doi: 10.17221/4/2015-RAE

Frequency analysis of noise exposure of dairy cows in the process of milking

M. Pšenka[1], M. Šístková[2], Š. Mihina[1], R. Gálik[1]

[1]*Department of Production Engineering, Faculty of Engineering, Slovak University of Agriculture in Nitra, Nitra, Slovak Republic*
[2]*Department of Agricultural, Transport and Handling Machinery, Faculty of Agriculture, University of South Bohemia in České Budějovice, České Budějovice, Czech Republic*

Abstract

Pšenka M., Šístková M., Mihina Š., Gálik R. (2016): **Frequency analysis of noise exposure of dairy cows in the process of milking**. Res. Agr. Eng., 62: 185–189.

In the environment of farms and farm buildings, cattle are exposed to various unnatural influences. Such an impact is also noise always arising with a certain energy conversion. In cattle farms, the sources of noise are represented by various mechanical equipment and machines that are used for enabling farm operations. The aim of the paper was to analyse the noise levels in dairy cattle production in the environment, during their day routine. Noise levels were measured at two farms with a different technological layout of milking parlour, with a different way of milking. The noise exposure of dairy cows was measured in three locations, namely in the milking parlour, during standing in the area before milking (in the so-called collection room) and directly in the stabling area. Noise exposure was measured during milking and when the milking parlour was turned off. The values were compared with the hearing sensitivity of cattle at selected frequencies (0.5, 1, 2, 4, 8 and 16 kHz).

Keywords: hearing sensitivity; welfare; cattle; milk production; milking parlour

Cattle bred in farm buildings are exposed to noise, which can come either from outside or from inside of the building. Several published studies demonstrate different sounds that can occur inside the building for animal husbandry (Castelhano-Carlos, Baumans 2009). Animals have often more sensitive hearing than humans. They have different frequency spectra of sound perception with the maxima of frequencies that are inaudible to humans (Voipio 1997). Some animals can well perceive sounds below and also above the frequencies in the audible range of an average human, and thus from 20 Hz to 20 kHz. Cattle have audible range in the frequencies from 25 Hz to 35 kHz and can capture lower lying sounds than other farmed animals (Heffner, Heffner 1993). Humans are more sensitive to perception of noise in the range from 500 Hz to 4 kHz, which is the range of normal ordinary human speech (within this range, one can hear quiet sounds) (Castelhano-Carlos, Baumans 2009). According to Heffner (1998), cattle can hear high-frequency sounds much better than humans. Their threshold point of sound perception is at the highest frequencies of 37 kHz,

Supported by the Scientific Grant Agency VEGA of the Ministry of Education of the Slovak Republic and the Slovak Academy of Sciences, Grant No. 1/0609/12.

doi: 10.17221/4/2015-RAE

compared to only 18 kHz for humans. Various undesirable noises arise as a secondary effect during normal activities such as feeding, removing of manure and milking. Anthropogenic noise from ordinary human activities can have a negative impact on the welfare of cattle (Brouček 2014). Noise sources on farms can be, in addition to ordinary activities (opening and closing doors, washing, speech of employees, dispensing feed, etc.), also machinery, basal levels of noise caused by mechanical ventilation, animal activity (climbing to barriers, chewing on barriers) and their own vocalization (Žitňák et al. 2011; Mihina et al. 2012). This study focused on noise analysis in the process of milking, in frequencies where the hearing of cattle is the most sensitive.

MATERIAL AND METHODS

Animal characterization. In the experiment, there were used production cows of dairy herd of the Czech Pied cattle and Holstein-Friesian cattle, bred on two farms in various proportions.

Research place. The experiment was conducted at two cattle farms in the Czech Republic. Measurements were performed at the dairy farm of ZD Čížkrajice in Čížkrajice, with a capacity of 160 heads, and the tandem milking parlour (TMP) (Bauer Technics, Stádlec, Czech Republic) 2 × 4, placed outside next to barn. These buildings were connected to each other with a collection room where cows are waiting for the milking process. Cows were milked twice a day. They were moved into the parlour in groups of about 40 heads. Another group of cows is coming to the collection room after the last cow from the first group finishes milking. Further measurements were performed in the farm ZD Skalka in Lipí, with capacity for 205 dairy cows, housed in three groups together in one barn. Cows in this farm were milked with three identical automatic milking systems (AMS) of type Lely Astronaut A2 (Lely Industries NV, Maassluis, Netherlands). Each of the three groups had own AMS located in the pen. Cows were milked according to their needs, in some cases up to three times a day. They waited to be milked in front of the automatic selection gate. In both farms, cows were housed in cubicles and fed by TMR (total mixed ratio) on the floor of the feeding pass. The feeding ration was dispensed by a mixer feeder wagon.

Measuring device. Brüel&Kjær type 2270, 611672-1:2002 Class 1, IEC 61260:1995 w. Am. 1, 1/1 and 1/3 Oct. Band Class 0, IEC 60804:2000 type 1, IEC 60651:1979 w. Am. 1 and 2, type 1 (Brüel&Kjær, Nærum, Denmark) was used for measuring noise. It allows measuring sound levels in a standard way and carrying out the evaluation of the living and working environment. It consists of a microphone, preamplifier, processor and reading unit. The software allows measuring parameters in time and evaluating data statistically. Frequency can be measured in bands of 1/3 or an entire octave. In addition, long-term monitoring is available and frequency analysis can be done there.

Data acquisition. Noise measurements were carried out at three places: (1) in the area of milking, (2) in the stable and (3) in the space where cows waited for milking. Measurements were made at these places during the milking process, both when the milking equipment was on and also when the milking equipment was off. The measuring device was placed at the level of animal heads. Equivalent sound pressure level (*LZF*ekv) was recorded. This level reflects the value of equivalent sound energy measured for a given period, with a zero-weighted filter. Another measured parameter was the max. time-weighted level (*LZF*max) with zero-weighted weighting filter. Each measurement lasted 1 min, and each measurement point was measured 10 times when the milking equipment was on and 10 times when the milking equipment was off.

Data analysis. The measured values were compared with the values of hearing sensitivity of cattle, with reference to experiment with two individuals of cattle according to Heffner and Heffner (1983). In this experiment, the minimum values of noise that cattle can capture at specific frequencies with its hearing device were determined.

RESULTS AND DISCUSSION

As can be seen in the graph (Fig. 1), the hearing apparatus of cattle is most sensitive at the frequency of 8,000 Hz. Cattle are the most sensitive to perception of noise in higher frequencies also according to Phillips (2009), i.e. at 8 kHz, compared to 4 kHz in humans. The values measured in the milking parlour, collection room and stall at the time when the milking equipment was in action were measured in both farms surveyed. Values measured in the

doi: 10.17221/4/2015-RAE

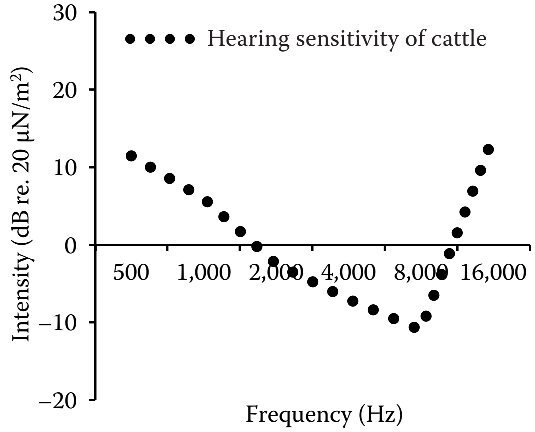

Fig. 1. Audiogram of hearing sensitivity of cattle (Heffner, Heffner 1983)

farm with the tandem milking parlour are marked as Farm A. Values measured in the farm with the automatic milking system are designated as Farm B. Sound pressure levels are shown for selected frequencies (0.5, 1, 2, 4, 8) kHz and 16 kHz. Values are expressed in equivalent levels *LZF*ekv and max. levels *LZF*max. Fig. 2a shows the levels of acoustic pressure in the milking equipment during milking. Equivalent level *LZF*ekv is at different levels in both farms. In the Farm B, it is 67.92 dB; in the Farm A, it is 72.50 dB. Animals milked in the Farm A are more exposed to noise. *LZF*ekv at 8 kHz was 53.70 dB in the Farm B and 58.90 dB in the Farm A. The max. noise at 8 kHz reached the levels of 83.20 dB in the Farm B and 88.30 dB in the Farm A. These results show higher noise pollution in the tandem milking parlour than in the Farm B. The max. level was 96.10 dB at 500 Hz in the Farm B.

The sound pressure level in the milking equipment when the milking was off can be seen in Fig. 2b. *LZF*ekv was at different levels in the farms. It is caused by the fact that the AMS is in the housing space where animals are all the time. An increased noise level is related to their biological sound expression. The equivalent sound pressure level was at 55.20 dB in the Farm B. In the Farm A, the equivalent noise level was only 49.50 dB because the animals were not present in the milking parlour when the parlour was off. *LZF*ekv at 8 kHz is 39.20 dB in the Farm B and only 20.00 dB in the Farm A. The max. noise levels at 8 kHz reached 56.4 dB in the Farm B and 42.00 dB in the Farm A.

Fig. 3a illustrates the sound pressure levels in the collection room during milking. Equivalent sound level *LZF*ekv is at approximately the same level in both farms (65 dB and 66 dB). *LZF*ekv at 8 kHz reached 51.20 dB in the Farm B and 50.30 dB in the Farm A. The max. noise levels at 8 kHz reached 71.90 dB in the Farm B and 74.50 dB in the Farm A, which shows higher noise pollution in the tandem milking parlour than in the Farm B. The highest max. sound level was 74.80 dB at 500 Hz in the Farm A.

Fig. 3b shows the sound levels in the collection room when the milking parlour was off. Equivalent sound level *LZF*ekv was at different levels in both farms. It was caused by the fact that in the Farm B, both the milking equipment and waiting area are in the same building where animals are housed. *LZF*ekv in the Farm B was 55.50 dB. An increased noise level is related to the biological sound expression of dairy cows. In the Farm A the animals are

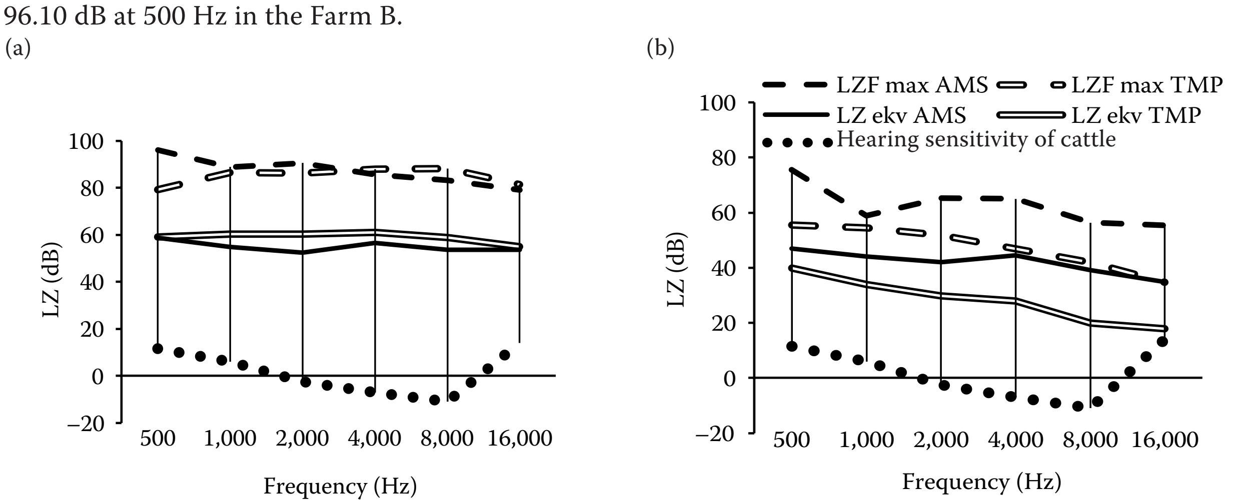

Fig. 2. Audiogram of noise exposure in milking parlour when milking parlour is on (a) and off (b)

LZ – Z-weighted (no frequency weighting) sound level; LZF – *Z*-weighted sound level, fast time weighted; AMS – automatic milking systems; TMP – tandem milking parlour

doi: 10.17221/4/2015-RAE

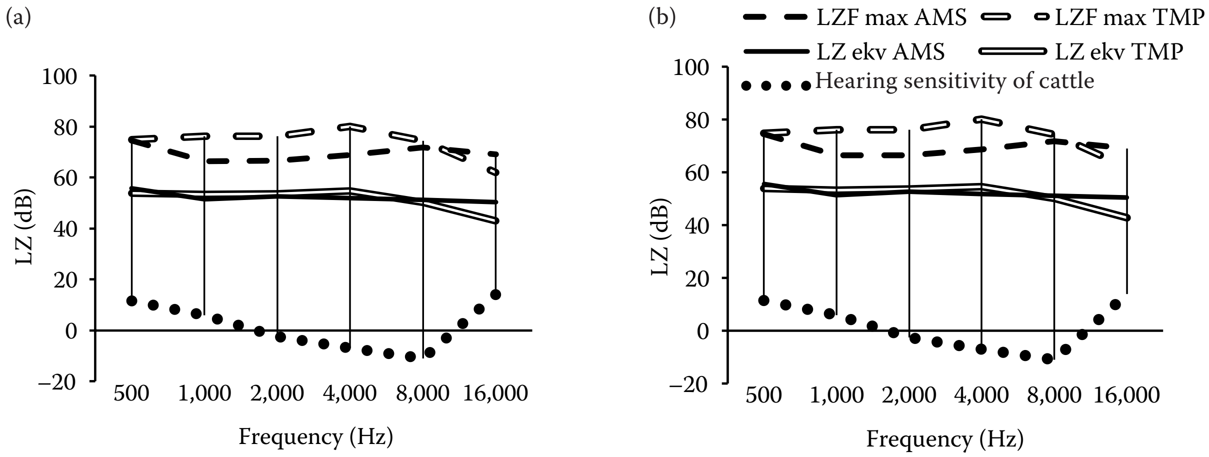

Fig. 3. Audiogram of noise exposure in waiting area when milking parlour is on (a) and off (b)
LZ – Z-weighted (no frequency weighting) sound level; LZF – Z-weighted sound level, fast time weighted; AMS – automatic milking systems; TMP – tandem milking parlour

located in a separated area of the collection room only while waiting to be milked by the operator, equivalent level *LZF*ekv was thus 51.10 dB. *LZF*ekv at 8 kHz was 38.80 dB in the Farm B and 22.60 dB in the Farm A. The max. noise levels at 8 kHz were 51.20 dB in the Farm B and 50.30 dB in the Farm A.

Fig. 4a illustrates the sound pressure levels in the stable during milking. Equivalent level *LZF*ekv is at a slightly different level in both farms. In the Farm B, *LZF*ekv was 59.53 dB, and in the Farm A, the animals were exposed to noise 57.30 dB in the stabling area. *LZF*ekv at 8 kHz was 41.50 dB in the Farm B and 36.10 dB in the Farm A. Higher values of noise in the Farm B were caused by the fact that the milking equipment was a part of the housing area. The max. noise levels at 8 kHz reached 65.50 dB in the Farm B and 64.00 dB in the Farm A. The max. level 80.20 dB was measured at 500 Hz in the Farm B.

Fig. 7 shows the sound pressure level in the stable when the milking equipment was off. Equivalent sound pressure level *LZF*ekv was at the same level in both farms. It was caused by the fact that dairy cows in stables are usually exposed only to normal biological noise coming from their natural vocalization. The cattle were exposed almost constantly to the noise of about 55 dB. *LZF*ekv at 8 kHz was 34.20 dB in the Farm B and 33.90 dB in the Farm A. The increased level of the max. noise was related to their biological sound expression.

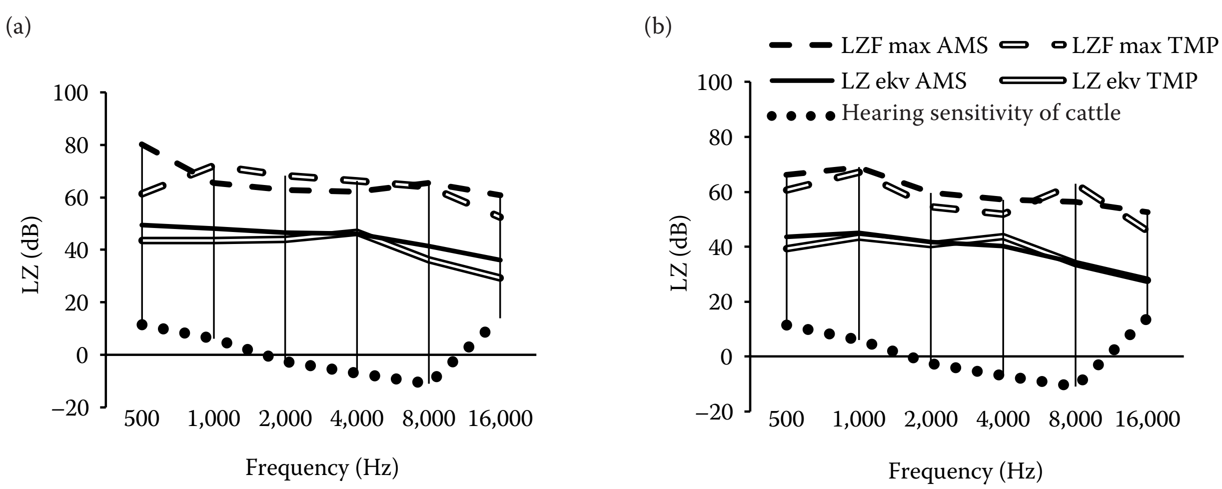

Fig. 4. Audiogram of noise exposure in stall during milking when milking parlour is on (a) and off (b)
LZ – Z-weighted (no frequency weighting) sound level; LZF – Z-weighted sound level, fast time weighted; AMS – automatic milking systems; TMP – tandem milking parlour

doi: 10.17221/4/2015-RAE

The max. noise levels at 8 kHz were 56.30 dB in the Farm B and 63.00 dB in the Farm A.

According to Phillips (2009), the inconvenience threshold for cattle is in the range from 90 dB to 100 dB, with a physical damage of the hearing apparatus at 110 dB. During our experiment, the noise level for cattle inconvenience was detected in two cases in the Farm B, both in the milking equipment during milking (*LZF*max 96.1 dB at the frequency of 500 Hz and *LZF*max 90.6 dB at the frequency of 2,000 Hz). During the experiment, there was no noise that causes physical damage to the hearing apparatus of cattle. The limits of noise causing response in the behaviour of animals are in the range from 85 dB to 90 dB (Manci et al. 1988). Noise greater than these limits evoked retreat, freezing, or strong startle response (Morgan, Tromborg 2007). Values in this range were recorded in the parlours of both farms during milking. In the Farm B, *LZF*max was as follows: 96.10 dB at the frequency 500 Hz, 88.80 dB at 1,000 Hz, 90.60 dB at 2,000 Hz, and 85.60 dB at 4,000 Hz. In the Farm A, *LZF*max was as follows: 86.60 dB at the frequency 1,000 Hz, 86.30 dB at 2,000 Hz, 88.00 dB at 4,000 Hz, and 88.30 dB at 8,000 Hz.

CONCLUSION

Our experiment focused on assessing the noise exposure levels in two farms for dairy cows, with different technological layouts of the milking system.

– The measured values were compared, focusing on the sound pressure level at 8 kHz, the frequency at which the hearing of cows is the most sensitive.
– The noise levels that are crossing the limits causing behavioural response in cattle were found in both farms in the milking equipment during milking.
– The noise levels that are exceeding the noise threshold causing discomfort in cattle were found in the automatic milking system during milking. This noise also causes a response in the form of retreat, freezing or strong startle response. Given the sensitivity of the hearing apparatus of cattle at 8 kHz, the limit of 85 dB was exceeded in the tandem milking parlour during milking. Exceeding this limit induces the behavioural response of dairy cows.

References

Brouček J. (2014): Effects of noise on performance, stress, and behavior of animals: a review. Slovak Journal of Animal Science, 47: 151–160.

Castelhano-Carlos M.J., Baumans V. (2009): The impact of light, noise, cage cleaning and in-house transport on welfare and stress of laboratory rats. Laboratory Animals, 43: 311–327.

Heffner H.E. (1998): Auditory awareness. Applied Animal Behavior Science, 57: 259–268.

Heffner H.E., Heffner R.S. (1993): Auditory perception. In: Phillips C.J.C., Piggins D. (eds): Farm Animals and the Environment. CAB International, Wallingford: 159–184.

Heffner R.S., Heffner H.E. (1983): Hearing in Large Mammals: Horses (*Equus caballus*) and Cattle (*Bos taurus*). Behavioral Neuroscience, 97: 299–309.

Manci K.M., Gladwin D.N., Villella R., Cavendish M.G. (1988): Effects of Aircraft Noise and Sonic Booms on Domestic Animals and Wildlife: A Literature Synthesis. U.S. Fish and Wildlife Service National Ecology Research Center, Ft. Collins, NERC-88/29: 88.

Mihina S., Kazimirova V., Copland T.A. (2012): Technology for farm animal husbandry. Nitra, Slovak Agricultural University: 99.

Morgan K.N., Tromborg C.T. (2007): Sources of stress in captivity. Applied Animal Behaviour Science, 102: 262–302.

Phillips C.J.C. (2009): Housing, handling and the environment for cattle. Principles of cattle production: 95–128.

Voipio H.M. (1997): How do rats react to sounds? Scandinavian Journal of Laboratory Animal Science, 24: 1–80.

Žitňák M., Lendelová J., Bureš Ľ. (2011): Working environment of dairymen in summer time. In: Rural Buildings in European Regions, Architecture – Constructions – Technology – Safety. Nitra: 165–172.

Received for publication January 16, 2015
Accepted after corrections October 10, 2015

Corresponding author:

Ing. Martin Pšenka, Slovak University of Agriculture in Nitra, Faculty of Engineering, Department of Production Engineering, Tr. A. Hlinku 2, 949 76 Nitra, Slovak Republic; e-mail: psenka.martin@gmail.com