

# AMMONIA AND GREENHOUSE GAS EMISSIONS FROM A STRAW FLOW SYSTEM FOR FATTENING PIGS

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## ABSTRACT

Animal welfare and environmental protection are increasingly important. Housing systems must be found that offer animal welfare and emit little ammonia, and greenhouse gases. The straw flow system is an animal friendly housing system for fattening pigs. The pen is separated into a lying area and an excretion area. In the lying area, straw is used. The pigs keep the lying area dry and clean and excrete on slats in the rear of the pen. The system can be operated economically efficient on commercial farms. It was to be investigated, if this animal friendly housing system offered environmental benefits and if it emitted less ammonia and greenhouse gases than a conventional fully or partly slatted system. Emissions of NH<sub>3</sub>, N<sub>2</sub>O, and CH<sub>4</sub> were measured at a commercial farm. The animal house consisted of three fully separated compartments. Each compartment was forced ventilated by a central exhaust fan. The compartments were separated into 16 pens that held 10 – 12 pigs. Gas concentrations were measured with high resolution FTIR spectrometry. Ventilation rate was recorded in the central exhaust fan. Measurements covered all seasons and all stages of fattening. Emissions from slurry storage were quantified, as well. Full data evaluation is currently ongoing.

**Keywords:** *animal welfare, environmental protection, nitrous oxide, methane.*

## INTRODUCTION

Animal welfare and environmental protection are increasingly important. Housing systems must be found that offer animal welfare and emit little ammonia and greenhouse gases. Often, a contradiction is seen between animal welfare and environmental protection.

Emissions from slurry based pig houses have intensively been researched. Data on emissions from straw based houses are limited. The “Guidance document on control techniques for preventing and abating emissions of ammonia” developed by the UN/ECE „Expert Group on Ammonia Abatement“ of the „Executive Body for the Convention on Long-Range Transboundary Air Pollution“ distinguishes 10 slurry based housing systems for pigs and assigns specific emission factors. Straw based systems are not differentiated, but given one single ammonia emission factor that is equal to the highest emission factor from the slurry based systems. Döhler et al. (2002) mention the deep litter and the Danish system as straw based systems in pig husbandry. According to Döhler et al. (2002), NH<sub>3</sub> and N<sub>2</sub>O emissions from deep litter systems are higher than from fully slatted floors. The Danish system leads to an increase in NH<sub>3</sub> emissions. The authors point to the considerable uncertainty of these emission factors and to the very limited data availability.

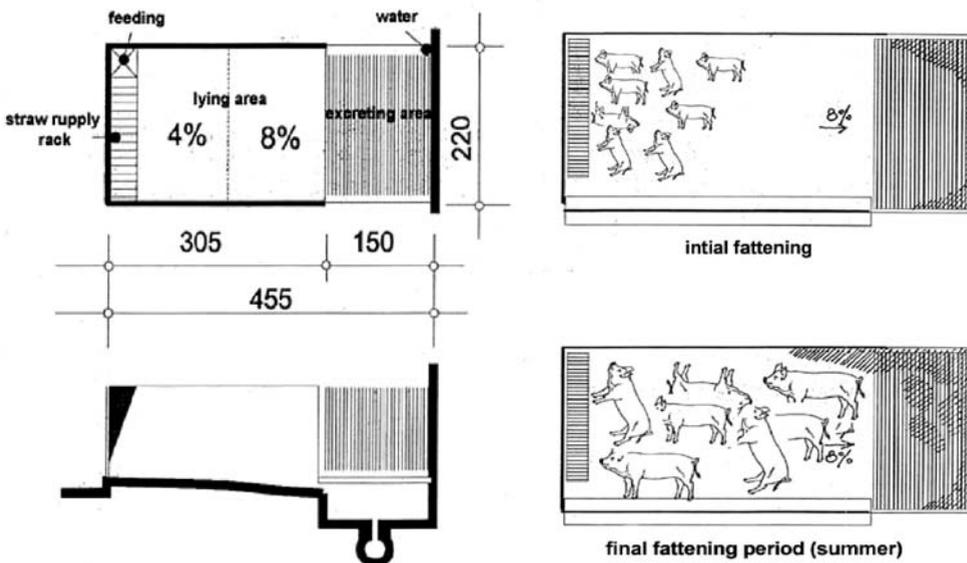
More research is needed into straw based systems for pigs. Mitigation options for NH<sub>3</sub>, and GHG must be proposed. The straw flow system is an animal friendly housing system (Bartussek et al. 1995, Zaludik 1997). It was to be investigated, if it emitted less ammonia and greenhouse gases than a conventional fully or partly slatted system.

## THE STRAW FLOW SYSTEM

An animal friendly system for pigs must provide straw or other materials where pigs can show exploratory behaviour (Wechsler 1997). It is important to renew the material daily or every second day (Amon et al. 2001). The normal behaviour of pigs is to separate a lying and an excretion area (Stolba 1983). Animal friendly systems must thus at least be separated into two functional areas. Pigs spend a considerable part of the day with resting and lying (Zerboni & Grauvogl 1984). They prefer non-perforated, soft lying areas (Sambraus 1991).

The Straw-Flow-Welfare-System was developed in Scotland (Bruce 1990). The Federal Agricultural Research Centre Braunschweig / Germany started to investigate this system in 1988 (Gebbe 1991). In 1990, the Federal Research Institute for Agriculture in Alpine Regions / Austria further improved the system and developed the "Straw Flow System Gumpenstein" (Bartussek et al 1995, Fig. 1). The pen is separated into a lying area and an excretion area. In the lying area, straw is used. The pigs keep the lying area dry and clean and excrete on elevated slats in the rear of the pen. Pigs are likely to suffer from thermal stress on warm days. They may then excrete on the lying area and lie on the excretion area. To avoid this, sprinklers are installed above the slats of the excretion area. They are automatically activated at intervals.

The concrete lying area has an inclination of 4 – 10 % and is surrounded by opaque walls. Feed is supplied at the front of the pen. All pigs can eat at the same time, which is an important factor for animal welfare.



**Figure 1.** Design of the straw flow system for fattening pigs (left side) and distribution of lying pigs at the beginning and towards the end of the fattening period (right side) (Bartussek 1993).

50 – 100 g non chopped straw per pig and day are provided in the rack at the front of the pen. The pigs take the straw from the rack, play with it, chew it and thus transport it slowly to the rear of the pen where it falls in the gut under the slats. As only a small amount of straw is used, it is still possible to produce slurry. Work requirement for straw supply is c. 7 min per produced pig (Bartussek & Geisperger 1998). The straw supply can ideally be used to control the pigs' condition.

A straw flow pen offers 1 – 1.3 m<sup>2</sup> per pig. This is more than 40 % more than in conventional fully slatted floors. Investment costs are not higher than in conventional fully slatted floors (Bartussek & Geisperger 1998). The straw flow system can be operated economically efficient on commercial farms.

## MATERIALS AND METHODS

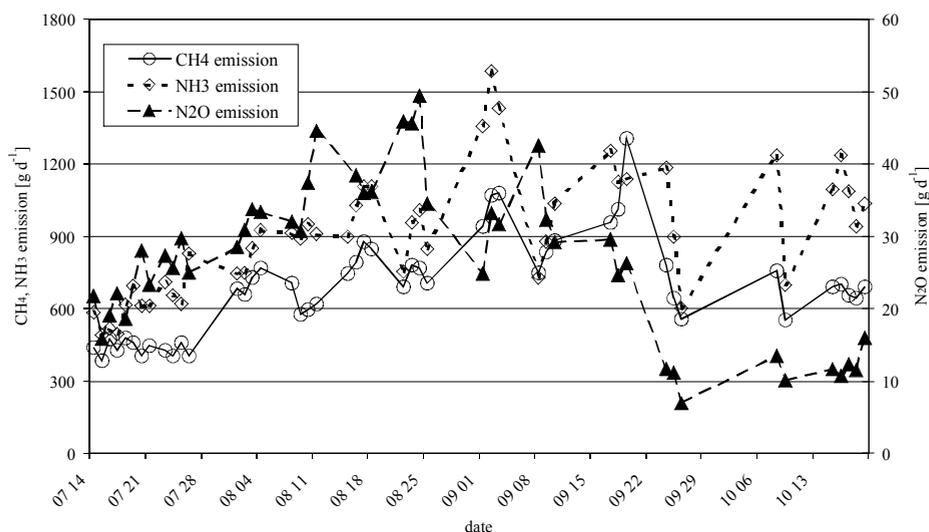
Emissions of NH<sub>3</sub>, N<sub>2</sub>O, CH<sub>4</sub>, and VOC were measured at a commercial farm. The animal house consisted of three fully separated compartments. Each compartment was forced ventilated by a central exhaust fan. The compartments were separated into 16 pens that held 10 – 12 pigs.

Concentrations of NH<sub>3</sub>, N<sub>2</sub>O, and CH<sub>4</sub> were measured with high resolution FTIR spectrometry. VOC were analysed by a flame ionisation detector. Ventilation rate was continuously recorded in the central exhaust fan. Measurements were carried out continuously 24 hours a day. The measurement period lasted from 2003-07-01 to 2004-01-31. It covered all seasons: hot – mild – cold, and all stages of fattening.

After emission measurements from the animal house were finished, pig slurry was stored in 10 m<sup>3</sup> pilot scale slurry tanks. Emissions were measured with a large open dynamic chamber. A full description of the measurement technology can be taken from “Influence of different levels of covering on greenhouse gas, and NH<sub>3</sub> emissions from slurry stores” (these proceedings). Influence of different levels of covering, and of slurry additives was investigated.

## RESULTS AND DISCUSSION

Figure 2 gives a preliminary example for emissions measured from 2003-07-14 to 2003-10-19. It shows total CH<sub>4</sub>, NH<sub>3</sub>, and N<sub>2</sub>O emissions from compartment 1 in g per day. A huge amount of emission data has been collected and data processing and analysis is currently carried out.



**Figure 2.** CH<sub>4</sub>, NH<sub>3</sub> and N<sub>2</sub>O emissions from a straw flow system for fattening pigs (preliminary results).

## CONCLUSIONS

Animal husbandry must combine animal welfare and environmental protection. The straw flow system for pigs is a promising option for an animal and environmentally friendly housing system that can be operated economically on commercial farms.

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## REFERENCES

- Amon, T., Jeremic, D., Gallob, M., Amon, B., Boxberger, J., Sölkner, J., Konrad, S., Meixner, O. 2001. Schweinefleischherzeugung im Stolba-Familienstall: Ermittlung von Kennzahlen von der Erzeugung bis zur Vermarktung und Optimierung des Systems, Endbericht zum Forschungsprojekt, Universität für Bodenkultur, Wien.
- Bartussek, H. 1993. Vollspaltenböden oder Tieflaufstall bei Mastschweinen? –Weder – noch! Der fortschrittliche Landwirt, 1993, 8, S. 18-19 und 1993, 9, S. 18-19.
- Bartussek, H., Hausleitner, A., Schauer, A., Steinwidder, R., Ubbelohde J. 1995. Schrägbodenbuchten für Mastschweine. Veröffentlichungen der BAL Gumpenstein, Heft 23, Irnding, 1995.
- Bartussek, H., Geisberger, W. 1998. Schweine auf der schiefen Bahn: Schrägbodenbuchten für Mastschweine bewähren sich. DLZ-Agrobonus, 1998, 3, S. 16-21.
- Bruce, J.M. 1990. Straw-Flow welfare systems for pigs. *Farm Building Progress*, 100: 6-7.
- Döhler, H., Dämmgen, U., Berg, W., Bergschmidt, A., Brunsch, R., Eurich-Menden, B., Lüttich, M., Osterburg, B. 2002. Anpassung der deutschen Methodik zur rechnerischen Emissionsermittlung an internationale Richtlinien und Prognose der Ammoniak-Emissionen der deutschen Landwirtschaft und Szenarien zu deren Minderung bis zum Jahre 2010. Final Report for Bundesministerium für Verbraucherschutz, Ernährung und Landwirtschaft and Umweltbundesamt, UBA-Texte 05/02.
- Gebbe, N. 1991. Schweinemast auf 10 % Gefälle. DLG-Mitteilung/ agrar-inform, 8/1991, 54-56.
- Sambras, H.H. (1991): Nutztierkunde. Verlag Eugen Ulmer, Stuttgart.
- Stolba A. 1983. Verhaltensmuster von Hausschweinen in einem Freigehege. In: Aktuelle Arbeiten zur artgemäßen Tierhaltung 1983. KTBL-Schrift 299, Landwirtschaftsverlag GmbH., Münster-Hiltrup.
- Wechsler, B. 1997. Schwein. In: Sambras, H.H., Steiger, A. (Hrsg.): Das Buch vom Tierschutz. Ferdinand Enke Verlag. Stuttgart, S. 173-185.
- Zerboni, H.N., Grauvogl, A. 1984. Schwein. In Bogner, H., Grauvogl, A. (Hrsg): Verhalten landwirtschaftlicher Nutztiere. Verlag Ulmer, Stuttgart.
- Zaludik, K. 1997. Untersuchungen zum Schrägbodensystem für Mastschweine. Diplomarbeit an der Universität für Bodenkultur, Wien.