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SELECTED CATTLE HOOF DISEASES: CHARACTERISTICS, CONSEQUENCES, CONTROL AND PREVENTION

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Abstract

Limb diseases are the most common ones next to the mammary gland diseases (*mastitis*) and those connected to reproduction (*metritis, endometritis*). Appearing lameness significantly decrease welfare and have an impact on the culling of cows in herds and what is more important lower milk performance and decrease its composition as well as its technological usefulness in processing. Prevention is based on the timely hoof correction and hoof baths in the 10% copper sulfate water solution or 5% formalin. The assessment of the level of lameness, which is performed on a moving cow (locomotion scoring) with the use of a 5-point Zinpro (2014) scale, is essential to the fast diagnosis. Performing timely hoof correction, should be performed twice a year in case of the all year alcove keeping system. It is advised to prefer the free-standing housing system, which considerably enhances welfare of cows.

Introduction

Systematically appearing increase in dairy performance of cows, as well as selection-achieved increase in cow body weight, especially in Holstein-Friesian breed, favors the more common appearance of metabolic diseases including locomotion diseases (GOFF and HORST 1997, KÖNIG et al. 2005). Such problem concerns most herds in Poland and in the world. Limb construction defects, lameness and soft pastern occurrence concerns from 6% to 16% of dairy herds in our country, additionally including over-

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-gaped hoof (5–7%), limbs twisted inward (5–9%) and to limbs directed under the trunk or too wide ankles (about 1%) (KOŁACZ and BODAK 1999, WINNICKI et al. 2006).

Frequency of various types of hoof diseases is different (Table 1). Lameness caused by the plantar ulcer, double sole, digital skin inflammation and the inflammation of the skin of the interdigital area most often occur in cows kept in the indoor system, without the access to pasture. In cows kept in the mix inn-outdoor system, which use pasture in the summer season the most often diseases are: toe ulcer, white line disease, hoof wall traumas, interdigital growth (limax), bruised soles and overgrown claws (GREEN et al. 2014). In 8/10 cases lameness is caused by toe diseases (HERNANDEZ-MENDO et al. 2007).

Table 1

Frequency of hoof diseases occurrence in dairy cattle based on different authors

Type of disease	Frequency of lameness occurrence [%]			
	WINKLER and MARGERISON (2012)	DE FRAIN et al. (2013)	NAVARRO et al. (2013)	GREEN et al. (2014)
Sole ulcer	17.14	21.05	6.84	38.68
Bruised sole	28.57	1.43	10.00	12.98
Digital dermatitis	22.86	47.67	3.68	10.00
White line disease	5.71	17.26	16.32	8.28
Interdigital growth	2.86	0.19	6.84	4.50
Overgrown claw	–	31.08	3.68	3.11
Toe ulcer	–	2.61	3.68	1.79
Double sole	–	–	6.84	7.42
Vertical sand cracks	–	0.33	8.42	–
Heel erosion	–	0.04	6.84	–
Other	22.86	8.34	26.86	13.24

Such diseases were observed on the 3rd place among the factors lowering milk producing breeding farm activity income, right after reproduction problems and mammary gland inflammations (*mastitis*) (GREEN et al. 2002) and reduce the healthy quality of cow's milk MICIŃSKI et al. 2012, MICIŃSKI et al. 2013). Appearing lameness significantly lower welfare and have an impact on the level of cow culling. The highest culling risk of cows appears at the beginning of lactation. Lameness, which appear during the first 30 days after calving may be connected to ovary cysts presence, which lower the calving probability (SOGSTAD et al. 2005).

In limping cows reproductive processes are elongated. Resting time i.e. time from calving to the 1st insemination attempt increases nearly

three times, whereas the service period i.e. time from the 1st insemination attempt to successful fertilization increases more than fifteen times. Such state results in an increase in insemination treatments per calving (HASKELL et al. 2006, HERNANDEZ-MENDO et al. 2007).

Lameness is considered a serious problem in high-performance dairy cattle hers. Their occurrence is matched to many factors, such as keeping system and nutrition, age, performance, condition. Lameness causes decrease of animal welfare, as well as economical losses caused by a decrease in performance and fertility of animals and by an increased cow culling (FLIS 2015).

For the breeder early (from the start of lactation) limping cow identification is essential. This way the spread of lameness in the herd is reduced allowing for hoof diseases treatment in their early stages.

The aim of this work was to present and characterize chosen hoof diseases, as well as to present their impact on performance and welfare of Holstein-Friesian cows.

The work is a review, where the scientific literature characterizing the most important limb diseases of cows was collected and main factors impacting the incidence of such diseases, as well as the decrease in morbidity level were presented.

Discussions

There is a very large diversity of limb diseases, mostly concerning hoof and the hoof gap, whereas in bedding-less cowsheds bruises as well. Those may be caused by differences in the ways of cow keeping, thus differentiated hoof exposure to environmental factors (SWALVE et al. 2005). The most common limb diseases are (BAGGOT and RUSSELL 1981, NOCEK 1997, BERGSTEN 1999, CRUZE et al. 2001, GREGORY 2004, VERMUNT and HILL 2004, SOGSTAD 2005, HOLZHAUER et al. 2006, ELLIOTT and ALT 2009, EVANS et al. 2009).

Horn rotting – mainly concerning heels. It occurs most often in cows kept in bad zoohygienic conditions i.e. standing in the so-called fecal manure. During the first period of a disease hoof correction and tar soaking may be enough. However, during the intensified stadium of disease it is essential to apply iodoform and copper sulfate dressing.

Whitlow – the disease of the hoof gap and its surroundings. It develops as a result of anaerobic bacteria activity, as well as due to inappropriate bedding, stony passes and pastures. Hard surface is a source of different types of hoof gap injuries. Treatment is based on antibiotics application at the place of injury, as well as iodoform and rivanol wraps.

Prevention means: disinfection, proper animal nutrition, obeying hoof correction schedule and keeping them clean, as well as hoof hardening.

Sprains and dislocations – these are painful and complicated diseases. Edema appears. They are hard to treat, often being untreatable.

Joints inflammation – develops during hits or sprains, as well as a result of injuries, when contamination from blood or surrounding tissues occurs. This disease is manifested by a painful and hot edema making animals lie most willingly, also decreasing their appetite and dairy performance.

Finger skin inflammation (*dermatitis digitalis*) – superficial skin inflammation at the border of the coronet edge of pads. Changes developing during the finger skin inflammation may transform into the papillary formations. The disease often appears in dairy cattle herds in Europe and South America. Favoring factors are not known. Only adult cattle get sick. Finger skin inflammation is a contagious disease. It is believed that spirochetes of the *Treponema* species are the infectious factor.

Fingerpad skin inflammation (*erosion ungulae*) – it appears as irregular cavities in the pad horn in the form of many dark holes (black color) or pockets with cavities. As time progresses, such cavities transform into oblique grooves. Such disease is widely distributed among the cattle kept in buildings during winter. Usually, symptoms disappear during the pasture period. Predispositions for the appearance of this disease are humid environment and long lasting contact with manure.

Interdigital fissure skin overgrowth (*hyperplasia interdigitalis*) – the disease is based on the expansion of the interdigital area skin of all limbs, most often posterior ones, with the tendency to keratosis and necrosis, as well as purulent inflammations. Disease etiology is complicated. One of the causes is a mechanical overload of the interdigital skin area and as a result it grows fast. Genetic factors have a major impact on occurrence of this disease, especially the low endurance for interdigital tendons stretching. The changes are located in the interdigital area in the form of growths and thickenings. The tumor is painless and hard. The disease develops into the disintegrating form manifesting itself as tumor rupture and wound contamination leading to inflammation.

Hoof box rupture – this disease is based on the mechanical damage to the hoof box. It is conditioned by the presence of obstacles on animal's way, which may lead to box injuries. The mechanical injury opens the way for pathogenic microorganisms to soft tissues of hoof and development of inflammation, thus leading to phlegmon and horn rotting.

Interdigital skin inflammation (*dermatitis interdigitalis*) – it is manifested through mild inflammatory changes in the interdigital skin, leading to moderate pain. Fissures in the pad's horn may lead to the

damage of dermis or later plantar ulcers. In such conditions the lameness may be of high degree or chronic. Such disease starts with the moment of wet, smelly skin inflammation in the interdigital area. Breeders often call this disease "smelly leg". The inflammation may expand to the heel horn of the adjacent hoof. The improper shaping of the horn area may lead to pressure on the cortex there with the evident pain or lameness.

Rusterholz ulcer – it concerns the softened hoof horn and leads to a change called the "plantar ulcer". It appears in animals of higher body weight, with faulty hoofs and improper posture. Changes in hoof called "plantar ulcers" need hoof correction with a proper cleaning, applying dressing with an antibiotic and then with iodoform. Prevention is based on a timely hoof correction and hoof bathing in formalin. Ulcers are mainly caused by a high body weight and injuries; they are very painful and usually lead to severe lameness. Rumen acidosis favors this disease. Plantar ulcer is manifested by an unwillingness to move, elongated standing phase ("kneeling" on wrists) and with both legs used – "sitting dog" posture. Sick cows avoid hard surfaces, moving better on the soft ones. Abduction relieving the outer hoof is visible and the movement may be mowing. Animals in the advanced state of the disease lose appetite. Treatment is based on the removal of the horn in places where the exudate had separated it from the laminar layer. Then the exposed dermis may be precisely cleaned. The role of the dressing under the band is to keep medicines for a longer time, put a pressure on the laminar layer, stop the bleeding and reduce overgrowth of the repair tissue. Treatment is supplemented by a proper hoof shape correction favoring the relocation of the point of support of limbs from the back to the front. It is recommended to use the relieving block (heel) in case of necrotic changes. Thanks to such a procedure the sick hoof is not used in supporting of the limb, thus it is not stimulated and it does not cause pain and is not getting dirty. The dressing should be changed in the 10-day intervals.

Exudate (*interdigital phlegma*) – it is an interdigital inflammation, thus inflammation above the interdigital skin and is connected to a hard swelling in the middle of the staple area, precisely above the interdigital area. Cow is evidently limping in this case. Fast treatment at the early stages makes the inflammation slowly disappear and not doing any persistent damage.

Laminitis – the aseptic inflammation of the laminar layer of the hoof wall; develops due to the damage of the capillaries caused by toxins and histamine, which are overproduced in severe indigestions (rumen acidosis), uterus and mammary gland inflammations and after complicated parturitions. Diffused inflammation of the hoof laminar layer is connected

to the permeation of the serous liquid from blood. The course of the process is subacute, acute or chronic. The disease attacks both posterior hoofs at the same time. Sick animals lie on the side with limbs stretched. Hoof cans are painful. Red discolorations are visible on the plantar side. Such animals are unwilling to stand up at all, taking improper postures, stretching front limbs, sometimes crossing them and consume the feed in the kneeling position. Their body temperature, heart rate and respiratory rates increase.

Most often the appearance of main limb diseases is caused by the improper cow keeping, thus it is connected to the technical equipment of farms, as well as cow keeping and nursing. It is also connected to feeding, posture of the back limbs or genetic factors (cattle breed for example). It is essential to avoid prolonged exposure of animals to wet surfaces, as well as to diagnose fast – the faster, the smoother the course.

Systematic control of hoof condition is an essential nursing element. It allows to detect posture faults, diseases and hoof deformation. Hoof nursing should be understood as taking care of proper environmental and hygienic conditions of barns and especially their state as well as material from which the ground for cattle stands is made (WEBB and CLARK 1981). Negligence of hoof nursing leads to lameness, bone and joints deformation. The most important part of nursing treatments is a timely hoof correction, which aims to reestablish physiological posture of a limb and hoof, deformed in the breeding conditions.

Decontamination and hoof hardening liquid baths are very helpful in the prevention of hoof diseases. A 10% aqueous solution of copper sulfate or 5% formalin is used for this purpose. Such prepared liquid is stored in special pools of smooth spades and shores to assure cows take a bath while moving through it. The deepness must be enough for cow to dip the hoof and the interdigital fissure. Proper feeding and animal maintenance is an equally essential prevention factor. Alternatively, spraying hoofs with disinfectant may be a good solution. Most often solutions based on copper compounds are used, however here environmental factors should be considered. Research concerning the effectiveness of aqueous copper sulfate solutions are still in progress. It has been stated that copper compounds have a significant impact on the treatment of skin processes. In some cases, depending on instructions, a proper solution of potassium permanganate is used. In cattle hoof nursing special self-adhesive bandages are used as well.

An assessment of lameness level in the herd of dairy cattle

The simplest form of on-farm lameness detection is visual locomotion scoring. For the assessment of the level of lameness in dairy cattle a 5-grade scale of locomotion review is commonly used. The assessment of a moving cow (locomotion scoring) provides basic information on the lameness level in each cow. The first people who introduced such locomotion assessment system were Americans, and then it was successfully introduced in other countries as well. It allows for a fast lameness diagnosis and use of proper treatment (ADAMS et al. 2016). Locomotion assessment is based on cow observation in the standing position, as well as in motion on the hard surface, focusing especially on the back line. The review is 5-grade, and according to Zinpro (2014) it consists of:

1^0 – normal posture. In the standing posture and while moving the back line is straight, legs and hoofs are properly aligned.

2^0 – light lameness. In the standing position the back line is straight, while moving it is slightly curved; a subclinical form of lameness.

3^0 – moderate lameness. The cow is standing and moving with the curved back, it makes short steps with one or few limbs; a subclinical form of lameness.

4^0 – lameness. The curved back in the standing position and while moving, cow is limping on one or more limbs, lameness is visible; a clinical form of hoof lameness.

5^0 – acute lameness. The back is strongly bent, the cow is unwilling to stand and load at least one of the limbs, it may have difficulties with standing up or it does not want to do it; a clinical form of lameness.

In order to keep the 1st level and avoid lameness in dairy cattle a proper hoof correction must be performed at least twice a year, while in case of cows in which the subclinical form of lameness has been diagnosed (2nd and 3rd degree) it is essential to perform an additional correction. The 4th degree is connected with the 17% decrease in milk performance, whereas the 5th degree – 36%. In cows with the 2nd degree or higher serious reproduction problems are diagnosed as well. The probability of culling of such cows increases 8.5 x as well. VAN NUFFEL et al. (2015) identified at least 25 different visual scoring systems for dairy cow lameness characteristics. They noted that although these methods are relatively easy to use and inexpensive to implement, the amount of time it takes to conduct scoring on an entire herd means they are not often executed.

Now, individual animal monitoring technologies have shown potential for lameness detection. Walk-over or stand-on load cells, pressure-sensitive position mats, vision techniques, accelerometers, and other already

available sensor data have all been evaluated for the possibility of automated lameness detection (VAN NUFFEL et al. 2015). Producers tend to underestimate the prevalence of lameness in their herds. They perceive lameness management to be more challenging to include in daily routines compared to other health issues, like mastitis, which can be managed in the parlor (LEACH et al. 2010). Instead, lame cows are often only identified after they become severely lame (MILL and WARD 1994), completely ignoring mildly lame cows that would benefit most from early detection.

In summary, a basic element of the hoof nursing in herds are periodic inspections of limbs. The aim of such inspections is to diagnose posture faults, as well as diseases or hoof deformations in order to perform correction.

The influence of chosen factors on lameness appearance in cows

Nutrition

In case of nutrition it is essential to focus attention on functioning of the rumen. High intake of concentrated feed (NFC fiber) with a simultaneous low volumetric feeds intake (NDF fiber) causes an increase in the pH level of rumen content, thus causing production of histamine and endotoxins, which get to capillaries in hoofs, destroy them and impair production of good quality horn tissue (BRAMLEY et al. 2008, LEAN et al. 2013). What is more, mineral i.e. S, Cu, Zn, Se, Mn and Co, as well as retinol and biotin deficiencies, so elements and vitamins taking part in keratin metabolism, decrease horn hardness. Such elements are components of antioxidative enzymes, which protect lipids in the horn tissue from free radicals. Their deficiency leads to an increase in concentration of sialic acid and malonic dialdehyde causing oxidative stress in the organism. Oxidative stress causes destruction of hoof`s capillaries, insufficiencies in oxygen and nutrients supply and as a consequence – development of low quality horn (AL-QUDAH and ISMAIL 2012, TOMLINSON et al. 2004, SEYREK et al. 2008).

Housing system

In the free standing cow keeping system a cow should spend half of the day on the bed. Interruption of that leads to limp overload and worsening of rumen digestion and blood circulation having a direct response in the decrease of milk yield. The main load of the body weight is on the back limbs (additionally loaded with the mammary gland) showed by a common appearance of hematomas on the lateral wall of the back hoofs. Standing

and moving takes the cow ⅕ of a day in average, so about 5 hours. It is important that the floor area, on which cows move or stand waiting for milking, is of a proper quality i.e. slightly roughened, non-slip and cushioning. It is important to take shape, hardness, abrasion and the ability to maintain hygiene into account (SOMERS et al. 2003). In proper conditions, when cows have an appropriate amount of motion, the balance between the horn proliferation and its abrasion appears (KOŁACZ and TRACZ 2008). The surface of the floor of high roughness leads to an excessive abrasion of hoofs, thus causing easily observable lameness. Increasing the number of cows in herds leads to building of bigger barns. In such barns cows move over higher distances in order to get to the milking hall. It also influences higher abrasion of the hoofs' horn (NAWROCKI et al. 2004).

Age

BIELFELDT et al. (2005) i HASKELL et al. (2006) during their lameness risk assessment in herds have shown that risk cofactors are higher in older cows, thus in IV, V and further lactations (Table 2).

Table 2

Cofactor of lameness appearance risk in dependence on age of cows (BIELFELDT et al. 2005, HASKELL et al. 2006)

Lactations	Risk cofactor	
	BIELFELDT et al. (2005)	HASKELL et al. (2006)
I	0.28	0.10
II	0.37	0.20
III		0.24
IV	0.80	0.23
≥ V		0.33

Whereas FLEISCHER et al. (2001), BARAŃSKI et al. (2008) and KUCZAJ et al. (2008) have shown that lameness are a cause of all cullings in herds in 13 to 23% and these indicators are higher in older cows (Table 3).

Table 3

Age-dependent cow culling in percentage (KUCZAJ et al. 2008)

Culling – reasons	Lactations				
	I	II	III	IV	≥ V
Lameness	19.15	12.68	22.37	25.00	29.17
Infertility	38.30	49.30	27.63	20.00	25.00
Low performance	12.77	14.08	11.84	2.50	–

Influence of lameness on production parameters of cows

Milk performance

Many papers show that the higher the milk yield of Holstein-Friesian cows the higher the risk of lameness appearance (Bielfeldt et al. 2005, Archer et al. 2010, Koeck et al. 2014, Alawneh et al. 2014). High-performance cows i.e. which performance per 100 kg of body weight exceeds 1000 kg of milk in the 305-day lactations are twice more often exposed for lameness than low-yield cows i.e. which performance is lower than 1000 kg of milk (Bielfeldt et al. 2005). A phase of lactation and cows age also have a significant impact. The most lameness were noted in the first three months of lactation and in older cows (Fleischer et al. 2001, Bielfeldt et al. 2005, Haskell et al. 2006, Winkler and Margerison 2012, Navarro et al. 2013).

Huxley (2013) summarized previous studies that estimated a milk yield loss of 270 to kg per lactation when lameness occurred. Evidence exists that this milk loss occurs during not only clinical lameness, but also pre-diagnosis and post-recovery depending on lameness type (Charfeddine and Pérez-Cabal 2017).

According to Hernandez (2005), Reader et al. (2011) and Van Hertem et al. (2013) the deterioration of cow locomotion causes a decrease in their daily milk yield. Such a decrease is noted even about 5 weeks before the lameness can be spotted. Simultaneously it was noted that cows with a slight lameness (3 BCS pts.) are characterized by a significant decrease in performance. The biggest yield decreases concern cows in which lameness appears at the beginning of lactation and in cows in which it persists (Archer et al. 2010). Olechnowicz and Jaśkowski (2010) noted a decrease in fat, protein, lactose yield and an increase in somatic cells content in the milk of cows, which received worse grade during locomotion assessment. Onyiro et al. (2008) have shown the negative correlation of milk yield with locomotion (-0.04±0.03) and positive concerning fat content in milk with locomotion (0.22±0.03). Gleeson et al. (2007) have shown that cows in which one of many lameness variants were found rarely approached milking robots in the VMS (voluntary milking systems). Such a situation had a negative impact on mammary gland health and caused infections through teats which were impaired by a higher pressure and swelling. Reader et al. (2011) state that in cows with treated lameness milk yield increases only after a month of milking since the moment of locomotion improvement.

In 1994 BARKEMA et al. (1994) have noticed that 1.1 x more lameness were seen in cows which yield in the last lactation increased by every 100 kg of milk in the first 100 days of lactation.

Reproduction

WALKER et al. (2008) stated that in cows with diagnosed lameness the period from calving to the first observed oestrus and the beginning of insemination is prolonged. It causes the elongation of parturition interval. In cows suffering from lameness the first successful insemination indicator decreases by 13%, whereas the calving indicator by 9% (MELENDEZ et al. 2003, KILIÇ et al. 2007). WALKER et al. (2008) present that cows of bad locomotion have a lower oestrus activity, lower progesterone and luteinizing hormone concentration in milk outside the oestrus period and higher concentration of progesterone during ovulation. MORRIS et al. (2011) have observed a decrease in the level of estradiol in the plasma of lame cows and have shown that 21% of suffering cows did not show oestral behaviordespite a properly developed ovarian follicle. What is more, authors presented that 29% of cows with improper locomotion did not develop follicles after the injection of oestrus synchronizing hormones. ONYIRO et al. (2008) have shown that the length of the calving interval is positively correlated with locomotion and susceptibility to hoof diseases.

Welfare

Nowadays the most popular are two types of barns: loose housing (*non-tethered*) and tie-up housing (*tethered*). The number of cattle influences the choice of the keeping system. In the barns amounting over 25 cows it is recommended to use the loose housing system, where the conditions are similar to the natural ones and where welfare needs are fulfilled.

The loose housing barns have many advantages, such keeping system is similar to a natural one, thus positively influencing animal performance. With the loose housing system cows tend to suffer less from the limb and mammary glands diseases and are more fertile. In the loose housing cowshed they have more movement freedom so they can fulfill their natural needs, having the possibility to move and contact with different animals in the herd. Milking is performed in the separate rooms i.e. in the milking halls or in the VMS system (voluntary milking systems) and thanks to that the milking itself is more efficient with a higher milking hygiene. Among the loose housing barns several types can be distinguished:

– with the separate standing while eating part, with deep bedding and a collective lying area,

– with the separated parts for laying and feeding,

– with boxes fulfilling the nutritional, as well as laying role at the same time (*combiboxes*).

In the loose housing barns the couching-places must allow laying down and standing up in a proper for a cow way. The number of the places must correspond to the number of animals. If this condition is not fulfilled weaker cows are phased out by the stronger ones and are not allowed to use the couching-places. The loose housing barn with a deep litter is divided into two parts: resting and feeding. The feeding part (3–3.5 m) should be separated from the resting part with the stairs. The area of the couching-place should be adjusted to the number of cows kept in the herd, for one animal there should be about 5 m^2 of a couching-place, bedding usage with such a keeping is around 8 kg per piece per day. Instead of bedding also grated floors are used, however these increase the point load of the hooves.

In the loose housing, boxed cowsheds there are special boxes corresponding to the number of the animals. These should be adjusted, so the animals can move freely. The ground may be bedded or un-bedded, where bedding is replaced by the plastic mattress. In the loose housing, boxed sheds the use of a bedding is about 1 kg per piece per day. With combiboxes feeding is performed on the couching place. On each side of the feed corridor there are combiboxes, their dimensions should be adjusted to the dimensions of the animals: 110–120 cm or 170–180 cm. The couching-place dimensions should be taken into consideration especially in the tie-up barns. Places too short or too narrow lower animal condition, restrict the movement and are unacceptable due to zootechnical reasons. The tether should allow the cow to move forward, stand up, lay down and move backwards freely. The grated couching-place must be secure from mammary gland damage. There are two types of couching-places: short and long. The short one is 180–190 cm long, used most often in the un-bedded cowsheds, the length should be adjusted in a way that the back limbs of a cow are 10 cm from its border. Too short place leads to cows standing in the manure canal, thus many diseases. If the proper distance from the border is kept, the excrements will land in the canal. The long couching-place is 210–250 cm long, such places are recommended for birth or treatment. They are bigger, so harder to keep clean. Contaminated couching-place helps to infect the mammary gland. When choosing a specific type of a barn it is essential to look on the herd's size, economic factors, animal welfare, as well as comfort and work safety. With 30 cows in a herd the cost of building of the loose housing and tie-up barns is similar, the difference is visible from

60 cows and more in favor of the loose housing system. Nowadays, in the EU countries there is a focus on the animal keeping conditions and that is why many breeders, after Poland's entrance into the EU, had to modernize their cowsheds, also in terms of welfare.

Conducted research (BERGSTEN 1999, MANSKE 2002, COOK 2003) has proven that the all-year keeping on concrete grates in the loose housing system is better for hooves if combined with pasture grazing in the summer. On the other hand, (WHAY 2002), gives proof that the least amount of lameness cases are observed during the all-year use of pasture, dominating in countries such as New Zealand, Argentina and Chile, where cows have total freedom of standing and laying on earth i.e. surface which is amortizing the pressure of body weight on limbs most efficiently.

An important factor for the occurrence of limb diseases is a surface of the milking hall anteroom, where cows sometimes spend several hours. Improper abrasive surface and ground slope predisposes for hoof horn damage appearance. Cows feel hesitant on such surface, making cautious steps, in wrong order and wrong angulation, which damages very delicate laminae of the white line of hoof. Similar effect is caused by improperly designed milking halls, where entrance and exit are set at an acute angle (HERLIN and DREVEMO 1997).

The stressed of cows often move out of the milking hall fast and when they meet the sharp turn on their way to the feeding table they perform unnatural limb twists, overloading the white line, leading to its strain or damage. Particular attention should be paid to primiparous cows, which are kept with older cows right after calving. Stress caused by relocation to a different place, change in feeding and beginning of milking is multiplied by the presence of dominating cows in the herd and may cause more seldom staying of primiparous cows on the couching place, thus overload of limbs. With the improper surface the risk of plantar surface ulcers rises (WEBB and CLARK 1981).

Research presented by TELEZHENKO and BERGSTEN (2004) concerned animal locomotion on different surfaces. Measurements of length of steps and hoof stepping angle on 5 different surfaces: grated concrete surfaces, grates covered with mattes, smooth concrete surfaces, concrete surfaces covered with mattes and compressed sand surface, as the one which is the most similar to the natural pasture surface, were performed. The abrasive ability of these surfaces was also examined. Three groups of cows were used for this research – the ones which did not show any signs of lameness, ones which showed the angulation of the back during walk, with no sign of it while standing and ones with angled back in both cases. The results showed that the most slippery surface was the grated concrete one and the

most abrasive was continuous concrete surface. The lowest movement speed was noted on the concrete surfaces. Cows were moving faster on grates covered with mattes.

Lameness prevention

Prevention means adopting a specific plan. These can be control and prevention strategies for reducing lameness incidence repetitive actions or one-time long-term investments. Examples of repetitive investments include preventive hoof trimming, footbaths, hoof health feed additives, or even genetic selection. An example of a long-term investment in lameness prevention would be the installation of rubber flooring or the redesigning of poorly constructed freestalls (FJELDAAS et al. 2006, LAVEN and HUNT 2002, BERGSTEN et al. 2003, PRITCHARD et al. 2013).

One of the most common prevention elements is a timely hoof trimmers. On-farm staff, hoof trimmers, or veterinarians most frequently treat lameness. In a survey of 184 farms across the United States, 77% of farms used a professional hoof trimmer for hoof trimming services whereas 16% used a veterinarian or on-farm staff and 7% used no hoof trimming services at all (ADAMS et al. 2016). Its frequency depends on the cow keeping system and is most often performed once a year – in the pasture-alcove system or twice a year – in the all-year alcove keeping system (MANSKE et al. 2002).

When making a decision of a treatment the abrasion of the hoof horn is taken into account assuming that the hoof's horn grows from 3 to 13 mm monthly in average. That is why there is a need to perform hoof trimmers at least twice a year. Most often the first one is performed in May i.e. before releasing animals onto the pasture or not later than 4 weeks before them leaving. In the loose housing barns it is enough to make such treatment only once, as an increased cow activity appears there. Animals are able to rub off the hoof horn only slightly during the daily activity both in the cowshed, as well as on pasture. The problem concerns cows kept in the deep-bedding system also, where the approach to the feeding table and its surroundings is most often hardened.

The lack of hoof trimmers and faulty surface makes the horn rub off unevenly or too slow. As a consequence the overgrown hoof horn, mainly in the front, causes improper body mass distribution leading to calluses, as well as an overload of the finger and joint capsule tendons. This leads to hoof joint bones inflammation and a visible lameness and unwillingness to move. Such animals stumble, slip, lose balance making injuries even bigger and deeper.

Skillfully carried out correction reestablishes a proper hoof shape, allowing to distribute body weight evenly and lowers the amount of visible joint swellings. An optimal slope angle of the frontal wall of the hoof is 50–55°, whereas the back wall 45–50°, the most optimal setting of the ankle joint viewed from the side is 145–155°.

Conclusion

Surfaces on which cows move should be clean, comfortable for moving and if possible allow to rub off the hoof. Hoof baths while moving should be regular and adjusted to herd's requirements. It is needed to observe cows in order to detect lameness early and perform a proper treatment fast. All lameness in the herd and their causes should be noted down to enhance cows welfare, for example to change cow keeping system. Hoof correction should be regular and carried out professionally. Cows with lameness of the 2° and 3° types show almost 3 times higher re-insemination per one fertilization index. Lameness lower cow performance, because they definitely eat less feed. The share of leftovers in cows reaches 36%. On farms, which do not perform limb and hoof based selection and do not maintain basic limb diseases prevention together with providing cows with welfare, more disease cases are observed with the biggest share of limb diseases. The enhancement of limb structure in dairy cattle, through selection, requires a very long time, as features connected to their structure and health are of a very low inheritance. Due to this fact it is essential to take care of the practical aspects connected to a good milk-producing environment.

In summary, it is right to say that lameness are very costly cow diseases, both in terms of herd health, as well as farm profitability. Costs include milk losses, veterinary services, decrease in milk performance and as an effect – much earlier cow culling. Research shows that the differences between farms in terms of appearance, as well as lameness degree assessment are significant, meaning that it is needed to act to improve such situation.

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