

USING 'HYGIENE-PAVERS' TO EVALUATE CLEANING PROCEDURES USED ON PIG FARMS

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Abstract

A number of studies have demonstrated improved production efficiency and reduced respiratory problems in pigs reared in a clean environment. Despite the compelling evidence presented by selected authors, there are few investigations in the literature that specifically evaluate different cleaning procedures and their efficiency in reducing bacterial load on the surface in livestock buildings. Studies were therefore required to assess cleaning methods and surface hygiene improvement techniques, to ensure a high level of animal welfare and productivity on farms. To achieve this aim, a number of controlled studies were implemented at the Roseworthy Research Piggery, to assess the effects of different cleaning procedures on the resultant microbiological load of floor surfaces. The data collected during experiments demonstrated the benefits of certain cleaning practices. The utilisation of degreasers, high-pressure washing and drying of pen floors proved to be beneficial practices.

Key words: Hygiene, cleaning, disinfection, building management

INTRODUCTION

Cleaning standards and procedures are increasingly recognised as one of the most important components of good livestock management (Hartung 2000; Wathes 1994). Often in the past, cleanliness and building hygiene issues have been under-estimated, but are emerging as one of the most important factors affecting air quality and livestock health (Banhazi *et al.* 2000; Hartung *et al.* 1986; Rantzer and Svendsen 2001b). A number of studies have demonstrated improved production efficiency and reduced respiratory problems in pigs reared in a clean environment (Rantzer and Svendsen 2001a; Rantzer *et al.* 1998). In a study conducted in Sweden, the effects of pen hygiene on post-weaning diarrhoea were demonstrated. Mortality and morbidity among pigs raised in "low-hygiene" pens were significantly higher than among pigs kept in "high-hygiene" pens. After weaning, there were significantly more treatments for *E. coli* associated with post-weaning diarrhoea among the pigs housed in the "low-hygiene" pens. The results demonstrated that a relatively small reduction in the level of pen hygiene had a marked negative effect on both the morbidity and mortality of pigs.

The general hygiene of sheds can be improved by facilitating cleaning procedures to become an integral part of the production management routine. For example, one of the benefits of applying all-in/all-out management in pig facilities is the extra "pig free" time gained, which can be allocated for thorough cleaning between batches. In a study by (Banhazi and Cargill 1998), it was shown that freshly cleaned "all-in/all-out" (AIAO) sections had reduced total dust (54%), respirable

dust (53%) and airborne bacteria concentrations (62%) compared to the uncleaned “continuous-flow” (CF) sections of the same buildings.

Normally a variety of physical cleaning processes are used prior to the use of chemical disinfectants. Piggery buildings are normally washed, by using either high-pressure cleaners or low pressure hose followed by the application of a degreaser and/or a disinfection agent (Roelofs *et al.* 1993). Surface hygiene may also be promoted in buildings by applying some common-sense principles, such as the elimination of unnecessary horizontal and uneven vertical surfaces. Choice of building material may also have some significant effects on surface hygiene (De Belie *et al.* 2000).

Despite the compelling evidence presented by selected authors, there are few investigations in the literature that specifically evaluate different cleaning procedures and their efficiency in reducing bacterial load on livestock buildings surfaces. Studies were therefore initiated and implemented at the Roseworthy Research Piggery with the aim of assessing cleaning methods and surface hygiene improvement techniques.

METHODOLOGY

Experimental tools

To facilitate easy and controlled assessment of cleaning procedures, a special experimental tool was developed in collaboration with “Direct Mix Concrete” Pty. and with the invaluable help of Mr F. Buia, Senior Control Engineer. Special cement pavers (150mm x 150mm x 50mm) were manufactured using Silica fume concrete to replicate the flooring material used in many Australian piggeries.

Two metal racks were also built which each enabled 9 pavers (3x3) to be placed next to each other and facilitating easy transportation of the pavers. This experimental tool enabled researchers to use the required number of identical replicates for different treatments and also to conduct the experiments under controlled conditions. However, it was also recognised that follow-up, farm based experiments need to be designed and implemented in the near future to complement these essentially laboratory based results.

Each “hygiene-paver” used during the study was pressure washed and disinfected with Virkon S[®] prior to use. Faecal material was collected from the pens of finisher pigs, homogenised and 100 grams of faeces was placed on each paver. The faecal material was evenly distributed over each paver with a spatula and left for 48 hours to mimic the hygienic conditions of dirty pen floors. The pavers were then treated accordingly to the different experimental protocols to determine the efficacy of various cleaning procedures.



Figure 1. "Hygiene pavers" are being prepared for future experimental work

Cleaning procedures

Individual pavers were hosed for 15 seconds to ensure all solid faecal material had been removed. Individual pavers were high pressure cleaned for 5 seconds. The degreaser used was Cyndan Farm Mate™, and this was placed in a squirt bottle with adjustable nozzle to create a foam that covered the paver uniformly. The active constituent was 250g/L Sodium Hydroxide and was mixed as a 1:3 ratio with water. The disinfectant used was Antec Farm FluidS™, a concentrated Virucidal Disinfectant that was also placed in a squirt bottle with adjustable nozzle to create a foam that covered the paver uniformly. The active constituents were 419.2g/L High Boiling Acids, 324.9g/L Acetic Acid and 52.4g/L Cresylic Acid. This was mixed as 7ml to 2.8L.

Sampling procedures

To determine the residual viable bacteria level on each paver, five 4 cm² sections were selected on each paver. These sections were towards each corner and one in the middle. A piece of perspex, 70mm x 70mm x 5mm, with a square hole in the middle, 20mm x 20mm was used as a guide for the swabbing area. The perspex square was disinfected with 80% ethanol solution between each site. A sterile swab was dipped into a solution of 0.1% peptone water, the perspex square was placed on the paver and the 4cm² area was swabbed by firmly rolling the swab tip back and forth. The swab tip was cut off into a 9ml solution of 0.1% peptone water. The solution was agitated for 30 seconds and 2ml was taken out into a test tube to be used as a stock solution (inoculum). A four times dilution series was performed if faecal material could be seen on the paver with the naked eye. 100ml of the inoculum was uniformly spread onto a Columbia Horse Blood Agar (HBA) plate, and incubated at 37 degrees Celsius for 48 hours. The plates were placed on a light box and the colony forming units were counted.

Experimental design

The following treatments were applied during five separate experiments:

The main aim of '*Experiment One*' was to assess the efficacy of hosing compared to high-pressure washing. Six pre-treated "hygiene-pavers" were used for the experiment, with five sites sampled per paver. Three pavers out of the six experimental pavers were hosed only, while the other three pavers were hosed briefly and then high pressure washed. The pavers were swabbed immediately after treatment.

The main aim of '*Experiment Two*' was to assess the efficacy of hosing compared to the utilisation of a degreaser product (Cyndan Farm Mate™). Four pre-treated "hygiene-pavers" were used for the study, with five sites sampled per pavers. Two pavers out of the four experimental pavers were hosed only, while the other two pavers were hosed briefly, treated with the degreaser for approximately 60 minutes and then hosed. The pavers were swabbed immediately after treatment.

The main aim of '*Experiment Three*' was to assess the effects of increased degreasing time on surface bacteria concentration, as a follow-up experiment after the previous one (Experiment Two). Eight pre-treated "hygiene-pavers" were used for the experiment, with five sites sampled per pavers. Two pavers out of the eight experimental pavers were not cleaned, while the other three times two pavers were hosed briefly and treated with degreaser for 1, 2 and 3 hours. The pavers were swabbed immediately after treatment.

The main aim of '*Experiment Four*' was to assess the effect of sub-optimal air quality on the re-infection rate of cleaned "hygiene pavers". Nine pre-treated "hygiene-pavers" were used for the study, with five sampling sites per paver. Six pavers out of the nine experimental pavers were hosed, degreased and disinfected and swabbed almost immediately, while the other three pavers were hosed, degreased and disinfected and left in a dirty environment for 24 hours before swabbed.

The main aim of '*Experiment Five*' was to follow up on the previous experiment (Experiment Four) and assess the effects of properly drying the surface of "hygiene-pavers" on the resulting surface bacteria concentration. Six pre-treated "hygiene" pavers were used for the study, with five sampling sites per paver. Two pavers out of the six experimental pavers were hosed, degreased briefly (10 minutes) and swabbed, another two pavers were hosed, degreased for 2 hours, disinfected and swabbed immediately, while the remaining two pavers were hosed, degreased for 2 hours, disinfected and left in a clean environment for 48 hours to completely dry before being swabbed.

RESULTS AND DISCUSSION

Experiment One

The results of Experiment One are presented in Figure 2. The number of Colony Forming Units (CFUs) was significantly higher on the surface of the hosed pavers, compared to the high pressure washed pavers. No significant differences were detected between the values obtained at the different sampling points used on individual pavers.

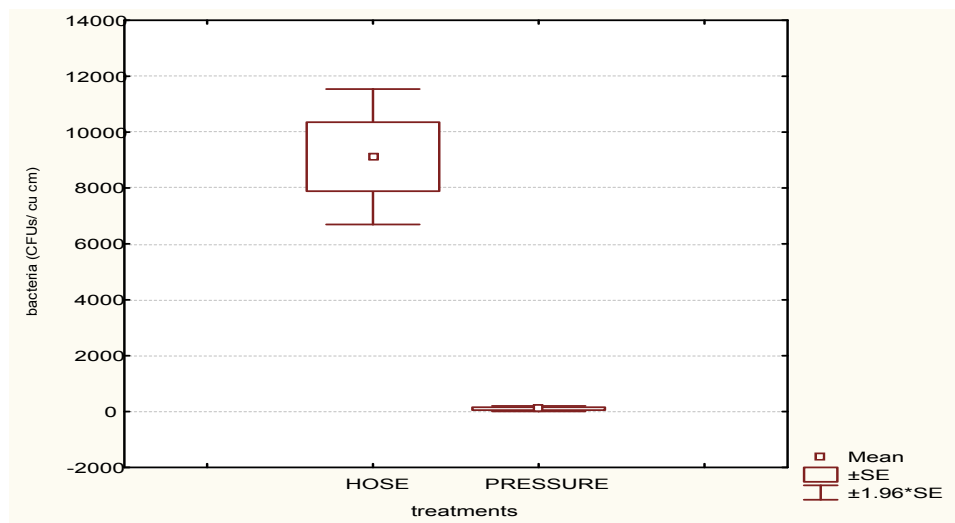


Figure 2. Mean (\pm SE) bacteria concentrations (Colony Forming Units per cm^2) measured on the surface of “hygiene pavers” for the two different treatments (Hose=hosing down only; Pressure=pressure washing)

The experiment demonstrated the superior cleaning ability of high-pressure washers, compared to the traditional hosing. It has to be emphasised that this experiment focused on the resulting surface hygiene of cleaned floor segments, ignoring other effects, such as the aerosol generating nature of high-pressure washing. According to anecdotal evidence, one of the potential drawbacks of high pressure washing in poorly ventilated areas is its tendency to re-distribute small particles (in the form of very fine aerosol) in the air, which can later settle on horizontal surfaces and potentially re-infect these surfaces. Pressure washing can also pose an OH&S hazard, if no protective equipment is supplied to the workers undertaking the cleaning task. However, the experiment demonstrated, what is generally accepted in practice, that high pressure washing could significantly improve both the visual and bacteriological cleanliness of floor surfaces.

Experiment Two

The results of Experiment Two are presented in Figure 3. The number of Colony Forming Units (CFUs) was significantly higher on the surface of hosed pavers, compared to the degreased pavers. No significant differences were detected between the values obtained at the different sampling points used on individual pavers.

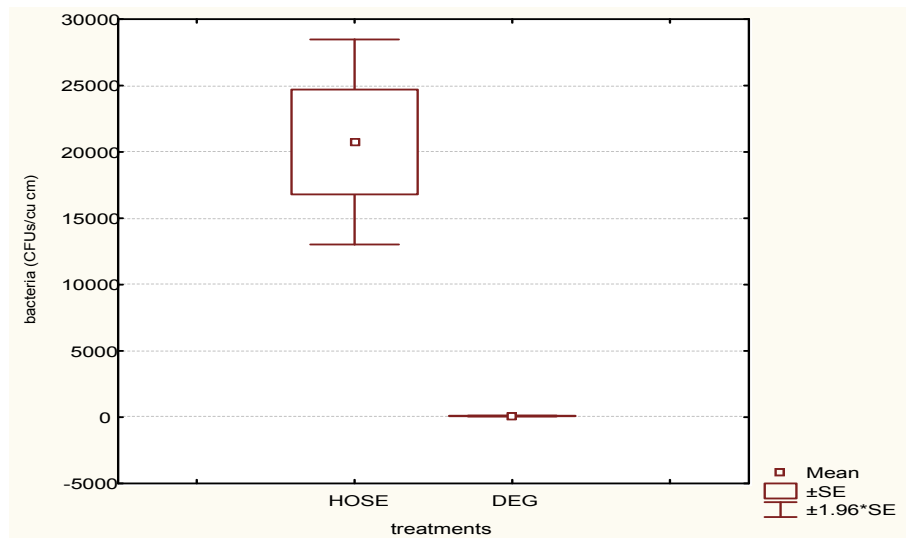


Figure 3. Mean (\pm SE) bacteria concentrations (Colony Forming Units per cm^2) measured on the surface of “hygiene pavers” for the two different treatments (Hose=hosing down only; Deg=degreaser)

This experiment demonstrated, that the use of degreaser could potentially help producers to achieve similar level of floor cleanliness, as could be achieved by high-pressure washing. However, this is only true, if the soiling of pen surfaces is totally removed. Any residual soiling will significantly decrease the biological cleanliness of pen surfaces (Hartung 1994; Wathes 1994).

Experiment Three

The results of Experiment Three are presented in Figure 4. The number of Colony Forming Units (CFUs) was significantly higher on the surface of the “hygiene-pavers” cleaned by hosing only. However, no significant differences were detected between the concentrations of CFUs measured on the surface of the “hygiene-pavers” degreased for 1, 2 or 3 hours. It appeared, that after leaving the degreaser on the soiled surface of the experimental “hygiene-pavers” for an hour, any further increase in degreasing time did not result in any improvements.

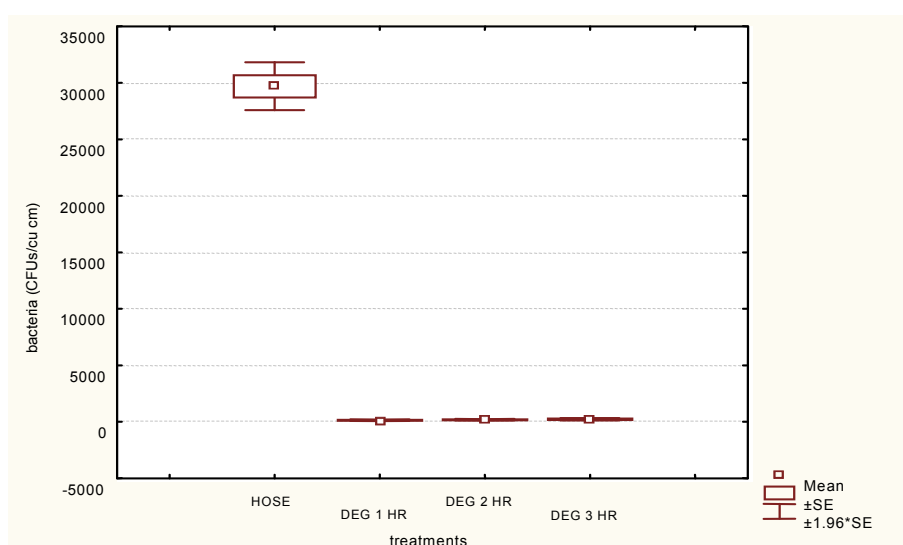


Figure 4. Mean (\pm SE) bacteria concentrations (Colony Forming Units per cm^2) measured on the surface of control and treatment “hygiene pavers” (Hose=hosing down only; DEG, DEG2, DEG3=degreasing for 1, 2 and 3 hours, respectively)

This experiment demonstrated that under our experimental conditions, the degreaser needs to be left on the floor surface for at least one hour. However, under commercial conditions, where the level of soiling could be much worse than under our experimental conditions, a longer degreasing time might be warranted. Specific degreasers are also expected to work differently, resulting in different optimal soaking time. However, producers should be aware that the benefits of degreasing do not necessarily increase in a linear fashion with increased soaking time. Based on the results of this experiment, it is most likely that an optimal soaking time exists for different degreasers, above which no extra benefits are to be gained. Observing and strictly adhering to such optimal soaking times will ensure that producers will gain the maximum benefits achievable, while minimising the downtime and therefore the expenditure associated with the cleaning procedure used.

Experiment Four

The results of Experiment Four are presented in Figure 5. The number of Colony Forming Units (CFUs) was higher on the surface of pavers kept in the dirty room, compared to the pavers sampled immediately after the implemented cleaning procedure. However, this difference was not statistically significant ($p=0.0554$) and the reinfection rate and the resultant hygiene levels of individual pavers were highly varied. This is demonstrated by the unusually high standard error obtained in this dataset.

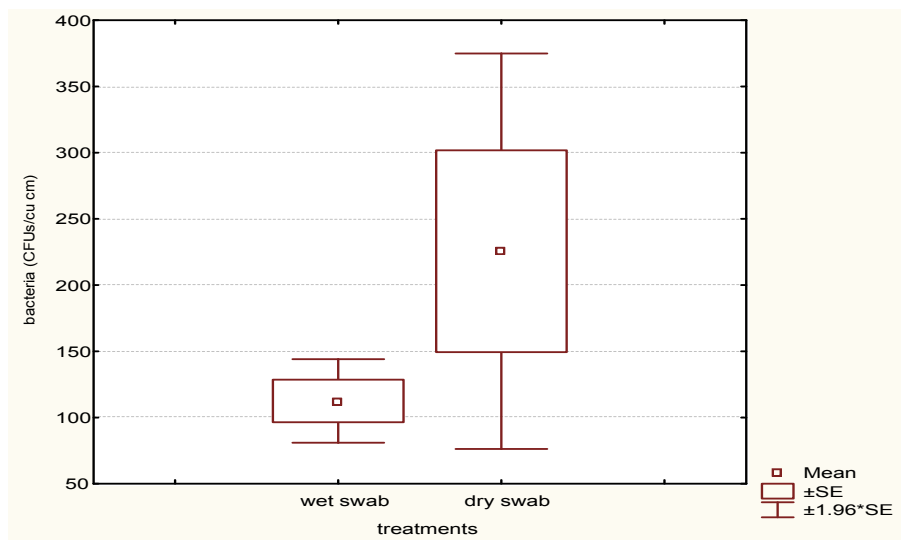


Figure 5. Mean (\pm SE) bacteria concentrations (Colony Forming Units per cm^2) measured on the surface of control and treatment "hygiene pavers" (wet swab=pavers sampler immediately after treatment; Dry swab=pavers kept in the 'dirty' room)

This experiment demonstrated the need for thorough cleaning of areas belonging to the same airspace in piggery buildings, as opposed to the 'old-fashioned' practice of selective cleaning of individual pens or selective cleaning of pen floors without cleaning other horizontal and vertical surface areas in the same building. Even thoroughly cleaned surfaces can be easily re-infected with bacteria via dirty, dusty air. The results demonstrated the potential of re-infection (and the unpredictable, varied nature of re-infection rate) of cleaned surfaces in a dirty environment.

Experiment Five

The results of Experiment Five are presented in Figure 6. The number of Colony Forming Units (CFUs) was significantly higher on the surface of the disinfected paver, compared to the disinfected and then properly dried pavers. Learning from the results obtained during the previous experiment (Experiment Four), a clean room was used to dry the experimental pavers. No significant differences were detected between the values obtained at the different sampling points used on individual pavers.

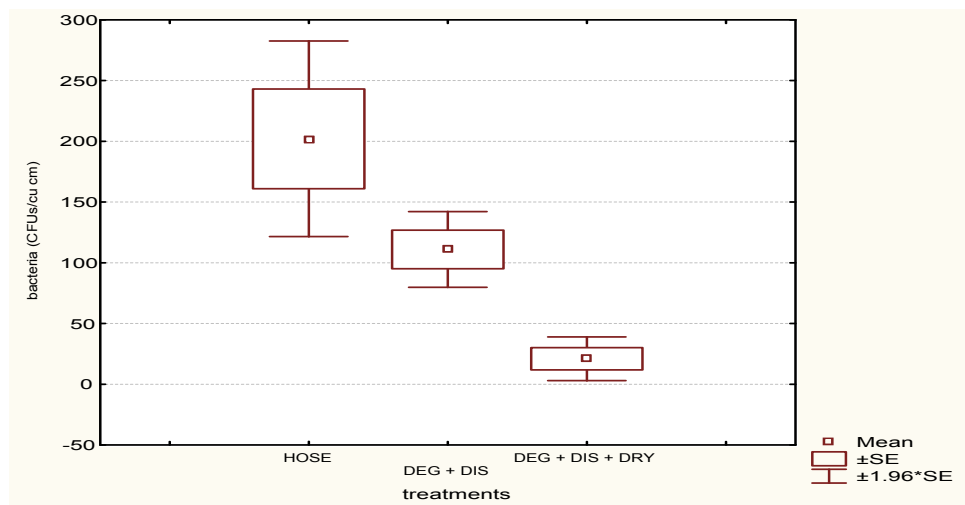


Figure 6. Mean (\pm SE) bacteria concentrations (Colony Forming Units per cm^2) measured on the surface of control and treatment “hygiene pavers” (Hose=hosing down and 10 minutes degreasing; Deg+dis= hosing+degreasing+disinfecting and immediate swabbing; Deg+dis+dry= hosing+degreasing+disinfecting and swabbing after 48 hours drying in a ‘clean’ room)

This experiment demonstrated the beneficial effects of thoroughly drying the pens in a clean environment on the resulting surface hygiene. Even after full disinfection, further improvements could be achieved by allowing the hygiene pavers to dry for 48 hours in a clean environment. Although, the obvious limitations of a laboratory trial are acknowledged by the authors, the results of this experiment are reinforcing current best practices on commercial farms. Thorough drying of piggens after cleaning under commercial conditions is recommended based on these results. Such practice is also encouraged to ensure optimal thermal comfort of pigs (Banhazi et al. 2001a; Banhazi et al. 2001b) and the establishment of correct dunging patterns in freshly stocked pens (Banhazi et al. 2002a; Banhazi et al. 2002b). However, these results demonstrated that additional benefits, such as the reduction of microbiological load, could be expected from such practice.

CONCLUSIONS

- The utilisation of either degreasing or high-pressure washing can result in high levels of cleanliness of concreted surfaces.
- The efficiency of degreasers will not increase linearly with increased soaking time.

- Drying of concreted areas can result in further improvement of microbiological cleanliness of surfaces, but only if the whole area is clean, otherwise re-infection can occur, via airborne particles.

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