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Respecting EU cross-compliance requirements as an indicator of animal welfare on dairy farms in Poland

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Abstract: *Respecting EU cross-compliance requirements as an indicator of animal welfare on dairy farms in Poland.* The aim of the study was to determine the level of animal welfare on dairy farms in Poland and to compare the measured parameters with the cross-compliance requirements. The study was conducted on 46 farms in the winter season. The microclimate measurements such as air moisture content, concentrations of selected air pollutants and the brightness of the room has been taken. A comparison of cattle housing systems on bedding and on the slatted floor has been examined. The barns were divided into four groups, depending on the size of the herd: 10–20 cows (12 barns), 21–40 cows (22 barns), 41–60 cows (7 barns), and 100–180 cows (5 barns), respectively. The largest group consisted of haerds housing 21–40 cows, which represented 48% of all herds involved in the study. Of all the barns that used slatted floors or bedding, we selected three largest herds each in order to compare hygienic parameters between both types of housing. The main findings were as follows: (1) the concentration of selected air pollutants in most of the barns did not deviate from the recommendations of the (Polish) National Research Institute of Animal Production; (2) the concentration of selected air pollutants was lower in barns where the cattle was kept on slatted floors; (3) the cattle housed on slatted floors also had better lighting conditions; (4) smaller herds of dairy cows were found to have relative air humidity conditions; (5) in 81% of farms, air humidity in the premises remained within the animal welfare standards.

Key words: dairy cows, housing, environment, microclimate, EU requirements

INTRODUCTION

Thanks to the Common Agricultural Policy of the European Union, farmers are able to produce food at prices affordable to consumers in exchange for direct payments that support the viability of production (ARiMR 2012). This direct aid is paid subject to the condition that the farm owners to all the standards within the scope of rules called cross-compliance (ARiMR 2012, Nowak 2013). Animal welfare standards have been in force since 1 January 2013 (Pośniak-Sobczyńska 2011). Farmers who keep animals must ensure that the humidity and concentration of selected target gases in the housing facilities are below acceptable levels and that lighting is appropriate. Regulated parameters are stocking density of animals, proper size of the stalls and their appropriate technical standards, sufficient manure removal, adequate care provided to animals and appropriate placement of technological equipment used in the production process (Sundrum et al. 1994, Bartussek 2000, Veissier et al. 2008, Bartussek et

al. 2011). Failure to comply with cross-compliance requirements will result in reduction or even withdrawal of direct EU payments (Kuczaj 2010, Pośniak-Sobczyńska 2011, Nowak 2013).

The cross-compliance are supervised by the Agency for Restructuring and Modernisation of Agriculture and the Veterinary Inspection. Checks by the Veterinary Inspection include the quality of animal welfare (ARiMR 2012). In the case of dairy cows, cross-compliance requirements do not specify the size of the stalls (Kuczaj 2010). These are dealt with by the Regulation of the Minister of Agriculture and Rural Development No 56, item 344 from 2010 although not all of the provisions contained in the Regulation are cross-compliance requirements (ARiMR 2012).

Dairy cattle housing premises should be equipped with fixed or portable lighting. The construction and arrangement of the stalls should eliminate the risk of injuries for the animals and should be made of materials facilitating their cleaning and disinfection. Sick or injured animals should be adequately taken care of and separated from the herd. They should be managed on straw bedding. The cattle must have freedom of movement. The farmer is obliged to ensure optimum microclimate conditions inside the livestock facilities (Averós et al. 2013), involving the control of particulate matter in the air, humidity, temperature, and concentration of selected gases (www.mrirw.gov.pl, Wyrębski and Reklewski 2000). The microclimate in the barn can be conditioned by means of ventilation systems and air humidification or dehumidification equipment. Animals themselves emit heat, moisture and gases, which has a major impact on the climate in the barn (Radoń 2005, Kołacz and Dobrzański 2006, Kośla 2011).

A dairy cow cubicle must fit to the size of the animal and to the type of tether. The breed of the cow must also be taken into account (Lenard 1993). The material used for the cubicle construction must be safe for the animals, without sharp edges that could cause injury. Cubicle separations should not be too long so as not to interfere with the passageway. It is recommended that they be approx. 30 cm shorter than the resting place of the cow. The curb between the alley and the stall should be 20–25 cm high. The cow is then unable to enter backwards into the stall, or to lie with her hind legs on the passageway (Romaniuk et al. 2004, Litwińczuk and Szulc 2005). Cubicles are mainly made of steel pipes. An important element is the neck rail, which should be installed at a height allowing cows to lie down and get up without risk of injuries. In the USA and Italy, the neck rail is installed at a height of 140 cm. In France, an adjustable neck rail has been designed, which allows changing in the range of from 125 to 130 cm, depending on the height at the withers (Dagorn 2008).

According to Czerniawska-Piątkowska et al. (2008), cows housed in free-stall system barns attain higher yields and produce better milk quality in terms of fat and protein, as compared with cows managed in the tie-stall system. Free-stall barn cows also demonstrate higher fertility. Moreover, Kaczor and Paschma (2008) and Kaczor et al. (2013) report that free-stall housing of heifers and cows promotes better cleanliness of animals, as compared with stanchion or tie-stall barns.

The aim of the study was to determine the level of animal welfare in dairy farms and to compare the measured parameters with the cross-compliance requirements. Specifically, parameters such as carbon dioxide, ammonia, hydrogen sulfide, relative humidity and light intensity we measured and compared.

MATERIAL AND METHODS

The herds

The data were collected in 46 barns divided into 4 groups, depending on the size of the herd: 10–20 cows (12 barns), 21–40 cows (22 barns), 41–60 cows (7 barns), 100–180 cows (5 barns). Due to the lack of barns housing between 60 and 100 cows, no such group has been created. The largest group consisted of herds housing 21–40 cows, which represented 48% of all herds involved in the study.

Survey methods

The survey was carried out during the winter of 2012–2013, in dairy cattle farms located in the Tomaszów Mazowiecki County, Łódź Voivodship, Poland. All measurements were performed between 9:30 and 15:00. In all the evaluated barns, we carried out a single measurement of the concentration of selected gases: carbon dioxide (CO_2), ammonia (NH_3) and hydrogen sulfide (H_2S). The measurements were done using the Gas Hunter IR (Alter, Poland), which allows simultaneous measuring of three gases (ppm). Relative humidity (%) was measured using a DT-8820 multifunctional environment measuring instrument. Light intensity (lx) was measured at a cow head height. Information on the floor type was also collected, whether cows were accommodated on slatted floor or bedding. The parameters were compared in relation to the floor type (slatted floor – bedding). The results were processed using the Statistica 12.0™ software (StatSoft, Inc., Kraków, Poland) package and the differences were compared by a non-parametric test.

RESULTS AND DISCUSSION

Concentration of selected gases

According to the Information Bulletins of the National Research Institute of Animal Production (Karta informacyjna IZ 10101), also other literature confirm these data (Kośla 2011, Majchrzak and Mazur 2012, Kaczor et al. 2013, Nowak 2013), the concentration of selected gases in the premises for cattle should not exceed the following levels: CO_2 0.3% (3,000 ppm), NH_3 0.0026% (26 ppm), and H_2S 0.001% (10 ppm).

Cross-compliance requirements for adult cattle do not specify acceptable concentration levels of gases; instead, one can learn that the animals must be kept in conditions that are not "harmful" (Journal of Laws 2010 No 116, item 778, with amendments).

Our study has shown (Table 1 and Fig. 1) that the average concentration of CO_2 inside the barns was 2,269 ppm, ranging from 730 to 4,500 ppm. Figure 1 shows the means of the values measured in four groups of barns (with standard deviations). The lowest CO_2 levels were measured in barns housing 100–180 cows.

The concentration of CO_2 should not exceed 3,000 ppm (Karta informacyjna

TABLE 1. The concentration of selected gases in the cowshed (ppm)

Gas	Group	Mean	*N*	*SD*	Min	Max	Q25	Median	Q75
CO_2	1	2 570a	10	1 044	1 500	4 500	1 600	2 400	3 100
	2	2 240	21	865	730	4 000	1 500	2 000	2 800
	3	2 486	7	778	1 500	3 500	1 500	2 800	3 100
	4	1 490b	5	911	700	3 000	850	1 400	1 500
	all	2 269	43	926	700	4 500	1 500	2 200	3 000
NH_3	1	7.30a	10	5.46	3.00	17.00	3.00	5.00	11.00
	2	5.43	21	4.55	3.00	20.00	3.00	4.00	5.00
	3	3.00b	7	1.63	0.00	5.00	2.00	3.00	4.00
	4	1.80b	5	1.64	0.00	3.00	0.00	3.00	3.00
	all	5.05	43	4.48	0.00	20.00	3.00	3.00	5.00
H_2S	1	0.19	10	0.27	0.00	0.70	0.00	0.05	0.50
	2	0.27	21	0.65	0.00	3.00	0.00	0.00	0.30
	3	0.20	7	0.20	0.00	0.50	0.00	0.30	0.30
	4	0.02	5	0.05	0.00	0.10	0.00	0.00	0.00
	all	0.21	43	0.48	0.00	3.00	0.00	0.00	0.30

1 – herd 10–20 cows, 2 – herd 21–40 cows, 3 – herd 41–60 cows, 4 – herd 100–180 cows.

N = cowshed, ab – the differences statistically significant $P \leq 0.05$.

IZ 10101, Kośla 2011, Nowak 2013) our survey shows, however, that the CO_2 concentration exceeds the recommended standards in 22% of herds. Mazur (2011), who conducted a spring survey in 10 multi-stall barns, observed that CO_2 concentration in most rooms exceeded 1,000 ppm. The measured values remained in the range of from 500 to 2,960 ppm, which conforms with the standards of the National Research Institute of Animal Production (Karta informacyjna IZ 10101). However, according to other studies (Mazur 2012) conducted in six free-stall housing systems with natural air ventilation through ridge exhaust, CO_2 concentration in winter ranged from 677 to 1,428 ppm. Majchrzak and Mazur (2012) on seven tested beef cattle barns investigated average concentration of the carbon dioxide did not exceed 1,000 ppm.

The mean concentration of NH_3 (Table 1) in the barns was 5.05 ppm, ranging from 0 to 20 ppm. With reference data indicate, that this concentration should not exceed 26 ppm (Karta Informacyjna IZ 10101, Kośla 2011, Nowak 2013). Figure 2 shows that mean air NH_3 concentration (and standard deviation) in large herds is much lower compared to small barns. The worst CO_2 and NH_3 concentration levels were found in barns with usable attic, those equipped with mechanical fans and natural draft chimney vents. According to the studies by Mazur (2012), conducted in six free-stall barns with natural air ventilation

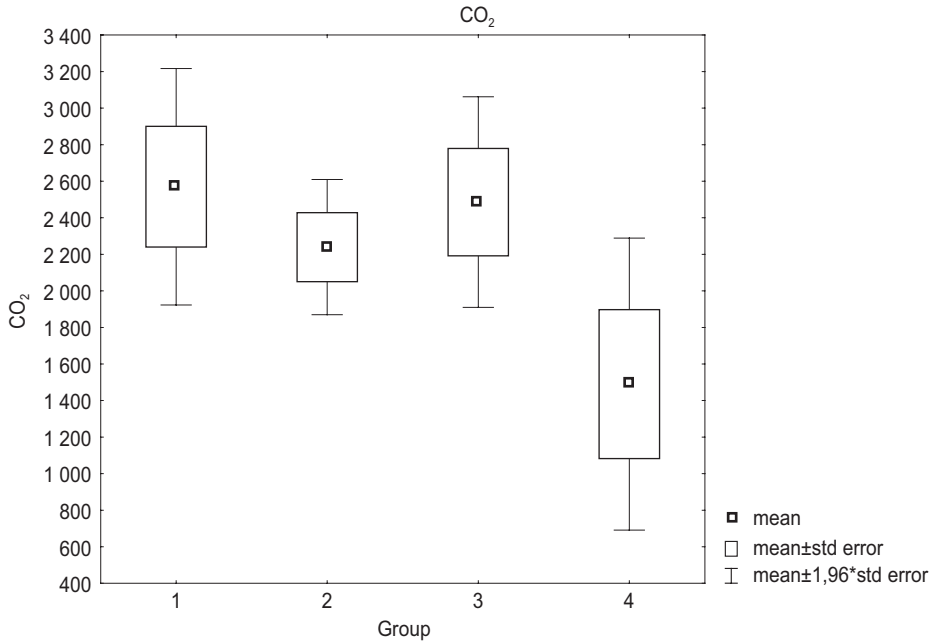

FIGURE 1. Mean carbon dioxide concentration in barns (ppm). Herd as in Tables 1 and 2

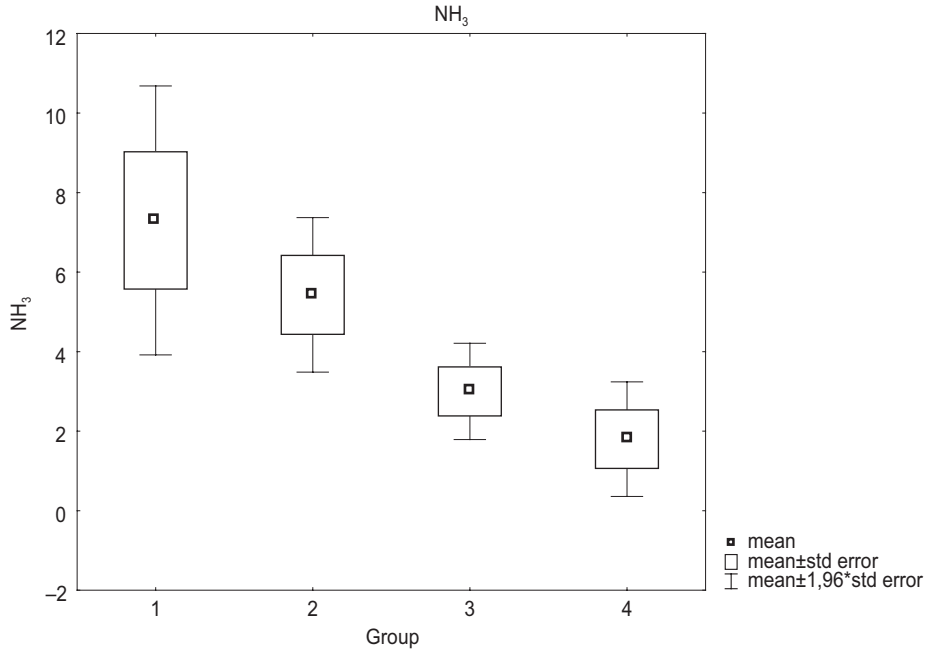

FIGURE 2. Ammonia concentration in barns (ppm). Herd as in Tables 1 and 2

through ridge exhaust, NH_3 concentration remained in the range from 7.8 to 13.2 ppm. In the results of Majchrzak and Mazur (2012) on seven tested beef cattle barns determined the average ammonia concentration from 1.08 to 4.02 ppm.

In our study, the mean concentration of H_2S in the barns was 0.21 ppm (Table 1 and Fig. 3). Figure 3 shows that the concentration of this gas in barns housing 100 cows or more is much lower, as compared with smaller herds. The National Research Institute of Animal Production (Karta informacyjna IZ 10101) recommends that the concentration of H_2S should not exceed 10 ppm; more recent studies suggest 5 ppm, though (Kośla 2011, Nowak 2013). The highest concentration observed in the surveyed barns was 3 ppm.

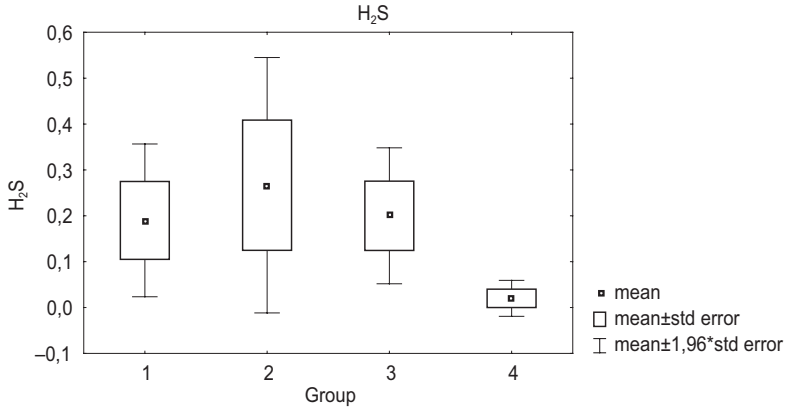

FIGURE 3. Hydrogen sulfide concentration in barns (ppm). Herd as in Tables 1 and 2

Illumination

Information Cards of the National Research Institute of Animal Production (Karta Informacyjna IZ 10101) recommend that light intensity in cow premises be at least 15–30 lx. The exception is the milking parlor, where light intensity should not be lower than 30–40 lx. A lack of good illumination, be it natural or artificial, adversely affects reproduction of cows. Cows kept in such conditions demonstrate poor heat symptoms, which results in longer calving intervals (Kołacz and Dobrzański 2006).

Regulation of Minister of Agriculture and Rural Development (Journal of Laws No 116, item 778 from 2010) recommends farmers to ensure that animals have adequate access to natural or artificial light. In our study, the intensity of light in the premises for dairy cows ranged from 16 to 400 lx. The measurements were performed at daylight, between 9:00 and 14:00. Given the averaged results shown in the Table 2 and diagram in Figure 4, considerable differences in lighting can be seen by individual barns. Large barns (100–180 cows) had better illumination parameters compared to other barns. In the literature (Majchrzak and Mazur 2012) it reported illumination over 30 lx which was in line with animal welfare requirements.

TABLE 2. Relative air humidity and illumination in the cowshed

Item	Group	Mean	*N*	*SD*	Min	Max	Q25	Median	Q75
Humidity (%)	1	68.75a	12	10.89	52.00	85.00	60.00	71.00	77.50
	2	78.05b	22	10.35	60.00	95.00	70.00	78.00	85.00
	3	72.29	7	12.85	55.00	96.00	65,.00	70.00	80.00
	4	71.00	5	7.42	60.00	80.00	70.00	70.00	75.00
	all	73.98	46	11.07	52.00	96.00	70.00	73.50	80.00
Illumination (lx)	1	81.92B	12	51.58	20.00	200.00	50.00	60.00	100.00
	2	88.19B	22	59.53	16.00	200.00	50.00	60.00	150.00
	3	87.71B	7	79.09	16.00	200.00	18.00	60.00	200.00
	4	280.00A	5	83.66	200.00	400.00	200.00	300.00	300.00
	sll	107.33	46	86.51	16.00	400.00	50.00	60.00	150.00

1 – herd 10–20 cows, 2 – herd 21–40 cows, 3 – herd 41–60 cows, 4 – herd 100–180 cows.

N = cowshed, ab – the differences statistically significant $P \leq 0.05$, AB – the differences statistically significant $P \leq 0.01$.

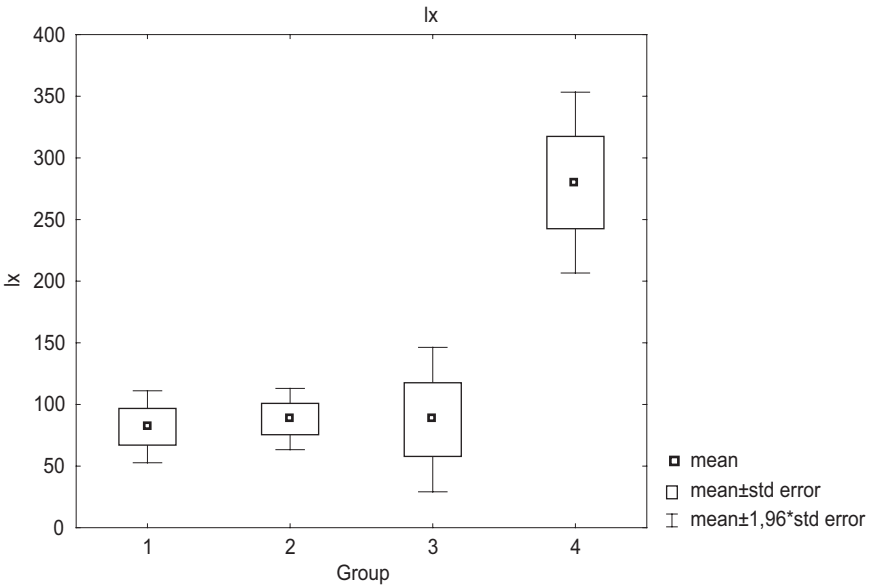

FIGURE 4. Illumination in barns (lx). Herd as in Tables 1 and 2

Sunlight is the best type of lighting for animals. This light kills bacteria and has a beneficial effect on productivity and wellbeing of animals. Solar radiation involves ultraviolet, which enhances the production of vitamin D_3, essential for proper development of young animals. It is advisable that the ratio of window area to floor area be 1 : 12–16 (Kośla 2011).

In the close proximity of windows, there should be no trees, silos or other buildings. The windows are usually installed above the level of the animals. It is recommended that they are placed as high as possible. Also, it must be ensured that door frames, window frames, roof eaves, or thick walls do not limit the flux of incoming light. Artificial lighting in cattle premises is complementary to natural light. With artificial lighting, adequate light intensity must be ensured. The lamps should be distributed so as to provide an equal level of visibility throughout the barn (Kołacz and Dobrzański 2006). Artificial lighting is particularly useful in winter, as the extension of daylight, which has a positive effect on the productivity of dairy cows. It is also recommended to use lighting at night so that the animals may retain orientation in space (Romaniuk et al. 2004).

Air humidity

According to the Regulation by the Minister of Agriculture and Rural Development 116, item 778 from 2010, cattle should be housed in air humidity that is safe for animals. According to Information Bulletins of the National Research Institute of Animal Production (Karta informacyjna IZ 10101), the optimum air humidity levels in dairy cow barns should remain within the range of 60–80%. Air humidity in a barn, depends on the ventilation system and the air exchange in the building, wall thermal insulation, ambient temperature ad relative humidity, the number and size of animals, manure removal system, the substrate on which the cows are kept, and the water content in the feed (Kuczaj 2010). Exhaled air and sweat of the cows are the main source of humidity, producing up to 75% of the total humidity of the premises (Kołacz and Dobrzański 2006, Kośla 2011). In some livestock buildings, humidity is so high, that vapor in the air condenses on the ceiling and the walls. The main reason for this is the lack of wall insulation (Litwińczuk and Szulc 2005). High air humidity, especially in combination with low temperatures, has a negative

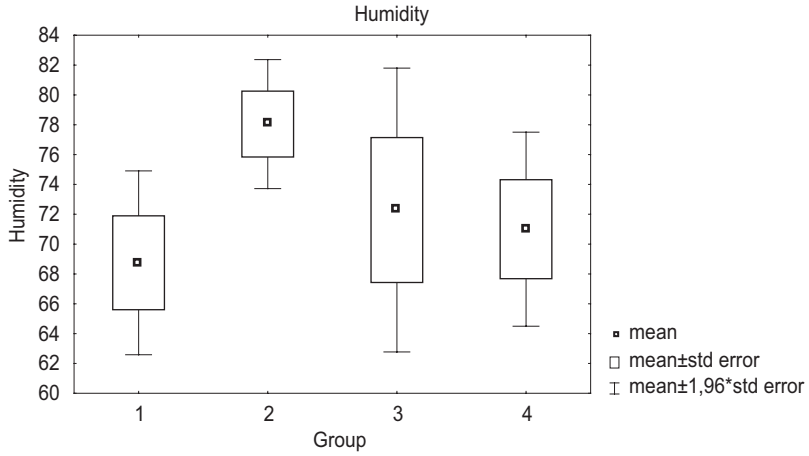

FIGURE 5. Relative air humidity (%) in barns. Herd as in Tables 1 and 2

impact on the animals (Kośla 2011). Under such conditions, animals show lower feed intake, a decrease in milk yields, and have problems with breathing. In winter, this can lead to colds, pneumonia, as well as muscular and articular rheumatism. High humidity in combination with high temperatures, on the other hand, can cause problems with body thermoregulation. This may result again in reduced yields, digestive tract disorders and apathy (Litwińczuk and Szulc 2005). In our study, air humidity in the barns ranged from 52 to 96%. As can be seen in Table 2 and Figure 4, 28% of barns failed to meet the standards. Relative air humidity in the study by Mazur (2011), carried out on 10 multi-stall barns, remained in the range from 32.2 to 99.9%. The high values indicated poorly functioning ventilation. Majchrzak and Mazur (2012) on seven tested beef cattle barns determined relative humidity of air oscillated between 56.13 and 76%, but in the two of them exceeded optimum value (70%). Kaczor et al. (2013) they found in barns open relative humidity from 60.3 to 85.9%, with average 76.5%, which results in the investigated barns in own research regardless of their size were similar (Table 2). While Daniel (2008) during the summer said relative humidity in barns for dairy cows during the afternoon hours in the field, which is below the recommended standards (Karta informacyjna IZ 10101, Kośla 2011, Nowak 2013).

Comparing hygienic parameters in barns with bedding versus barns with slatted floor

Of all the barns that used slatted floors or bedding, we selected three largest herds each in order to compare hygienic parameters between both types of housing. In barns with straw bedding, CO_2 concentration was much higher than in barns with slatted floors (Table 3). According to Kołacz and Dobrzański (2006), CO_2 levels in slatted-floor barns is lower in the part occupied by the cows compared to the upper space inside the barn. Although CO_2 is heavier than air, the warm air exhaled by animals lifts it up.

Ammonia concentration was low in both housing systems. The concentration of this gas to a large extent depends on the hygiene in the barn (Table 3). Barns with slatted floors, where manure sinks to the gutter under the floor, the air concentration of NH_3 was low (Kołacz and Dobrzański 2006).

TABLE 3. Measured concentrations of gases in selected barns with bedding and slatted floors

Herd size	Type of barn	CO_2 concentration (ppm)	NH_3 concentration (ppm)	H_2S concentration (ppm)
100 cows	bedding	3 000	3	0.1
100 cows	bedding	1 400	3	0
56 cows	bedding	3 100	0	0
150 cows	slatted floor	850	0	0
180 cows	slatted floor	700	3	0
110 cows	slatted floor	1 500	0	0

No H_2S has been detected in any of the three studied slatted-floor barns (Table 3). This may have resulted from a well designed gutter system in the building. Slurry tanks must be tight so that gases are not able to drift back through the gutter into the barn (Kołacz and Dobrzański 2006).

Measurements show that the slatted-floor barns had a lower humidity indicator. In both types of barns, however, humidity was maintained within the relevant standards (Table 4). The results of humidity measurements conducted in winter in two multiple-stall barns equipped with side curtains was 66–85% (Daniel 2008). Similar results in humidity studies were reported by Kaczor and Paschma (2008). Relative humidity was measured in a heifer shed in the barn and remained in the range of 60–85%.

According to the Regulation of the Minister of Agriculture and Rural Development 166, item 778 from 2010, cows should be provided with natural or artificial light. Our study (Table 4) shows that the light intensity in bedded barns was 60–200 lx, whereas in the barns with slatted floors 300–400 lx. Slatted-floor barns included in the study were equipped with side curtains and ridge skylights that let in much light. In the case of bedded floor barns, often old or adapted from other buildings, the intensity of the entering light was much lower.

TABLE 4. Results of humidity and illumination measurements in selected barns with bedding and slatted floors

Herd size	Type of barn	Humidity (%)	Illumination (lx)
100 cows	bedding	80	200
100 cows	bedding	70	200
56 cows	bedding	70	60
150 cows	slatted floor	75	300
180 cows	slatted floor	70	300
110 cows	slatted floor	60	400

CONCLUSION

The 46-barn survey enabled evaluation of the welfare of dairy cows in Poland. The main findings were as follows:

1. The concentration of selected gases in most of the barns did not deviate from the recommendations of the National Research Institute of Animal Production.
2. The cattle housed on slatted floors also had better lighting conditions.
3. Smaller herds of dairy cows were found to have poorer air humidity conditions.
4. In 81% of farms, air humidity in the premises remained within the animal welfare standards.

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Rozporządzenie Ministra Rolnictwa i Rozwoju Wsi w sprawie wymagań i sposobu postępowania przy utrzymaniu gatunków zwierząt gospodarskich, dla których normy ochrony zostały określone w przepisach UE (Journal of Laws 2010 No 56, item 344).

Rozporządzenie Ministra Rolnictwa i Rozwoju Wsi w sprawie minimalnych warunków utrzymania gatunków zwierząt gospodarskich innych niż te, dla których normy ochrony zostały określone w przepisach UE (Journal of Laws 2010 No 116, item 778).

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Streszczenie: *Respektowanie unijnych wymogów wzajemnej zgodności jako wskaźnik dobrostanu zwierząt w gospodarstwach krów mlecznych w Polsce.* Celem pracy było określenie poziomu wskaźników dobrostanu zwierząt i porównanie ich w wymogami wzajemnej zgodności w gospodarstwach utrzymujących krowy mleczne. Badania zostały przeprowadzone w 46 gospodarstwach w okresie zimowym. Przeprowadzono pomiary mikroklimatyczne: wilgotności, stężenia wybranych gazów, oświetlenia. Porównano systemy utrzymania bydła na ściółce i na ruszcie. Obory podzielono na cztery grupy w zależności od liczebności stada krów: 10–20 sztuk (12 obór), 21–40 sztuk (22 obory), 41–60 sztuk (7 obór), 100–180 sztuk (5 obór). Największą grupę tworzą stada liczące 21–40 sztuk krów. Stanowią one 48% wszystkich stad uwzględnionych w badaniach. Spośród wszystkich obór rusztowych i ściółkowych wybrano po trzy stada o największej liczebności w celu porównania parametrów zoohigienicznych w obu typach obór. Badania pozwoliły na ocenę warunków utrzymania krów mlecznych. Stwierdzono co następuje: (1) stężenia gazów szkodliwych w większości obór mieszczą się w normach Instytutu Zootechniki; (2) krowy utrzymywane w oborach na ruszcie mają lepsze warunki oświetleniowe; (3) w stadach o mniejszej liczebności krów stwierdzono gorsze warunki wilgotnościowe; (4) w 81% gospodarstw wilgotność w pomieszczeniach jest utrzymana w normach zootechnicznych.

Słowa kluczowe: krowy mleczne, obory, środowisko, mikroklimat, wymogi UE

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