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Daily Activity of Cows based on Pedometer Reports

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Modern tools for monitoring and managing dairy cattle herds allow not only for tracking the 24-hour behaviour of each animal but also obtaining answers to many questions about behavioural, reproductive or nutritional issues. As a consequence, the commonly used observation of animals (Dochi et al., 2005, Nebel et al., 2000, Mosaferi et al., 2012) is slowly replaced by the new technologies. One of them are electronic measuring devices for animal movement activity, typically mounted on cow legs (Roelofs et al., 2005, Peter and Bosu, 1986). The complexity of the pedometer module allows the farmers to decide which information they want to have in their systems through a properly customised software. Modern pedometers no longer have an auxiliary role in determining the moment of heat and the proposed optimal mating time but provide much more important information about the animal itself and its behaviour. Modern research in the field of increasing the efficiency of the use of these devices has demonstrated the high effectiveness of using such a solution in improving the overall health of the animal, including the detection of leg and foot diseases (Liu and Spahr, 1993, Roelofs et al., 2005).

Basically, cows spend 4 to 6 hours in the cowshed for the fodder intake. These activities are cyclical, and one such cycle lasts from half an hour to an hour for the fodder intake and three minutes for drinking (Mróz et al., 2017). Within 24 h, cows rest from 10 to 14 hours, and the lowest activity is observed from midnight to 6.00 a.m. and from 3.00 to 6.00 p.m. (Wójcik and Olszewski, 2015). Grant (2007), on the other hand, claims that cows spend between 8 and 12% of their time moving and standing, and the activities related to milking take from 11 to 15%. According to Mróz et al. (2017), taking food and water lasts from 20 to 25% of the day, and the most time, because 40 to 50% is devoted to resting. The given time intervals conform to the results of other tests, according to which resting is a priority activity for cows and lasts from 12 to 14 hours (Reinholz-Trojan, 2007; Czerniawska-Piątkowska et al., 2008, Solan and Jóźwik, 2009; Guliński et al., 2014, DeVries et al., 2005).

The motor activity of animals is determined by many factors, such as age, and consequently, the following lactation, the milk production level (Yániza et al., 2006), the level of individual mobility (Reader et al., 2011), and the type and number of available bed places. A good example is the restriction of access to feed as a result of compaction in a pen, which leads, according to Jørgensen et al. (2007) to changes in the behaviour of animals.

Research in the field of cattle behaviour was conducted by Mróz et al. (2017) on a group of cows kept in the sector without an enclosure of the initial area of 3.80 m2/item (group I) as well as when cows were kept in the free range sector with an initial area of 7.74 m2/item (group II). The analysis of the cows' activity indicated a number of significant interdependencies and differences between the studied groups (Tab. 1). Animals not using the enclosure (group I) were definitely the most active.

This group was characterised by the shortest total rest time (555.22 minutes), resulting from the shortest time of a single rest (58.78 minutes), but also by a high rest frequency (10.70).

Table 1. Characteristics of daily activity of the cows in different study groups (Mróz et al., 2017)

Research group (n)	*Activity (steps/hour)* $\bar{x}$ /sd	*Resting frequency* (n) $\bar{x}$ /sd	*Duration of a single rest* (min) $\bar{x}$ /sd	*Total resting time* (min) $\bar{x}$ /sd
I n=2181	126,34 Aa 54,19	10,70 A 4,75	58,79 AB 27,40	555,22 A 186,18
II n=2176	122,82 Ba 42,52	10,57 B 4,28	64,29 A 26,17	616,53 AB 191,59

In column for AA – P≤0.01; aa – P≤0.05.

In a situation when the density of cattle reached the level of 3.16 m2/item in group I and 6.45 m2/item in group II, the authors observed high activity of individuals from group I as compared to group II (tab. 2). Phillips (2002) stated that when the space per animal falls below 4-5 m2 it is likely that during the first few days the activity of cows will increase due to their competition for space. Cows in group I rested often but for a short time, which resulted in the lowest total resting time. Cows in group II decreased their activity. Also Telezhenko et al. (2012), examining the impact of density increase and the size of a pen on animal activity, noticed that in both small and large pens while increasing the stocking density, it was noticeable to increase the frequency of rest and shorten its time. In the studies of Krawczel et al. (2012) with the density of 131%, both the frequency and the length of a single rest, as well as its total duration, were noted (as compared to the reference group). However, when the density of animals increased by 11%, the frequency of rest decreased from 11.7 to 10.7, while the length of a single rest increased from 67 to 69.3 minutes. Wang et al. (2016), reducing the density of animals to 82%, however, noticed the extension of the average rest period from 11.79 to 12.19 hours per day.

Table 2. Characteristics of daily activity of the cows in different study groups during the experimental period (Mróz et al., 2017)

Research group (n)	*Activity (steps/hour)* $\bar{x}$ /sd	*Resting frequency* (n) $\bar{x}$ /sd	*Duration of a single rest* (min) $\bar{x}$ /sd	*Total resting time* (min) $\bar{x}$ /sd
I n=1028	133,65 A 53,15	11,88 AB 5,69	55,94 AB 26,98	576,07 Aa 206,47
II n=951	114,01 A 38,08	10,59 A 4,76	68,98 A 30,81	642,47 AB 207,81

aa – P≤0,05. – *In column for AA – P≤0.01; aa – P≤0.05.*

Higher activity of animals at an early age was demonstrated in the studies of Wójcik and Olszewski (2015), where heifers were characterised by a higher level of stress than cows. As a consequence, it was evidenced by more steps per hour. In the morning hours (7.00-9.00 a.m.) these differences were on average from 23 to 70 steps, and in the afternoon (6.00-8.00 pm) from 35 to 104 steps/hour. Heifers with increased daily activity were characterised by the highest rate of rest frequency and, at the same time, the shortest resting time per single rest time. Research carried out by Vasseur et al. (2012) confirmed this interdependency. They compared cows' activity with regard to the division into lactation phases, whether the cow was multiparous or first-calf heifer as well as due to the maintenance system (tethering or free-standing). Matthews et al. (2012), however, point out that cows with a lower BCS score were more active because they took more dry matter. Therefore, they spent less time resting.

The living conditions we provide to the animal within the cowshed itself as well as the waiting room for milking and the enclosures are important. Research has shown that cows kept individually on large sites with mattresses spend more than 4.2 hours more for rest than animals kept in the stall barn with concrete beds (Haley et al., 2000). Cows in the stall cowshed had an extended period of individual behaviour of standing and lying, thereby reducing their activity. Observations have shown that animals are less willing to change their position in the tether system (Haley et al., 2000). This may be due to the fact that the bedding is concrete, and thus, the animal rests on the wrists while standing up (Metzner, 1978). Changes in daily activity are also affected by routine activities performed in the cowshed. It has been found that cows change their pattern of behaviour during food intake - especially when feed is infrequent or there is insufficient space at the feeding table. It should be remembered that the cattle used to have their feed rhythm related to the time of day (Albright, 1993) while now it is related to the time of delivery of fresh feed (DeVries et al., 2005) and depends on the farmer.

Short-term increase in animal activity is usually caused by stressful situations (Medrano-Galarza et al., 2012). The change of the production group is a good example because animals leaving the existing group feel threatened (Abramowicz et al., 2014). The symptoms include an increase in timidity and worse tolerance of stress (Reinholz-Trojan, 2007). The time of day itself causes animals to be more active in the morning than in the afternoon or evening (Wójcik and Rudziński, 2014, Wójcik and Olszewski, 2015).

Szewczyk and Pawłowska (2015) compared the activity of cows in conventional farming (without paddocks and access to pasture) and two groups of cows from an organic farm divided into those using and not using pasture but fed with greenery. The authors found that the highest activity was demonstrated by cows using pasture - the cows devoted 137.73 minutes/day to the movement, then cows with access to enclosures - 125.62 minutes/day. The group with access to the enclosure with less daily activity had more rest time for digestion and rumination of feed, which resulted in higher daily milk production.

Cows in the pasture are also exposed to the effects of weather conditions and, thus, the response of their organisms to adverse conditions is variable. Keeping track of activity during this period allows for the optimisation of the grazing time, efficient harvesting of the forage and reducing stress in the herd. The research by Cook et al. (2007) has shown that animals feel high temperature and reduce the time spent lying down. Later studies by Wójcik et al. (2015) revealed that cows kept during the whole grazing period in the pasture had higher anxiety level, lower total resting time but also higher session performance during both morning and evening milking (11-13 kg). As the wind speed increased, the frequency of rest of the animals increased, especially at the speeds above 20 km/h. At the same time, the authors noticed that both at very low and very high temperatures the cows were characterised by increased activity. The temperature at which the stabilisation of activity took place was 1-10^{o}C. The

highest activity was recorded at temperatures above 26°C - 155-156 steps. At a temperature of -10°C, the activity ranged from 124 to 139 steps. An increase in ambient temperature above 11°C caused a slow decrease in milk yield during the morning and evening milking sessions.

In the analysis of the cows' daily activity, the breed specifics of the animals and the utility type should also be taken into account as these may be important factors conditioning the correct interpretation of the results. The said studies by Wójcik et al. (2015) showed that ZB cattle (Polish black and white) with weaker wind showed lower activity than PHF cattle (Polish Holstein-Friesian) but at speeds above 30 km/h, this breed was more active. The ZB breed is more likely to relax regardless of the strength of the wind. ZB cattle also had a higher rate of anxiety as compared to the PHF breed. In the low temperature ranges the daily activity of the animals was very similar.

In the case of the meat breeds, such as Limousine, with respect to which research was carried out at the National Research Institute of Animal Production (Wójcik and Olszewski, 2015), it was demonstrated that the lowest daily activity of cows and heifers was observed at night between 0.00 and 5.00 a.m., the least active being cows and heifers from 3.00-4.00 a.m. with 49 and 66 steps per hour. Within 24 hours, the average activity was higher in heifers than in cows. The daily activity of cows and heifers was almost twice as high as the night one, which was also observed by Bogucki et al. (2012). Particularly high differences were found between the groups from 5.00 to 7.00 a.m. at the level from 94 steps/hour for cows up to 241 for heifers and from 1.00 to 5.00 p.m., respectively, from 97 steps/hour for cows up to 187 steps/hour for heifers. Heifers with increased daily activity were also characterised by a higher rate of rest frequency, with a simultaneous shorter rest period per a single rest time ($P \leq 0.01$). During the night session between 8.00 p.m. and 8.00 a.m., the rate of the rest for heifers was 9.06 as compared to cows - 7.72, while in the daily session 10.00 a.m. -6.00 p.m. it was 7.20 versus 5.26, respectively. The average rest time for heifers was from 49.8 to 56.6 minutes/1 rest time while for cows from 59.1 to 61.0 minutes/1 rest time, with a higher time at night.

In summary, it should be noted that at the farms there is a possibility of very thorough monitoring of behavioural patterns of animals, including their activity. As a consequence, it allows not only for its proper shaping in the daily cycle but also for responding to disturbing behaviours among animals. A quick analysis of irregularities and counteracting enables optimisation of production, improvement of wellbeing and, consequently, increase in the production efficiency. Modern dairy cattle herd management systems are capable of spontaneous learning and monitoring of the daily activity of cows, and signalling when there are deviations from the accepted assumptions or expression of the animals themselves to unfavourable environmental and nutritional conditions.

Bibliography

Abramowicz P., Brzozowski P., Gołębiewski M. (2014). Praktyczne aspekty społecznych zachowań bydła. Med. Weter., 70, 02: 90–93.

Albright J.L. (1993). Feeding behavior of dairy cattle. J. Dairy Sci., 76: 485–498.

Bogucki M., Sawa A., Neja W., Oler A., Ziemer M. (2012). Daily activity cows in a herd Charolaise. Acta Sci. Pol., Zoot., 11,4: 3–10.

Cook N.B., Mentink R.L., Bennett T.B., Burgi K.J. (2007). The effect of heat stress and lameness on time budgets of lactating dairy cows. J. Dairy Sci., 90: 1674–1682.

Czerniawska-Piątkowska E., Szewczuk M., Snopkowska M. (2008). Porównanie użytkowości mlecznej krów rasy polskiej holsztyńsko-fryzyjskiej w różnych systemach utrzymania. Zesz. Nauk. UP Wrocław, 566: 25–34.

DeVries T.J., Keyserlingk M.A.G. von, Beauchemin K.A. (2005). Frequency of feed delivery affects the behavior of lactating dairy cows. J. Dairy Sci., 88 (10): 3553–3562.

Dochi O., Maekawa Y.T., Kiyozane A., Moreta S., Izumi K., Koiwa M., Koyama H. (2005). Efficacy of a continuous measurement by pedometer for estrus detection in dairy cows. Jpn. J. Embryo Transfer, 27: 95–100.

Grant R. (2007). Taking advantage of natural behavior improves dairy cow performance. Proc. Western Dairy Manag. Conf., Reno, NV, pp. 225–236.

Guliński P., Salamończyk E., Młynek K. (2014). Czy odpoczynek bydła jest priorytetowym typem ich zachowania? Bydło, 11: 52–55.

Haley D.B., Rushen J., Passillé A. de (2000). Behavioural indicators of cow comfort: activity and resting behaviour of dairy cows in two types of housing. Canadian J. Anim. Sci., 80 (2): 257–263.

Jørgensen G.H.M., Andersen I.L., Bøe K.E. (2007). Feed intake and social interactions in dairy goats – The effects of feeding space and type of roughage. Appl. Anim. Behav. Sci., 107: 239–251.

Krawczel P.D., Klaiber L.B., Butzler R.E., Klaiber L.M., Dann H.M., Mooney C.S., Grant R.J. (2012). Short-term increases in stocking density affect the lying and social behavior, but not the productivity, of lactating Holstein dairy cows. J. Dairy Sci., 95: 4298–4308.

Liu X., Spahr S.L. (1993). Automated electronic activity measurement for detection of estrus in dairy cattle. J. Dairy Sci., 76, 10: 2906–2912.

Matthews L.R., Cameron C., Sheahan J.A., Kolver E.S., Roche J.R. (2012). Associations among dairy cow body condition and welfare-associated behavioral traits. J. Dairy Sci., 95: 2595–2601.

Medrano-Galarza C., Gibbons J., Wagner S., Passillé A.M. de, Rushen J. (2012). Behavioral changes in dairy cows with mastitis. J. Dairy Sci., 95 (12): 6994–7002.

Metzner R. (1978). Analyse tierischer Bewegungsabläufe zur Gestatung artemäber Rinderkrippen. Landtechnik, 9: 397–404.

Mosaferi S., Moghadam Z.A., Ostadi Z., Khodabandeloo V. (2012). Evaluating accuracy rate of oestrus detection in dairy cow by pedometer. Res. J. Biol. Sci., 7, 4: 170–174.

Mróz P., Wójcik P., Pankowski M. (2017). Daily activity of polish Holstein-Friesian cows depending on variable housing conditions during lactation. Folia Pomer. Univ. Technol. Stetin., Agric. Aliment. Pisc., Zoot., 338 (44), 4: 119–130.

Nebel L.R., Dransfield M.G., Jobst S.M., Bame J.H. (2000). Automated electronic systems for the detection of oestrus and timing of AI in cattle. Anim Reprod. Sci., 60–61: 713–723.

Peter A.T., Bosu W.T.K. (1986). Postpartum ovarian activity in dairy cows: Correlation between behavioral estrus, pedometer measurements and ovulations. Theriogenology, 26, 1: 111–115.

Phillips C. (2002). Cattle behaviour & welfare. Oxford: Blackwell Publishing, pp. 1–224.

Reader J.D., Green M.J., Kaler J., Mason S.A., Green L.E. (2011). Effect of mobility score on milk yield and activity in dairy cattle. J. Dairy Sci., 94, 10: 5045–5052.

Reinholz-Trojan A. (2007). Znaczenie wiedzy o zachowaniu zwierząt w kontekście dobrostanu na przykładzie bydła domowego *Bos taurus taurus*. W: Zachowanie się zwierząt. Przegląd wybranych zagadnień z zakresu psychologii porównawczej, Vizja Press, ss. 132–147.

Roelofs J.B., Eerdenburg F.J., Soede N.M., Kemp B. (2005) Pedometer readings for estrous detection and as predictor for time of ovulation in dairy cattle. Theriogenology, 64 (8): 1690–1703.

Solan M., Jóźwik M. (2009). Wpływ mikroklimatu oraz systemu utrzymania na dobrostan krów mlecznych. Wiad. Zoot., 38, 1: 25–29.

Szewczyk A., Pawłowska J. (2015). Wpływ warunków środowiskowych w sezonie pastwiskowym na jakość mleka i dobrostan krów w chowie ekologicznym. Rocz. Nauk Zoot., 42, 2: 181–194.

Telezhenko E., Keyserling M.A.G. von, Talebi A., Weary D.M. (2012). Effect of pen size, group size, and stocking density on activity in freestall-housed dairy cows. J. Dairy Sci., 95: 3064–3069.

Vasseur E., Rushen J., Haley D.B., Passillé A.M. de (2012). Sampling cows to assess lying time for on-farm animal welfare assessment. J. Dairy Sci., 95: 4968–4977.

Wang F.X., Shao D.F., Li S.L., Wang Y.J., Azarfar A., Cao Z.J. (2016). Effects of stocking density on behavior, productivity, and comfort indices of lactating dairy cows. J. Dairy Sci., 99: 3709–3717.

Wójcik P., Olszewski A. (2015). Use of pedometers to analyse 24-hour activity and fertility of limousin cows. Folia Pomer. Univ. Technol. Stetin., Agricult. Aliment. Piscaria, Zoot., 322 (36) 4: 119–124.

Wójcik P., Rudziński J. (2014). Effectiveness of using activity tags in management of high-producing dairy herd. Folia Pomer. Univ. Technol. Stetin., Agricult. Aliment. Piscaria, Zoot., 315 (32): 59–66.

Wójcik P., Walczak J., Cwynar M. (2015). Czynniki środowiskowe kształtujące behawior krów utrzymywanych w warunkach chowu ekologicznego. Mat. XXIII Szkoły Zimowej Hodowców Bydła, UR, Kraków, s. 245.

Yániz J.L., Santolariaa P., Giribetb A., Lopez-Gatius F. (2006). Factors affecting walking activity at estrus during postpartum period and subsequent fertility in dairy cows. Theriogenology, 66: 1943–1950.

DAILY ACTIVITY OF COWS BASED ON PEDOMETER REPORTS

Summary

Modern activity meters (pedometers) not only play an auxiliary role in determining the onset of estrus and optimal time for mating, but also provide much more important information about the animal and its behavior. Recent studies have shown that these devices are highly effective in improving the animal's overall health, including the possible detection of leg and claw diseases. Research demonstrated that the animal's locomotor activity is determined by many factors such as age, milk production level, individual mobility, type and number of lying stalls available. Pasture activity of the cows is also influenced by weather conditions, which can largely affect milk production. Monitoring their activity during that time helps to optimize grazing time and forage intake, and to reduce stress in the herd. The analyses of daily activity should mainly account for breed specificity of the cows as well as their productive type, because these factors may significantly contribute to the correct interpretation of the results obtained.

Key words: cattle, daily activity, pedometer, environment