Eva Gallmann, Eberhard Hartung and Thomas Jungbluth, Hohenheim

Environmentally-friendly production of feeding pigs

Sensitivity of emission measurements

To evaluate the effect of feeding pig production systems on the environment a fully slatted (FS) and a natural ventilation production system with separately ventilated (SV) areas were compared at Hohenheim through continuous emission recording. The quality control of the input data within the emission calculation allows the sensitivity of the emission recording to be evaluated, the careful preparation of the data and, finally, a critical data selection with the aid of trial criteria.

Dipl.-Ing. sc. agr. Eva Gallmann is a member of the scientific staff, Dr. Eberhard Hartung is scientific assistant, in the Specialist Subject Procedural Technology in Animal Production and Agricultural Buildings (director: Prof. Dr. T. Jungbluth), Institute for Agricultural Engineering of University Hohenheim, Garbenstraße 9, 70599 Stuttgart;
e-mail: gallmann@uni-hohenheim.de
The following study was supported by the DFG within the University of Hohenheim research group"Climate-relevant gases".

A refereed paper for LANDTECHNIK, the full-length version of which can be accessed under LANDTECHNIK-NET.com

Keywords

Feeding pig production, environmental-friendliness, emissions, climatically and environmentally relevant gases, measurement methodology

At the Institute for Agricultural Engineering , University of Hohenheim comprehensive investigations were carried out for the evaluation of different feeding pig production systems in a specially developed trial building [1]. Presented in this report are the methodological procedure and the sensitivity of the measuring system for the recording and evaluation of the environmental effect of two feeding pig production systems.

The main aim is a system comparison of two different production systems for feeding pigs regarding the emissions of NH_3, CO_2, CH_4 and N_2O. This was achieved via the following part aims:

- Recording of dependable data from two production systems in simultaneous parallel operation with high time area dissolution
- Comparison of the interior air quality and housing atmosphere parameters
- Comparison of daily and seasonal influences
- Comparison of sensitivity for different factors of influence
- Comparison of emission rates

Materials and methods

The investigations were carried out during four consecutive feeding cycles through different seasons. Objects of the investigation were a fully slatted house (FS) with forced ventilation (underfloor exhaust air removal) compared with a system with separate ventilation areas (SV), part-slatted floor and natural ventilation (chimney ventilation) [2].

An exact description and presentation of

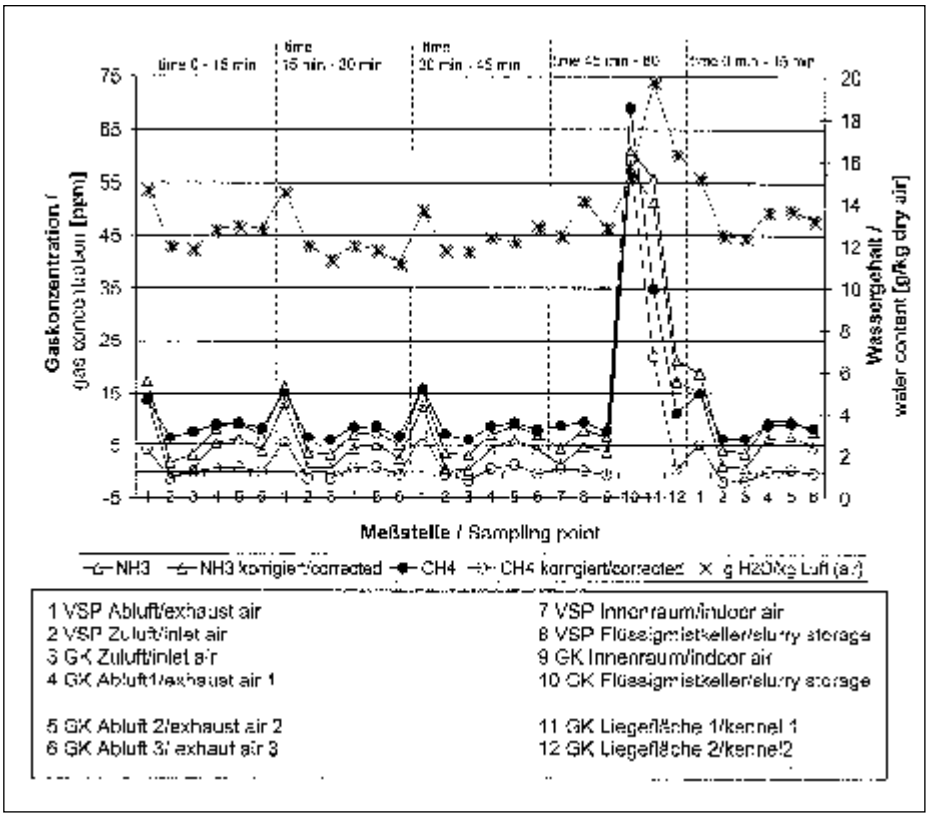

Fig. 1: Influence of the sentivity for water on the NH_3- and CH_4- concentrations at the different sampling points

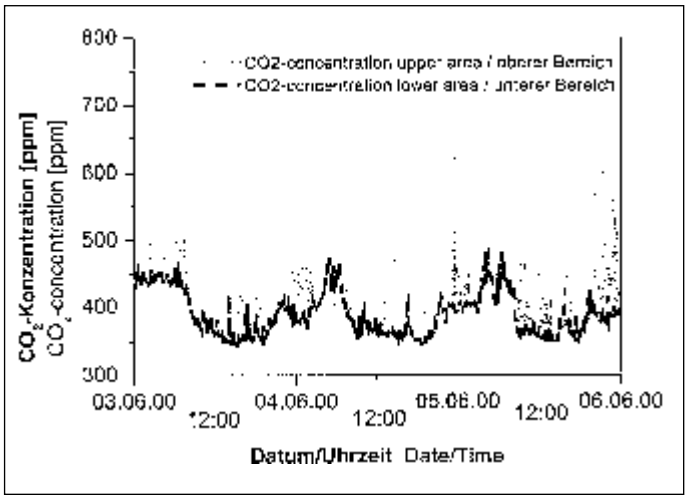

Fig. 2: CO_2-concentrations at the upper and lower area of the inlet air opening of the kennel housing system for detecting of leaking air

the investigated housing systems, as well as the trial conception, is contained in the full-length version of this report in LANDTECHNIK-NET.

The measurement parameters relevant for gas concentration and volume flow and influence factors (sources, release conditions and surrounding conditions) on the emission procedure were, as far as possible, continuously recorded online with a high time interval dissolution. The individual measurement parameters and the measurement procedure are described in detail in LANDTECHNIK-NET.

Influence of air moisture cross-sensitivity during sampling testing of measurement points

In the gas concentration measurement for NH_3 and CH_4 via non-dispersive infrared spectroscopy there existed a air moisture content cross-sensitivity of 0.23 ppm/g H_2O/kg air (NH_3) and 0.65ppm/gH_20/kg air (CH_4) respectively. In *figure 1* concentrations of NH_3 and CH_4, in each case with and without air moisture content correction, as well as the moisture content of the sample air on the consecutively sampled measurement points over a recording time of 75 seconds are presented. The gas concentrations for emission calculations at the measurement points 1 to 6 of the inlet and exhaust air points were in each case sampled three times after the other within 15 minutes. Finally, the gas concentrations were determined at the measurement points 7 to 12 in the interior, the lying areas and in the slurry cellar. The measurement assessment time of 120 seconds per sampling point was sufficient for recording the gas concentration range at these points, even in the case of very different gas concentrations.

In association with the measurement point the air moisture content varied in the presented section by from 12 to 20 g/kg dry air which represents a cross-sensitivity for NH_3 of from 2.7 to 4.6 ppm and from 7.8 to 13 ppm for CH_4. After subtraction of the air moisture content cross-sensitivity at the measurement points 2 to 6 in this cycle no further concentrations were detectable and the readings went, in part, into the negative area. This is a result of the sum of the measurement precision of the gas analyser and the temperature and moisture sensors and revealed itself in the calculated air moisture correction at low CH_4 concentrations. Thus, for the time period in each case it must be tested as to whether the CH_4 emissions and the differences between the production systems are able to be identified and quantified by the measurement system. It can be assumed that, with indicated measurement values lower than 10 ppm, only air moisture and no methane caused the reaction of the measurement instruments.

Evidence of air leakage flows

Understood as air leakage is interior air that does not leave the livestock building through the openings designed for this action, but instead escapes through the air inlets. A special sampling of the CO_2 concentration at two heights and at 75 second intervals was carried out in the air inlets of the SV housing for evidence of air leakage flow. Air volume and velocity at the inlet served as further test criteria for the emission of air leakage flows in the SV system and thus factors for the evaluation of ventilation function. The air leakage flow was able to be accurately determined through comparison of the CO_2 concentrations in the upper and lower area of the air inlet opening (*fig. 2*).

With lesser air leakage flows, the warmer interior air escaped only through the upper area of the opening whilst in the lower area exterior air flowed into the building with a typical background concentration of 380 ppm. When, however, higher CO_2 concentrations were also recorded in the lower measuring point, this meant that leakage air was escaping through the entire inlet area. During this period of time it is not possible to precisely determine the amount of leakage air, so that no emission rate determination is possible [3].

Comparison of gas concentrations in the slurry cellar

The SV system exhibited a parallel development of inlet air temperature and gas concentrations in the slurry storage area featuring small overnight gas concentrations of (1000 ppm CO_2, (20 to 30 ppm NH_3 and (10 to 20 ppm CH_4 with, however, gas concentrations doubled during the day (see full-length report in LANDTECHNIK-NET). As described by Brose [3], it is thought that the colder inlet air in the evening and night hours flows down through the slatted flooring into the slurry storage area because of its higher density and thus leads to an air exchange through the slats resulting in reduction of gas concentrations in the slurry cellar.

Summary and outlook

The trial methodology and measuring system for the comparison of emission rates from two parallel-operated feeding pig production systems must, because of the targets, conform with high demands of reliability, accuracy and time interval dissolution of the data from both production systems. Here, the quality controls of the recording through to the data preparation play a central role in the ability to define the systems' possibilities and limits and the securing of a selection of unreliable and reliable data from test criteria. With regard to the accuracy of the measuring system and the influence factors of the emission process, the next step will be a comparison of the emission rates from both production systems. The results of this should be publicised here in a second report on environmentally-friendly feeding pig production.

Literature

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