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# Design of rooting yards for better hygiene and lower ammonia emissions within the outdoor concrete area in organic pig production

Anne-Charlotte Olsson*, Jos Botermans, Mats Andersson, Knut-Håkan Jeppsson, Christer Bergsten

*Swedish University of Agricultural Sciences, Department of Biosystems and Technology, P.O. Box 103, SE-230 53 Alnarp, Sweden*

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ABSTRACT

Large fouled concrete areas outdoors and high nitrogen emissions are a problem in organic pig production. This is not consistent with the goal of organic farming to minimise the environmental impact of agricultural production. Introduction of a special rooting yard with rooting material in the outdoor concrete area could possibly be a way to create more activity in one part of the outdoor area, in which the pigs do not want to excrete. In the present study, the aim was to find an optimal design for such a rooting yard in the outdoor area. Four different designs of rooting yards, with varying sizes and wall heights ((LH=large (8.4 $m^2$) with one high wall (1.0 m); LL=large (8.4 $m^2$) with low walls (0.3 m); SH=small (5.3 $m^2$) with one high wall (1.0 m) and SL=small (5.3 $m^2$) with low walls (0.3 m)), were tested in parallel and compared with a reference pen (R) without a rooting yard. Peat was used as rooting material in all the outdoor rooting yards. In total, two batches, in a research facility with eight pens of 16 pigs each, were studied. Data on performance, location and activity in the pen and hygiene and ammonia emissions in the outdoor area were used for evaluation of the designs. No significant differences were seen in performance, total activity and total rooting activity between treatments. However, the pigs in the pens with rooting yards were observed rooting outdoors significantly more than those in the reference pens. Significantly better hygiene and a tendency for lower ammonia emissions from the area with rooting material were recorded in the pens with rooting yards compared with the same area in the reference treatment.

It was concluded that use of a rooting yard in the outdoor area in organic pig production allows the excretory behaviour of the pigs to be steered in the desired direction, improving hygiene and the appearance of the outdoor area. A large rooting yard with one high wall was found to be the best design, giving a 14% reduction in chamber $NH_3$ emissions ($E_{CH}$) from the total outdoor area compared with the reference pen.


## 1. Introduction

Livestock Production has a negative impact on the environment (Food and Agriculture Organization of the United Nations, 2006; Garnett, 2011, 2009; Hermansen and Kristensen, 2011; Herrero and Thornton, 2013). Examples of environmental problems associated with livestock production are climate change, acidification and eutrophication. Nitrogen excretion by the animals is involved in all these environmental problems. For pigs, these excretions are in the form of urine and faeces and are the result of the nitrogen input to the animal (feed, straw etc.) minus the nitrogen retained in the animal (Olsson et al., 2014).

During decomposition of excreta, nitrogen may manifest itself as various nitrogen compounds (for instance $NH_4^+$, $NH_3$, $NO_3^-$ or $N_2O$). The management and manure system determines which nitrogen compound is most likely to occur. In intensive indoor housing with solid or slatted floors and slurry collection, emissions of ammonia are the main problem (Aarnink et al., 1997; Philippe et al., 2011). In such systems there is a strong relationship between ammonia emissions and the manure handling system under the slats (Aarnink et al., 1997; Koger et al., 2014). In more extensive systems, such as deep litter systems with or without access to a solid concrete yard outdoors, the nitrogen emissions comprise varying levels of $NH_3$ and $N_2O$ (Eriksen et al., 2002; Rigolot et al., 2010). In organic pig production, deep litter indoors and access to a solid concrete yard outdoors is a common solution (Olsson et al., 2014). In free range systems with outdoor production, the nitrogen emissions occur both to the air ($NH_3$ and $N_2O$) and as leaching to the soil ($NH_4^+$, $NO_3^-$) (Williams et al., 2000, 2005; Halberg et al., 2010; Salomon et al., 2012; Webb et al., 2014).

One of the goals of organic farming is to minimise the environmental impact of agricultural production (Hansen et al.,

* Corresponding author.
*E-mail address:* anne-charlotte.olsson@slu.se (A.-C. Olsson).

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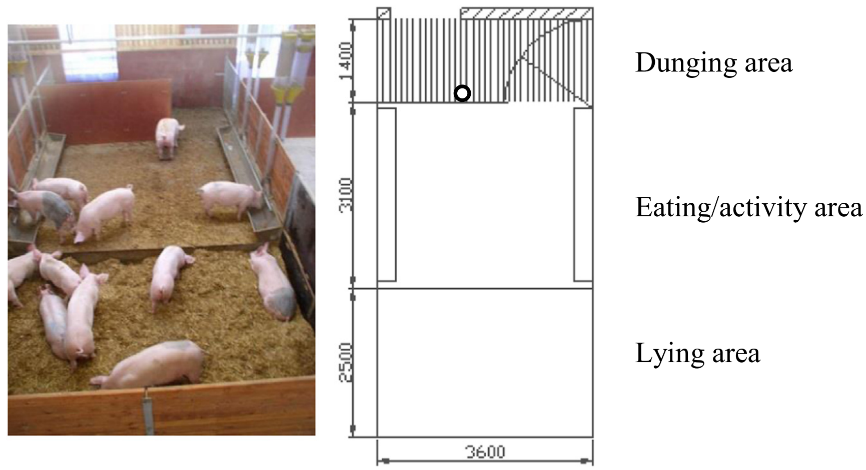


**Fig. 1.** Example of indoor layout in the basic organic pig pen.

2001). However, a number of scientific studies have shown that N emissions from organic pig production systems (Carlsson et al., 2009; Kool et al., 2009; Halberg et al., 2010; Olsson et al., 2014) are higher than those from conventional pig production. In a previous study (Olsson et al., 2014), we found 3–4 times higher nitrogen emissions in an organic production system, which we attributed to 10% greater feed usage (factor of 1.2), 15% higher crude protein level (factor of 1.3) and much larger fouled area per pig, especially outdoors (factor of 2.3), compared with conventional pig production. Problems with large fouled areas outdoors and high nitrogen emissions have also been reported in other studies on organic pigs (Olsen et al., 2001; Ivanova-Peneva et al., 2008; Vermeer et al., 2015).

The larger fouled area in organic pig production than in conventional pig production is because organic pigs are given a much larger total area. Larger pen area is positive for pig welfare (Street and Gonyou, 2008; Vermeer et al., 2014), but most often negative for pen fouling (YiCui et al., 2008). Since ammonia emissions are positively related to fouled pen area (Aarnink et al., 1996), there is a strong direct relationship between pig excretory behaviour and ammonia emissions. As a consequence of this and to improve organic pig production, measures to encourage organic pigs to excrete in a smaller area within the pen are desirable. Decreasing the dirty pen area is also important for the image of the organic farming concept, since consumers who choose organic meat are quality conscious and set high animal welfare standards.

Steering the excretory behaviour of pigs is not an easy task. Pigs are clean animals, but excrete more or less in all places outside their lying area (Mollet and Wechsler, 1991). The size of the area that pigs occupy when lying depends on the age, size and lying behaviour (lying on the abdomen or lying on the side, with or without contact with pen mates) of individual pigs. Lying behaviour is also influenced by ambient air temperature (Spoolder et al., 2012), with pigs tending to cover a larger pen area when the temperature is high, as they want to cool down by spreading out (Botermans and Andersson, 1995). Since pens are larger and the environment is often colder in organic pig production (due to uninsulated buildings and access to outdoor yards) than in conventional production, the lying area comprises a much smaller proportion of the pen in organic than in conventional production.

However, pigs also seem to seek isolation when excreting (Baxter, 1982). Therefore, one way to decrease the hygiene problem in the outdoor area for organic pigs may be to divide this area into one zone with higher pig activity and one zone with lower pig activity. Exploratory behaviour, in particular rooting, is often discussed as being a behavioural need (Jensen and Toates, 1993) of the pig (Studnitz et al., 2007; Pedersen et al., 2014). Introduction of a special rooting yard with rooting material in the outdoor area could possibly be a way to create more activity in one part of the outdoor area, in which the pigs do not want to excrete.

The aim of the present study was to find an optimal design for a rooting yard in the outdoor area in organic pig production. Rooting yards of different sizes and with different dividing wall heights were compared. Data on performance, location and activity, hygiene and ammonia emissions in the outdoor area were used for evaluation of the designs.

## 2. Material and methods

### 2.1. Experimental facility and design

The experiment was carried out in the research facility for organic pig production at Odarslöv Pig Research Farm at the Swedish University of Agricultural Sciences (SLU) in Alnarp. Within this facility, eight pens for 16 pigs each were established. Each pen had an indoor area (1.5 $m^2$ per pig, Fig. 1) and an outdoor area (1.125 $m^2$ per pig). The area indoors consisted of a straw-bedded lying area, a concrete area for eating and activity and a slatted dunging area. The floor in the outdoor area consisted entirely of concrete and this area was covered to 60% with a roof (Fig. 2).

Different designs of rooting yards were tested in the outdoor area in the eight pens. Four different designs, with varying sizes and wall heights, were tested in parallel (Fig. 3): (1) LH=large (8.4 $m^2$) with one high wall (1.0 m), (2) LL=large (8.4 $m^2$) with low walls (0.3 m), (3) SH=small (5.3 $m^2$) with one high wall (1.0 m), and (4) SL=small (5.3 $m^2$) with low walls (0.3 m). The rooting yards were compared with a reference pen (R) without a rooting yard (Fig. 3). Two batches, one during spring (batch 1, February–June) and one during autumn (batch 2, July–November), were introduced into the pig house. The placement of the various rooting yards and the reference pens was randomised in the two batches and distributed as shown in Table 1. However, due to a mistake in communication with the staff at the research facility, two pens in batch 2 were provided with SL rooting yards, instead of one SL and one SH yard as originally planned. The experimental setup allowed comparisons between reference pens and pens with rooting yards, between pens with large and small rooting yards and between pens with low and high walls around the rooting yards.