventilation windows are reflected in Figure 1 and 2.

⇒For ammonia, the calculated emission was 10.47 kg/ NH_3/ head/ year

⇒The estimated ammonia values are slightly lower than the emissions used by Spain in the National Inventory.

⇒For methane, the calculated emission was 79.05 kg/ CH_4/head/year.

⇒The estimated values are moderately lower than the emissions used by Spain in the National Greenhouse Gases (GHG).

Conclusions

⇒The fluxes estimated for the dairy farm per head were for both,ammonia and methane, slightly or moderately lower than the emission factor used for reporting the emissions for dairy cattle in the National Inventory .

⇒More experimental measures need to be done to determine if the present emission factors used by Spain in the compilation of the ammonia and GHG National Inventory for dairy cattle can be improved by acquiring country specific factors.

⇒The ammonia plume of the dairy farm is characterized by concentrations near the feed lot building as high as 150 µg/m³ (average 96 hours).

⇒The concentration around the farm rapidly decreases with distance down to background concentrations (4 µg/m³) at 200 m.

⇒At larger distances than 300 m influence of other farms are observed by the increase of the ammonia concentrations.

Acknowledgements

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