BARBARA AMON, MARTINA FRÖHLICH, VITALIY KRYVORUCHKO, THOMAS AMON UND JOSEF BOXBERGER, WIEN

ALFRED PÖLLINGER, ANTON HAUSLEITNER, IRENE MÖSENBACHER, IRDNING

NH_3-, N_2O- and CH_4 emissions from a straw flow system for fattening pigs

Steckbrief

Dr. B. Amon, DI M. Fröhlich, and Dr. V. Kryvoruchko are research assistants, ao.Univ.Prof. Dr. T. Amon is head of the working group "Environmental and animal husbandry engineering", and o.Univ.Prof. Dr. J. Boxberger is head of the Division of Agricultural Engineering of the Department of Sustainable Agricultural Systems, University of Natural Resources and Applied Life Sciences, Peter-Jordan Strasse 82, A-1190 Vienna, Austria; e-mail: barbara.amon@boku.ac.at

DI A. Pöllinger, Dr. A. Hausleitner and Ing. I. Mösenbacher work with the Federal Research Institute for Agriculture in Alpine Regions, A – 8952 Irdning, Austria

Kurzfassung

The straw flow system is an animal friendly housing system for fattening pigs. It can be operated economically efficiently on commercial farms. Greenhouse gas and ammonia emissions were continuously measured from a commercial straw flow system 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.

Keywords:

Greenhouse gases, ammonia, pig husbandry, animal welfare

1 Introduction

Animal welfare and environmental protection are increasingly important. Housing systems must be found that take the animal's welfare into consideration and emit little ammonia (NH_3) and greenhouse gases (GHG). Often, animal welfare and environmental protection are seen as being mutually exclusive. 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.

Emissions from slurry based pig houses have been intensively researched. Data on emissions from straw based houses are limited. The "Guidance document on control techniques for pre-

venting and abating emissions of ammonia[1]" 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 pig's 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 said to emit high levels of NH_3 and 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 may contribute to a reduction in emissions.

The straw flow system is a promising animal friendly system that can be operated economically efficiently 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.

2 The straw flow system for fattening pigs

The "straw-flow-welfare-system" was developed in Scotland. Investigations have been carried out at the Federal Agricultural Research Centre Braunschweig. Research into the straw flow system is 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" [3,1,4].

A straw flow house is separated into several pens that each holds 10 – 12 pigs. 1 – 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 – 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 a 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 in the channel under 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 *c.* 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

[1] Version July 2002

lie on the excretion area. To avoid this, sprinklers are installed above the slats of the excretion area. They are automatically activated at intervals.

3 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 – 12 pigs. In two compartments, the dung channel was equipped with a scraper that was 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 – mild – 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.

4 First results

The emission measurements collected a huge amount of data that 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.

FIGURE 1

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 (Figure 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.

FIGURE 2

Emissions of CH_4 and N_2O were summarised to greenhouse gas emissions that are expressed as CO_2 equivalents (figure 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 warm temperature, anaerobic decomposition of the organic substance in the manure is promoted. The more manure 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.

5 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. NH_3, N_2O, and CH_4 emissions were lower than current default values for forced ventilated fully slatted floors.

Acknowledgements. The work was funded by the Austrian Federal Ministry of Agriculture, Forestry, Environment and Water Management, and by Multikraft Ltd.

References

[1] BARTUSSEK, H., HAUSLEITNER, A., SCHAUER, A., STEINWENDER, R., UBBELOHDE J. (1995). Schrägbodenbuchten für Mastschweine. Veröffentlichungen der BAL Gumpenstein, Heft 23, Irdning, 1995.

[2] ZALUDIK, K. (1997). Untersuchungen zum Schrägbodensystem für Mastschweine. Diplomarbeit an der Universität für Bodenkultur, Wien.

[3] BARTUSSEK, H. (1993). Vollspaltenböden oder Tieflaufstall bei Mastschweinen? – Weder – noch! Der fortschrittliche Landwirt, 1993, 8, S. 18-19 und 1993, 9, S. 18-19.

[4] BARTUSSEK, H., HAUSLEITNER, A., ZALUDIK, K. (1999). Schrägbodenbuchten in der Schweinemast: Die funktionssichere und kostengünstige tierschutzalternative zum Vollspaltenboden, In: Bericht zur Tagung Bau-Technik und Umwelt in der landwirtschaftlichen Nutztierhaltung, München-Freising, 1999.

[5] STOLBA A. (1983). Verhaltensmuster von Hausschweinen in einem Freigehege. In: Aktuelle Arbeiten zur artgemäßen Tierhaltung 1983. KTBL-Schrift 299, Landwirtschaftsverlag GmbH., Münster-Hiltrup.

[6] WECHSLER, B. (1997). Schwein. In: Sambraus, H.H., Steiger, A. (Hrsg.): Das Buch vom Tierschutz. Ferdinand Enke Verlag. Stuttgart, S. 173-185.

[7] FRASER, D., PHILLIPS P.A., TENNENSEN, T. (1991): Effect of straw on the behaviour of growing pigs. Applied Animal Behaviour Science, 17, 61-68

[8] BARTUSSEK, H. (2001). Möglichkeiten der geeigneten Beschäftigung von Schweinen. Gumpensteiner Bautagung 2001. BAL Gumpenstein, Irdning. S. 49-57.

[9] BARTUSSEK, H., GEISBERGER, W. (1998). Schweine auf der schiefen Bahn: Schrägbodenbuchten für Mastschweine bewähren sich. DLZ-Agrobonus, 1998, 3, S. 16-21.

[10] 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.

[11] UMWELTBUNDESAMT DER BRD (2001). Entwurf: Erstellung eines Gutachtens für einen deutschen Beitrag zur Vollzugsvorbereitung zum Umsetzung der IVU-Richtlinie für den Bereich Intensivtierhaltung, UBA Vorhaben FKZ 360 08 001, Stand November 2001, KTBL Darmstadt, Umweltbundesamt Berlin; In: UBA-Text 75/02 „Beste verfügbare Techniken in der Intensivtierhaltung“.

[12] IPCC (1996). Climate Change 1995: The Science of Climate Change. In: Intergovernmental Panel on Climate Change; J.T. Houghton, L.G. Meira Filho, B.A. Callander, N. Harris, A. Kattenberg, and K. Maskell, (Ed.), Cambridge University Press, Cambridge, U.K.

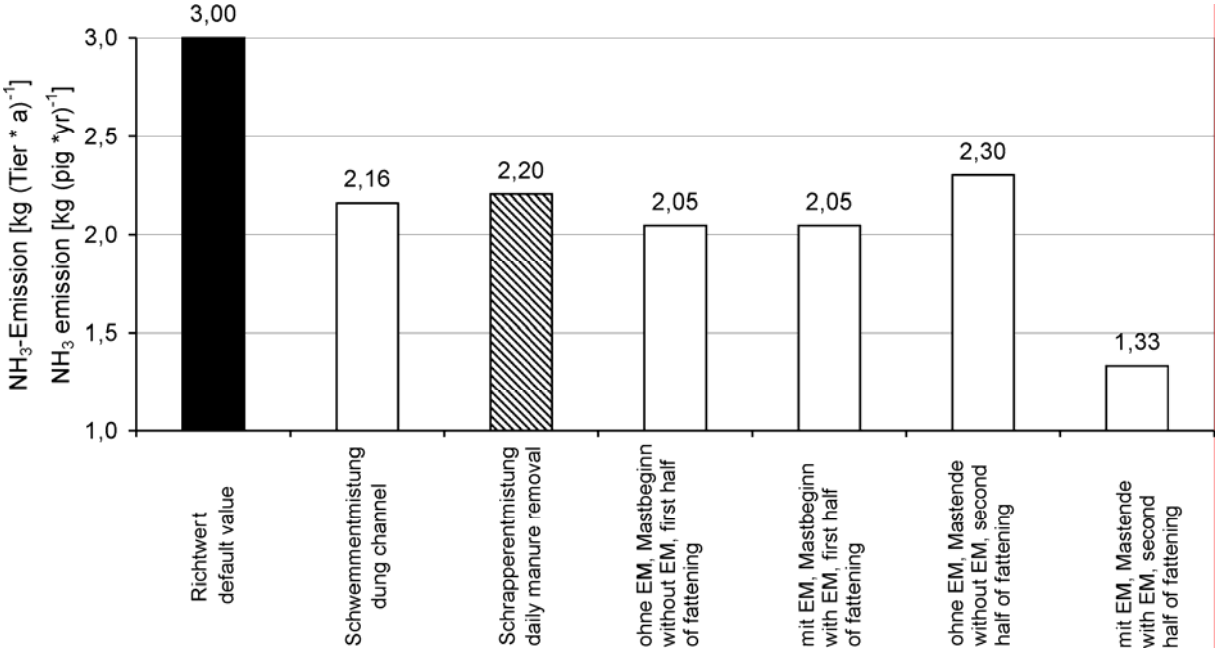

Abb. 1. NH_3-Emissionen aus einem Schrägbodenstall für Mastschweine

Figure 1. NH_3 emissions from a straw flow system for fattening pigs

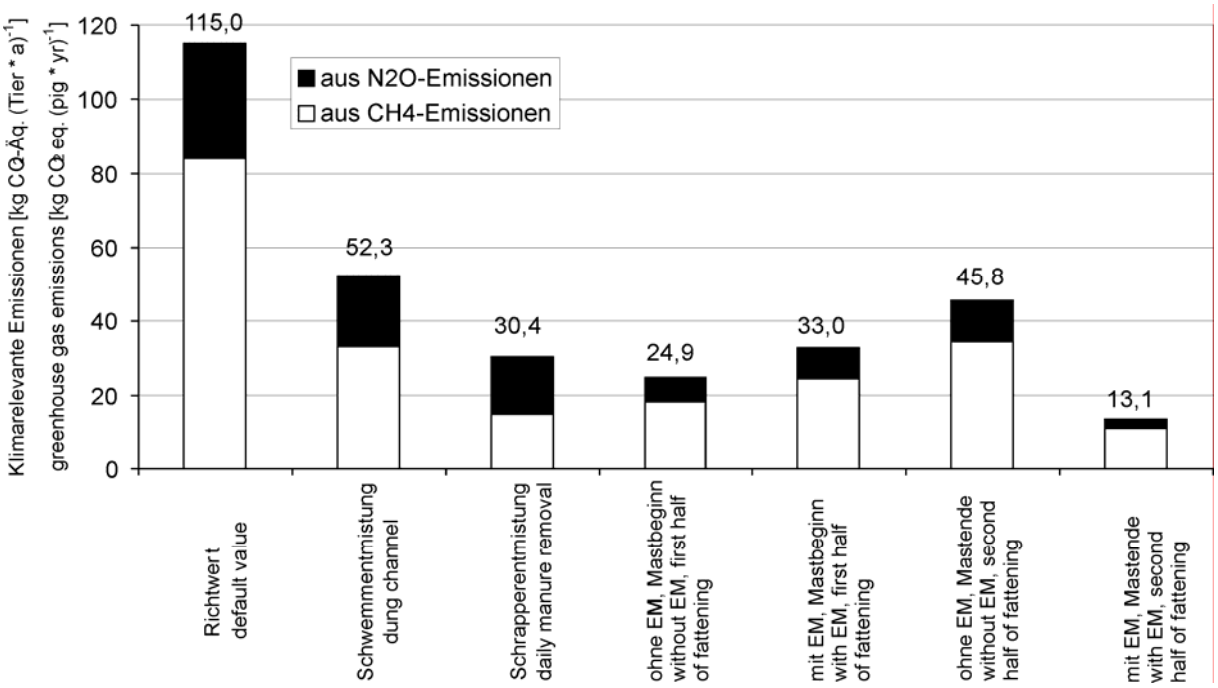

Abb. 2. Klimarelevante Emissionen aus einem Schrägbodenstall für Mastschweine

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