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NH_3-, N_2O- and CH_4-Emissions from a Straw Flow System for Fattening Pigs

The straw flow system is an animal friendly and functioning housing system for fattening pigs. Greenhouse gas and ammonia emissions from a commercial straw flow system were continuously measured from June 2003 to April 2004. Emissions were always lower than the default values of forced ventilated fully slatted floor systems. The straw flow system combines animal welfare and environmental protection.

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Literatur

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Animal husbandry must be animal-friendly as well as eco-friendly. Consumers demand pork to be produced in straw based systems that they consider animal friendly. On the environmental side there is a tendency to favour slurry based systems because these are assigned lower NH_3 and GHG emissions. A solution to this conflict must be found.

The „Guidance document on control techniques for preventing and abating emissions of ammonia1" developed by the UN/ECE „Expert Group on Ammonia Abatement" of the „Executive Body for the Convention on Long-Range Transboundary Air Pollution" distinguishes 19 slurry based housing systems for pigs and assigns specific emission factors to them. Straw based systems are only differentiated into two systems due to the limited data availability.

Straw based systems are often equated with deep litter systems, where the lying and the excretion area are not separated. In deep litter systems, most of the pigís requirements are fulfilled, however some disadvantages are encountered. The straw consumption is high, the pigs are likely to be more dirty and deep litter systems are assumed to emit high levels of NH_3 and greenhouse gases (GHG).

The straw flow system distinguishes a lying and an excretion area. Only a small part of the pen is soiled with excreta. Additionally, excreta may be frequently removed from the pig house by a scraper. The small emitting surface and the frequent manure removal contributes to a reduction in emissions.

The straw flow system is a promising animal friendly system that can be operated economically efficient on commercial farms [1, 2]. It was to be investigated, if it emitted less NH_3 and GHG than a conventional fully or partly slatted system.

The straw flow system for fattening pigs

The „straw-flow-welfare-system" was developed in Scotland. Research into the straw flow system has been carried out in Austria since 1990, when the Federal Research Institute for Agriculture in Alpine Regions further improved the system and developed the „Straw Flow System Gumpenstein" [1, 3 ,4], which can be operated economically.

A straw flow house is separated into several pens that each holds 10 to 12 pigs. 1 to 1.3 m^2 per pig are offered which is more than 40 % more than in conventional fully slatted floors. Investment costs are not higher than in conventional fully slatted floors [9]. The concrete lying area has an inclination of 4 to 10 % and is surrounded by non-translucent walls. The pigs excrete on elevated slats in the rear of the pen. A dung channel is situated under the slats. It may be equipped with a scraper for frequent manure removal. The normal behaviour of pigs is to separate a lying and an excretion area [5, 6]. The pigs keep the lying area dry and clean and excrete on elevated slats in the rear of the pen. This limits soiling of the pigs and of the pen [1, 2].

An animal friendly system for pigs must provide straw or other materials where pigs can show exploratory behaviour [6]. In housing systems where the pigs can not show exploratory behaviour, they tend to bite the ears and tails of their penmates [7 cited in 8]. In a straw flow system, non chopped straw is provided in a 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 into the channel underneath the slats. As only a small amount of straw is used, it is still possible to produce slurry. It is important to renew the material daily or every second day. Work requirement for the straw supply is ~ 7 min per produced pig including straw transport and processing [9]. The straw supply can ideally be used to control the pigs' condition.

Dry or liquid 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. Water is offered in the excretion area. Pigs are likely to suffer from thermal stress on hot 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.

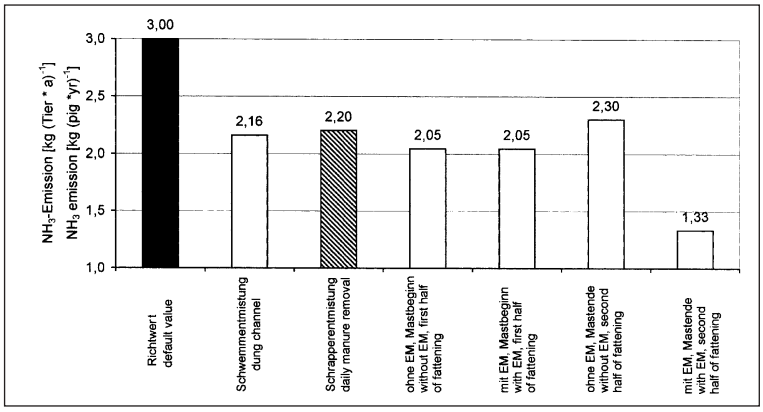

Fig. 1: NH_3 emissions from straw flow system for fattening pigs

Emissions from a straw flow system for fattening pigs

Emissions of NH_3, N_2O, CH_4, and VOCs were measured at a commercial farm in Upper Austria. The animal house consisted of three fully separated compartments. Each compartment was forced-ventilated by a central exhaust fan. Here, the samples of exhaust air gas concentrations were taken. The compartments were separated into 16 pens that each held 10 to 12 pigs. In two compartments, the dung channel was equipped with a scraper and operated twice a day. The pigs in each compartment were of the same age, between compartments, the pig's age and weight varied. Emissions were followed from June 2003 to April 2004. The measurement period covered all seasons: hot to mild to cold, and all stages of fattening. Each compartment was sampled at least once per week for 48 hours. Concentrations of NH_3, N_2O, and CH_4 were measured with high resolution FTIR spectrometry. VOCs were analysed by a flame ionisation detector (results not shown). The ventilation rate was continuously recorded in the central exhaust fan. From January to April 2004 the influence of the additive „Effective Micro-Organsims (EM)" on NH_3 and GHG emissions was additionally investigated.

First results

The emission measurements collected a huge amount of data, which are currently processed and analysed. First results are available, and more details will be worked out in the coming months. *Figures 1 and 2* give emissions per animal and year in the dung channel, in the daily manure removal system and after EM addition. The first column pictures the current default emission factors for forced ventilated fully slatted floors.

A default value of 3 kg NH_3 per pig and year is assigned to forced ventilated fully slatted floors [10, 11]. NH_3 emissions from the straw flow system were always below this value (*Fig. 1*). The reason for this probably lies in the small excretion area. The lying area, which forms the major part of the pen, is not soiled with excreta. The pigs only excrete on the elevated slats in the rear of the pen. Only little differences in NH_3 emissions were observed between the dung channel and the daily manure removal system. EM application in the first half of the fattening period did not alter NH_3 emissions. In the second half of the fattening period, a distinct reduction in NH_3 emissions was observed with EM application. For a full fattening period, emissions of 2.17 kg NH_3 per pig and year were measured. With EM application, ammonia emissions were reduced by 22 % to 1.69 kg NH_3.

Emissions of CH_4 and N_2O were summarised to greenhouse gas emissions expressed as CO_2 equivalents (*Fig. 2*). The global warming potential (GWP) of CH_4 is 21times the GWP of CO_2. N_2O has a 310times higher GWP than CO_2 [12]. Forced ventilated fully slatted forced ventilated pig houses are currently estimated to emit 4 kg CH_4 per pig and year [11]. CH_4 emissions from the straw flow system were always below this value. This is probably due to the fact that less manure is stored inside the warm pig house. Temperatures inside pig houses are in the range of 20 °C. At this high temperature, anaerobic decomposition of the organic substance in the manure is promoted. The more manure is in the house, the higher the CH_4 emissions. The dung channel system stores a greater amount of manure inside the pig house than the daily manure removal system. This is probably the reason why CH_4 emissions are higher from the dung channel system.

The current default value for N_2O emissions from fully slatted floors is 100 g N_2O per pig and year [11]. Due to the very limited data availability, this default value comprises a high range of uncertainty. N_2O emissions from the straw flow system ranged between 7.82 and 61.95 g per pig and year. The dung channel system emitted more N_2O than the daily manure removal system. As with CH_4 emissions, this is probably due to the bigger amount of manure stored inside the pig house.

Net total GHG emissions from the straw flow system were lower than the current default value for fully slatted floors. Daily manure removal could further reduce GHG emissions compared to the dung channel system. In the second half of the fattening period, spraying of EM strongly reduced GHG emissions. Considering a full fattening period, EM application resulted in a 35 % reduction of GHG emissions.

Conclusions

The straw flow system is an animal friendly housing system for fattening pigs. It can be operated economically efficiently on commercial farms. NH_3, N_2O, and CH_4 emissions were lower than current default values for forced ventilated fully slatted floors. The straw flow system combines animal welfare and environmental protection.

Acknowledgements

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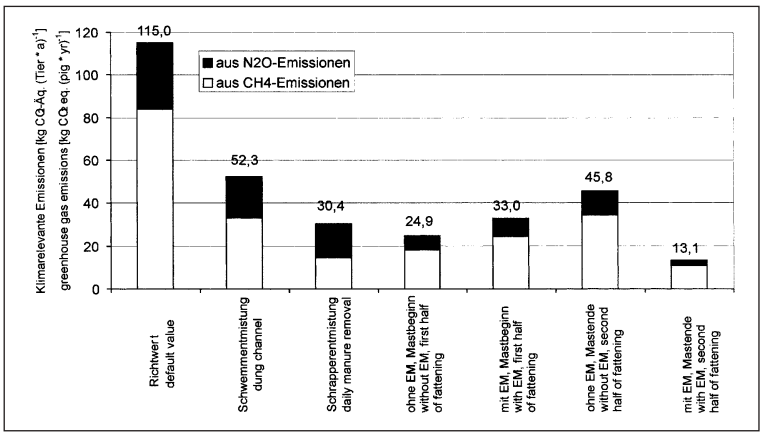

Fig. 2: Greenhouse gas emissions from a straw flow system for fattening pigs