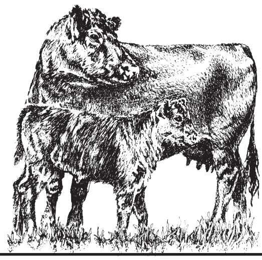

Pelvic Area in Beef Cattle Production

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Calving difficulty (dystocia) results in calf losses, reduced calf health, and delays in rebreeding of cows. Studies from Montana and Oregon indicate that over 50 percent of all calf deaths are from dystocia. The primary cause of dystocia is fetal-pelvic disproportion. In other words, the size of the calf is too great for the size of the pelvic opening.

Primiparous cows (first-calf heifers), because they have smaller pelvises than mature cows, are four to five times more susceptible to dystocia than mature cows. One indicator, according to surveys by the USDA, is the calving assistance rate for primiparous cows is 22 percent compared to 5 percent for mature cows (USDA-APHIS 2009).

Calf birthweight is the primary cause of dystocia, however, sex of calf, dam pelvic area, and dam weight are other major factors. The relative influence of these traits is listed in Table 1.

Table 1. Relative importance of factors affecting dystocia in first-calf 2-year-old heifers.

Factor	Statistical sign. level	Importance rating
Calf birthweight	.01	3.05
Dam precalving pelvic area	.05	1.16
Dam precalving weight	.05	1.10
Calf sex	.05	1.00

Source: Miles City, Montana (Bellows 1995).

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For the past 30 years, beef producers have recognized the importance of using sires that produce light birthweight calves to minimize dystocia. Through the development and use of birthweight and calving ease direct EPDs to select bulls to breed heifers, the percentage of primiparous cows that experience dystocia has continued to decline. Still, having to assist 20 to 30 percent of first-calf heifers is time consuming, costly, and frustrating.

Pelvic area is the other part of the dystocia equation. Producers and researchers have been interested in the ability to measure pelvic areas and thereby reduce dystocia. In an Oklahoma study, heifers with small pelvic areas experienced an 85 percent difficulty rate compared to 31 percent difficulty for heifers with large pelvic areas. South Dakota research showed heifers with below average pelvic areas (<140 cm^2) had twice as much dystocia as those with pelvic areas larger than 140 cm^2 (49% vs. 24%) (Deutscher 1975).

A classic Montana study (Bellows 1995), using records from thousands of heifers and calvings, demonstrated that keeping calf birthweight low while increasing the pelvic opening will reduce calving problems. Unfortunately, pelvic area is highly correlated to other skeletal and growth traits, so if heifers are selected for greater pelvic area then they are usually larger heifers as well.

Table 2 (Gregory et al. 1993) gives the heritability of traits related to birth as well as the genetic and phenotypic correlations between traits. Although pelvic area is heritable [$h^2 = 0.30$ (other studies indicate $h^2 > 0.50$)] and will respond to selection, undesirable responses in other traits may be noted. The high genetic correlation

Table 2. Relationship of pelvic area and calf birthweight and dystocia for females producing calves at Meat Animal Research Center (MARC).

	Pelvic area (cm)	Birthweight (lb)	368-d weight (lb)	Calving diff. score	368-d height (inches)	Calving diff. (%)
Pelvic area (cm)	**.30**	.62	.81	.55	-.26	-.19
368-d weight (lb)	.39	**.43**	.74	.40	.01	.27
368-d height (inches)	.38	.62	**.39**	.44	.03	.29
Calf birthweight (lb)	.13	.23	.24	**.25**	.50	.52
Calving difficulty score	-.09	.00	-.06	.51	**.12**	.90
Calving difficulty (%)	-.07	.01	-.03	.40	.85	**.07**

Heritability on diagonal: genetic correlation above; phenotypic correlation below.
Source: MARC (Gregory et al. 1993).

(r_g = 0.81) between hip height and pelvic size means that selecting for larger pelvic size also selects taller and heavier heifers (r_g = 0.62). These heifers tend to give birth to larger calves (r_g = 0.55), thus a direct reduction in dystocia is not seen.

Multiple studies from the U.S., Canada, and South Africa examined different methods to use pelvic area measurements alone or in combination with other measurements such as bodyweight, hip height, or age to predict a heifer's likelihood of experiencing dystocia (Basarab et al. 1993; Nix et al. 1998; Holm et al. 2014). Some of these studies generated complex prediction equations or formulas incorporating multiple measurements. In general, these studies found:

- Groups of heifers with small pelvic areas experience a greater incidence of dystocia than heifers with larger pelvic areas.
- Pelvic area measurements, even when included in complex formulas, are more effective in predicting heifers that **will not** experience dystocia than they are at predicting heifers that **will** have calving problems.
- When these predictions were used across large groups of heifers, pelvic area measurements alone or as part of a formula did not have a huge impact on reducing incidence of dystocia.

Using Heifer Pelvic Measurements

If pelvic measurements have limited value in predicting dystocia, should they be taken? If so, how should they be used? The best use of pelvic measurements is to identify heifers with abnormally small or misshapen pelvises. These heifers can then be eliminated from the breeding pool.

Pelvic measurements should be incorporated into a complete prebreeding evaluation program that consists of reproductive tract scoring, vaccinations, and pelvic measurements. Ideally, this exam will take place 30 to 45 days before the beginning of the breeding season.

Such a program helps ensure that a high percentage of the heifers are cycling and could become pregnant early in the breeding season, which should result in reduced incidence of dystocia. The program also would aid in an estrous synchronization and artificial insemination program by determining, and therefore, selecting a high percentage of heifers that are cycling.

The best use of pelvic measurements is to remove heifers that are below a threshold. Typically, this is <140 to 150 cm^2 at 1 year of age. As average cow size has increased in the United States to approximately 1,300 pounds, the 150 cm^2 is preferred. The Missouri Show Me Select Heifer program has used the 150 cm^2 cutoff, along with breeding to calving ease bulls, for thousands of heifers over many years. Producers report a significant decrease in calving difficulty. However, each operation may want to establish their own threshold based on experience, heifer development system, and breed type.

Some producers may wish to adjust pelvic areas of heifers to a standard 365 days of age to compare individuals. This is currently done by using a standard growth factor of 0.27 cm^2/day. This can be an inaccurate adjustment as shown in an Iowa State University study (Strohbehn and Wilson 1993). These results (Table 3) showed that the growth in heifers was not linear and varied with frame score of heifers. Changes in pelvic area varied from 0.23 cm^2/day for frame score 2 and 3 heifers to 0.30 cm^2/day for frame size 6 heifers. Make certain that the adjustments and actual size fits your ranch cattle.

Many operations are developing heifers to a target weight of 55 percent of mature weight compared to the traditional 65 percent of mature weight. Depending on

Table 3. Pelvic area growth in developing beef heifers differing in frame size.

Frame size	12-month pelvic area (cm^2)	Change/day pelvic area (cm^2)
2	131.3	.226
3	138.7	.228
4	148.6	.264
5	161.0	.294
6	165.5	.295
7	176.0	.286
8	185.4	.285

Source: Iowa State University (Strohbehn and Wilson 1993).

the study, heifers developed to 55 percent target weight will have smaller or similar pelvic areas compared to heifers developed to 65 percent (Patterson et al. 1992; Funston and Deutscher 2004). Similarly, reports indicate an increase or no effect on dystocia in heifer developed to lighter target weights. The key is that heifers still need to attain 85 to 90 percent of mature weight by calving time. A prebreeding pelvic area cutoff of 140 cm^2 may be more appropriate for heifers developed to 55 percent of mature weight.

Using Bull Pelvic Measurements

Pelvic size can be transmitted readily from the sire to the resulting progeny. In a Colorado study, a 0.60 genetic correlation was found between male and female pelvic areas, indicating selection for large pelvic size in bulls should result in increased pelvic size for female offspring. Nebraska research on 915 yearling bulls indicated only small differences in average pelvic size among breeds, but a large variation existed among bulls within a breed (Deutscher 1991). However, in recent years less emphasis has been placed on measuring and using bull pelvic area as a selection criterion primarily due to the high correlation among pelvic area and other skeletal measures.

Both direct and maternal effects on calving difficulty must be considered in relation to genetic influences. Calving Ease Direct (CED) indicates the likelihood that heifers mated to a particular bull will experience dystocia. Calving Ease Maternal (CEM) indicates the likelihood that heifers that are daughters of the selected bull will experience dystocia.

A common practice is to select sires for calving ease based only on birthweight (BW) EPD or CED EPD. However, retaining females from multiple generations of sires high CED may result in heifers that are smaller, have smaller pelvic areas, and experience more dystocia. The genetic correlations between direct and maternal components of calving ease are highly negative (-0.30 to -0.80; Burfening et al. 1981; Cubas et al. 1991). With this consideration in mind, sires need to be evaluated on both the direct and indirect (maternal) EPDs for calving ease if daughters are to be considered as candidates for replacement females.

Pelvic areas of bulls are smaller than heifers of the same weight and age. Yearling bulls weighing 900 to 1,100 pounds average about 150 to 170 cm^2 in pelvic area, which is similar to yearling heifers weighing 650 to 700 pounds.

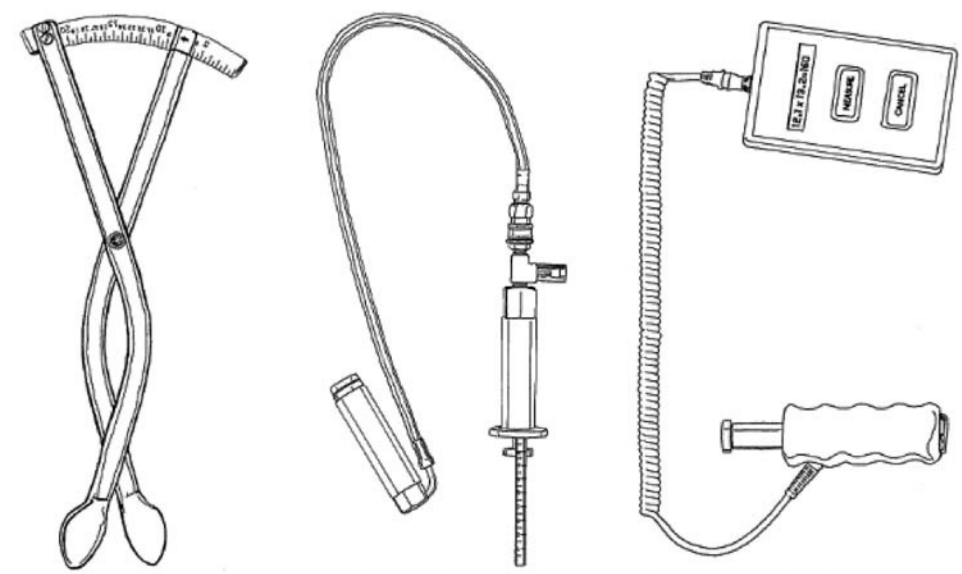
Pelvic area measurements should be adjusted to an average weight or age of bulls in the group in order to compare genetic potential. Age and weight of bulls influence pelvic area. Estimates of pelvic growth rates have been 0.25 cm^2/day of age or 0.09 cm^2/pound of body weight in bulls ranging from 10 to 15 months old and 700 to 1,400 pounds. These values can be used to adjust a set of bulls to a given standard, but both age and weight adjustments should not be used on the same bull.

The best time to measure bulls is when they are yearlings, or at the end of their performance feeding test. A veterinarian can obtain the measurements in combination with the breeding soundness exam (fertility evaluation).

How to Measure Pelvic Area

Several instruments are used to measure pelvic area (Fig. 1). The Rice Pelvimeter (1A) is a metal inside-caliper-type instrument (Lane Manufacturing, Inc., 8200 E. Pacific Pl., Unit 107, Denver, CO 80231 http://www.lane-mfg.com/). Two other types of pelvimeters, the Krautmann-Litton hydraulic (1B) and Equibov electronic micrometer (1C), were previously available, are still reliable products, but are no longer marketed (Krautmann-Litton formerly by Jorgensen Labs, Loveland, CO, and Equibov formerly from Equibov, Rockland, Ontario, Canada).

Users should read and follow instructions for operating each of the instruments. Each instrument is designed to be placed in the rectum of the animal, and the pelvic measurements are read on a scale outside the animal.



A. Rice Pelvimeter B. Krautmann–Litton Bovine Pelvic Meter C. Equibov Bovine Pelvimeter

Fig. 1. Instruments for measuring pelvic area.

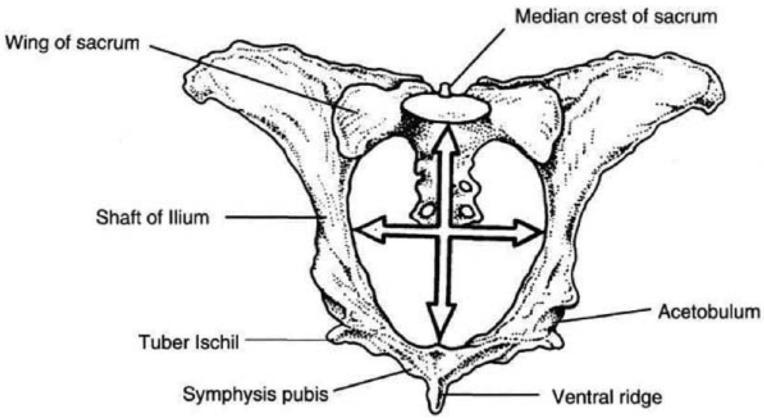


Fig. 2. Location of vertical and horizontal pelvic measurements for calculation of pelvic area (Walker et al. 1992).

Pelvic measurements are taken at points indicated in Fig. 2 and should be taken by someone with experience who has a thorough understanding of the birth canal, pelvic structure, and reproductive tract. Practice and experience are necessary before accurate measurements can be obtained.

The general procedure is to restrain the animal in a chute with light squeeze. A comfortable, normal standing position is best. Feces should be removed from the rectum, and the instrument should be carefully carried into the rectum with the hand. Use of undue force should be avoided during the procedure, since tissues can be torn or injured. Proceed forward with the instrument to the pelvic inlet.

Obtain the width of the pelvic inlet at its widest point, between the right and left shafts of the ilium (Fig. 2). This is the horizontal diameter of the pelvis. Then obtain the height of the pelvic inlet, between the dorsal pubic tubercle on the floor of the pelvis and the sacrum (spinal column) on the top.

Be sure not to slip off the pubic tubercle ventrad or miss the spinal column dorsad. This measurement, which should be the smallest dimension between these points, is the vertical diameter of the pelvis. The two measurements are read in centimeters and multiplied together to give the pelvic area in square centimeters.

Conclusion

Pelvic area measurements can identify heifers and groups of heifers that may have a lower rate of dystocia. Primarily, pelvic area measurements should be used as a culling tool rather than a selection method. Pelvic area measurements should be included as part of a complete heifer prebreeding examination including reproductive tract scoring, vaccination, and physical evaluation.

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