AgriLIFE EXTENSION
Texas A&M System

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Assisting Difficult Calving

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Dystocia is the scientific word used to describe a difficult delivery during the birthing process. In cattle, such difficulty occurs most frequently in first-calf heifers. On the average, 50 percent of dystocias in cattle occur in first-calf heifers and 25 percent occur in second-calf heifers. The remaining dystocias are distributed throughout the rest of the calving cow herd

Calving difficulty is frequently caused by disproportionate size—the calf is too big for the birth canal. The weight of the calf at birth is the most important factor influencing calving ease; other factors are the calf's breed, sex and conformation.

Parturition

The entry of a fetus into the birth canal during parturition (birthing process, labor) is described by three terms. These are presentation, position and posture. Presentation refers to whether the fetus is coming forwards, backwards or sideways. Position refers to whether the fetus is right side up or upside down. Posture refers to whether the head and neck are in proper position or if the feet and legs are in the proper relationship to the body for delivery. Improper presentation, position or posture can result in dystocia.

Normal parturition is a continuous process, but is often divided into three stages for purposes of description. Stage 1 is cervical dilation. Stage 2 is expulsion of the fetus. Stage 3 involves expulsion of the fetal membranes. The time sequences involved with these stages can be helpful in determining if dystocia is occurring.

Stage 1 labor begins with initial contraction of the uterus and ends when the cervix is dilated and fetal parts (feet, nose) enter the birth canal. Visible signs of labor usually are absent during this stage. The heifer or cow will be restless and have a tendency to lie down and get up frequently. Stage 1 lasts from 2 to 6 hours, sometimes longer in heifers.

Stage 2 labor begins when fetal parts enter the birth canal and stimulate the abdominal press. The first water bag (chorioallantoic sac) usually ruptures early in stage 2. The second water bag (amniotic sac) is often forced through the vulva after the cow has been in labor for a short time. Delivery should be completed within 2 hours after the appearance of the amniotic sac at the vulva. Stage 2 labor may last from 30 minutes to 4 hours.

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Stage 3 labor, or expulsion of the fetal membranes, usually is completed within 8 to 12 hours following delivery of the fetus.

Assisting parturition

Assistance should be provided if the cow or heifer has been in stage 1 labor for 6 hours or more and the abdominal press has not begun. If the female is in stage 2 labor with signs of abdominal pressing for 2 hours and no fetal parts have been presented, she should be examined. If a cow is observed with a water sac presented through the vulva and has not delivered the fetus within 2 hours, she should be assisted.

When fetal parts protrude through the vulva to the outside, the heifer or cow should be observed at hourly intervals. If no progress is made within an hour or the nose protrudes further than the feet, she should be assisted. Assistance is not necessary if progress occurs during the hourly observations. As normal progress develops, she should calve within 4 hours.

A high percentage of cows and heifers that calve unassisted contaminate their reproductive tract. Fortunately, they are able to overcome infection and become pregnant again.

To prevent gross and potentially overwhelming contamination during assisted calving, properly restrain the heifer or cow. Restrain by using a low head tie, not a chute, to give the animal room to lie down during assisted delivery. Thoroughly cleanse the perineum or rear portions of the animal before examining the birth canal. Liberally apply mild soap and water and rinse thoroughly the area of the tail head down to an area approximately 12 inches below the vulva. The width of the scrubbed area should extend laterally to include the pin bones. The tail can be tied to the animal's neck or elbow to keep it out of the way during assistance. The assistant's hands and arms should be cleansed with soap, water and an antiseptic solution.

Examination through the vagina reveals the diameter of the bony pelvic canal. Cervical dilation is limited to the size of the pelvic bones, therefore, a decision as to whether or not a cesarean is necessary should be made before initiating assistance.

The delivery of the fetus is eased by the use of obstetrical chains. Cotton ropes and nylon web obstetrical straps also can be used. Chains are preferred because they can be easily cleaned and sanitized by boiling in water between calvings. Chains allow for more accurate placement of handles, which increases traction. Chains also are less restrictive to circulation. When chains are laid aside during assistance, place them in a disinfectant solution to keep them clean.

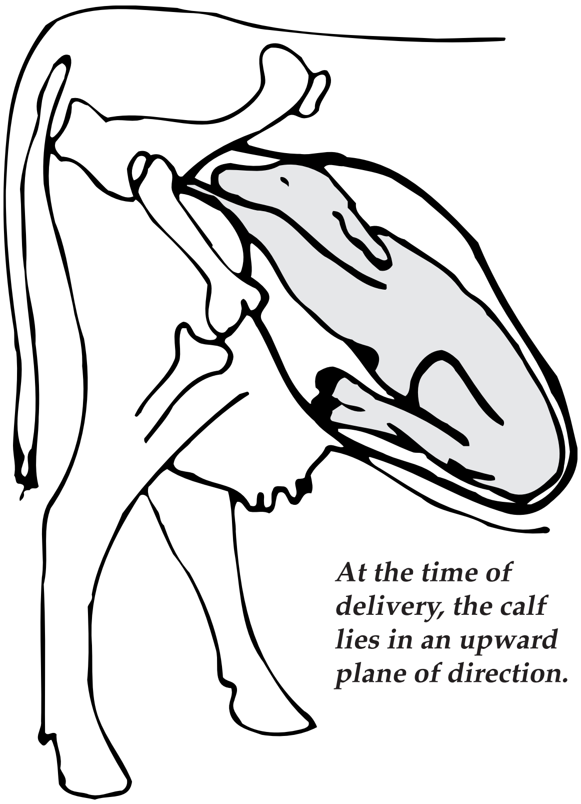
Properly place chains above and below the ankles.

The best placement of a rope or chain on the limb of a calf is a loop above the ankle and a half-hitch below the ankle. This distributes the point of pull to reduce the potential of fracturing a fetal limb during delivery. Place the chains or other straps directly on the skin. Placing them over the second water sac covering the limbs while applying traction will impede delivery.

Adequate lubrication is essential in assisted delivery when a cow or heifer is in dystocia. Although nature has provided the calving cow with ample amounts of lubricant, the heifer or cow in dystocia often expends her natural lubricating fluids. Delivering a fetus through a relatively dry birth canal may well add unnecessary trauma to the dam.

Petroleum-based jellies or solid cooking compounds make satisfactory lubricants. A water slurry made with baby-clothes detergents (non-bleaching or non-harsh detergents) can be used as well. Apply lubricants liberally and frequently during assistance.

The calf is delivered by walking the calf out. This is accomplished by alternating the pull on each leg. Pull one leg, one at a time, with a maximum traction of 200 pounds to fully extend both legs before applying more traction to pull the calf. Pull in an upward direction.



At the time of delivery, the calf lies in an upward plane of direction.

Be sure to keep the nose in position with the ankles and continue to pull upward to deliver the calf beyond its shoulders. Then pull downward, through an arc, to complete delivery of the calf. The maximum traction to apply to the calf with extended legs is 600 pounds.

If assistance is attempted using the guidelines to walk the calf out and progress is not made after working 30 minutes, obtain professional help immediately.

Fetal extractors, or calf-pullers, often are used to assist delivery of a calf. These instruments can prove to be invaluable, but they also can be dangerous. Excessive traction with this instrument can tear cows and even cause paralysis. Regardless of the type of calf-puller used, a quick-release mechanism is essential. Avoid using extractors without this feature. Apply no more traction with a fetal extractor than can be supplied by three strong men. If traction for delivery is applied to a standing animal, the pressure will often cause the animal to lie down. Make sure enough room is provided for the animal to lie down and for the attendants to work.

Post parturition

After the calf has been delivered, check for a heart beat by placing a hand on the lower chest just behind the front limbs. Another way to determine if the calf is alive is to gently touch the surface of the eyeball. A blinking reflex indicates life.

After delivering a live fetus, the next critical step is to provide an open airway for breathing. Use a dry paper or cloth towel to wipe the mouth of excess mucus. Stimulate respiration by placing a piece of hay or straw in the nostril to initiate a sneeze and clear the airway. Insert a finger in the calf's rectum to initiate a respiratory response, also. Vigorous rubbing of the back of the calf also can stimulate breathing.

After the calf is breathing and relatively stable, tend to the calf's umbilicus. Treat it with a minimum 2 percent solution of iodine. This preventive practice greatly reduces the chance of the calf developing a systemic illness later.

Also, make sure the calf drinks 1 to 2 quarts of colostrum (first-milk) from the dam within the first 6 hours of life. It is best when nursed, but if the calf is too weak, provide the colostrum by stomach tube. If the calf is small, divide the colostrum into two to three feedings during the first 6 hours.

After delivery, re-examine the birth canal of the dam. The most important consideration is to check for the presence of an additional fetus. Also examine the posterior birth canal for excessive tearing or bruising that could require a veterinarian's observation. Allow the cow to naturally expel the placenta because it is too tightly attached at this time for manual removal. Administer intrauterine boluses or parenteral injections of antibiotics after consultation with a veterinarian regarding approved usage and withdrawal time of antibiotics.

Suspend the calf, head down, for no more than 5 seconds to help drain mucus from air passages. The calf will die if suspended too long. Use towels to remove mouth mucus and to rub the calf's back.

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Avoiding Calving Problems

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Beef heifers experience calving difficulty, or dystocia, more frequently than do mature cows. Dystocia is characterized by prolonged or difficult labor due to heavy birthweight and/or small pelvic area of the dam. Death of these calves, and sometimes their dams, is a result of injuries received during difficult delivery. This obviously reduces calf crop and potential profits. Cows that experience dystocia also have lower rebreeding rates than animals that have normal, unassisted deliveries. Consequently, producers should make every effort to avoid dystocia.

Causes of Dystocia

There are a number of factors that influence dystocia; fortunately most of them can be controlled through good management practices.

One factor is improper selection and development of replacement heifers. Small, underdeveloped heifers generally have a higher incidence of dystocia than properly developed heifers because they have smaller pelvic openings. Select heifers that are heaviest, and feed them to ensure proper growth (1.5 to 1.75 pounds of gain per day). At this rate of growth, the heifers should weigh betwen 65 and 70 percent of their expected mature weight by 14 months of age (first breeding). Gain during gestation should average about 1 pound per day, provided that this allows for enough fat cover, or body condition, at the time of calving.

Much research has been done to determine the effect of feed level prior to calving on the incidence of dystocia. From this research one can conclude that feed levels during gestation do not influence dystocia as much as we once thought. Excess energy during gestation is not as much of a problem as excess protein. The latter increases birthweight of the calf and the incidence of calving difficulty. Therefore, pay particular attention to the amount of protein fed to heifers during gestation. The best experiments in this subject show the need to feed a balanced ration that affords proper growth as described above. If pregnant heifers are on winter pastures (wheat, oats, ryegrass, clovers), limit grazing to 30 minutes per day rather than grazing full time. This helps avoid excess protein in the diet and its associated increase in the offspring's birthweight. In other research, efforts were made to starve dystocia out of heifers through feed restriction. The assumption in these trials was that less feed would reduce birthweight and, thus, dystocia. These efforts were futile, and this practice is not recommended since it will reduce the body condition of heifers at calving time, which is proven to reduce subsequent rebreeding rates.

As cows mature and their pelvic openings grow larger, the incidence of dystocia decreases. Knowing this, many producers calve their heifers first at 3 years of age rather than at 2 years. This helps, but never totally eliminates dystocia. Furthermore, calving heifers first at 3 years of age is not recommended because it increases the costs of production per individual animal and can reduce their total lifetime productivity.

Improper calf posture (breech, head or hoof turned back) during delivery can cause problems, but this can be corrected simply by giving assistance at birth. We know that calf posture can change, even during the early stages of delivery. The reasons for this are undetermined, and we are not able to affect calf posture except during delivery.

It is a common belief that exercising the dam during gestation can reduce dystocia. But an experiment in which heifers were forced to move and travel during gestation revealed that no advantage was gained through exercise.

The main cause of calving problems is heavy birthweight. As birthweight increases, so does the degree and intensity of dystocia, especially when heifers also have small pelvic openings.

Causes of Heavy Birthweights

Three major factors influence birthweight: 1) sex of the calf (bull calves are heavier); 2) nutrition level of the dam during gestation; and 3) the genetic influence on birthweight by the sire. Obviously, sex of the calf can not be easily controlled. Methods of doing this are currently being developed, but only for the purpose of offering the cattleman the choice of gender in his calf crop in order to increase his marketing options. Nutrition level of the dam during gestation can be controlled, but efforts to reduce dystocia through excessive nutritional restriction have been futile. The most prudent and effective way to reduce birthweight is to use a bull that is known to sire calves with light birthweights. Mating this type of bull to properly developed heifers has, in many experiments, almost entirely eliminated calving problems except those associated with improper calf posture.

Finding the Desired Bull

Some breeds have gained the reputation of being difficult calvers while others have not. This is unfortunte and unjustified because within every breed there are "easy calving" and "hard calving" bulls. Some of the breeds that have been intensively selected for growth without regard for calving ease have a higher proportion of bulls that can be characterized as hard calvers. This does not imply that these breeds no longer have any easy calving bulls, and it is unwarranted to classify any breed as hard or easy calving. Admittedly, crossing bulls of a breed with light mature weights to females of a breed with heavy mature weights may reduce the incidence of dystocia. But on the other hand, random mating of those same bulls to females of the same breed may or may not influence dystocia. Therein lies the problem. What can be done to find a sire, within any breed, that is an easy calver? The solution is to use a good set of progeny records for that breed. This kind of record program is essential to finding the easy calving bulls, and a number of breed associations have adopted these procedures. This makes it easier for the bull buyer to find the correct bull.

As a buyer, what evidence do you need to see? Look for records that show the expected progeny differences (EPDs) in birthweight for calves from the bull in question. Bulls with a low EPD (less than +5 pounds) for birthweight are the easier calving bulls in that particular breed. Most importantly, look at the bull's calving ease score. Acceptable scores are further evidence that the bull in question is an easy calver.

Most of the breeds which have selected their cattle for performance likely have several sires with records on a high number of offspring. As the number of offspring from a sire increases, the accuracy of his predicted performance increases. Thus, look for accuracy figures in the performance data. These figures are given in fractions such as 0.5 up to 1.0. The higher the accuracy figures the more predictable the bull's performance. A low accuracy figure for any trait means that the bull has not yet produced enough offspring to accurately predict his performance.

When dealing with breeds that do not utilize performance records, it is very difficult to predict the performance of a sire for any trait. People who sell bulls should supply their buyers with performance data. This helps assure the buyer that he is getting the product he wants, and assures the seller of a repeat customer.

Summary

The best way to avoid calving problems is to choose the heaviest heifers as replacements, grow them to an acceptable weight and mate them to an easy calving bull. This approach will be successful in reducing dystocia except in those instances involving improper calf posture. Since the incidence of posture problems is low, dystocia attributed to excess birthweights and small pelvic openings can be almost entirely eliminated.

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BEEF QUALITY GRADES

A quality grade is a composite evaluation of factors that affect palatability of meat (tenderness, juiciness, and flavor). These factors include carcass maturity, firmness, texture, and color of lean, and the amount and distribution of marbling within the lean. Beef carcass quality grading is based on (1) degree of marbling and (2) degree of maturity.

MARBLING

Marbling (intramuscular fat) is the intermingling or dispersion of fat within the lean. Graders evaluate the amount and distribution of marbling in the ribeye muscle at the cut surface after the carcass has been ribbed between the 12th and 13th ribs. Degree of marbling is the primary determination of quality grade.

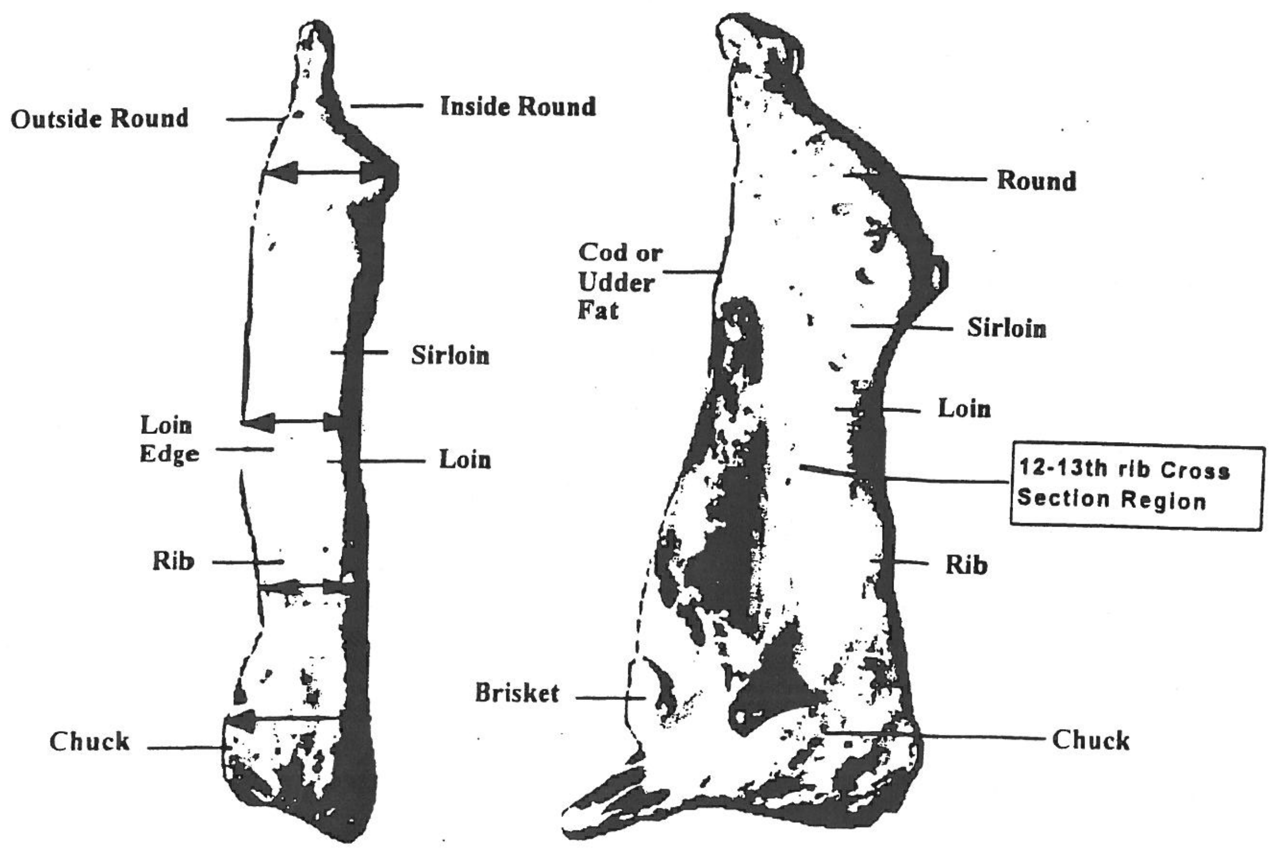
Degrees of Marbling

Each degree of marbling is divided into 100 subunits. In general, however, marbling scores are discussed in tenths within each degree of marbling (e.g.,Slight ^{90}, Small ^{00}, Small ^{10}).

Quality Grade	Marbling Score
Prime $^{+}$	Abundant $^{00-100}$
Prime $^{\circ}$	Moderately Abundant $^{00-100}$
Prime $^{-}$	Slightly Abundant $^{00-100}$
Choice $^{+}$	Moderate $^{00-100}$
Choice $^{\circ}$	Modest $^{00-100}$
Choice $^{-}$	Small $^{00-100}$
Select $^{+}$	Slight $^{50-100}$
Select $^{-}$	Slight $^{00-49}$
Standard $^{+}$	Traces $^{34-100}$
Standard $^{\circ}$	Practically Devoid $^{67-100}$ to Traces $^{00-33}$
Standard $^{-}$	Practically Devoid $^{00-66}$

In addition to marbling, there are other ways to evaluate muscle for quality. Firmness of muscle is desirable, as is proper color and texture. Desirable ribeyes will exhibit an adequate amount of finely dispersed marbling in a firm, fine textured, bright, cherry-red colored lean. As an animal matures, the characteristics of muscle change, and muscle color becomes darker and muscle texture becomes coarser.

Beef Quality and Yield Grading



MATURITY

Maturity refers to the physiological age of the animal rather than the chronological age. Because the chronological age is virtually never known, physiological maturity is used; and the indicators are bone characteristics, ossification of cartilage, color and texture of ribeye muscle. Cartilage becomes bone, lean color darkens and texture becomes coarser with increasing age. Cartilage and bone maturity receives more emphasis because lean color and texture can be affected by other postmortem factors.

Cartilage evaluated in determining beef carcass physiological maturity are those associated with the vertebrae of the backbone, except the cervical (neck). Thus the cartilage between and on the dorsal edges of the individual sacral and lumbar vertebrae as well as the cartilage located on the dorsal surface of the spinous processes of the thoracic vertebrae (buttons). Cartilage in all these areas are considered in arriving at the maturity group. The buttons are the most prominent, softest and least ossified in the younger carcasses. As maturity proceeds from A to E, progressively more and more ossification becomes evident. Ribs are quite round and red in A maturity carcasses, whereas E maturity carcasses have wide and flat ribs. Redness of the ribs gradually decreases with advancing age in C maturity, and they generally become white in color because they no longer manufacture red blood cells and remain white thereafter. Color and texture of the longissimus muscle are used to determine carcass maturity when these characteristics differ sufficiently from normal.

There is a posterior-anterior progression in maturity. Thus, ossification begins in the sacral region and with advancing age proceeds to the lumbar region and then even later it begins in the thoracic region (buttons) of the carcass. Because of this posterior-anterior progression of ossification, even young A maturity carcasses will have some ossification in the sacral cartilage.

In terms of chronological age, the buttons begin to ossify at 30 months of age. Determine age using thoracic buttons. When the percentage ossification of the cartilage reaches 10, 35, 70, and 90 percent, the maturity is B, C, D, and E respectively.

Carcasses are stratified into five maturity groups, based on the estimated age of the live animal:

Carcass maturity	Approximate live age
A	9 - 30 mos.
B	30 - 42 mos.
C	42 - 72 mos.
D	72 - 96 mos.
E	> 96 mos.

Skeletal Ossification

Sacral vertebrae (first to ossify)

Lumbar vertebrae

Thoracic vertebrae (buttons - last to ossify)

Size and shape of the rib bones

Condition of bones

Ossification of the vertebral column:

	MATURITY GROUP				
Vertebrae	A	B	C	D	E
Sacral	Distinct separation	Completely fused	Completely fused	Completely fused	Completely fused
Lumbar	No ossification	Nearly completely ossified	Completely ossified	Completely ossified	Completely ossified
Thoracic	No ossification	Some ossification	Partially ossified	Considerable ossification (outlines of buttons are still visible)	Extensive ossification (outlines of buttons are barely visible)
Thoracic buttons	0-10%	10-35%	35-70%	70-90%	>90%

Condition of the bodies of the split chine bones:

A- Red, porous and soft
B- Slightly red and slightly soft
C- Tinged with red, slightly hard
D- Rather white, moderately hard
E- White, nonporous, extremely hard

Appearance of the ribs:

A- Narrow and oval
B- Slightly wide and slightly flat
C- Slightly wide and moderately flat
D- Moderately wide and flat
E- Wide and flat

Lean Maturity:

Color and Texture - As maturity increases, lean becomes darker in color and coarser in texture

Lean Maturity Descriptions

Maturity	Lean Color	Lean Texture
A^0	light cherry-red	very fine
B^0	light cherry-red to slightly dark red	fine
C^0	moderately light red to moderately dark red	moderately fine
D^0	moderately dark red to dark red	slightly coarse
E^0	dark red to very dark red	coarse

Balancing lean maturity and bone maturity:

1. Use a simple average when bone and lean maturities are within 40 units of each other.

2. When there is more than 40 units difference in lean and bone maturity, average the two maturities and adjust the average 10% toward the bone except when:

Crossing the B/C line

- If the average of the lean and bone maturities doesn't move across the B/C line from the bone maturity side (e.g., Bone = B and Lean = C with the average being B or Bone = C and Lean = B with the average being C); average the two maturities and adjust the average to the nearest 10% toward the bone.

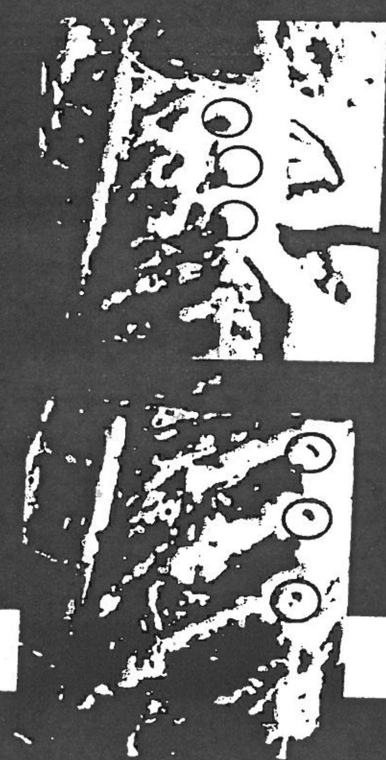
- If the bone and lean maturities are not considerably different, but one is in B maturity and the other in C maturity and the average of the two moves across the B/C line from the bone maturity side, the overall maturity will be on the side of bone maturity -- it will be either B-100 or C-00.

- In no case may overall maturity be more than one full maturity group different than bone maturity. A^{80} lean + D^{20} skeletal = C^{20} overall.

Determination of Final Quality Grade:

After the degree of maturity and marbling has been determined, these two factors are combined to arrive at the Final Quality Grade. The fundamentals involved in applying quality grades are learning the degrees of marbling in order from lowest to highest and minimum marbling degrees for each maturity group and understanding the relationship between marbling and maturity in each quality grade.

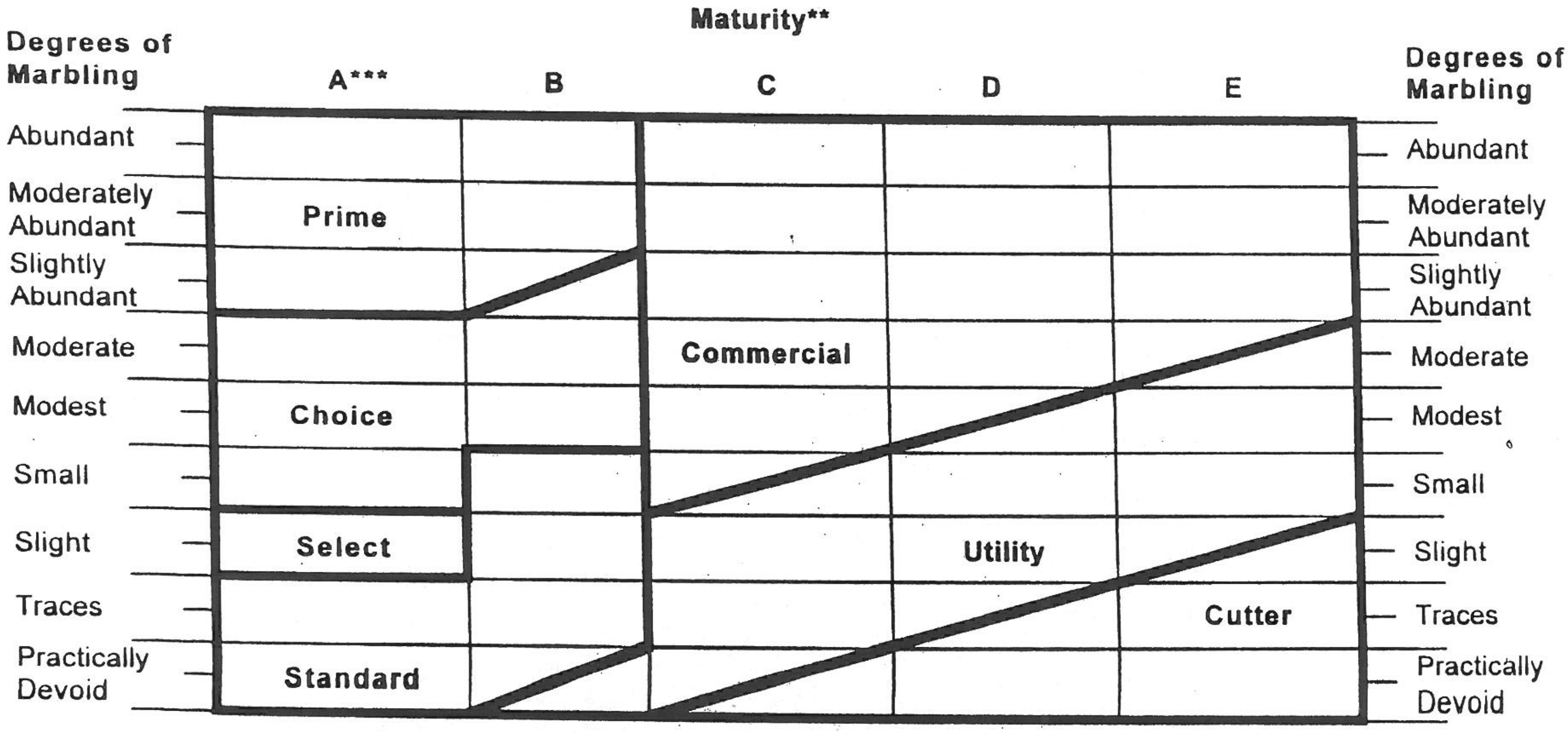
"A" and "B" Maturity Carcass Thoracic Chine Buttons



"A" Maturity

"B" Maturity

Relationship Between Marbling, Maturity, and Carcass Quality Grade*.



* Assumes that firmness of lean is comparably developed with the degree of marbling and that the carcass is not a "dark cutter."

** Maturity increases from left to right (A through E).

*** The A maturity portion of the Figure is the only portion applicable to bullock carcasses.

USDA (1996) Standards for Grades of Slaughter Cattle and Standards for Grades of Carcass Beef.

Step-Wise Procedure for Quality Grading Beef Carcasses

1. Determine carcass skeletal maturity by evaluating the degree of skeletal ossification in the top three thoracic vertebra (buttons), and the sacral and lumbar vertebra. Also evaluate the color and shape of the ribs. Determine lean maturity by evaluating the color and texture of the lean in the ribeye exposed between the 12th and 13th ribs.

Skeletal Maturity + Lean Maturity = Overall Maturity

A^{60}	+	A^{40}	=	A^{50}	(SimpleAverage)
B^{60}	+	A^{80}	=	B^{30}	(>40; 10% to bone)
C^{60}	+	B^{10}	=	C^{00}	(B/C line)
D^{60}	+	B^{20}	=	C^{60}	(≤ 100% from bone)

2. Evaluate the marbling in the ribeye and determine the marbling score.

Overall Maturity + Marbling Score = USDA Quality Grade

A^{70}	+	Sm^{40}	=	Ch^{-}
B^{60}	+	Md^{40}	=	Ch^{o}

3. Determine lean firmness to ensure that the minimum degree of firmness specified for each maturity group is met.

Table illustrating the minimum marbling score requirements for USDA quality grades within each final maturity group

USDA QUALITY GRADE	FINAL MATURITY SCORE				
	A^{00}	B^{00}	C^{00}	D^{00}	E^{00}
PRIME+	AB^{00}	AB^{00}	----	----	----
PRIME°	MAB^{00}	MAB^{00}	----	----	----
PRIME-	SLAB^{00}	SLAB^{00}	----	----	----
CHOICE+	MD^{00}	MD^{00}	----	----	----
CHOICE°	MT^{00}	MT^{00}	----	----	----
CHOICE-	SM^{00}	----	----	----	---- ----
SELECT+	SL^{50}	----	----	----	----
SELECT-	SL^{00}	----	----	----	----
STANDARD+	TR^{00}	TR^{00}	----	----	----
STANDARD-	PD^{00}	PD^{00}	----	----	----
COMMERCIAL+	----	----	MD^{00}	SLAB^{00}	AB^{00}
COMMERCIAL°	----	----	MT^{00}	MD^{00}	SLAB^{00}
COMMERCIAL-	----	----	SM^{00}	MT^{00}	MD^{00}
UTILITY+	----	----	SL^{00}	SM^{00}	MT^{00}
UTILITY°	----	----	TR^{00}	SL^{00}	SM^{00}
UTILITY-	----	----	PD^{00}	TR^{00}	SL^{00}

* AB = Abundant; MAB = Moderately Abundant; SLAB = Slightly Abundant; MD = Moderate; MT = Modest; SM = Small; SL = Slight; TR = Traces; PD = Practically Devoid.

* Carcasses with B, C, D, or E final maturity scores require an increasing amount of marbling as maturity increases to remain in the same quality grade.

* Carcasses having B final maturity scores with Small and Slight marbling must grade U.S. Standard. There is no U.S. Select grade for B maturity carcasses.

BEEF YIELD GRADES

In beef, yield grades estimate the amount of boneless, closely trimmed retail cuts from the high-value parts of the carcass--the round, loin, rib, and chuck. However, they also show differences in the total yield of retail cuts. We expect a YG 1 carcass to have the highest percentage of boneless, closely trimmed retail cuts, or higher cutability, while a YG 5 carcass would have the lowest percentage of boneless, closely trimmed retail cuts, or the lowest cutability. The USDA Yield Grades are rated numerically and are 1, 2, 3, 4, and 5. Yield Grade 1 denotes the highest yielding carcass and Yield Grade 5, the lowest.

The USDA prediction equation for percent boneless, closely trimmed retail cuts (% BCTRC) of beef carcasses is as follows:

% BCTRC = 51.34 Minus 5.78 (Fat opposite the ribeye, in.)
Minus 0.46 (Percentage KPH fat)
Minus 0.0093 (Carcass weight, pounds)
Plus 0.74 (Ribeye area, $in.^2$)

Expected percentage of boneless, closely trimmed retail cuts from beef carcasses within the various yield grades

YIELD GRADE	% BCTRC
1	≥ 52.3
2	52.3 - 50.0
3	50.0 - 47.7
4	47.7 - 45.4
5	< 45.5

Meat graders assign a yield grade to a carcass by evaluating:

(1) the amount of external fat;
(2) the hot carcass weight;
(3) the amount of kidney, pelvic, and heart fat; and
(4) the area of the ribeye muscle.

Graders evaluate the amount of external fat at the 12th rib by measuring the thickness of fat three-fourths the length of the ribeye from the chine. They adjust this measurement to reflect unusual amounts of fat in other areas of the carcass. Only graders highly skilled in evaluating cutability of beef carcasses make these adjustments according to whether the measured fat thickness is representative of the fat coverage over the rest of the carcass.

Carcass weight is the "hot" or unchilled weight in pounds (taken on the slaughter-dressing floor shortly after slaughter). The grader usually writes this weight on a tag or stamps it on the carcass. The amount of kidney, pelvic, and heart (KPH) fat is evaluated subjectively and is expressed as a percentage of the carcass weight (this usually will be from 2 to 4 percent of carcass weight). The area of the ribeye is determined by measuring the size (in inches, using a dot-grid) of the ribeye muscle at the 12th rib.

The following descriptions will help you understand the differences between carcasses from the five yield grades:

Yield Grade 1 - The carcass is covered with a thin layer of external fat over the loin and rib; there are slight deposits of fat in the flank, cod or udder, kidney, pelvic and heart regions. Usually, there is a very thin layer of fat over the outside of the round and over the chuck.

Yield Grade 2 - The carcass is almost completely covered with external fat, but lean is very visible through the fat over the outside of the round, chuck, and neck. Usually, there is a slightly thin layer of fat over the inside round, loin, and rib, with a slightly thick layer of fat over the rump and sirloin.

Yield Grade 3 - The carcass is usually completely covered with external fat; lean is plainly visible through the fat only on the lower part of the outside of the round and neck. Usually, there is a slightly thick layer of fat over the rump and sirloin. Also, there are usually slightly larger deposits of fat in the flank, cod or udder, kidney, pelvic and heart regions.

Yield Grade 4 - The carcass is usually completely covered with external fat, except that muscle is visible in the shank, outside of the flank and plate regions. Usually, there is a moderately thick layer of external fat over the inside of the round, loin, and rib, along with a thick layer of fat over the rump and sirloin. There are usually large deposits of fat in the flank, cod or udder, kidney, pelvic and heart regions.

Yield Grade 5 - Generally, the carcass is covered with a thick layer of fat on all external surfaces. Extensive fat is found in the brisket, cod or udder, kidney, pelvic and heart regions.

Step-Wise Procedure for Yield Grading Beef Carcasses

1. Determine the preliminary yield grade (PYG).

Measure the amount of external fat opposite the ribeye. This measurement should be made at a point three-fourths of the way up the length of the ribeye from the split chine bone. Based on this fat thickness, a preliminary yield grade (PYG) can be established. The base PYG is 2.00. The more fat opposite the ribeye, the higher the numerical value of the PYG.

- A carcass with no fat opposite to ribeye has a PYG of 2.00
- For each .1 inch of fat add .25 to the PYG

Fat opposite ribeye	PYG
0	2.00
.2	2.50
.4	3.00
.6	3.50
.8	4.00
1.0	4.50

2. Adjust for carcass weight deviations from 600 pounds.

The base weight in the yield grade equation is 600 pounds. If a carcass weighs more than 600 pounds, then we increase the PYG, and if a carcass weighs less than 600, then we decrease the PYG.

- For each 25 pounds over 600 pounds, add .10 to the PYG
- For each 25 pounds under 600 pounds, subtract .10 from the PYG

Carcass weight (lbs)	Adjustment to the PYG
500	- .40
550	- .20
600	No adjustment
650	+ .20
700	+ .40
750	+ .60

3. **Adjust for percentage KPH deviations from 3.5 percent.**

It has been determined that the average carcass has 3.5% KPH. If a carcass has more than 3.5% KPH, then the carcass is fatter than the average and the PYG should be adjusted up, raising the numerical yield grade. If a carcass has less than 3.5% KPH, then the carcass is leaner than average and the PYG should be adjusted down, thus lowering the yield grade.

- For each 1%KPH over 3.5%, add .20 to the PYG
- For each 1%KPH under 3.5%, subtract .20 from the PYG

%KPH	Adjustment to the PYG
1.5	- .40
2.0	- .30
2.5	- .20
3.0	- .10
3.5	No adjustment
4.0	+ .10

4. **Adjust for ribeye area (REA) deviations from 11.0 sq. in.**

The average carcass has a ribeye area of 11 sq. in. If a carcass has a ribeye area greater than 11.0 in., then it is probably more muscular then average, and the PYG should be adjusted down to lower the numerical value of the yield grade. If the ribeye area is less than 11.0 in., then the carcass is probably less muscular than average and the PYG should be adjusted up.

- For each 1.0 sq. in. over 11.0 sq. in., subtract .33 from the PYG
- For each 1.0 sq. in. under 11.0 sq. in., add .33 to the PYG

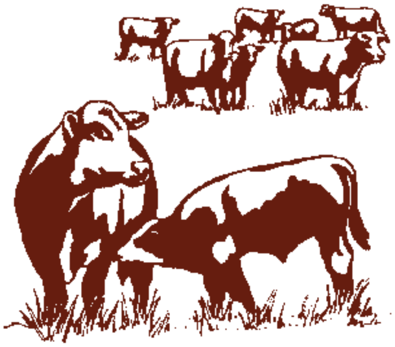
Ribeye area (sq. in.)	Adjustment to the PYG
9.5	+ .49
10.0	+ .33
10.5	+ .16
11.0	No adjustment
11.5	- .16
12.0	- .33
12.5	- .49
13.0	- .66

Example yield grade problem using the short cut method:

Fat thickness: 0.5 in. Carcass weight: 750 lbs. %KPH: 2.0 REA: 14.0 sq. in.

a. 0.5 in. = 3.25
b. 750 minus 600 = 150 / 25 = 6 *.1 = .6 (add)
c. 3.5 minus 2.0 = 1.5 * .2 = .30 (subtract)
d. 14.0 minus 11.0 = 3 * .33 = .99 (subtract)

	3.25	PYG
plus	.60	Weight
minus	.30	KPH
minus	.99	REA
	2.56	Final YG



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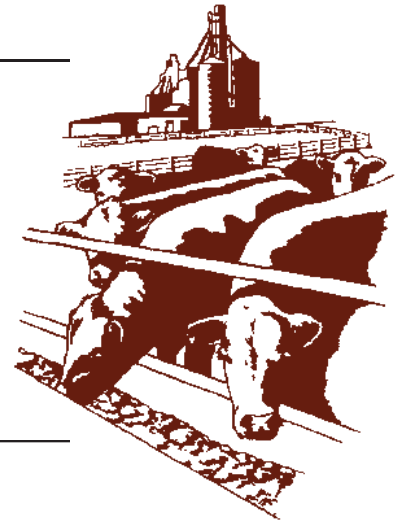

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Product of Extension Beef Cattle Resource Committee
Adapted from Beef Improvement Federation

Beef Performance Glossary

John Hough, Amercian Hereford Association
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Accuracy (of selection) - Correlation between an animal's unknown actual breeding value and a calculated estimated breeding value (or expected progeny difference).

Average daily gain (ADG) - Measurement of an animal's daily body-weight change.

Adjusted weaning weight (WW) - An unshrunk, off-the-cow weight adjusted to 205 days of age and to a mature dam age equivalence.

Adjusted yearling weight (YW) - An unshrunk weight adjusted to either 365, 452, or 550 days of age.

Alleles - Alternate forms of genes. Because genes occur in pairs in body cells, one gene of a pair may have one effect and another gene of that same pair (allele) may have a different effect on the same trait.

Artificial insemination (AI) -The technique of placing semen from the male into the reproductive tract of the female by means other than natural service.

Backcross -The mating of a two-breed crossbred offspring back to one of its parental breeds. Example: A Hereford-Angus cross cow bred back to an Angus bull.

Beef carcass data service - A program whereby producers, for a fee, can receive carcass evaluation data on their cattle by using a special "carcass data" eartag for their animals to be processed. See your county extension director, breed representative, Beef Cattle Improvement Association representative, or area office of USDA meat grading service for information.

Beef Improvement Federation (BIF) - A federation of organizations, businesses, and individuals interested or involved in performance evaluation of beef cattle. The purposes of BIF are to bring about uniformity of procedures, development of programs, cooperation among interested entities, education of its members, and the ultimate of user performance evaluation methods. It also builds the confidence of the beef industry in the principles and potentials of performance testing.

Birth weight (BW) -The weight of a calf taken within 24 hours after birth. Heavy birth weights tend to be correlated with calving problems, but the conformation of the calf and the cow are contributing factors.

Body condition score - A score on a scale of 1 to 9, reflecting the amount of fat reserves in a cow's body, where 1 = very thin and 9 = extremely fat.

Bos indicus -These are the Zebu (humped) cattle including the Brahman breed in the United States.

Bos taurus - Includes most cattle found in the United States, including their European ancestors.

Breed - Animals which have a common origin and common characteristics that distinguish them from other groups of animals within that same species.

Breeding program goals - The objective or "direction" of breeders' selection programs. Goals are basic decisions breeders must make to give "direction" to their breeding program. Goals should vary among breeders due to relative genetic merit of their cattle, their resources, and their markets.

Breeding soundness examination - Inspection of a bull involving evaluation of physical conformation and soundness through genital palpation, scrotal circumference, and testing semen for motility and morphology.

Breeding value - Value of an animal as a parent. The working definition is, twice the difference between a very large number of progeny and the population average, when individuals are mated at random within the population, and all progeny are managed alike. The difference is doubled because only one gene of each pair is transmitted from a parent to each progeny.

British breeds - Breeds of cattle such as Angus, Hereford, and Shorthorn originating in Great Britain.

Caesarean section - A process where the calf is removed from the cow during parturition by making a large incision in the right side of the cow just above the flank.

Calving difficulty (Dystocia) - Abnormal or difficult labor, causing difficulty in delivering the fetus and/or placenta.

Calving season - The season(s) of the year when the calves are born. Limiting calving seasons is the first step to performance testing the whole herd, accurate records, and consolidated management practices.

Carcass evaluation - Techniques of measuring components of quality and quantity in carcasses.

Carcass merit - Desirability of a carcass relative to quantity of components (muscle, fat, and bone), USDA quality grade, plus potential eating qualities.

Carcass quality grade - An estimate of palatability based primarily on marbling and maturity and generally to a lesser extent on color, texture, and firmness of lean.

Carrier - A heterozygous individual having one recessive gene and one dominant gene for a given pair of genes (alleles). For example, an animal with one gene for polledness and one gene for horns will be polled but can produce horned offspring when mated to another animal carrying the gene for horns.

Central test - A location where animals are assembled from several herds to evaluate differences in certain performance traits under uniform management conditions.

Chromosome - Chromosomes are long DNA molecules on which genes (the basic genetic codes) are located. Domestic cattle have 30 pairs of chromosomes.

Closed herd - A herd in which no outside breeding stock (cattle) are introduced.

Collateral relatives - Relatives of an individual that are not its ancestors or descendants. Brothers and sisters are an example of collateral relatives.

Compensatory gain - Gain from cattle that have been nutritionally deprived for part or all of their life. Once fed feedlot diets they compensate for the earlier restriction of feed by gaining very rapidly.

Conformation - The shape and arrangement of the different body parts of an animal.

Congenital - Acquired during prenatal life. Condition exists at or dates from birth. Often used in the context of congenital (birth) defects.

Contemporary breed type group - A group of cattle that are of the similar breed type, sex, and age, and have been raised in the same management group (same location on the same feed and pasture). Contemporary groups should include as many cattle as can be accurately compared.

Correlation - A measure of how two traits vary together. A correlation of +1.00 means that as one trait increases the other also increases—a perfect positive relationship. A correlation of -1.00 means that as one trait increases the other decreases—a perfect negative, or inverse, relationship. A correlation of 0.00 means that as one trait increases, the other may increase or decrease—no consistent relationship. Correlation coefficients are always between +1.00 and -1.00.

Crossbreeding - The mating of animals of different breeds (or species). Crossbreeding usually results in heterosis (hybrid vigor).

Culling - The process of eliminating less productive or less desirable cattle from a herd.

Cutability - An estimate of the percentage of salable meat (muscle) from a carcass versus percentage of waste fat. Percentage of retail yield of carcass weight can be estimated by a USDA prediction equation that includes hot carcass weight, rib eye area, fat thickness, and estimated percent of kidney, pelvic, and heart fat.

Deviation - A difference between an individual record and the average for that trait for that contemporary group. These differences sum to zero when the correct average is used. A ratio deviation is the ratio less the average ratio or 100.

Dominance - Dominant genes affect the phenotype when present in either homozygous or heterozygous condition. A dominant gene need only be obtained from one parent to achieve expression.

Double muscling - A simple recessive trait evidenced by an enlargement of the muscles with large grooves between the muscle systems especially noticeable in the hind leg.

Dressing percent - (Chilled carcass weight/live weight) x 100.

Dwarfism - A recessive trait in which the skeleton is quite small and the forehead has a slight bulge.

Dystocia (calving difficulty) - Abnormal or difficult labor causing difficulty in delivering the fetus and/or placenta.

Economic value -The net return within a herd for making a pound or percentage change of the trait in question.

Effective progeny number (EPN) - An indication of the amount of information available for estimation of expected progeny differences in cattle evaluation. It is a function of number of progeny but is adjusted for their distribution among herds and contemporary groups and for the number of contemporaries by other sires. EPN is less than the actual number because the distribution of progeny is never ideal.

Embryo transfer - Removing fertilized ova (embryos) from one cow (donor dam) and placing these embryos into other cows (recipient cows), usually accompanied by hormone-induced superovulation of the donor dam. More calves can be obtained from cows of superior breeding value by this technique. Only proven producers should become donor dams.

Environment - All external (nongenetic) conditions that influence the reproduction, production, and carcass merit of cattle.

Estimated breeding value (EBV) - An estimate of an individual's true breeding value for a trait based on the performance of the individual and close relatives for the trait. EBV is a systematic way of combining available performance information on the individual and siblings and the progeny of the individual. Expected progeny differences have replaced EBVs in most breed associations.

Expected progeny difference (EPD) -The difference in performance to be expected from future progeny of an individual compared with that expected from future progeny of another individual. EPDs are estimates based on progeny testing and are equal to one-half the estimated of breeding values calculated from progeny test records.

F_1 - Offspring resulting from the mating of a purebred (straight-bred) bull to purebred (straight-bred) females of another breed.

Fat thickness - Depth of fat over the ribeye muscle at the 12th rib. It consists of a single measurement at a point three-fourths of the lateral length of the ribeye muscle from the split chine bone.

Feed conversion (feed efficiency) - Units of feed consumed per unit of weight gained. Also, the production (meat, milk) per unit of feed consumed.

Fertilization -The union of the male and female gametes to form a new individual.This union combines two haploid cells to restore the diploid number of chromosomes in the new individual.

Frame score - A score based on subjective evaluation of height or actual measurement of hip height.This score is related to processing weight at which cattle should grade choice or have comparable amounts of fat.

Freemartin - Female born twin to a bull calf (approximately 9 out of 10 will not be fertile).

Generation interval - Average age of the parents when the offspring destined to replace them are born. A generation represents the average rate of turnover of a herd.

Genes -The basic units of heredity that occur in pairs and have their effect in pairs in the individual but which are transmitted singly (one or the other gene at random of each pair) from each parent to offspring.

Genetic correlations - Correlations between two traits that arise because some of the same genes affect both traits. When two traits (e.g., weaning and yearling weight) are positively and highly correlated to one another, successful selection for one trait will result in an increase in the other trait. When two traits are negatively and highly correlated (e.g, birth weight and calving ease) to one another, successful selection for one trait will result in a decrease in the other trait.

Genotype - Actual genetic makeup (constitution) of an individual determined by its genes or germ plasm. For example, there are two genotypes for the polled phenotype [PP (homozygous dominant) and Pp (heterozygote)].

Genotype X Environment Interaction - Variation in the relative performance of different genotypes from one environment to another. For example, the "best" cattle (genotypes) for one environment may not be the "best" for another environment.

Gestation -The period of pregnancy or the period of time from conception until young are born.

Half-sibs - Individuals having the same sire or dam. Half-brothers and/or half-sisters.

Heat synchronization - Causing a group of cows or heifers to exhibit heat together at one time by artificial manipulation of the estrous cycle.

Heredity -The transmission of genetic or physical traits of parents to their offspring.

Heritability -The proportion of the differences among cattle, measured or observed, that is transmitted to the offspring. Heritability varies from zero to one. The higher the heritability of a trait, the more accurately the individual performance predicts breeding value and the more rapid should be the response due to selection for that trait.

Heritability estimate - An estimate of the proportion of the total phenotypic variation between individuals for a certain trait that is due to heredity. More specifically, hereditary variation due to additive gene action.

Heterosis (hybrid vigor) - Amount that measured traits of the crossbreds exceed the average of the two or more purebreds that are mated to produce the crossbreds.

Heterozygous - Genes of a specific pair (alleles) are different in an individual.

Homozygous - Genes of a specific pair (alleles) are alike in an individual.

Hot carcass weight - Weight of carcass just prior to chilling.

Inbreeding - Production of offspring from parents more closely related than the average of a population. Inbreeding increases the proportion of homozygous gene pairs and decreases the proportion of heterozygous gene pairs. Also, inbreeding increases prepotency and facilitates expression of undesirable recessive genes.

Incomplete dominance - A situation in which neither gene with a gene pair is dominant to the other, with the result that both are expressed in the phenotype which is intermediate between the two traits.

Independent culling levels - Selection of culling based on cattle meeting specific levels of performance for each trait included in the breeder's selection program. For example, a breeder could cull all heifers with weaning weights below 400 pounds (or those in the bottom 20% on weaning weight) and yearling weights below 650 pounds (or those in the bottom 40%).

Kidney, pelvic and heart fat (KPH) -The internal carcass fat associated with the kidney, pelvic cavity and heart expressed as a percentage of chilled carcass weight. The kidney is included in the estimate of kidney fat.

Lactation -The period following calving during which milk is formed in the udder.

Lethal Gene - A gene or genes that cause the death of an individual that expresses them.

Libido - Sexual desire or sex drive.

Linebreeding - A form of inbreeding in which an attempt is made to concentrate the inheritance of one ancestor or line of ancestors in a herd. The average relationship of the individuals in the herd to this ancestor (outstanding individual or individuals) is increased by linebreeding.

Linecross - Offspring produced by crossing two or more inbred lines.

Marbling -The specks of fat (intramuscular fat) distributed in muscular tissue. Marbling is usually evaluated in the ribeye between the 12th and 13th rib.

Maturity - An estimation of the chronological age of the animal or carcass by assessing the physiological stages of maturity of bone and muscle characteristics.

Metabolic body size -The weight of the animal raised to the 3/4 power ($W^{.75}$); a figure indicative of metabolic needs and of the feed required to maintain a certain body weight.

Metabolism -The transformation by which energy is made available for body uses.

Most probable producing ability (MPPA) - An estimate of a cow's future productivity for a trait (such as progeny weaning weight ratio) based on her past productivity. For example, a cow's MPPA for weaning ratio is calculated from the cow's average progeny weaning ratio, the number of her progeny with weaning records, and the repeatability of weaning weight.

National Cattle Evaluation - Programs of cattle evaluation conducted by breed associations to genetically compare animals. Carefully conducted national cattle evaluation programs give unbiased predictions of expected progeny differences (EPDs). Cattle evaluations are based on field data and rely on information from the individual animal, relatives and progeny to calculate EPDs.

Nonadditive gene effects - Favorable effects or actions produced by specific gene pairs or combinations. Nonadditive gene action is the primary cause of heterosis. Nonadditive gene action occurs when the heterozygous genotype is not intermediate in phenotypic value to the two homozygous genotypes.

Number of contemporaries -The number of animals of similar breed type, sex, and age against which an animal was compared in performance tests. The greater the number of contemporaries, the greater the accuracy of comparisons.

Optimum level of performance -The most profitable or favorable ranges in levels of performance for the economically important traits in a given environment and management system. For example, although many cows produce too little milk, in every management system there is a point beyond which higher levels of milk production may reduce fertility and decrease profit.

Outbreeding - Mating of animals less closely related than the average of the population.

Outcrossing - Mating of individuals that are less closely related than the average of the breed. Commercial breeders and some purebred breeders should be outcrossing by periodically adding new sires that are unrelated to their cow herd. This outcrossing should reduce the possibility of loss of vigor due to inbreeding.

Ovulation - Release of the female germ cell (egg) by the ovary. Cows usually ovulate several hours (up to 15 hours) after the end of estrus or standing heat.

Palatability - Acceptable to the taste or sufficiently agreeable in flavor to be eaten.

Parturition -The act of giving birth; calving.

Pedigree - A tabulation of names of ancestors, usually only those of the three to five closest generations.

Percent calf crop -The number or percentage of calves produced within a herd in a given year relative to the number of cows and heifers exposed to breeding.

Performance data -The record of the individual animal for reproduction, production, and possibly carcass merit. Traits include birth, weaning, and yearling weights, calving ease, calving interval, milk production, etc.

Performance pedigree - A pedigree that includes performance records of the individual, ancestors, relatives and progeny in addition to the usual pedigree information. Also, EPDs are included by some breed associations.

Performance testing -The systematic collection of comparative production information for use in decision making to improve efficiency and profitability of beef production. Differences in performance among cattle must be utilized in decision making for performance testing to be beneficial. The most useful performance records for management, selection, and promotion decisions will vary among purebred breeders and for purebred breeders compared with commercial cattle producers.

Phenotype -The visible or measurable expression of a character; for example, weaning weight, postweaning gain, reproduction, etc. Phenotype is influenced by genotype and environment.

Phenotypic correlations - Correlations between two traits caused by both genetic and environmental factors influencing both traits.

Polled - Naturally hornless cattle. Having no horns or scurs.

Pounds of retail cuts per day of age - A measure of cutability and growth combined, it is calculated as follows: cutability multiplied by carcass weight, divided by age in days. Also, it is reported as lean weight per day of age (LWDA) by some breed associations.

Possible change -The variation (either plus or minus) that is possible for each expected progeny difference .This measurement of error in prediction or estimation of EPD decreases as the number of offspring per sire increases.

Postpartum - After the birth of an individual.

Prepotent -The ability of a parent to transmit its characteristics to its offspring so that they resemble that parent, or each other, more than usual. Homozygous dominant individuals are prepotent. Also, inbred cattle tend to be more prepotent than outbred cattle.

Preweaning gain - Weight gained between birth and weaning.

Progeny -The young, or offspring, of the parents.

Progeny records -The average, comparative performance of the progeny of sires and dams.

Progeny testing - Evaluating the genotype of an individual by a study of its progeny records.

Puberty -The age at which the reproductive organs become functionally operative and secondary sex characteristics begin to develop.

Purebred - An animal of known ancestry within a recognized breed that is eligible for registry in the official herd book of that breed.

Qualitative traits -Those traits in which there is a sharp distinction between phenotypes, such as black and white or polled and horned. Usually, only one or few pairs of genes are involved in the expression of qualitative traits.

Quantitative traits -Those traits in which there is no sharp distinction between phenotypes, with a gradual variation from one phenotype to another, such as weaning weight. Usually, many gene pairs are involved as well as environmental influences.

Random mating - A system of mating where every female (cow and/or heifer) has an equal or random chance of being assigned to any bull used for breeding in a particular breeding season. Random mating is required for accurate progeny tests.

Rate of genetic improvement - Rate of improvement per unit of time (year). The rate of improvement is dependent on: (1) heritability of traits considered; (2) selection differentials; (3) genetic correlations among traits considered; (4) generation interval in the herd; and (5) the number of traits for which selections are made.

Recessive gene - Recessive genes affect the phenotype only when present in a homozygous condition. Recessive genes must be received from both parents before the phenotype caused by the recessive genes can be observed.

Reference sire - A bull designated to be used as a benchmark in progeny testing other bulls (young sires). Progeny by reference sires in several herds enable comparisons to be made between bulls not producing progeny in the same herd(s).

Regression (regressed) - A measure of the relationship between two variables. The value of one trait can be predicted by knowing the value of the other variable. For example, easily obtained carcass traits (hot carcass weight, fat thickness, ribeye area, and percentage of internal fat) are used to predict percent cutability. Likewise, breeding value estimates based on limited data are regressed back toward the population average to account for the imperfection of this relationship.

Ribeye area - Area of the longissimus muscle measured in square inches between the 12th and 13th rib.

Rotational crossbreeding - Systems of crossing two or more breeds where the crossbred females are bred to bulls of the breed contributing the least genes to that female's genotype. Rotation systems maintain relatively high levels of heterosis and produce replacement heifers from within the system. Opportunity to select replacement heifers is greater for rotation systems than for other crossbreeding systems.

Scrotal circumference - A measure of testes size obtained by measuring the distance around the testicles in the scrotum with a circular tape. Related to semen producing capacity and age at puberty of female sibs and progeny.

Scurs - Horny tissue or rudimentary horns that are attached to the skin rather than the bony parts of the head.

Seedstock breeders - Producers of breeding stock for purebred and commercial breeders. Progressive seedstock breeders have comprehensive programs designed to produce an optimum or desirable combination of economical traits (genetic package) that will ultimately increase the profitability of commercial beef production.

Selection - Causing or allowing certain individuals in a population to produce offspring in the next generation.

Selection differential -The difference between the average for a trait in selected cattle and the average of the group from which they came. The expected response from selection for a trait is equal to selection differential times the heritability of the trait.

Selection index - A formula that combines performance records or EPDs from several traits or different measurements of the same trait into a single value for each animal. Selection indexes weigh the traits for their relative net economic importance and their heritabilities plus the genetic associations among the traits.

Sibs - Brothers and sisters of an individual.

Sire summary - Published results of sires from national cattle evaluation programs.

Sperm - A mature male germ cell.

Super ovulation - Process by which a cow produces more eggs than normal. Utilized in embryo transfer techniques.

Systems approach - An approach to evaluating alternative individuals, breeding programs, and selection schemes that involves assessment of these alternatives in terms of their net impact on all inputs and output in the production system. This approach specifically recognizes that intermediate optimum levels of performance in several traits may be more economically advantageous than maximum performance for any single trait.

Tandem selection - Selection for one trait at a time. When the desired level is reached in one trait, then selection is practiced for the second trait.

Terminal sires - Sires used in a crossbreeding system where all their progeny, both male and female, are marketed. For example F_1 crossbred dams could be bred to sires of a third breed and all calves marketed. Although this system allows maximum heterosis and breed complimentarity, replacement females must come from other herds.

Trait ratio - An expression of an animal's performance for a particular trait relative to the herd or contemporary group average. It is usually calculated for most traits as:

$$\frac{\text{Individual record}}{\text{Average of animals in group}} \times 100$$

Ultrasound measurements - Used to estimate carcass and reproductive characteristics. Operates off the principle that sound waves echo differently with different densities of tissue.

USDA yield grade - Measurements or estimates of carcass cutability categorized into numerical categories with 1 being the leanest and 5 being the fattest. Yield grade and cutability are based on the same four carcass traits.

Variance - Variance is a statistic that describes the variation we see in a trait. Without variation, no genetic progress is possible, because genetically superior animals would not be distinguishable from genetically inferior ones.

Weight per day of age (WDA) - Weight of an individual divided by days of age.

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BCH-1000 Beef Performance Glossary

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Body Condition, Nutrition and Reproduction of Beef Cows

Texas Agricultural Extension Service • Zerle L. Carpenter, Director • The Texas A&M University System • College Station, Texas

Contents

Body Condition, Nutrition and Reproduction of Beef Cows

Dennis B. Herd and L. R. Sprott*

The percentage of body fat in beef cows at specific stages of their production cycle is an important determinant of their reproductive performance and overall productivity. The amount and type of winter supplementation required for satisfactory performance is greatly influenced by the initial body reserves, both protein and fat, of the cattle at the beginning of the wintering period.

Profitability in the cow-calf business is influenced by the percentage of cows in the herd which consistently calve every 12 months. Cows which fail to calve or take longer than 12 months to produce and wean a calf increase the cost per pound of calf produced by the herd. Reasons for cows failing to calve on a 12-month schedule include disease, harsh weather and low fertility in herd sires. Most reproductive failures in the beef female can be attributed to improper nutrition and thin body condition. Without adequate body fat, cows will not breed at an acceptable rate. The general adequacy of diets can be determined by a regular assessment of body condition.

To date, there has been no standard system of describing the body condition of beef cows which could be used as a tool in cattle management and for communication among cattlemen, research workers, Extension and industry advisors. This publication's purpose is to outline a system for evaluating beef cow's body reserves and to relate the evaluation to reproductive and nutritional management. When used on a regular and consistent basis, body condition scores provide information on which improved management and feeding decisions can be made.

Practical Importance of Body Condition Scoring

Variation in the condition of beef cows has a number of practical implications. The condition of cows at calving is associated with length of post partum interval, subsequent lactation performance, health and vigor of the newborn calf and the incidence of calving difficulties in extremely fat heifers. Condition is often overrated as a cause of dystocia in older cows. The condition of cows at breeding affects their reproductive performance in terms of services for conception, calving interval and the percentage of open cows.

Body condition affects the amount and type of winter feed supplements that will be needed. Fat cows usually need only small amounts of high protein (30 to 45 percent) supplements, plus mineral and vitamin supplementation. Thin cows usually need large amounts of supplements high in energy (+70 percent TDN), medium in protein (15 to 30 percent), plus mineral and vitamin supplementation.

Body condition or changes in body condition, rather than live weight or shifts in weight, are a more reliable guide for evaluating the nutritional status of a cow. Live weight is sometimes mistakenly used as an indication of body condition and fat reserves, but gut fill and the products of pregnancy prevent weight from being an accurate indicator of condition. Live weight does not accurately reflect changes in nutritional status. In winter feeding studies where live weight and body condition scores have been measured, body condition commonly decreases proportionally more than live weight, implying a greater loss of energy relative to weight.

Two animals can have markedly different live weights and have similar body condition scores. Conversely, animals of similar live weight may differ in condition score. As an example, an 1,100 pound cow may be a 1,000 pound animal carrying an extra 100 pounds of body reserves, or a 1,200 pound cow which has lost 100 pounds of reserves. These two animals would differ markedly in both biological and economical response to the same feeding and management regime with possible serious consequences.

The body composition of thin, average and fat cows is illustrated in Table 1. Protein and water exist in the body in a rather fixed relationship. As the percentage of fat in the body increases, the percentage of protein and water will decrease. The gain or loss of body condition involves changes in protein and water as well as fat, though fat is the major component. Breed, initial body condition, rate of condition change and season affect the composition and energy value of weight gains or losses. Body condition scoring provides a measure of an animal's nutrition reserves which is more useful and reliable than live weight alone.

In commercial practice, body condition scoring can be carried out regularly and satisfactorily in circumstances where weighing may be impractical.

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The technique is easy to learn and is useful when practiced by the same person in the same herd over several years.

Table 1. Effect of body condition score on body composition and composition changes assuming an 1,100 pound cow at body condition score of 5.

Body condition score	3 (thin)	5 (average)	7 (fat)
Live weight/lb.	946	1,100	1,284
Composition of empty body[a]			
total weight/lb.	843	980	1,144
fat, lb.	67 (8)[b]	157 (16)	275 (24)
protein/lb.	171 (20)	181 (18)	191 (17)
water/lb.	564 (67)	598 (61)	632 (55)
mineral/lb.	39 (5)	41 (5)	44 (4)
total megacalories	700	1,107	1,647
megacalories/lb.	.83	1.13	1.44

Difference in composition	BCS 3 versus 5	BCS 5 versus 7
empty body weight/lb.	137	164
fat/lb.	90 (66)	118 (72)
protein/lb.	10 (7)	10 (6)
water/lb.	34 (25)	34 (20)
mineral/lb.	2 (<2)	3 (<2)
total megacalories	409	529
megacalories/lb.	2.99	3.23
Pounds of shelled corn required for		
weight gain	610	790
saved by weight loss	307	397

[a]Empty body weight is the live weight less the contents of the digestive tract.

[b]Values in parentheses are percentages.

Body Condition Scores

Body condition scores (BCS) are numbers used to suggest the relative fatness or body composition of the cow. Most published reports are using a range of 1 to 9, with a score of 1 representing very thin body condition and 9 extreme fatness. There has not been total coordination by various workers concerning the descriptive traits or measures associated with a BCS of 5. As a result, scoring done by different people will not agree exactly; however, scoring is not likely to vary by more than one score between trained evaluations, if a 1 to 9 system is used. For BCS to be most helpful, producers need to calibrate the 1 to 9 BCS system under their own conditions.

Guidelines for BCS

Keep the program simple. A thin cow looks very sharp, angular and skinny while a fat one looks smooth and boxy with bone structure hidden from sight or feel. All others fall somewhere in between. A description of conditions scores is given in Table 4.

A cow with a 5 BCS should look average—neither thin nor fat. In terms of objective measures, such as fat cover over the rib, percent body fat, etc., a BCS 5 cow will not be in the middle of the range of possible values but rather on the thin side. A BCS 5 cow will have 0.15 to 0.24 inches of fat cover over the 13th rib, approximately 14 to 18 percent total empty body fat and about 21 pounds of weight per inch of height. (See Table 2 for the range in values for all condition scores.) The weight to height ratio has not been as accurate as subjective scoring for estimating body composition. Pregnancy, rumen fill and age of the cow influence the ratio and reduce its predictive

Table 2. Best estimates of various values for the Texas system of body condition scoring[a].

Body condition score	% Fat: Empty body	% Fat: Carcass	Carcass fat cover inches	Mcal/lb.: Empty body	Mcal/lb.: Carcass	Wt./Ht. lb./in.	Ratio of weight	Weight to change score as a % of wt. at BCS 5	Caloric value/ lb. wt. gain Mcal[b]
1	0	.7	0	.52	.56	15.7	0.740		
								5.8	2.68
2	4	5.0	0	.67	.72	16.9	0.798		
								6.2	2.81
3	8	9.3	.05	.83	.89	18.3	0.860		
								6.7	2.95
4	12	13.7	.11	.98	1.05	19.7	0.927		
								7.3	3.09
5	16	18.0	.19	1.14	1.21	21.3	1.000		
								8.0	3.22
6	20	22.3	.29	1.29	1.37	23.0	1.080		
								8.7	3.36
7	24	26.7	.41	1.44	1.53	24.8	1.167		
								9.1	3.50
8	28	31.0	.54	1.59	1.70	26.7	1.258		
								10.2	3.63
9	32	35.3	.68	1.75	1.86	28.9	1.360		

[a]Abbreviations: Mcal = Megacalorie, wt = weight, lb = pound, in = inches, BCS = Body Condition Score.
[b]Net energy of gain. For weight loss, multiply values by 0.75.

potential. The ratio of weight to height can help separate the middle scores from the extremes.

There is controversy about whether one needs to feel the cattle to determine fatness (Figure 1) or simply look at them to assess condition scores. A recent study indicated that cattle could be separated equally well by palpation of fat cover or by visual appraisal, but the set point or average score may vary slightly depending on the method used. For cattle with long hair, handling is of value, but when hair is short, handling is probably not necessary. Keep in mind that shrink can alter the looks and feel of the cattle as much as one score. Animals in late pregnancy also tend to look fuller and a bit fatter.

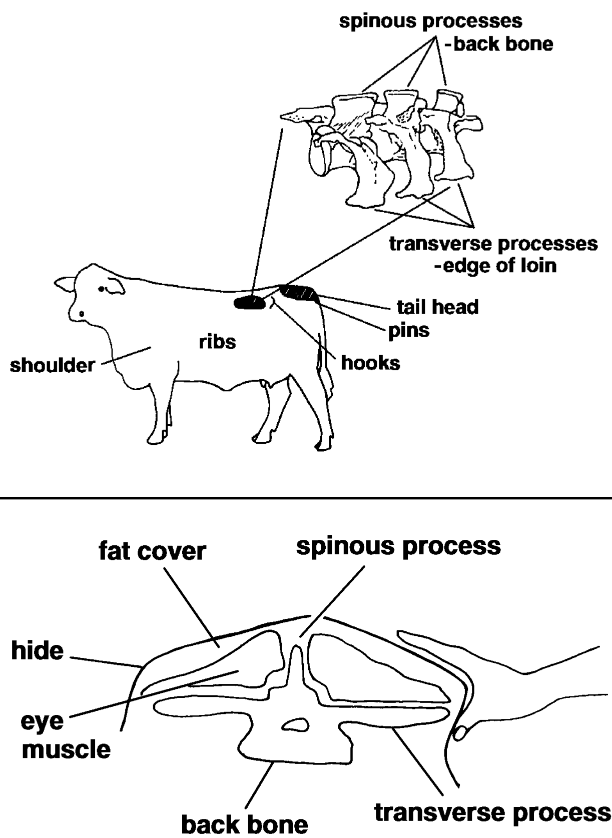


Figure 1. Anatomic areas that are used for scoring body condition in beef cows.

By recognizing differences in body conditions, one can plan a supplemental feeding program so that cows are maintained in satisfactory condition conducive to optimum performance at calving and breeding. These scores are meant to describe the body condition or fatness of a cow and have no implications as to quality or merit. Any cow could vary in condition over the nine-point system, depending on health, lactational status and feed supply.

Effect on Reproductive Performance

Calving Interval and Profitability

Calving interval is defined as the period from the birth of one calf to the next. To have a 12-month calving interval, a cow must rebreed within 80 days after the birth of her calf. Cows that do, produce a pound of weaned calf cheaper than cows that take longer than 80 days to rebreed.

In a Hardin County, Texas study, maintenance costs were compared for cows with a 12-month calving interval against those with a longer interval. Costs of production per calf from cows with intervals exceeding 12 months ranged from $19 to $133 more than for calves from cows with 12-month intervals. To compensate for increased production costs, calves from cows with extended calving intervals must have a heavier weaning weight than calves from cows with intervals of 12 months or less. Otherwise, an increase in sale price must occur. Depending on either factor for compensation is an unreasonable gamble.

BCS at Calving

The results of 5 trials which explain the effect of body condition at calving on subsequent reproductive performance are shown in Table 3. In trial 1 the percent of cows that had been in heat within 80 days after calving was lower for cows with a body condition of less than 5 than for cows scoring more than 5. Low body condition can lead to low pregnancy rates as evidenced in the other four trials. In all

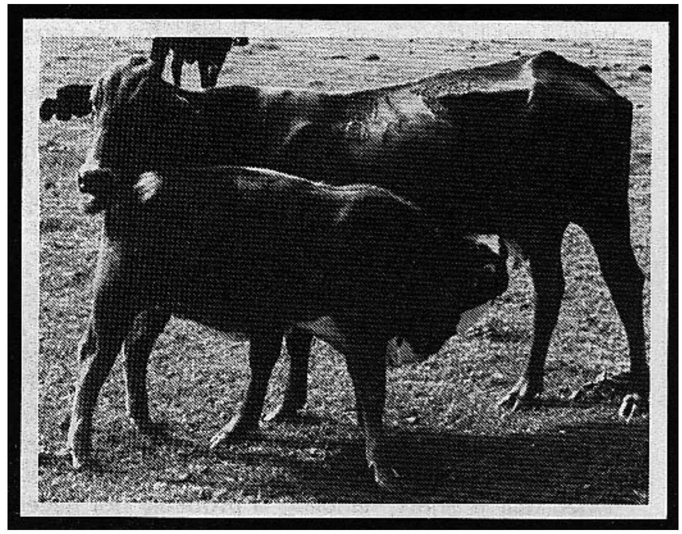
Table 3. Effect of body condition at calving on subsequent reproductive performance.

	Body Condition at Calving		
	4 or less	5	5 or more
Trial 1			
Number of cows	**272**	**364**	**50**
Percent in heat within 80 days after calving	**62**	**88**	**98**
Trial 2			
Number of cows	**78**	**10**	**0**
Percent pregnant after 60 days	**69**	**80**	**–**
Trial 3			
Number of cows	**25**	**139**	**23**
Percent pregnant after 60 days	**24**	**60**	**87**
Trial 4			
Number of cows	**32**	**60**	**32**
Percent pregnant after 180 days	**12**	**50**	**90**
Trial 5			
Number of cows	**168**	**274**	**197**
Percent pregnant after 60 days	**70**	**90**	**92**

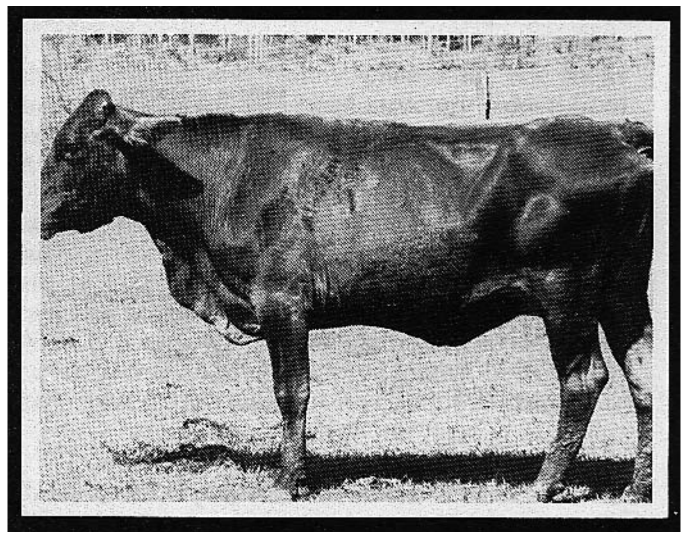
Adapted from Whitman. 1975 (Trial 1) and Sprott, 1985 (Trials 2-5).

Table 4. Description of body condition scores. Adapted from Lowman, 1976.

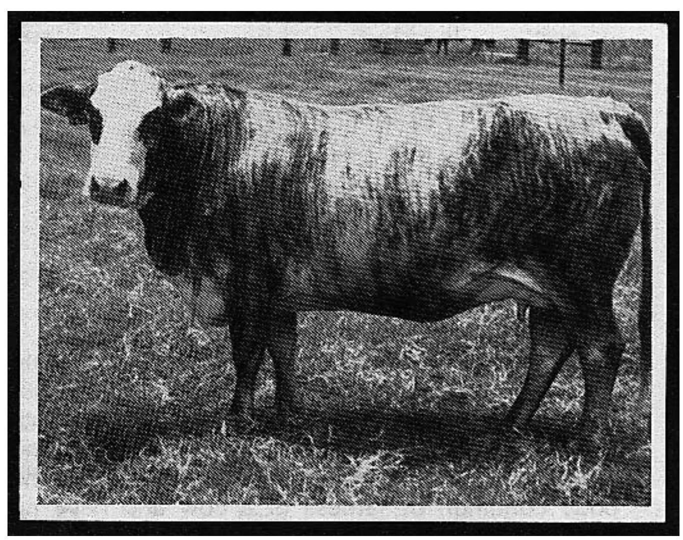
	BCS	Description
Thin Condition	1	**Bone structure of shoulder, ribs, back, hooks and pins sharp to touch and easily visible. Little evidence of fat deposits or muscling. (Photo 1)**
	2	**Little evidence of fat deposition but some muscling in hindquarters. The spinous processes feel sharp to touch and are easily seen with space between them. (Photo 2)**
	3	**Beginning of fat cover over the loin, back, and foreribs. Backbone still highly visible. Processes of the spine can be identified individually by touch and may still be visible. Spaces between the processes are less pronounced. (Photo 3)**
Borderline Condition	4	**Foreribs not noticeable; 12th and 13th ribs still noticeable to the eye particularly in cattle with a big spring of rib and ribs wide apart. The transverse spinous processes can be identified only by palpation (with slight pressure) to feel rounded rather than sharp. Full but straightness of muscling in the hindquarters. (Photo 4)**
Optimum Condition	5	**12th and 13th ribs not visible to the eye unless animal has been shrunk. The transverse spinous processes can only be felt with firm pressure to feel rounded–not noticeable to the eye. Spaces between the processes not visible and only distinguishable with firm pressure. Areas on each side of the tail head are fairly well filled but not mounded. (Photo 5)**
	6	**Ribs fully covered, not noticeable to the eye. Hindquarters plump and full. Noticeable sponginess to covering of foreribs and on each side of the tail head. Firm pressure now required to feel transverse processes. (Photo 6)**
	7	**Ends of the spinous processes can only be felt with very firm pressure. Spaces between processes can barely be distinguished at all. Abundant fat cover on either side of tail head with some patchiness evident. (Photo 7)**
Fat Condition	8	**Animal taking on a smooth, blocky appearance; bone structure disappearing from sight. Fat cover thick and spongy with patchiness likely. (Photo 8)**
	9	**Bond structure not seen or easily felt. Tail head buried in fat. Animal's mobility may actually be impaired by excess amount of fat. (Photo 9)**



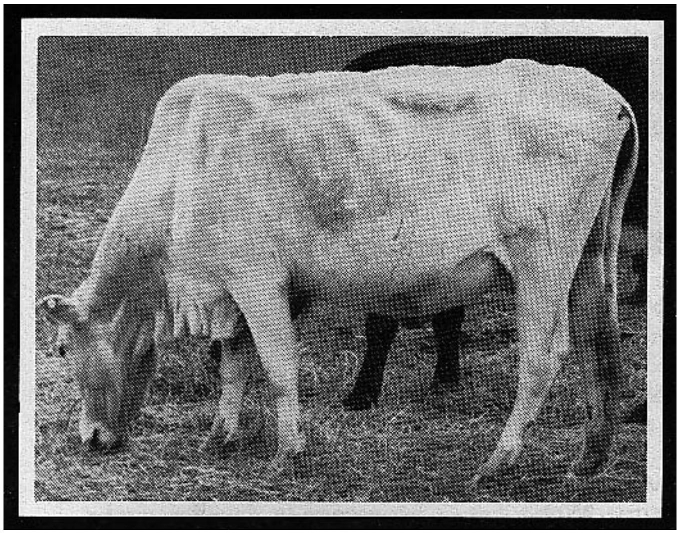
BCS 1



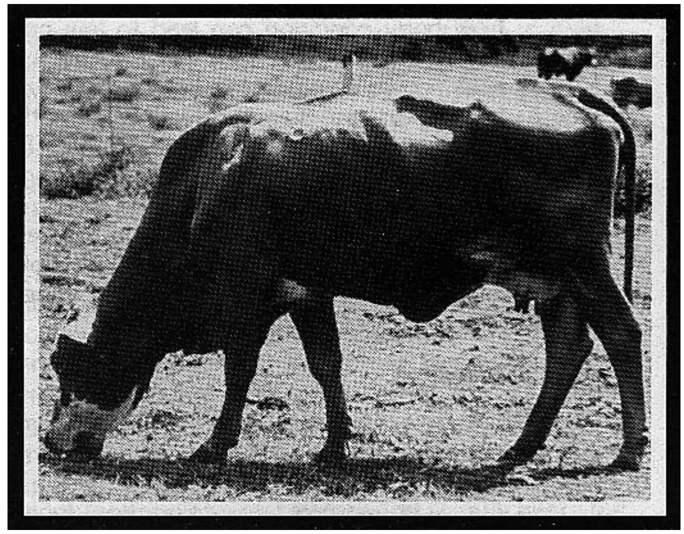
BCS 4



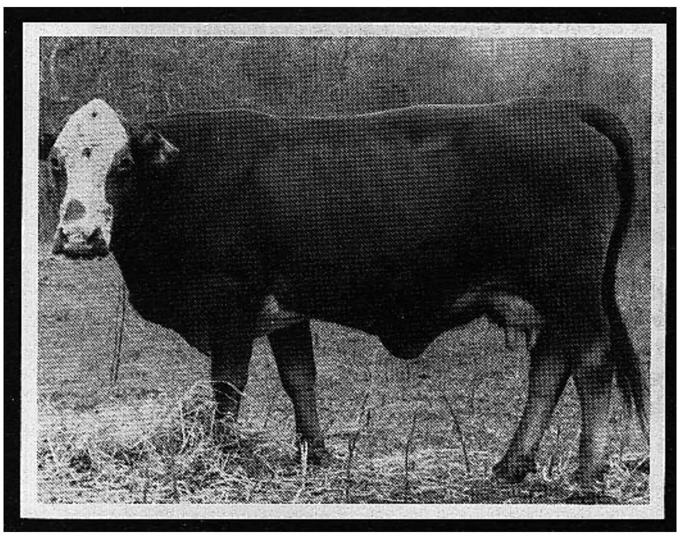
BCS 7



BCS 2

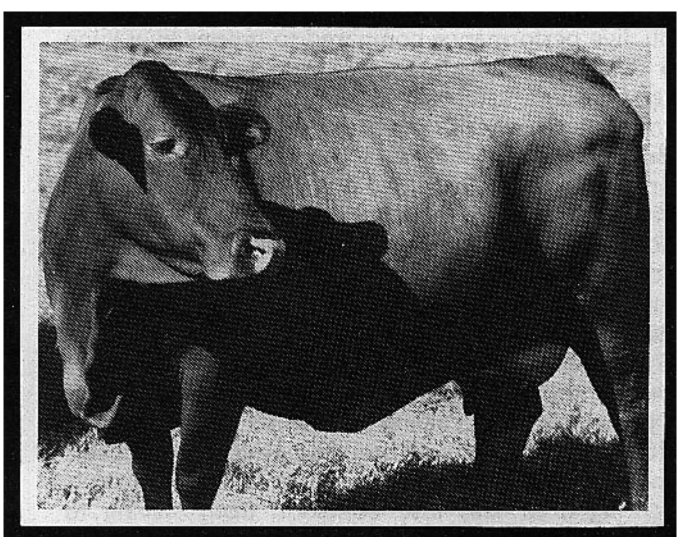


BCS 3

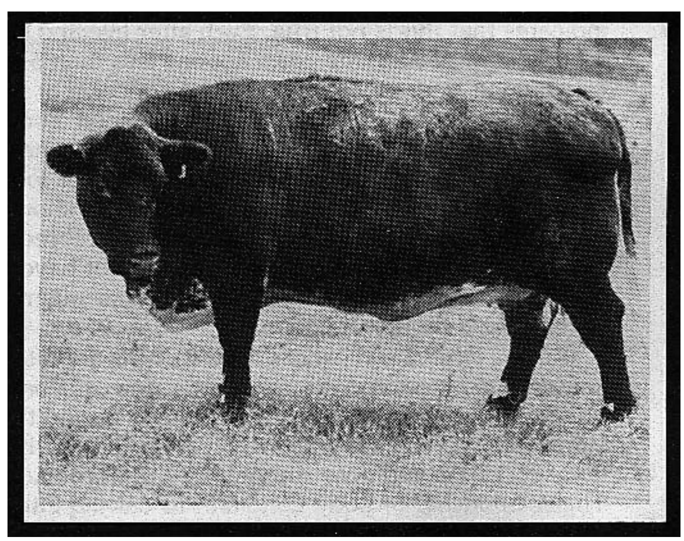


BCS 5

BCS 6



BCS 8



BCS 9

instances, cows scoring less than 5 at calving time had the lowest pregnancy rates indicating that thin condition at calving time is undesirable. The acceptable body condition score prior to calving is at least 5 or possibly 6. These should be the target condition scores at calving for all cows in the herd. Anything higher than 6 may or may not be helpful. Scores at calving of less than 5 will impede reproduction.

BCS at Breeding

Cows should be in good condition at calving and should maintain good body condition during the breeding period. Table 5 shows results of a trial involving more than 1,000 cows where the effect of body condition during the breeding season on pregnancy rates was studied. That trial supports the fact that condition scores of less than 5 during breeding will result in extremely low pregnancy rates. Proper nutrition during the breeding season is necessary for acceptable reproduction.

Table 5. Effect of body condition during the breeding season on pregnancy.

	Body condition during breeding		
	4 or less	5	6 or more
Number of cows	**122**	**300**	**619**
Percent pregnant after 150 days	**58**	**85**	**95**

(Sprott, 1985.

Long Breeding Seasons Not the Answer

Some producers believe long breeding seasons are necessary to achieve good reproductive performance. Evidence in Table 3—Trial 4 and Table 5 indicates that this is not true. Even after five and six months of breeding, the cows scoring less than 5 at calving and during breeding did not conceive at an acceptable level. Until they have regained some body condition or have had their calf weaned, most thin cows will not rebreed regardless of how long they are exposed to the bulls. Trials have shown that thin cows may take up to 200 days to rebreed. Cows requiring that long to rebreed will not have a 12-month calving interval, which subsequently reduces total herd production.

Calving intervals in excess of 12 months are often caused by nutritional stress on the cow at some point either before the calving season or during the subsequent breeding season. This results in thin body condition and poor reproductive performance. The relationship of body condition to calving interval is shown in Figure 2. The thinnest cows have the longest calving intervals while fatter cows have shorter calving intervals. Producers should evaluate their cows for condition and apply appropriate supplemental feeding practices to correct nutritional deficiencies which are indicated when cows become thin. These deficiencies must be corrected or reproductive efficiency will remain low for cows in thin body condition.

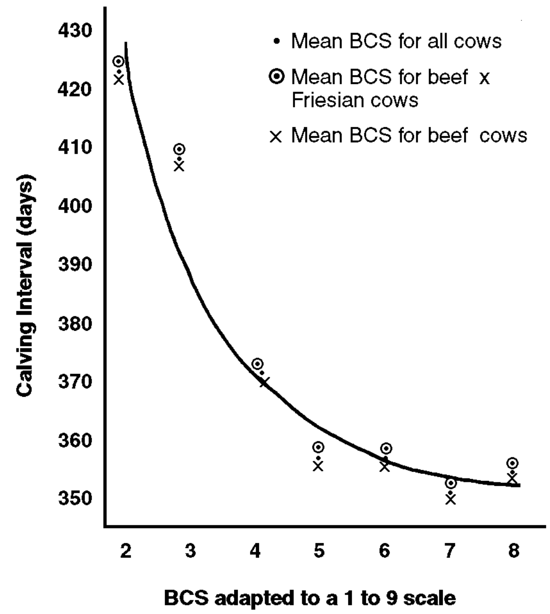


Figure 2. Relationship between cow body condition score at mating and subsequent calving interval. (Adapted from Kilkenny, 1978.)

Critical BCS

Groups of cows with an average BCS of 4 or less at calving and during breeding will have poor reproductive performance conpared to groups averaging 5 or above. Individual cows may deviate from the relationships established for groups; however, the relationship is well documented for herd averages. Body condition scores of 5 or more ensure high pregnancy rates, provided other factors such as disease, etc., are not influencing conception rates. It is acceptable for cows calving regularly to obtain a score of 7 or more through normal grazing, but buying feed to produce these high condition scores is uneconomical and not necessary.

It is desirable to maintain cows at a BCS of 5 or more through breeding. This implies that cows scoring less than 5 at calving need to be fed to improve their condition through breeding, which is expensive to accomplish while they are nursing calves. If cows scoring 5 or less lose condition from calving to breeding, pregnancy rates will be reduced. Cows scoring 7 or 8 can probably lose some condition and still breed well provided they do not lose enough to bring their score below 5.

An efficient way to utilize BCS involves sorting cows by condition 90 to 100 days prior to calving. Feed each group to have condition scores of 5 to 7 at calving. These would be logical scores for achieving maximum reproductive performance while holding supplemental feed costs to a minimum.

Supplemental Feeding Based on BCS

Regular use of BCS will help evaluate the body composition or fatness of cattle in a fairly accurate and rather easy manner. Cows which score 5 or more and still have reproductive problems likely have a mineral or vitamin deficiency, disease or genetic problem, or the problem may exist with the bull. Cows scoring less than 5 may not be receiving adequate levels of energy (total feed with reasonable quality) and protein, although other factors such as phosphorus and internal parasites may be involved. A combination of these nutritional problems is frequently observed.

In a commercial cow-calf program, the digestible energy requirement of the cow and calf should come from forage produced on the operator's farm or ranch. Purchasing large amounts of energy supplements on a regular basis is not economically feasible. A cow's energy deficit periods must be satisfied from body stores established during periods of forage surplus. Protein, mineral and vitamin supplements facilitate this process efficiently from both a biological and economical basis. The higher sale value of purebred cattle can make replacement of forage-energy with grain-energy economically feasible and often necessary for extra condition and marketing or sales appeal. Purebred breeders need to remember that their cattle should fit the production environment of their commercial customers, minimizing grain input, if they expect repeat sales.

Numerous supplemental feeds are available in a variety of different forms. None of the supplements are best suited for all situations. The body condition of the cow, lactation status and quality of forage are major factors to consider in choosing a supplement. The influence these factors have on supplementation requirements is illustrated in Tables 6 and 7 for a cow that weighs 1,000 pounds at BCS 5. Producers should remember that other factors also influence nutritional requirements, such as weight, mature size, breed type, milk production level, travel and environmental stresses.

Body condition significantly alters the requirement for supplemental energy and slightly alters the need for supplemental protein, but it is not a determining factor of mineral or vitamin supplementation. Mineral supplementation with emphasis on salt, phosphorus, magnesium, copper, zinc and calcium is advisable in all situations. Vitamin A supplementation may not be needed with excellent forage, unless it is hay stored for a lengthy period. Vitamin A should be supplemented, especially for lactating cows, with lower quality forages regardless of body condition.

All cattle, fat or thin, need protein supplementation to consume and utilize low quality forage with any degree of effectiveness. Protein supplementation is recommended with low quality forage regardless of the BCS or lactation status of the cow. The efficiency of response to protein supplementation is normally greater than that to energy.

Table 6. Pounds of feed needed daily by a pregnant 1,000 pound cow (last 1/3 of gestation) of varying body condition, when fed forage of varying quality, assuming fleshy cows will be allowed to lose weight (1.33 lb./day) and condition and thin cows will be fed to increase weight (+1.33 lb./day) and condition.[a]

	Pasture, Range or Hay Quality								
	Excellent 13% Crude Protein 52% TDN[b] .51 Mcal NE_M[c]			Average 7.5% Crude Protein 47%TDN .43 Mcal NE_M			Poor 4% Crude Protein 42% TDN .35 Mcal NE_M		
Condition score of cows	**3**	**5**	**7**	**3**	**5**	**7**	**3**	**5**	**7**
Cow weight/lb.	**860**	**1,000**	**1167**	**860**	**1,000**	**1,167**	**860**	**1,000**	**1,167**
Required by cow									
Crude Protein/lb.	**1.9**	**1.5**	**1.2**	**1.9**	**1.5**	**1.2**	**1.9**	**1.5**	**1.2**
NE_M, Mcal	**13.4**	**9.5**	**6.2**	**13.4**	**9.5**	**6.2**	**13.4**	**9.5**	**6.2**
Hay/lb.	**24.7**	**18.7**	**12.2**	**20.2**	**22.0**	**16.0**	**16.7**	**18.3**	**15**
Cottonseed meal/lb.	**--**	**--**	**--**	**--**	**--**	**--**	**1.5**	**1.5**	**1.5**
Milo or corn/lb.	**1**	**--**	**--**	**5.5**	**--**	**--**	**7.5**	**2.5**	**--**

[a]At 1.33 pounds per day, 105 days would be required for the thin cow to reach a BCS of 5, 125 days would pass before the fleshy cow would drop down to a BCS of 5. When feed is available and reasonably priced, it may be desirable to save some of the condition on the BCS 7 cow for a later time, e.g., a drought where feed will be scarce and expensive.

[b]Total Digestible Nutrients.

[c]Megacalories of Net Energy for Maintenance (used as basis for calculations).

Table 7. Pounds of feed needed daily by a 1,000 pound lactating cow (14 lbs. milk/day) of varying body condition, when fed forage of varying quality, assuming the fleshy cows will be allowed to lose weight (-1.33 lb./day) and condition and the thin cows will be fed to increase weight (+1.33 lb./day) and condition.[a]

	Pasture, Range or Hay Quality								
	Excellent 13% Crude Protein 52% TDN[b] .51 Mcal NE_M[c]			Average 7.5% Crude Protein 47% TDN .43 Mcal NE_M			Poor 4% Crude Protein 42% TDN .35 Mcal NE_M		
Condition score of cows	**3**	**5**	**7**	**3**	**5**	**7**	**3**	**5**	**7**
Cow weight/lb.	**860**	**1,000**	**1,167**	**860**	**1,000**	**1,167**	**860**	**1,000**	**1,167**
Required by cow									
Crude Protein/lb.	**2.6**	**2.2**	**1.9**	**2.6**	**2.2**	**1.9**	**2.6**	**2.2**	**1.9**
NE_M, Mcal	**17.5**	**13.5**	**10.2**	**17.5**	**13.5**	**10.2**	**17.5**	**13.5**	**10.2**
Hay/lb.	**26.0**	**26.5**	**20.0**	**21.9**	**23.7**	**23.0**	**17.5**	**19.0**	**19.5**
Cottonseed meal/lb.	**--**	**--**	**--**	**1.0**	**1.0**	**1.0**	**2.5**	**2.5**	**2.0**
Milo or corn/lb.	**5.0**	**--**	**--**	**8.0**	**3.0**	**--**	**11.0**	**6.0**	**2.5**

[a]At 1.33 pounds per day, 105 days would be required for the thin cow to reach a BCS of 5, 125 days would pass before the fleshy cow would drop down to a BCS of 5. When feed is available and reasonably priced, it may be desirable to save some of the condition on the BCS 7 cow for a later time, e.g., a drought where feed will be scarce and expensive.

[b]Total Digestible Nutrients.

[c]Megacalories of Net Energy for Maintenance (used as basis for calculations).

There are limits, however, to the improvement in animal performance that can be achieved with protein supplementation. if protein supplementation will not result in satisfactory performance, large amounts of grain-based supplements (including protein) must be fed or a better forage must be used.

Whether energy supplementation or grain feeding is necessary depends largely on the lactation status and BCS of the cows and the quality of forage. Grain feeding is recommended only as a last resort since it is normally expensive and has negative associative effects on the efficiency with which cattle utilize forage. The depressing effect of grain feeding on forage digestion is greatest when large amounts are fed infrequently. Depressing effects result from reductions in rumen pH, changes in the rumen microbes and antagonistic alterations in the rate of passage of each feed through the digestive tract. Where energy supplementation is necessary in order to sustain a desired level of performance, provide small amounts at frequent intervals.

Protein and energy should be in proper balance. If protein is in excess compared to the level of energy, the excess protein will be used for energy. Although high protein feeds are good energy feeds, they are usuallly quite expensive sources of energy. Adding a high energy supplement to a forage that is deficient in protein will result in a total diet that is deficient in protein and poor utilization of total dietary energy. Timely use of energy in combination with protein supplements is often necessary with typical forage programs to properly develop replacement heifers and supplement heifers with their first calf. Mature cows should not need much energy supplementation on a routine basis.

Nutritional Management

Many cows in Texas need a higher level of condition at calving and breeding to improve reproductive performance and income. Grain feeding can be used to maintain or increase body condition, but this approach has economic limitations. Tables 6 and 7 illustrate that cows receiving higher quality forage require little or no grain supplementation, especially dry pregnant cows. Dry pregnant cows can utilize low quality forage without excessive grain supplementation. Cows with body condition scores of 6 to 8 can lose some condition without reducing performance and therefore need little, if any, grain.

With these points in mind, producers should choose a calving season that is compatible with their forage program, use a good mineral program which improves body condition year-round due to improved forage utilization, and consider protein supplementation whenever forage protein is less than 7 percent on a dry matter basis (e.g., summer drought pasture, mature frosted grass, etc.). Since protein supplementation stimulates the intake and digestion of low protein forage (<7 percent), body condition can be improved on droughty summer pasture and condition losses can be decreased on dormant winter pasture. This approach minimizes the amount and expense of energy supplementation, but may not eliminate it completely. Where minerals, vitamins and protein are furnished in adequate amounts, but body condition continues to decline, large amounts of energy supplementation will be required to stop further decline or to produce an improvement. Because combinations of low quality forage and grain are used so inefficiently, it would be more economical to produce or buy a higher quality forage when high levels of animal performance are desired.

If the requirement for energy supplementation is a yearly necessity, a change in management is suggested. The supply of nutrients from forage must be increased, both in quality and quantity, or the nutritional requirements of the cattle must be reduced (cattle with less milk potential and probably smaller in size). The stocking rate of many herds needs to be reduced to allow a greater volume of forage for each animal thus reducing the need for so much supplement.

Summary

A BCS of 5 or more (at least 14 percent body fat) at calving and through breeding is required for good reproductive performance. Over-stocking pastures is a common cause of poor body condition and reproductive failure. Proper stocking, year-round mineral supplementation and timely use of protein supplements offer the greatest potential for economically improving body condition scores and rebreeding performance of beef cows in Texas. Sorting cows by condition 90 to 100 days ahead of calving and feeding so that all cows will calve with a BCS of 5 to 7 will maximize reproductive performance while holding supplemental feed costs to a minimum. Nutritional and reproductive decisions, so important to profitability, are made with more precision and accuracy where a body condition scoring system is routinely used.

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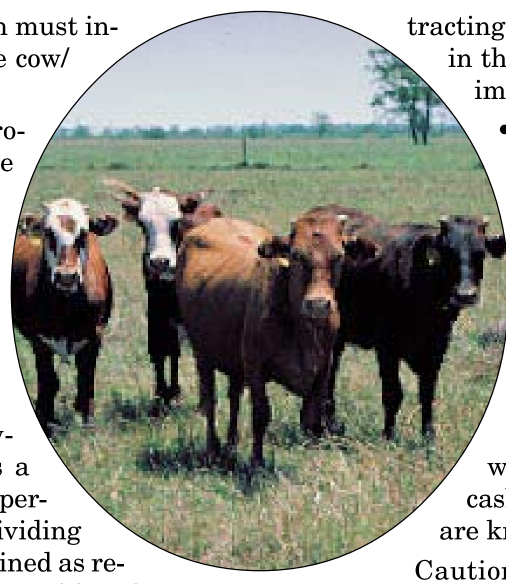
Break-even Costs for Cow/Calf Producers

L.R. Sprott*

Calculating break-even costs of production can help cow/calf producers make better management decisions for the current year or for the near future.

By definition, break-even cost is the total cost of production divided by the total pounds of calf produced, whether marketed or retained. Another way to describe break-even is that it is the minimum sale price needed to recover all cash costs in a given year. The total cost of production for a cow/calf operation must include all costs associated with the cow/calf enterprise.



To determine break-even, a producer must know or closely estimate three values:

- Annual costs (cash basis) of owning a cow. The value will vary from year to year and among different ranches. Use the value for your ranch and keep records of all costs to determine this value;
- Annual calf crop. In the following formulas, enter the value as a decimal number; for example: 90 percent = 0.9. Calculate calf crop by dividing the number of calves sold and retained as replacements in a year by the number of females exposed for breeding; and
- Average weaning or market weight of calves.

Using these three values, multiply the calf crop times the average weaning or market weight of calves sold and retained, and divide that number into the annual cash cost per cow to determine the break-even cost per pound of calf produced. The formula for break-even:

$$\frac{\text{annual cash cost per cow}}{\text{calf crop} \times \text{average weaning or market weight of calves sold and retained}} = \text{break-even cost per pound of calf produced}$$

Producers who know the market prices can determine the potential income per pound of calf by subtracting the break-even cost. Adjustments in this formula can answer three other important questions:

- What are the maximum allowable cash costs per cow if calf crop, average weaning (or market) weight and market price are known?
- What is the minimum calf crop needed if annual cash costs, average weaning (or market) weight and market price are known?
- What is the minimum market weight needed if calf crop, annual cash costs per cow and market price are known?

Caution: When trying to answer these questions, producers who don't know some of the values will need to make estimates. For example, producers who pregnancy test their cows can estimate their next calf crop fairly closely by adjusting their pregnancy rates down by 1 to 3 percent (accounting for embryonic death loss and death before marketing). Estimate the average weaning or market weights by weighing calves, calculating the weight per day of age, and then projecting to the expected day of sale (or weaning).

If it is not possible to weigh calves, estimate the projected market weight by using an average daily gain

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for calves of 1.8 to 2.0 pounds per day. The problem with estimating market weight is that producers cannot predict variables such as weather, and hence available feed, which affects gain. Although estimating market prices is difficult, help is available from market specialists, order buyers and market reports. Obviously, dependable answers to the three questions above can be obtained only when close estimations (or actual values) of the variables in the formula are available.

What are the maximum allowable annual cash costs per cow?

To answer this question, rearrange the formula and multiply calf crop (as a decimal) by the average weaning (or market) weight of calves sold and retained; then multiply that number by the market price. The formula:

Calf crop x Average weaning or market weight of calves sold and retained x Market price = Maximum allowable annual costs per cow

Example: Assumes $0.80 per pound market, 450 pound weaning (or market) weight and a 90 percent (0.9) calf crop

Annual cash costs per cow (maximum allowed under these conditions) = $.80 x 450 x 0.9 = $324 per cow

This formula obviously implies that high market prices afford a better chance at profit.

Less obvious is that when market prices are low, controlling costs can help increase the chances of profit. However, costs must be controlled in such a way that production is not sacrificed disproportionately. Sacrificing production is acceptable as long as the lost production's value is less than the reduction in cost. This can be accomplished by using practices known to have a moderate or high return rate, such as conducting annual pregnancy tests, vaccinating to control disease, providing adequate nutrition and using quality herd sires with genetics for growth.

What minimum calf crop is needed?

To answer this question, rearrange the formula again. Multiply the market price times the average weaning or market weight of calves sold and retained, and divide that number into the annual cash cost per cow. The formula:

$$\frac{\text{Annual cash cost per cow}}{\text{Market price x Average weaning or market weight of calves sold and retained}} = \text{Minimum calf crop needed}$$

Example: Assumes $250 annual cash cost per cow, 450 pound weight and $0.80 per pound.

$$\text{Calf crop} = \frac{\$250}{\$0.80 \text{ x } 450} = 0.694\text{, or 69 percent}$$

This implies that even a marginal calf crop may be profitable under relatively high market prices, but lower market prices require a higher market weight, improved calf crop or lower annual production costs.

What minimum weaning (or market) weight is needed?

To figure the minimum weaning or market weight required to break even, multiply the market price by the calf crop, and divide that number into the annual cash cost per cow. The formula:

$$\frac{\text{Annual cash cost per cow}}{\text{Market price x calf crop}} = \text{Minimum weaning or market weight to break even}$$

Example: Assumes $250 annual cash cost per cow, $0.80 per pound market price and 90 percent (0.9) calf crop.

$$\text{Average weaning (or market) weight} = \frac{\$250}{\$0.9 \text{ x } 0.80} = 347 \text{ pounds}$$

Practice using these formulas, entering different values for the variables. For instance, choose a particular annual cow cost and compare break-even between two different calf crops at the same market price. Then compare break-even between two different market weights at the same calf crop.

Tables 1 through 4 show various production scenarios at different market prices.

Remember: Heavier calves usually bring less per pound than lighter calves. For example, on a $50/cwt market (see tables), not all calves are worth exactly $50/cwt. Consequently, knowing an accurate price for each weight category is essential to determining an accurate value not shown in the tables.

Producers should pay particular attention to the pasture and range quality so that grazing is adequate in quality and quantity.

Table 1 shows break-even costs for 12 production scenarios and four annual cash costs per cow. Table 2 shows the calf crop percent needed to break even at different annual cash costs per cow and average calf weights of 350, 450 and 500 pounds. Table 3 lists the average calf market weight needed to break even at different annual cash costs per cow and calf crops of 70, 80 and 90 percent. Table 4 shows the maximum affordable annual cash costs per cow at different market weights and calf crops of 70, 80 and 90 percent.

Low production can be profitable only when annual cash costs per cow are low or market prices are high. A higher production level affords the best chance for profit even when annual cash costs are relatively high (more than $200 per cow). Clearly, producers should work to ensure high production levels while keeping their annual cash costs as low as possible without unduly sacrificing calf crop and calf weights.

If a break-even analysis indicates that the calf crop is too low, producers should learn why. Poor nutrition, inadequate disease control and bulls of low fertility are usually the culprits. If calf weights are too low, the reason may be poor-quality sires with minimal genetics for growth, or nutrition so limited that cows produce too little milk to sustain or ensure calf growth.

Pay particular attention to pasture and range quality so that grazing is adequate in quality and quantity. Producers may need to adjust the stocking rate, particularly during drought. Test hay samples for quality, and provide feed supplements that supply what is absent in the hay. Remember that cows with calves need more nutrients than cows that have not yet calved.

If it is not possible to weigh calves, estimate the projected market weight by using a average daily gain for calves of 1.8 to 2.0 pounds per day.

Break-even analysis can be used as a starting point to determine possible shortcomings in production practices. For a more detailed analysis, use NCBA-IRM-SPA Cow Calf (SPA), a computer software package available through the Texas Agricultural Extension Service. It calculates not only break-even costs, but also a number of other variables much more useful in identifying problems missed by a simple break-even analysis.

The package can track a ranch's historic production costs and compare costs against regional and national averages. It also calculates a return on assets, which is needed by producers trying to compare returns of alternative investments. For more information on this program, call (409) 845-8012.

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Table 1. Break-even prices per pound of calf at 12 production levels and 4 annual cash costs per cow.

Calf crop percent/average market weight	Pounds of calf per cow	Annual cash costs per cow			
		$100	$200	$300	$400
90/600	540	$0.19	$0.37	$0.56	$0.74
90/500	450	$0.22	$0.44	$0.66	$0.89
90/400	360	$0.28	$0.56	$0.83	$1.11
90/300	270	$0.37	$0.74	$1.11	$1.48
80/600	480	$0.21	$0.42	$0.63	$0.83
80/500	400	$0.25	$0.50	$0.75	$1.00
80/400	320	$0.31	$0.63	$0.94	$1.25
80/300	240	$0.42	$0.83	$1.25	$1.67
70/600	420	$0.24	$0.48	$0.71	$0.95
70/500	350	$0.29	$0.57	$0.86	$1.14
70/400	280	$0.36	$0.71	$1.07	$1.43
70/300	210	$0.48	$0.95	$1.43	$1.90

Table 2. Calf crop needed to break even at various annual cash costs per cow and average calf weights of 350, 450 and 500 pounds.

On a $50/cwt market

Average	Annual cash costs per cow											
calf weight	($)180	200	220	240	260	280	300	320	340	360	380	400
350 lbs.	.... impossible, unless costs are below $175 per cow											
450 lbs.	80	89	98	>100	.... impossible							
500 lbs.	72	80	88	96	>100	.... impossible						

On a $60/cwt market

Average	Annual cash costs per cow											
calf weight	($)180	200	220	240	260	280	300	320	340	360	380	400
350 lbs.	86	95	>100	.... impossible								
450 lbs.	67	74	82	89	97	>100	.... impossible					
500 lbs.	60	67	74	80	87	94	100	.... impossible				

On a $70/cwt market

Average	Annual cash costs per cow											
calf weight	($)180	200	220	240	260	280	300	320	340	360	380	400
350 lbs.	74	82	90	98	>100	.... impossible						
450 lbs.	57	64	70	76	83	89	96	>100	.... impossible			
500 lbs.	52	57	63	69	74	80	86	92	97	>100	....	

On an $80/cwt market

Average	Annual cash costs per cow											
calf weight	($)180	200	220	240	260	280	300	320	340	360	380	400
350 lbs.	64	72	79	86	93	100	.... impossible					
450 lbs.	50	56	61	67	72	78	84	89	95	100	....	
500 lbs.	45	50	55	60	65	70	75	80	85	90	95	100

On a $90/cwt market

Average	Annual cash costs per cow											
calf weight	($)180	200	220	240	260	280	300	320	340	360	380	400
350 lbs.	57	64	70	76	83	89	95	>100	.... impossible			
450 lbs.	45	50	55	59	64	69	74	79	84	89	94	99
500 lbs.	40	45	49	54	58	63	67	71	76	80	85	89

Table 3. Average calf market weight needed to break even at various annual cash costs per cow and calf crop percentages of 70, 80 and 90.

On a $50/cwt market

Calf crop	Annual cash costs per cow											
percentage	($)180	200	220	240	260	280	300	320	340	360	380	400
70	514	571	628	685								
80	450	500	550	600	650							
90	400	445	489	533	578	622						

On a $60/cwt market

Calf crop	Annual cash costs per cow											
percentage	($)180	200	220	240	260	280	300	320	340	360	380	400
70	428	476	524	571	619							
80	375	417	458	500	541	583	625					
90	333	370	407	445	481	518	555	592	629			

On a $70/cwt market

Calf crop	Annual cash costs per cow											
percentage	($)180	200	220	240	260	280	300	320	340	360	380	400
70	367	408	448	489	530	571	612					
80	321	357	392	428	464	500	535	571	607			
90	285	317	349	380	413	445	476	507	539	571		

On a $80/cwt market

Calf crop	Annual cash costs per cow											
percentage	($)180	200	220	240	260	280	300	320	340	360	380	400
70	321	357	392	428	464	500	536	571	607			
80	281	313	343	375	407	438	469	500	531	563	594	
90	250	278	306	333	361	389	417	445	472	500	528	556

On a $90/cwt market

Calf crop	Annual cash costs per cow											
percentage	($)180	200	220	240	260	280	300	320	340	360	380	400
70	286	317	349	381	413	445	476	508	540	571	603	
80	250	278	306	333	361	389	417	445	472	500	528	556
90	222	247	271	296	321	345	370	395	420	445	469	494

Table 4. Maximum affordable annual cash costs per cow at various average market weights and calf crop percentages of 70, 80 and 90.

On a $50/cwt market

Calf crop	Average calf market weight (lbs.)								
percentage	350	375	400	425	450	475	500	525	550
70	($)123	131	140	149	158	167	175	184	193
80	140	150	160	170	180	190	200	210	220
90	158	169	180	192	203	214	225	237	248

On a $60/cwt market

Calf crop	Average calf market weight (lbs.)								
percentage	350	375	400	425	450	475	500	525	550
70	($)147	158	168	179	189	200	210	221	231
80	168	180	192	204	216	228	240	252	264
90	189	203	216	230	243	257	270	284	297

On a $70/cwt market

Calf crop	Average calf market weight (lbs.)								
percentage	350	375	400	425	450	475	500	525	550
70	($)172	184	196	209	221	233	245	258	270
80	196	210	224	238	252	266	280	294	308
90	221	237	252	268	284	300	315	331	347

On a $80/cwt market

Calf crop	Average calf market weight (lbs.)								
percentage	350	375	400	425	450	475	500	525	550
70	($)196	210	224	238	252	266	280	294	308
80	224	240	256	272	288	304	320	336	352
90	252	270	288	306	324	342	360	378	396

On a $90/cwt market

Calf crop	Average calf market weight (lbs.)								
percentage	350	375	400	425	450	475	500	525	550
70	($)221	237	252	268	284	300	315	331	347
80	252	270	288	306	324	342	360	378	396
90	284	304	324	345	365	385	405	426	446

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Breeding Soundness of Bulls

L.R. Sprott, T.A. Thrift and B.B. Carpenter*

The importance of the bull in a cattle breeding program often is underestimated. A cow is responsible for half the genetic material in only one calf each year, while the bull is responsible for half the genetic material in 20 to 50 calves. The bull's ability to locate cows in estrus and breed them is clearly vital to a successful breeding program.

Bulls differ in physical appearance, fertility and sex drive (libido). In the past, when a cow failed to become pregnant it was assumed that she was at fault. Occasionally, that is true. However, a clear understanding of the male reproductive system and the differences between reproductive capabilities of bulls indicates that the cow is not always at fault.

Reproductive System

One of the major organs of the bull's reproductive system, the testis (or testicle), is made up of two tissues that perform different functions. The seminiferous tubules produce sperm, while the Leydig cells (interstitial tissue) produce tes-tosterone. The testes should be free and not adhering to the inside of the scrotum. A minor twist in the scrotum resulting in a slightly sideways suspension of the testicles may not affect reproductive performance but is abnormal in conformation and visually unpleasing. A major twist may indicate structural defect and reduced fertility.

The scrotum supports and encloses the testes. Its main function is to regulate testicular temperature. It does so through perspiration and by muscular contraction that raises the testicles in cold weather and relaxation that lowers them during warm weather.

Inside the scrotum (Fig. 1) and adjacent to each testicle is the epididymis, a 10- to 12-foot long, tightly coiled tube made up of three sections (head, body and tail). The functions of the epididymis are concentration (from 100 million/cc to 4 billion/cc), storage, maturation and transportation of sperm cells. Immature sperm cells are immobile when they enter the epididymis, but become mobile after maturation. Their ability to fertilize an egg requires a period of retention in the female reproductive tract after mating, and exposure to certain compounds contained there.

The vas deferens extend from the epididymis to the ampullae. They aid in transport of sperm cells. Prior to ejaculation, sperm cells are pooled in the ampullae. The seminal vesicles and prostate gland contribute volume to the ejaculate by secreting fluid that contains substrates, buffers, inorganic ions (sodium, chlorine, calcium, etc.) and proteins. These proteins (known as fertility associated antigens) are particularly important since they bind to certain compounds in the female tract that increase the chances of fertilization. At ejaculation, the semen is transported via the urethra and through the penis.

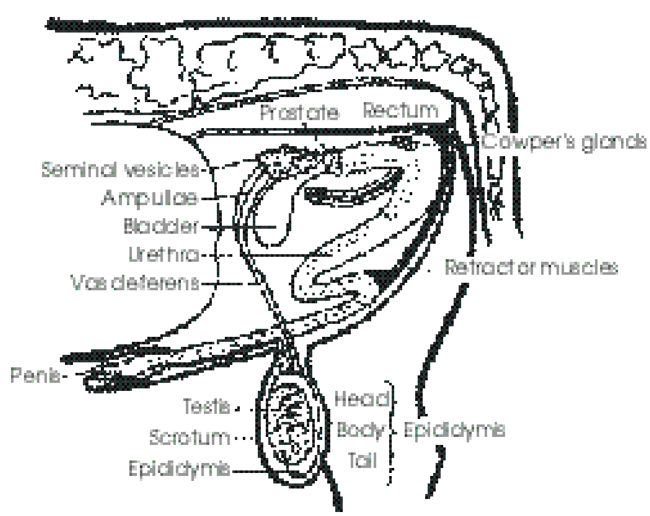

Figure 1. The reproductive tract of the bull.

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Breeding Soundness Evaluation

Bulls should be evaluated for breeding soundness 30 to 60 days before the start of breeding to allow sufficient time to replace questionable bulls. Bulls should also be evaluated at the end of breeding to determine if their fertility decreased. This second evaluation may explain a low calf crop percentage.

A breeding soundness evaluation (BSE) is administered by a veterinarian and includes a physical examination (feet, legs, eyes, teeth, flesh cover, scrotal size and shape), an internal and external examination of the reproductive tract, and semen evaluation for sperm cell motility and normality. Libido is not included in a BSE; it must be measured through visual observation during mating activity.

Physical Examination

Part of the physical examination involves the overall appearance of the bull. Flesh cover (body condition) is one factor to evaluate. Body condition can vary by breed, length of the breeding season, grazing and supplemental feeding conditions, number of cows the bull is expected to service, and distance required to travel during breeding. A thin bull may not have the stamina needed to service many cows in a short period on extensive range conditions (large acreage). An overly fat bull may lack vigor and not be able to breed up to his potential. Excessively thin bulls and fat bulls usually have low quality sperm. Ideally, bulls should have enough fat cover at the start of breeding so their ribs appear smooth across the animal's sides.

Sound feet and legs are very important. Bulls with structural unsoundness such as sickle hocks, post legs, and bent or knock knees may develop soreness. The result is the inability to travel and mount for mating. Long hooves and corns between the hooves result in similar problems.

Eyes should be clear and injury free. The teeth are checked for excess wear or loss. The general health of the bull is critical since sick, aged and injured bulls are less likely to mate and usually have lower semen quality.

Examination of the Reproductive Tract

An internal (rectal exam) and external examination should be conducted. The rectal exam is to detect any abnormalities in the seminal vesicles, prostate, ampullae and the internal inguinal rings. Rarely are there any problems with the prostate, but an infection can occur in the seminal vesicles leading to a condition called seminal vesiculitis. This is not an unusual condition in bulls and is characterized by enlargement of the seminal vesicles. Rarely are there complications with the ampullae, but the inguinal rings are examined for indications of hernia. Major herniation can also be observed externally. The latter is characterized by abnormal enlargement of the scrotum and manual palpation of intestinal loops within the scrotum.

The external examination of the reproductive tract includes manual palpation of the testes, spermatic cords and epididymis. The testes should feel firm, while the upper portion of the epididymis should feel soft and free of any lumps or enlargements.

Degeneration of the testes may occur at any time and can be caused by prolonged hot weather with high humidity, poor blood circulation, age, trauma, stress, bacterial diseases of the testes and genetic susceptibility. A general sign of degeneration is a decrease in testicular size. Maintaining records of annual BSE results for each bull will help detect changes in testicular size.

Scrotal circumference is an important measure since it is directly related to the total mass of sperm producing tissue, sperm cell normality, and the onset of puberty in the bull and his female offspring. Bulls with large circumference will produce more sperm with higher normality. They also reach sexual maturity sooner, as do their daughters. Table 1 shows average scrotal circumference of various beef breeds.

Examination of the penis and prepuce will detect inflammation, prepucial adhesions, warts, abscesses and penile deviations. The erect penis should be parallel to the bull's body.

Semen Evaluation

During a BSE, bulls will be electroejaculated and their semen should be microscopically evaluated for sperm cell motility and normality. Unless there is an obvious lack of sperm cells in the sample, cell concentration in the sample may not be very informative, as some bulls do not always respond well to electrical stimulus. Even then, it is wise to collect semen a second time to confirm if concentration is low. Sperm cell motility and normality are not necessarily

Table 1. Comparison by age of average scrotal circumference (cm) of beef breeds.

Breed	Months							
	<14	14-17	18-20	21-23	24-26	27-30	31-36	>36
Angus	34.8	35.9	36.6	36.9	36.7	36.3	36.6	38.2
Charolais	32.6	35.4	34.5	34.9	34.6	36.2	37.1	38.1
Horned Hereford	33.0	32.2	34.1	36.2	33.4	33.8	35.2	34.0
Polled Hereford	34.8	34.2	34.9	34.9	34.8	35.0	35.6	36.4
Simmental	33.4	36.5	—	—	36.0	—	—	37.2
Limousin	30.6	31.7	32.0	33.9	—	—	—	35.5
Santa Gertrudis	34.0	35.3	35.5	36.7	36.5	36.4	38.3	40.5
Brahman	21.9	27.4	29.4	31.4	31.7	33.5	34.7	36.7

affected by electroejaculation and can easily be assessed during examination. They are the most important characteristics because a high number of moving, normal sperm cells are required for fertilization of an egg.

The criteria for scoring on a BSE are shown in Table 2. Any bull meeting all minimum standards for the physical exam, scrotal size (varies by age and breed), and semen quality will be classed as a satisfactory potential breeder. Bulls that fail any minimum standard will be given a rating of "classification deferred." This rating indicates that the bull will need another test to confirm status. Mature bulls should be retested after 6 weeks. Should they fail subsequent tests, mature bulls will be classed as unsatisfactory potential breeders.

Young bulls rated as classification deferred may not have reached sexual maturity and should be retested at monthly intervals until puberty is confirmed. It should be remembered that, even though accurate, a BSE is nothing more than a snapshot of a bull's breeding potential at that point in time. Since a bull's physical condition and sperm quality can change, a BSE should be done on all bulls annually prior to the start of breeding.

Table 2. Scoring criteria for a BSE.

Minimum sperm motility - 30%

Minimum sperm normality - 70%

Minimum scrotal circumference (by age)

Age (months)	Circumference (cm)
15 or younger	30
16-18	31
19-21	32
22-24	33
25 or older	34

Physical exam

Must have adequate body condition and sound feet, legs and eyes.

Must have no abnormalities in:

- seminal vesicles
- ampullae
- prostate
- inguinal rings
- penis
- prepuce
- testicles
- spermatic cord
- epididymis
- scrotum (shape & content)

Adapted from Society of Theriogenology (1992).

Libido and Ability to Mate

Libido is, of course, a precursor to the ability to mate, but some bulls (10 to 35 percent) can not mate even though they have high libido. Injury, lameness, illness, and penile abnormalities may prevent bulls from accomplishing the act of mating. There is also evidence that libido and mating ability are genetically influenced.

Libido and the ability to mate are not measured during a BSE and can only be assessed by observing bulls in the presence of females. The number of mounts and services accomplished by the bull in a given period of time are recorded. Based on a scoring system, bulls are classed as having either high, moderate or low serving capacity. High serving capacity bulls are the most desirable because they settle more cows in fewer days than do moderate and low bulls. Whether formal tests for serving capacity are performed or not, producers are encouraged to observe their bulls during the breeding period to detect any bulls not performing their duties.

Unfortunately, libido and serving capacity are not related to BSE results or visual estimates of masculinity (thickness of the neck, muscle definition, coarseness of hair). Testosterone levels in the blood are slightly related, but only to a minimum threshold. Bulls with testosterone levels beyond this threshold are not necessarily good breeders.

Nutrition

Nutrition is important during the development of a young bull's reproductive system. Improved levels of nutrition will hasten puberty and body development. Extremely high levels of nutrition may lower libido and magnify structural weakness.

Underfeeding for prolonged periods will delay puberty and cause irreversible testicular damage. If a mature bull is subjected to prolonged underfeeding, sperm quality and libido will decrease. Overfeeding of mature bulls may result in similar problems, but adjustments in feed levels may reverse the situation. Approximate nutrient requirements for growing and mature bulls are shown in Table 3.

Genetic Factors Affecting Fertility

The onset of puberty, libido and serving capacity are influenced by genetics. There are differences both between and within breeds. Recent work regarding the presence of fertility associated antigens in sperm (see "Reproduction System") also indicates a degree of genetic control.

Generally, *Bos taurus* breeds mature at an earlier age than *Bos indicus*. Crossbreeds of these two will reach puberty at some age between their parent breeds. Other research indicates that earlier maturity in any breed can be accomplished by selection for increased yearling scrotal circumference.

Table 3. Approximate nutrient requirements for bulls.

Body weight	Gain	TDN	Total protein	Ca	P
600	2.5	73.5%	11.4%	.46%	.24%
700	2.5	73.5%	10.5%	.40%	.22%
800	2.0	67.5%	9.2%	.31%	.20%
900	1.5	63.0%	8.4%	.25%	.19%
1000	1.5	63.0%	8.1%	.24%	.19%
1100	1.5	61.0%	8.1%	.24%	.19%
1300	1.5	56.0%	7.6%	.22%	.19%
1500	1.5	56.0%	7.4%	.21%	.19%
1700	0	48.0%	6.8%	.21%	.21%
1900	0	48.0%	6.8%	.21%	.21%
2200	0	48.0%	6.8%	.22%	.22%

From National Research Council, 1984. Nutrient requirements of beef cattle.

In summary, many producers work hard to manage their cows for high fertility. They may assume that the bulls will do their expected duties, but thorough fertility management also includes attention to the bulls.

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Texas Adapted Genetic Strategies for Beef Cattle

IV: Breeding Systems

*Stephen P. Hammack**

There are three steps in establishing a logical genetic strategy for beef production. First, determine the production and marketing conditions and match applicable levels of animal performance to these conditions. Second, choose a breeding system. Third, select genetic types, breeds, and individuals within breeds for compatibility with the first two considerations.

Beef cattle producers face two types of decisions concerning breeding systems—which animals are allowed to reproduce and which males are bred to which females.

Mating Plans

Mating plans can be based on: 1) randomness;2) genetic relationship (pedigree); or 3) performance or visual appearance (phenotype).

- **Random mating** does not mean random selection. Rather, individuals are selected for breeding. Then they may be managed in one breeding group, with one or multiple sires, or both males and females can be randomly gate-cut into separate breeding groups. Either way, there is no action taken to determine which animals mate. Random mating is a rather common procedure, especially for multiple-sire herds where it is difficult to maintain more than one breeding group.
- **Pedigree mating** implies that all individuals in a genetic population (such as a herd, family line, or breed) are related to some extent. One pedigree plan mates individuals more closely related than the average of the population; it is termed inbreeding. While long-term inbreeding in a closed herd may increase genetic uniformity, inbreeding usually reduces performance, especially in fertility and survival. This is called inbreeding depression. One type of inbreeding is linebreeding, which is used to concentrate the genetic influence of some line or individual while minimizing increases in inbreeding.

  Mating animals less related than average is called outbreeding or outcrossing. Outcrossing of lines within a breed can restore performance lost to inbreeding depression. Mating individuals of different breeds is called crossbreeding, which often increases performance above what might be expected from the parent breeds. This effect is called hybrid vigor or heterosis. It is commonly thought that outbreeding increases variability, but well-planned outcrossing or crossbreeding produces uniform progeny.
- **Phenotype mating** plans are based on performance or visual appearance, not pedigree, and are called assortative. Mating individuals most alike in performance or appearance is positive assortative mating such as mating the heaviest males to the heaviest females or the shortest males to the shortest females. Compared to random mating, this results in more variation in progeny, fewer progeny near average, and more extremes.

  This plan is used mainly in hopes of producing a few extreme animals to quickly change a population. Positive assortative mating is sometimes called "mating the best to the best," a sound concept if parents are superior in all important factors.

Examples of the opposite plan, negative assortative, are mating the heaviest males to the lightest females or the shortest males to the tallest females. Consequences of this scheme, compared to random mating, are decreased variation, more individuals near average, and fewer extremes. If population-average performance in offspring is optimum, then this plan is useful. Often these types of matings are used to correct problems. For example, in a herd with milk production levels too high for existing forage resources, sires of lower milking genetics would produce better adapted replacement heifers. Unless dramatic genetic change is needed, negative assortative mating often is a sound strategy.

Crossbreeding

Crossbreeding begins with the mating of two purebreeds. The term F_1 applies to progeny of such a cross. A more useful definition of F_1 is the progeny of parents with no common genetic background. The most desirable crossbreds are results of genetically superior purebred parents. In fact, superior purebreds may easily exceed the performance of crosses from mediocre purebred parents.

There are three benefits of crossbreeding over restriction to a single breed (straightbreeding)—heterosis, breed combination, and complementarity.

Heterosis

Heterosis is measured as performance of crossbred progeny compared to the average of purebred parents. Heterosis is usually positive. It is highest in the progeny of least related parents. For instance, there is greater heterosis in crossing the genetically dissimilar Hereford and Brahman breeds than in crossing the more similar Hereford and Angus.

Heterosis is reduced when the same breed is a constituent of both parents. As an example, if cattle sired by Angus and out of Hereford are bred back to one of these breeds (a backcross), the resulting offspring average 50 percent less heterosis than the F_1 Angus-Hereford. If the F_1 is bred instead to a third breed, then heterosis of progeny can be either higher, the same, or lower, depending on the genetic relationship of the third breed to Angus and Hereford. If, instead of a backcross, you mate two F_1s of the same breed makeup, the progeny, called F_2, also average 50 percent reduction of heterosis from the F_1, the same as a backcross. But if you intermate those F_2s, producing an F_3, there is no additional loss of heterosis, on the average, beyond that experienced in going from the F_1 to F_2. Heterosis is reduced beyond the F_3 only to the extent that inbreeding occurs.

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Characteristics differ in heterosis. Heterosis is highest in fitness traits such as fertility, livability, and longevity. It is intermediate in milk production, weight gain, feed efficiency, and body size. It is lowest in carcass traits. Heterosis is highest in factors affecting efficiency in dams.

Breed Combination

Even if heterosis was not a factor, there could be benefits merely from combining breeds with different characteristics to produce a superior package. For example, females with genetics for high carcass quality but small body size and low rate of gain could be mated to sires with genetics for large size and fast weight gain but low carcass quality, resulting in progeny acceptable in both growth and carcass quality. In many instances, favorable combinations are the most important benefit from crossbreeding.

Complementarity

The mating just discussed might be called complementary, as it combines parents with differing strengths and weaknesses to produce desirable progeny. However, what if the females in the example were as large in body size as could be efficiently maintained on that particular forage resource? The smaller body size of these females is an advantage for cow adaptability in this situation but a disadvantage in gaining ability of progeny. That disadvantage could be countered with large, fast-gaining sires. But the heifers from that mating would not be useful for replacements in that herd, as they would be too large in body size. The only way to exploit this mating in that environment is to continually use a particular genetic type of female and a different type of sire. This technique is called complementarity, and it is possible only with a particular breeding system, discussed below.

Types of Breeding Systems

There are two basic breeding systems. If the source of replacement females is heifers produced in the herd, there is a continuous system. If heifers are not put back in the herd, there is a terminal system. Differences in these systems must be well understood, or serious mistakes can be made.

Continuous

A continuous system produces its replacement females but requires an external infusion of sires (unless inbreeding is involved, and that is rarely desirable in commercial production). Since replacement females are retained in this system, the cowherd has genetics of both the sires and dams. Therefore, if sires have traits that are undesirable in brood cows, those traits cannot be hidden in a continuous system. Both sires and dams in continuous systems should be similar in important traits and without any undesirable characteristics. Genetic extremes generally are not compatible with continuous breeding systems.

Terminal

In a terminal system, both replacement females and sires must come from external sources; they are either purchased or come from another herd. However, since heifers produced in terminals are not retained for breeding, there is more flexibility in choice of genetic types. Specialized maternal and sire types can be used in terminals, since undesirable traits can be masked in a properly designed system.

A combination of relatively small dams bred to larger sires in a terminal system fully exploits complementarity. However, in some cases, breeds similar in body size also are useful for terminals as, for example, where climate favors females of heat-tolerant breeds, many of which are relatively low in carcass quality. Sires from breeds known for high carcass quality, most of which are no larger than medium in size, might be the best choice in this case. Some complementarity in body size and weight gain is given up for female adaptability.

Continuous Systems

Straightbreeding

Here the same breed of sire and dam is used continually, so progeny usually are rather uniform in appearance. Straightbreeding is particularly useful in producing parents for crossbreeding. The biggest shortcoming of commercial straightbreeding is the important lack of heterosis.

True Rotations

True rotation systems use two or more breeds and the same number of breeding groups. The simplest rotation is a two-breed, sometimes called a crisscross. A different breed of sire is used continually in each of the two breeding groups. Replacement heifers are moved or rotated for breeding from the group where they were produced to the other group, where they remain for all of their lifetime matings. Figure 1 shows a two-breed true rotation. In a rotation of three or more breeds, a heifer is placed in the breeding group with the breed of sire to which the heifer is least related. This ensures minimal loss of heterosis in progeny.

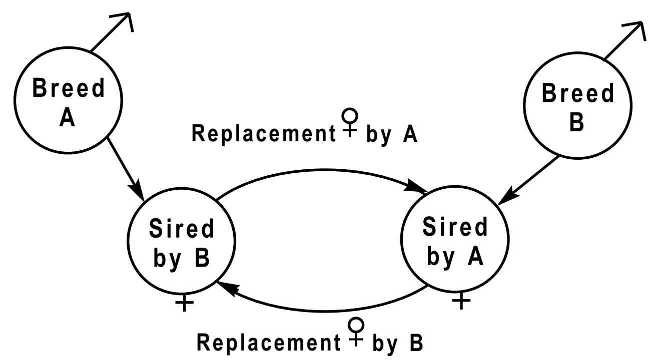

Figure 1. A two-breed true rotation.

Because they require multiple breeding groups, true rotations are rather complicated unless artificial insemination is used. (A. I. simplifies many of the mechanics of most crossbreeding systems.) Once a true rotation is fully in place, all breeding groups are present every year. Also, a compromise must be made between complementary matings and uniformity between groups. You cannot maximize both in rotations. Because of these complexities and limitations, true rotations are uncommon.

Sire Rotations

Sire rotations are sometimes called rotations in time. Instead of rotating females among multiple breeding groups as in true rotations, sire breeds are changed periodically in a single breeding group. A sire breed might be used for from one to several breeding seasons, most commonly for two or three. Ordinarily, a single breed of sire is used during a breeding season to produce more uniform progeny and simplify identification of the breed composition of potential replacement females.

Heterosis is lower in sire rotations than in true rotations, though the reduction is slight in well planned systems. Highest heterosis is maintained by keeping replacement heifers out of dams that are least related to the heifer's breed of sire. This merely requires identifying a dam's breed of sire, if a single breed of sire is used in a breeding season.

Sire rotations are much simpler to conduct than true rotations, because there is only one breeding group. This is one of the most common crossbreeding systems. Unfortunately, in many cases such plans are conducted haphazardly, with little thought given to a logical schedule.

Terminal Systems

Static Terminal

In a static terminal, replacement females must come from outside, either by purchase or from another herd. It is simplest to purchase replacement females because then only one breeding group is needed for the terminal cross. This is a particularly simple plan when purchases are limited to females that have calved at least once or twice, in which case there are no heifers that require separate facilities and easy-calving sires.

A straightbred terminal is mechanically possible, but there usually is no good reason to do so because the benefits of crossbreeding are absent. A possible exception is if a strong market exists for some straightbred and the breeder does not wish to or cannot develop heifers.

A two-breed static system, using straightbred males and sraightbred females of different breeds, produces heterosis in crossbred calves. However, such a system forfeits the considerable benefits of heterosis of crossbred dams.

A three-breed terminal is more efficient. It uses two-breed F_1 cows and a third breed of sire. First, straightbred females with desirable maternal traits are produced. Then these are crossed with another desirable maternal breed to produce the F_1. Then the F_1 females are used in a terminal cross. Figure 2 shows a three-breed static terminal system.

In a complete static system, about one-fourth of the females are straightbred, about one-fourth produce the F_1, and only about one-half of the females are in the terminal portion. Someone must perform all these functions in order for three-breed terminals to be possible, and this requires time and expense. The unique advantage of static terminal crossing is the opportunity to fully exploit complementarity. The main disadvantage is in the creation of replacement females.

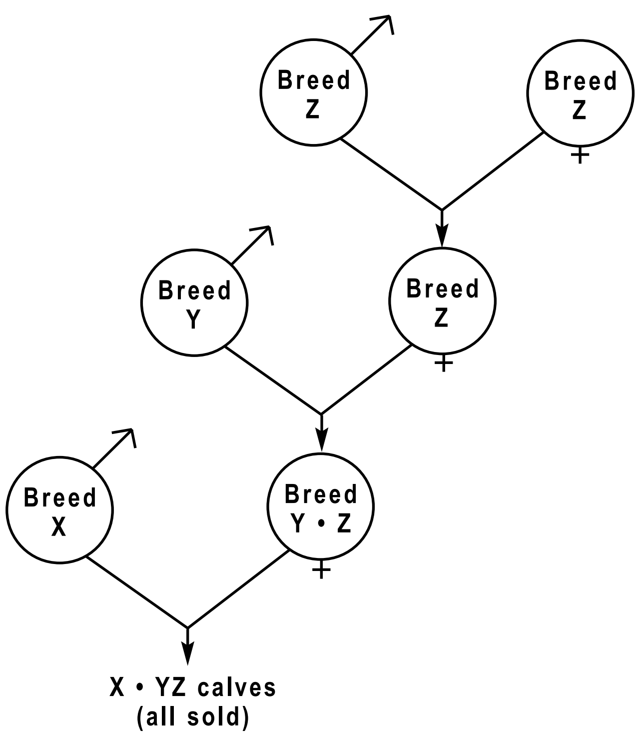

Figure 2. A three-breed static terminal.

Rotation Terminals

A rotation terminal (actually a combination of the two basic systems) is designed to solve some of the problems of providing replacement females for static terminals. Here, a rotation system produces replacement females both to keep itself going and for use in a separate terminal. In most instances, middle-aged females (4 to 6 years old) are moved out of the rotation to the terminal, because they are less prone to calving problems if terminal sires are large in body size. For a rotation terminal, only two breeding groups are needed—one for the sire rotation and one for the terminal cross.

Heterosis is relatively high in these rotation terminals, because all progeny and breeding females are crossbred. However, a high percentage of the rotation heifer progeny must be retained for replacements, so there is little opportunity for selection of females. Approximately 65 to 75 percent of sale calves are from the terminal, with most of the rest being male calves from the rotation.

Composites

A composite is formed from two or more established breeds, usually in exact percentages that can vary depending on the goals. There is specific attention given to retaining heterosis as generations progress. The primary motivation for creating composites is to create desirable breed combinations while producing some heterosis without continual crossbreeding.

Composites as discussed above are not breeds in the usual sense of the word. There are numerous breeds that have been created by combining existing breeds. Formula breeds contain specific percentages of the constituent breeds. Pool breeds do not have specified percentages. These combination breeds also retain some heterosis, but that is not usually a primary motivation in their creation or propagation.

For a more complete discussion of this subject, see another publication in this series, E-180, “Texas Adapted Genetic Strategies for Beef Cattle—VI: Creating Breeds and Composites.”

Breeding Systems and Breeding Groups

The choice of breeding systems depends partly on the number of separate breeding groups that can be maintained. The development, breeding, and calving of heifers is conducted most efficiently in a management group separate from older females using easy-calving sires.

One breeding group

One-breeding-group herds, ranging from those requiring only one bull to large, multiple- sire herds, have several choices of breeding systems. Straightbreeding is an option, which could be done with either a traditional or combination breed. A static terminal cross could be run, with F_1 females being purchased. A sire rotation could be implemented, using breeds that are similar in functional characteristics. A fourth option for one breeding group is the use of a composite.

Two breeding groups

Two groups offer other choices including:

- True two-breed rotation
- Straightbreeding in one group to produce females for use in another group, particularly to create F_1 replacement females
- Straightbreeding in one group to produce females for a two-breed static terminal cross in another group

- Purchasing straightbred females for creation of an F_1 in one group to be used in a three-breed static terminal cross in another group
- Sire rotation in one group, producing replacement females for a terminal cross in another group.

Three breeding groups

There are three options that require three breeding groups. One is a true three-breed rotation. Another is a true two-breed rotation generating replacement females for a terminal cross. The third is to carry out all three matings for a complete three-breed static terminal cross (production of straightbred females, creation of F_1 females, and the terminal cross).

Multiple breeding groups are more complex to manage, and for each breeding group there is a different breed composition in market animals. This can reduce marketing flexibility. Also, some breed combinations may be less valuable than others. Consider these factors before implementing systems requiring multiple breeding groups.

Efficiencies of Breeding Systems

To compare breeding systems at the cow-calf level, a simple measure of production efficiency is pounds of calf weaned per cow exposed to breeding, which combines reproductive efficiency and calf weight. Table 1 compares several breeding systems on this basis. Values shown are percentage increases above continuous straightbreeding. These increases are due to average levels of heterosis and any progeny weight increase from large terminal sires.

As shown in the table, simple continuous systems requiring a single breeding group (sire rotations and composites) can increase efficiency by about 10 percent to 20 percent. Most of the more complicated plans (true rotations, terminals, and combinations) increase efficiency about 15 percent to more than 25 percent. These estimates are for systems using British and Continental breeds in temperate environments. In harsh tropical or subtropical environments, including tropical-adapted breed types can produce even greater increases. These are significant advantages over straightbreeding.

In choosing a breeding system, possible effects on the major profit factors should be considered, including:

- Number of animals to sell
- Pounds per animal
- Price per pound
- Total cost of production.

The measure of efficiency used in Table 1, pounds of calf per cow exposed, lacks any consideration of animal numbers. Larger cows may wean more pounds per cow. But fewer large cows can be run on the same piece of land, so the number of sale calves is reduced.

Pounds weaned per cow does not take into account price per pound. Some breed combinations typically receive price discounts, some severe. Also, heavier calves bring less per pound. Finally, pounds of calf per cow exposed does not consider cost of production. If high levels of reproduction and calf weight increase costs (particularly nutrition costs), the advantage of crossbreeding may be reduced. Research indicates that when all costs are included, the total economic advantage from crossbreeding may drop approximately two-thirds to three-fourths of the levels shown in Table 1, still an important advantage.

Table 1. Breeding system production efficiencies.

System	Advantage[1]
2-breed true rotation	16
3-breed true rotation	20
2-breed sire rotation	12
3-breed sire rotation	16
2-breed composite[2]	12
4-breed composite[2]	18
2-breed static terminal (complete)	9
3-breed static terminal (complete)	20
3-breed static terminal (buy F_1 females)	28
3-breed sire rotation or composite[2] + terminal cross	24

[1]Average percent increase over straightbreeding in pounds of calf weaned per cow exposed, using only *Bos taurus* breeds (British and Continental European). Crossing *Bos taurus* and *Bos indicus* (Zebu) can increase these values by 50 to 100 percent, depending on the environment.

[2]Substituting a combination breed for a composite reduces values slightly to moderately, depending on heterosis retained.

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It is a major challenge for beef cattle producers to select breeding systems and breeds compatible with climate, forage conditions, general management practices, and market demands. For a discussion of genetic types and breeds of cattle, see another publication in this series, E-190, “Texas Adapted Genetic Strategies for Beef Cattle—V: Type and Breed Characteristics and Uses.”

When selecting a breeding system, give careful thought to the entire process. Do not embark on the first stage of a system without planning for subsequent stages. A system that works well for one producer might be completely unsuitable for another.

For further reading

To obtain other publications in this Texas Adapted Genetics Strategies for Beef Cattle series, contact your county Extension office or see the Extension Web site *http://tcebookstore.org* and the Texas A&M Animal Science Extension Web site *http://animalscience.tamu.edu*.

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Buying Vs. Raising Replacement Heifers

Jason Cleere*

Should beef cattle producers raise replacement heifers, or buy them? Many pieces of paper have been scribbled on by producers trying to find the right answer. The problem is that no one answer is right for all producers. Each producer operates under conditions unique to that situation.

When deciding on the best strategy for replacing heifers, producers need to weigh the advantages and disadvantages of raising or buying replacement females as well as consider other economic and general management issues specific to their operations. Factors to consider include:

- Current and future market prices
- Herd size
- Pastures, facilities and management level
- Available labor
- Economics
- Herd health concerns
- Cow genetic base (crossbreeding system)
- Herd quality
- Purchase replacement alternatives

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To clarify which strategy is best for a specific operation, producers should develop individualized budgets and management plans for each option.

Current and future market prices

The beef industry is cyclical, with a series of high and low prices occurring about every 10 years. The law of supply and demand governs these cycles. As in other businesses, when supplies are down and demand is steady, prices tend to rise.

When cattle prices are high, producers begin to rebuild their herds by retaining “high value” heifers or by purchasing replacements. The thinking is that with high cattle prices, it is time to get into beef production or to increase current cow inventories. After the rebuilding phase occurs, supplies increase and prices drop. This is the beginning of the herd liquidation phase of the cattle cycle.

Another explanation of the cattle cycle is that cash flow often determines the number of heifers retained or purchased. When prices are low, producers often must sell more or buy

fewer heifers to meet cash flow demands. Conversely, as prices rise, producers are able to sell fewer heifers to meet cash flow demands. Thus, a common joke in the beef industry is “buy high and sell low.”

Buying or retaining more replacements when prices are high is contrary to good business principles. Another problem with this practice is that heifers born during periods of high prices will produce calves during the following period of low prices, and vice versa.

To improve cow-calf profitability, producers need to adjust their replacement strategies. A study of replacement strategies by Iowa State University in 2001 examined production and financial data from 1970 to 1999. The strategies that were studied included:

- Maintaining the same number (SS) of heifers each year
- Maintaining the same cash flow (CF) each year—when calf prices are high, the producer retains or buys more heifers
- Retaining the same dollar value (DV) of heifers each year—when calf prices are low, the producer retains more heifers

The researchers found that the return over cash costs for the DV strategy was 55 percent higher than the CF strategy and 33 percent higher than the SS strategy. These findings indicate that it is more profitable to use countercyclical replacement strategies. That is, they should purchase more replacements when calf prices are low. However, producers using a countercyclical strategy must be able to weather large variations in cash flow.

Cycles are affected by changes in consumer demand, environmental conditions that affect production, and other unforeseeable events that can affect the market, such as the cases of bovine spongiform encephalopathy (BSE, or mad cow disease) in Canada and United States. To make informed decisions, the producer must evaluate the current market situation and develop an individualized budget.

Herd size

One of the first issues to address in deciding whether to buy or raise replacements is operation size. Typically, to maintain herd size, a producer must retain about 30 percent of the heifers in the herd. For a 30-head herd, this means an average over time of five heifers per year.

Is it more economical for a producer to raise these five heifers, or buy replacement females? Usually, small producers find that buying replacements is more cost-efficient because of economies of scale. For this reason, larger producers find that raising replacement females is the more economical choice. However, even some large producers prefer to buy replacements to free up time and resources that could be better used elsewhere.

Pastures, facilities and management level

Young, growing heifers require more management than do cows. The amount of labor associated with heifer development can be substantial and should always be considered in making this financial decision.

To reach the optimal level of maturity for breeding, heifers must be managed separately from the rest of the herd. The higher level of management required for heifers begins when they are weaned. The first 14 to 21 days post weaning requires good management skills and an extra time commitment because of the increased risk of sickness during this period. Also, heifers must be developed carefully to ensure that they reach puberty and can be bred at about 14 to 15 months old.

Because their nutritional needs are different, additional pastures and facilities are necessary to properly wean and develop replacement heifers. Sound holding pens are required to keep heifers contained during the initial weaning period and to keep bulls away before the breeding season.

The extra management does not stop after the bulls are removed. Heifers need to reach 85 to 90 percent of mature weight by the time of calving to ensure high levels of breed back after calving. The development phase of heifers will affect their lifetime productivity. Taking shortcuts in management will affect the value of the female for its entire productive life.

Buying replacements can free up pastures for about 10 percent more cows in an operation. When making your economic analysis, be sure to factor in this additional income.

Need for additional heifers

Another factor to consider is the need to raise more heifers than will be retained. The average conception rate of heifers is 85 percent. Most producers will cull about 20 percent of heifers because of non-reproductive issues such as structure or poor weight gain. Consequently, raising replacement heifers requires keeping about 45 percent more heifers than needed. This ties up capital for an extra 10 to 12 months before the culled heifers are marketed.

When considering whether to raise or buy replacements, remember to factor in the cost of the additional heifers that will need to be kept. The cost adjustment for culling or death loss is shown in Table 1.

Economics

The decision on whether to buy or raise replacement females involves many economic factors. These include opportunity costs, feed costs, interest, labor, facilities, tax advantages, conception rates, replacement costs, bull costs and cull rates.

The cost of raising replacement heifers from weaning to first calf varies from operation to operation, depending on the resources available. As described previously, be sure to factor in your herd size, pastures, facilities, management and feed costs, which are a substantial portion of the total cost of developing heifers. Each producer must develop a budget that accurately reflects the individual operation.

In developing an individualized budget, assign a fair market value for weaned heifers as an opportunity cost. Also factor in the labor costs, which are often omitted in replacement heifer cost analyses.

The sample budget in Table 1 can be used as a guide. To make the most informed decision, substitute the data from your operation and add any extra costs based on your situation.

Assumptions:

1. The value of the retained heifers is for example purposes and will vary.
2. Estimated expenses will vary among producers; to make the most educated decision, you will need to develop your own budget.

Most economic analyses indicate that there is a slight advantage in raising rather than buying replacement heifers, especially for larger producers who can take advantage of economies of scale to reduce feed and labor costs. For the small producer with fewer than 50 cows, buying heifers is usually more economical because of feed and labor costs.

For detailed and interactive cow-calf budgets, see the Texas Cooperative Extension Agricultural Economics Web site at http://agecoext.tamu.edu/budgets/commodity/cow-calf/index.php.

Table 1. Sample budget for raising a replacement heifer from weaning to first calf.

Value of heifer at weaning (500 lb x $1.05)	$525.00
Cost of gain weaning to breeding ($0.45/lb x 250 lb)	$112.50
Cost of bull service	$35.00
Interest	$30.00
Management	$50.00
Grazing and feeding cost to calving	$150.00
Vet costs	$20.00
Cost adjustment for culls and death	$75.00
Total	**$997.50**

Herd health concerns

One reason producers choose to raise their own replacement females is to help prevent diseases from being introduced into their herds. Buying cattle from outside sources always carries a risk of introducing diseases into a herd. This is a valid issue because herd health affects profitability.

Taking action to prevent the introduction of disease-causing agents into a herd is called biosecurity. In cattle operations, the highest level of biosecurity is to maintain a closed herd. The lowest level is to introduce animals of unknown health without a quarantine period.

To minimize the risk of introducing disease when buying cattle:

- Buy only cattle that have clean health records and that are from reliable sources. Consult a local veterinarian about the health requirements that purchased females should meet.
- Quarantine new cattle.
- Maintain a sound vaccination program.

Cow genetic base

The U.S. beef industry has changed dramatically in the past 15 years and will continue to do so to satisfy consumer demands for consistent, high-quality beef products. To meet these demands, the industry is shifting toward a production system based on quality.

In the beef industry, quality begins with genetics. In making replacement female selections, cow-calf producers must realize that a cow's genetics can affect herd profitability for 8 to 14 years.

Raising replacement heifers allows producers to use genetic selection criteria to improve production and management. The producer can select cattle for maternal traits, performance traits or carcass traits for sires of heifers.

A major advantage of raising replacements is the opportunity to select heifers that are born in the first 60 days of the calving season and that are heavier at weaning. These heifers are more likely to reach the proper weight needed for onset of puberty. Also, these older heifers are usually from the most fertile dams that conceived early in the breeding season.

Raising replacement females also allows producers to cull those females that fail to conceive. Field trials in eight Texas herds in 2000 demonstrated that open heifers held over for a second breeding 6 months after first breeding had average pregnancy rates of 58 percent. In another study that year, calving data from five Texas commercial herds (1,500 calving events) was evaluated. This research found that the average lifetime calf weight was highest in females whose first calving date as a heifer occurred the first 21 days of calving.

This does not mean that buying replacement females is not an option for selecting the most fertile and productive females. There are many good replacement female sources that implement strict selection criteria and provide quality genetics. You may want to choose outside sources for replacement heifers if you want to improve the genetics of your herd quickly or if your herd's genetic selection is limited due to heavy culling because of drought or age.

Crossbreeding systems

When cattle are crossbred, the resulting offspring are often more vigorous or fast-growing than are the parents. This improvement from crossbreeding is called heterosis.

Research has shown that heterosis effects can increase production per cow by about 20 to 25 percent in *Bos taurus x Bos taurus* crosses (example: Angus x Hereford) and by 40 to 50 percent in *Bos indicus x Bos taurus* crosses (example: Brahman x Hereford). Most commercial beef producers use crossbreeding to take advantage of heterosis and genetic improvement from combining breeds with different characteristics.

For more information on crossbreeding, see *Texas Adapted Genetic Strategies,* a series of 10 Texas Cooperative Extension publications available at http://tcebookstore.org.

Another goal for producers is to select cattle that are genetically adapted to the local environment. A producer should match the cow to the environment and then use a bull that complements the cow to produce a calf to fit a specific market. But if the appropriate cow and bull are genetically different, a terminal cross is required. A terminal cross can be defined as a mating that produces progeny that are not suitable as replacement animals. Ultimately, producers strive for excellent maternal traits, longevity and efficiency in a cow that will produce a marketable calf.

In the southern United States, producers should choose cattle that are genetically adapted to hot, humid climates. Crossbred females with a combination of *Bos indicus* (typically Brahman) and *Bos taurus* genetics have become the female base for producers in the South. Producers often use *Bos taurus* terminal sires on *Bos indicus* cross females to maximize growth and performance, improve carcass quality and/or decrease the amount of "*Bos indicus* appearance" in the calves. However, when a terminal crossbreeding system is used, the daughters may not be as maternally oriented or environmentally adapted as their dams and are usually not kept as replacements.

The alternative is to use a continuous crossbreeding system that may not maximize growth, performance or carcass quality of the calves but will produce good-quality, marketable calves and females for replacement that are at least as productive as their dams. Producers must decide whether to give up some growth, performance and possibly carcass traits to raise their own replacements or opt to maximize calf performance and buy replacements.

This issue should be factored into the cost analysis. Larger producers can operate a split-herd design in which one group of cows is designated to produce replacement females and the other group is placed in a terminal system or rotational crossbreeding system.

Calving difficulty

Studies at the University of Nebraska Meat Animal Research Center and Colorado State University indicate that 2-year-old first-calf heifers are three to four times more likely to have calving difficulties (dystocia) than are 3-year-old cows. The two major causes of dystocia in heifers are small pelvic area in underdeveloped heifers and heavy calf birth weights. Heavy birth weights are most commonly attributed to genetics of the sire and can be reduced by using low-birth-weight or calving-ease sires on heifers.

A major concern when buying heifers is whether they are bred to a calving-ease bull. Producers raising their own replacement heifers decide which bull to use and so have more assurance that the heifers are bred to a calving-ease bull. Buying replacements from a reputable source can help reduce this concern.

The use of calving-ease bulls on heifers does not a guarantee a dystocia-free calving season. Calving problems can also occur because the heifers have not reached full maturity at calving, because the heifers lack calving experience, or because of improper calf presentation. Thus, producers without the ability, facilities or time to calve heifers may choose to buy second-calf heifers or cows.

Conclusion

Decisions on replacing females play an important role in the future profitability of the cow herd and should be considered carefully. Producers should address both economic and general management considerations when deciding whether to raise or purchase replacements. Always base your decisions on the circumstances of your individual operation.

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BCM-28A

Calf Scours: Causes, Prevention and Treatment

Introduction

Calf scours causes more financial losses *to* cow-calf producers than any other health problem in their herds. Calf scours is not a single disease; it is a clinical sign associated with several diseases characterized by diarrhea. Regardless of the cause, diarrhea prevents the absorption of fluids from the intestines; also, body fluids pass from the scouring calfs body into the intestines. A calf is approximately 70 percent water at birth. The scouring calf loses fluids and rapidly dehydrates. In addition, dehydration is associated with loss of essential body chemicals (electrolytes)-sodium and potassium-and the buildup of acid. The scouring calf becomes dehydrated and suffers from electrolyte loss and acidosis. Infectious agents cause the primary damage to the intestine, but death from scours usually results from dehydration, acidosis, and loss of electrolytes. The identification of infectious agents which cause scours, however, is essential for implementing effective preventive measures.

Causes of Calf Scours

The known causes of scours are grouped into two categories: (1) noninfectious causes, and (2) infectious causes. The noninfectious causes are often referred to as "predisposing" or "contributing" factors. Whatever they are called, there is a dramatic interaction between noninfectious causes and infection. Any effort to prevent infectious causes is usually fruitless unless serious control of contributing (non-infectious) factors is part of the overall program.

Noninfectious Causes of Calf Scours

Noninfectious causes are best defined as flaws in management which appear as nutritional shortcomings, inadequate environment, insufficient attention to the newborn calf, or a combination of these. The most commonly encountered noninfectious problems include:

(a) Inadequate nutrition of the pregnant dam, particularly during the last third of gestation. Both the quality and quantity of colostrum are adversly affected by shortchanging the pregnant dam in energy and protein. Deficiencies in vitamins A and E have been associated with greater incidence of calf scours.

(b) Inadequate environment for the newborn calf. Muddy lots, crowding, contaminated *lots,* calving heifers and cows together, wintering and calving in the same area, storms, heavy snow or rainfall, etc. are stressful to the newborn calf and may increase the chance for easy exposure to infectious agents. The wet and chilled newborn calf experiences a drainage of its body heat, may be severly stressed, and all too often lacks the vigor to nurse sufficient colostrum early in life.

(c) Insufficient attention to the newborn calf, particularly during difficult birth or adverse weather conditions. The calf is born without scours-fighting antibodies. The calf will acquire these antibodies only by nursing colostrum early in life. Any effort to prevent scours by vaccinating cows is wasted unless the calf nurses colostrum, preferably before it is two to four hours old. As the calf grows older, it loses its ability to absorb colostral antibodies by the hour. Colostrum given to calves 24-36 hours old is practically useless; antibodies are seldom absorbed this late in life.

Infectious Causes *of* Calf Scours

Infectious causes of calf scours may be grouped as follws:

Bacterial cause	*Escherichia Coli*
	Salmonella spp.
	Clostridium perfringens
	and other bacteria
Viral causes	Rotavirus
	Coronavirus
	BVD virus
	IBR virus
Protozoan parasites	Cryptosporidium
	Coccidia
Yeasts and molds	

Some pathogens may be more predominant than others in a given area. It appears that cryptosporidum is more common than previously thought. Single infectious are common, but mixed infections (eg: E. *Coli* + cryptosporidium or coronavirus + salmonella, etc.) are often reported.

Bacterial Causes *of* Calf Scours

Escherichia Coli (E coli)

E. coli appears to be the single most important cause of bacterial scours in calves. There are numerous kinds of *E. Coli.* Recent research indicates that the majority of E. coli strains able to cause diarrhea first colonize (or adhere) to the calfs gut. They do so by means of very fine, fuzz-like protrusions known as "pili" or limbriae. These pili arc designated as the K99 antigen. E. *coli* strains which possess the K99 antigen are called enterotoxigenic E. coli (ETEC). Enterotoxrgenic means ablitty *to produce* toxins in the intestines. Obviously there are exceptions to any rule: some ETEC have a different type of pili known as the K88 antigen. Some other features of scour-causing E. *coli* are known as "capsular antigens," but it would appear that the K99 (pilus) antigen is the most common characteristic of ETEC.

Most newborn calves have a chance to pick up E. *Coli* scours infections from the environment, particularly when sanitation is marginal. Severe outbreaks of E. *coli* may affect calves as young as 16 to 24 hours. The younger the calves, the greater the chance for death from progressive, severe dehydration.

Salmonella

Salmonella produces a potent toxin or an endotoxin (poison) within its own cells. Animals may be more severely depressed following treatment with antibiotics because treatment causes fhe Salmonella cells *to* release *the* endotoxin, producing shock. Therefore, treatment should be designed to combat endotoxic shock.
Calves are usually affected at six days of age or older. The source of Salmonella infection in a herd can be fromother cattle, birds. cats, rodents. water supply or human carriers.

Clinical signs associated with Salmonella infmion include diarrhea. blood and fibrin in the feces, depression, and elevated temperature. The disease is more severe in young or debilitated calves. Finding a membrane-like coating in the intestine or necropsy is strong evidence that Salmonella might be involved.

Clostridium Perfringens

Clostridium perfringens infections are commonly known as enterotoxemia. Enterotoxemia is fatal and caused by toxins released by various types of C. perfringens . Types B, C, and D have been reported. The disease has a sudden onset. Affected calves become listless, display uneasiness, strain or kick at their abdomen. Bloody diarrhea may or may not occur. This is usually associated with a change in weather, change in feed of the cows, or management practices that cause the calf to not nurse for a longer period of time than usual. The hungry calf may over-consume milk, which establishes a media in the gut conducive to growth and production of toxins by Clostridial organisms. In many cases, calves may die without any signs being observed.

Viral Causes *of* Calf Scours

Coronavirus and Rotavirus

Little was known about the role played by these two viruses prior to 1970 when researchers at the University of Nebraska published their findings. Today, many diagnostic laboratories are using technology pioneered in Nebraska, and the importance of these viruses in outbreaks of calf scours have been confirmed.

Both of these viruses possess the ability to disrupt the cells which line the small intestine with resulting diarrhea and dehydration. Coronavirus also damages the cells in the intestinal crypts and slows down the healing process in the intestinal lining. Furthermore, the damage caused by either corona or rotavirus is often compounded by bacterial infections. and the risk for fatal diarrhea is increased when mixed infections occur.

The rotavirus was originally known as reovirus, or reo-like virus, but the correct name, as used today, is rotavirus.

Calves as young as one or two days old may scour from corona *or* rotavirus infection; however, most outbreaks seem to occur when calves are near a week of age and older. The morbidity (number of sick calves) ranges from one to two percent up to 20-30 percent. Mortality rates are quite variable. Many calves will recover if treated early. Conversely, up to 25 percent losses have been reported, particularly when bacteria compounded either corona or rotavirus infections. Death losses were consistently associated with pronounced dehydration.

Bovine Virus Diarrhea (BVD) Virus

Exposure to the BVD virus can cause diarrhea and death in young calves. Diarrhea begins about 26 hours to three days after exposure and may persist for quite a long time. Erosions and ulcers on the tongue, lips and in the mouth are the usual lesions found in the live calf. These lesions are similar to those found in yearling and adult animals affected with BVD virus.

Infectious Bovine Rhinotracheitis (IBR) Virus

The IBR ("red nose") virus causes mainly respiratory disease, abortions, vaginitis and conjunctivitis. There are, however, reports associating the IBR virus with digestive disorders in young calves. Affected calves had erosions and ulcers in the esophagus and complicated by dullness, loss of weight, scours and death.

Protozoan Causes of Calf Scours

Ctyptosporidium

Cryptosporidium is a protozoan parasite much smaller than coccidia. It has the ability to adhere to the cells which line the small intestine and to damage the microvilli. Several reports from researchers and diagnosticians have associated cryptosporidium with outbreaks of calf scours. As a rule, cryptosporidium is detected in combination with coronavirus, rotavirus, and/ or *E.* coii. Calves infected by cryptosporidium have ranged from one to three weeks in age.

Coccodiosis

Coccidiosis is seldom a problem in young calves. However; outbreaks in calves three to four weeksof age and older have been reported. Most outbreaks were associated with stress, poor sanitation, over-crowding, or sudden changes in feed. Some affected calves may exhibit signs of brain damage but tarry or bloody scours are commonly observed.

Yeasts and *Molds*

Yeast and molds are sometimes associated with lesions in the stomach or intestines of scouring calves. These organisms are not considered *a primary cause of scours* but rather secondary invaders. Very often they are found when scouring calves are victims of overuse of antibiotics or sulfas when very little was done to counteract dehydration by using fluids and electrolytes.

Nutritional Scours

Under range conditions, a calf adapts a pattern of nursing that fills its needs. Nutritional scours can be caus*ed* by anything that disrupts this normal habit. A storm, strong wind or the mother going off hunting for new grass disrupts the normal nursing pattern. When the calf does get up to nurse, it is overly hungry and the cow has more milk than normal, so the calf may overload, resulting in a nutritional scours. This is usually a white scours caused by undigested milk passing through the intestinal tract. This type of scours usually presents little problem in treatment. Many of these calves, if they are still active and alert, do not require treatment. If the calf becomes depressed or quits nursing, treatment should be started. Oral antibiotics can be used for treatment along with fluids, if the calf begins to dehydrate.

Prevention of Calf Scours

Because calf scours result from a combination of noninfectious factors and infectious microorganisms, *it* is essential to use more than shots and pills in any effort to control scours successfully. There are managerial as well as medical requirements which must be met. They must complement each other. Furthermore, calf scours prevention is a year-round effort, not a set of activities centered only around the calving season.

Management Aspects

All facets of management are important. Particular attention should be paid to nutrition, environment, sanitation, and care of the newborn calf.

Nutrition. The ration of the pregnant female should be balanced in energy, protein, minerals and vitamins. Care should be given to adjust the nutritional requirements during cold, inclement weather and to keep in mind that pregnant replacement heifers have not reached their mature size. Particular care must be taken to provide them with sufficient feed energy for maintenance and growth. Failure to meet energy needs will not only result in a weak calf at birth but also contributes to delays in return to estrus and lowered conception rates. Best results occur when replacement heifers are wintered and calved in advance of, and separate from the mature cow herd. Special attention should be given to energy deficiencies and/or vitamin A and E shortages.

Environment and sanitation. Historically, severe outbreaks of scours are associated with bad weather, storms, slush and mud. Weather conditions are unpredinable and beyond our control. We can, however, control the environment in which the calf is born and raised early in life. The newborn calf needs a dry/clean place if we expect it to survive free of scours. Geographic and climatic conditions dictate the type of management needed to assure decent shelter.

Sanitation is just as important as a dry/clean environment. Ideally, provide a special area used only for calving. Many cattlemen have to winter their pregnant females in confinement. Manure and urine accumulate and it becomes necessary to have a special calving area separate from the wintering area. After the calf is born and has nursed, it should be moved with its dam to a nursing area before being turned to pasture.

Attention to the newborn. Calving difficulties may weaken the newborn and its dam; the calf may not nurse sufficient colostrum and scour later on. Perhaps the single most important requirement for the newborn calves is to nurse colostmm early in life. The calf must nurse one to two quarts of colostrum during the first two to four hours immediately after birth. The calf is born without disease protection. Only by absorbing antibodies present in the colostrum will a calf acquire immunity against the various infectious causes of scours. At times it is not practical to milk a beef cow or heifer, but the calf still needs colostrum. Many cattlemen will have frozen colostrum on hand in small containers. Plastic bags, one to two pints in size, are ideal for storage. Colostrum may be saved from dairy cows. Make sure it is from cows vaccinated against infections predominant in your area and attempt to get it from older cows in the dairy herd. Older, vaccinated cows are more likely to have greater antibody levels than young, unvaccinated heifers. Colostrum should be saved from only the first two milkings. When needed, frozen colostrum should be thawed out slowly; boiling will destroy most of the antibodies. Colostrum may be kept frozen almost indefinitely. Many calves will also benefit from a vitamin A injection. Vitamin A deficiency is associated with scours. The calf should be given 500,000 I.U. (usually 1 cc) of vitamin A early in life.

Vaccination Programs

A well-planned and consistent vaccination program is an effective tool to prevent scours if the management aspects are taken care of. Different regions, even different herds in the same region, may vary in the type of infectious agents present. There is no such thing as a universal vaccination program. Each program must be tailored to the herd's specific needs. A productive relationship with the local veterinarian, accurate records and diagnostic laboratory assistance are integral components in designing an effective vaccination program.

Effective vaccines have been developed during the last decade, but the vaccination program is not completed until the calf nurses sufficient colostrum early in life. Some of the disappointment associated with the use of scour vaccines may reflect a missing link-the cow was vaccinated and collected antibodies in the colostrum, but the calf did not ingest colostrum early enough to be protected.

Treatment

Treatment of calves for scours is very similar regardless of cause. Treatment should be directed toward correction of the dehydration, acidosis and electrolyte loss. Antibiotic treatment can be given simultaneously with the treatment for dehydration. Dehydration can be overcome with simple fluids given by mouth early in the course of the disease. If dehydration is allowed to continue, intravenous fluid treatment becomes necessary. The clinical signs of dehydration first occur when the fluid loss reaches five to *six* percent of the body weight. Fluid loss of eight percent results in depression, sunken eyes. dry skin and a calf will probably be unable to stand. A 12 percent loss of fluids usually results in death. Oral fluids used early in the scouring process have been quite successful. Consult your veterinarian for electrolytes to be given orally. There are dry electrolvte powders available that can be mixed with water for oral administration.

Most dehydrated calves suffer from hypothermia (body temperature lower than normal); it is often necessary to provide them with an external source of heat during fluid / electrolyte treatment. A warm barn or heat lamps are needed during treatment of hypothermic calves.

If electrolyte powders are not available, a solution for administration can be prepared on the ranch by using a tablespoon of baking soda, one teaspoon of salt. and P 50 cc (eight ounces) of 50 percent dextrose. DO NOT USE TABLE SUGAR. Add enough warm water to make one gallon and administer up to one quart of this material every three to four hours, depending upon the degree of dehydration and fluid loss. This solution can be used as the only source of nutrients for a period of 24 to 48 hours. Do not use milk or milk replacers, as milk in the intestinal tract makes an ideal medium for bacteria such as E. *coli* to grow. Return the calf to the cow that has been milked out as soon as the calf is able to follow its mother.

Another formula often used includes: One package (one ounce) of fruit pectin, one teaspoon of Lite salt, two teaspoons of baking soda, one can of beef consumme, plus enough warm water to make two quarts. Give one warm quart orally at four to six hour intervals.
Giving electrolytes orally may be difiicult unless the calf will nurse from a bottle. There is, however, a device on the market that works well for administering oral fluids to calves. It is a collapsible plastic pouch, about one-half to one gallon capacity, with a lid and a flexible esophageal tube. This plastic pouch or a stomach tube should be used when gxving calves large amounts of fluids. If the plastic pouch or stomach tube are used, thoroughly disinfect and lubricate them between uses.

Antibiotics should be used both orally and by injection whenever treating calves for diarrhea. Use systemic antibiotics, that is, either those that are injected or those which are absorbed from the intestinal tract. These are necessary to prevent pneumonia. Drugs which decrease intestinal motility and corticosteriods should not be used.

Oral antibiotics, sulfas or scour-pills may or may not be beneficial. If used, they should only be used at the proper dosage and frequency and for two or three days at the most. If they are ineffective after two to three days, discontinue use. Otherwise, resistant bacteria or molds and yeast may overgrow in the calf's gut. Consult your veterinarian. In some Salmonellosis outbreaks antibiotics may cause the release of excess endotoxins, so consider using fluid therapy only.

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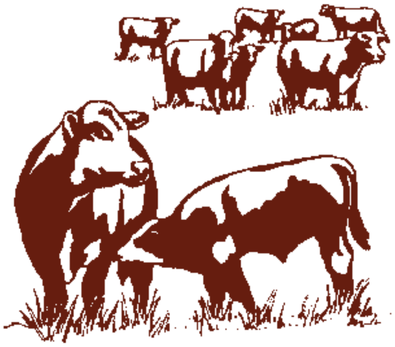

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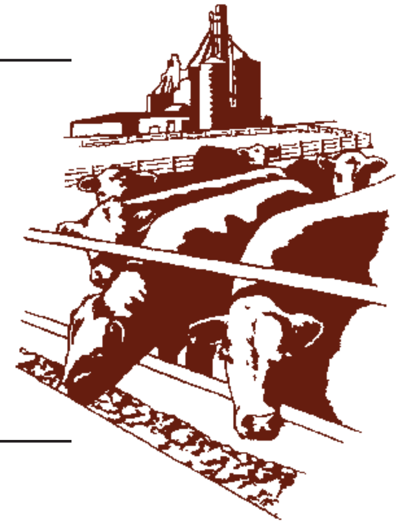

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Adapted from the Beef Improvement Federation

Calving Difficulty in Beef Cattle: Part I[1]

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Calving difficulty (dystocia) can increase calf losses, cow mortality, and veterinary and labor costs, as well as delay return to estrus, and lower conception rates. In two studies at the United States Meat Animal Research Center (MARC), Clay Center, Nebraska, calf losses within 24 hours of birth averaged four percent for those born with little or no assistance, compared to 16 percent for those requiring assistance. Calf mortality increased by a 0.35 percent per pound increase in birth weight. In a Hereford herd at the United States Livestock and Range Research Station, Miles City, Montana, 57 percent of all calf losses were reported to be due to dystocia.

Researchers at MARC noted that the number of cows detected in estrus during a 45-day Artifical Insemination period was 14 percent lower in those requiring assistance than in those calving with no difficulty. Conception to A. I. was six percent lower in cows experiencing dystocia than in those without dystocia. Pregnancy rate after the entire breeding season (70 days) was 16 percent lower in cows that had been assisted (85 percent versus 69 percent). At Miles City, pregnancy rate among cows that had caesarean deliveries was 26.6 percent lower (52.4 percent versus 79.0 percent) than the herd average.

Factors Affecting Dystocia

The numerous factors that are believed to influence calving difficulty are listed below. As will be noted later, several of these factors are interrelated.

1. Age of dam
2. Calf's birth weight
3. Sex of calf
4. Pelvic area
5. Gestation length
6. Cow size
7. Shape of calf
8. Breed of sire
9. Breed of dam
10. Hormonal control
11. Uterine environment
12. Geographic region
13. Season of year
14. Environmental temperature
15. Nutrition of dam
16. Condition of dam
17. Implants and feed additives
18. Feeding time
19. Exercise
20. Other unknown factors

This bulletin (Part I) covers the first 14 factors. The second bulletin (Part II) covers the remainder of these factors, and finishes with a discussion of calving time and genetic management.

Age of Dam

Table 1 is a summary of calving data from MARC and Colorado State University (CSU), relating age of dam to calving difficulty. This data illustrates that age of dam has a profound effect on the incidence of dystocia. First-calf, two-year-old heifers represent the greatest source of

[1] (Authors' note: This bulletin is first in a series of two on calving difficulty).

trouble to the beef herd owner. Difficulty in two-year-olds is three to four times as high as in three-year-olds, and three-year-olds have about twice as much difficulty as four-year-olds. By the time a cow reaches 4 - 5 years of age, dystocia problems are minimal. Calving difficulty in MARC Hereford and Angus cows was higher than in CSU Hereford cows, presumably because the former tended to be mated to larger continental sires, whereas the latter were mated only to Hereford sires.

Table 1. Effect of Dam's Age on Calving Difficulty

Dam's age (years)	Research station MARC	CSU
	% calving difficulty	
2	54	30
3	16	11
4	7	7
5 and over	5	3

Calf's Birth Weight and Sex

Table 2 is taken from a Miles City study correlating calving difficulty with several traits in two-year-old Hereford and Angus heifers. A perfect correlation would be 1.0; anything over 0.40 was highly significant; 0.18 to 0.40, significant; less than 0.18, nonsignificant. Birth weight of the calf was the trait most highly correlated with calving difficulty, followed by sex of calf. Pelvic area, gestation length, and cow weight had considerably less influence. Much of the influence of sex of calf is believed to be indirect, through its effect on increased calf size. However, after correcting for birth weight, differences in dystocia between sexes still remain, suggesting that other factors besides fetal size may be involved.

Table 2. Effect of Various Traits on Dystocia in Hereford and Angus Heifers

Trait	Breed of cow Hereford	Angus
	Correlation with dystocia	
Calf's birth weight	.54	.48
Calf's sex	-.47	-.26
Pelvic area, precalving	-.18	-.22
Gestation length	.25	.10
Cow wt., precalving	-.01	-.20

As birth weight increases, percent assisted births increases 0.7 - 2.0 percent per pound of birth weight. Compared to heifer calves, bull calves have a slightly longer gestation length, weigh 5 - 12 pounds more at birth, and exhibit a 10 - 40 percent higher assistance rate. Several researchers have reported that calves requiring assistance weigh 5 -7 pounds more than those born without assistance. Research has also shown that the impact of birth weight on dystocia is much greater in two-year-old cows, and that as cows become older, birth weight assumes less significance.

Pelvic Area

It is generally agreed that a major cause of dystocia is the disproportion between the size of the fetus and the pelvic opening of the dam, especially in first-calf heifers. This disproportionality is illustrated in Table 3, which is a summary of data from CSU. As birth weight increased and pelvic area declined, calving difficulty increased. Relative to the amount of variability in the two traits, changes in birth weight were considerably greater than changes in pelvic area. Unfortunately, phenotypic correlations between pelvic area and calving difficulty are not high, averaging only -.20 (*Table 2*).

Table 3. Effect of Birth Weight and Pelvic Area on Calving Difficulty in First-calf Heifers

Calving difficulty score	Yearling pelvic area (cm2)	Calf birth wt. (lb)
1 (no assistance)	151	72
2 (minor assistance)	145	77
3 (major assistance)	141	82
4 (caesarean)	131	94

Heritability estimates for pelvic area are moderate to high, averaging about .50. This means that selection for larger pelvic size can be quite effective. However, several studies have demonstrated a positive relationship between pelvic area and body size (weight and frame) from birth to 18 months. Consequently, selection for increased pelvic area without some constraint on body size could possibly result in a parallel increase in birth weight and mature size and little change in calving ease. Therefore, it has been recommended by several researchers that selection for increased pelvic area be conducted within a size category.

It is agreed among many authorities that pelvic size should be viewed as a threshold trait and that heifers below a certain minimum pelvic area should be culled. Pre-breeding minimum culling levels for pelvic area may range from 140 - 180 square centimeters depending upon the breed, herd, environment and other factors. Based on Miles City data; pelvic measurements have limited usefulness in predicting dystocia on an individual basis, but can be significant herd-wide. Their research shows that a 10 square centimeter increase in pelvic area would be accompanied by a two-pound increase in calf birth weight and a 0.02 decrease in calving difficulty score.

Many purebred breeders now measure pelvic areas on their yearling bulls and publish the data in their sale catalogs. Because the genetic correlation between male and female pelvic area is high (.60), selection for increased pelvic size in bulls should result in increased pelvic size in heifer progeny. However, as noted above, selection for increased pelvic size should not be conducted without some constraint on birth weight. If no attempt is made to control birth weight, selection for increased pelvic size by itself may not be very effective. Ideally, pelvic areas in sale catalogs should be adjusted to a standard age such as 365-days. Beef Improvement Federation (BIF) suggests the following age adjustments be used: .25 and .27 square centimeters per day of age for yearling bulls and heifers, respectively.

Gestation Length

As shown in *Table 2*, gestation length is not highly correlated with dystocia. Using Simmental field data, Cornell researchers reported similar results. They found the correlation between birth weight and calving difficulty to be somewhat higher than the correlation between gestation length and calving difficulty (.40 versus .26). They concluded that sire differences in gestation length are not particularly useful predictors of differences in calving ease and that birth weight is a better, and more frequently recorded, predictor of calving ease. Nevertheless, using short-gestation sires has two important advantages: (1) calves are older and heavier at weaning time; and (2) because calves are born earlier, the cows have more time to recover and rebreed on schedule.

Cow Size

As indicated in *Table 2*, smaller heifers tend to have a higher incidence of dystocia than larger heifers but the correlations are low (-.01 and.20). In Alberta research, it was reported that the ratio of calf birth weight to dam weight was the most important factor affecting dystocia, accounting for 28 percent of the total variation in calving difficulty. Calf birth weight by itself accounted for 18 percent of the total variation, and dam's pelvic area accounted for less than one percent of the total variation. If one reviews all of the research that has been conducted on calving difficulty, no more than 50 percent of the total variation in dystocia can be explained by factors that can be defined or measured. In many studies, only 20 - 30 percent of the variation can be explained by quantifiable traits.

Shape of Calf

Many cattle producers believe that differences in a newborn calf's shape can have an important effect on ease of delivery. For example, a slender, lighter-muscled, finer-boned calf theoretically should be born more easily than a thicker, heavier muscled, coarser-boned calf of the same weight. However, researchers at MARC were unable to find any calf shape measurements significantly correlated with calving ease, even though they believe that such relationships likely exist. Data from Germany showed a relatively high correlation (.62) between chest girth at 330-days of age in Simmental sires and the calving difficulty of their progeny. In France, it was reported that the calf's body length and rump width were significantly correlated with calving difficulty in two-year-old cows, and that selection of French beef breeds based on muscle development and growth rate early in life had led to an increase in birth weight and calving difficulty. In a Virginia study, researchers concluded that selection for calf shape, independent of birth weight, would not be expected to reduce dystocia. In summary, calf shape probably plays a role in dystocia but it is extremely difficult to quantify.

Breed of Sire

Research at MARC and elsewhere has demonstrated that significant differences exist between breeds of sires in calving difficulty and birth weight. In Cycles I, II and III (1970-76) at MARC, average assistance rates and birth weights of half-blood calves sired by 16 diverse breeds ranged from 2.9 - 20.4 percent and from 68.6 - 90.6 pounds, respectively. In Cycle IV (1986-89), the ranges were 0.3 - 9.2 percent and 71.3 - 90.2 pounds. In general, birth weights and assistance rates increased as mature size and growth rate increased.

Breed of Dam

Breed of dam effects on dystocia and birth weight do not follow a consistent pattern, except for Zebu-influenced females. Data from many sources clearly demonstrate that as the percentage of Zebu breeding increases in the dam, birth weight and dystocia decline. In Cycles I, II and III at MARC, Brahman- and Sahiwal-sired F1 dams exhibited assistance rates of only one and two percent, respectively, compared to a range of 7 - 17 percent for 14 European breedtypes.

Uterine Environment

Researchers at MARC reported that fetal growth during the last 20 percent of gestation is dramatically lower in Brahman than in Charolais cows, which helps explain the lower birth weights of calves from Brahman-influenced dams, as noted above. They provided evidence which suggested that this difference is due to differences in uterine blood flow and function of the utero-placental tissues. Research at Miles City has likewise shown that diverse breeds of dams differ greatly in the growth rate of the fetuses they are carrying.

Hormonal Control

Several hormones are associated with parturition (e.g., ACTH, cortisol, estrogen, prostaglandin, progesterone, oxytocin and relaxin). Increased blood levels of relaxin prior to parturition have been shown to enhance cervical and pelvic dilatation, resulting in normal delivery of the fetus. Unlike some species, circulating blood concentration of relaxin in cows remains consistently low during the last days of pregnancy. Iowa research has shown that injecting first-calf heifers with relaxin within the last 5 - 6 days before calving significantly reduces the incidence of dystocia. Cows can be induced to calve within 48 - 60 hours by injecting them with a corticosteroid or a prostaglandin within ten days of parturition. However, such treatments commonly result in difficult calvings and retained placentas. When the Iowa researchers combined relaxin with either dexamethasone (a corticosteroid) or cloprostenol (a prostaglandin), these problems were reduced significantly. Whether hormonal control of parturition can become a practical management strategy remains to be determined.

Geographic Region

Hereford cows of comparable genetic make-up were moved from Miles City, Montana, to Brooksville, Florida, and vice versa. Ten years after this switch was made, birth weights in the Montana herd that had been moved to Florida had declined from 81 pounds to 64 pounds. Conversely, birth weights in the Florida herd that had been moved to Montana had increased from 66 pounds to 77 pounds. Other studies have yielded similar results, indicating that calves of comparable genotype will be born lighter in the south than in the north.

Season of Year

Research has shown that calves born in the fall of the year are generally lighter in weight and experience less dystocia than those born in the spring.

Environmental Temperature

Prolonged exposure to high environmental temperatures will result in reduced birth weights, which can, in turn, lower the incidence of dystocia. There is less information on cold stress. However, the available data have shown that low environmental temperatures are related to heavier birth weights and increased calving difficulty. It is likely that differences observed between geographic regions and seasons of the year, as discussed above, are related to differences in environmental temperature.

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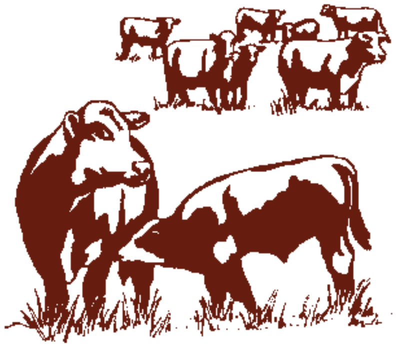
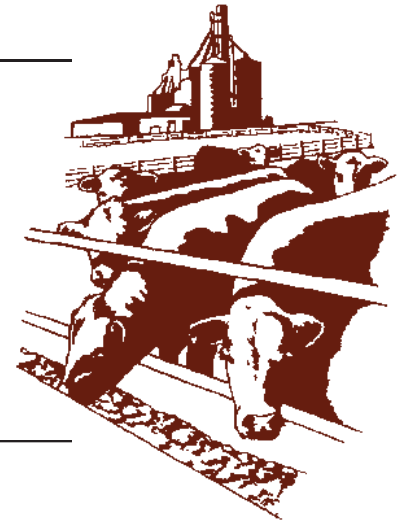
BCH-2120 Calving Difficulty in Beef Cattle: Part I1



Beef Cattle Handbook



BCH-2121

Product of Extension Beef Cattle Resource Committee
Adapted from the Beef Improvement Federation

Calving Difficulty in Beef Cattle: Part II[1]

Harlan D. Ritchie, Michigan State University
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Dietary Energy

Many cattle producers believe reducing dietary energy during late pregnancy will decrease fetal size resulting in improved calving ease, whereas increasing energy will increase fetal size leading to a higher incidence of dystocia. Generally speaking, research has shown that lowering the energy allowance will decrease birth weight but will not significantly reduce dystocia. At MARC, Hereford and Angus two-year-old heifers were fed three levels of energy (10.8, 13.7 or 17.0 pound TDN per head per day) for 90 days prior to calving. Increasing the level of dietary energy resulted in increased birth weight but not increased dystocia; in fact, the incidence of calving difficulty was lower in the medium and high energy groups than in the low energy group.

Inadequate nutrition of the young developing heifer can affect her subsequent calving performance. Miles City research showed that restricting the energy of weaned heifer calves during their first winter can have a carry-over effect, resulting in decreased precalving pelvic area and increased dystocia (46 percent versus 36 percent) compared to adequately fed heifers. From weaning to first breeding as yearlings, heifers should be fed to weigh at least 65 percent of their potential mature cow weight. This translates to a range in average daily gain of approximately 1.25 - 1.75 pounds for 200 days. Depending upon initial weight, frame size, body condition and environment, this means that daily TDN requirement will range from 8 - 13 pounds per head.

When they calve as two-year-olds, heifers should weigh 85 percent of their mature cow weight. This translates to an average daily gain of about one pound per day from breeding to calving. Adequate pasture conditions will support this level of performance. During the winter prior to calving, pregnant heifers require from 9 - 13 pounds of TDN per day. The mature pregnant cow requires from 7.5 - 13 pounds of TDN.

Dietary Protein

There is some concern in the cow-calf industry that high levels of protein during the last trimester of pregnancy may lead to a significant increase in birth weight and dystocia. At Miles City, crossbred, two-year-old pregnant heifers were fed diets containing either 86 percent (low) or 145 percent (high) of the National Research Council (NRC) crude protein requirement for 82 days prior to calving. Heifers fed the low protein diet had significantly lighter calves at birth and less calving difficulty. Heifers on the high protein diet gained more weight, had higher condition scores at calving, maintained more body weight throughout the study, and weaned significantly heavier calves. In a repeat study at Miles City, there were no differences in calf birth weight or calving difficulty. Research at other institutions has shown no consistent effect of protein level on dystocia. It would appear that precalving dietary protein levels should be near the NRC requirement. If it is extremely low, weight and condition of the cows and weight, vigor and post-natal growth rate of the calves may be reduced. If it is unduly high, it represents an economic waste. During the last trimester of pregnancy, crude protein requirements range form

1 (Authors' note: This fact sheet is second in a series of two on calving difficulty).

8.2 - 9.8 percent for heifers and 7.6 - 8.2 percent for mature cows.

Body Condition

Prior to the last trimester of gestation, females should be evaluated for body condition. Those in thin condition (body condition score 4 or less on a 1 - 9 scale) should be fed separately from those in moderate or higher condition so their dietary energy level may be increased. By calving time, the goal would be to have mature cows in moderate condition (score of 5) and first-calf heifers in high moderate condition (score of 6). Over-feeding females to the point of obesity has been shown to increase the incidence of dystocia. Texas researchers reported that as fatness score increased above a moderate level in first-calf Santa Gertrudis heifers, calving difficulty increased. They concluded that efforts should be made prior to calving to prevent over-conditioning of females in an effort to reduce dystocia.

Implants and Feed Additives

Numerous studies have shown that implanting heifer calves with zeranol (Ralgro™) increases pelvic area at breeding time. However, in most instances, this increase did not persist up to calving time and there was little effect on calving difficulty. Similar results have been reported when Synovex-C™ implants were used on suckling heifer calves. Some producers believe that feeding an ionophore such as monensin (Rumensin™) or lasalocid (Bovatec™) increases calving problems. However, research has shown these compounds have no effect on gestation length, calf birth weight, pelvic area, or dystocia.

Feeding Time

The time of day the cow herd is fed during calving season has been shown to influence when calves are born. The data indicate that cows fed at night are more apt to calve during daylight hours when they can be observed closely. Gus Konefal, a Hereford breeder in Manitoba, was the first to recommend this feeding strategy. Consequently, it has been called the "Konefal Method" of daytime calving. This system involves feeding twice daily, once at 11:00 a.m. - 12 noon and again at 9:30 p.m. - 10:00 p.m. This regime starts about one month before the first calf is born and continues throughout the calving season By following this feeding program, Konefal reported that 80 percent of his cows calved between 7:00 a.m. and 7:00 p.m. Similar results were obtained in a study at Iowa State University. These two studies prompted Miles City researchers to conduct a three-year study on feeding time. Their results were not as dramatic as those of the earlier studies. Nevertheless, the percentage of cows calving between 10:00 p.m. and 6:00 a.m. was consistently 10 - 20 percent lower for the late-fed than for the early-fed cows. Similar research conducted at the Brandon Research Station showed a 13.5 percent reduction in cows calving between midnight and 7:00 a.m.

Exercise

Forced exercise for several weeks prior to calving has been shown to improve the calving ease of closely confined dairy heifers. However, Miles City researchers could find no difference in calving ease between heifers maintained in a typical feedlot and those forced to walk two miles a day. It was concluded that unless beef heifers are under extremely close confinement, exercise is of no benefit in reducing dystocia.

Calving Time Management

In addition to knowing **how** to give assistance, it is also important to know **when** to help. For years, the general recommendation was to intervene if the cow was in intense labor for 2 - 3 hours without making progress. Research at Miles City suggests that it may be beneficial to give assistance earlier. They reported that intervening as soon as the cervix was fully dilated and the membranes and the calf's feet extended from the vulva (beginning of second stage of labor), resulted in significant advantages over a group of females that received no assistance unless it was needed to save the calf. These advantages were; higher percent in heat at beginning of breeding season (91 percent versus 81 percent); higher first service conception rate (75 percent versus 60 percent); and higher pregnancy rate in October (90 percent versus 76 percent). These advantages were observed in mature cows as well as in first-calf heifers. It was reported that duration of the second stage of labor averaged 54 minutes for heifers and 23 minutes for cows. Out of this research, the following time limit was set at the Miles City station: if definite progress has not been made after one hour of intense labor, the calf is pulled. They caution, however, that the cervix should be fully dilated and the calf's feet visible. Also, the position of the fetus must be normal; for example, if either of the legs or head are back they must be corrected before assistance is given.

Genetic Management

From a genetic standpoint, there are several traits which may be considered in a selection program to keep dystocia under control; they are: (1) Individual birth weight; (2) EPD (expected progeny difference) for birth weight; (3) The sire's EPD for direct (his own) calving ease on first-calf heifers; (4) The sire's EPD for maternal (his daughters) calving ease on first calves (5) The sire's pelvic area; (6) The pelvic area of potential replacement heifers.

Birth Weight and EPDs for Birth Weight

Although individual birth weights can be used as a guide in selecting young unproven bulls, EPDs are better predictors because they combine data from several sources—the individual, his ancestors and his half-sibs. As a bull becomes older and sires a significant number of progeny, the accuracy of his EPDs improve markedly. By then, his individual birth weight is of little or no significance. A number of studies have shown strong correlations between EPDs of sires and actual birth weights of their progeny, especially among sires with high accuracy (over .80).

In order to minimize dystocia in first-calf heifers, ideally, they should be mated to bulls with breed average or lower birth weight EPDs. For maximum precision, a young unproven bull's EPD should be compared against the breed average for bulls in his own birth year group. Breed average information is contained in many of the sire summaries published by National breed associations.

As noted before and shown in *Table 4* (CSU data), birth weight is a moderately heritable trait and is positively genetically correlated with other growth traits. Therefore, many bulls having average to below average birth weight EPDs will be average or lower for other growth traits. However, there are exceptions, and a search of sire summary lists can be used to identify bulls that have low birth EPDs and average or higher weaning and yearling EPDs.

A calf's birth weight is influenced by both the sire's and the dam's genotype for birth weight. Therefore, selecting heifers from sires with low birth weight EPDs can stack the herd's pedigrees in favor of calving ease.

Table 1. Heritabilities of Growth Traits and Their Genetic Correlations with Birth Weight.

Trait	Heritability	Genetic correlation with birth weight
Birth weight	.41	—-
Weaning weight	.32	.36
Yearling weight	.43	.29
18-month weight	.61	.69

EPDs for Calving Ease

Direct Calving Ease. Except for Simmentals, this EPD is reported as a ratio; sires with higher ratios will calve easier when mated to first-calf heifers. The Simmental Association provides direct calving ease EPDs for **both** heifers and cows. Simmental EPDs are expressed in percent unassisted births, with positive numbers indicating greater calving ease. In general, EPDs for direct calving ease are closely related to EPDs for birth weight. All breed associations publish EPDs for birth weight, but only three associations report calving ease EPDs.

Maternal Calving Ease. This trait is reported and interpreted in a manner similar to direct calving ease. This EPD predicts how easily a sire's **daughters** will calve. Heritability estimates of calving ease have been lower than those reported for birth weight. This suggests that genetic progress made by selecting directly on calving ease EPDs would be slower. An exception would be the Simmental breed in which calving ease EPDs have been shown to be a more accurate indicator of dystocia than birth weight EPDs. This is because Simmental calving ease EPDs incorporate birth weight as well as a score for calving ease. For long-term improvement in the herd, using sires with high maternal calving ease EPDs and retaining their daughters should be beneficial.

Pelvic Area

Please refer to the first fact sheet (Part 1) in this series for a complete discussion of selecting for pelvic area.

Selecting Natural Service Bulls

The producer who is not in a position to artificially inseminate first-calf heifers does not normally have the option of using highly proven sires with high accuracy EPDs for birth weight and/or calving ease. An alternative is to purchase an older bull, known for his calving ease, from another producer in the area. Transmission of disease is a potential risk when this is done. A more realistic option is to purchase an unproven bull that has a low birth weight EPD, a large pelvic area and a low individual birth weight (adjusted fox age of dam). If birth weight EPDs are not available, try to look for sons of highly proven calving ease sires. Even better, look for young bulls whose sire and maternal grandsire are both highly proven calving ease sires. If no information is available except for an individual birth weight, consider the age of the dam when the bull was born because younger cows give birth to lighter calves. Ideally, birth weights should be adjusted to a 5 - 10-year-old dam equivalent by adding the following adjustments: two-year-olds, 8 pounds; three-year-olds, 5 pounds; four-year-olds, 2 pounds; eleven1-year-olds and over, 3 pounds. These are standard adjustments published by the Beef Improve-ment Federation; some breeds have their own adjustments. However, relying solely on individual birth weight is risky business. A low birth weight bull whose sire may have unknowingly been a high birth weight sire is not likely to be a good candidate for use on virgin heifers.

Summary

In summary, research has shown the following strategies to aid in alleviating calving problems:

1. Develop heifers properly so they achieve at least 65 percent of their mature weight by breeding time and 85 percent by the time they calve as two-year-olds.
2. Breed virgin heifers one heat period before the mature cow herd and give them extra attention at calving time.
3. Know the pregnant female's nutrient requirements. Neither underfeed nor overfeed her. Body condition scores at calving time should fall within a range of 5 - 6 on a 9-point scale.
4. Using the Konefal Method may cause more emales to calve in the daytime when they can be observed closely.
5. Know when and how to give assistance and when to consult a veterinarian.
6. Measure pelvic areas of potential replacement heifers and cull the lower end.

7. Mate virgin heifers to low-risk bulls:
   a. Proven A.I. sires with high accuracy EPDs for birth weight and/or calving ease.
   b. Unproven bulls with low birth weight EPDs, large pelvic areas and low individual birth weights.
8. Retain daughters of sires that combine low birth weight EPDs and high maternal calving ease EPDs.

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Cattle Vaccines

Floron C. Faries, Jr.*

Veterinary biological products are antigen and antibody products, produced by laboratory techniques, that use microorganisms such as bacteria or viruses.

Vaccine products contain high numbers of modified (live) or inactivated (killed) organisms or subunits (portions) or inactivated toxins (waste products) of organisms known to cause a particular disease. These products deliver antigens that stimulate the body's immune response through the production of antibodies. Antibodies also are found in biological products such as antisera, antitoxins, colostral antibodies and monoclonal antibodies. Biological products can be administered to cattle before exposure to disease to provide protection and after exposure to disease to reduce spread of infection.

A vaccine containing inactivated toxins is called a toxoid. A toxoid is not a killed vaccine or a modified live vaccine.

A vaccine containing killed bacteria is called a bacterin. Adjuvants are added to bacterins to increase effectiveness of the antigens. Adjuvants slow the release of the antigen into the body and prolong the immune response. Antigen-adjuvant mixtures form tissue deposits at the injection site beneath the skin (subcutaneous) that are observed as knots in the skin. Also, injection site lesions in the muscle can be caused by intramuscular injections of vaccines containing an adjuvant.

Noninfectious Vaccines

Noninfectious vaccines are unable to infect and replicate. They are usually much safer to cattle than live vaccines but may be weaker in their ability to stimulate an immune response. They are approved for pregnant cows and calves nursing pregnant cows.

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Noninfectious vaccines include killed vaccines, bacterins, toxoids, leukotoxoids and chemically altered, body temperature sensitive, modified live vaccines that are injected intramuscularly. To be effective, two doses of a noninfectious vaccine administered at a 2- to 4-week interval are necessary. The first vaccination is a priming,

Crowd cattle in a lane chute to properly administer injections in the neck.

sensitizing dose that may provide no protection or a low protection for 1 to 4 months. The second vaccination is a required booster dose, recommended within 2 to 4 weeks but acceptable within 4 months after the first dose. Immunity following the second dose lasts from 6 to 12 months. To maintain immunity, the vaccinated animal should receive semiannual or annual boosters, depending on the type and risk of disease. The booster vaccine is a noninfectious vaccine.

Infectious Vaccines

The virulence of an organism in a live vaccine is modified or reduced (attenuated) so that it no longer causes disease, but it is able to infect and replicate. Some live vaccines may possess the ability to revert to a virulent organism and spread disease to unvaccinated cattle.

A modified live vaccine is an infectious vaccine that establishes a desired infection in the vaccinated animal. Immunity prevents the desired infection of a modified live vaccine from being established; therefore an infectious vaccine generally is not effective when administered after a noninfectious vaccine.

The infectious vaccine may give properly vaccinated cattle immunity for life. Repeated modified live infectious vaccinations are unnecessary. However, immunity of the vaccinated animal can be ensured by using a noninfectious vaccine booster every year or an infectious vaccine every 3 years.

Infectious vaccines include modified live vaccines that are not body temperature sensitive and modified live vaccines that are chemically altered, body temperature sensitive, and injected in the nasal passage.

Handling Vaccines

All vaccines should be refrigerated. Remove only briefly for dose measurement and administration. Do not expose the vaccine to direct or indirect sunlight for any extended period of time. Sanitary measures help to ensure the vaccine is free of blood, feces, hair and dirt. If handling a live vaccine, do not use chemicals to disinfect syringes, needles, skin or vaccine vials. The unused portion of a vial of vaccine must be properly discarded and not stored for later use.

Proper Vaccination Procedures

Follow label directions for proper procedures in administering a vaccine. Use the correct dose and route of administration. The measured volume (dose) of a vaccine is in milliliters (ml) or equivalent in cubic centimeters (cc). The routes of administration are subcutaneous or SQ (inject under skin), intramuscular or IM (inject in muscle), and intranasal or IN (inject in nasal passage). The recommended site for SQ or IM injections is in the side of the neck in front of the shoulder. Do not administer an expired vaccine. Follow the withdrawal time recommendations for slaughter printed on the label.

Systemic protection provided by colostral immunity in calves lasts from 2 to 12 weeks and depends on the quantity and quality of colostrum (first milk) consumed, the disease, and the level of exposure. As this immunity decreases, young calves should be actively immunized by use of vaccines. However, maternal antibodies interfere with active immunity by reducing the effectiveness of administered vaccines. Because the exact time of colostral immunity loss cannot be predicted, young calves must be vaccinated at least twice, beginning at 2 months of age, to ensure successful active immunization.

A subcutaneous injection should be given in the side of the neck in front of the shoulder.

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Common cattle parasites

Floron C. Faries, Jr.*

Calves are more susceptible to internal parasites.

WITH PROPER PREVENTIVE AND TREATMENT METHODS, producers can control many common internal and external parasites in cattle. Common important internal parasites of cattle are hairworms, lung worms, liver flukes and coccidia. Common external parasites include horn flies, lice and grubs.

Internal parasites

Hairworms

The gastrointestinal tract of cattle is often infected with hairworms, also called stomach worms and intestinal worms. These worms are transmitted when:

1. Infected cattle pass eggs in manure onto the ground;
2. Eggs hatch in the manure;
3. Rain washes the larvae from the manure; and
4. Cattle swallow larvae on wet grass in moderate temperatures.

The worms mature in about 3 weeks and lay eggs. In June, July and August, larval development of the brown stomach worm, the most common and harmful of the hairworms, is inhibited in the stomach lining. The worms are usually transmitted when soil temperatures are 55°F to 85°F in rainy periods in spring (April through June) and fall (October). Pasture larvae hibernate in winter (November through March) and die from heat, sunlight, drying and nutrient depletion in summer (July through September).

Normally the disease (wormy cattle) is secondary to inadequate nutrition. Poor nutritional management practices such as overcrowdedness and overgrazing create inadequate nutrition and allow cattle to be reinfected continuously. Under these conditions, the cattle's gastrointestinal tracts are a suitable environment for worms to establish; their immune response is low, allowing establishment; and being in poor condition, the wormy cattle cannot withstand effects of the worms.

The primary malnutrition condition, a protein deficiency, worsens because the larvae interfere with digestion, causing diarrhea and reducing the appetite.

Calves have low immunity and usually become wormy during their exposures. Heavy exposures cause disease; light exposures produce immunity. Adult cattle and young cattle have immunity from previous exposures, but often become wormy when:

- Nutrition is inadequate and their immunity has lowered;
- Brown stomach worm larvae have emerged from the stomach lining in September; and
- Heavy exposures have occurred.

Clinical signs of wormy cattle include pale mucous membranes, bottle jaw, pot belly, diarrhea, drawed, not grazing, not chewing cud, rough and dry haircoat, thinness, weakness and inability to stand. These signs are similar to those caused by malnutrition and liver flukes.

The most important way to control hairworms is to maintain good nutrition by:

- Rotating pastures;
- Preventing overcrowding and overgrazing; and
- Providing good quality pasture, hay and supplements.

When cattle have a diet with enough protein, vitamins and minerals, fewer worms are normally established and the cattle are more able to withstand their effects. Management practices that maintain good nutrition also prevent severe reinfection of worms. Additional

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Manure-contaminated environment provides exposures to internal parasites.

control measures include proper drainage and sanitation, separating age groups and strategic worming.

Lung worms

Lung worms cause a lung disease in cattle with clinical signs similar to those caused by viruses, bacteria and allergies. Transmission and control are the same as for hairworms. Lung worm disease occurs in previously unexposed cattle, such as in calves or moved cattle.

Liver flukes

Cattle living in wet areas with alkaline soils may develop liver fluke infections. Liver flukes are transmitted when:

1. Infected cattle, deer and rabbits pass eggs in manure and drop the manure in water;
2. Eggs hatch in water and larvae develop in snails; and
3. Cattle swallow cysts on grass or hay.

Clinical signs of digestive inefficiency are evident in young cattle with acute liver disease and in older cattle with chronic liver disease. Fluky cattle show signs similar to those with malnutrition and hairworms.

Strategic worming

Wormers are administered to cattle not only as a treatment to kill internal parasites and to stop damage caused by parasites, but also to prevent pasture contamination and reinfection of the cattle. Strategically administering drugs reduces environmental contamination and infection of cattle and snails.

A strategic method requires proper timing. This means that a drug against a parasite must be administered at the right time considering the parasite's biology. Therefore, the correct time is not when the cattle are confined and accessible, or because it has been a long time since the cattle received a drug, or because administrations are spaced evenly (fall and spring, every 6 months). The correct time is when cattle have become infected, the parasite is beginning to develop and cause damage, and conditions are best for transmission.

Administering a drug at the right time breaks the life cycle of the worms and prevents them from building up in cattle. The right time to administer cattle wormers normally depends on the parasite and the development of optimal environmental conditions, which include moderate temperatures, rainfall and wet grass. For stomach worms, administer drugs 3 to 6 weeks after optimal environmental conditions develop. For liver flukes, administer drugs 4 to 6 months after optimal conditions are present.

Examine feces each month to check fluctuations of worm eggs per gram of feces, which will help you time the drug administration properly and monitor the effectiveness of your control measures.

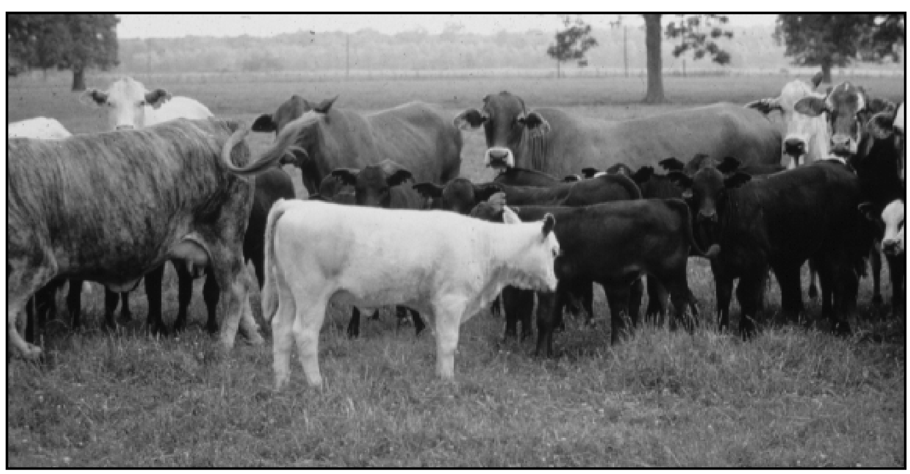
Drugs to control internal parasites should supplement but not replace management practices to improve sanitation and nutrition. Table 1 shows what products can be used for various parasites and how to administer them.

Coccidia

Coccidia cause an intestinal disease of young cattle, usually 3 weeks to 6 months old, but can affect cattle up to 2 years old. They are transmitted when:

1. Infected cattle pass cysts in manure onto the ground;
2. Rain washes the cysts from the manure;
3. The cysts develop under moist and moderate temperature conditions; and
4. Cattle swallow cysts on moist ground.

As with hairworms and lung worms, transmission is common during rainy times in spring and fall. The diarrhea caused by coccidia may be confused



Good nutrition and sanitation practices prevent severe reinfection of internal parasites.

with the diarrhea caused by hairworms, bacteria and viruses.

Wormers are ineffective against coccidia. Effective drugs are amprolium (Amprol®, Corid®), decoquinate (Deccox®), lasalocid (Bovatec®), and sulfonamides. After 1 week of optimal conditions, administer the drug in feed or water for 2 weeks to calves maintained in a manure-contaminated environment, such as haying and feeding areas. Control measures include the management practices for hairworms.

External parasites

Horn flies

Horn flies reproduce in fresh cattle manure from early spring to late fall. Horn fly populations usually peak in late spring and again in late summer or early fall. Hot, dry conditions may naturally reduce horn fly numbers during mid-summer. Thousands of flies may infest a single animal, causing extreme nervousness and energy loss. Horn flies suck blood, irritate and annoy, reduce weight gains and cause weight losses. The annoyance and irritation interfere with cattle's feeding and resting.

Treatment is economically justified when horn fly populations reach 250 per head. To control them satisfactorally throughout the season, use self-treatment insecticides or routinely apply spray, pour-on, spot-on or dust chemicals.

Used properly, self-treatment devices are more effective than hand application in controlling horn flies and lice. Such devices include oil back rubbers, dust bags and tubes, liquid wicks and impregnated ear tags. Insecticide-impregnated ear tags control horn flies well for 2 to 5 months if they are properly attached to the ear and if pyrethroid resistance is not a factor. Currently labeled ear tags contain either a pyrethroid, an organophosphate or a pyrethroid/organophosphate/synergist mixture.

Pyrethroid ear tags (permethrin, fenvalerate) have induced widespread horn fly resistance. Vary the types of ear tag insecticides rather than using the same kind year after year. Remove tags as soon as possible once they have lost their effectiveness in killing horn flies. Tags used 4 to 5 months emit too little insecticide to control fly populations adequately. Tags emitting reduced doses seem to add to the resistance problem by prolonging fly exposure, thus making the surviving population more resistant to the insecticide.

Lice

Biting lice and blood-sucking lice are transmitted between cattle by contact, especially in the fall, winter and spring when egg production increases in cool weather. Because cattle tend to bunch up more in cold weather, uncontrolled lice spread easily from animal to animal and quickly infest an entire herd.

Lice cause a condition called lousy, an itching skin disease with possible anemia. Clinical signs are dry, scaly skin, hair loss and itching exhibited by biting, rubbing and scratching. Lice bites and allergies to lice cause the itching. The allergic dermatitis may persist after the lice are gone. These signs may be confused with malnutrition and allergies caused by horn flies, mosquitoes and gnats.

Although chemicals do not harm lice eggs, cattle can be treated effectively by administering insecticides twice at a 2-week interval or once with avermectins (Ivomec®, Eprinex®, Dectomax®) or milbemycin (Cydectin®). Use spray, dust, pour-on, spot-on, injection or self-treatment methods in fall and winter for control. Injection does not work for biting lice.

Grubs

Cattle grubs (warbles, wolves) are larvae of heel flies, which lay eggs on hairs of the lower legs of cattle in late winter and spring. Grubs appear in the backs of cattle in winter. The migratory damage by the grubs in cattle causes weight losses and reduces weight gains and milk production.

To control grubs, administer systemic organophosphate insecticides (CoRal®, Warbex®, Spotton®, Neguvon®, Tiguvon®, Prolate®), avermectins (Ivomec®, Eprinex®, Dectomax®) or milbemycin (Cydectin®) to cattle no later than 3 months before grubs appear in the back. Use pour-on, spot-on, spray or injection methods to kill migrating grubs before they reach the esophagus. If cattle are not treated for cattle grubs in the summer, the systemic organophosphate insecticides and avermectins used in the fall and winter for control of lice, horn flies, and worms may cause reactions in the esophagus if many grubs are present.

Horn flies and lice cause hair loss and itching.

Table 1. Cattle Parasiticides

Products (Trade Name)	Parasites	Methods
Levamisole (Levasole®, Tramisol®, Totalon®)	Stomach worms[1], lung worms[1]	Drench, injection[4], pour-on, bolus, feed, block
Fenbendazole (Safe-Guard®)	Stomach worms[1], lung worms[1]	Drench, paste, feed, block
(Panacur®)	Stomach worms[2], lung worms[1], tapeworms	Drench, paste
Oxfendazole (Synanthic®)	Stomach worms[2], lung worms[1], tapeworms	Drench, paste, injection[5]
Albendazole (Valbazen®)	Stomach worms[2], lung worms[1], common liver fluke, tapeworms	Drench, paste
Moxidectin (Cydectin®)	Stomach worms[2], lung worms[1], grubs, sucking lice, mange mites, biting lice, horn flies	Pour-on
Eprinomectin (Eprinex®)	Stomach worms[2], lung worms[1], grubs, sucking lice, mange mites, biting lice, horn flies	Pour-on
Doramectin (Dectomax®)	Stomach worms[2], lung worms[1], grubs, sucking lice, mange mites, biting lice[3]	Injection[4], pour-on
Ivermectin (Ivomec®)	Stomach worms[2], lung worms[1], grubs, sucking lice, mange mites, biting lice[3], horn flies[3]	Injection[4], pour-on, bolus[6]
Ivermectin + Clorsulon (Ivomec Plus®)	Stomach worms[2], lung worms[1], grubs, sucking lice, mange mites, common liver fluke	Injection[4]
Clorsulon (Curatrem®	Common liver fluke	Drench

[1]Adults, developing larvae; [2]Adults, developing larvae, inhibited larvae; [3]Pour-on; [4]Subcutaneous; [5]Intraruminal; [6]Sustained release

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The Texas A&M University System

Dehorning, Castrating and Branding

Successful cattlemen do everything they can to make their cattle worth more on the market. Proper dehorning, castration and branding are standard practices that add value to calves to be marketed.

Dehorned calves headed for the feedlot take up less bunk space, are less likely to injure other cattle and do not prevent other stock from feeding properly. The dehorned calves look more uniform, feed better and bring a higher market price.

Advantages of castrating include fewer nuisance problems and easier handling. Branding cuts down on lost calves and provides a trademark for the ranch's good quality cattle.

Dehorning, castrating and branding all have one other characteristic in common; they are most successful and less stressful to young calves than to animals at weaning or older.

Sanitation Precautions

It is critical that instruments used in castration and dehorning be kept clean and be disinfected thoroughly before each use. This helps prevent infected wounds and the spread of infectious diseases such as anaplasmosis, bluetongue and leukosis. The operator's hands also should be kept clean.

Disinfectant mixed in a bucket of warm water should be available to rinse off the instruments. The instruments should be allowed to soak in this bucket between uses on different animals. A second bucket should be available to help keep the operator's hands clean.

There are several good disinfectants available, such as chlorhexadine (nolvasan), lysol, various quanternary ammonium preparations (Roccal®, dairy utensil cleaners) and chlorine preparations. Each has certain advantages and disadvantages. Iodine is a good skin antiseptic, but it is corrosive to instruments. Kerosene, which occasionally has been suggested, has no disinfectant qualities. Consult your veterinarian on specific disinfectants.

Applying antiseptics to the calf's skin before castration or dehorning is of little use unless the hair is shaved and the area scrubbed with soap several times prior to applying the antiseptic.

Dehorning Methods

Bloodless Dehorning

Because horn tissue is formed in the specialized cells in the small ring of skin encircling the horn button, bloodless dehorning seeks to destroy this ring. To be successful, these methods must be performed before significant horn growth has occurred.

Dehorning liquid with a colodian base dries to form a rubber-like covering that is not easily rubbed or washed off. The liquid should be applied with a brush or swab. Calves up to 10 days of age can be dehorned with this material.

Dehorning paste is applied to the horn button with a small wooden paddle. Prevent paste from contacting other skin areas on either the calf or the operator.

Caustic soda or potash also is called "caustic stick." Clip hair around the small, undeveloped horns or buttons. Next, wrap one end of the caustic in paper or cotton. The operator should hold the caustic by the wrapped end and moisten the open end. Rub the moist end on the undeveloped horn and the skin immediately surrounding it. Skin adjacent to the treatment area should be protected by applying petrolatum. Two or three applications of caustic are necessary and the treated area should be allowed to dry after each application—this should take only a few minutes. Thorough applications will prevent further horn growth.

Protect treated calves from rain for a few days following the treatment to prevent the caustic soda from washing onto the face area and causing chemical burns.

Most **electric dehorners** have a cupped attachment. The horn tissue is burned by placing the cup over the horn buttons. This method is bloodless but must be done when the calves are young and the horns very small. The burning application must be applied liberally to destroy all potential new horn tissue. The skin usually will be copper or bronze colored when the treatment is completed.

Mechanical Dehorning

The objective of this method is the surgical removal of the horn and a small ring of skin encircling it. The horns may be surgically removed from any age or size of animal, but the potential complications increase with the animal's age. The instruments used must be kept sharp by filing or honing, especially when dehorning adult animals. The bone tissue should be cut rather than just crushed or cracked. Damaged bone tissue is prone to infection.

Spoon dehorners are used on small calves to cut or gouge out horn buttons. Some ranchers use a heavy knife to cut off the horn buttons, followed by a caustic stick to coat the edges.

Tube dehorners are used on calves up to 4 months old. Tubes come in various sizes. Use one that fits the base of the horn. The horn is gouged out by a turning action. This is an excellent method for removing horn buttons.

Dehorning saws usually are used when mature animals are dehorned to avoid crushing or cracking the bones of the skull. The blade of a dehorning saw is especially designed for cutting bone and horn tissue. A fine-toothed, stiff-backed carpenter's saw also can be used. Make the cut about one-half inch below the junction of the horn with the skin to prevent horn regrowth.

It will reduce stress on mature animals if a local anesthetic is used to block the nerves that supply the horn area. These are prescription drugs, however, and must be administered or prescribed by a veterinarian.

Special concerns with wounds produced by mechanical dehorning methods include hemorrhage, infection and fly blow.

Hemorrhage (bleeding) is of little concern in young calves and usually requires no treatment, although many producers apply "blood stopper" chemicals.

In older calves and adult animals, uncontrolled hemorrhage can result in severe weight loss or death. There are two or three main arteries that supply the horn area and their bleeding should be stopped. The arteries can be pulled and twisted until they break under the subcutaneous tissues which then will provide pressure and a base for clot formation. The arteries can be cauterized with a hot iron or the arteries can be tied off with a string tied around the horn base to apply pressure for 24 hours. Blood-stopper chemicals should not be placed down into an open sinus as they may cause serious complications.

Infection usually is a problem only when the animals have matured enough to develop a "horn" (cornual) sinus, and dehorning then leaves the open hole down into the sinuses of the head. It is very difficult to provide adequate drainage for this area of the head and infection, once established, often results in a serious, long-term sinus infection.

The open hole into the head can be covered with gauze or cotton to keep out debris. Take care that no hay is thrown on the animal's head at feeding time and protect the dehorned animal from rain and dust storms until the open sinus has completely healed over. Keep blood stopper and fly sprays out of the open sinus if they are used around the wound.

Fly blow is a problem during the warm months and can be prevented by application of a fly spray or smear that will last for a week. In some areas, repeated applications may be necessary.

Castration

Calves from a few weeks to 8 months of age may be castrated without serious consequences. Older animals are more difficult to restrain and usually bleed more, so greater care must be used. If a calf is not castrated before 8 months, he may become "staggy," which is objectionable in the feeder and market steer.

Bloodless Castration

An **elastrator** is a forceps-like instrument used to slip a strong elastic band around the scrotum down to its attachment at the groin. The pressure exerted by the rubber band shuts off the blood supply to the scrotum and testicles, causing them to slough off. It should be used before 1 month of age. Possibilities of tetanus (lockjaw) and the lack of cod development are disadvantages of this method.

The elastrator also can be used to castrate calves physiologically without removal of the testicle. In the process, the testicles are forced as close to the abdomen as possible, and the rubber band is placed on the scrotum below the testicles. The animal's body heat is high enough that the testicles will not produce viable sperm cells, but the growth response from testosterone and other male hormones produced by the testicles continues. These calves will have a normal sex drive and may become staggy. This method of castration should be done before calves are 6 to 8 months old.

The **burdizzo** is often used for bloodless castration of older calves and can be successful if properly applied. The "cord" above the testicle is isolated to the side of the scrotum and the heavy burdizzo clamp is applied over it with the skin intact. The clamp is closed and left in position for approximately one minute. This crushing of the blood and nerve supply to the testicle causes sufficient impairment to result in a shrunken, nonfunctional testicle. The same procedure is applied to the opposite testicle.

It is very important that no damage or injury occur to the penis, which some operators occasionally have mistaken for the cord. As there is no break in the skin of the scrotum, there is no external bleeding. This is an advantage in areas where screwworms are troublesome. Steers so castrated usually develop larger and fuller cods by the time they are marketed. This is considered desirable by some cattlemen.

If the operation is performed too hastily, the cord may not be completely crushed and the steer is likely to develop stagginess later on.

Surgical Castration

The testicles can be removed surgically from any age bull, but the risks and potential complications increase greatly with age. Surgical castration can be performed with the calf standing in a chute and the tail held up over the back for restraint; lying on a calf table; or stretched out on its side on the ground. The most important considerations are cleanliness, hemorrhage control and providing adequate drainage.

The scrotum is opened to expose the testicles. This can be done by cutting off the lower one-third of the scrotum, but this may result in the wound closing too quickly so it does not provide adequate drainage.

Another method for opening the scrotum is to push the testicles up in the scrotum toward the abdomen and insert the knife into the side of the scrotum below the testicles. It should extend completely through the scrotum and out its opposite side. The scrotum is then cut into two halves from there out on the bottom. This type of incision is less likely to heal closed too quickly.

Once the scrotum is opened, the next step is proper removal of the testicles. They should be grasped and extended while pushing back the connective tissue surrounding the cord to free it adequately. On very young calves, the testicles can be pulled out gradually until the cord breaks. On older calves, this may result in excessive bleeding or hernia development. The cord may be "scraped" to reduce these problems. This involves grasping the testicle and stretching the cord while scraping on the cord with a knife. Scrape toward the abdomen to allow for gradual separation of the cord tissues and vessels.

An emasculator is a good instrument for removing the testicle with a cutting blade, while at the same time crushing the blood vessels to control hemorrhage. The cord is extended and the emasculator applied with the crushing jaw toward the abdomen of the calf. Use of the emasculator is especially important when castrating older calves. In mature bulls, the blood vessels of the cord should be tied off with surgical gut suture before the testicle is removed.

Branding

Register your brand because it is your trademark. A good brand on your good calves is your best advertisement. The brand usually is placed on the calf before weaning time. Although the hot iron method of branding is the most common, electrical branding irons are becoming popular. Branding liquids are discouraged. They lead to blurred brands and wounds that are difficult to heal.

A recent development is a calf branding table. This places the calf in a convenient position to be branded, vaccinated, dehorned and castrated. A branding table is placed at the end of the chute and calves are run in one at a time.

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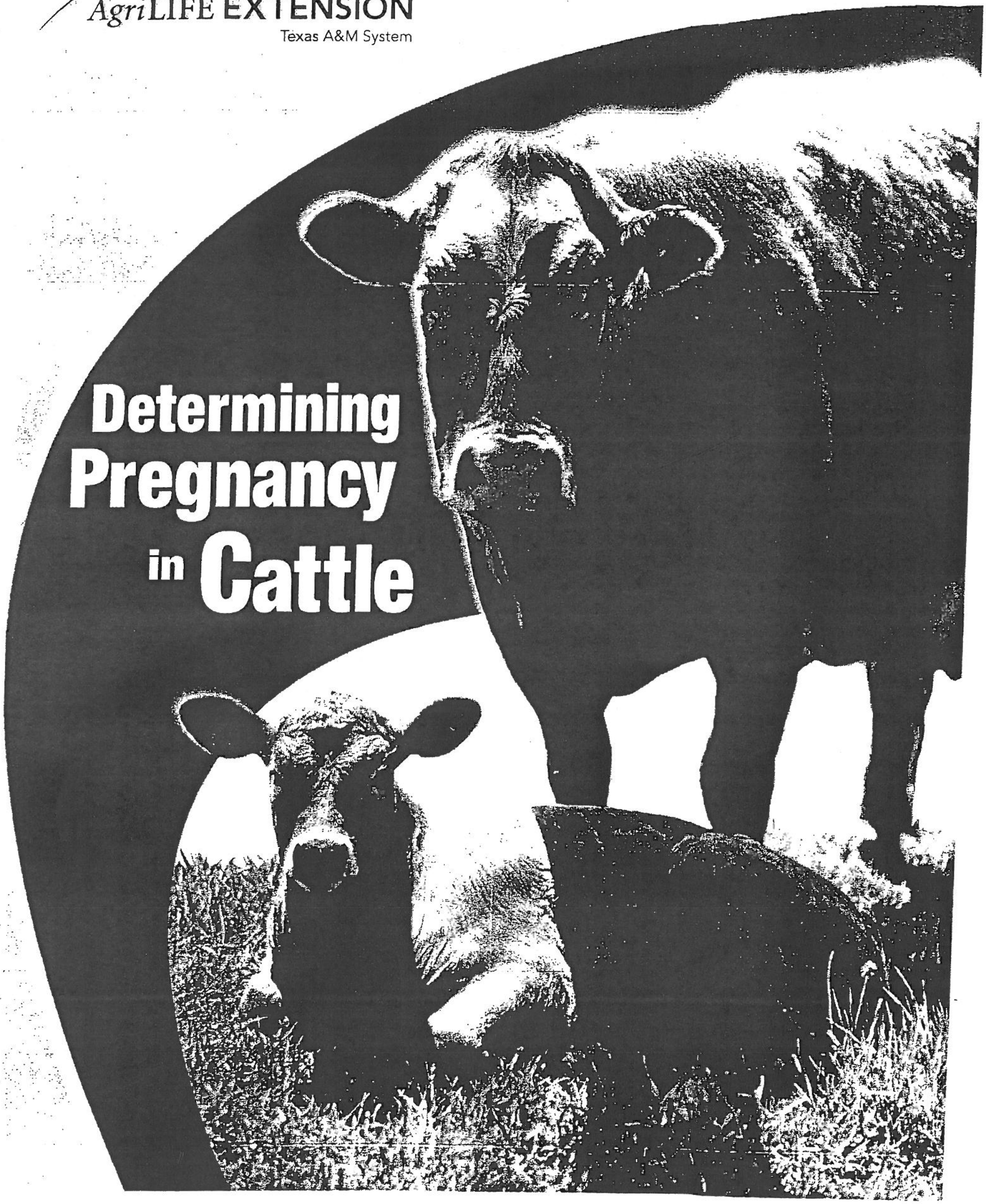
Determining Pregnancy in Cattle



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Determining Pregnancy in Cattle

Bruce B. Carpenter and L. R. Sprott*

Determining pregnancy in cattle is an important management tool. The ability to determine pregnancy can allow you to make timely culling decisions and focus the resources of your operation on sound, reliable breeders. With experience, you can determine the fetal age which will allow you to predict expected calving dates and plan for the necessary labor at calving time. Pregnancy determination can also help you manage feeding to meet the high nutritional demands of gestation, calving, lactation and rebreeding more effectively.

Knowing expected calving dates can also be an advantage when marketing bred replacement heifers. Potential buyers often want to purchase females whose calving dates coincide with those of their present herd.

Increasing Herd Productivity

A cow-calf producer's economic returns depend largely on the percent calf crop and the weaning weight of the calves to be sold. You can compute your calf crop percentage by dividing the number of calves raised to weaning age (7 months) by the number of cows in your herd at the start of the breeding season.

Percent Calf Crop and Weaning Weight

Table 1 shows the cost per pound of calf produced for various production levels with an operating cost of $550 per cow per year. To determine the required level of production for this example, take an arbitrary selling price of $1.31 per pound and locate the break-even point in Table 1.

Weanling calves weighing 450 pounds would require a 90 percent calf crop to break even. If only a 60 percent calf crop is produced, then the needed break-even would be 65 cents higher than the $1.31 market value. Calves weighing 500 pounds would break even at an 80 percent calf crop, and calves weighing 550 pounds would break even at just over a 70 percent calf crop.

Or, viewing it another way, lightweight calves averaging 350 pounds with only a 60 percent calf crop would need to sell for $2.52 per pound to break even.

You can see the economic importance of calf crop and its interaction with weaning weight in Table 2. Clearly, break-even prices decrease as calf crop and weaning weight increase. This is true under any annual operating cost per cow.

Management Practices To Improve Production

The challenge for cow-calf producers is to use management techniques that stimulate production without drastically increasing operating costs. You can improve weaning weight through a number of methods, including:

- Internal parasite control.
- Using growth stimulants.
- Using sires with the genetic potential for increased growth.
- Providing adequate herd nutrition which also helps optimize reproduction.

Another effective and inexpensive way to improve reproduction is through annual pregnancy

Table 1. Production cost per pound of calf at $550 per cow operating cost.

Weaning weight (lb)	550	500	450	400	350
Calf crop (%) 100	550[1] $0.96[2]	500 $1.06	450 $1.17	400 $1.33	350 $1.51
90	495 $1.07	450 $1.17	405 $1.31	360 $1.47	315 $1.68
80	440 $1.20	400 $1.32	360 $1.47	320 $1.66	280 $1.89
70	385 $1.38	350 $1.51	315 $1.68	280 $1.89	245 $2.16
60	330 $1.61	300 $1.77	270 $1.96	240 $2.21	210 $2.52

[1]Top figures indicate pounds of calf produced per cow
[2]Bottom figures break-even price at a given production level

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Table 2. Break-even prices at various levels of production and annual costs of production.

Calf crop (%)	Weaning weight (lb)	Pounds of calf per cow	Annual costs per cow $250	$275	$300
90	500	450	$0.56[1]	$0.61	$0.67
80	450	360	$0.69	$0.76	$0.83
70	400	280	$0.89	$0.98	$1.07
60	375	225	$1.11	$1.22	$1.33

[1]Break-even prices per pound of calf, dollars.

testing and culling of subfertile cows. In addition, culling open cows (and sometimes even bred cows) during an extended drought, may be necessary in order to balance stocking rate with declining forage supplies. However, there may be unique years when a drought during the breeding season is followed by rain later in the year. If forage conditions improve significantly, so may chances for re-breeding. Under such circumstances, "low risk" cows (e.g., middle-aged cows that are physically sound and proven breeders) are sometimes kept over until the next breeding season and given a second opportunity. This is also an acceptable option if replacement costs are higher than the cost of retaining the open cow. Remember that open heifers and aged cows are "high risk." They should probably never be allowed a second breeding opportunity. Regardless of environmental considerations or replacement costs, any cow that is open more than once should be culled. If you follow this practice annually and your cows are under otherwise good management, pregnancy rates will increase. Table 3 shows that the increases in the pregnancy rate in Texas test herds were sustained at an acceptable level.

Visual observation is also important in culling decisions. Some pregnant cows should be culled on the basis of age. Other determining factors are conditions of the udder, feet, legs and teeth that make them poor breeding stock. The decision to cull an open cow may also depend on her reproductive history.

Table 3. Effects of annual pregnancy testing and culling of subfertile cows on subsequent herd fertility.

Herd	Percent pregnant by year 1	2	3	4	5
1	75	97	96	93	98
2	64	56	84	89	–
3	59	66	79	92	85
4	85	90	94	–	–
5	82	94	93	93	–
6	74	76	86	94	98
7	49	89	92	89	89

Sprott and Carpenter, 1994; Unpublished data.

Culling decisions may also depend on the animal's monetary value. You can retain highly valued registered females that fail to conceive until some or most of their initial cost is recovered. This strategy is prudent as long as these animals are free of abnormalities of the reproductive tract and have previously produced at an economically acceptable level.

Palpating To Determine Pregnancy

Pregnancy determination, or *palpation*, is made by inserting the arm into the rectum and feeling the reproductive tract for pregnancy indications.

Equipment

Little equipment is needed in palpation. The palpator should wear a protective plastic sleeve that covers the arm and hand up to the shoulder. The sleeve guards against disease and prevents irritation of the arm. Use an obstetrical lubricant or mineral oil to make entry into the rectum easier. Don't use soap or detergents as a lubricant, since both are irritants. Plastic sleeves may tear after several uses, reducing protection. If the sleeve tears, replace it before palpating the next animal.

The chute for holding the animal during palpation should allow her to stand in a normal position. It should have a front wall or gate and a bar just above the animal's hocks in the rear (Figure 1). This bar keeps the cow from kicking and protects the palpator. Include an entrance gate in the chute at the rear of the animal to allow the palpator to

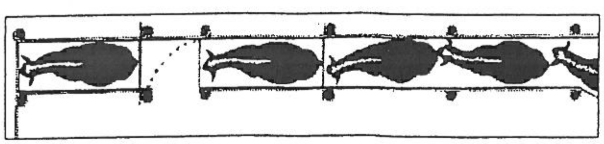

Figure 1. Chute arrangement for restraining cows.

enter and exit easily. Provide a gate to swing across the crowding chute and fasten it in front of other animals coming behind the palpator. You may use squeeze chutes, but do not need to catch the cow's head for this procedure.

Palpation alone takes only a few seconds. The speed of pregnancy determination depends on three factors: management of the cows as they come through the chutes, the stage of pregnancy and the palpator's experience. Ideally, an experienced palpator can examine several hundred head of cattle in a normal working day. However, the process is much slower if the palpator has to help bring the cattle into the chute or climb over the chute wall to get behind the animal to palpate her.

To ensure the safety of the animals and the palpator, you must practice certain precautions:

- Restrain the animal so she cannot jump over the side of the chute or kick the palpator.
- Prevent other cattle from coming up behind the palpator as he or she attempts to determine pregnancy.
- Replace broken boards in the chute that could injure the animal's legs and check for exposed nails.
- Place cleats across the floor if it is slick to help stabilize the animal's footing

These precautions make it much more likely that the cow will remain calm and stand quietly during palpation. In addition, the process becomes more efficient and safe for the cow and the palpator.

Reproductive Tract Structures

Thorough knowledge of the structures of the female reproductive system is essential for successful palpation. Only the reproductive tract and associated organs will be discussed here, but you should be aware that endocrine glands located in other parts of the body, particularly the brain, are also involved in the sexual cycle. Figure 2 is a general diagram of the reproductive tract.

The **vulva** is the external portion of the reproductive tract and can be seen as two prominent lips. Its size may vary with the animal's age and between breeds. Brahman-influenced females usually have a larger vulva than do cattle of English and European breeds.

Figure 2 (right to left) shows the next portion of the tract: the **vagina**. It serves as a receptacle for semen during natural mating, is a thin-walled structure and is not easily felt during palpation.

The **urinary bladder** (not shown in Figure 2) is underneath the vagina. It may extend beyond the pelvic brim and slightly into the body cavity, particularly when it is full of urine. During urination, the bladder empties through a small opening (urethral orifice) on the floor of the vagina, eventually exiting the body through the vulva.

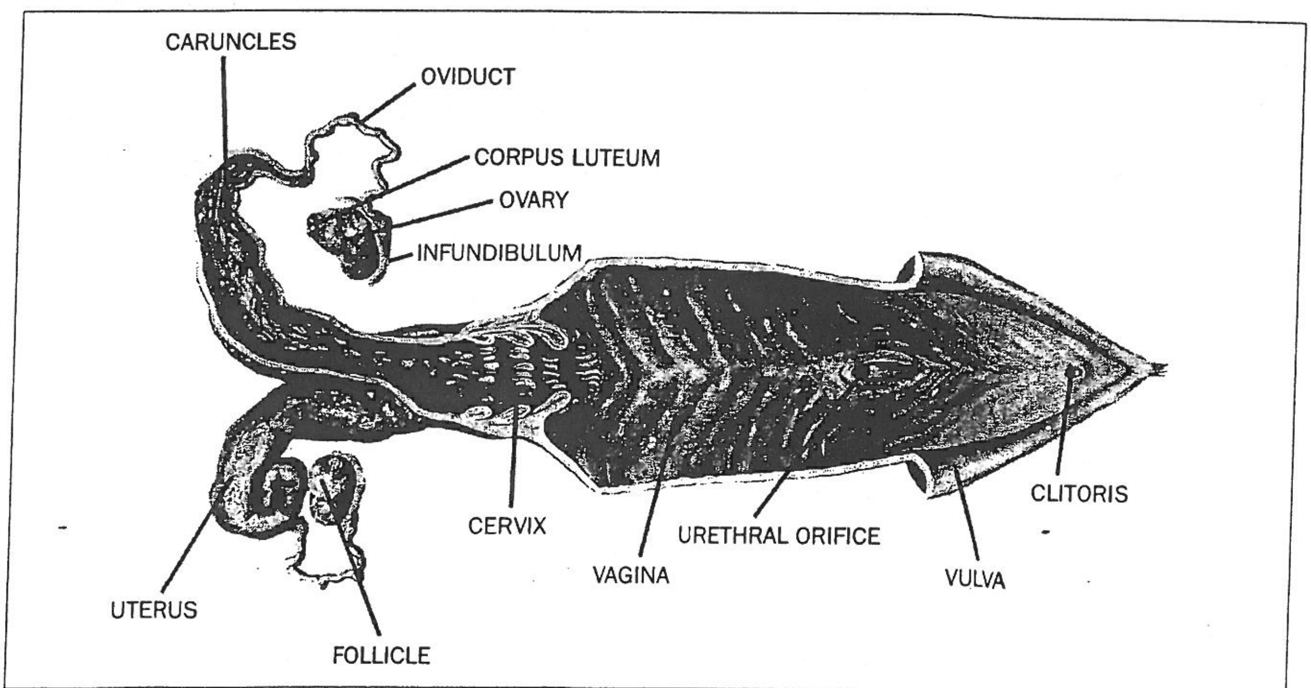

Figure 2. Anatomy of the reproductive tract.

The **cervix** is a thick-walled structure attached to the vagina. It is comprised of connective tissue, which feels much like gristle. Because of the thickness and firm feel, the cervix is a good landmark for orientation while you are palpating. The internal walls of the cervix are folded and protrude toward the exterior of the reproductive tract. These folds are sometimes called *cervical rings*. The surface of these rings is lined with special mucus-secreting cells. This mucus is often seen smeared on the rumps or flowing out of the vulva of cows in estrus. During pregnancy, the mucus is much thicker than at estrus and plugs the cervix. This protects the developing embryo from foreign debris in the vagina. The cervix may also act as a sperm sieve, trapping some abnormal sperm cells and allowing normal sperm cells to travel into the uterus and oviducts.

The **uterus** is Y-shaped with a right and left horn. The horns share a connecting region known as the body. During artificial insemination, semen is deposited in the uterine body. The walls of the uterus are lined with special glands that secrete *uterine milk*, the substance that nourishes an early embryo. By approximately 16 to 18 days of gestation, the placental membranes are well developed and extend into both horns of the uterus. About 38 days into gestation, these membranes begin attaching to the uterine wall at special, raised areas known as *caruncles*. Located throughout the uterus, these are the exchange points for nutrients coming from the dam. The placental side of these attachment points are called *cotyledons*. The cotyledon with the caruncle is forms a combination known as a placentome, or *button*. In mid- and later gestation, these buttons become firm and are easy to detect when you are palpating the uterine surface.

The end of each uterine horn is attached to an **oviduct**, also known as a fallopian tube. The oviducts are small, tube-like structures. Because they are very small, they are difficult to feel. They transport sperm cells to the site of fertilization (the upper third of the oviduct) and an embryo back to the uterus if conception occurs. At the end of each oviduct is a thin, cup-like membrane that is difficult to feel: the infundibulum. It catches the egg, or *ovum*, as it is expelled from an ovarian follicle during ovulation, and transports the egg into the oviduct for eventual fertilization. That is why each ovary is located close to the infundibulum.

The entire reproductive tract is attached to a thin suspensory membrane known as the **broad ligament**. This elastic-like ligament will stretch and move within the pelvic and body cavities to allow the reproductive tract to move. This movement is necessary because of the weight of the fetus and the crowding of the tract by other internal organs. The broad ligament acts as a cradle for the tract and is attached to the upper pelvic and body cavities. It also contains arteries and veins that supply the tract with blood to nourish the tissues.

Figure 3 shows an interior view of the reproductive tract and broad ligaments of an open (non-pregnant) cow. Table 4 gives a general size description of the various parts of the tract in an open cow. The complete tract with all its parts varies in size and feel. This depends on the stage of the estrous cycle and on the breed, size, and reproductive history of the animal. Generally, the size of the entire open tract is 12 to 18 inches long. In young heifers that have just reached puberty, the tract may be only 8 inches long. The tract of mature cows that have had several calves may extend to 24 inches.

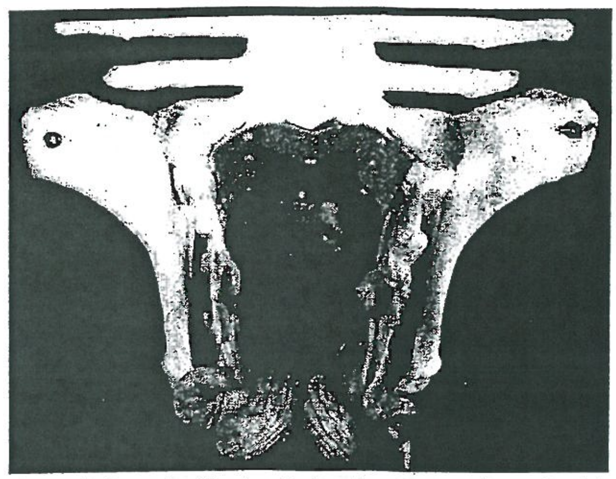

Figure 3. Reproductive tract of mature cow on floor of pelvis.

Changes Associated with Pregnancy

The sexual cycle of a normal cow is characterized by estrus, or heat, periods that occur at 21-day intervals. Figure 4 diagrams the estrous cycle and some of its activities.

At estrus, the cow is influenced by estrogen being produced by follicles on the ovaries. This hormone causes her to display estrus. Within 24 hours after the initial stages of estrus, one of the follicles ruptures and releases a single ovum, or egg. This is *ovulation*. The egg moves into the infundibulum and eventually down into the oviduct. The cavity on the

Organ	Size	Shape	Remarks
Vagina*	Varies with position of tract	Thin-walled, hollow tube.	Difficult to feel during palpation.
Cervix	2 to 12 inches long. ¾ to 8 inches in diameter. Average diameter 1½ inches.	Tube-like and thick-walled.	Cervix is tube-shaped, but may be funnel-shaped in some cows or bent and crooked. Firm, gristle-like feel. Good landmark.
Uterine Body	Interior: ¼ to ¾ inch long. Exterior: 1 to 3 inches long.	Intersecting region of the two horns.	Feels like soft, flat muscle. Not as firm as the cervix.
Uterine Horns	5 to 12 inches long, ½ to 1½ inches in diameter.	Tube-like and sometimes coiled. See Figures 4 and 7.	Feels meaty and soft to slightly firm, depending on stage of the estrous cycle.
Oviducts*	1⁄16 to ⅛ inch in diameter	Long, crooked tube.	Difficult to feel because of the small diameter and soft texture.
Ovaries*	½ in wide, ¾ inch thick, 1 inch long.	Rounded or elliptical shape.	Feels firm and distinct as if you were holding a grape or plum.

Table 4. Size characteristics of reproductive organs in an open (non-pregnant) cow.

*It is not necessary to feel the vagina, oviducts and ovaries when palpating for pregnancy.

ovary left by the ruptured follicle develops into a new structure known as a corpus luteum (Figure 2). The corpus luteum produces *progesterone*, the hormone responsible for maintaining pregnancy. If conception does not occur with this ovulation, the uterus releases a hormone called *prostaglandin*. It regresses, or destroys, the corpus luteum.

Regression is complete by approximately 16 to 17 days into the cycle. Meanwhile, follicles continue to grow on the ovary. Since the corpus luteum has regressed and is no longer producing progesterone, a new ovulatory follicle is recruited. Within 4 to 5 days, the cow returns to estrus. The process of development and regression of a normal corpus luteum causes a cow to have her characteristic 21-day sexual cycle.

If the cow is mated during estrus, the sperm cells will travel from the site of deposition (the vagina) to the site of fertilization (upper third of the oviduct) within minutes. While there, the sperm cells undergo a 6- to 8-hour maturation period called *capacitation*. Only then can the sperm cells fertilize an egg. Consequently, when the egg arrives at the fertilization site, the sperm cells are already there and probably have undergone capacitation. The chances of fertilization and pregnancy average about 50 to 70 percent.

When fertilization occurs, the cow's physiological cycle begins a dramatic change. This leads to the development of a full-term fetus. About 8 days after fertilization, the embryo is transported to the uterus. At 16 to 17 days after fertilization, the embryo and its placental membranes begin to release a hormonal signal that prevents the usual release of prostaglandin from the uterus. As a result, the corpus luteum does not regress and continues to release progesterone to maintain the pregnancy. The embryo houses itself in the uterine horn nearest the ovary that produced the ovulating follicle. Therefore, an embryo found in the right horn came from an egg produced by the right ovary, and vice versa. For this reason, particularly in cows that are open or may be in the early period of gestation, you must palpate both uterine horns.

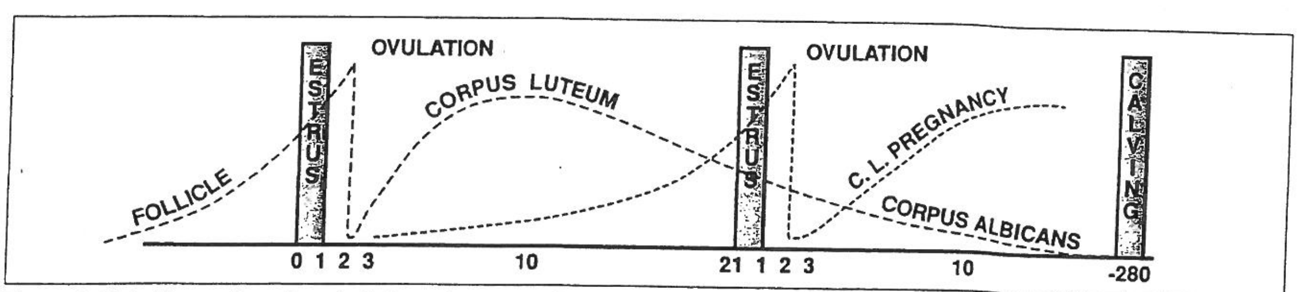

Figure 4. Note the cycle pattern is followed at approximately 21-day intervals.

The major changes in the structure of the reproductive tract after conception occur mainly in the uterus. Its shape, size, texture or feel, and location will change. Also, the embryo will grow, and its growth is directly responsible for changes noted in the uterus. Figure 5 shows embryo or fetal growth by month and stage of gestation.

Developmental Stages

There are three main periods of development in a young calf's life. The period of the ovum is that time from fertilization until the egg has divided enough times to take on a particular form. This occurs on approximately the thirtieth day when there is an enfolding of the layers of the developing egg. At this stage the newly developing animal is called an embryo. The period of the embryo lasts until the fetal membranes begin to attach to the lining of the uterus which takes approximately 38 days. During the embryonic stage, various organs and systems are laid down. These include the respiratory, nervous, digestive, circulatory and reproductive systems. As the embryo develops, it floats freely in uterine milk in the uterine cavity.

The fetus period begins when the embryo is approximately 38 days old and ends when the newborn is expelled at *parturition*, or birth (Figure 5). During the fetus stage, continued attachment takes place at the numerous caruncles lining the uterus. These attachments provide transfer of nutrients and waste materials for the developing fetus. Birth occurs approximately 280 days after fertilization.

Palpation Technique

You may use either hand in palpation. With one hand, you may grasp the cow's tail as a handle while you palpate with the other. The hand used for palpation should be well lubricated and shaped into a wedge by bringing the fingers together as closely as possible.

Rectum

Push through the anus into the rectum with one continuous thrust. As your hand enters the rectum, fold your fingers into a modified fist by tucking under the fingertips (Figure 6).

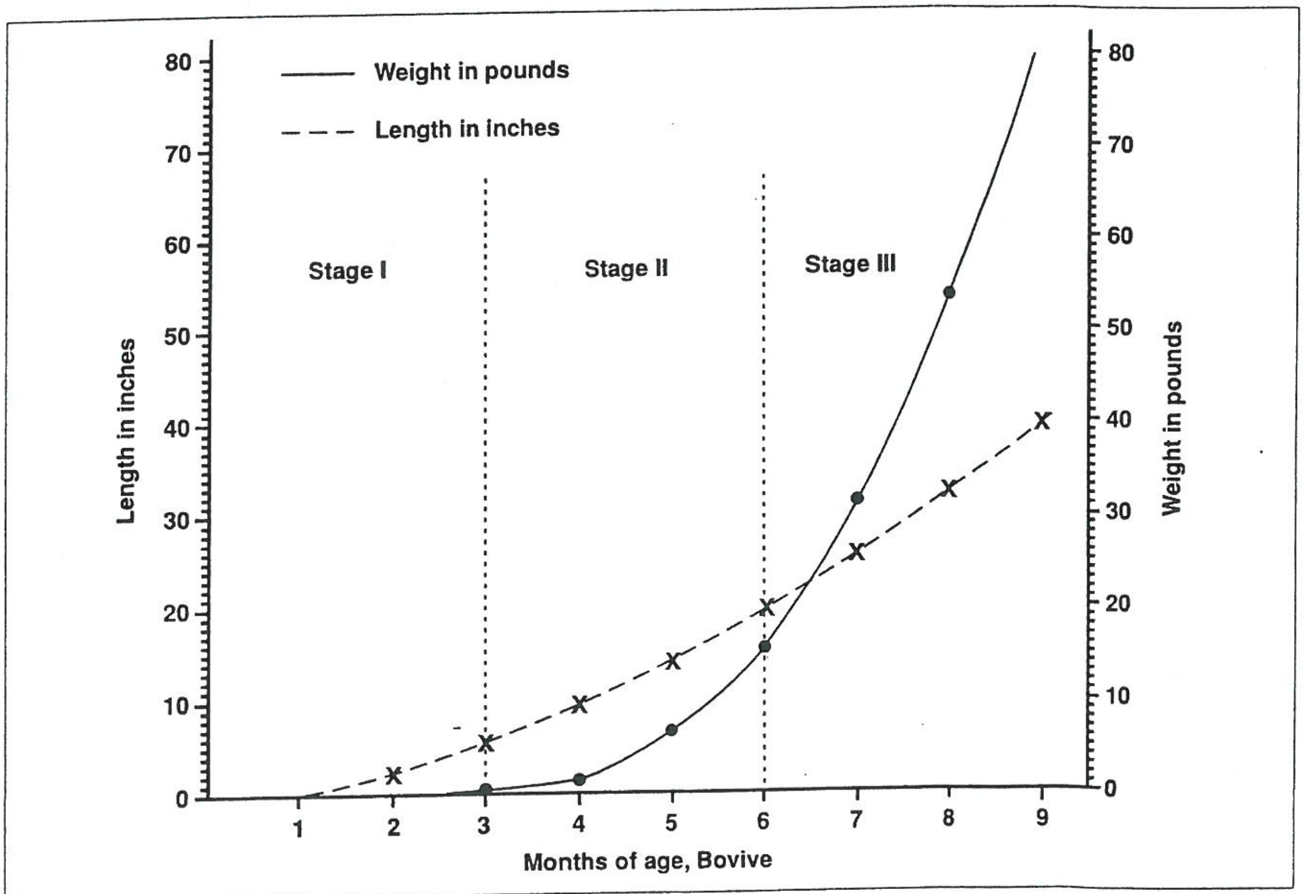

Figure 5. Growth of fetus. Parturition occurs approximately 280 days after fertilization.

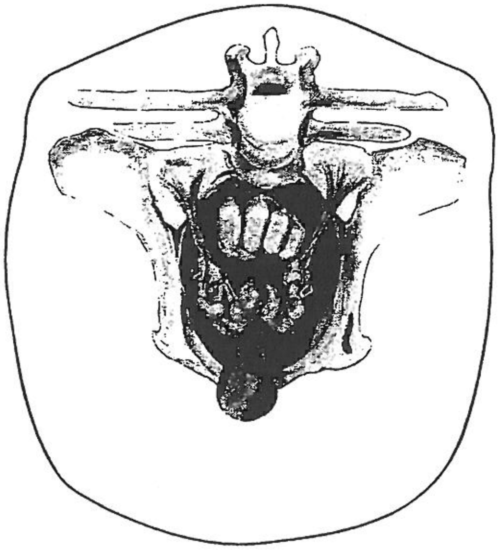

Figure 6. Reproductive system of young cow viewed from inside of animal. Note hand's position (fingers folded into a modified fist) inside rectum directly above uterine horns.

In this position, your hand will push the fecal material aside and straighten the rectum. Folds in the rectum do not straighten as easily if the fingers are pointed. The modified fist also eliminates the risk of puncturing the rectal wall with sharper, pointed fingers. However, puncturing is rare, as the rectum is thick-walled and resistant. Cleaning the cow's rectum of fecal material usually is unnecessary. However, in early stages of learning, cleaning the rectum will help you feel other structures more easily.

Rectal straining may result from the entry of your hand. This is a reflex response by the cow. Straining can be alleviated by simply moving your hand back and forth in a gentle massaging motion. If straining reoccurs, massage the rectal wall again.

Usually, the longer the examination, the more rectal straining you will encounter. Do not be upset by a small amount of bleeding, as this occurs occasionally and is not necessarily a sign of damage to the rectum. An indication of rectal damage is a sandpaper or gritty feeling, which means that the mucosa lining of the rectum has been rubbed off during palpation. If this occurs, it is best to stop palpating immediately.

Feeling through the rectal wall is similar to feeling through one or two layers of thin rubber. Most cattle are cooperative, so you should be able to detect and pick up the reproductive organs easily.

Experienced palpators usually learn to follow a consistent routine. When first entering the rectum, thrust the arm beyond the elbow and deep into the abdominal cavity. Feel in a downward direction toward the udder. Since late-term fetuses will be located here, initial deep entry allows palpators to determine pregnancy quickly and reduces time spent in the cow. If a fetus or other indications of pregnancy are not found in the abdominal cavity, palpators should move back toward the pelvic cavity. Most open tracts and early pregnancies will be located here. While feeling in or near the pelvic cavity, locate the pelvic brim. This is a good landmark for orientation. Most importantly, find the cervix and move forward to the uterus to determine pregnancy. Following this simple routine will help reduce palpating errors.

Paunch

Upon entry into the rectum and just past the pelvic brim, palpators may encounter the paunch, or rumen. It is the first and largest of the cow's four stomachs (Figure 7). It has a dorsal (upper) and ventral (lower) sac. The dorsal sac is forward and to the left of the pelvic brim. It may feel like the end of a football and be mushy or gritty. This protruding end of the dorsal sac may even extend into the pelvic cavity. In such cases you might mistake it for an enlarged uterus or late-term fetus. By mashing the paunch, you will notice an indentation which gradually smooths back to its original shape. This

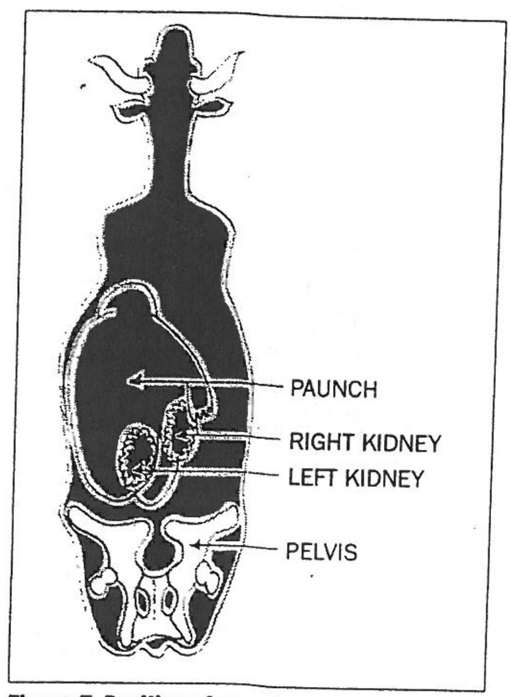

Figure 7. Position of paunch and kidneys.

indicates that the paunch is full of feed. The paunch does not have the watery feel like a pregnant uterus.

The ventral sac of the paunch is deep into the body cavity and located toward the udder region. This sac lies either to the right or to the left side of the body, depending on your gut fill. It has the same mushy or gritty feel as the dorsal sac and will indent if mashed with the hand.

Reproductive Tract

The open reproductive tract normally lies on the pelvic floor or against either pelvic wall. The horns of this tract are usually coiled on their front edge and may hang slightly into the abdominal cavity (Figure 8) in older cows. Two characteristics confirm the absence of a pregnancy: (1) when palpated, both uterine horns in the open cow will feel thick-walled and have a meaty texture; and (2) fluid will not be in the horns. At this stage you can hold the entire uterus in your hand and palpate it from underneath or from the side. However, when learning to palpate, it may be easier for you to feel the top surface (Figures 8 and 9).

Tone, or firmness, of the open horns varies with the estrous cycle. Shortly before and after estrus (under *estrogen influence*), the uterus will feel turgid or firm. During the period of the corpus luteum (*progesterone influence*), the uterine horns will feel flaccid or soft. Slight pressure with the middle finger (Figure 9) will separate the horns, allowing you to palpate each horn. Both horns must be felt, since a pregnancy may occur in either. Inexperienced palpators sometimes have difficulty grasping the uterine horns. To overcome this problem, move the uterus down against the pelvic floor or to either pelvic wall. Flatten your hand and apply gentle pressure against the uterus to separate the horns.

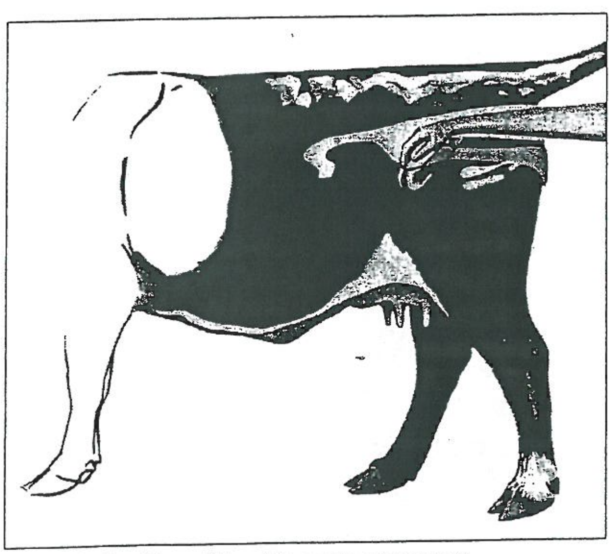

Figure 8. Position of hand in early pregnancy.

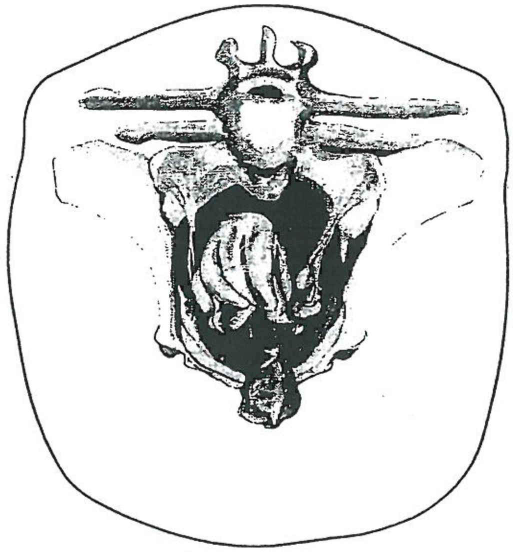

Figure 9. Separation of uterus horns.

The ovaries are in the broad ligament toward the end of the uterine horns or at their sides. However, it is not necessary to palpate the ovaries when determining pregnancy. The most important step is to feel the uterus for its texture and content.

Determining Stage of Pregnancy

Stage I: 30- to 35-day pregnancy

Because embryos at this early stage are delicate, beginning palpators should not try to feel them. An experienced palpator, however, can detect pregnancy as early as 30 days after breeding. Palpation which at this early stage should be accompanied by good breeding herd records. These records help the palpator know the approximate breeding date of the animal.

In the early stage of pregnancy, the uterus is filled with a small amount of fluid and will feel slightly thin-walled. One horn is enlarged a little more than the other. At this stage you can determine the presence of the embryonic vesicle by carefully running the horn between your fingers in a milking action. You can feel the vesicle slide through your fingers.

At this stage the embryo is only about ½ inch long. The vesicle surrounding it is about ¾ inch in diameter and filled with fluid—like a balloon filled tightly with water. However, the borders of this vesicle are indistinct. What you actually feel is something slightly smaller than a marble as it slides through your fingers. The uterus, in much the same location as a non-pregnant uterus, has not been displaced because of size or weight at this time. The outer embryonic vesicle, which occupies both horns, is rather thin with little fluid. It may be 18 to 24 inches long. By pinching the horn of the uterus carefully, you can feel the membranes of this vesicle as they slip between your fingers.

Stage I: 45-day pregnancy

Most palpators prefer that bulls be separated from cows at least 45 days before pregnancy determination. At 45 days, the horn of the uterus containing the fetus is somewhat enlarged and thinner-walled compared to the other. The fetus at this stage is about 1 inch long. The vesicle around it is egg-shaped and measures about 1 to 1½ inches long. You can feel the outer membrane, which contains fluid, through the uterine wall. The attachment of the membranes to the uterus has just taken place at about 38 to 40 days. Therefore, avoid moving the fetus about in the uterus. The caruncles on the uterus join the cotyledons, on the fetal membranes for nutrient exchange. These two structures form the placentome. Buttons cannot be felt by palpation until later in pregnancy

Slipping of the fetal membranes is a valuable aid to early pregnancy determination. Although the membranes can be slipped at any stage of gestation, it is easiest to perform and of the most value between 40 to 90 days of pregnancy. The procedure involves picking up and gently pinching together the walls of either uterine horn. The palpator feels the fetal membranes as they slip between the thumb and fingers. Be gentle when using this technique, since the embryo and membranes are rather delicate in pregnancies under 45 days.

Stage I: 60-day pregnancy

The uterus, which will have enlarged considerably by this time, is filled with fluid and increased growth of the fetus (Figure 10). The fetus now is about 2½ inches long and may have displaced itself into the abdominal cavity, indicating that the uterus has stretched. The cervix may be pulled over the pelvic brim; but the cervix, body and horns of the uterus are within reach. In larger animals, this is a difficult stage for pregnancy determination. This is due to displacement and the distance from the anus to the developing fetus.

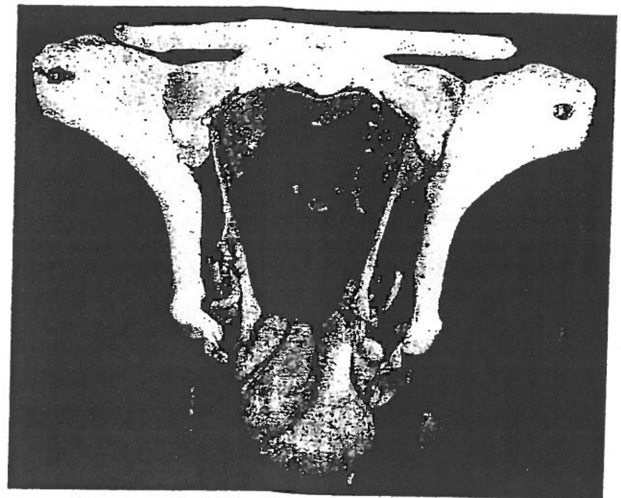

Figure 10. 60-day pregnancy. Uterus may hang over pelvic brim.

The uterine walls have thinned considerably. The best method of feeling the fetus is to bobble it with your hand so that, if you gently tap the uterus, the fetus swings like a pendulum and hits against the wall of the uterus and vesicle. The cervix remains on top of the pelvic cradle, and the uterine horns move toward—and possibly beyond—the brim.

Stage I: 90-day pregnancy

The fetus now is about 6 inches long and may have displaced itself into the abdominal cavity, indicating that the uterus has stretched (Figure 12). The cervix may be pulled over the pelvic brim; but the cervix, body and horns of the uterus are within reach. In larger animals, this is a difficult stage for pregnancy determination. This is due to displacement and the distance from the anus to the developing fetus.

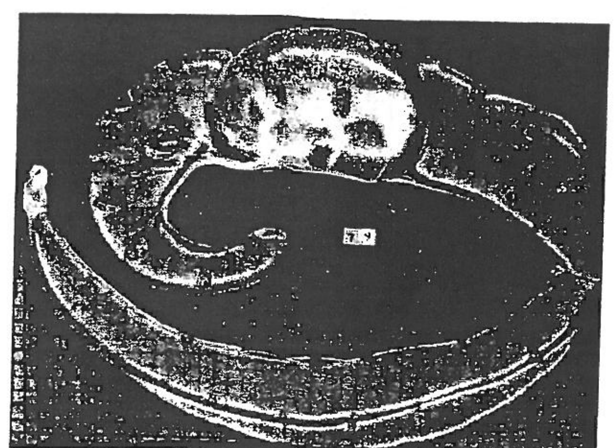

Figure 11. Grid scale of ½ inch showing 79-day fetus with surrounding membranes filled tightly with fluid.

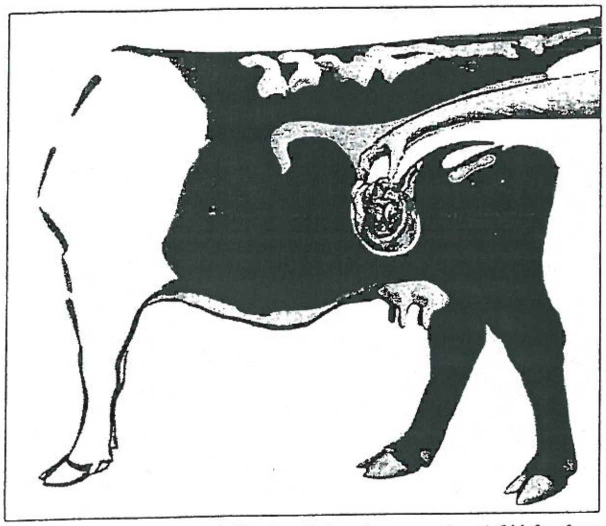

Figure 12. Position of 90-day fetus is now about 6½ inches long. It has displaced itself over pelvic brim and down into abdominal cavity.

You may have to consider factors other than the presence of the fetus at this stage. Consider displacement of the uterus as a possible indication of pregnancy. Another indication of pregnancy is enlargement of the uterine arteries with their characteristic pulsation. These arteries (one for each uterine horn) are in the forward fold of the broad ligament (Figure 13), which supports the uterus. In a three-month pregnancy, the artery supplying blood to the pregnant uterine horn is about ⅛ to 3/16 inch in diameter. The artery feeding the non-pregnant horn is only half that size. When you grasp the artery, you can easily feel the pulse of the heartbeat as blood is carried into the uterus to nourish the developing fetus. Do not confuse the uterine artery with the femoral artery lying on the inside of the thigh which supplies the hind legs. The femoral artery is in the muscle, but may be palpated. Remember that the uterine artery is in the broad ligament and can be moved 4 to 6 inches, while the femoral cannot.

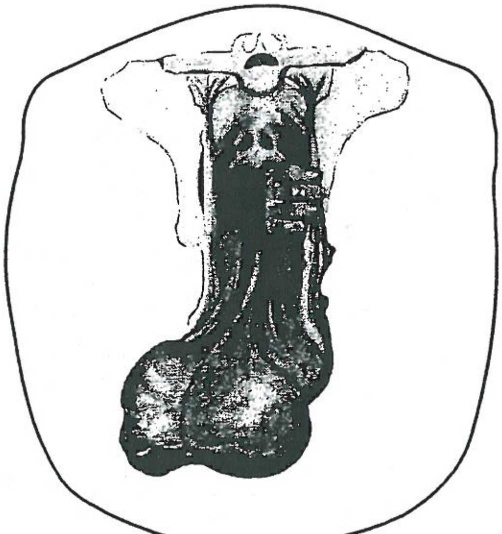

Figure 13. Tract lying on floor of abdominal cavity with palpation of uterine artery at 4-month pregnancy stage.

If you are unable to reach the fetus, the best indication of pregnancy is the presence of buttons, which are now large enough to palpate. In a 3-month pregnancy, they are flattened and egg-shaped and measure ¾ inch to 1 inch across. At this stage they are still rather soft to the touch, but they are firmer than the thin-walled uterus. The membranes still are filled tightly with fluid.

Stage II: 120 days until 6 months

At approximately 100 days, buttons become more apparent (1 to 1½ inches) and can usually be palpated. At this stage the fetus is still displaced similarly to the 90-day fetus. However, it has grown to approximately 10 to 12 inches long, with the head almost the size of a lemon. Often, the palpator can detect the head of the developing fetus before any other body part.

As the fetus enlarges and grows (now 4 to 6 months), its sheer weight displaces the entire reproductive tract deeper into the body cavity. This requires palpation deep in the body cavity (Figure 14). All other characteristics have also changed. The buttons are more noticeable, since they have developed to about 2 to 2½ inches in length and have a much firmer feel. The pulsating uterine artery may be palpated (Figure 13) and is now about the size of your little finger.

Stage III: 7 months until 9 months

At 6 to 7 months, the fetus may or may not be deep in the body cavity (Figure 14). Remember to reach deep and toward the stomach floor.

By 7 to 9 months, the fetus has grown to where it is often easy to palpate without reaching deeply. You can often feel the large bony structures (e.g., head, legs and back). You may feel fetal movement. Occasionally in large bodied cows, the fetus may still be completely out of reach. To help confirm pregnancy, look for well developed buttons or weight on the displaced cervix. You can also check the uterine arteries, which are now about the size of your thumb. The main change until parturition will be in size, as the fetus grows rapidly and uses more of the abdominal cavity. Table 5 summarizes outstanding identifying characteristics.

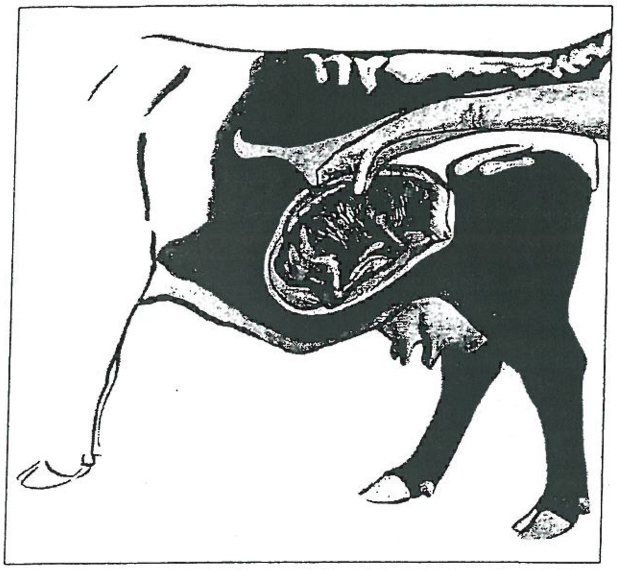

Figure 14. Enlarged calf now fills abdominal cavity at 5- to 6-month pregnancy stage.

A Word of Caution

One word of caution is necessary to help avoid errors in determining pregnancy. The position of the reproductive tract, in and of itself, is not a reliable way to determine pregnancy. Many 90-day (and shorter) pregnancies may be located entirely in the pelvic cavity and not be displaced beyond the pelvic brim. On the other hand, pregnancies beyond 90 days are big enough that they most often are displaced beyond the pelvic brim. Conversely, some open tracts are not always located entirely within the pelvic cavity. In large-frame, fat cows, the open uteri may fall beyond the pelvic brim. In all cases, the tract must be adequately traced to correctly determine pregnancy status. Simply stated, the location of the tract should be used as a roadmap to lead the hand to the uterus, whether it is displaced beyond the pelvic brim or not.

Table 5. Fetal size and characteristics used in determining pregnancy.

Stage	Days of gestation	Fetal size		Identifying characteristics
		Weight	Length (inches)	
I	30	1/100 oz.	2/5	One uterine horn slightly enlarged and thin; embryonic vesicle size of small marble. Uterus in approximate position of nonpregnant uterus. Fetal membranes may be slipped between fingers from 30-90 days.
	45	1/8 – 1/4 oz.	1 – 1¼	Uterine horn somewhat enlarged, thinner-walled and prominent. Embryonic vesicle size of small egg.
	60	¼ – ½ oz.	2½	Uterine horn 2½ to 3½ in diameter; fluid filled. Fetus size of mouse.
	90	3 – 6 oz.	5 – 6	Both uterine horns swollen (4" to 5" in diameter). Fetus is size of rat. Uterine artery 1/8 to 3/16" in diameter. Cotyledons ¾" to 1" across, but very soft.
II	120	1 – 2 lb.	10 – 12	Similar to 90-day fetus more easily palpated. Fetus is size of small cat with head the size of a lemon. Uterine artery ¼" in diameter. Cotyledons more noticeable and 1½" in length. Horns are 5" to 7" in diameter.
	150	5 – 8 lb.	12 – 16	Difficult to palpate fetus. Uterine horns are deep in body cavity with fetus size of large cat—horns 6" to 8" in diameter. Uterine artery ¼" to 3/8" in diameter. Cotyledons 2" to 2½" in diameter.
III	180	10 – 16 lb.	20 – 24	Horns with fetus still out of reach. Fetus size of small dog. Uterine artery d" to d" in diameter. Cotyledons more enlarged. From sixth month until calving a movement of fetus may be elicited by grasping feet, legs or nose.
	210 240 270	20 – 30 lb. 40 – 60 lb. 60 – 100 lb.	24 – 32 28 – 36 28 – 38	From 7 months until parturition, fetus may be felt. Age is largely determined by increase in fetal size. The uterine artery continues to increase in size—210 days, ½" in diameter; 240 days, ½" to 5/8" in diameter; 270 days, ½" to ¾" in diameter.

Other Factors

The paunch. Remember that the paunch (Figure 6) is often encountered when entering the rectum and feeling beyond the pelvic brim and toward the left or very low in the body cavity. The shape of the dorsal and ventral sacs may be mistaken for the head or rear quarters of a calf. The difference can be determined by mashing on these large objects. The paunch will indent when mashed, while a well developed calf may move away from the pressure of your touch. Also at these late stages of pregnancy, you can easily distinguish fetal features (e.g., ribs, hooves and ears) when you touch them.

Kidneys. The kidneys (Figure 6) are suspended directly under the spinal column at about a 30-degree downward angle. Because the left kidney in cattle is more toward the rear of the animal than the right one, it is often touched during palpation. The left kidney is elliptically shaped and is sometimes mistaken for a calf's nose. Practice helps you to distinguish the difference, but inexperienced palpators can avoid the left kidney by feeling at a steeper angle into the abdominal cavity. It is usually at this steep angle that large fetuses are located.

Buttons. Buttons may be mistaken for ovaries or vice versa. Buttons do not have the solid feel of an ovary but are rather soft. The best comparison is that they feel like dried apricots soaked in water. The ovaries are more rounded and egg-shaped with a firm feel. Only two are present.

Pyometra. In this condition, the uterus is filled with white blood cells attempting to clear up disease organisms. The uterus may be fluid to the touch or may be somewhat solidified, feeling rather plastic. This stage may be confused with early pregnancy stages if the uterus is in a fluid condition and only partly filled. In the latter stages of pyometra, the uterus becomes rather firm.

Large uteri. In older cows that have had many calves, the uterus may not return to its normal size, as it will in a younger cow. The enlarged uterus may be displaced over the brim of the pelvis as in a 3 to 4 month pregnancy. In the open cow, careful manipulation of the uterus will allow you to determine that no fluid and no developing buttons are present. Relaxation of the broad ligament tends to cause a similar condition.

Bladder. A full urinary bladder may be interpreted as a pregnancy in the 60- to 75-day stages. The full bladder feels similar to the uterus filled with fluid. Careful tracing should allow you to determine if the structure is the bladder, where there is only one body. This will also help you determine if the structure is a pregnant horn of the uterus, where both horns can be palpated and traced back to the cervix.

Enlarged cervix. Some Brahman and Brahman crossbred cattle have an enlarged cervix that is firm and feels like a developing fetus in the latter stages. You can distinguish between the two by tracing the reproductive tract.

Breed differences. Because of their large size, certain Brahman crossbreeds, Santa Gertrudis, Charolais, Holstein and Brown Swiss cattle are more difficult to palpate in certain stages of pregnancy than the smaller European breeds. In the 3- to 4-month stages, the uterus may have dropped so deeply into the body cavity that it is almost impossible to palpate. In these cases, pass your hand under the cervix and lift the uterus to feel the fetus itself. By lifting the uterus and quickly moving your hand down into the body cavity, you can locate the fetus by gently bobbing the fluid and the fetus through the wall of the uterus.

Brahman and Charolais breeds appear to have more tissue inside than smaller breeds. More folds of the omentum seem to cover the intestines, making it slightly more difficult to pick up the uterus. Charolais cattle seem to have less flexibility in the rectum. It is commonly harder to feel deep in the body cavity in these cattle, and lateral movement is somewhat restricted. In Holstein cows, the anal sphincter may be tight. This limits the deep entry into the body cavity necessary to determine the stage of pregnancy. In these cases, proficiency at mid-uterine artery palpation may be necessary (Figure 13).

The uteri of Brahman or Brahman-influenced heifers vary considerably. It is not uncommon to find 1,000-pound heifers with uteri measuring only 4 to 6 inches in length compared to a normal uterus, which would be 10 to 12 inches.

Highly finished cattle may be filled with fat which interferes with movement and feel. These cattle may be difficult to palpate. If you are uncertain, repalpate at a later date.

Systematic Determination

Once you understand the variations in location and size of the reproductive organs, your ability to determine pregnancy accurately depends upon a careful and logical check of the various reproductive and fetal structures. Using a systematic approach to checking each cow will ensure that you determine critical changes and variations in the location, size and feel of the reproductive organs. A systematic approach not only helps assure accuracy, but saves the palpator a lot of work. Figure 15 shows a systematic approach to determining pregnancy. While the system can be modified, it has proven to be a very functional approach for beginning and experienced palpators.

Figure 16 provides an outline of the important and critical factors that must be carefully checked and considered in determining the stage of pregnancy. If your pregnancy determination is to be accurate, you must consider all factors. The outline is basically an arbitrary division of pregnancy based upon the location of their reproductive organs and/or fetus. It is included to summarize the more important factors that indicate whether the cow is open or pregnant. Beginners should study carefully the outline and be familiar with the changes and variations that occur in each stage of pregnancy.

Even after following a systematic approach to palpation, some beginners will be unable to confirm pregnancy status on some cows. If this happens to you, simply wait 30 days and check these few again. If they are pregnant, their uteri will have grown which makes it easier to confirm their status. Never speculate on their status, as incorrect guesses can be costly.

Occasionally, cattle producers want an anticipated calving date (or known date of conception) from pregnancy records. The best way to determine it is by palpating in the early stages of pregnancy (90 to 100 days or less). These pregnancies are usually within the palpator's reach and are small enough to be sized. This allows a close estimate of anticipated calving date. In late pregnancies (120 days or more), fetal size can vary greatly among cows that actually conceived on or about the same day. Consequently, determining anticipated calving date (or day of conception) from records taken in late pregnancy is difficult and often inaccurate.

Recommendations

Practice! Experience is the key to palpation. In many instances, the ranch manager should not be the one to palpate but should supervise the operation and critically observe the cows. Unhealthy, unsound and undesirable types should be eliminated, as should open cows.

Shorten the calving interval by reducing the time during the breeding season when the bulls are with the cows. Cows that settle first are most adapted to reproduction. Wait about 90 days after the bulls are removed before you palpate. Most cows should conceive at the beginning of the season, and only a few will be short-term pregnancies. Cull as critically as is feasible for your operation. If every open, unsound cow can be removed, cull immediately.

Remember, palpation is an art and a skill. It pays dividends to the person who uses it wisely.

Other Methods for Determining Pregnancy in Cattle

Ultrasound

Trans-rectal ultrasonography has many uses for reproductive diagnostics in cattle, including pregnancy determination. However, using it as a method for routine pregnancy determination on animals in late stage I or in stages II or III of gestation is often not cost-effective. This is due to the high cost of ultra sound equipment and/or ultrasound service. Still, there are situations where ultrasound might be the best way to examine the uterus and/or conceptus. These might include early pregnancy determination, fetal sexing, or determining the number and/or viability of the conceptuses.

When performing a trans-rectal ultrasound examination, a trained person places a transducer probe in the rectum of the cow. Using the same hand to manipulate the probe and the uterus, the transducer sends and receives sound waves that have been directed along the uterine horns. Since tissues and/or fluid will reflect or absorb sound waves differently, those sound waves are transduced into an electronic image. This is then viewed on a special monitor. Skill is needed to maniuplate the probe and to interpret the image produced on the monitor (Figure 17). Pregnancy may be detected as early as 26-28 days, but examinations will be more accurate if they are preformed after 30 days.

Blood Test for Pregnancy Specific Protein B

A new method to determine pregnancy became commercially available in 2004. Called the *Bio-PRYN® test*, it utilizes a laboratory procedure to test tail- or jugular-bled animals for pregnancy (Figure 18). It is essentially a "yes/no" test and is highly accurate: more than 99 percent on pregnant cows and about 95 percent on open cows. Blood collec-

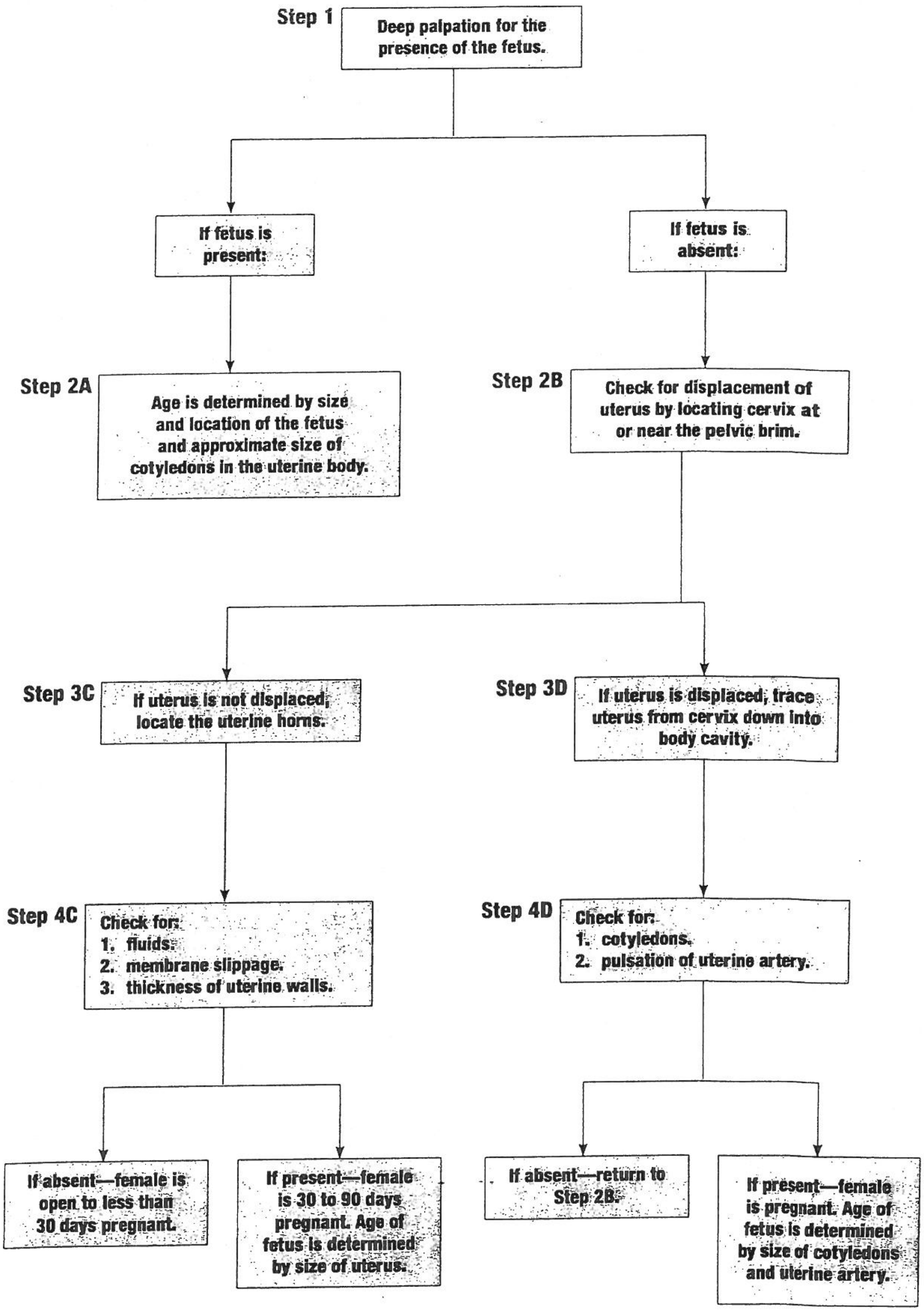

Figure 15. A systematic approach to pregnancy determination in the cow.

tions are shipped by commercial carrier to a laboratory. Results are available by fax or e-mail within 27 hours after arrival at the lab. Cost of the test is $2.25 per sample plus purchase of blood collection equipment and shipping.

BioPRYN® stands for *pregnant ruminant yes/no*, as it has application in many species of domestic and wild ruminant animals. The test uses an enzyme-linked immunosorbent assay (ELISA) that detects the presence of a protein known as *pregnancy specific protein B (PSPB)* in the blood of the mother. PSPB is produced by cells in the embryonic trophoblast or fetal placenta where it enters the into the mother's blood from the uterine caruncles. PSPB can be accurately detected as early as 30 days post-conception. (Cows and heifers, for example, can be tested as early as 30 days after breeding.) However, there is a caveat. Cows that have calved will have residual PSPB in their blood. Therefore, to allow for clearance time, it is recom-

Open cows

In females that are nonpregnant or open, the entire reproductive tract is usually located within the pelvic cavity; however, in older cows and large-frame cows, the cervix and uterine horns may be distended over the pelvic brim into the body cavity.

Determining Factors:

1. No fluids in uterus.
2. No membranes present upon slippage.
3. Thick uterine wall with meaty texture.
4. Uterine tone
   a. firm – at or near estrus.
   b. flaccid – between estrous periods.

Stage I Pregnancy

Females in this stage vary from 40 days to 3 months of pregnancy. Cervix and uterine horns in pelvic cavity or perhaps moving over the pelvic brim into the body cavity as Stage I advances.

Determining Factors:

1. Fluids in uterus and somewhat enlarged.
2. Presence of membranes upon slippage.
3. Thin uterine walls.
4. Buttons indistinct to touch.

Stage II Pregnancy

Determining Factors:

1. Displacement of uterus.
2. Presence of buttons.
3. Pulsation of middle artery.

(Any two factors are considered sufficient evidence.)

Stage III Pregnancy

Females in this stage vary from 5½ months pregnant to term. Cervix at or near pelvic brim. Developing calf has achieved sufficient size to be reached. Palpation of the calf becomes progressively easier as Stage III advances.

Determining Factors:

1. Displacement of uterus.
2. Palpation of large fetus.
3. Presence of buttons.

Figure 16. Factors that must be considered in determining pregnancy at different stages of gestation.

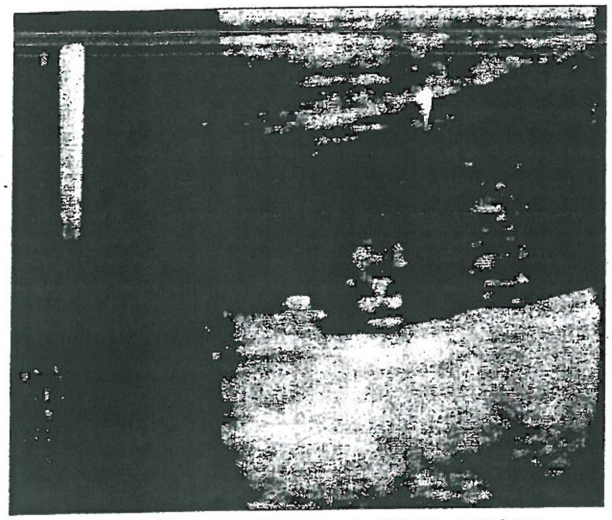

Figure 17. An ultrasound image of a 37-day-old fetus.

mended not to test lactating cows until at least 90 days after calving. When individual calving and/ or AI records are available (e.g., dairy), individual lactating cows, could be tested as early as 90 days post-calving, assuming that breeding records also showed at least 30 or more days since breeding. With cows that are managed by pasture or herd (e.g., beef cows), the earliest that testing could be done would be 90 days after the end of the calving season. For example, a herd with a 90-day calving season would have a 90-day breeding season following that. Therefore, the earliest that testing could be done would be 30 days after the end of the breeding season. Testing can also be done anytime up until the end gestation.

Figure 18. Bleeding by tail venipuncture.

Cows are reported as open or pregnant based on the optical density of blood samples as measured by calibrated laboratory equipment. Although BioPRYN® is a "yes/no" test, some estimation of length of gestation can be made based on the relative magnitude of optical densities between samples. That is, animals in late gestation will have a relatively higher optical density score compared to animals that are in early gestation. Sometimes a cow will be reported as "open-repeat" or "pregnant-repeat." This indicates that the age of the embryo may be just less than 30 days or that it has died leaving some residual PSPB. It is recommended to bleed and test these animals again after a 5-day or more waiting period to allow for either embryo growth or clearance of residual early embryonic PSPB.

When comparing BioPRYN® to rectal palpation or ultrasound, note that the results of the BioPRYN® test are not immediately available, so any keep or cull decisions would be postponed until receipt of the lab report. In addition, cattle must be individually identified to allow for culling or other management once the results of the BioPRYN® test are known. With the other two methods, neither individual ID nor the need to re-work cattle is required. Also, a skilled person can determine the stage of pregnancy (e.g., I, II or III) with either rectal palpation or ultrasound. This type of information may be useful for culling and marketing decisions, or in determining if conception may have occurred (unintentionally) after the end of a breeding season.

Specialized uses for the BioPRYN® test are that it can be used in artificial insemination programs to determine conception to estrous synchronized AI versus clean-up bulls. To do this, clean-up bulls are not placed with the herd until 16 days after the last AI breeding. Blood testing at 30 to 35 days after AI will detect AI pregnancies but not early pregnancies to bulls. All cows or heifers classified as "open" with the first test, are re-tested 30 or more days after the end of the bull breeding season. For more information, contact BioTracking LLC (*www.biotracking.com*).

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Disease Prevention in the Newborn Calf

The newborn of each species is provided protection in various ways to provide resistance to infectious diseases during the critical period of life. The offspring of man and monkey receive most of their protection with the passage of immunity through the placental membranes plus some through the first milk of nursing. Conversely, the newborn of the ruminant, pig or horse are protected by the colostrum only which is received during early life only.

Pre-Partum Protection in the Bovine

Blood consists of cellular elements (red and white blood cells) and the fluid portion that carries the cells. The fluid portion is known as plasma which is composed of proteins, one of which is designated as gamma globulin. Gamma globulins play an important role in protecting the animal or human from infectious disease.

Antibodies to infectious disease become attached to the gamma globulins which are then referred to as "immunoglobulin." The normal newborn calf has no immunoglobulin, hence, little protection to infectious disease.

During gestation the calf (fetus) has been protected by a barrier of placental membranes (afterbirth) which has served to prevent disease organisms from contacting the fetus and which also has provided a route of transportation for nutrients, oxygen, and waste gases. When the fetus is 5 to 6 months old it develops the ability to produce needed antibodies. This event seldom occurs because of the protected environment in which the fetus exists. If disease producing organisms do penetrate the placental barrier and the fetus becomes infected after 5 months gestation it will synthesize antibodies to the specific disease. If abortion does not occur the calf is born with immunoglobulins or resistance to the specific disease organisms that stimulated the immunoglobulin synthesis in the fetus.

Approximately six weeks before parturition there is an increase in immunoglobulins in the mammary gland secretions. The peak or optimum concentration is obtained approximately 2 weeks pre-partum. Each time the mammary gland secretions are removed by nursing or milking before or after parturition the immunoglobulin levels are rapidly decreased, hence, pre-partum milking to alleviate edema or leaking teats results in a mammary secretion low in immunoglobulins or disease protection for the newborn calf.

To obtain the maximum benefits of the immunoglobulin concentration at the time ofparturiti0!l the dam can be vaccinated for specific diseases that may be a problem in the newborn calf. These include diseases such as enterotoxemia and/or scours. Vaccinations should be done six to ten weeks pre-partum thus allowing three weeks for maximum immunity to be established and in time to be passed into the mammary secretions during the peak period of immunoglobulin concentration.

Immunoglobulins are synthesized in the immune system of the dam and transported by the blood to the mammary gland. At the time of parturition normal colostrum contains a greater concentration of immunoglobulin than the blood serum of the cow.

It has been repeatedly demonstrated that calves dying from septicemia or scours have few or no immunoglobulins. Calves that have scours and survive have below normal quantities of immunoglobulins but the healthy calf has adequate blood serum levels of immunoglobulins. Many of the infectious disease problems of the newborn can be alleviated by management that will provide the newborn with adequate protection through the colostral immunoglobulins.

Post-Partum Protection of the Newborn

The newborn calf arrives with few or no immunoglobulins and so, minimum protection to infectious disease. The calf that nurses receives immunoglobulins from the colostrum that will provide systemic and local protection to infectious disease. The immunoglobulins are nonselectively absorbed through the gut and within two hours are present in the bloodstream of the calf. The calf gut possesses its greatest ability to absorb immunoglobulins during the first six hours of life, after which the ability to absorb rapidly decreases and is completely absent after 24hours.

To obtain maximum protection the newborn calf should receive 3 to 6 pints of colostrum during the first hours after birth. The peak immunoglobulin blood serum level in the calf under optimum conditions is obtained in 24 hours after birth and then begins to decline unless the calf is infected which will stimulate its own immune system to begin synthesizing immunoglobulins. Each time the milk is removed from the mammary gland the immunoglobulin level is drastically decreased in the mammary secretions.

The immunoglobulin content of the dam's milk is affected by the rest period between drying off and calving, pre-partum or post-partum milking, breed and inherited individual differences. Older cows have greater immunoglobulin content in the colostrum than heifers. In general, beef breeds have higher levels of immunoglobulin than the dairy breeds.

Management can play an important part in the maximum availability and effectiveness of colostrum. Calves that will not nurse should receive three to six pints of colostrum within the first hour post-partum and not later than six hours post-partum via any artificial method. Keeping the calf with the dam for at least 24 to 36 hours will provide a minimum of stress and a maximum of immunoglobulin absorption. Calves that are removed from their dams and bucket fed always have a lower immunoglobulin absorbing ability. Other forms of stress that decrease immunoglobulin absorption include chilling or any discomfort that causes apprehension. Pendulous udders and/or large funnel-shaped teats are not conducive to nursing. and hence, reduced consumption of colostrum. Cows with poor udders should be eliminated as soon as economically practical. During the dry periods teats are sealed and in some instances sufficiently sealed so that the newborn calf cannot obtain colostrum upon nursing. The manual breaking of the teat seal and removal of a stream of colostrum upon parturition will aid the calf in nursing.

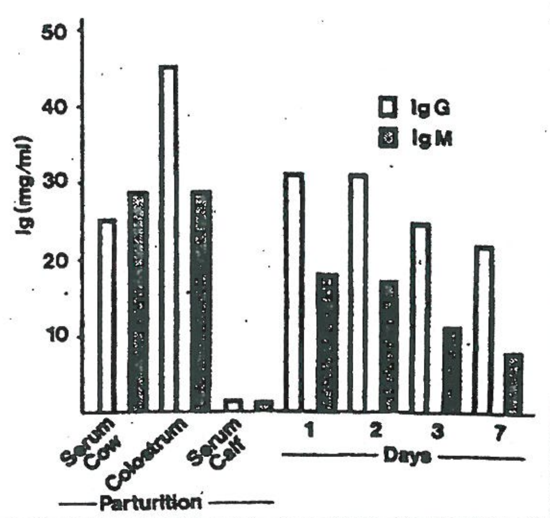
Calves that have scours will likely obtain little benefit from colostrum. Calves with scours lose many immunoglobulins from their body and from unabsorbed milk in the intestine. Some calves are inefficient absorbers of immunoglobulin and, hence. under optimum conditions are still susceptible to disease. Blood serum of calves that have nursed within 12 hours will contain immunoglobulins. The nursing status of ill or purchased calves can be determined by evaluation of blood serum for immunoglobulins with the sodium sulfite test.

Figure 1. Serum and colostrum levels of Immunoglobulins (Ig) M and G at parturition In the cow and postpartum serum levels of the calf. IgM Is the first Ig formed. IgG provides the predominant Ig and protection to the calf. (After Klaus Imm. 16-1969.)

Colostrum can be stored frozen for at least a year or probably longer without any loss of immunity or immunoglobulins. The immunoglobulins of fermented colostrum do not deteriorate for at least six weeks of fermentation.

Colostrum may also be effectively stored by the addition of preventatives such as proprionic, acetic or formic acids and thus be preserved for short periods without utilizing freezer space.

In summary many disease problems of newborn calves can be avoided by exerting maximum efforts to provide the calf, naturally or artificially with colostrum within the first hour of birth. Colostrum can be stored for emergency use by freezing fermentation or by using preservatives.



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