FARM-LEVEL MEASURES TO REDUCE AMMONIA EMISSION FROM TIED DAIRY CATTLE COMPATIBLE WITH IMPROVED ANIMAL HEALTH AND PRODUCTIVITY

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Introduction

Ammonia is a water-soluble gas, which can travel over great distances in the atmosphere and deposit as rain. Ammonia deposition affects the environment through eutrophication and acidification of the ground and water. The presence of ammonia in the atmosphere is a result of human activities; all handling of manure causes ammonia emission and farming causes 90% of all emissions. Efforts are made to reduce ammonia emissions at an international level, e.g. through conventions like CLRTAP from 1979 (10) and the National Emissions Ceiling Directive of 2001 (3).

However, farm-level efforts to minimize ammonia emission are not necessarily accompanied by improved animal health and welfare. For instance, reduced ventilation of a cowshed would reduce emission from the building but increase indoor gas concentrations. Likewise, manure-draining flooring may be uncomfortable for the animals when walking and resting. Ammonia paralyses the cilia of the upper respiratory tract and presumably increases the risk of respiratory disease (4, 8). According to the Swedish animal-welfare regulations, indoor air in buildings for domestic animals shall not have higher concentrations of ammonia than 10 ppm. Poor hygienic conditions in animal houses – related to high ammonia emission – reduces livestock welfare through itch, pain, burns, infections and a reduced heat-insulating capacity of the haircoat. Both hoof lesions and mastitis are to a great extent caused by poor hygiene (1, 2, 6, 9).

The objective of the present study was to describe cow health, fertility and milk production in connection with technical steps to reduce ammonia emission from a dairy farm.

Material and Methods

At a university farm with 42 tied dairy cattle of the Swedish Red and White Breed and 92 ha of arable land in southwest Sweden, methods and techniques to reduce the ammonia emission in milk production were studied and demonstrated during two winter seasons, as part of a large 4-year EU-financed project with cooperation of major agricultural organizations and companies.

At the start of the study, the cows were kept in a traditional Swedish cowshed, together with heifer calves to 1 yr of age. The cows were tied in 220-cm (long) stalls with lockable stanchions and rubber or EVA mats. Half of the stalls were equipped with rubber-slatted flooring (Fritz Foderstyrning AB, Nässjö, Sweden) in the rear part. Chopped straw was used as bedding material. The gutters lacked a well-functioning urine drainage system. The building was ventilated by a fan in the ceiling, with a maximum capacity of 273 m^3/cow-h. The cows were fed grass/clover silage, hay, grains (oats and wheat) and protein concentrates. The animals were managed by a full-time herdsman. Cleaning of stalls was done several times a day (whenever needed) and the cows were groomed manually twice daily. Claw trimming was done twice a year.

In connection with rebuilding of the cowshed in the summer of 2000, changes were made regarding feeding, housing and indoor manure handling, including:

- lowered dietary crude protein concentration (from approx. 170 to 160 g/kg dry-matter in early lactation), paying attention to recommended levels of rumenally degradable and undegradable proteins,
- 181-cm (short) tie-stalls with indivídually adjustable fronts and rubber-covered slatted flooring,
- wood shavings used as litter material,
- improved gutters with a 3% slope towards a urine drainage channel equipped with a rotating auger,
- cooling of gutters by incoming water,
- main ventilation by four wall fans, giving a maximum capacity of 457 m^3/cow-h, and
- manure-gas ventilation from the urine channels and manure culvert.

During rebuilding, from May to September 2000, the cows were kept on another farm. Cow cleanness and performance were recorded continuously or at regular intervals before and after rebuilding. Clinical diseases were recorded by veterinarians.

Results

The technical changes made reduced the ammonia emission through the exhaust air by 30%, from 24 to 18 g/cow-d, or from 7.2 to 5.0 kg/cow-year. Average indoor ammonia concentration dropped from 7.9 to 3.2 ppm. Average indoor temperature dropped from 16.5 to 13.5 °C and the relative humidity remained unchanged at 62-64%.

The changes made influenced feed costs and milk revenues only marginally. Feed consumtion increased with almost 2 kg dry-matter. Milk yield dropped during rebuilding, but then increased by approx. 2.4 kg energy-corrected milk per cow-d, from 30.6 kg before to 33.0 kg after rebuilding, wheras the milk composition and nitrogen efficiency in milk production remained almost unchanged for lactating cows. When the dry period was included, the nitrogen efficiency increased by 2 percentage units, from 25 to 27%. From 1999 to 2002, the yearly recruitment rate (percentage of heifer calvings) varied between 37 and 46% and the culling rate between 35 and 50%.

Animal cleanness on hind legs and udder improved considerably (Table 1), and the need for cleaning of stalls and grooming diminished substantially. At all recording occasions, the variation in dirtiness between cows was great. There was less variation between seasons, with a tendency of higher scores for hindfeet and udder during late winter than during the rest of the housing period. Cows that were kept in stalls with rubber-slat flooring before rebuilding were considerably cleaner than cows kept on ordinary flooring (5).

Table 1. Degree of dirtiness on different body areas before and after rebuilding (min.-max. of median scores for monthly recordings).

	Before	After
Hindfoot-hock[1]	8-9	3-4
Gaskin-thigh-rump[2]	2-3	1-2
Udder[3]	2-4	0-1

[1,2,3] Maximum sum of points attainable: 12, 6 and 9, respectively.

The incidence of clinical mastitis during the housing period dropped by 56%, from 0.69 cases/cow-yr before to 0.30 after rebuilding.

Milk somatic-cell counts remained low during the study; based on monthly test-day recordings, the average bulk milk-cell count was calculated to be 143,000 cells/ml both before and after rebuilding.

The prevalence of heel horn erosion, sole haemorrhage, sole ulcer and double sole at spring claw trimming dropped by 65-87% (Table 2). The total prevalence of any type of lesion varied between trimming occasions from 60 to 92% before and from 50 to 76% after rebuilding.

Table 2. Prevalence (percentage of cows diseased) of different hoof lesions at spring claw trimming before (one trimming) and after rebuilding (mean of two trimmings).

Lesion	Before	After
Dermatitis	12.3	20.5
Heel-horn erosion[1]	29.6	6.3
Heamorrhage[1,2]	38.3	13.4
Sole ulcer	6.2	0.8
White-line separation	16.0	5.5
Other lesions[3]	3.7	2.4
Any lesion	86.4	70.9

[1] Moderate or severe lesion.
[2] Heamorrhage in the sole or white line.
[3] Double sole, wharts, cracks or abnormal hoof shape.

In the spring before rebuilding, the prevalence of hoof lesions was generally lower in cows on rubber slats than on solid floor (5).

Before rebuilding, the prevalence of hock burns varied between 57 and 100%, and similar lesions on other body parts were rare. After rebuilding, however, the prevalence of lesions increased to 83% for the hocks, 2% for the knee area and 62% for the carpal joint. In most cases, lesions were superficial, small and without any appreciable complications. Moderate carpal hygroma was observed in some animals.

Reproductive performance remained excellent throughout the study, with 1.4-1.6 services/pregnancy, 81-87 d open, and a 11.7-12.0 mo calving interval.

Discussion

It is not possible to compare the cleanness of these animals with that of other dairy herds. With respect to clinical disease, official incidence estimates are missing, and some cases in the present study did not result in any veterinary treatment. Therefore, the incidences recorded in this study cannot be compared directly with figures from the official disease-recording system.

During the year before rebuilding, the incidences of clinical mastitis and acute hoof diseases were substantially increased, while the incidences of other clinical diseases were similar to other Swedish herds. After rebuilding, all common clinical diseases were in level with other Swedish herds. Cell counts may be compared with the arithmetic mean for all Swedish herds in the official milk-recording scheme during the same period, which was 185,000 to 212,000 cells/ml.

The prevalence of hoof lesions may be compared with the prevalence recorded (with the same scheme) by Manske *et al.* (7) in 101 Swedish dairy herds, showing that hoof health was relatively good before rebuilding (except for some white-line separations and sole haemorrhages) and good to excellent after rebuilding.

Conclusion

The results show that measures to reduce efficiently the ammonia emission from buildings for dairy cattle are compatible with improved animal health and production.

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