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THE USE OF ZOOMETRIC MEASUREMENTS OF COWS FOR DETERMINATION OF RUMP CONFORMATION AND COURSE OF PARTURITION

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Abstract

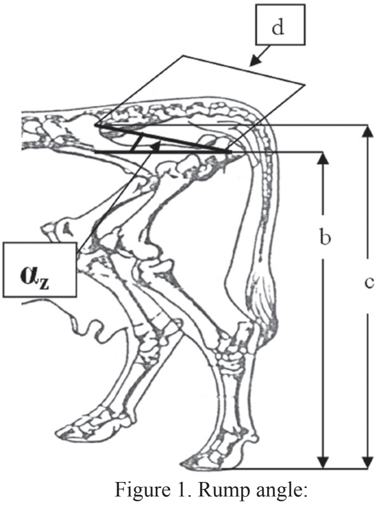
A total of 900 Polish Black-and-White Holstein-Friesian (PHF) cows with at least 75% HF blood and the mean yield of over 6000 l milk were kept in a loose barn at the Chorzelów Experimental Station of the National Research Institute of Animal Production. Zoometric measurements of the cows were made 26–30 days (28 days on average) before calving. The aim of this study was to show rump conformation traits that are critical to rump angle and the course of parturition, and to test the possibility of using these traits in conformation indices and breeding work. The results showed that the change in rump angle from raised rump to sloping rump was paralleled by a steady decrease in height at pins and thurls by an average of 0.45 to 0.58 cm for each degree of rump angle. Among the traits of external pelvic measurements, the greatest effect on calving ease was exerted by a set of measurements describing both the width of hips and pins and the height of thurls and pins. The conformation indices based on the differences in height between hips and thurls and between pins and thurls were the most reliable in predicting easy calvings. The body conformation indices analysed can be successfully used to determine rump conformation and course of parturition.

Key words: dairy cattle, zoometric measurements, course of parturition

Studies conducted over many years in Poland and abroad have shown that conformation traits have a significant effect on improving the milk yield as well as the health and reproductive traits of dairy cattle (Borkowska et al., 1995; Guliński and Litwińczuk, 1998; Jagusiak, 2005; Kozaniecki et al., 1985; Wójcik et al., 2002, 2003; Wójcik, 2002). From the viewpoint of milk production economics, of great importance are cattle fertility parameters such as conception rate, non-pregnancy rate, calving ease and number of stillborn calves. Most of these traits are directly or indirectly connected with the evaluation of rump conformation. Philipsson (1976), Ali et al. (1984), De Jong (1991), Hoffman (1997), Nogalski et al. (2000, 2001) and Nogalski (2005) confirmed that the course of parturition and calf survival are affected by both pelvic size and rump angle. Boldman and Famula (1985), Dadati et al. (1985) showed that the relationship of calving ease with rump width and rump angle is $r_p = 0.397$ and $r_p = 0.218$, respectively. Studies conducted in the 1990s revealed that rump conformation type may be related to conception rate and course of parturition (Tyczka, 1998). Rump angle may also have an effect on the type of parturition (Brzozowski, 1988; Strandberg et al., 1996; Nogalski et al., 2001). These authors suggest that "slightly sloping rump" is the most favourable rump angle. Steep rump angle may facilitate calving but it is associated with subsequent complications such as vaginal and uterine prolapse. Steinbock et al. (2003), Mc Clintock et al. (2003) and Sawa and Neja (2001) showed an increased number of abortions in first-calving cows. Therefore, the use of rump score in selection may considerably reduce the risk of complications during parturition. It should be remembered that each successive calving is paralleled by increased incidence of multiple pregnancies and may result in increased calving problems (Sawa and Neja, 2001). The above complications can be avoided if pelvic conformation is properly diagnosed. The aim of this study was to show rump conformation traits that are critical to rump angle and the course of parturition, and to test the possibility of using these traits in conformation indices and breeding work.

Material and methods

A total of 900 Polish Black-and-White Holstein-Friesian (PHF) cows with at least 75% HF blood and the mean yield of over 6000 l milk were kept in a loose barn at the Chorzelów Experimental Station of the National Research Institute of Animal Production. Zoometric measurements of the cows were made 26–30 days (28 days on average) before calving. Measurements were made of height at sacrum, withers and hips; height at thurls and pins; width of chest, hips, thurls and pins; oblique pelvic diameter (hips-thurls); oblique pelvic diameter (thurls-pins); oblique pelvic length; and lateral length of the pelvis. Rump angle was calculated based on the diagram and formula below, and expressed in degrees.



$$\alpha_z = \arcsin[(c - b)/d]$$

Figure 1. Rump angle:
b – height at pins, c – height at hip, d – length of pelvis, α_z – rump slope

Breeding records also provided data on the course of calving (1 – normal parturition, without assistance, 2 – dystocia, human assistance). Numerical data were subjected to 3-way analysis of variance based on the SAS package using the following model:

$$Y_{ijkl} = \alpha + A_i + B_j + C_k + e_{ijkl}$$

where:
Y_{ijkl} – value of trait,
α – mean,
A_i – effect of year, calving season,
B_j – effect of j^{th} rump angle trait (slope); (point score in the second model),
C_k – effect of k^{th} sire,
e_{ijkl} – random error.

The effect of individual measurements and indices on calving ease was determined using the χ^2 Wald test. The significance of logistic regression coefficients for body conformation traits on calving ease was estimated. Taking into account the possibility of making zoometric measurements and the results of tests and analyses, we determined zoometric measurements that affect the course of parturition (width of hips, pins and thurls; height at pins and thurls; oblique pelvic length; pelvic length). These were used to create a set of at least two measurements that can easily describe rump conformation and determine calving ease. This was followed by repeated estimation of the significance of logistic regression coefficients using the χ^2 Wald test.

Results

The mean results of zoometric measurements taken on cows around 28 days before calving, according to rump angle, are given in Table 1. It was shown that the change in rump angle from raised rump to sloping rump was paralleled by a steady decrease in the height at pins from 139.83 cm to 126.40 cm. Each degree of change resulted from the decrease in height at pins by 0.45 cm on average. Likewise for the height at thurls (129.00–119.60 cm), a 0.58 cm decrease per degree of rump angle was found for slightly sloping rump and a 0.52 cm decrease for sloping rump. Therefore, the decrease in the analysed trait resulted in the increase in rump slope. The present study showed that unlike height at thurls and pins, the increase in height at hips (134.66–141.20 cm) had a negative effect on rump angle by causing a steady increase in rump slope. The mean increase of height by 0.24 cm reflected one degree change in angle from level rump to raised rump, while for sloping rump every successive degree resulted from a markedly greater increase in height (by 0.49 cm on average). The relationship between height at pins, thurls and hips and rump angle was significant or largely highly significant. For the measurement of height at withers (134.83–140.00 cm) it was shown that the initial change of rump angle from raised rump to level rump resulted from a non-significant effect of this trait (negative correlation with a 0.58 cm increase equalling one degree less), while starting from the slightly sloping rump (height of 137.49 cm) the effect of height at withers was in some cases significant and ranged from 0.03 to 0.13 cm for each degree.

Table 1. Height measurements according to rump angle

Rump angle – interpretation	Rump angle in degrees (°)	Height at withers (cm)	Height at pins (cm)	Height at thurls (cm)	Height at hips (cm)
		x/sd	x/sd	x/sd	x/sd
Raised rump	+5.1 – +7.0° n = 6	134.83 4.91	139.83 2.78	129.00 6.18	134.66 3.01
	+3.1 – +5.0° n = 18	136.50 2.91	138.77 DHIa 3.31	126.44 4.04 I	134.61 FKLT 3.08
	+1.1 – +3.0° n = 60	137.16 4.49	138.03 BCG 3.91	126.91 Aade 5.15	136.65 GHOPSab 3.90
Level rump	0.0 ± 1.0° n = 52	136.67 c 4.21	135.96 BCI 4.03	125.19 Af 5.27	135.96 ABCDE 4.03
Slightly sloping rump	1.1 – 3.0° n=157	137.49 b 4.37	135.64 ABGa 4.11	123.50 bcf 5.55	137.26 CDEFINb 4.13
	3.1 – 5.0° n = 190	137.60 a 4.03	133.41 ABCDE 3.79	121.21 ab 4.23	136.98 ABCDEFab 3.89
Sloping rump	5.1 – 7.0° n = 176	138.43 3.59	132.78 ABCDE 3.30	120.91 3.67	138.27 AGHIKc 3.33
	7.1 – 9.0° n = 166	137.48 3.63	130.99 ABCDE 3.31	120.34 acd 3.20	138.41 BLNO 3.40
	9.1 – 11.0° n = 120	138.64 abc 3.46	130.80 ABCDE 3.16	120.50 2.76	140.14 ABKP 3.38
	11.1 – 13.0° n = 60	137.63 3.55	128.66 ACF 3.32	119.88 e 3.59	140.60 CSTc 3.75
	13.1 – 15.0° n = 22	138.90 4.04	128.09 BH 3.92	119.77 3.61	141.09 DGL 4.25
	15.1 – 17.0° n = 5	140.00 3.67	126.40 1.51	119.60 1.14	141.20 2.38

A, a – means in columns with the same letters are significant: capital letters – $P \leq 0.01$, small letters – $P \leq 0.05$.

Analysis of cow conformation indices according to rump angle (Tables 2 and 3) showed that except “height at pins – height at thurls” they were highly significantly related to rump angle. It is significant to note the effect of four out of six parameters, i.e. the difference in height between sacrum and point of rump, between sacrum and thurl, between point of hip and point of rump, and between point of hip and thurl.

Table 2. Cow conformation indices according to rump angle

Rump angle – interpretation	Rump angle in degrees (°)	Height at sacrum – height at pins (cm)	Height at sacrum – height at thurls (cm)	Height at sacrum – height at hips (cm)
		x/sd	x/sd	x/sd
Raised rump	+5.1 - +7.0° n = 6	-1.88 1.09	8.33 4.44	3.66 1.50
	+3.1 - +5.0° n = 18	0.66 3.33	12.77 3.79 ABDGML	3.82 2.53 FIMPR
	+1.0 - +3.0° n = 60	2.07 2.16 A	12.88 4.07 ACEF	3.20 2.05 CEHOS
Level rump	0.0 ±1.0° n = 52	2.76 1.56 A	13.26 4.04 IK	2.76 1.56 CDGN
Slightly sloping rump	1.1 - 3.0° n = 157	4.16 1.80 A	16.24 4.55 HML	2.64 1.55 ABCDML
	3.0-5.0° n = 190	6.36 1.65 A	18.79 3.91 ABDFHI	2.90 1.50 ABCDEFGHIK
Sloping rump	5.1-7.0° n = 176	7.85 1.83 A	19.72 3.28 ACEGHI	2.46 1.69 ADFGHIK
	7.1-9.0° n = 166	9.66 1.49 A	20.31 3.09 AHI	2.43 1.23 BCLMNOP
	9.1-11.0° n = 120	11.26 1.38 A	21.56 2.32 AHI	2.09 1.25 CSR
	11.1-13.0° n = 60	12.50 1.58 A	21.28 2.63 BCK	1.95 1.32 D
	13.1-15.0° n = 22	14.40 1.70 A	22.72 2.22 DEKM	1.72 1.67 ABE
	15.1-17.0° n = 5	16.00 1.00	22.80 1.78	1.20 0.44

A, a – means in columns with the same letters are significant: capital letters – $P \leq 0.01$, small letters – $P \leq 0.05$

The increase in the differences between the analysed traits determined the increase in rump angle, namely the gradual change from raised rump to sloping rump. Our study showed that the increased difference in height between sacrum and point of rump and between point of hip and point of rump determined the change from raised rump through level rump to sloping rump (increases of 0.99 and 0.95 cm, respectively, for each successive degree), and to the smallest extent the change of angle for slightly sloping rump (increases of 0.56 and 0.51 cm respectively for raised rump and increases of 0.68–0.78 cm per degree for sloping rump). Likewise, the increased difference in height between sacrum and thurl and between point of hip and thurl determined the change from raised rump to sloping rump (in both cases an initial increase from 1.14 cm for each successive degree to 0.25 cm for sloping rump). While these parameters had a positive effect on rump angle, the next two parameters (the difference in height between sacrum and point of hip and between point of rump and thurl) had a negative effect on rump angle, namely the increase in these differences caused a steady decrease in this angle. There was a markedly higher but non-significant effect of the latter index on rump angle (a negative increase of 0.51 cm for each successive degree within sloping rump).

Table 3. Cow conformation indices according to rump angle

Rump angle – interpretation	Rump angle in degrees (°)	Height at hips – height at pins (cm)	Height at hips – height at thurls (cm)	Height at pins – height at thurls (cm)
		x/sd	x/sd	x/sd
Raised rump	+5.1 - +7.0° n = 6	-5.16 0.40	5.16 4.26	10.33 4.41
	+3.1 - +5.0° n = 18	-3.16 0.38 A	9.16 1.94 ABCDE	12.33 1.90
	+1.0 - +3.0° n = 60	-1.38 0.49 A	9.73 3.45 GHIK	11.11 3.52
Level rump	0.0 ±1.0° n = 52	---	10.76 3.03 ABCDG	10.76 3.03
Slightly sloping rump	1.1 - 3.0° n = 157	1.61 0.60 A	13.75 3.93 EFGHK	12.14 3.76
	3.0-5.0° n = 182	3.60 0.57 A	15.73 3.63 ABCDEG	12.13 3.25
Sloping rump	5.1-7.0° n = 176	5.48 0.58 A	17.35 2.83 ABCDEG	11.86 2.81
	7.1-9.0° n = 166	7.42 0.65 A	18.07 2.94 ABCDEG	10.65 2.81
	9.1-11.0° n = 120	9.33 0.74 A	19.63 2.37 AEG	10.30 2.28
	11.1-13.0° n = 60	10.93 0.86 A	19.71 2.52 BFHa	8.79 2.39
	13.1-15.0° n = 22	13.00 0.92 A	21.31 2.43 CGIa	8.31 2.31
	15.1-17.0° n = 5	14.80 1.09	20.60 2.07	5.80 1.64

A, a – means in columns with the same letters are significant: capital letters – $P \leq 0.01$, small letters – $P \leq 0.05$.

Analysis of the differences in height between particular conformation traits, resulting from extreme values observed within particular rump conformation types showed that the greatest disproportions occurred for hips-pins ($\Delta = 9.32$ cm), sacrum-pins ($\Delta = 8.15$ cm) and pins-thurl ($\Delta = -6.06$ cm). Meanwhile, the differences calculated in the same manner for the other parameters were markedly lower and ranged from 0.14 to 4.57 cm (absolute values).

Table 4. Suitability of selected sets of first calver conformation traits that determine easy calving

Traits	Wald test		
	value of parameter	χ2	p
Free term	–5.34	63.00	0.0001
Width of hips – SB /cm/	0.06	33.26	0.0001
Width of pins – SK /cm/	0.07	41.14	0.0001
$P(Y) = \frac{\exp(-5.34 + 0.06\ SB + 0.07\ SK)}{1 + \exp(-5.34 + 0.06\ SB + 0.07\ SK)}$			
Free term	–4.10	4.58	0.03
Height at pins – WK /cm/	–0.05	7.01	0.008
Height at thurls – WKR /cm/	0.09	20.55	0.001
$P(Y) = \frac{\exp(-4.10 - 0.05\ WK + 0.09\ WKR)}{1 + \exp(-4.10 - 0.05\ WK + 0.09\ WKR)}$			
Free term	–3.96	25.13	0.0001
Oblique pelvic length – SDM /cm/	0.07	18.20	0.0001
Pelvic length – DM /cm/	–0.002	0.03	0.02
$P(Y) = \frac{\exp(-3.96 + 0.07\ SDM - 0.002\ DM)}{1 + \exp(-3.96 + 0.07\ SDM - 0.002\ DM)}$			
Free term	–1.41	0.75	0.38
Width of thurls – SKR /cm/	–0.09	10.49	0.001
Width of pins – SK /cm/	0.11	26.82	0.001
Pelvic length – DM /cm/	0.04	3.11	0.05
$P(Y) = \frac{\exp(-1.41 - 0.09\ SKR + 0.11\ SK + 0.04\ DM)}{1 + \exp(-1.41 - 0.09\ SKR + 0.11\ SK + 0.04\ DM)}$			

Table 4 shows some cow conformation traits that determine the course of calving based on the Wald test. Of the traits associated with external measurements of the pelvis, calving ease was most strongly influenced by the set of two traits describing both the width of hips and the width of pins. The measurements of height at thurls and pins were equally reliable. Slightly lower reliability was characteristic of pelvic length measurements (oblique pelvic length and pelvic length) and the set of traits associated with the width of thurls and pins together with pelvic length. Taking into account the parameters of the analysed traits given in Table 4, logistic regression functions were developed to determine the probability of easy calvings, which are shown in the table.

We also tested the possibility of using cattle growth indices in selection for easy calving (Table 5). Individual parameters were subjected to the same analysis as the earlier sets of measurements. It was found that of the presented indices, the most reliable index is based on the difference in height between hips and thurls and between pins and thurls. Likewise, the difference in the height at hips and pins has a significant effect on calving ease, although the coefficient of repeatability is lower. The other indices were unrelated to the course of parturition and cannot be used to predict calving ease.

Table 5. Suitability of first calver conformation indices that determine easy calving

Cow conformation indices	Wald test		P
	value of parameter	$\chi 2$	
Height at sacrum – height at pins	–0.03	0.81	0.36
Height at sacrum – height at thurls	–0.02	2.87	0.09
Height at sacrum – height at hips	–0.006	0.02	0.87
Height at hips – height at pins	0.09	4.42	0.03
Height at hips – height at thurls	–0.08	18.28	0.0001
Height at pins – height at thurls	–0.05	6.42	0.01

Discussion

Analysis of the cows' height measurements in Table 1 clearly indicates that measurable rump traits (height at sacrum, pins and hips) are related to rump angle. However, it is difficult to find exhaustive information on such relationships in the existing literature. Ali et al. (1984) found a non-significant positive correlation between height at thurls (r = 0.16), pins (r = 0.08) and hips (r = 0.16) and rump angle. They also showed these traits to be significantly correlated in the range from r = 0.76 (hips-pins) to r = 0.91 (hips-thurl), thus indicating that rump angle can be predicted based on each of these traits with comparable accuracy. Our study showed that the increase in height at pins and thurls caused a steady decrease in rump angle ($P<0.01$), while the increase in height at hips translated into a steady increase in rump angle ($P<0.01$). It was shown that each degree of change towards level rump resulted from the decrease in height at pins by 0.45 cm on average, and each degree of change towards sloping rump resulted from the decrease of 0.59 cm on average. We evaluated the usefulness of measuring height at thurls, which in the study by Ali et al. (1984) was correlated with height at pins (r = 0.83). The evaluation showed that in addition to measurement of height at pins, this measurement is as much useful for determining rump angle change from level rump to sloping rump. Analysis of height at hips demonstrated that the mean increase of height from 0.24 cm to 0.49 cm was reflected in one degree of change in rump angle from level rump to sloping rump. While the effect of these traits on rump angle was significant, the relationships under discussion were not so conclusive for the measurement of height at withers. The change in rump angle from raised rump to level rump was due to increased measurement of the analysed trait by an average of 0.58 cm for each degree, but a further increase did not have such a significant effect on the analysed trait (sloping rump) and ranged from 0.03 to 0.13 cm for each degree. This may suggest that this trait determines rump angle only to a certain extent, and after exceeding a certain height (137.40 cm in our study) the effect is much weaker.

Our study supports the findings of Nogalski (2003), who observed a significant but negative correlation (r = –0.18) between height at withers and rump angle. In HF breeds Johnson et al. (1988) reported highly significant correlations between pelvic angle (defined as the difference in height between point of hip and point of rump and between point of hip and thurl) and internal pelvis measurements (i.e. pelvic width and area). According to the above authors, rump angle was highly significantly and positively correlated ($r = 0.20$) with pelvic height, and pelvic height was highly significantly correlated with the difference in height between point of hip and point of rump. In our study we only concentrated on the effect these differences have on rump angle and showed that the above parameters positively affected ($P<0.01$) the change from raised rump to sloping rump (Table 3). Ali et al. (1984) demonstrated that slope from hip to pin was positively correlated with slope from hip to thurl ($r = 0.81$) and negatively with slope from thurl to pin ($r = –0.75$), while slope from hip to thurl was negatively correlated with slope from thurl to pin ($r = –0.33$). Our results indicate a significant effect of four out of six parameters analysed (i.e. the difference in height between sacrum and point of rump, between sacrum and thurl, between point of hip and point of rump, and between point of hip and thurl) on rump slope (Tables 2 and 3). These results suggest that the increase in the above differences was highly significantly ($P<0.01$) correlated with the increase in rump angle, i.e. the gradual change from raised rump to sloping rump. This change was determined the most by the differences in height between sacrum and point of rump and between point of hip and point of rump (a change of one degree as a result of the difference increased by 0.90–1.00 cm on average), and to a lesser degree by the difference between sacrum and thurl and between point of hip and thurl (a change of one degree as a result of the difference increased by 0.71–0.77 cm on average). Thus the analysis showed that rump angle can be predicted based on the analysed indices with comparable and high accuracy. The evaluation of linear regression parameters for significance using the Wald test clearly showed the conformation traits that are important in terms of future calving ease. Both the measurements of pelvic width (determined in hips and thurls) and the measurements of pelvic angle (expressed as height at pins and thurls) were clearly shown to have a highly significant effect on calving ease. It was also demonstrated that the association of three measurements (i.e. width of thurls, width of pins and pelvic length) had a significant effect on the course of parturition ($P<0.01–0.05$). Similar relationships were observed by Cue et al. (1990), who found a correlation between calving ease and width of thurls ($r = 0.33$) and width of pins ($r = 0.43$). Ali et al. (1984) reported the effect of width of pins on calving ease, while Dadati et al. (1985) did not observe these relationships. Different results from ours were obtained by Johnson et al. (1988), who showed that width of pins and height at thurls have no effect on the course of parturition whatsoever. However, they demonstrated that pelvic area, height and width are highly significantly correlated with measurements such as width of hips ($r = 0.51$) and height at pins ($r = 0.51$) and thus may affect the course of parturition. Nogalski (2004) reported that the width of pins and especially the width of hips are highly significantly correlated with the internal measurements of the pelvic canal. Bellows et al. (1971) found the correlation between the width of hips and the internal pelvic measurement to be significant. In our study, we also found that both pelvic length and oblique pelvic length ($P<0.01$), i.e. the parameters directly describing pelvic area, determined calving ease. Likewise, earlier studies by

Nogalski (2004) and Wójcik and Choroszy (2007) showed a significant effect of pelvic length on calving ease. Analysis of the results for growth indices that determine easy calving (Table 5) showed that the indices for measurements of height at hips and thurls (P<0.0001) and height at pins and thurls (P<0.01) are the most reliable. Slightly lower parameters were obtained by the index based on measurements of hips and pins (P<0.03), but also Johnson et al. (1988) reported that this index is significantly and positively (r = 0.16) correlated with calving ease. Similarly, Naazie et al. (1989, 1991) showed low (r = –0.22) but significant correlations between height at hips and type of parturition.

The present results showed that the change in rump angle from raised rump to sloping rump was paralleled by a steady decrease in height at pins and thurls by an average of 0.45 to 0.58 cm for each degree of rump angle. With the difference in height between point of pelvis and sacrum, rump conformation changed from raised rump to sloping rump. Four out of six conformation indices analysed had a significant effect on rump angle, and the increase in the differences between the analysed traits within the index had a clear effect on rump slope. Among the traits of external pelvic measurements, the greatest effect on calving ease was exerted by a set of measurements describing both the width of hips and pins and the height of thurls and pins. The conformation indices based on the differences in height between hips and thurls and between pins and thurls were the most reliable in predicting easy calvings. The body conformation indices analysed can be successfully used to determine rump conformation and course of parturition.

References

Ali T.E., Burnside E.B., Schaeffer L.R. (1984). Relationship between external body measurements and calving difficulties in Canadian Holstein-Friesian cattle. J. Dairy Sci., 67 (12): 3034–3044.

Bellows R.A., Gibson R.B., Anderson D.C., Short R.E. (1971). Precalving body size and pelvic area relationships in Hereford heifers. J. Anim. Sci., 33: 455–457.

Boldman K.G., Famula T.R. (1985). Association of sire dystocia transmitting ability with progeny linear type traits in Holsteins. J. Dairy Sci., 68: 2052–2061.

Borkowska D., Tarkowski J., Gajewska A. (1995). Współzależność pomiędzy niektórymi cechami pokroju i mleczności krów zarodowych w trzech kolejnych laktacjach. Ann. UMCS, Lublin, Sectio EE Zoot., XIII, 8: 57–61.

Brzozowski P., Kaczmarek A. (1988). Zależność między wymiarami krów i cieląt a przebiegiem ocielenia. Zesz. Probl. Post. Nauk Rol., 333: 185–189.

Cue R.I., Monardes H.G., Hayes J.F. (1990). Relationships of calving ease with type traits. J. Dairy Sci., 73 (12): 3586–3590.

Dadati E., Kennedy B.W., Burnside E.B. (1985). Relationships between conformation and reproduction in Holstein cows. J. Dairy Sci., 68: 2639–2645.

De Jonga G. (1991). What is the optimal rump angle for the dairy cow? Veepro Mag., 11: 20–21.

Guliński P., Litwińczuk Z. (1998). Próba określenia zależności między pokrojem a mlecznością krów czarno-białych. Ann. UMCS, XVI: 33–42.

Hoffman P.C. (1997). Optimum body size of Holstein replacement heifers. J. Dairy Sci., 75: 836–845.

Jagusiak W. (2005). Korelacje genetyczne między cechami wydajności mlecznej a cechami opisowymi typu i budowy u krów czarno-białych. Rocz. Nauk. Zoot., Supl., 22: 525–528.

Johnson S.K., Deutscher G.H., Parkhurst A. (1988). Relationships of pelvic structure, body measurements, pelvic area and calving difficulty. J. Anim Sci., 66: 1081–1088.
Kozaniecki M., Grabowski R., Sciubisz A., Długołęcki L. (1985). Określenie zależności między budową wymienia i zdolnością wydojową krów a zapadalnością na mastitis. Zesz. Probl. Post. Nauk Rol., 300: 137–143.
Mc Clintock S., Beard K., Gilmour A., Goddard M. (2003). Relationships between calving traits in heifers and mature cows in Australia. Interbull Bulletins, 31: 102–106.
Naazie A, Makarechian M., Berg R.T. (1989). Factors influencing calving difficulty in beef heifers. J. Anim. Sci., 67 (12): 3243–3249.
Naazie A., Makarechian M., Berg R.T. (1991). Genetic, phenotypic, and environmental parameter estimates of calving difficulty, weight, and measures of pelvic size in beef heifers. J. Anim. Sci., 69: 4793–4800.
Nogalski Z., Klupczyński J., Miciński J. (2000). Przebieg porodu, wielkość i żywotność cieląt w zależności od wymiarów ciała krów. Rocz. Nauk Zoot., 27, 3: 43–57.
Nogalski Z., Klupczyński J., Miciński J. (2001). Próba określenia zależności między przebiegiem pierwszego porodu a wymiarami miednic u krów. Zesz. Nauk. PTZ, 59: 173–180.
Nogalski Z. (2003). Wpływ udziału genów bydła holsztyńsko-fryzyjskiego na wybrane cechy budowy pierwiastek czarno-białych. Zesz. Nauk. Prz. Hod., 68, 1: 327–335.
Nogalski Z. (2004). Zootechniczne uwarunkowania jakości porodu jałówek i krów czarno-białych. Rozpr. Monogr., UWM Olsztyn, 101: 5–76.
Nogalski Z. (2005). Łatwość porodu a budowa miednic jałówek holsztyńsko-fryzyjskich i jersey. Rocz. Nauk. Zoot., Supl., 22: 579–582.
Philipsson J. (1976). Studies on calving difficulty, stillbirth and associated factors in Swedish cattle breeds. IV. Relationships between calving performance, precalving body measurements and size of pelvic opening in Friesian heifers. Acta Agri. Sand., 2, 6: 221–229.
Sawa A., Neja W. (2001). Częstotliwość rodzenia się jałóweczek, buhajków, bliźniąt oraz występowania anomalii płodu. Zesz. Nauk. Prz. Hod., 59: 255–260.
Steinbock L., Nasholm A., Berglund B., Johansson K., Philipsson J. (2003). Genetic effects on stillbirth and calving difficulty in Swedish Holsteins at first and second calving. J. Dairy Sci., 86: 2228–2235.
Strandberg E., Groen A.F., Soelkner J. (1996). General introduction in international workshop on genetic improvement of functional traits in cattle. Interbull Bulletin, 12: 5–10.
Tyczka J. (1998). Charakterystyka i ocena niektórych czynników wpływajacych na przebieg porodu u krów rasy czerwono-białej. Zesz. Nauk. AR Wrocław, 350: 173–197.
Wójcik P. (2002). Selekcja bydła mlecznego w oparciu o cechy pokroju. Rocz. Nauk. Zoot., 15: 99–104.
Wójcik P., Czaja H., Majewska A. (2002). Współzależności pomiędzy oceną pokroju zwierzęcia a późniejszą wydajnością mleczną. Zesz. Nauk. Prz. Hod., 62: 37–43.
Wójcik P., Czaja H. (2003). Selekcja bydła mlecznego pod kątem budowy zadu i łatwości wycieleń. Zesz. Nauk. Prz. Hod., 67: 57–65.
Wójcik P., Choroszy B. (2007). Zmiany wymiarów miednicy w kolejnych wycieleniach i ich wpływ na przebieg porodu u krów rasy polskiej holsztyńsko-fryzyjskiej. Rocz. Nauk. PTZ, 3, 1: 91–99.

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Wykorzystanie pomiarów zoometrycznych krów przy określaniu budowy zadu i przebiegu porodu

STRESZCZENIE

Badania przeprowadzono na krowach rasy PHF odmiany czarno-białej (900 sztuk). W tym celu wykonano 13 pomiarów zoometrycznych w okresie 26–30 dni przed ocieleniem. Wpływ poszczególnych pomiarów oraz indeksów na łatwość porodów określono przy pomocy testu χ^2 Walda. Oszacowano istotność współczynników regresji logistycznej cech opisujących budowę ciała pierwiastek na łatwość porodu. Zaobserwowano, że zmianie kąta ustawienia zadu od uniesionego do spadzistego towarzyszyło systematyczne zmniejszanie się wysokości w kulszach i krętarzach średnio od 0,45 do 0,58 cm na każdy stopień kąta ustawienia zadu. Stwierdzono znaczący wpływ czterech z sześciu badanych indeksów budowy krowy na kąt ustawienia zadu, a wzrost różnic pomiędzy badanymi cechami w obrębie indeksu wyraźnie determinował jego nachylenie. Spośród cech związanych z wymiarami zewnętrznymi miednicy najwyższy wpływ na łatwość porodów miała grupa pomiarów opisujących zarówno szerokość w biodrach i kulszach, jak i wysokość w krętarzach i kulszach. Wykazano, że indeksy budowy oparte o różnice wysokości w biodrach i krętarzach oraz kulszach i krętarzach były najbardziej wiarygodne w przewidywaniu łatwych porodów. Tym samym badane indeksy budowy zwierzęcia można z powodzeniem stosować w określaniu budowy zadu i przebiegu porodu.