Livestock Science 135 (2011) 265–273

Contents lists available at ScienceDirect

Livestock Science

journal homepage: www.elsevier.com/locate/livsci

Free-stall cleanliness is affected by stall design

L.E. Ruud [a,*], C. Kielland [b], O. Østerås [b], K.E. Bøe [a]

[a] Department of Animal- and Aquacultural Sciences, Norwegian University of Life Sciences, P.O. Box 5003, N-1432 Ås, Norway
[b] Department of Production Animal Clinical Sciences, Norwegian School of Veterinary Science, P.O. Box 8146 dep., N-0033 Oslo, Norway

ARTICLE INFO

Article history:
Received 7 April 2010
Received in revised form 16 July 2010
Accepted 22 July 2010

Keywords:
Free-stall design
Stall cleanliness
Bedding
Head rail

ABSTRACT

The objective of this study was to describe free-stall design and free-stall contamination in a cross sectional field study and to evaluate the effect of free-stall design on free-stall cleanliness. Five trained observers recorded cleanliness and use of bedding in 7 different sectors in 15 random selected free-stalls in each of 232 dairy herds. Of these, 8 herds were excluded from the statistical analyses due to stalls recently being cleaned out despite instructions not to do so. The observers also recorded the position of head and neck rails as well as stall width and construction of a possible brisket locator. The free-stall base was divided into seven sectors and the cleanliness of each sector was scored using a five grade scale reflecting the degree of contamination of each section. Two types of contamination were registered; faeces fallen on stall base (FAECES) and wet footprints (FOOT). Mean stall base length was 2.39 ($\pm$0.21) m when placed against wall and 2.23 ($\pm$0.11) m in a double row. Mean height of the neck rail was 1.07 ($\pm$0.05) m, upper head rail 0.90 ($\pm$0.15) m and lower head rail 0.37 ($\pm$0.18) m. Contamination was mainly observed in the three rear sectors of the stalls. The most important factors in improving stall cleanliness on the basis of FAECES, in ranked order, were found to be: amount of bedding $>$1.0 L, diagonal stall length $\leq$1.96 m, absence of lower head rail, stall length $<$2.30 m, brisket locator distance $\leq$1.83 m, stall width $>$1.13 m and upper head rail $>$0.70 m. Regarding FOOT contamination, the most important preventive factors were, in ranked order: amount of bedding $>$0.5 L, soft stall base with $>$0.5 L of bedding, brisket locator height $\leq$0.10 m, upper head rail $>$1.0 m, concrete stall base and stall width $\leq$1.13 m.

1. Introduction

Major Bramley invented the free-stall in his attempts to reduce the usage of bedding material as he realized that the animals had to be restricted in some way in order not to foul their bedding or get dirty when lying down (Bramley, 1962). The free-stall design must allow the cows to unhindered lie down, lie and rise easily and at the same time the construction should also contribute in keeping the cows and stall clean. Studies by Schmisseur et al. (1966) confirmed that free-stall housing kept cows cleaner and reduced bedding requirements by 75% compared to loose housing. Later, several studies have investigated different aspects of free-stall design (e.g. Bickert, 2000; Weary and Taszkun, 2000), but the connection between free-stall design and stall cleanliness still seems to be poorly documented. However, e.g. installing a neck rail in a free-stall, actually reducing the accessible length of the stall, improves the cleanliness of the free-stall, while wide stalls tends to be more soiled (Tucker et al., 2005). Further Gygax et al. (2005) discovered that enlargement of free-stalls increased the degree of soiling of the rear end of the stall and increased the number of dung droppings in the same area, whereas increased stall occupancy was found to be associated with a more contaminated free-stall base (Gaworski et al., 2003). No information on the connection between free stall floor length and free stall cleanliness was found, however Gjestang (1980) showed that

* Corresponding author. Tel.: +47 90117419; fax: +47 62520601.
E-mail address: lars.erik.ruud@tine.no (L.E. Ruud).

1871-1413/$ – see front matter
doi:10.1016/j.livsci.2010.07.021

for cows in tie stalls, cow cleanliness was improved when the length of the stall floor was reduced. Free-stalls equipped with mats stays cleaner than concrete floored stalls (Herlin, 1997), and use of bedding material is an important factor in keeping the cows clean (e.g. Nygaard, 1979), but the link to free-stall cleanliness is less clear.

The origin of faeces in free-stalls is, either from cows standing or lying in the stalls defecating directly on the stall base, or is following the cows from the alley into the stalls. Stall contamination could also be as splashing from cow activities in the alley. Stall design influences on the space accessible for the cows in the stalls and thereby the cows movements and positions, hence e.g. a short stall or a restrictive neck rail position, influences on the possibility for the cow to contaminate the stall base as illustrated by e.g. Gygax et al. (2005) and Tucker et al. (2005). The main hypothesis of this study was therefore that a stall design with less space accessible for the cow will contribute to a cleaner stall. The aim of this study was to describe the level of contamination in free-stalls, and to investigate the effect of free-stall design on stall cleanliness.

2. Materials and methods

2.1. The herds

This study was part of a larger descriptive and cross-sectional project on identifying optimal parameters in free-stall housing, where the selection of study farms reflects the entire project. From a questionnaire sent to all dairy advisers in Norway, a list was obtained of 2400 herds that were presumed to be housed in free-stalls. The farmers received a questionnaire covering several aspects of their free-stall housing system. To be included in the study, the farmers had to fulfil our inclusion criteria; volunteering to participate, herd size>20 standardized cow-years based on the year 2005 (cow-year = sum of number of days within a herd from calving to culling within one year, divided by 365), and barns built from 1995 to 2005. As we expect some housing systems to be common in the future, all farms with robotic milking ($n=44$), with solid concrete floors ($n=80$) or solid rubber floors ($n=16$) in the alleys were included in the study. As most farms had slatted floors, herds on slatted floors fulfilling the inclusion criteria were included only if they were located in the same municipality as farms mentioned above. The material used in this study consisted of 232 free-stalled dairy herds located all over Norway. As we wanted to study certain effects of alley flooring in other parts of the project, herds on solid concrete floors or rubber in the alleys are overrepresented in our dataset compared to the total population. This study is therefore not a random study, but a stratified cross-sectional descriptive study with random selection within groups, e.g. cows, stalls, cleanliness observations etc. From the initial phase of the free-stall project, the distribution of floor types in the alleyways in free-stall housed herds in Norway was approximately 80% slatted concrete floors, 18% solid concrete floors and 2% solid rubber floors. Floors in the selected 232 farms comprised 57.3% slatted concrete floors, 34.5% solid concrete floors and 6.9% solid rubber floors.

2.2. Observations

During the indoor feeding period from September 2006 until May 2007, 232 herds were visited once by one of five trained observers. To standardize the data collection, an initial two-day training session followed by three additional training sessions during the recording period was performed. Two of the observers conducted the majority of the registrations (73%) and had regular meetings between farm visits to enhance the consistency in data recording. A systematic protocol was used to record data on each farm. Additionally data was analyzed for significant clustering effect of observer to ensure no significant differences in recording during the study. On each farm the object was to choose 15 stalls for cleanliness and bedding observations by selecting every second, third etc. stall, dependent on the herd size (n stalls/15 and then closest integer). Each stall base was divided into seven sectors (Fig. 1). Some farmers had not followed the required routines regarding stall cleanliness (they were instructed not to clean out excreta or add bedding that actual day before until after our registrations in the stalls), consequently the stall contamination part of this study includes only 224 herds. In total, stall cleanliness was observed in 3,459 stalls on 224 farms with stall sector as unit in the statistical models.

2.3. Free-stall design

In each farm, the mid-stall in the row against a wall and the mid-stall located in a double row were selected and parameters recorded as illustrated in Fig. 2. For each type of stall, at least 4 other stalls per row of stalls were also measured to secure that the middle stall was representative for that specific type of stall in that herd. Each dirtiness recording was then linked to the correct stall type measure

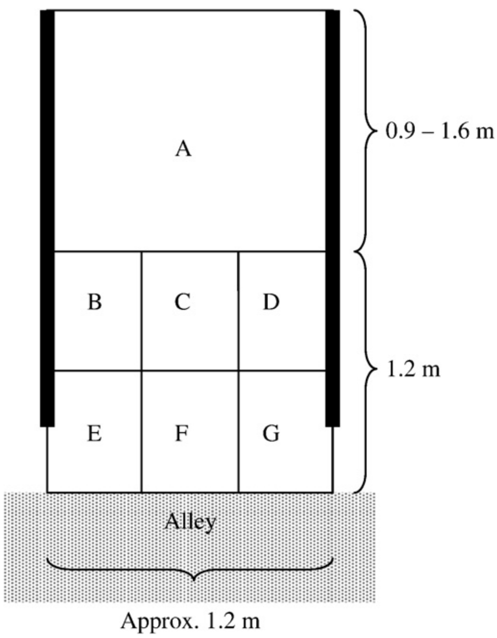

Fig. 1. The free-stall base was divided into 7 sectors (A to G) where cleanliness was scored individually on a scale of 1 to 5.