Research Article:

EXTERNAL PELVIMETRY OF CATTLE AND BUFFALOES AND ITS ASSOCIATION WITH THE INCIDENCE OF DYSTOCIA

Ashesh Kafle[a], Gokarna Gautam[b]*, Amrit Poudel[a] and Bishal Kandel[a]

[a]Faculty of Animal Science, Veterinary Science and Fisheries, Agriculture and Forestry University, Rampur, Chitwan, Nepal

[b]Department of Theriogenology, Faculty of Animal Science, Veterinary Science and Fisheries, Agriculture and Forestry University, Rampur, Chitwan, Nepal

*Corresponding author: ggautam@afu.edu.np

DOI: https://doi.org/10.3126/jafu.v7i1.95405

Received date: 28 Feb 2026; **Revised date:** 09 May 2026; **Accepted date:** 15 May 2026; **Published date:** 10 Jun 2026

ABSTRACT

Pelvimetry is the measurement of dimensions of bony pelvis for the assessment of pelvic area. The objectives of this study were to determine the pelvic dimensions of cross-bred cattle and buffaloes using non-invasive external pelvimetry and to understand the association of pelvic dimension with the incidence of dystocia. Total 111 cows and 58 buffaloes were included in the study. Distances between two hook bones, two pin bones and that from top of the croup to the level of hip joint were measured using a measuring tape and scale; the established formulas were used to determine the transverse and conjugate diameters, mean diameter and area of the pelvic inlet. Body weight was estimated using a Shaeffer's formula by measuring heart girth and body length. Conjugate diameter and pelvic area to body weight ratio (PA:BW) were found to be significantly lower in dystocic animals than in non-dystocic ones. Pelvic area was additional significant parameter in dystocic buffaloes. Conjugate diameter was significantly associated with higher odds of dystocia. There was a tendency that male calves had 6.23 times greater odds of causing dystocia than female calves. This study documented pelvimetric data and its association with dystocia in cross-bred cattle and buffalo in Nepal, which could be an important selection criteria in breeding programs.

Keywords: Breeding program, conjugate diameter, pelvic area, selection tool

INTRODUCTION

Cattle and buffaloes are two most common livestock species reared by Nepalese farmers. In terms of animal mass units, cattle and buffaloes are two largest livestock species in Nepal, with their population 5,198,388 and 3,307,031, respectively (Krishi Diary, 2025). Since indigenous breeds are less productive in terms of milk production, exotic crossbred cows are preferred for commercial purpose (Gautam & Khadka, 2022). Major exotic crossbreds reared are Holstein cross and Jersey cross; and one of the important reproductive disorders affecting them is dystocia.

Dystocia means difficulty in giving birth, which may be due to both maternal and fetal factors. There were cases of dystocia based mortality because of the cross breeding of local Achhami cattle with other larger breeds in Far-western Nepal (Pandeya et al., 2020). A study ranked the dystocia incidence in different crosses and observed that the highest number of dystocia cases was shown by F1 of Nepali Non-descript x Holstein Friesian (Pradhan et al., 1992). Also, dystocic cows had 2.9 times higher risk of re-experiencing dystocia in the future (Mee et al., 2009). Among several causes, fetopelvic disproportion is recognized as the principal cause of dystocia (Tsaousioti et al., 2023).

Pelvimetry is branch of obstetrics that deals with the study of the pelvic size and dimensions. Rice Pelvimeter is a device used to measure the internal pelvic sizes (Price & Wiltbank, 1978; Thandavan et al., 2021). But due to the potential damage to rectal mucosa, this method is used less these days due to growing animal welfare concerns. External pelvimetry is a non-invasive tool to determine external dimensions of the pelvis, and also has significant correlation with internal pelvic sizes (Dhaliwal et al., 1981).

Pelvimetry aids in timely culling and replacement of heifers from the herd at pre-breeding and pre-calving period. Although, there are studies on pelvimetry and its association with dystocia in pure breeds like Jersey and Holstein, the pelvic size of crossbreeds and Nepalese indigenous cows is still under-explored (Sharma et al., 2020). Also, there has not been any study that has established a baseline pelvimetric profile of cattle and buffaloes in Nepal. This study aims to determine breed-wise and parity-wise pelvic dimensions of cattle and buffaloes using non-invasive external pelvimetry tool and to understand the association of pelvic dimension with the incidence of dystocia in crossbred dairy cattle and buffaloes.

RESEARCH METHODS

All research involving human participants, use of animals and field studies complied with institutional, national and international ethical standards. The study involved only the non-invasive tool.

Study site

This study was conducted in the livestock farms of the Agriculture and Forestry University (AFU), and the National Cattle Research Program (NCRP), Rampur, Chitwan, Nepal and household farms of wards 12, 15, 17 and 19 of Bharatpur metropolitan city (27°41′15″N, 84°25′30″E). The study was conducted from October to December 2025.

Animals

A total of 169 animals, cattle (n = 111) and buffaloes (n = 58) were selected from the research sites that included 17 dystocic and 152 non-dystocic ones (Table 1). Purposive selection of dystocic ones was done from the nearest areas around the vicinity of AFU, Rampur, Chitwan. Animals with a history of dystocia were identified initially by the animal's history provided by farmers and the confirmation was done by local veterinary doctors or technicians, who handled the case.

Table 1. Number of cows and buffaloes used in the study

Species	Breed	No history of dystocia	History of dystocia	Total
	Jersey cross	53	9	62
Cow	Holstein cross	41	2	43
	Sahiwal	6	0	6
Buffalo	Murrah cross	52	6	58
Total		152	17	169

Measurement of pelvic dimensions

Identification of three breeds of cattle (Jersey cross-bred, Holstein cross-bred and Sahiwal-bred) and one breed of buffalo (Murrah cross-bred) was done based on their external phenotypic appearance and data from record books. The measurement of various distances was done using a measuring tape. Wooden sticks and a regular sized 30 cm scale were used for assistance. Measurement of distance between two hook bones (A), the lower and innermost part of two pin bones (B) and top of the croup to level of hip joint (C) in cm was done to estimate the transverse and conjugate diameters using the formula described earlier (Kalyaan et al., 2021).

Transverse diameter of pelvic outlet (cm) = 1/4 * (A+B)

Conjugate diameter of pelvic outlet (cm) = 3/4 * (C)

Transverse diameter of pelvic inlet (cm) = 12.2/10 * (Transverse diameter of pelvic outlet)

Conjugate diameter of pelvic inlet (cm) = 13/10 * (Conjugate diameter of pelvic outlet)

Pelvic area = Transverse diameter of pelvic inlet (cm) x Vertical diameter of pelvic inlet (cm) (Dhaliwal et al., 1981)

Measurement of heart girth (circumference of chest just behind the forelimbs) and body length (distance between tip of shoulder and pin bone) was also done to estimate the body weight of the animal using the Shaeffer's formula (Sánchez-Rodríguez et al., 2023).

Live body weight (lbs.) = [Heart girth^2 (in) * Body length (in)] / 300

Any available data regarding risk factors of dystocia like breed, parity, calving season, calf sex, date of AI, calf birth weight were also recorded.

Data analysis

Data were analyzed using MS excel 2016 (Version16.0) and R studio version 4.5.1. The normality of data was checked by performing Shapiro-Wilk test. Kruskal-Wallis test was performed to investigate the difference in pelvic diameters across parities. Wilcoxon rank-sum test was performed to compare the mean diameters between dystocic and non-dystocic animals for any significant differences at 5% significance level. Logistic regression and odds ratio values were computed to assess the effect of various risk factors on the incidence of dystocia.

RESULTS AND DISCUSSION

Descriptive statistics of external pelvic measurements

The distance (mean±SD) between two hook bones in the first parity Jersey cross-bred cows was 36.3±2.58 cm, which was less than that (45.5 cm) in pure Jersey cows reported by a previous study (McDowell et al., 1954). Likewise, the distance (mean±SD) between two hook bones in the first parity Holstein cross-bred cows was 39.5±2.36 cm, which was less than that observed in pure Holstein cows (Nogalski & Mordas, 2012; Tsaousioti et al., 2023). These differences indicate that the width at hook bones in cross-bred cows was lower than in the pure breeds of Jersey and Holstein cows. Similarly, the distance between two pin bones of Jersey cross-bred and Holstein cross-bred was 12.33 cm, 12.82 cm, respectively, which was comparable to the findings of other studies that reported an average pin width of 13 cm and 11.8 cm, respectively (Coopman et al., 2003; Murray et al., 1999).

The distance between two hook bones in first, second or greater than second parity Murrah cross-bred buffaloes (47.2 cm, 49.7 cm and 54.1 cm, respectively) was almost similar to that (47 cm) reported by a previous study in lactating Murrah buffaloes (Dahiya et al., 2020), but smaller than that (62.8 to 64.1 cm) reported by another study (Alvarenga et al., 2001). This discrepancy might be due to differences in the breed of the buffalo as well as the nutritional and growth status of the animal. The hook width continued to increase with respect to parity.

Descriptive statistics of pelvic dimensions in cattle and buffaloes

The external pelvic parameters were used to compute the transverse and conjugate diameters of the pelvic inlet. Dimensions were computed for each breed and parity. Kruskal-Wallis test revealed that both the conjugate and transverse diameters in Holstein cross-bred cows were not significantly different across parity (Table 2), highlighting the fact that there was no significant increase in the dimension of pelvic cavity after first parity in Holstein cross-bred cows. However, in Jersey cross-bred, although the conjugate diameter remained similar across parities, the transverse diameter significantly increased from first to third parity, indicating that width of the pelvic cavity increases even up to third parity. There were only six cows of Sahiwal breed and no information was available regarding the parity; thus, the parity-wise comparison within Sahiwal breed was not done, and only the overall diameters were determined.

Table 2. Descriptive statistics of pelvic diameters at pelvic inlet in cattle

Breed	Parity	No. of animals	Conjugate diameter (cm)		Transverse diameter (cm)	
			Mean ± SD	Median	Mean ±SD	Median
Jersey cross-bred	1	20	23.27 ± 1.02	23.15	14.60 ± 0.83[a]	14.72
	2	9	23.34 ± 1.36	23.40	15.50 ± 1.2[ab]	15.40
	≥3	20	23.81 ± 0.97	23.64	15.7 ± 0.74[b]	15.55
Holstein cross-bred	1	14	24.13 ± 1.22	24.13	16.33 ± 1.31	16.39
	2	11	23.98 ± 0.74	23.98	17.27 ± 1.74	16.62
	≥3	13	24.62 ± 0.59	24.38	17.21 ± 1.83	16.62
Sahiwal	>1	6	23.40 ± 0.53	23.40	14.87 ± 0.66	14.97

Note: [a, b, c], the values with different superscripts within a column differ significantly within the breed ($p \leq 0.05$).

In Murrah cross-bred buffaloes, both the conjugate and transverse diameters showed significant differences across parities (Table 3) indicating that the dimension of pelvic cavity increases even up to third parity. The data also demonstrated that the buffaloes had significantly greater pelvic diameters and area than cows. The conjugate diameter was greater than the transverse diameter both in cattle and buffaloes. Similar findings were reported by the previous studies (Perumal et al., 2019; Sary et al. 2022; Shalik et al., 2024).

Table 3. Descriptive statistics of pelvic diameters at pelvic inlet in Murrah crossbred buffaloes

Parity	No. of buffaloes	Conjugate diameter (cm)		Transverse diameter (cm)	
		Mean ±SD	Median	Mean ± SD	Median
1	5	25.15 ± 1.74[a]	25.83	18.85 ± 0.5[a]	18.91
2	9	26.48 ± 0.55[ab]	26.81	19.69 ± 0.64[b]	19.82
≥3	36	27.72 ± 1.89[c]	27.54	21.43 ± 1.07[c]	21.35

Note: [a, b, c] values with different superscripts within a column differ significantly ($p \leq 0.05$).

Comparison of pelvic dimensions between dystocia and non-dystocia cases

There were only two cases of dystocia in Holstein cross-bred. Thus, the pelvic dimensions between dystocia and non-dystocia cases were compared only in Jersey cross-bred cows and Murrah cross-bred buffaloes. Wilcoxon rank-sum test performed for the comparison of pelvic diameters of dystocic and non-dystocic Jersey cross-bred cows revealed that dystocic cows had significantly smaller conjugate diameter, mean diameter and ratio of pelvic area to body weight as compared to non-dystocic ones (Table 4). Furthermore, there was a tendency ($p = 0.07$) that the pelvic area in Jersey cross-bred cows was smaller in dystocia cases than in non-dystocia cases.

Table 4. Comparison of pelvimetry between dystocia and non-dystocia cases in Jersey cows

Parameters (Mean ± SD)	Dystocia (n=9)	Non-dystocia (n=53)	p-value
Conjugate diameter at pelvic inlet, cm (A)	22.04 ± 0.9	23.50 ± 1.08	<0.001
Transverse diameter at pelvic inlet, cm (B)	15.45 ± 0.66	15.21 ± 1.0	0.49
Mean diameter of pelvic inlet, cm [(A+B)/2]	18.74 ± 0.5	19.36 ± 0.84	0.01
Pelvic area, cm^2 (A x B)	340.56 ± 17.91	358.05 ± 32.55	0.07
PA:BW*	0.88 ± 0.09	0.97 ± 0.11	0.03

Note: *PA:BW; ratio of pelvic area to body weight of the animal.

Likewise, in Murrah cross-bred buffaloes, the dystocic buffaloes had significantly smaller conjugate diameter, mean diameter, pelvic area and the ratio of pelvic area to body weight as compared to non-dystocic ones (Table 5).

Table 5. Comparison of pelvimetry between dystocia and non-dystocia cases in buffaloes

Parameters (Mean ± SD)	Dystocia (n=7)	Non-dystocia (n=51)	p-value
Conjugate diameter at pelvic inlet, cm (A)	25.18 ± 1.91	27.77 ± 2.23	<0.001
Transverse diameter at pelvic inlet, cm (B)	20.58 ± 1.44	21.3 ± 1.48	0.22
Mean diameter of pelvic inlet, cm [(A+B)/2]	22.88 ± 1.27	24.53 ± 1.61	0.01
Pelvic area, cm^2 (A x B)	518.84 ± 54.97	593.45 ± 75.22	0.01
PA:BW*	0.92 ± 0.06	1.1 ± 0.17	0.02

Note: *PA:BW; ratio of pelvic area to body weight of the animal.

In a previous study, the pelvic area in cows calving unassisted had 11-23% larger pelvic area compared to those that required assistance (Murray et al., 1999). Another study also reported that for every 1cm^2 increase in pelvic area, the odds of dystocia decreased by 2% (Holm et al., 2014). Similar findings were reported by Van Donkersgoed et al. (1993).

In the present study, the pelvic area of the animal with respect to its body weight (PA:BW) was significantly smaller in dystocic cattle and buffaloes than the non-dystocic ones. Previous study demonstrated that the culling of the animals by PA:BW resulted in lower dystocia rates (Holm et al., 2014).

Risk factors of dystocia

Multiple logistic regression revealed that for one-unit increase in conjugate diameter, the odds of dystocia decreased by 86%, indicating that cows with smaller pelvic diameter were more likely to experience dystocia (Table 6). There was a tendency ($p = 0.08$) that male calves had 6.23 times greater odds of causing dystocia compared to female calves. This was in agreement with the previous study that demonstrated that the male calves had three times greater odds of having dystocia as compared to female calves (Tsaousioti et al., 2023). This could be because the male calves weigh more than female calves, which increased the odds of dystocia incidence.

In the present study, there was no significant difference on the incidence of dystocia between Jersey cross-bred and Holstein cross-bred. Previous study reported that Jersey cows having smaller pelvis, experienced more cases of dystocia than Holstein cows (Smeaton et al., 2004). In contrary, another study demonstrated that the incidence of dystocia was higher in Holstein-Friesians (15.2%) than in Jersey (2.2%) heifers; this was supported by the fact that the Holstein-Friesians, compared with Jersey cows, had a higher calf weight to cow weight ratio, and higher ratios of pelvic area to cow weight and pelvic area to calf weight (Nogalski & Mordas, 2012). Problems of dystocia incidence in pure breeds of Holstein and Jerseys due to feto-pelvic disproportion may be managed by the crossbreeding of pure Jerseys and Holsteins by local cattle bull. Parity also did not have a significant effect on dystocia. However, studies have shown that the heifers are at a higher risk of dystocia than parous cows. The first parity cows had 4.7 times greater odds of experiencing dystocia than pluriparous cows (Johanson & Berger, 2003; Gaafar et al., 2011). This may be due to difference in age at first calving. As cows and buffaloes conceive late in Nepal compared to other countries, there was more time for pelvic growth.

Table 6. Multiple logistic regression of risk factors of dystocia in cattle

Parameters	Level	n	Incidence of dystocia (%)	Odds ratio	95% CI	p-value
Calf sex	Female	51	7.84	Reference		
	Male	47	14.89	6.23	0.79 - 49.0	0.08
Breed	Holstein cross-bred	40	5.0	Reference		
	Jersey cross-bred	58	15.51	2.31	0.2 - 27.36	0.51
Parity	Pluriparous	60	11.67	Reference		
	Primiparous	38	10.52	1.07	0.13 - 8.82	0.94
Conjugate diameter at pelvic inlet	Continuous variable	98	-	0.14	0.05 - 0.41	<0.001

Complete information regarding history of either natural breeding or artificial insemination (AI) and the occurrence of dystocia or no dystocia in the latest calving was available for 98 cows. Among those, the incidence of dystocia was 12.8% (6/47) in cows with natural breeding and 9.8% (5/51) in cows with AI, which was not statistically different ($P = 0.64$). This was not in alignment with the findings of a study in Bangladesh that reported that the artificially inseminated dairy cows had a higher dystocia rate compared with naturally inseminated cows (Wasef & Islam, 2024). No difference in the incidence of dytocia between naturally inseminated and artificially inseminated cows in the present study can be assumed due to the use of moderate-sized sires both in case of natural breeding and AI program.

CONCLUSION

The pelvimetric data of cross-bred cattle and Murrah buffaloes of Nepal were documented using external pelvimetric measurements. Study demonstrated that the selection of dams with appropriate conjugate diameter and the ratio of pelvic area to body weight could significantly reduce the risk of dystocia. Conjugate diameter was more important predictor than transverse diameter; each centimeter decrease in conjugate diameter was associated with significant increase in the likelihood of dystocia. Overall, the findings suggested that the simple non-invasive external pelvimetry can be a useful tool to reduce the risk of dystocia in cattle and buffalo. Incorporating pelvic assessment into breeding plans might contribute to reducing calving difficulties and improving reproductive efficiency in cattle and buffaloes.

ACKNOWLEDGEMENTS

The authors would like to thank the staffs of National Cattle Research Program, Livestock farm of AFU and the owners of the study animals for their support and cooperation. We are also thankful to Prasiddha Sapkota, Sudip Sharma, Roshan Babu Pandey, Prashant Pandey, Manoj Sherpali, Saroj Khadka and Suman Khadka for their assistance during pelvimetry and data collection.

AUTHOR CONTRIBUTIONS:

AK: Methodology, Formal analysis, Writing – original draft; **GG:** Conceptualization, Methodology, Formal analysis, Writing – original draft, Writing – review & editing, Visualization, Supervision; **AP:** Methodology, Writing – original draft; **BK:** Methodology, Writing – original draft.

CONFLICT OF INTEREST

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

ETHICAL APPROVAL AND PERMITS

Not applicable.

REFERENCES

Alvarenga, C., Bombonato, P., Baruselli, P., Oliveira, J., & Souza, A. (2001). Pelvimetry and pelvilogy in female mixed buffaloes (*Bubalus bubalis*). *Brazilian Journal of Veterinary Research and Animal Science, 38*(3), 114–121. https://doi.org/10.1590/S1413-95962001000300004

Coopman, F., De Smet, S., Gengler, N., Haegeman, A., Jacobs, K., Van Poucke, M., Laevens, H., Van Zeveren, A., & Groen, A. F. (2003). Estimating internal pelvic sizes using external body measurements in the double-muscled Belgian Blue beef breed. *Animal Science, 76*(2), 229–235. https://doi.org/10.1017/S1357729800053480

Dahiya, S. P., Kumar, M., Dhillod, S., & Patil, C. S. (2020). Relationship of linear type traits with production and reproduction performance in Murrah buffaloes. *Indian Journal of Animal Sciences, 90*(6), 875–879.

Dhaliwal, A. S., Dugwekar, Y. G., & Sharma, R. D. (1981). In vivo pelvimetry in buffaloes (*Bos bubalus*). *Theriogenology, 15*(5), 501–504. https://doi.org/10.1016/0093-691X(81)90093-5

Gaafar, H. M. A., Shamiah, Sh. M., El-Hamd, M. A. A., Shitta, A. A., & El-Din, M. A. T. (2011). Dystocia in Friesian cows and its effects on postpartum reproductive performance and milk production. *Tropical Animal Health and Production, 43*(1), 229–234. https://doi.org/10.1007/s11250-010-9682-3

Gautam, G., & Khadka, U. (2022). Reproductive and productive performance of crossbred and Terai cattle in Bardiya District of Nepal. *Journal of Nepal Agricultural Research Council, 8*, 64–71. https://doi.org/10.3126/jnarc.v8i.44862

Holm, D. E., Webb, E. C., & Thompson, P. N. (2014). A new application of pelvis area data as a culling tool to aid in the management of dystocia in heifers. *Journal of Animal Science, 92*(5), 2296–2303. https://doi.org/10.2527/jas.2013-6967

Johanson, J. M., & Berger, P. J. (2003). Birth weight as a predictor of calving ease and perinatal mortality in Holstein cattle. *Journal of Dairy Science, 86*(11), 3745–3755. https://doi.org/10.3168/jds.S0022-0302(03)73981-2

Kalyaan, U. S., Rajalakshmi, R., Rangasamy, S., Gnana Devi, R., & Arthanari, T. A. K. (2021). Pelvimetry—a boon to bovine breeding. *Raksha Technical Review, 11*(1), 17–24.

Ministry of Agriculture and Livestock Development, Nepal. (2025). *Krishi Diary 2082 (2025).* Agriculture Information and Training Center, Hariharbhawan, Lalitpur, Nepal.

McDowell, R. E., Lee, D. H. K., McMullan, H. W., Fohrman, M. H., & Swett, W. W. (1954). Body weights, body measurements, and surface area of Jersey and Sindhi-Jersey (F1) crossbred females. *Journal of Dairy Science, 37*(12), 1420–1428. https://doi.org/10.3168/jds.S0022-0302(54)91427-7

Mee, J. F., Berry, D. P., & Cromie, A. R. (2009). Risk factors for calving assistance and dystocia in pasture-based Holstein-Friesian heifers and cows in Ireland. *The Veterinary Journal, 187*, 189–194. https://doi.org/10.1016/j.tvjl.2009.11.018

Murray, R. D., Cartwright, T. A., Downham, D. Y., & Murray, M. A. (1999). Some maternal factors associated with dystocia in Belgian Blue cattle. *Animal Science, 69*(1), 105–113. https://doi.org/10.1017/S1357729800051134

Nogalski, Z., & Barański, W. (2023). Pelvic dimensions and occurrence of dystocia in Black-and-White and Holstein-Friesian heifers. *Polish Journal of Veterinary Sciences, 26*(4), 687–693. https://doi.org/10.24425/pjvs.2023.148288

Nogalski, Z., & Mordas, W. (2012). Pelvic parameters in Holstein-Friesian and Jersey heifers in relation to their calving. *Pakistan Veterinary Journal, 32*(4), 507–510.

Pandeya, Y. R., Niraula, S., & Ghimire, S. H. (2020). Study on health and husbandry practices of Achhami cattle in farwestern region of Nepal. In *Proceedings of the 11th National Workshop on Livestock and Fisheries Research in Nepal*, 169–172. https://doi.org/10.6084/m9.figshare.12137562.v3

Perumal, P., De, A. K., Bhattacharya, D., Muniswamy, K., Sunder, J., Kundu, A., & Ahmad, S. K. Z. (2019). Pelvimetric profiles in crossbred cows of Andaman and Nicobar Islands. *The Indian Journal of Animal Sciences, 89*(6), 637–639. https://doi.org/10.56093/ijans.v89i6.91119

Pradhan, S. M., Shrestha, R. P., & Shrestha, H. R. (1992). A comparative study on the production performances of the crossbreds (F1) dairy cattle. In *Proceedings of the 1st National Animal Science Convention* (pp. 77–81). National Animal Science Association, Lalitpur, Nepal.

Price, T. D., & Wiltbank, J. N. (1978). Predicting dystocia in heifers. *Theriogenology, 9*(3), 221–249. https://doi.org/10.1016/0093-691X(78)90031-6

Sánchez-Rodríguez, H. L., Colón-Rodríguez, I., & Domenech-Pérez, K. (2023). Shaeffer's formula as an estimator of body weight in slick and wild type-haired Puerto Rican Holstein calves and heifers. *The Journal of Agriculture of the University of Puerto Rico, 107*(2), 109–120. https://doi.org/10.46429/jaupr.v107i2.21237

Sary, R. G., Abdelrahman, H. A., Mohamed, R. H., Hussien, A. M., Hussein, H. A., & Khalil, K. M. (2022). Relationships between the parity and pelvimetry of Egyptian buffalo cows: Prediction of dystocia and estimation of age. *Journal of Buffalo Science, 11*, 1–7. https://doi.org/10.6000/1927-520X.2022.11.01

Shalik, R. S., Bramhadev, K. A., Dinkarrao, P. A., Baburao, N. S., Mukunda, S. A., & Bhagwanrao, D. V. (2024). Systemic investigation of pelvimetric profile in three strains of Deoni cattle. *The Indian Journal of Animal Sciences, 94*(10), 852–855. https://doi.org/10.56093/ijans.v94i10.152293

Sharma, S. P., Sapkota, S., Kolachhapati, M. R., Gorkhali, N. A., Bhattarai, N., & Upadhayay, S. (2020). Review on the association of birth weight of crossbred calf for dystocia. *Journal of the Institute of Agriculture and Animal Science*, 291–298. https://doi.org/10.3126/jiaas.v36i1.48433

Smeaton, D. C., Scott, M. L., Webby, R. W., Cameron, C., McGowan, L., & Brooky, A. (2004). Factors associated with calving difficulty in embryo transfer mated cattle. *Proceedings of the New Zealand Society of Animal Production, 64*, 252–256.

Thandavan, A. K., Rajalakshmi, R., Seerangan, R., Gnana Devi, R., & K., U. S. (2021). Pelvimetry—a boon to bovine breeding. *Epidemiology and Research in Veterinary Science, 11*(1), 17.

Tsaousioti, A., Praxitelous, A., Kok, A., Kiossis, E., Boscos, C., & Tsousis, G. (2023). Association between dam and calf measurements with overall and fetopelvic dystocia in Holstein heifers. *Journal of Dairy Research, 90*(3), 261–268. https://doi.org/10.1017/S0022029923000468

Van Donkersgoed, J., Ribble, C., Booker, C., McCartney, D., & Janzen, E. (1993). The predictive value of pelvimetry on beef cattle. *Canadian Journal of Veterinary Research, 57*, 170–175.

Wasef, A., & Islam, M. (2024). Incidence and management of dystocia of dairy cows in Manoharganj upazila of Cumilla district, Bangladesh. *Ovozoa: Journal of Animal Reproduction, 13*, 178–185. https://doi.org/10.20473/ovz.v13i3.2024.178-185