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Pelvic Measurements: Applications in Beef Cattle Practice Today

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Dystocia (difficult calving) is a major cause of loss for beef cattle producers. It results in an increased incidence of calf mortality at or near birth, increased cow mortality, and higher veterinary and labor costs. In one study, calf loss within 24 hours of birth was 4% when heifers gave birth unassisted, 16% when calving difficulty ensued. Of the calves that died at or near calving, 57% of these were attributed to dystocia. Another study revealed that heifers calving unassisted weaned 70% of their calves; heifers needing assistance calving weaned 59%. Dystocia also results in delayed return to estrus and decreased conception rate in heifers and cows subsequent to their calving difficulty. Pregnancy rates following first calving in one study were 85% for heifers calving unassisted and 69% for heifers that had dystocia. Subsequent weaning rates for heifers that underwent dystocia in their first calving were 14% lower than for their non-dystocia counterparts.

Judging from the preceding information, it should be easy for the cow-calf practitioner to point out to his or her clients that reducing the incidence of dystocia in their herds is very desirable economically. However, in recent years, dystocia has increased as a problem for most beef producers as more emphasis is being placed on crossbreeding, often involving larger exotic breeds, and the resultant rapid growth rates and heavier weaning and yearling weights. As producers select for these higher growth traits, birth weights increase, along with the resulting dystocia. These problems are compounded in the case of first-calf heifers. These heifers have not yet reached their mature size, and, unless they have very small calves, calving difficulties are increased. It is not economically feasible to wait until these heifers are of mature size to have their first calves: maximizing a cow's total lifetime production requires she have her first calf at two years of age.

Many factors, relating to cow, calf and environment, have been implicated as influencing (increasing) dystocia. These include: 1) small, young cow; 2) large, heavy fetus; 3) male fetus; 4) small pelvic size of the dam; 5) prolonged gestation length; 6) large-breed sire; 7) dam over- or under conditioned; and 8) improper fetal presentation. Of these, the major factor contributing to dystocia is a disproportion in size between the dam and the fetus. In other words, the size of the fetus and the pelvic dimensions of the dam are the most significant factors implicated in dystocia in beef cattle. Therefore, a reduction in calving difficulty in a client’s cow herd could be achieved either by decreasing calf size or by increasing heifers’ pelvic sizes in the herd.

With the widespread interest in increasing growth rates (and therefore birth weights), increasing a herd’s average pelvic area is receiving more and more interest. By utilizing pelvic measurements and using these values in decisions relative to the breeding herd, veterinarians can play a role in managing replacement heifer selection and management, and ultimately dystocia rates, within clients' herds. In dystocia cases in the field, pelvic measurements, when combined with an estimate of the size of the fetus, can also aid veterinarians in deciding whether to assist the dam manually or whether to intervene surgically to deliver the calf. The purpose of this paper is to explain pelvic measurements and outline their possible uses in beef cattle veterinary practice today.

Instrumentation and Methods

Three instruments are commercially available to veterinarians for taking pelvic measurements: the Rice pelvimeter, the Bovine (Krautmann-Litton) pelvic meter, and the EquiBov Bovine Pelvimeter. All are designed to take internal pelvic measurements via the rectum of the cow or heifer. The Rice pelvimeter is a metal caliper-type instrument. One end is placed on known internal pelvic structures per rectum, and the resultant pelvic diameter is read on a scale on the opposite end, which is calibrated in increments of 0.25 cm. This device costs approximately $100.00 and is

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available from Lane Manufacturing in Denver, Colorado.

The Krautmann-Litton Bovine pelvic meter utilizes hydraulic fluid flow through a plastic flexible tube between two modified “syringes.” This device is available from Dr. Ed Krautmann, Chillicothe, Missouri, and costs approximately $250.00.

The latest instrument to become available for pelvimetry is manufactured by EquiBov of Rockwood, Ontario, Canada. This device utilizes a piston-like sensor as the Krautmann-Litton device does; however, the EquiBov device records measurements electronically. This device retails for approximately $450.00.

Any of the three devices can be used to measure pelvic dimensions in a similar manner. Pelvic measurements taken with these instruments appear to be reasonably accurate (around 80%). Pelvic measurement procedures are best undertaken with the animal standing in a chute with light squeeze. The operator should evacuate the cow’s rectum of feces, and the instrument of choice should be carefully carried into the rectum with either right or left hand. The instrument should be adequately protected by the hand and undue force should not be exerted, in order to minimize tissue trauma. The instrument should be carried cranially to the pelvic inlet.

The pelvic width should be taken at the widest point of the pelvic inlet between the right and left shafts of the ilium. The height of the pelvic inlet is obtained by measuring between the dorsal pubic tubercle on the pelvic floor and the sacrum dorsal to this point. This should be the smallest measurement between these two points. Both measurements should be read in centimeters. By convention, pelvic area is calculated by multiplying these two measurements together. This method of obtaining pelvic area, as will be shown later, is significantly associated with dystocia rates.

Characteristics of Pelvic Measurements

In order for veterinarians and their clients to understand how pelvic measurements can best be utilized in the management of the cow herds they work with, a basic understanding of the characteristics of pelvic measurements is needed.

Heritability of pelvic areas has been estimated to be moderate to high. Ranges between 40 to 60% have been reported.1,3,4,6,9,10 Both calf birth weight and pelvic area could be selected for, but due to its higher heritability, greater selection “pressure” could be placed on pelvic size.

As a general rule, pelvic area is positively correlated with the body weight of the heifer; larger heifers tend to have larger pelvic areas.1,2,3,4,7,10,11 Differences in pelvic areas unrelated to heifer weight are important: it is not always true that heavier heifers have larger pelvic areas. Also, heavier heifers, while tending to have larger pelvic areas, also tend to have heavier calves.3,7,10,11 Selection for size of dam alone as a means of reducing dystocia may therefore be ineffective because of the offsetting effect the larger calf will have on the larger pelvic opening. On the other hand, selecting heifers for large pelvic area, rather than by body weight, should be advantageous. Researchers have, however, found a generally low environmental correlation between pelvic area and the heifer’s growth characteristics. Growth measured by weight is thought to represent mostly fat, protein, and bone deposition, while pelvic area is more of a function of bone growth alone.10

On the average, heifers with larger pelvic areas have larger than average calves: a large genetic correlation between birth weights and dam’s pelvic areas has been found by researchers. For every 20 sq. cm increase in pelvic area, the birth weight of the heifer’s calf will increase by 3.5 pounds (heifers with pelvic areas 140 to 250 sq. cm at breeding time). The calves from dams with larger pelvic areas also exhibit faster growth characteristics. Selection of breeding stock for growth characteristics by themselves would eventually increase pelvic areas within the cow herd, and vice-versa. Because of the genetic correlation between a heifer’s pelvic area and the birth weight of the calf she throws, it should be understood that, when attempting to alleviate a herd’s dystocia problem by selecting stock with larger pelvic areas, the potential benefit from increasing pelvic areas may be partially offset by a correlated increase in calf body weight.10

To a certain extent, pelvic area in young heifers is a function of age. Pelvic areas in two-year-old first-calf heifers were found to be 42 sq. cm smaller than in three-year-old first-calf heifers of the same breed in one study. Age of the heifer plays a smaller role as heifers mature. Generally, heifers mature earlier for pelvic area than for mature weight.7 Pelvic area growth continues until the cow reaches full maturity at five to seven years of age; the pelvic opening of a two-year-old is only 80% of what it will be when she’s mature.8

It would be considerably more convenient to producers and veterinarians if internal pelvic diameter was consistently related to an external pelvic measurement or measurements that could be easily obtained without the use of specialized instruments. Unfortunately, this is not the case.
Numerous researchers have found that external width of hooks, length of rump, and other external pelvic measurements were poor indicators of actual pelvic size. Therefore, the use of internal measuring devices is necessary for obtaining pelvic areas.

**Uses of Pelvic Measurements**

**Replacement Heifer Selection.** Using pelvic measurements of heifers as a criteria in selecting replacements to a herd’s average-calving bulls; 2) heifers with a calving-ease bull; and 3) heifers with very small pelvic areas. A similar bull if a herd simply wants to reduce calving difficulty, if a herd simply wants to reduce calving difficulty, even as early as pre-breeding can be used to accurately predict the animal’s pelvic area at calving.

Pelvic measurements taken before heifers are bred allow the cattle producer to devise breeding strategies for replacements. A group of replacement candidates could be divided into three groups based on pelvic area: 1) heifers with large enough pelvic areas that they could be bred to the herd’s average-calving bulls; 2) heifers with pelvic areas too small to be bred to the regular herd bull, but that could be mated to a proven calving-ease bull; and 3) heifers with very small pelvic areas that should be culled from the herd.

Alternatively, a producer could select heifers meeting a minimum pelvic area and breed them to a bull selected for low birth weights. A similar bull could conceivably be used by a producer on his entire heifer group in the absence of pelvic measurements in an attempt to offset some of the herd’s dystocia problems. This practice is sound if a herd simply wants to reduce calving difficulty, but a problem arises when the economics of using “calving ease” bulls is considered. As bulls go, there is a genetic “mismatch” between low birth weights and high growth rates: calves born small will also have smaller weaning and yearling weights. Very few bulls exist that have good ratings for both calving ease and superior growth. In one survey conducted at the University of Georgia, only ten out of 30,000 bulls analyzed would sire calves with both low birth weights and good weaning and yearling weights with high predictability. Certainly, the economic advantages of preventing dystocia are very high; by basing a dystocia prevention program on selection of calving-ease sires alone, calving difficulty will decrease, but at the expense of maximal calf growth traits. By knowing pelvic measurements of replacement heifers, grouping the animals such that heifers with the largest pelvic areas can be bred to bulls siring growthy calves, and saving the smaller pelvic area-heifers for breeding to the calving ease sires (while culling heifers with very small pelvic areas), a bigger and better overall calf crop could be obtained. 1,4,5,7,9,14,16 This three-group strategy would especially be useful in operations with large enough heifer numbers to utilize selective breeding or in herds where artificial insemination is employed. 5,14

A legitimate question producers may ask of veterinarians is, at what pelvic area should I begin culling? This is not always an easy question to answer: many factors come into play—factors that may differ among operations. The foremost factor involved is the bulls utilized in the herd’s breeding system. Other factors may include breed differences (there are significant differences in pelvic area both among and within breeds), age of the heifer at measurement, and frame size of the heifer. 16

Because a wide variety of bulls can be utilized for a range of calf birth weights, no minimum pelvic area has been recommended for industry-wide use. One researcher has, however, pointed out that in order for a heifer to deliver a small 65-pound calf, her internal pelvic diameter will need to be greater than 150 sq. cm at breeding. 1 This calculation will be explained later. Another investigator suggests all heifers with pelvic areas below 126 sq. cm should be culled. 5 Dr. Robert Bohlander, a Nebraska veterinarian with many years’ experience in pelvic measurements and their uses, has recommended to his producers that they cull heifers with pelvic areas less than 154 to 160 sq. cm (pre-breeding) if they use British-breed bulls, and heifers less than 175 sq. cm if using the heavier continental-breed bulls in their programs. 14
Researchers have developed methods to calculate the maximum calf birth weight a heifer can deliver without difficulty, given her pelvic dimensions. This data could be put to very good use by producers who have data on the bulls they use in their breeding programs, or in the selection of bulls or semen from a sire summary. If the cattleman has an idea of what calf birth weights he can expect from the bulls he uses, he can then assign a culling “threshold” for his own herd. Ratios of pelvic area (sq. cm) to calf birth weight (lbs.) have been developed for this purpose.5,11,12,16 These ratios change as the heifer ages and gains weight (see Table 1).

### Table 1. Pelvic area:calf birth weight ratios for various heifer weights and ages to estimate deliverable calf birth weight.

<table>
<thead>
<tr>
<th>Heifer weight lbs.</th>
<th>Age at measurement months 8-9</th>
<th>12-13</th>
<th>18-19</th>
<th>22-23</th>
</tr>
</thead>
<tbody>
<tr>
<td>500</td>
<td>1.7</td>
<td>2.0</td>
<td>-----</td>
<td>-----</td>
</tr>
<tr>
<td>600</td>
<td>1.8</td>
<td>2.1</td>
<td>2.6</td>
<td></td>
</tr>
<tr>
<td>700</td>
<td>1.9</td>
<td>2.2</td>
<td>2.7</td>
<td>3.1</td>
</tr>
<tr>
<td>800</td>
<td>2.0</td>
<td>2.3</td>
<td>3.2</td>
<td></td>
</tr>
<tr>
<td>900</td>
<td>2.1</td>
<td>2.4</td>
<td>3.3</td>
<td></td>
</tr>
<tr>
<td>1000</td>
<td>2.2</td>
<td>2.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1100</td>
<td>2.3</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

By dividing a heifer’s pelvic area by this ratio, the result is the maximum birth weight possible for that heifer to deliver without assistance (see Table 2).

### Table 2. Using pelvic measurements to estimate deliverable calf birth weight at Pre-breeding.

<table>
<thead>
<tr>
<th>Heifer Age, Months</th>
<th>Heifer Weight, Lbs.</th>
<th>Pelvic Area, Sq. cm.</th>
<th>Pelvic Area: Birth Wt. Ratio</th>
<th>Estimated Calf Birth Weight, Lbs.</th>
</tr>
</thead>
<tbody>
<tr>
<td>12-13</td>
<td>600</td>
<td>140</td>
<td>2.1</td>
<td>67</td>
</tr>
<tr>
<td></td>
<td></td>
<td>160</td>
<td>2.1</td>
<td>76</td>
</tr>
<tr>
<td></td>
<td></td>
<td>180</td>
<td>2.1</td>
<td>86</td>
</tr>
</tbody>
</table>

As a general rule, when pelvic measurements are taken pre-breeding, dividing the heifer’s pelvic area (in sq. cm) by two will give one an estimate of the maximum deliverable calf weight for that heifer.5 Ratios over 2.0 generally result in few dystocias and ratios under 2.0 indicate many dystocias could be expected. Ratios in the 1.6 range generally require Caesarian section.5,11,12 Replacements could also be selected using pelvic measurements at pregnancy-checking time in the fall, after heifers have been pregnant for several months. Problem heifers (small pelvic areas) identified at that time could be either culled or induced to abort and sold as feeder heifers. Also, heifers not removed from the herd and that may have potential calving problems could be marked for identification for close observation at calving time.1

Pelvic area:birth weight ratios could again be used at this time to estimate the heifer’s maximum deliverable calf weight. Higher ratios must be used for the heavier and older heifers relative to pre-breeding (see Table 1). This number is divided by the heifer’s pelvic area in square centimeters to estimate how heavy a calf can be delivered by the heifer (Table 3).
Table 3. Using Pelvic measurement to estimate deliverable calf birth weight at pregnancy exam time.  

<table>
<thead>
<tr>
<th>Heifer Age, Months</th>
<th>Heifer Weight, Lbs.</th>
<th>Pelvic Area, Sq. cm.</th>
<th>Pelvic Area: Birth Wt. Ratio</th>
<th>Estimated Calf Birth Weight, Lbs.</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-19</td>
<td>800</td>
<td>180</td>
<td>2.7</td>
<td>67</td>
</tr>
<tr>
<td></td>
<td></td>
<td>200</td>
<td>2.7</td>
<td>74</td>
</tr>
<tr>
<td></td>
<td></td>
<td>220</td>
<td>2.7</td>
<td>82</td>
</tr>
</tbody>
</table>

Numbers that can be used as a rule of thumb when attempting to estimate ease of calving are given in Table 4.

Table 4. General pelvic area:birth weight ratios that can be used to estimate deliverable calf weight.

**Time of Measurement** | **PA:BW Ratio**
---|---
Pre-breeding | 2.0
Mid-gestation | 2.5
Term or calving time | 3.1
**Therefore 2 + .1/month of gestation**

Bull Selection. The heritability of pelvic areas, alluded to previously, has been estimated to be moderate to high (30 to 60%). Therefore, it could be expected that selection of bulls for increased pelvic areas would result in larger pelvic areas in the bulls' future daughters and therefore an increased average pelvic area in the cow herd. In order for the food-animal practitioner to advise his or her clients on the use of bull pelvic measurements, a few facts are helpful.

Before considering using pelvic measurements of bulls as a means of selection, it would be helpful to know whether other effects besides simply increasing pelvic areas in the female progeny came into play. For instance, do bulls that sire progeny with larger pelvic areas also sire larger calves, thereby negating some of the genetic progress made? One study showed no significant effect for large pelvic areas. Other work indicated that selection for large pelvic areas may help increase overall growth rates and weaning weights, since there seem to be positive correlations between pelvic areas and these growth traits.

Another trait for which pelvic areas have positive correlations include hip height, frame score, and scrotal circumference. As with heifers, bull pelvic areas have a poor correlation to body weight, so internal measurements are necessary. Also, a wide variation of pelvic areas exists between bulls within a certain breed. This means that bulls with relatively large pelvic areas can be easily selected over the average. Interestingly, pelvic areas of bulls are smaller on a weight-related basis relative to heifers. Also, age and weight of bulls have a significant effect on pelvic area. This is illustrated in Table 5. For bulls 10 to 14 months of age, and in the range of 800 to 1200 pounds, growth factors for age (.165 sq. cm/day) and for weight (.053 sq. cm/pound) can be added. It is important to use just one of the factors to adjust the pelvic area, and not both of them.  

Table 5. Average pelvic areas and growth estimates for yearling and two-year-old bulls.

<table>
<thead>
<tr>
<th>Bull Age, Months</th>
<th>Bull Weight, Pounds</th>
<th>Average Pelvic Area, Sq. cm.</th>
</tr>
</thead>
<tbody>
<tr>
<td>12-15</td>
<td>900-1200</td>
<td>150-170</td>
</tr>
<tr>
<td>23-25</td>
<td>1300-1500</td>
<td>190-210</td>
</tr>
</tbody>
</table>

Ideally pelvic area EPD's (Expected Progeny Differences) would be offered by seedstock producers in their sire summaries. Unfortunately, no breed associations currently report these values, although there seems to be increasing interest in making this information available. For cattlemen who purchase bulls, it would be advantageous to buy from a seedstock producer that supplies such data. For producers who raise their own bulls, several criteria may be helpful in selecting the right replacement bulls. These criteria also are helpful for bull purchasers in evaluating their own purchases. Obviously, bulls with small pelvic areas should be avoided; the question then arises, How small is small? One researcher states that a general rule is that if EPD's for pelvic area are not available, a bull weighing between 1000 and 2000 pounds should have pelvic areas between 150 and 170 sq. cm. Hereford bulls, it has been found, tend to have smaller average pelvic areas at given ages than do other breeds. Others recommend that all herd bulls should be measured as yearlings and any bull with a pelvic...
Obviously, the numbers above should only be used as rough guidelines, since it is apparent that more research on the subject would be valuable. In general, selecting the relatively larger pelvic area bulls for replacements should result in larger pelvic areas in the female progeny of a herd, and therefore reduce the overall incidence of dystocia over time.

Predicting Dystocia at Calving Time. The above discussion has given us a general overview of some of the aspects of pelvic measurements, and has given us a method by which we can use pelvic area to estimate the maximum size of calf that a female can deliver without difficulty. This information is valuable in the management of a beef breeding herd.

It would be very desirable to veterinarians (and their beef clients) if a method could be used to aid in the decision-making process when a dystocia case due to fetal-maternal size mismatch is presented. If some method of determining the extent of the fetomaternal disproportion was available, this could help the practitioner decide whether the calf can be pulled (delivered vaginally) or whether a Caesarian section is necessary. One side of the story, the maternal pelvic size, can easily be measured as described earlier. Determining the calf’s weight in utero is understandably more difficult.

Researchers have determined that a measurement of the calf’s hoof circumference at the coronary band is highly correlated (.841 for all females, .876 for first-calf heifers) with calf birth weight. This measurement could easily be taken while the calf’s limbs are within or close to the birth canal. As the hoof circumference increases, birth weight increases also, in a linear fashion. This fact can be exploited to obtain an estimate of the calf’s birth weight (see Table 6).

<table>
<thead>
<tr>
<th>Hoof Circumference At Coronary Band, cm</th>
<th>Birth Weight, Pounds</th>
</tr>
</thead>
<tbody>
<tr>
<td>15.0</td>
<td>52</td>
</tr>
<tr>
<td>16.0</td>
<td>62</td>
</tr>
<tr>
<td>17.0</td>
<td>72</td>
</tr>
<tr>
<td>18.0</td>
<td>82</td>
</tr>
<tr>
<td>19.0</td>
<td>92</td>
</tr>
<tr>
<td>20.0</td>
<td>102</td>
</tr>
<tr>
<td>21.0</td>
<td>112</td>
</tr>
<tr>
<td>22.0</td>
<td>122</td>
</tr>
<tr>
<td>23.0</td>
<td>132</td>
</tr>
</tbody>
</table>

Researchers at Iowa State University have developed a method of using these measurements to come up with a more objective estimation of the degree of calving difficulty present. A scale of calving difficulty was devised (Table 7).

<table>
<thead>
<tr>
<th>Table 7. Calving Scores</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 = Unassisted</td>
</tr>
<tr>
<td>2 = Some Assistance</td>
</tr>
<tr>
<td>3 = Mechanical Calf Puller</td>
</tr>
<tr>
<td>4 = Caesarean Section</td>
</tr>
</tbody>
</table>

A formula was then developed using pelvic height, pelvic width, and hoof circumference:

\[
\text{Predicted Calving Score} = \frac{(HC - PH + 3.5) + (HC - PW + 3.5)}{2}
\]

Where:
- \(HC\) = Hoof circumference
- \(PH\) = Pelvic height of dam
- \(PW\) = Pelvic width of dam

With the information now at hand, the likelihood of an uncomplicated calving can be determined by comparing pelvic area:birth weight ratios and the calf’s known (actually estimated) weight. An example may be of benefit in illustrating this point. A 900-pound crossbred heifer (23 months old) is undergoing some difficulty in calving. Her pelvic height is measured at 17 cm, pelvic width at 16 cm, for a pelvic area of 272 sq. cm. The calf’s hoof circumference is measured at 20 cm, which gives an estimated calf weight of 102 pounds. Finding the appropriate pelvic area:birth weight ratio in Table 1, 3.2, and dividing to come up with the maximum deliverable calf weight, \(272 / 3.2 = 85\) pounds. Therefore, this calf is in need of assistance to be delivered. The difference between these two calf weights could be used to get a rough idea of the degree of dystocia present. Another quick way of obtaining the same information is to add 3.0 cm to each pelvic dimension. The lesser of these two values is the maximum hoof circumference of a calf that could be delivered without difficulty. In the above example, pelvic height = 17 cm + 3.0 cm = 20 cm, pelvic width = 16 cm + 3.0 cm = 19 cm. The maximum calf hoof circumference that should be attempted to be delivered in this case is therefore 19 cm. Again, the difference between the actual and calculated values could be used to subjectively get an idea of the degree of dystocia present.
The result of the equation, the predicted calving score, can be related to the calving difficulty score as shown in Table 8.\textsuperscript{17}

Table 8. Relation of Predicted Calving Score to actual calving score.\textsuperscript{17}

<table>
<thead>
<tr>
<th>Predicted Calving Score</th>
<th>Calving Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.00 - 4.00</td>
<td>1 or Unassisted</td>
</tr>
<tr>
<td>4.01 - 5.50</td>
<td>2 or Some assistance</td>
</tr>
<tr>
<td>5.51 - 6.50</td>
<td>3 or Mechanical calf puller</td>
</tr>
<tr>
<td>6.50 and up</td>
<td>4 or Caesarean section</td>
</tr>
</tbody>
</table>

Using the above example, the formula would be:
\[
\frac{(20 - 17 + 3.5) + (20 - 16 + 3.5)}{2} = 7
\]

The predicted calving score of 7 would indicate that a Caesarean section should be performed in this case.

Calculating a predicted calving score can be of use to the beef cattle practitioner in devising his or her strategy in dealing with individual cases of dystocia. Researchers have reported a 63% overall match of the predicted calving scores to actual calving scores (52% for first-calf heifers) when calving scores 2 and 3 were combined.\textsuperscript{17} So, while not perfect, this method is of some use in managing dystocia cases.

**Summary**

The current interest in maximizing growth traits in beef cattle and the resultant use of heavy exotic breeds in producers herds has brought dystocia to the forefront of many producers’ and veterinarians’ minds, especially during calving season. This paper has outlined some of the ways pelvic measurements can be used in the management of this problem, and how they can be economically feasible for producers and a practice builder for veterinarians. It could be said that pelvic measuring is in its infancy in beef cattle practice today. It is hoped that with increasing use of these techniques in the field, their usefulness can be studied in greater depth and refined for more and broader applications in the future.

**References**


**Book Review**

*The Veterinary Formulary, First Edition*  
Y.M. Debuf, Ed.  

This publication is a handbook of drugs used in veterinary practice in the United Kingdom. Drugs are classified according to their actions on a body system, disease or condition. Each class of drugs begins with a brief review of mechanism of action, disposition and therapeutic use, and is followed by a listing of individual members of each class of drugs with indications, side effects, dosage and available commercial preparations in the U.K. In addition, there are special sections dealing with drug administration in fish, birds, reptiles, rabbits and rodents, lactating animals, and other species or situations.

*The Veterinary Formulary*’s usefulness to the U.S. veterinarian is limited since a number of drugs used in this country are not included (e.g. fluoroquinolones) and others are included that are not available in the U.S. Nevertheless, most of the compounds discussed (but not their proprietary names) are identical to those used in the U.S. and the book may be useful for a quick review of pharmacology and of special therapy in exotic species.

F.A. Ahrens DVM, PhD