Texas A&M AgriLife Extension

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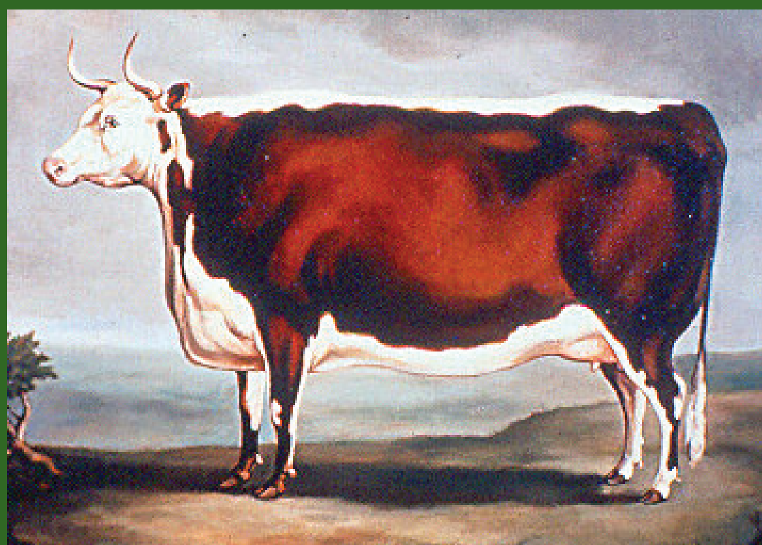
Texas Adapted Genetic Strategies for Beef Cattle V: Type and Breed Characteristics and Uses



A 1700s painting of the foundation cow of an early cattle breed. (Source: Michigan State University Animal Science Department)

Stephen P. Hammack*

The subject of breeds intrigues most beef cattle producers. However, breeds are only part of a genetic strategy, which should include:

- Matching applicable performance or functional levels to environmental, management, and marketing conditions
- Choosing a breeding system, either continuous (in which replacement females are produced within the herd) or terminal (in which replacements are introduced externally)
- Selecting functional types, breeds within types, and individuals within breeds that are compatible with the performance levels needed and breeding system chosen

Genetic classifications and breeds

Cattle have been divided into two basic classifications, Bos taurus (non-humped) or Bos indicus (humped, also called Zebu). Because these two types readily interbreed, some authorities now classify them as Bos taurus, subspecies taurus, and Bos taurus, subspecies indicus, or simply call them taurine and indicine.

Cattle are not native to the western hemisphere; the Bos taurus in the United States originally came from the British Isles and western continental Europe. Although the Bos indicus originated in south central Asia, most in the United States came by way of Brazil.

Although it has no strict biological definition, a breed can be described as a group of animals of common origin with certain distinguishing characteristics that are passed

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Texas Adapted Genetic Strategies

from parent to offspring. Breed characteristics result from both natural selection and from that imposed by people.

Most breeds have registry associations that record ancestry, define and document characteristics, and promote the breed. About 75 breeds have registry associations in the United States.

For a discussion of breed development, see another publication in this series by the Texas A&M AgriLife Extension Service, *Texas Adapted Genetic Strategies for Beef Cattle—VI: Creating Breeds.*

Functional traits or characteristics

The major functional traits that are important in beef production in Texas are body size and growth, milking potential, age at puberty, hot climate adaptability, fleshing ability, muscle expression, cutability, and marbling. The estimates of functional trait levels listed below are based on breed averages; individuals can vary considerably within breeds.

Body size and growth

Inherent body size is best evaluated as weight at the same level of body condition or fatness. However, growth or rate of gain is often evaluated over time-constant periods or to the same age; this type of comparison can produce differences in fatness among individuals of different functional types or breeds within types.

As a result, evaluations of rate of gain and feed efficiency over time- or age-constant periods often differ from evaluations of cattle at the same level of fatness. Genetically larger, later-maturing animals generally gain faster and more efficiently than do smaller, earlier maturing animals over time- or age-constant periods but often not when fed to the same level of fatness. Weight also correlates closely with nutritional requirements for body maintenance.

Although there are individual exceptions, cattle that are heavier at birth tend to be heavier throughout life. An important exception is in Bos indicus. Calves of Bos indicus **dams,** even by Bos taurus sires, tend to be relatively smaller at birth than later in life, usually resulting in fewer difficulties in calving. However, calves by Bos indicus **sires** out of Bos taurus dams often are relatively large at birth, so calving may be more difficult.

Size is discussed in *Texas Adapted Genetic Strategies for Beef Cattle—III: Body Size and Milking Level.* Frame score, an objective measure of skeletal dimension used to estimate current and future body size, is discussed in *Texas Adapted Genetic Strategies for Beef Cattle—X: Frame Score and Weight.*

Milking potential

Milking potential is the genetic capability to produce milk. It is not the actual volume of milk produced, which is also influenced by the cow's nutrition and the calf's nursing pressure.

Estimate milking potential in relation to body size. Higher-milking females need more nutrients for body maintenance and require higher-quality diets, even when not lactating. Again, see *Texas Adapted Genetic Strategies for Beef Cattle—III: Body Size and Milking Level.*

Age at puberty

Age at puberty relates to body size, milking potential, and genetic classification. Smaller individuals and higher milking types usually mature earlier; Bos indicus mature relatively late. Although higher milking females, even large ones, often reach puberty and conceive when relatively young, their subsequent reproductive performance can suffer because they may become thin after beginning lactation and therefore be slow to start cycling. While Bos indicus types reach puberty relatively late, their productive life is usually longer.

Heat tolerance

The cattle best adapted hot climates are those with Bos indicus inheritance. However, to a lesser degree, some Bos taurus animals do have heat tolerance, especially those with dark skin and lighter-colored short hair coats.

High humidity intensifies the effects of heat because it decreases the ability of respiration to reduce heat load. Also, hot, humid climates often add the stresses of parasites and low-quality forage. Heat with high humidity will stress cattle that fail to shed long, thick hair coats, particularly those that are dark colored.

As might be expected, animals tolerant to hot climates are relatively less adapted to cold.

Fleshing ability/fatness

Fleshing ability, or inherent fatness, is the body's capacity to fatten and retain fat. Fleshing ability tends to decrease with rises in maintenance requirements relative to body size, milking level, or muscularity. Also, larger animals may be unable to consume enough forage when it is sparse, thus reducing fatness. Animals poorly adapted to their environment generally are less able to maintain and increase flesh.

Compared to Bos taurus, Bos indicus often flesh more easily on low-quality forage and roughage. Easy-fleshing cattle may better tolerate periods of nutritional energy deficiency and, therefore, may reproduce more consistently. However, they may also over-fatten more readily in the feedyard unless they are fed for a shorter period than is typical.

Muscle expression

Muscle expression is inherent muscularity relative to body size. Muscling is the second most important factor in cutability, or leanness. Some heavy-muscled types may also have less fleshing ability, which reduces their reproductive efficiency.

Cutability

Cutability is usually evaluated in beef carcasses as USDA Yield Grade. Cutability depends on the relative proportions of fat (which varies most), muscle, and bone (which varies least).

Cutability is most commonly evaluated over time-constant feeding periods; in this type of evaluation, the animals that grow faster and mature later tend to be higher in cutability. However, producers can manipulate fatness, and therefore cutability, by varying nutrition and length of feeding.

Marbling

Marbling, or intramuscular fat, is the primary factor determining USDA Quality Grade, an indicator of the palatability factors of tenderness, juiciness, and flavor. Marbling increases with age up to physiological maturity and generally is higher in earlier-maturing types.

Marbling can generally be increased by feeding high-energy rations for extended periods starting early in life.

Bos indicus and most heavy-muscled, later-maturing types tend to have relatively low marbling. Because marbling tends to increase with overall body fatness, comparing types or breeds usually involves a trade-off between Yield Grade and Quality Grade. As one improves, the other tends to decline. Also, as with cutability, marbling can be affected by nutrition and length of feeding.

For a discussion of carcass genetic considerations, see *Texas Adapted Genetic Strategies for Beef Cattle—IX: Selection for Carcass Merit.*

Functional types and their best uses

U.S. cattle can be categorized into six primary functional types based on their genetic classification and levels of functional traits. The trait rankings in Table 1 are based on breed-comparison research conducted for over 40 years at the U.S. Meat Animal Research Center (MARC) at Clay Center, Nebraska, as reported in 2012.

For yearly updates of breed genetic trends calculated each July by MARC, see the *Beef Improvement Federation Proceedings* at beefimprovement.org. Use the proportions of the constituent breeds to estimate the characteristics of multi-breed cattle.

Differences in some functional levels among breeds have changed over the years. This is particularly true when comparing Continental breeds to other types. Compared to the existing breeds, most of the Continental breeds that came to the United States in the late 1960s and 1970s were considerably larger and, in some cases, notably higher in milk production. Since then, some of these differences have diminished or even disappeared as increased weight and milk have been emphasized in selection of breeding stock within existing breeds.

There is no “best” type or breed for beef production because of extensive variation in climates, production conditions, and market preferences. These factors often cause differences in optimal functional levels of all traits.

For more information, see *Texas Adapted Genetic Strategies for Beef Cattle—II: Genetic-Environmental Interaction.*

Following is a list of the types and most numerous breeds in Texas, presented alphabetically within type, and their best uses based on functional characteristics. Keep in mind that individual animals within a breed can vary considerably.

- ***British Beef***

  The British Beef type consists of British-originated breeds that were developed and used for beef production only: Angus, Hereford, Red Angus, and Shorthorn. British Beef are widely applicable, with some limits in subtropical and, especially, tropical climates. These breeds are the most numerous in the U.S. beef herd.

  Producers who use only one breed, i.e., for straightbreeding, often choose a British breed. To take advantage of hybrid vigor, cross them with other breeds of this type or with any other type.

  British breeds are suitable for general-purpose production as well as for both the dam and sire sides of a terminal cross, depending on the target market.

- ***Continental Beef***

  These are Continental European breeds and derivatives developed exclusively for beef production where they originated and used in the United States for the same purpose: Charolais, Limousin, and Maine-Anjou. These breeds are part of what were once sometimes called “exotics.”

The most effective use of Continental Beef has been as terminal sires. When selecting sires for this group, pay attention to birth weight and calving ease, especially for use on smaller dams. If desired, Continental Beef increases muscling and leanness in females without elevating milk production.

In general, do not straightbreed this type or cross it with other Continentals. These breeds vary in adaptability to hot climates.

- ***Continental Dual Purpose***

These breeds were developed and selected for both beef and dairy production in their native areas: Braunvieh, Gelbvieh, Salers, and Simmental. U.S. producers use these breeds only for beef. They are the other part of "exotics."

As with Continental Beef, these breeds are often used as terminal sires. Maternal use of this type can create females that are leaner, more muscular, and possibly higher milking.

Use the same cautions as with the Continental Beef type in birth weight, straightbreeding, and crossing with other Continentals.

- ***Dairy***

These breeds originated in western Continental Europe or the British Isles and are used in the United States for dairy purposes only: Holstein and Jersey. Beef is produced secondarily from these breeds. Though uncommon, the dairy type could be used to create crossbred early-maturing, high-milking, moderate-muscled females for beef production. Smaller cattle of this group may also

Table 1. Rankings of functional levels of the most numerous cattle breeds in Texas.[1]

Functional type breed	Growth and size[2]	Milking potential[3]	Age of puberty	Heat tolerance	Fleshing ability	Muscling	Cutability[4]	Marbling[4]
British Beef								
Angus	5	3–4	4	1	3	3	2	5
Hereford[5]	4	2	3	1	3	3	2	3
Red Angus	4	3	4	1	3	3	2	4
Shorthorn	4	3–4	4	1	3	3	2	4
Continental Beef								
Charolais	5	2	2	1	2	4	5	2
Limousin	4	1	2	1	2	5	5	1
Maine-Anjou	4	2	3	1	2	4	4	2
Continental Dual Purpose								
Braunvieh	3	3	3	2	2	4	4	2
Gelbvieh	4	4	4	1	2	4	4	2
Salers	4	3–4	3	1	2	3	4	3
Simmental	5	3–4	3	1	2	4	4	2
Dairy								
Holstein	5	6	4	1	1	2	4	3
Jersey	1	5	5	2	2	1	1	5
Bos indicus								
Brahman	4	4	1	4	3	3	3	1
American Beefmaster	4	3	3	3	3	3	3	2
Brangus	4	3	3	3	3	3	3	3
Santa Gertrudis	4	3	3	3	3	3	3	2
Specialty								
Texas Longhorn	1	2	3	2	3	1	3	2

[1] Breeds most numerous in Texas that have been evaluated by U.S. Meat Animal Research Center (MARC). Rankings are estimates of purebred breed-wide averages reported by MARC IN 2012. See text for explanation of productive functions. Higher numbers = greater expression of the trait. Range exists within these levels, so breeds with the same numerical designation do not necessarily average exactly the same level. Also, considerable individual variation exists within breeds. Levels for cattle of multi-breed background can be estimated from proportions of the constituent breeds.
[2] Rate of gain and mature weight.
[3] Higher numbers=earlier expression of puberty
[4] On time-constant feeding. See text for explanation.
[5] Horned and polled.

maintain or possibly increase fertility if body condition is maintained.

However, it may be difficult to keep dairy crosses in good flesh on typical rangeland or coarse pasture, especially those of large body size. Significant price discounts are common for stocker and feeder animals of visible dairy breeding.

- ***Bos indicus***

  This group contains straight Bos indicus and are used only for beef production: American Brahman. They are used primarily to create crossbred females that are adapted to hot climates and have the most longevity, hybrid vigor, and calving ease.

  Generally, these females are best used in terminal crossing systems. Do not straightbreed or cross them with other cattle containing Bos indicus, unless persistently hot and humid climatic conditions preclude any other logical choice.

- ***American***

  This type includes beef breeds that were created in the United States from combinations of about 3/8 to 1/2 Brahman, with the remainder usually consisting of a British Beef breed or breeds, or a Continental breed: Beefmaster, Braford, Brangus, Red Brangus, Santa Gertrudis, and Simbrah.

  American breeds are widely applicable, especially for but not limited to hot climates.

  They can be straightbred, crossed with other American breeds, or crossed with other types except for purebred or high-percentage Bos indicus. American breeds can be used effectively in general-purpose production and in terminal systems. They often can be the most logical choice for sires used in natural service in hot climates.

- ***Specialty***

  These breeds cannot be placed logically in any of the types above. They are often characterized by strong emphasis on certain traits: Texas Longhorn.

  Specialty breeds vary considerably in level of functional traits. They may be used where their particular combinations of unusual traits are needed or desired.

- ***"New" intermediate types***

  Just as Bos indicus and Bos taurus were combined years ago to form intermediates now known as American breeds, newer intermediates have been formed. One involves combining Continental and British breeds. The more numerous of those combinations (and their registry associations) include Beef Builder (Braunvieh), ChiAngus (Chianina), Balancer (Gelbvieh), Lim-Flex (Limousin), MaineTainer (Maine Anjou), Optimizer (Salers), and SimAngus (Simmental).

  Also, some American or Bos indicus have been combined with British or Continental to reduce the proportion of Bos indicus to 1/4 or less. The more numerous of these breeds are Angus Plus (Red Angus), Advancer (Beefmaster), UltraBlack and UltraRed (Brangus), Southern Balancer (Gelbvieh), and SimAngus HT (Simmental).

  Use the proportions of their constituent breeds to estimate the functional characteristics of these new intermediate types and therefore their best uses in commercial herds.

Matching functional levels to production criteria

Climate and nutrition are key variables affecting where differing groups and breeds can be used efficiently. Production suffers when cattle are not adapted to climatic conditions. In hot, humid climates, cattle benefit from some Bos indicus or other tropical-adapted genetics.

Table 2, from the Beef Improvement Federation, shows the effects of nutrition on the optimum levels of the three primary production functions in cow herds. In general, as nutrition declines, the smaller, lower-milking, easier-fleshing cattle are better adapted and more efficient. This is discussed in detail in *Texas Adapted Genetic Strategies for Beef Cattle—III: Body Size and Milking Level.*

Appropriate functional levels can differ depending on the breeding system implemented.

Cattle for general-purpose, continuous systems should contain a blend of important production traits in both sires and dams.

Conversely, dissimilar types may be more effectively used in terminal systems. To reduce cow herd nutritional needs or increase stocking rate, use rela-

Table 2. Matching cowherd functional levels to nutrition (Source: Beef Improvement Federation).

Nutritional availability[1]	Mature size	Milking potential	Fleshing ability
Low	Low to Medium	Low to Medium	High
Medium	Medium	Medium	Medium to High
High	Medium to High	Medium to High	Medium

[1] Quantity, quality, and consistency of nutrition whether from grazing, harvested forage, or supplemental concentrates

tively small terminal dams complemented by high-growth sires. Maternal ability is unimportant in terminal sires because their heifers are not kept for replacements.

For more discussion on breeding systems, see *Texas Adapted Genetic Strategies for Beef Cattle—IV: Breeding Systems.*

Summary

Genetics vary widely within functional types and breeds. However, in creating specific production levels, it is usually more effective to exploit breed averages of applicable functional types than to look for genetic outliers in other types.

A fundamental challenge in commercial beef production is to match genetic capability with climatic, nutritional, management, and market conditions. Knowing the functional levels of types and breeds can help you optimize animal performance to achieve the highest profit.

For further reading

Sire choice is greatly influenced by types represented in a cow herd. This subject is discussed in Extension publication *Texas Adapted Genetic Strategies for Beef Cattle—VII: Sire Types for Commercial Herds.*

To obtain other publications in this Texas Adapted Genetics Strategies for Beef Cattle series, contact your AgriLife Extension county office or see the website of the AgriLife Extension Bookstore at http://AgriLife-Bookstore.org and the Texas A&M Animal Science Extension at http://animalscience.tamu.edu.

Appendix A. Additional cattle breeds, less numerous in Texas, with registry associations.

British Beef	Continental Beef	Dual Purpose	Dairy	Bos indicus	American	Specialty
Belted Galloway	Belgian Blue	Amerifax	Ayrshire	Boran	American	Akaushi
Black Hereford	Blonde d'Aquitaine	Beef Friesian	Brown	Gyr	Barzona	Ankole-Watusi
British White	Marchigiana	Devon	Swiss	Indu-Brazil	Bonsmara	Beefalo
BueLingo	Parthenais	Dutch Belted	Guernsey	Nelore	Brahmousin	Corriente
Galloway	Piedmontese	Kerry	Milking	Sahiwal	Bralers	Dexter
Highland	Romagnola	Normande	Shorthorn		Braunbray	Florida Cracker
Irish Black		Norwegian Red			Charbray	Geltex
Irish Red		Pinzgauer			Gelbray	Salorn
Lincoln Red		Red Poll			Mashona	Texas Longhorn
Murray Grey		South Devon			Romosinuano	Texon
RX^{3}		Sussex			Santa Cruz	Wagyu
Welsh Black		Tarentaise			Senepol	
White Park					South Poll	
					Tuli	

Revision

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Texas A&M System

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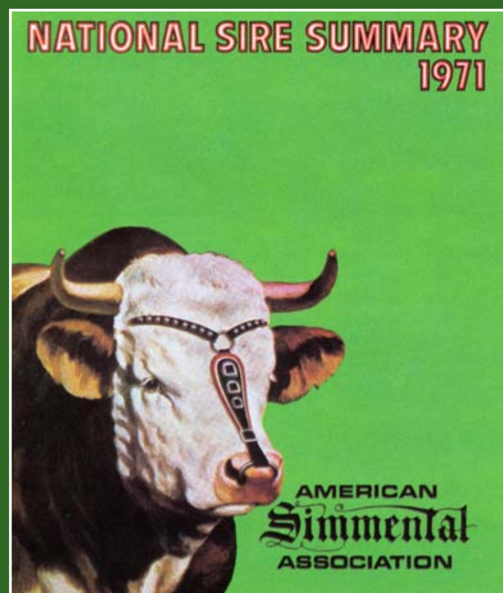
Texas Adapted Genetic Strategies VIII:
Expected Progeny Difference (EPD)



The first EPD evaluation. (Courtesy of American Simmental Association)

Stephen P. Hammack* and Joe C. Paschal*

When evaluating prospective breeding animals, it is helpful to have an estimate of their genetic transmitting potential. For most production traits, this estimate is best calculated using records of performance.

The first performance records of beef cattle were primarily weights or weight gains measured at weaning or as yearlings. Sound comparisons of individuals were often impossible because of animal and management differences. Standard adjustments were developed for calf age, sex, and age of dam, but there were no good ways to adjust for differences in management, nutrition, location, season, and year. So the comparisons had to be limited to animals managed alike in a contemporary group.

To facilitate comparisons, ratios were sometimes calculated for individual animal performance within a contemporary group; however, these ratios still contained unaccounted-for differences between groups.

Progress in genetic evaluation came with Estimated Breeding Value (EBV), which used ratios calculated within a contemporary group. EBV added an animal's own records to those of relatives and progeny. It also incorporated heritability, the average part of the difference in a trait derived from transmittable genetic content, which is not the same for all traits.

However, EBV still consisted mostly of within-group records. Because this limitation was often ignored, faulty comparisons were sometimes made of EBVs from different groups or herds.

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Texas Adapted Genetic Strategies

National Sire Evaluation

More improvement in genetic evaluation came with Expected Progeny Difference (EPD). The term *expected* can be misleading as it implies a high degree of certainty, which may or may not be true. *Predicted* or *estimated* would probably be better terms than expected.

As was true for EBV, the basis of EPD is ratios within a contemporary group, but EPD has more scope and precision. With EPD, more valid comparisons can be made of animals **across** contemporary groups, not just **within** a single group.

The first practical implementation of EPD came through National Sire Evaluation (NSE), conducted by some breed registry associations. The widespread use of popular bulls through artificial insemination, particularly in breeds first available in the United States in the late 1960s, allowed them to serve as so-called Reference Sires, the benchmark in NSE. The first National Sire Summary, comparing EPDs of 13 bulls, was published by one of those breeds in 1971.

The only bulls that could be included in NSE were those with adequate numbers of progeny managed in contemporary groups where at least one Reference Sire was represented. Some often incorrect assumptions reduced the validity of the estimates. One of these assumptions was that bulls are not genetically related. Another was that bulls are mated to females of equal genetic merit. It was assumed that no progeny are culled before all records are collected and that breed averages for traits do not change over time.

National Cattle Evaluation

Refined mathematical techniques and expanded computing capacity made possible the next step in genetic prediction, National Cattle Evaluation (NCE). This evaluation compares animals within a breed more accurately than does NSE. All major breed associations have such programs. Using NCE, breed-association EPD programs include:

- Data from the individual, relatives, and progeny
- An adjustment for differences in genetic merit of mates
- Genetic correlation between traits
- Adjustments for genetic change over time and genetic relationships among individuals
- Adjustments for differences between contemporary groups in environment and management, such as climate and nutrition
- The requirement by some associations for Total Herd Reporting, which provides records on more individuals
- No more Reference Sires, because any individual with progeny in more than one contemporary group is, in effect, a reference
- EPDs that are directly comparable within a breed for all individuals (males and females) in all locations and management systems across all years

EDP Traits

All of the breed associations that have EPD report four traits:

- **Birth Weight**—in pounds at birth, excluding maternal influence. Birth weight is the most important factor in Direct Calving Ease (see below).
- **Weaning Weight**—in pounds at 205 days of age, excluding maternal influence (evaluated as Milk below)
- **Yearling Weight**—in pounds at 365 days of age, excluding maternal influence
- **Milk**—expressed as pounds of weaning weight (not pounds of milk) due to maternal influence of an individual's daughters, excluding genetics for growth to weaning (evaluated as Weaning Weight above). The use of "milk" is inexact because this is an estimate of all maternal influences on weaning weight, milk production being the major element. Total Maternal EPD, combining Milk and Weaning Weight, also is reported by some breeds. Total Maternal should be ignored and the two components considered separately unless a producer merely wishes to increase weaning weight without regard for what causes the increase.

Other traits that may be included by a breed are:

- **Direct Calving Ease**—in percentage of unassisted births or as a ratio. This is an estimate of a calf's ease of birth, excluding maternal factors (evaluated as Maternal Calving Ease below). Direct Calving Ease depends primarily on the size of the calf. If Direct Calving Ease is available, it should be emphasized instead of Birth Weight, which only indirectly estimates calving ease.
- **Maternal Calving Ease**—in percentage of unassisted births or a ratio. It is the ease of calving of daughters excluding factors associated with the calf (evaluated as Direct Calving Ease above). This essentially involves the size, internal structure, uterine environment, and other factors of the calving female.
- **Calving Ease Total Maternal**—combines Direct and Maternal Calving Ease
- **Gestation Length**—in days; is related to birth weight, calving ease, and calving interval

- **Yearling Height**—in inches, another estimate of genetic size; a predictor, along with weight traits, of mature body size
- **Scrotal Circumference (SC)**—in centimeters; a predictor of mass of sperm-producing tissue. Also, SC is positively related to younger age at puberty in males and their female relatives.
- **Days to Finish**—in days; the length of time needed to reach a set amount of fat cover
- **Carcass Weight**—in pounds, another measure of body size that is highly related to yearling weight
- **Marbling**—in USDA marbling degrees, the primary factor in USDA Quality Grade
- **Tenderness**—in pounds of shear force; a mechanical estimate of tenderness
- **Ribeye Area**—in square inches between the 12th and 13th rib; a predictor of total amount of muscle. Ribeye area is highly related to carcass and yearling weights.
- **Fat Thickness**—in inches over the ribeye at the 12th/13th rib; a predictor of total carcass fat which is the most important factor in percentage red-meat yield (cutability)
- **Yield Grade**—in USDA Yield Grade units; a measure of cutability
- **Retail Product (RP)**—in percent; another measure of cutability
- **Ultrasound measures**—for Ribeye Area, Ribeye Fat Thickness, Rump Fat Thickness, Retail Product, and Ribeye IMF (intramuscular fat, in percent), which is a predictor of marbling
- **Mature Daughter Weight and Height**—in pounds and inches; measures of mature size of daughters
- **Cow Energy Indexes**—in dollars or units of energy; assess differences in cow nutritional energy requirements
- **Docility**—in percentage of deviation from the probability of Behavior Score being either docile or restless as opposed to being nervous, aggressive, or very aggressive.
- **Heifer Pregnancy**—in percent; the pregnancy rate of daughters when exposed to calve first at 2 years of age
- **Stayability**—in percentage deviation from a 50 percent probability of daughters remaining in the herd to at least 6 years of age. This involves all factors in culling of females, and so is thought to be related to structural soundness, fleshing ability, reproductive efficiency, and general fitness.
- **Value Indexes**—in dollars, also called economic selection indexes and $ indexes; multi-trait indexes combining relevant production EPDs with cost to produce and value of product. Various breed associations have indexes for value: 1) as weaned calves, 2) after feeding, 3) as carcasses marketed on a Quality Grade-Yield Grade price "grid", 4) with combined feeding and carcass value, and 5) for the total production cycle from conception to carcass.

Individual animal records such as weight and ultrasound measurements are necessary to provide data that make EPD possible. **(Photo on left by kimberlybrianphotography.com)**

Interpreting EPD

EPD values are calculated as average relative deviations, not actual levels, of the unit of measurement of the trait. Assume that one bull has a Birth Weight EPD of +4.2 and another bull of the same breed has -1.4. This means that, if used on genetically equal females managed under equal conditions, the first bull is predicted to sire calves averaging 5.6 pounds heavier at birth (the difference between +4.2 and -1.4).

As another example, if one bull has a Weaning Weight EPD of +42 and another has +27, the predicted average difference between the two bulls is 15 pounds in weight of their calves at weaning.

EPD does not predict performance level. If a bull has +4 Birth Weight, this does not predict that he would increase birth weights by 4 pounds, nor would a bull with -1 Birth Weight decrease birth weights by 1 pound. The two bulls are predicted to sire calves averaging 5 pounds difference. The actual average birth weights, depending on other factors, might be 75 pounds and 70 pounds or 95 pounds and 90 pounds or any other average difference of 5 pounds. EPD predicts **comparative** differences, not level of performance.

If the EPDs of both parents are known, they can be combined to predict the relative performance of the progeny. For example, compare a sire of Weaning Weight +55 mated to a dam of +35 with a sire of +40 mated to a dam of +30. Their progeny would be predicted to differ in weaning weight by 20 pounds (55 + 35 minus 40 + 30).

Breed associations calculate their own EPDs that are comparable only within the breed. However, EPDs of individuals of the same breed can be legitimately compared even if they are to be mated to another breed, or cross of breeds, as long as the proposed mates are the same. For example, the EPDs of two Charolais bulls can be compared for use in a herd of Brahman-cross females.

There are some adjustment factors for comparing EPDs from different breeds, but they may be less reliable than within-breed EPDs. In most cases, producers should first determine which breed(s) to use and then decide which individuals to select from within the breed(s). To assist in choosing applicable breeds, see the publication in this series E-190, *Texas Adapted Genetic Strategies for Beef Cattle V: Type and Breed Characteristics and Uses.*

All breed associations establish a base period when the breed-average EPD value for a trait is zero, and those bases differ for each breed. Selection changes genetic level over time. As time passes since the base was established, the breed average could differ increasingly from zero.

Breed averages can vary considerably. For example, recent average Yearling Weight EPD in one breed is +11 and is +76 in another breed. These breed averages cannot be compared, so the values do not mean that the second breed averages 65 pounds heavier.

Current breed averages can be used to see where an individual ranks within a breed. Maintaining a fixed base provides a benchmark that can be used to help determine the level of EPD in a breed that might be appropriate for particular production conditions. This benchmark would not be available if the breed average was reset to zero every time EPDs are recalculated.

Once or twice a year, associations update individual animal EPDs, breed averages, distribution of EPDs within the breed, and genetic trends. The most recent reports should be used and EPDs from different reports cannot be compared.

Accuracy

Suppose two individuals have Weaning Weight EPDs of +32 (0.62) and +46 (0.41). The values in parentheses are for Accuracy, which ranges between 0 and 1. (Accuracy usually is not calculated for Pedigree EPD, based only on parental EPDs, or for Interim EPD, based on pedigree EPDs plus the individual's record.) Accuracy is influenced by the number of records, genetic relationship among individuals providing the records, heritability of the trait, and number of contemporary comparison groups.

Accuracy is not related to variation in progeny. Progeny of low-Accuracy parents will vary no more, on average, than progeny of high-Accuracy parents. Also, difference in parental EPD is not related to progeny EPD variation. For example, consider a sire and dam both with Yearling Weight EPD of +60 compared to a sire with +80 and a dam with +40. On average, there is no difference in progeny variation from these two matings and both sets of progeny are predicted to average +60 EPD.

So what is more important, the magnitude of EPD or Accuracy? EPD is an estimate of true breeding value in relation to other individuals in a breed. Accuracy is a measure of confidence that the EPD is the true breeding value. If a producer wants large and rapid change in a trait then EPD should be stressed, even if Accuracy is low. But if predictability is more important, higher Accuracy individuals should be selected. Regardless of Accuracy, EPD is the best estimate available of true breeding value.

Possible Change

Over time, Accuracy increases and EPD often changes as more records relating to an individual (primarily progeny) are accumulated. Breed associations publish and regularly update Possible Change Values, which are measures of the average amount that EPD could change over time.

For a given Accuracy, about two-thirds of the time an individual should have a true progeny difference within the range of the EPD plus and minus the Possible Change Value. But about one-third of the time, the true value could fall outside that range. Therefore, "Possible Change" is another misleading term because it implies incorrectly that greater change is not possible. However, for any range of Possible Change the true progeny difference is much more likely to be toward the center of the range than the extremes.

Assume a breed reports Possible Change in Weaning Weight EPD as shown in Table 1.

Table 1. Possible Change Values for Weaning Weight EPD*

Accuracy	0.1	0.3	0.5	0.7	0.9
Possible Change	16	13	9	6	2

*This is only an example. Possible Change varies for every breed and trait.

From this table, with Accuracy of 0.3, the Possible Change is ± 13 units of the EPD. So, for example, with an EPD of +30 about two-thirds of individuals are expected to have true progeny differences between +17 and +43 (30 ± 13), sometimes called the confidence range. With Accuracy of 0.7 the Possible Change is only ± 6, so with EPD of +30 the true progeny difference is expected to be between +24 and +36. Note in the table that Accuracy of 0.9 predicts almost no change in EPD, but Accuracy this high is possible only for individuals with hundreds of progeny records. In short, higher Accuracy means greater **predictability.**

The anticipated direction of any future change is unrelated to the magnitude of the current EPD. That is, a numerically high EPD is as likely to change to an even higher value as it is to move downward. And a low EPD is as likely to change to an even lower value as it is to move upward. These considerations are taken into account in the calculations.

Genetic Potential

How much potential is there for genetic change within a breed? A good estimate can be obtained from a percentile breakdown, which shows distribution of EPD. Table 2 shows a percentile breakdown for Yearling Weight EPD and also lists the total range within the breed. With this information, a producer can determine potential for genetic change and also see where the EPD of a particular individual stands in the breed.

Table 2. Percentile breakdown for Yearling Weight EPD*

Percentile	1%	5%	20%	50%	80%
EPD	+95	+85	+68	+53	+38

*An example only. Current breed average is at the 50th percentile (+53). The total breed range is from -13 to +131.

This table shows an example of the EPD level for various percentiles. Based on the upper end of the range (+131), it would be possible to find a bull with EPD 78 pounds (131 minus 53) above breed average. However, only 1 percent of the individuals in the breed have EPDs of +95 or higher. Finding a bull just 30 pounds above average would require restricting selection to the top 5 percent of the breed. Broadening to the top 20 percent of bulls reduces the difference to just 15 pounds above average.

Although the range of genetic expression in a breed may be wide, the majority of EPDs will be near the average. But this means a producer who wants a performance level for a particular trait that is near breed average has large numbers of potential sires available. In that case, it is easier to find sires acceptable in all traits important in the herd.

Making a lot of change quickly in several traits requires unusual outlying sires. For example, a search in a breed with over 2,300 sires listed found only four in the top 10 percent for low Birth Weight EPD, high Weaning Weight EPD, and high Milk EPD. And those four sires might be undesirable in other important traits.

The fastest genetic change can be made by using superior sires from a breed noted for high expression of the trait of interest. However, other changes would probably accompany a substitution of breeds. Considering the number of factors that should be considered in sire selection, only small change may be feasible in any one trait in a short time.

Does EPD Work?

What evidence is there to confirm the theory of EPD? A recent summary reviewed research results. The first part of the study compared sire EPD with actual performance of progeny. Nine studies of growth traits involved 27 trait analyses. In 23 instances, progeny response was higher from high-EPD sires than for low-EPD sires. Five maternal studies had 14 trait analyses, of which 13 resulted in higher response from cows whose sires had high EPD for maternal traits. And four carcass studies included 23 trait analyses; in 16 of these the response was higher from high-EPD sires.

In the second part of the review, progeny response was regressed on what was predicted from sire EPD. For growth traits there was an average response of 1.03 pounds in progeny for each 1.00 pound of sire EPD. In maternal traits the response averaged 1.45 to 1.00. And for carcass traits the response averaged 1.04 to 1.00.

In conclusion, the review of available research confirmed that EPD is a valid and useful estimate of true breeding value for growth, maternal, and carcass traits.

Using EPD

Suppose four producers are looking for sires of a particular breed. All four producers have used sires of this breed before in their herd.

- **Producer A** has F1 Brahman-cross cows weighing 1,200 to 1,400 pounds in moderate body condition. Calves are often retained through the feeding phase. All replacement females are purchased.
- **Producer B** has a group of yearling heifers to breed. All calves will be sold at weaning. No replacement heifers will be saved.
- **Producer C** sells at weaning and wants to increase weaning weights but not cow size. Cows

usually stay in good body condition without much supplementation. Replacement heifers are saved to go back into this herd.

- **Producer D** saves heifers to go back into the herd and feeds out some calves. The producer is generally satisfied with current levels of calving ease, weaning weight, and postweaning performance.

Potential sires are shown in Table 3. For reference, the current breed-average EPDs are shown. Which of these potential sires should be selected?

Table 3. Selecting a sire using EPD

Sire No.	Birth EPD	Weaning EPD	Yearling EPD	Milk EPD
1	-1.3	+15	+39	+4
2	+4.7	+42	+81	-2
3	+2.5	+34	+56	+13
4	+1.9	+28	+47	+22
Breed average	+2.1	+30	+51	+12

- **Producer A** would benefit most from growth potential, so long as carcass weights are not excessive. Milking ability is irrelevant, since replacements are not saved. With large Brahman-cross cows, calving difficulty (predicted from Birth Weight EPD) is of little concern. Therefore, the best choice is probably Sire 2, which is highest in Weaning and Yearling Weight EPDs.
- **Producer B** should give primary consideration to calving ease. Sire 1, with the lowest Birth Weight EPD, is the best choice for that purpose. Although Sire 1 is lowest in Weaning and Yearling Weight EPDs, in this case growth potential is secondary to calving ease. And no replacement heifers are saved, so Milk EPD is not a factor.
- **Producer C**, to increase weaning weight but not cow size, appears to need increased milk production in heifers going back in the herd. The body condition of the herd indicates that higher milking ability can probably be supported on existing production conditions. Sire 4, highest in Milk EPD and around breed average in Birth, Weaning, and Yearling Weight EPDs, is probably the best choice.
- **Producer D** does not seem to need significant change in any of these traits. Sire 3 is near breed average in Birth Weight and Milk EPDs and a little above average in Weaning and Yearling Weight EPDs. This is probably the best choice for this producer.

The best choice depends on the particular herd and what is needed from the sire. Many other production traits are important besides the four discussed above that are common to all breeds reporting EPD. Where EPD is available for other important traits, it should be the primary selection criterion for that trait. For traits without EPD, other valid measures of comparison should be used.

Production conditions and markets dictate appropriate levels of animal performance. For example, where forage is sparse or low in quality, mature cow size or milking potential may need to be moderated. Producers with experience using particular breeds in their production conditions have a better idea of appropriate levels of EPD within those breeds.

Summary

EPDs can be directly compared for all animals (male and female), from all locations and management conditions, across all years, within an entire breed. For the traits where available, EPD is the most accurate estimator of true breeding value.

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://AgriLifeBookstore.org and the Texas A&M Animal Science Extension Web site http://beef.tamu.edu.

Produced by AgriLife Communications, The Texas A&M System
Extension publications can be found on the Web at: http://AgriLifebookstore.org

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Revision

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Factors and Feeds for Supplementing Beef Cows

Stephen P. Hammack and Ronald J. Gill*

A beef cow requires energy, protein, minerals, and vitamins in its diet. What determines how much of these nutrients is required? What determines if they need to be supplemented in the diet?

Many factors affect the amounts of required nutrients. A female performs many functions—body maintenance, activity, weight gain, reproduction, and milk production—that all require nutrients. The amount of nutrients required depends on body size, environmental conditions, how far an animal travels, desired rate of gain, stage of gestation, and level of milk production.

The nutritional value and quantity of available forage determine if nutrients need to be supplemented in the diet. During most of the year, warm-season forages are likely to be deficient in some minerals, especially phosphorus and certain trace elements like copper and zinc. In most situations, supplementation should include at least year-round provision of salt and a mineral with 8 percent to 12 percent phosphorus and a similar level of calcium. Vitamin A, which usually is low in dry or weathered forages, should be injected or fed in mineral or other supplements if it is suspected to be deficient. Mineral and vitamin supplementation should be a high priority because deficiencies can be corrected for relatively little cost.

After addressing mineral and vitamin needs, protein and energy deficiencies must be considered. Forage protein and energy vary seasonally. Warm-season forage typically becomes deficient in protein in mid-summer and again in winter. Forage lacks adequate energy content primarily in winter, but energy available to the animal is restricted more often by a limited supply of forage rather than by deficiencies in plant composition.

Factors Affecting Supplementation

Many factors affect the type and amount of protein or energy supplement that a beef cow may require. There are six critical factors that affect supplementation needs.

Forage Quantity. The amount of available forage obviously affects the need for supplemental feed. If grazing or hay will be limited, take immediate action. Reduce the number of animals in order to lessen the need for supplemental feeding of the remaining cows. As forage supply declines, the opportunity for animals to selectively graze decreases, and so does diet quality. Then, supplementation may become necessary even if animal numbers are reduced.

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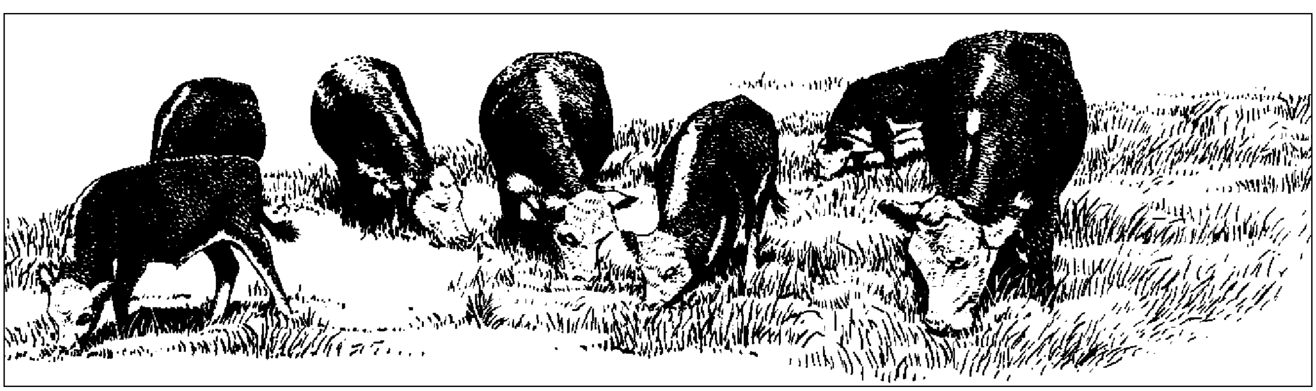


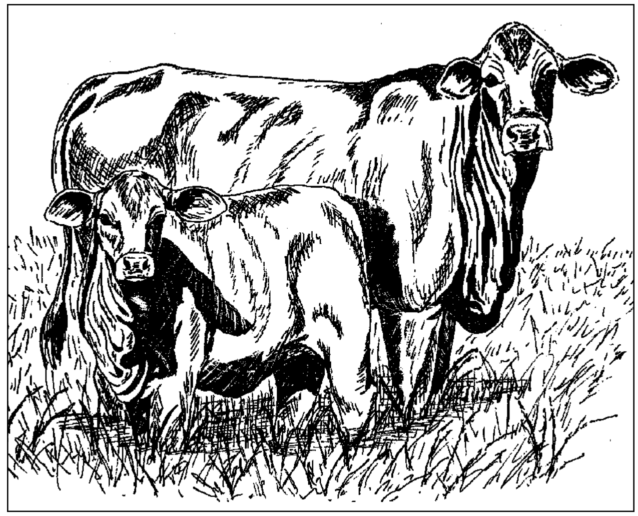
Forage Quality. Poor quality forage has less than 6 percent to 7 percent crude protein (CP) and is low in digestibility, with less than 50 percent total digestible nutrients (TDN). These deficiencies limit the amount of such forage that an animal can eat. Because both consumption and nutrient content of poor quality forage are low, supplemental needs are high. Medium quality forage (7 percent to 11 percent CP, 50 percent to 57 percent TDN) eliminates or significantly reduces the need for supplementation. High quality forage (above 12 percent to 14 percent CP and 57 percent TDN) can be consumed in the largest amounts and usually removes any need for supplementation, except possibly for high milking cows in low body condition. However, forage that is high in quality but low in quantity, a common situation in early spring, increases the need for supplementation of dietary bulk and energy. The amount a cow can eat in a day ranges from as little as 1.5 percent of body weight for very low quality forage to near 3.0 percent for very high quality forage. The typical amount is 2.0 percent to 2.5 percent.

Body Condition. The level of body condition (amount of fat) affects supplemental requirements. Low body condition markedly increases the need for supplemental nutrients, and meeting such needs often is cost prohibitive. Moderate body condition significantly reduces or eliminates the need for supplements. Fleshy cows generally need little if any supplement and the daily amount of forage required often can be reduced. If forage consumption is not reduced, higher production is possible or reserves of stored body energy can be maintained.

Body Size. The potential for forage consumption is related to body size, so larger animals may not require more supplement than smaller ones. Adjustments in stocking rate, to allow adequate amounts of forage per cow, may offset differences in size but will increase the cost per cow. But if forage is sparse or limited, larger cows require proportionately more supplement.

Milking Level. Higher milking cows can consume somewhat more forage, but not enough to completely satisfy extra needs. When forage quality is inadequate, higher milking cows need more supplement; from 50 percent to 100 percent more may be required for high versus low milk production in cows of the same body size.

Age. Young animals are still growing and require extra nutrients, but their body size is not as large as mature animals. Because of their smaller body size, growing heifers cannot consume as much forage as mature cows. For these reasons, young females require higher quality diets than mature cows and often require more and different supplements.



Feeds for Supplementation

What are some protein and energy supplements and how should they be used?

Oilseed Meals. Cottonseed, soybean, and peanut meals often are manufactured as large pellets or cubes for feeding convenience. These are high protein (38 percent to 45 percent CP), medium to high energy sources, commonly fed at 1 pound to 3 pounds a day. Although relatively costly per ton, they often are the cheapest source of protein. These feeds are most useful when supplemental protein, and little or no energy, is needed. Oilseed meals are especially suitable for dry cows in moderate to good flesh when they have access to adequate amounts of low protein, medium energy forages.

Grain. Corn and grain sorghum (milo) are the most common low protein, high energy sources. Other grains include oats, wheat, and barley. Grains often are the cheapest sources of supplemental energy. Similar feeds include processed byproducts such as wheat mids, soybean hulls, and rice bran. These byproducts are slightly higher in protein and a little lower in energy than grains and are relatively low in starch. Starch can interfere with forage digestibility, so these are excellent supplements to forage. Feeds in this category commonly are found in breeder/range cubes.

Breeder/Range Cubes. These are most commonly 20 percent CP but also are found as 30 percent to 32 percent products. These feeds are designed to provide a combination of protein and energy, fed in larger amounts (3 to 6 pounds a day) than high protein feeds. The equivalent of a 20 percent cube can be prepared with a mix of about one-third oilseed meal and two-thirds grain. A mix of about three-fourths meal and one-fourth grain is the equivalent of a 32 percent cube. Some cubes use nonprotein nitrogen (NPN), usually urea, to supply nitrogen for potential synthesis of rumen microbial protein. Cubes with low crude fiber (below 10 percent) generally are highest in energy. Whole cottonseed, brewers grains, and some corn gluten meals are similar in protein and energy content to these cubes.

Protein Blocks and Liquids. These feeds usually contain 30 percent to 40 percent CP and typically are low to medium in energy. Their formulation or physical structure limits consumption to around 1 pound to 3 pounds daily. The protein portion often consists of 50 percent to 90 percent from NPN, but can be considerably lower. Their primary use is to provide supplemental protein on low protein, medium energy forages (below 7 percent CP, 50 percent to 52 percent TDN) where convenience of self-feeding is a priority. These feeds generally will not fill large voids of nutrient deficiency, nor support higher levels of animal performance.

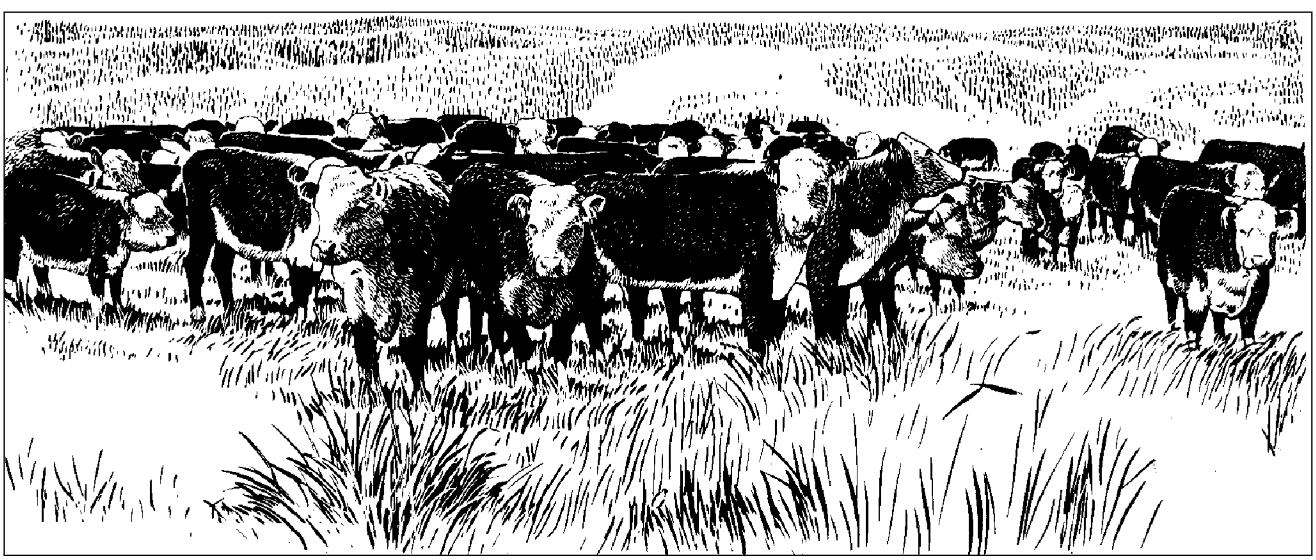
Syrup Blocks and Tubs. These generally range from 12 percent to 24 percent CP (often about half from NPN) and are medium in energy. Consumption of these blocks usually is very low (typically 1/2 pound to 1 1/2 pounds a day), so higher protein versions probably are most useful. These products are not intended to directly supply much supplemental protein or energy. Rather, their theoretical function is to stimulate rumen microbes to digest more forage and produce microbial protein, which can be utilized in the small intestine. For this to occur, sufficient amounts of at least moderately digestible forage must be available. These feeds work best when supplied year-round, allowing accumulation of body fat reserves that animals can utilize during typical fall and winter decline in forage quality and quantity. They generally will not support high performance.

Hays. High quality hays, such as alfalfa, peanut, and soybean, can be used as supplements. These medium protein (usually 15 percent to 20 percent CP), medium energy sources can be limit-fed in place of one of the feeds discussed previously. Such hays also can be fed free choice, although protein is wasted, if their cost is competitive.

Supplementation Strategies

Supplements must be chosen to meet particular nutrient deficiencies. Body condition is a key factor in the choice of supplements. Thin cows are relatively more deficient in dietary energy than in protein. In contrast, fleshier cows may need extra protein, if they need anything.

To minimize supplementation, use forage supplies logically. In general, hay (excluding supplemental alfalfa, etc.) should not be limit-fed with standing forage. Limit-feeding of hay encourages cows to reduce grazing and fails to use pastures while quality is reasonably good. For example, assume available forage for grazing or feeding includes some tame pasture (such as coastal bermudagrass), some native range, and some hay. As winter approaches, the tame pasture should be used first, native range next, and hay last. That way each forage is utilized most efficiently, and there is a better chance some hay will be left in late winter to early spring when high quality green growth begins but is limited in amount.



It is difficult to make general recommendations about supplementation of protein and energy. Usually, dry mature cows in medium or higher body condition on typical dormant warm-season pasture or low quality hay often need only 1 pound to 2 pounds a day of a high protein feed. (On extremely low quality forage, such as tall-grass prairie in winter, 3 pounds to 4 pounds of high protein feed may be needed.) A thin, dry, mature cow may require 2 pounds to 4 pounds daily, but of a medium-protein, high-energy supplement. After calving, all of these amounts essentially should be doubled.

Daily feeding usually is not necessary when using high-protein supplements such as cottonseed meal cubes. Instead, depending on the amounts, weekly required totals can be divided and fed every other day, twice a week, or even once a week. In fact, nondaily feeding of these supplements often is more efficient. However, combination protein-energy supplements, especially breeder/range cubes and meal-grain mixes, that are required in larger daily amounts, generally should be fed daily for best forage utilization, highest animal performance, and greatest efficiency.

Self-fed, controlled consumption can be accomplished with some feeds, especially oilseed meals and meal-grain mixes, by including an intake limiter such as salt. Cattle then will consume salt in maximum amounts of approximately 0.1 percent of body weight, or about 1 pound of salt consumption daily by a 1,000-pound cow. So, to obtain supplement consumption of 3 pounds daily in a 1,000-pound cow, a mix of 1 pound salt to 3 pounds supplement should be provided. When using salt to limit consumption, plenty of high quality water must be available. Also, cows consume more of a salt-limited supplement when it is located close to a water supply.

Perhaps the most common supplement is a high quality 20 percent CP breeder/range cube (high or all-natural protein and low crude fiber), or the equivalent. Such a supplement often is a compromise for the common situation of low quality forage and low to medium body condition. But this must be fed in adequate amounts, typically 3 to 6 pounds a day, to be effective. In fact, with the exception of managing weight loss in fleshy cows, there are few situations where feeding smaller amounts of such cubes is applicable. If a producer is unwilling or unable to assume the cost of required amounts of these cubes (or the equivalent), then a lower amount of a higher protein feed should be fed. But realize, however, that body condition, reproduction, productivity, and profit are likely to decline if nutrient requirements are not met.

The following Texas Agricultural Extension Service publications can provide additional information.

B-1526, "Body Condition, Nutrition and Reproduction of Beef Cows"

B-1553, "Nutrient Composition of Feeds"

B-1554, "Nutrient Requirements of Beef Cattle"

B-6056, "Mineral Supplementation of Beef Cows in Texas"

B-6067, "Supplementation Strategies for Beef Cattle"

L-2163, "Feed Label Information"

L-5194, "How to Control Cow Herd Feeding Expense"

Produced by AgriLife Communications and Marketing, The Texas A&M University System
Texas AgriLife Extension publications can be found on the Web at: http://AgriLifebookstore.org

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Revision

Texas Cooperative EXTENSION
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Feed Label Information

The feed label (tag) lists the nutrients and ingredients in commercial feeds so cattlemen can estimate potential performance. The Texas Feed and Fertilizer Control Service regulates feed and fertilizer labeling and monitors the guaranteed analyses of manufactured products sold in Texas.

Any individual or firm offering a commercial feed product for sale must supply a label for each bag or bulk load of feed listing net weight, product name and brand name (if any), guaranteed analysis for certain nutrients, content of any drugs or feed additives, name of each ingredient or the collective term for each grouping of feed ingredients, directions, for use and cautionary statements, and the name and principal address of the manufacturer.

The term "commercial feed" does not include whole seeds, grain, hays, straws, hubs, stover, silage, cotton plant by-products (gin trash) or salt when unmixed with other materials. Three different feed tags are included to illustrate various information. Feed Tag 1 is for a simple feed where no drugs or non-protein nitrogen are used. Feed Tag 2 includes a non-protein nitrogen source, and Feed Tag 3 is for a medicated feed. Each item on Feed Tags 1, 2 and 3 has a letter in parentheses which corresponds to expanded discussion of that item m the text.

(A) Guaranteed Analysis. Crude protein, crude fat and crude fiber must be guaranteed on all feeds. The exceptions are straight mineral or vitamin— supplements, molasses and drug compounds. Liquid feed supplements also must show a guarantee for the maximum moisture content (if more than 20 percent) and minimum phosphorus content. Guarantees for other nutrients are optional depending on the manufacturer. A protein, fat and fiber guarantee is not required for substances, which primarily supply minerals. Phosphatic materials for feeding purposes shall be labeled with a guarantee for the minimum and maximum percent calcium, the minimum percent phosphorus and the maximum percent fluorine. Commercial feeds containing 6.5 percent or more mineral elements must show the minimum and maximum percent calcium, minimum percent phosphorus and the minimum and maximum percent salt (if added).

(B-1) Minimum Crude Protein Content. The amount of crude or total protein in a feed is guaranteed, Crude protein is determined by multiplying the nitrogen content of a feed by 6.25. The factor 6.25 is used since an average protein contains 16 percent nitrogen (16/100 = 6.25).

(B-2) Non-Protein Nitrogen (NPN). When NPN is added to feedstuffs, a statement "for ruminants only" must appear underneath the feed name. Commercial feeds containing added non-protein nitrogen should be labeled as:

1. Complete feeds, supplements and concentrates containing more than 5 Percent protein from natural sources shall be guaranteed as follows:

   Crude protein, minimum___%. (This includes not more than ___% equivalent protein from non-protein nitrogen.)

   Feed Tag 2 shows a feed containing 20 percent crude protein that includes not more than 5 percent equivalent crude protein from NPN. Correct interpretation would be that 5 percentage units of the .20 percentage units of protein is coming from NPN. It is incorrect to assume that 5 percent of the 20 percent, which would amount to 1, is the amount of protein equivalent being, supplied by NPN.

2. Mixed feed concentrates and supplements containing less than 5 percent protein from natural sources may be guaranteed as follows:

   Equivalent Crude Protein from Non-protein Nitrogen, minimum,___%.

3. Ingredient sources of non-protein nitrogen such as urea, diammonium phosphate, ammonium polyphosphate solution, ammoniated rice hulls or any other basic non-protein nitrogen ingredients defined by the Association of American Feed Control officials shall be guaranteed as follows:

   Nitrogen, minimum, ___%. Equivalent Crude Protein from Non-protein Nitrogen, minimum, ___%.

If the equivalent crude protein exceeds 8.75 percent or 1/3 of the total crude protein in a mixed feed, a warning or caution statement must appear on the feed tag.

Most vegetable or native protein sources have a fairly constant nutritional value when fed to livestock. This is not true for NPN products, such as urea, biuret or ammoniacal compounds. The feeding value of NPN products varies greatly with the digestible energy content of the diet, the vegetable protein content, the amount of NPN added, the frequency of feeding and the protein requirement of the animal. Thus in evaluating feeds, it' is important to distinguish between crude protein from natural sources and crude protein equivalent being supplied from NPN. One can determine the amount of vegetable or native protein which is contained in a feed by subtracting the percentage of crude protein equivalent from the total crude protein guarantee. For example Feed Tag 2 there would be 15 percent protein coming from vegetable feed sources (20 – 5 = 15). For NPN to have feeding value it must be converted into protein by microbial populations which inhabit the ruminant animal's stomach. Recommendations concerning the nutritional value and use of NPN products are discussed in other Extension publications.

(C) Minimum Crude Fat Content. Fat has an energy value approximately 2.25 times the value of carbohydrate feedstuffs. Generally the fat content of similar mixed feeds does not vary greatly. Feeds with more fat will have higher energy values, assuming fiber levels are equal. Including over 5 percent fat in the total diet of ruminant animals may reduce the efficiency of digestion. High levels of added fat (5 to 12 percent) will limit feed intake.

(D) Maximum Crude Fiber Content. Crude fiber is a measure of the indigestible or non-useful portion of a feed. Crude fiber is not as accurate a measure of feed nutritional value as desired, but it does provide a useful indication. Feeds having low fiber values tend to be highest in digestible energy than those feeds having high fiber values. The relationship between crude fiber and digestible energy or TDN is outlined in Table-1. The relationship described in Table 1 will not hold true for feeds containing nonfibrous energy dilutants such as water or mineral matter.

(E) Collective Terms. It is permissible to include feedstuffs in a mixed feed under collective terminology where the individual feedstuff is not identified. A list of collective terms and feeds which are included in each classification is provided in table 2. Collective terms recognize a general classification of ingredient origin which performs a similar-function, but do not imply equivalent nutritional values. When a collective term is used, individual ingredients within that group cannot be listed on the label.

(F) Feeding Instructions. Feeding instructions are given with most feeds but they must be provided when drugs or NPN products are in the feed. Some digestive problems and animal deaths may be attributed directly to the use of commercial feeds.

Table 1. Maximum energy or TDN content based on crude fiber level. [a]

Maximum Crude fiber As Guaranteed	Digestible Energy	TDN [b]
%	Mcal./lbs.	%
4.0	1.58	79
6.0	1.52	76
8.0	1.46	73
10.0	1.40	70
12.0	1.34	67
14.0	128	64
16.0	1.22	61
18.0	1.16	58
20.0	1.10	55
22.0	1.04	52
24.0	0.98	49

[a] Individual feeds may vary considerably from these values due to safety margins in the fiber guarantee, mineral and urea content, and specific ingredients used. Estimates are not valid for salt-limited feeds or liquid supplements.
[b] Total Digestible Nutrients, indicative of energy content.

More often, such problems are related to improper feeding techniques—not following feeding instructions. Close adherence to feeding instructions and warnings would eliminate many of the digestive problems and animal deaths related to commercial feeds.

(G) Drug Additives. Whenever drugs are included in a feed, the word "medicated" must follow the brand or product name. Medicated feeds must show the name and amount of each drug, the purpose for which the drug is added, directions for use, and an adequate precaution and warning statement.

Consumer Complaints

Where it can be established that feed or fertilizer is reasonably suspected as a cause of animal loss, an investigation will be conducted by the Feed and Fertilizer Control Service Compliance section. The Feed and Fertilizer Control Service is responsible for seeing that feed and fertilizer laws have not been broken. They do not serve as claim adjustors, attorneys or counselors for the complainant. In order for a complaint to be accepted and investigated, the control service recommends that (1) a veterinarian be involved immediately in cases of animal sickness or loss, (2) other local plant or animal specialists be involved. (3) the suspected feed or fertilizer product be available for official sampling without having lost its original identity; and (4) documents identifying the product, manufacturer and supplier be available.

A complainant should agree that the manufacturer be notified of the complaint and should sign necessary investigation forms. Remember, the request for "feed or fertilizer analysis should not be for informational purposes only. There are numerous commercial labs for this purpose.

Summary

Give the feed label its due credit. It provides useful information concerning the appropriate use and economic value of a feed or supplement. With guarantees for protein and crude fiber (from which energy can be estimated) the cattleman is in a better position to select the proper feed or supplement for different groups of cattle. Information about fat, NPN or moisture in liquid feeds can aid in nutritional decision-making. Knowledge of collective terms can improve the understanding of information furnished on feed labels. By properly following warnings and instructions on labels, there will be less inefficient feed use and fewer animal losses,.

Table 2. List of collective terms.

ANIMAL PROTEIN PRODUCTS

- Animal Blood, Dried Animal
- By-Product Meal
- Buttermilk, Condensed
- Buttermilk, Dried
- Casein
- Casein, Dried Hydrolyzed
- Cheese Rmd
- Crab Meal
- Fish By-Product
- Fish Liver and Glandular Meal
- Fish Meal
- Fish Protem Concentrate
- Fish ReSidue Meal
- Fish SOlubles, Condensed
- Fish Solubles, Dried
- Fleshings Hydrolysate Hair. Hydrolyzed
- Leather Meal, Hydrolyzed
- Meat and Bone Meal
- Meat and Bone Meal Tankage
- Meat Meal
- Meat Meal Tankage
- Meat Solubles, Dned
- Milk Albumin, Dried
- Milk Protein, Dned
- Milk, Dried Whole
- Poultry By-Product Aggregate, Hydrolyzed
- Poultry By-Product Meal
- Poultry Feathers, Hydrolyzed
- Poultry Hatchery By-Product
- Shrimp Meal
- Skimmed Milk, Condensed
- Skimmed Milk, Oiled Skimmed
- Milk. Dried Cultured
- Skimmed Milk, Cultured Condensed
- Wheay. Condensed Cultured
- Whey SOlubles, Condensed
- Whey Solubles, Dried
- Whey, Condensed
- Whey, Condensed Hydrolyzed
- Whey. Oiled
- Whey, Oiled Hydrolyzed
- Whey-Product, Condensed
- Whey-Product, Oiled

FORAGE PRODUCTS

- Alfalfa Hay, Ground
- Alfalfa Leaf Meal
- Alfalfa Meal. Dehydrated
- Alfalfa Meal, Suncured
- Coastal Bermudagrass Hay
- Corn Plant, Dehydrated
- Corn Plant Pulp
- Flax Plant Product
- Grass. Ground
- Lespedeza Meal
- Lespedeza Stem Meal
- Silage. Dehydrated (Ensilage Pellets)
- Soybean Hay, Ground

GRAIN PRODUCTS

In any of the normal forms such as whole. ground, cracked, screened cracked, flaked, kibbled, toasted, or heat processed.

- Barley
- Corn
- Corn Feed Meal
- Grain Sorghums
- Oats
- Oats, Mixed Feed
- Rice, Brewers
- Rice, Ground Brown, Ground Paddy, Ground Rough, Broken or Chipped
- Rye
- Wheat

PROCESSED GRAIN BY -PRODUCTS

- Barley By-Products, Pearl
- Buckwheat Middlings Corn Bran
- Corn Extractives, Condensed Fermented, with Germ Meal Bran
- Corn Flour
- Corn Germ Meal (Wet and Dry Milled)
- Corn Gluten Feed
- Corn Grits
- Flour
- Grain Sorghum Germ Cake
- Grain Sorghum Germ Meal
- Grain Sowhum Gnts
- Grain Fra~tions. Aspirated
- Grain Sorghum Mill Feed
- Grains, Brewers Dned
- Grains, __ Distillers Dried
- Grains/Solubles, __ Distillers Dried
- Hominy Feed
- Malt Sprouts
- Oat Groats
- Oat Meal, Feeding
- Peanut Skins
- Rice Bran
- Rice Polishmgs
- Rye Middlings
- SOlubles, Condensed Distillers
- Solubles, __ Distillers Dried
- Sorghum Grain Flour, Gelantinized
- Sorghum Gram Flour, Partially Aspirated Gelatinized
- Soy Flour
- Soy Grits
- Wheat Bran
- Wheat Feed Flour
- Wheat Germ Meal, Defatted
- Wheat Germ Meal
- Wheat Middlings
- Wheat Mill Run
- Wheat Red Dog
- Wheat Shorts

PLANT PROTEIN PRODUCTS

- Algae Meal
- Beans
- Cocunut Meal
- Cottonseed Cake
- Cottonseed Flakes
- Cottonseed Meal
- Cottonseed Meal, Low Gossypol
- Cottonseed, Whole Pressed
- Guar Meal
- Linseed Meal
- Peanut Meal
- Peas
- Rapeseed Meal
- Safflower Meal
- Soy Protein Concentrate
- Soybea n Feed
- Soybean Meal
- Soybean Meal, Kibbled
- Soybeans, Ground
- Soybeans, Heat Processed
- Sunflower Meal
- Sunflower Meal, Dehulled
- Yeast, Active Dry
- Yeast, Brewers
- Yeast Culture
- Yeast, Oiled
- Yeast, Gram Distillers Dried
- Yeast, Molasses Distillers Dried
- Yeast, Primary Dried
- Yeast, Torula Dried

ROUGHAGE PRODUCTS

- Almond Hulls, Ground
- Apple Pectin Pulp, Dried
- Apple Pomace. Dried
- Bagasse
- Barley Hulls
- Barley Mill By-Product
- Beet Pulp, Dried
- Buckwheat Hulls
- Citrus Meal, Dried
- Citrus Pulp, __ Oiled
- Citrus Seed Meal
- Corn Cob Fractions
- Corn Plant Pulp
- Cottonseed Hulls
- Flax Straw By-Product
- Husks
- Malt Hulls
- Mill By-Product, Clipped
- Oat Hulls
- Oat Mill By-Product
- Peanut Hulls
- Rice Hulls
- Rice Mill By-Product
- Rye Mill Run
- Soybean Hulls Soybean
- Mill Feed Soybean Mill
- Run Straw, Ground
- Sunflower Hulls Tomato
- Pomace, Dried

MOLASSES PRODUCTS

- Beef Molasses
- Beef Molasses Product, Dned
- Beet Pulp Molasses, Dried
- Cane Molasses
- Citrus Molasses
- Molasses Distillers Solubles, Dried
- Molasses Distillers SOlubles, Condensed
- Molasses Fermentation Solubles, Condensed
- Molasses Yeast Solubles, Condensed
- Starch Molasses

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Implanting beef calves and stocker cattle

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Extension Beef Cattle Specialist
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Of all the management practices available to cow/calf and stocker cattle producers, implanting suckling calves and stocker cattle offers one of the highest benefit-to-cost ratios. Many implants are available, but selection of an implant is less critical than the decision on whether to implant or not.

Implants for calves and stocker cattle

Table 1 lists implants available for use in suckling calves and pasture cattle. The active compounds in calf implants are zeranol, estradiol benzoate-progesterone, or estradiol 17-beta. Stocker cattle implants contain the same active compounds, plus a combination of estradiol and trenbolone acetate. Some stocker cattle implants are designated for use in heifers or steers; they generally are denoted by an "H" or "S" in the implant name. These implants have no withdrawal time before sale or slaughter.

Implant administration

To administer implants, designate one person to implant while processing or working cattle. To avoid infections and reduced implant performance, make sure the ear surface, the implant applicator needle and the hands of the person implanting the cattle are clean. Some companies distribute disinfectant trays along with the implant applicator. Use these trays at chuteside as a place to rest the implant applicator when not in use and to clean the applicator needle. Before administering the implant, use a sponge soaked in disinfectant to remove manure and other foreign material from the ear surface. You can also use the sponge to clean the applicator needle.

Protect implant cartridges and belts from dust and other contaminants during storage and at chuteside. Some implants must be refrigerated during storage.

Place the implant under the skin on the backside of the middle third of the ear (Figure 1). Implanting at any other location violates federal law.

Applicators vary for different implants. Become familiar with the mechanical operation of the applicator to ensure proper implant placement, and avoid crushing, bunching or wasting implant pellets. The needle on the implant applicator must be sharp and free of spurs to avoid unnecessary trauma to the ear and implant site.

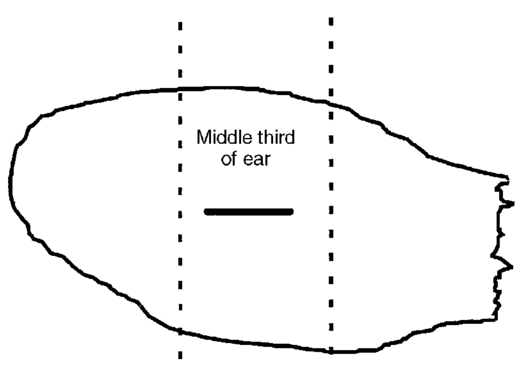

Figure 1. Proper implant placement on the backside of the ear.

Table 1. Guidelines for currently approved implants for suckling beef calves and stocker cattle.

Implant trade name	Marketing company	Active ingredient(s)	Target animal	Estimated payout period
Implus-C®or Calf-oid®	UpJohn Co.	100 mg progesterone 10 mg estradiol benzoate	Suckling beef calves up to 400 lbs.; not for use in calves less than 45 days old or calves intended for reproduction	100 - 140 days
Component-C®	VetLife, Inc.	100 mg progesterone 10 mg estradiol benzoate	Steer and heifer calves up to 400 lbs.; not for use in calves less than 45 days old or bull calves intended for reproduction	100 - 140 days
Synovex-C®	Ft. Dodge Animal Health	100 mg progesterone 10 mg estradiol benzoate	Steer and heifer calves up to 400 lbs.; not for use in calves less than 45 days old or bull calves intended for reproduction	100 - 140 days
Ralgro®	Schering-Plough Animal Health	36 mg zeranol	Steer and heifer calves; weaned steers and heifers; not for use in calves less than 30 days old or bull calves intended for reproduction	70 - 100 days
Compudose®	VetLife, Inc.	25.7 mg estradiol	Suckling steers; weaned steers and heifers; not for replacement heifers	170 - 200 days
Encore®	VetLife, Inc.	43.9 mg estradiol	Suckling steers; weaned steers and heifers; not for replacement heifers	400 days
Component-H®	VetLife, Inc.	200 mg testosterone 20 mg estradiol benzoate	Heifers over 400 lbs.; not for replacement heifers	100 - 140 days
Component-S®	Vetife, Inc.	200 mg progesterone 20 mg estradiol benzoate	Steers over 400 lbs.	100 - 140 days
Implus-H®	UpJohn Co.	200 mg testosterone 20 mg estradiol benzoate	Heifers over 400 lbs.; not for replacement heifers	100 - 140 days
Implus-S®	UpJohn Co.	200 mg progesterone 20 mg estradiol benzoate	Steers over 400 lbs.	100 - 140 days
Synovex-H®	Ft. Dodge Animal Health	200 mg testosterone 20 mg estradiol benzoate	Heifers over 400 lbs.; not for replacement heifers	100 - 140 days
Synovex-S®	Ft. Dodge Animal Health	200 mg progesterone 20 mg estradiol benzoate	Steers over 400 lbs.	100 - 140 days
Revalor-G®	Hoechst-Roussel Agri-Vet Co.	8 mg estradiol 40 mg trenbolone acetate	Weaned steers and heifers; not for replacement heifers	100 - 140 days

After placing the implant in the ear, palpate the site to ensure that the implant was properly placed. Apply pressure on the area punctured by the needle to help the wound close and prevent dirt and other foreign materials from entering the implant site.

Cattle performance

Suckling calves: Implanting suckling calves once with zeranol or estradiol-progesterone type implants will increase daily weight gains an average of 0.10 pound per day for steer calves and 0.12 pound per day for heifer calves (Selk, 1997). Implus-C® (Calf-oid®), Component-C®, Compudose®, Encore®, Ralgro®, and Synovex-C® are labeled for suckling steers and heifers. Component-S®, Component-H®, Implus-S®, Implus-H®, Synovex-S®, and Synovex-H® can also be used in sucking calves but are recommended for calves weighing over 400 pounds. Table 1 lists specific information and restrictions.

Potential replacement heifers: Concerns about reproductive performance have limited the use of growth implants in heifer calves that are potential herd placements. Currently, Synovex-C®, Component-C® and Ralgro® are the only implants labeled for use in replacement heifer calves (see Table 1). Use is restricted to heifers older than

30 days for Ralgro® and 45 days for Synovex-C® and Component-C®.

Implanting heifers at or near birth can reduce future reproductive performance. However, research has shown that one implant administered between 2 months of age and weaning has little effect on subsequent reproductive performance. The impacts on future reproductive performance are less predictable and can be severe in some cases when implants are administered after weaning. The probability and severity of reduced reproductive performance increases when heifers are implanted more than once between birth and puberty. Heifer calves that have been implanted have a larger pelvic area at 1 year of age. However, by calving time at 2 years of age, these differences are small and calving ease is not improved.

If replacement heifers are identified at a young age, do not implant them, as it provides no benefits; implants do not improve age at puberty nor calving ease. However, if replacement heifers cannot be identified at an early age, implanting all the heifer calves once between 2 months of age and weaning does not significantly affect reproduction in heifer calves eventually selected for replacements. The remaining heifer calves will be heavier at weaning.

Potential herd bulls: No implants are labeled for use in bull calves intended for future use as herd sires. Implants can suppress testicular development and reduce libido and semen quality.

Stocker cattle: A single implant will increase weight gain 8 to 18 percent, or 15 to 40 pounds, during the grazing season (Kuhl, 1997). If the grazing season is more than 100 to 120 days and the plane of nutrition is adequate, reimplanting or using an implant with a longer release period stimulates additional weight gain. All the implants listed in Table 1 can be used in stocker cattle. Implus-C® (Calf-oid®), Component-C®, and Synovex-C® are recommended for calves weighing less than 400 pounds and can be used with lightweight stocker cattle.

Reimplanting cattle: Reimplanting, or administering a second implant at some interval after the first implant, improves performance if the plane of nutrition is adequate. An implant releases (or "pays out") compound for 70 to 400 days depending on the implant (Table 1).

Although the implant releases active compound over an extended period, at some point the quantity of active ingredient released declines to a level that does not stimulate performance adequately. Therefore, the recommended reimplanting interval for each implant is shorter than the estimated payout.

As a rule of thumb, the window to reimplant cattle is about 30 days less than the estimated payout. So, if an implant has a 100- to 140-day payout, then administer another implant between 70 and 100 days if you want to maintain circulating levels of the active compounds.

Food safety concerns

The Food and Drug Administration requires no withdrawal period before slaughter of implanted cattle. Beef from implanted cattle has a very low level of estrogen activity compared to other common foods. Table 2 lists the estrogenic activity of several common foods. Likewise, the potential amount of estrogen consumed in beef from implanted cattle is extremely low compared to that produced daily by the

Table 2. Estrogenic activity of several common foods (adapted from Preston, 1997).

Food	Estrogenic activity (nanograms/lb. of food)
Soybean oil	908,000
Cabbage	10,896
Wheat germ	1,816
Peas	1,816
Eggs	15,890
Ice cream	2,724
Milk	59
Beef from a pregnant cow	636
Beef from implanted cattle	10
Beef from non-implanted cattle	7

human body. If a person consumed 1 pound of beef per day from implanted cattle, the potential estrogen intake would be about 10 nanograms. In comparison, the daily estrogen production by the human body is about 100,000 nanograms for adult men, about 5,000,000 nanograms for non-pregnant women, and about 40,000 nanograms for a prepuberal child.

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The Texas A&M University System

Internal Parasites of Cattle

The internal parasites of cattle in the southern United States fall into distinct groups: the roundworms or nematodes, the one-celled protozoa, the flukes, and the cestodes or tapeworms. Some members of these groups cause considerable disease. These include the gastrointestinal roundworms, the cocidia, liver flukes and the lungworms. These vary in their life cycle, means of spread from animal to animal and method of control and treatment and each will be discussed separately in this fact sheet.

Roundworms (Nematodes)

Twelve different roundworms can be found with regularity in southern cattle of various ages. Several more species are seen occasionally. Of these kinds of worms, the medium (or brown) stomach worm (*Ostertagia ortertagi*), the stomach hairworm or lesser stomach worm (*Trichostrongylus axei*), large stomach worm (*Haemonchus placei*) and cooperids (*Cooperia*) are the most common and most likely to be causing disease among southern cattle.

A recent Georgia survey of apparently normal cattle (beef and dairy cows, yearlings and replacement heifers and calves) showed a high level of parasite infestation: 83.9 percent of fecal examinations were positive and 100 percent of animals examined at slaughter had one or more types of worms in the gut. It is quite likely that this pattern will be seen in every part of the southern regions of the United States.

Determining if Roundworms are a Problem

While all southern cattle can be expected to have some roundworms in their gastrointestinal tract, it should not be assumed that all southern cattle are suffering from parasite-caused disease. The most accurate and least practical method to diagnose parasitic disease is to relate the clinical signs of disease with a postmortem examination on one or more afflicted animals from a herd and look for the presence of roundworms and the signs of injury caused by the worms in the gut.

Veterinarians and animal scientists, by identifying the eggs of various roundworms with the aid of a microscope, can learn something about the number and kind of intestinal parasites present in cattle. Various physical signs such as diarrhea, constipation, anemia, loss of weight, rough coat, edema and loss of appetite are some indications that cattle may be parasitized.

Experience in many herds will indicate that worms are a burden even though a postmortem is not feasible and worm egg counts are slight. "Diagnostic drenching" is a useful tool in these herds. A safe, broad spectrum dewormer will usually bring an end to signs of parasitic disease and improve the condition of the animals.

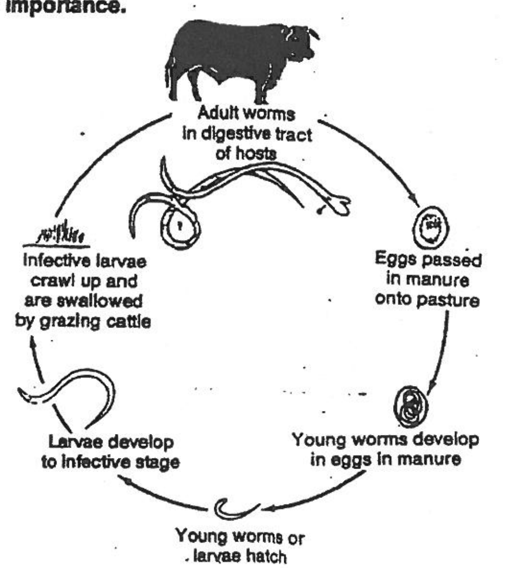
How Different Roundworms Affect Cattle

The roundworms that cause serious economic loss to southern cattle producers can be roughly divided into the blood suckers and those that cause inflammation and damage to the gut lining. The large stomach worm (Haemonchus) and brown (medium) stomach worm (Ortertagia) bury themselves in the wall of the abomasum or true stomach and feed upon blood, producing effects upon the host cow or calf by loss of red blood cells and albumin. In addition, the brown stomach worm, probably the single most devastating parasite for southern cattle, causes serious disruption of the digestion by drastically reducing stomach acidity and inducing a severe diarrhea.

Among the parasites which cause damage to the surface of the gut, the small stomach worm (*Trichostrongylus* and the cooperids (Cooperia) are the most common. These parasites usually produce an irritation to the lining of the abomasum and small intestine.

Stomach worm infections in the south are usually the result of both blood suckers and those that cause gut irritation being present in the calf or cow.

Figure 1. Life cycle of the nematodes of economic importance.



The most likely signs seen in these animals with mixed infections are loss of appetite, mushy to fluid feces, loss of weight or slowed rate of gain. Anemia (deficiency of red blood cells) mayor may not be observed. Although "bottle jaw," an accumulation of fluids under the skin of the lower jaw, may be seen in severely parasitized cattle, and is considered a sign diagnostic of heavy internal parasitism, it should not be expected in every case.

How Cattle Get Roundworms

The mature female worms living in the gut of a cow or calf produce large numbers of eggs which pass out of the animals with the manure. In the fecal pad, moisture and warmth cause the eggs to hatch and develop into larvae. These larvae will emerge out of the fecal pad and migrate when there is proper moisture. In the infective or third stage, larvae will migrate into grass. If the calf or cow grazes contaminated forage, the animal may acquire an active infection of roundworm parasites (Figure 1).

Development and survival of the larvae outside of the cow or calf depend upon many factors, including moisture, warmth, character of soil, type of vegetation, terrain type and degree of stocking. Once the larvae are accidentally eaten by the cow or calf with the forage, the larvae may penetrate the abomasal glands, as in the brown stomach worm, or develop into mature parasites in the mucosa of the stomach or small intestine, as in the lesser stomach worm and cooperids.

Prevention and Control

Overstocking of pastures contributes greatly to internal parasitism of cattle because it enhances the movement of parasites from animal to animal. Adult cattle and yearlings are the source of worm eggs which develop into larvae and infect young animals. Therefore, separation of cattle by age group as much as possible is helpful in controlling parasitism. Larvae require moisture for their development and migration; poorly drained pastures encourage internal parasitism. Rotation of pastures so that they are free of cattle for 4 to 6 months can help greatly in controlling parasites in young cattle. Since roundworm parasites have a free living phase in soil and forage, raising cattle in dry lots will help to control parasitism. Frequent removal of manure and care that it does not contaminate feed and water also will contribute to the control of parasites.

Immunity and Resistance to Internal Parasites

Age, diet, treatment programs, amount and types of larvae available and inherited resistance are all factors which contribute to immunity and resistance of cattle to internal parasites. Young cattle are more likely to be seriously affected by internal parasites than are cows and yearlings. Cattle develop natural immunity with age, in part due to infection of calves with small numbers of larvae which stimulate resistance.

Diet is important because the intake of essential nutrients aids in resistance to parasitic infestations. The newly weaned calf is twice burdened in dealing with internal parasites: it loses the supply of mother's milk, rich in needed nutrients and immunity factors, and it begins to graze pasture, often of low quality, which at the same time is likely to be heavily contaminated with larvae. Treatment at weaning with movement to clean pasture is probably the single most useful set of practices for controlling internal parasites in southern cattle.

Creep feeding, though not often economically feasible, will aid in the control of parasites. Any nutritional practice, such as higher quality pastures, which contributes to intake of better quality nutrients, will aid greatly in helping young cattle achieve a satisfactory equilibrium with their parasites.

Current intensive management practices which compel excessive numbers of cattle, especially cows and calves, to be pastured on limited acreage, contribute severely to the parasite side of the parasite-calf equilibrium. In such a management situation, regular therapeutic medication is necessary to achieve reasonable growth in young animals.

Treatment

If the cattle producer and/or veterinarian determine from clinical observation; fecal examination or other laboratory tests that gastrointestinal parasitism is causing disease, several products are available to help control the infection. Alternating drugs is a useful technique to help reduce the development of parasite resistance to drugs.

Highly effective drugs are Ivermectin (Ivomec®), Fenbendazole (Panacur®, Safe-Guard®), Thiabendazole (TBZ®, Omnizole®, Thibenzole®) and Levamisole (Tramisol®, Ripercol®, Levasole®). Coumaphos (Baymix®), Haloxon (Loxon®), Morantel (Rumatel®, Nematel®, Paratect® and Phenothiazine are available for treatment of GI parasitism in cattle but are not as widely effective.

Ostertagia Resistance

The brown stomach worm passes its fourth larval stage encysted in the wall of the stomach (abomasum). In this phase the roundworm is much more resistant to anthelmintics. Worm medicine may remove the adult worms in the stomach proper, but in a few days the larvae develop into adults, resulting in a situation similar to that prior to worming. It is important to remember that the effects of this parasite on cattle reduced stomach acidity, reduced pepsin production and albumin leakage into the gut-result mainly from the damage to the abomasal glands exposed by the departing larvae, and that these leave the glands when the number of adult worms in the abomasum are reduced. Treatment may therefore reduce the number of adults, stimulate migration and result in more disease. Anthelmintics that are effective against Ostertagia larvae and adults are Ivermectin, Fenbendazole and Levamisole.

Coccidia

Coccidiosis is a protozoan parasite of cattle which may cause anything from few signs of disease to serious blood problems, diarrhea and death. The oocysts or infective units of the disease can be found in the droppings of a high percentage of cattle in the south. At least 12 different species of coccidia have been identified in cattle in the U.S. Of these only three have been shown to cause serious disease in cattle and the rest apparently live in the gut without causing disease.

Three species of coccidia, *E. auburnensis*. *E. bovis* and *E. zuernii,* are usually implicated in outbreaks of coccidiosis of cattle. Signs of the disease are diarrhea, usually bloody, ranging from a soft dropping with specks of blood to passages which are composed entirely of clotted blood and mucus. With the diarrhea the animal will strain because the large bowel is irritated. Anemia, weakness and gaunt appearance usually accompany an acute case of the disease. Secondary disease such as pneumonia often occurs as a result of the coccidial infection.

An outbreak of coccidiosis usually occurs in young cattle at the time of some stress such as cold weather and the change of rations from high levels of roughage to more concentrates.

The most serious effect of coccidiosis is probably the lessening of feedlot efficiency due to the unseen effects of the parasite on cattle. These losses are not recognized because no visible signs of disease are noted. In subclinical disease, the attack of the parasite on the lining of the gut causes injury which is not great enough to be seen externally but results in reduced feed efficiency and rate of gain in the growing or feedlot animal.

Prevention and Control

Since a large portion of cattle are carriers of coccidia in their gut, calves are exposed to the infection early in life. Measures which lessen calves contact with feces of older cattle are important in controlling coccidiosis. Regular removal of manure and segregation of young cattle from yearlings and older animals will help.

Treatment

The sulfa drugs are effective in the treatment of coccidiosis. Those commonly used include sulfamethazine, sulfaguanidine and sulfaquinoxaline. Amprolium is a relatively new drug which has been used with good results in the treatment of the disease. Monensin, a growth promotant chemical, is also effective against coccidia.

Lungworms

Southern cattle occasionally are infected with lungworms because of the moderate temperatures and abundant moisture prevailing in most of the region.

Signs of Lungworm Disease

This parasite lives in the air passages of the lung, causing irritation, mucus production and leading to secondary bacterial infection. Clinical cases occur most frequently in young calves. The most common sign is rapid, shallow breathing. Infected animals usually have a loose cough which is made more severe by exercise. Animals with heavy infections tend to lose condition and may stand with head extended, mouth open with saliva drooling from mouth.

Diagnosis

The most positive diagnosis is by means of post-mortem examination. This procedure will expose the lungworms in the trachea and bronchi of the animal's lungs. The standard fecal flotation process for gastrointestinal parasites will not show the lungworm because the eggs usually hatch into larvae in the gut. The larvae in a fecal sample can be recovered easily and identified by the use of the Baermann technique. In many cases diagnosis is made on the basis of clinical sign; treatment with an appropriate anthelmintic will relieve the signs of a moderate infection and confirm the diagnosis.

Treatment

Effective anthelmintics against lungworms are Ivermectin, Fenbendazole and Levamisole.

Control

Because this parasite does not persist on the leaves of grass or on the soil for long periods of time, a 2-month interruption of grazing is enough to free a field of the parasite. Treatment of infected cattle before going to a clean pasture will reduce the numbers of larvae shed by these animals and aid in keeping calves free of the infection. Separation of calves from mature and yearling cattle and the careful pasturing of weanling calves will aid in protecting them from heavy exposures.

Liver Flukes

Disease from liver fluke occurs in certain regions of the south. It is rarely fatal but can cause serious losses because of damage to the liver and bile duct.

Life Cycle of the Fluke

Fluke eggs pass out of the cow with feces. In moist areas these eggs hatch into an intermediate stage which requires snails for further development. After 1 to 2 months in a snail, another phase in the life-cycle leaves the snail and encysts upon water vegetation. After being eaten with vegetation, the young flukes penetrate the gut wall, migrate in the gut cavity and finally penetrate the liver. In the liver the fluke causes serious tissue damage and reaches maturity in the bile duct where it releases eggs which pass out of the cow's body with feces to start the cycle again.

Signs of Fluke Infection
The liver fluke affects cattle by the damage which it does to the liver. This organ has large reserves of tissue and tolerates even large numbers of flukes, often without showing obvious clinical signs. Anemia, unthriftiness, "bottle jaw" and reduced milk flow are the most common signs of liver fluke.

Diagnosis
Eggs of the liver fluke cannot be detected in a standard fecal flotation. Sedimentation can be used if flukes are suspected because the eggs are heavy and will sink to the bottom of the tube for isolation and microscopic examination. Production of eggs does not take place until after the liver migration and serious tissue injury have occurred, so diagnosis in this manner is not helpful to the infected animal but is useful in identifying infected premises.

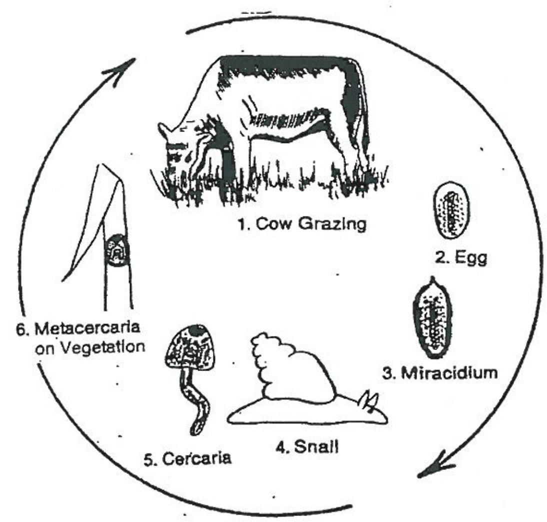
A history of liver fluke disease in a herd which is pastured in moist areas with heavy snail populations is enough evidence for a presumptive diagnosis of liver fluke disease.

Treatment
Clorsulon (Curatrem®) is the only drug available for removing the mature flukes from the bile ducts. The drug is not effective against gastrointestinal roundworms and lungworms.

Control
Because the disease requires an aquatic snail as an intermediate host, it can be best be prevented by eliminating exposure of cattle to the snail. This can be done by drainage to remove water necessary for the snail's environment and fencing cattle away from areas where the snail lives.

The information given herein is for educational purposes only. Reference to commercial products or trade names is made with the understanding that no discrimination is intended and no endorsement by the Cooperative Extension Service is implied.

Figure 2. Life cycle of liver fluke.



This information was prepared for the Southern Regional Beef Handbook by Ralph F. Hall, D.V.M.; Robert G. Scholtens, D.V.M., College of Veterinary Medicine, University of Tennessee.

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Texas Agricultural Extension Service
The Texas A&M University System

Managing External Parasites of Texas Livestock and Poultry

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

TABLE OF CONTENTS

Managing External Parasites of Texas Livestock and Poultry

Clifford E. Hoelscher, Carl D. Patrick, and James V. Robinson

Extension Entomologists
The Texas A&M University System

Integrated Pest Management (IPM) is a system approach that combines a variety of livestock production practices using both biological and chemical control methods. External and internal arthropod parasites of livestock and poultry are a constant menace. These pests lower the quality of animal products (hides, hair, wool) by physical feeding damage; reduce meat, milk and egg production by sucking blood from animals; transmit diseases; and cause energy loss. Suggested pesticides will aid in control of the major parasites where insecticide resistance has not developed. A special section addresses the management of insecticide-resistant pests.

Safety Tips for Using Pesticides

- ★ Read the labels and follow directions and safety precautions. (Never use pesticides inconsistent with the label).
- ★ Record all pesticide usage including the common name, trade name, formulation, dilution, application rate and date of treatment.
- ★ Use face masks or respirators and protective clothing during spraying. Avoid breathing spray mist or dust.
- ★ If pesticides are spilled on the skin or clothing, wash thoroughly with soap and water and change clothes.
- ★ Do not eat, drink or smoke when handling pesticides.
- ★ Provide adequate ventilation when applying pesticides.
- ★ To prevent illegal meat and milk residues and possible harm to the animal, never exceed label rates of application.
- ★ Never apply pesticides closer to slaughter dates than the number of days listed on the label.
- ★ Avoid drift to adjacent cropland, yards, wood lots, lakes or ponds. Some materials may injure and kill fish or wildlife crops.
- ★ Avoid treatment to animals that are sick, overheated or stressed from shipping, dehorning, castration, recent weaning, etc.
- ★ Avoid contamination of feed, mangers, water, milk and milking equipment.
- ★ Do not spread treated manure on cropland unless label approval is given.
- ★ Store pesticides in the original, labeled containers, safely locked away from children, pets and livestock.
- ★ Dispose of empty pesticide containers promptly and properly according to specified recommendations. Stay out of the smoke if containers are burned.
- ★ Contact a physician at once in all cases of suspected poisoning. Symptoms of organic phosphate poisoning include blurred vision, abdominal cramps and tightness in the chest. Atropine is antidotal for some organophosphorus pesticides.

Livestock Pests

House Fly

The house fly is suspected of reducing weight gains and feed efficiency in livestock. Pesticides alone will not control house flies. Sanitary measures that eliminate fly breeding areas such as spreading of manure, regular cleaning and prevention of waste accumulation, and regular removal of spilled feed are necessary. Spread manure thinly in fields so fly eggs and larvae will be killed by drying and heat. Several pesticides can be used on manure piles to prevent maggot development.

Pesticides in spray or bait forms may be used to control adult flies in livestock barns and poultry houses. Do not contaminate feed, utensils, drinking water or milking equipment with any pesticide.

Stable Fly

Stable flies suck blood, irritate animals and reduce weight gain and milk production. These flies breed in mixtures of manure and decaying litter around barns. Dispose of manure and litter as outlined for house flies. Sanitation is important in reducing stable fly numbers. Immediate fly control may be obtained by spraying fly resting areas with approved pesticides.

Screwworm Fly

The screwworm fly has been eradicated from Texas. The last confirmed case was reported in 1982. Eradication was accomplished over a 20-year period using sterile-male fly releases, insecticide baits and producer diligence and support. Screwworm eradication has now been achieved in the Republic of Mexico. Eradication efforts are presently underway in Costa Rica and Panama.

There is a constant threat of reintroduction of the screwworm by the accidental transportation of infested animals to uninfested areas. Producers must always be aware of the potential threat of screwworm infestations. Producers are urged to inspect livestock for screwworms and submit all suspect blow fly larvae found in animals for positive identification. Collect 10 larvae from deep within the wound. Place them in alcohol and send samples to the Southwest Screwworm Eradication Laboratory, Box 969, Mission, TX 78572. Telephone (409) 845-7027 at Texas A&M University for additional information. The USDA, APHIS, international services office at (301) 734-8892 also can provide assistance. Suspect screwworm samples can be sent directly to the National Veterinary Science Laboratory, Box 844, Dayton Road, Ames, IA 50010, (515) 239-8301.

Report any suspected screwworm cases to your county Extension agent or local veterinarian. Eradication personnel can take the appropriate measures only when they are aware of the problem.

Horn Fly

Horn flies suck blood, irritate cattle and reduce weight gains by decreasing animal thrift and vigor. Horn flies can become numerous on cattle from late spring to early fall. There are several self-treatment devices that may be used to control horn flies. Cable-type back rubbers covered with an absorbent material treated with an insecticide-oil solution, or fabric dust bags partially filled with an approved pesticide dust, have been used successfully. Place these devices near water, feed or mineral sources or in gaps or gateways to encourage use. A 2- to 3-week adjustment period may be necessary before cattle begin to use self-treatment devices regularly. Forced use of these self-applicating devices results in more rapid and effective control of horn flies and may aid in lice control.

Insecticide-impregnated ear tags provide excellent horn fly control for periods of 2 1/2 to 5 months if properly attached to the ear and if pyrethroid or organophosphate resistance is not a factor.

Automatic, animal-activated sprays often are installed in exit chutes of milking barns. Animals can be treated conveniently twice each day (or less often as necessary) with very small volumes of specially formulated pesticides for biting fly and other insect control.

Management of Pyrethroid-resistant Horn Flies

Field observations and laboratory studies conducted during the summer and fall of 1984 confirmed the development of pyrethroid resistance in horn flies. The combination of very effective insecticides and widespread ear tag use by cattlemen has allowed horn fly resistance to develop. Cross-resistance to the common pyrethroids has been confirmed by field observations. Flies that have developed resistance to one of the pyrethroids will be resistant to all other pyrethroid insecticides currently labeled for use in Texas. However, the newer products may continue to provide acceptable control for several years by using more potent materials.

Continued treatment of successive generations of flies with the same type of insecticide can cause insecticide resistance to develop. Individuals in the population that are carrying genes susceptible to the toxicant are quickly killed, and the survivors, carrying resistant genes, reproduce to build the next, more difficult to kill generation. Rotation of insecticides with different modes of action is extremely important in avoiding or delaying resistance.

Insecticide ear tags perform by dispensing a small amount of the insecticide continuously over a 2 1/2- to 5-month period. The insecticide diffuses to the tag surface and is deposited on the animal's body through normal body movement. Flow of the insecticide from the tag starts at a high rate and decreases to a point where fly control is no longer achieved. Ear tags have provided economical control of the horn fly, Gulf Coast tick and spinose ear tick. Data show that horn flies are the most obvious pest that can become resistant to pyrethroid insecticides dispensed from ear tags.

The following are management options for control of pyrethroid-resistant horn flies:

Option 1: Do not treat cattle for horn flies.

Option 2: Treat cattle with insecticides only after horn fly populations reach 250 to 300 per head. Research has indicated that if there are fewer than 250 flies per animal, economic losses rarely occur.

Treatment Options:

a) Use alternate chemistry type sprays, dusts or other formulations. Treat only when horn fly populations exceed 200 to 250 per head.

b) Use organophosphate (OP) ear tags such as Cutter 1®, Terminator®, Optimizer® or Commando®. Do not use organophosphate ear tags if they have been used the previous 2 or more successive years. If ear tags are used, remove tags when calves are weaned or cows are worked in the fall. If horn fly populations exceed 200 to 250 per head at the time tags are removed, apply a spray or dust treatment to reduce the potential population of overwintering flies.

Where there are flies resistant to pyrethroid or OP insecticides, continued use of these chemistry types can increase resistance levels. Do not use pyrethroids in any formulation including organophosphate/pyrethroid combination ear tags where resistance is a problem. Left untreated, susceptible flies will mate with other susceptible or resistant flies. This reduces the rate at which resistance develops. Periodic application methods tend to increase resistance levels less than continuous release methods.

The combination ear tags include Double Barrel® and Max Con®. These dual chemistry tags are not listed because resistance develops for both types of compounds.

Blow Fly

Blow fly larvae, commonly referred to as fleeceworms or wool maggots, attack sheep and goats. Infestations usually start around the crotch in wool or mohair contaminated with feces and urine. Ordinarily, tagging and docking animals prevents fleeceworm infestations. If fleeceworms occur, shear the affected area and treat with a labeled insecticide.

Blow fly maggots also are found in wounds on other livestock. Black blow fly larvae frequently infest dehorning wounds during winter months and occasionally infest the navels of newborn animals.

Cattle Grub (Heel Fly)

Cattle grubs cause economic losses because they reduce milk production, weight gain, feed efficiency and hide value. Losses also are suffered with carcass trim and lower meat quality.

Cattle grubs are the larval stage of heel flies. Adult heel flies emerge in late winter, spring or summer. Female flies lay eggs on the legs and lower body regions of cattle. Heel fly activity causes cattle to run widely with tails in the air (gadding), or to stand in water to protect themselves. Eggs attached to the hairs hatch into tiny larvae that penetrate the skin and begin to migrate through the body of the animal. Larvae congregate in the tissues of the esophagus, but eventually move to the back in later summer, fall or winter. Grubs develop with a "cyst" or "warble" just under the skin on the back. After 6 to 8 weeks, grubs leave the animal's body through holes cut in the hide, fall to the soil and pupate.

Although cattle grubs can be controlled after they reach the animal's back, earlier control is preferable. Once the grubs reach the back, most of the damage has been done.

Systemic pesticides administered as sprays, dips, pour-ons, boluses and injectables are distributed through the animal's body; systemic pesticides destroy cattle grubs by contact action. To avoid the possibility of a host-parasite reaction, cattle should be treated with systemics as soon as possible after heel fly activity ceases but not within a 6- to 7-week period prior to the expected appearance of grubs in the back. Typical host-parasite reaction symptoms include a swollen esophagus, bloat, profuse salivation, discomfort and, in extreme cases, death. Do not confuse a host-parasite reaction with organophosphate poisoning, which is quite similar. Atropine, an antidote for OP poisoning, is NOT RECOMMENDED for a host-parasite reaction and may make the problem worse.

Bot Fly

Two species of bot flies attack horses. With heavy infestations horses become unthrifty. Eggs are attached to hairs on the lip and under the jaw or on the front legs of horses, depending upon the bot fly species. Eggs hatch directly or in response to warmth and moisture, usually where horses lick themselves. Larvae become attached to and feed in various portions of the digestive tract, from the mouth to the rectum. Mature larvae are passed with the feces. Pupation occurs in the soil and adults emerge 3 to 10 weeks later. Treatment for bots is an oral dose of an approved pesticide.

The sheep nose bot is a hairy, yellowish fly about the size of a honey bee. It deposits living larvae around the nostrils of sheep. The larvae crawl into nasal passages where they remain until mature. After varying lengths of time, they fall to the ground where they pupate.

Horse Fly, Deer Fly, Mosquito, Black Fly

Horse fly and deer fly adults are vicious biters. They cause livestock to lose weight and may transmit anaplasmosis, anthrax and other diseases. Most horse flies and deer flies are found in brushy or low lying pasture areas near creeks, streams or tanks that provide damp soils in which the immature stages develop. Moving livestock from such areas may provide them some relief from the attacks of horse flies and deer flies.

Mosquitoes are important pests of livestock in irrigated areas or where there is heavy rainfall. Producers may not fully appreciate the losses that mosquitoes cause, for heaviest attacks often occur at night. Mosquitoes are carriers of several diseases, including sleeping sickness in horses.

The black fly is a small, humpbacked fly which can occur in tremendous numbers, causing irritation and even death to livestock. They are important vectors of diseases such as leucocytozoan disease of turkeys. Smokey fires can give animals relief from black flies. Insecticides also give temporary relief if applied frequently. Larvae develop in rivers and streams. Larvacidal control requires careful study and the accurate application of insecticide.

Lice

Lice cause the U.S. cattle industry annual losses of several million dollars. These losses result from anemia, unthriftiness, reduced rates of growth, inefficient feed utilization, secondary diseases resulting from lowered resistance of the animals and even mortality.

Four species of lice suck blood from cattle; one feeds on hair and scales. Lice are more abundant during winter and spring when the hair is long and animals are in close proximity. For effective control, treat cattle in the late fall and early winter.

Several species of sucking and biting lice attack sheep and goats. Animals infested with lice rub, bite and pull the infested area, damaging wool and mohair.

Only one species of lice occurs on hogs. These blood-sucking lice transfer from one animal to another when the animals are in close contact.

Poultry are attacked by several species of biting lice that cause irritation and weight loss, reduce egg production, decrease market quality of birds and even kill some birds.

Two species of lice are commonly found on horses in Texas. One sucks blood and the other is a chewing louse which feeds on skin scales and hair. Both produce intense itching and irritation that cause the animal to rub and scratch.

Mites

Mange mites burrow into the skin, producing tunnels in which the eggs are deposited. Scab mites deposit their eggs at the bases of hairs or in the skin. Feeding of the mites produces scabs which constantly enlarge as feeding progresses.

Certain species of scab mites attacking cattle, sheep or goats are under state quarantine regulations. If the presence of mites is suspected, contact personnel of the Texas Animal Health Commission, Box 12966, Austin, Texas 78711, (512) 719-0700.

The chicken mite is an intermittent feeder, usually remaining on the host a short time. The northern fowl mite and the tropical fowl mite usually spend their entire life cycles on hosts.

The scaley-leg mite burrows under the scales on the feet and legs of fowl, causing irritation, sores and secretions.

Depluming mites burrow into the skin of chickens and cause irritation around the bases of feathers.

Chiggers are frequent pests of chickens and turkeys on range. They cause irritation and lowered feed conversion efficiency, but the main concern is skin blemishes which lower the carcass grade of processed poultry.

Ticks

Several species of hard and soft ticks attack livestock and poultry. The lone star tick occurs principally in wooded or brushy areas during spring and summer, and is most abundant in east central and west central Texas. The Gulf Coast tick now ranges from the Gulf Coast of Texas to central Oklahoma. Peak adult activity in Texas occurs in late summer and early fall. Adults attack cattle mainly around the ears, eyes and poll of the head; the lesions often resulted in screwworm infestations before fly eradication was achieved. The winter tick can become a problem during the late fall and winter. In the eastern half of the state, the black-legged tick occurs in the spring and winter. The spinose ear tick is not found throughout Texas. These ticks, which attach deep within the ears of livestock, cause intense irritation, wax accumulation and excretions, which may cause ear infections.

The fowl tick ("blue bug") injures poultry by sucking blood, transmitting disease, causing weight loss, lowering egg production and causing skin blemishes which reduce market value.

The tropical horse tick attacks horses and is usually found attached within the ears and on the mane and nostrils. Its distribution is restricted to the southern tip of Texas and Florida. Its feeding activity causes intense irritation, making infested horses very head shy. The tick also can transmit equine piroplasmosis.

Fleas

Stick tight fleas are a common pest of poultry throughout the southern areas of the United States. When fleas are abundant, their blood sucking reduces egg production and kills young birds. They attach to the comb and wattles and around the eyes.

Pesticide Formulations

Livestock pesticides are formulated as wettable powders, pour-ons, spot-ons, emulsifiable concentrates, smears, feed additives, dusts, injectables, aerosols, impregnated PVC, baits and pastes. Only those pesticides made specifically for animals should be used. Other formulations of the same pesticide may be dangerous to the animal. Handle all pesticides carefully and follow exactly all label instructions.

Sprays

Prepare only enough solution to adequately spray the animals. Pesticides may undergo chemical changes after being mixed with water, creating potential hazards to the applicator and animals. Emulsifiable concentrate or soluble formulations are better than wettable powders for use in small sprays because less agitation is required to maintain a uniform mixture.

When spraying to control ticks, lice and mites, use enough water to cover the animal thoroughly. Wet animals to the skin when spraying systemic pesticides for cattle grub control. Sprayers can be moved easily from pasture to pasture; however, transporting water may be a problem because up to 1 gallon of spray per animal is often required for effective parasite control. Sprayers should have a high-volume piston pump with a suitable agitator when applying sprays made from wettable powders. Apply sprays at a pressure of 250 to 350 pounds per square inch.

Dips

Properly maintained dip vats provide effective parasite control. Vats can be filled early in the season and used several times during the year. Initial cost of filling and charging the vat is high, but cost per animal may be relatively low since many animals can be dipped in the vat during the season with little additional expense. Because animals are wet thoroughly in a vat, good coverage is ensured.

When filling or recharging a dipping vat, use only formulations specially prepared for dipping animals. Do not mix two or more different products unless specified on their labels. Follow the manufacturer's label directions for mixing fresh dips and for replenishing previously used dips. Mix the material thoroughly in the vat before each use.

Pour-ons

Pour-on pesticides are formulated for direct application to the backlines of animals. They are used principally for cattle grub and louse control. Recommended materials may be purchased in ready-to-use or water-miscible formulations. The chemical is absorbed through the skin and circulates through the animal's system. Backline treatments with pour-on material also provide horn fly control for a short period of time.

Spot-ons

Spot-on pesticides can be easily applied for cattle grub and louse control. This method involves the application of a small amount of pesticide with specially designed applicators in a single spot on the backlines of animals.

Dusts

Dusts can be applied to animals by hand shakers or in self-treatment dust bags. Their chief value is for horn fly and lice control on large animals and for lice and mite control on poultry.

Injectables

Avermectin treatment for beef cattle is labeled as a subcutaneous injection. Present formulations are also labeled for internal parasite control.

Feed and Mineral Pesticide Additives

Certain pesticides may be administered as feed or mineral additives. These control certain fly species whose maggot stages occur in animal manure.

Insecticide-Impregnated Ear Tags

Ear tags are plastic devices that contain an insecticide for ear tick and horn fly control. They control ear ticks for 4 to 5 months and horn flies for 2 1/2 to 5 months (in areas where flies are not resistant to pyrethroids). Observations across Texas have indicated that longer residual control can be expected in the central and western areas compared to the more humid coastal areas of south Texas.

Baits

Baits are primarily used to help control house flies around feedlots, dairies, poultry houses, livestock barns and other places flies tend to congregate. Baits are made from dry sugar, syrup or other substances that attract flies. A small amount of pesticide is added to the mixture to kill flies that feed on the bait.

Pastes

Several treatments for horses and cattle are formulated as pastes to be applied orally with a ready-to-use syringe. Label instructions should be followed closely.

Boluses

Boluses are designed to slowly release materials in the animal's reticulum. Vigilante® contains dimilin which is an insect growth regulator. Ivomec SR Bolus® contains an avermectin which controls a broad spectrum of internal and external pests.

Read the Label - Follow Directions

The Environmental Protection Agency establishes tolerances for pesticide residues in agricultural commodities intended for human consumption. Follow suggestions in this publication and on the manufacturer's label concerning dosage, frequency of application and slaughter interval to avoid illegal residues. Read thoroughly the remarks and safety restrictions in the following table and on the manufacturer's label.

Pesticide Suggestions

NOTE: The tables on the following pages are intended to serve only as a guide to the selection of pesticides for control of specific parasites. Space does not permit presenting full instructions for use of all products. Before purchasing any insecticide, read the label closely to determine whether the product is appropriate for your uses. Pay particular attention to all directions, restrictions and precautions and use the product in strict accordance with the label to avoid personal or animal injury or illegal residues in meat or milk. A list of chemical and corresponding trade names for various insecticides is provided on page 23 of this guide.

Dilution Chart for Mixing Sprays or Dips

Amount of Insecticide Concentrate in 100 Gallons and 5 Gallons of Total Mixture

	1% Mix		0.5% Mix		0.25% Mix		0.60% Mix		0.03% Mix		0.01% Mix	
Insecticide concentrate	**100 Gal.**	**5 Gal.**	**100 Gal.**	**5 Gal.**	**100 Gal.**	**5 Gal.**	**100 Gal.**	**5 Gal.**	**100 Gal.**	**5 Gal.**	**100 Gal.**	**5 Gal.**
5.7%EC	1.75 gal.	7.0 pt.	8.8 gal.	3.5 pt.	4.4 gal.	28.0 oz.	1.0 gal.	6.7 oz.	4.2 pt.	3.4 oz.	1.4 pt.	1.1 oz.
10% EC	10.0 gal.	2.0 qt.	5.0 gal.	1.0 qt.	2.5 gal.	1.0 pt.	4.8 pt.	3.8 oz.	2.4 pt.	1.9 oz.	0.8 pt.	0.63 oz.
11% EC	9.0 gal.	3.6 pt.	4.5 gal.	1.8 pt.	2.3 gal.	14.5 oz.	4.4 pt.	3.5 oz.	2.2 pt.	1.7 oz.	0.73 pt.	0.57 oz.
11.6 ELI	8.6 gal.	3.4 pt.	4.3 gal.	1.7 pt.	2.2 gal.	13.8 oz.	4.1 pt.	3.3 oz.	2.1 pt.	1.6 oz.	0.70 pt.	0.55 oz.
25% WP	33.4 lb.	1.6 lb.	16.7 lb.	13.3 oz.	8.3 lb.	6.7 oz.	2.0 lb.	1.6 oz.	1.0 lb.	0.8 oz.	0.33 lb	0.27 oz.
25% EC	4.0 gal.	25.6 oz.	8.0 qt.	12.8 oz.	1.0 gal.	6.4 oz.	1.9 pt.	1.5 oz.	1.0 pt.	0.8 oz.	0.33 pt.	0.26 oz.
40% WP	20.8 lb.	1.0 lb.	10.4 lb.	8.3 oz.	5.2 lb.	4.1 oz.	1.3 lb.	1.0 oz.	10.0 oz.	0.5 oz.	3.34 oz.	0.17 oz.
40% WP	2.5 gal.	1.0 lb.	5.0 qt.	0.5 pt.	2.5 qt.	4.0 oz.	19.2 oz.	1.0 oz.	9.6 oz.	0.5 oz.	3.20 oz.	0.17 oz.
50% WP	16.7 lb.	13.3 oz.	8.3 lb.	6.7 oz.	4.2 lb.	3.4 oz.	1.0 lb.	0.8 oz.	0.5 pt.	0.3 oz.	0.17 pt.	0.10 oz.
57% EC	7.0 qt.	11.2 oz.	3.5 qt.	5.6 oz.	3.6 pt.	2.8 oz.	13.4 oz.	6.7 oz.	6.7 oz.	0.3 oz.	2.20 oz.	0.11 oz.

WP = Wettable powder
EC = Emulsifiable concentrate
ELI = Emulsifiable liquid insecticide
WDL= Water dispersible liquid

Fluid conversion for EC only:

1 gallon (gal.) = 4 quarts (qts.)
1 gallon = 128 fluid ounces (oz.)
1 quart (qt.) = 2 pints (pts.)
1 pint = 16 fluid ounces
1 fluid ounce = 2 tablespoons (tbsp.)
1 tablespoon = 3 teaspoons (tsp.)

Formulas and Examples

To use wettable powders (WP) use the following formula to find the number of ounces of wettable powder to mix in the spray tank.

$$\frac{A \times S \times 8.345}{WP} \times 16 \text{ oz.} = \text{amount of WP in ounces}$$

Where: A = amount finished spray (gallons)
S = percent spray mix desired
WP = % wettable powder

Example: To make 5 gallons of a 0.06% spray mix from a 25% WP

$$\frac{5 \text{ gal.} \times 0.06\,\% \text{ spray} \times 8.345}{25\% \text{ WP}} \times 16 \text{ oz.} =$$

$$\frac{2.5}{25} \times 16 \text{ oz.} = 0.1 \times 16 = 1.6 \text{ oz.}$$

To use an EC, ELI or WDL use the following formula to find the number of **liquid ounces** to mix in the spray tank.

$$\frac{A \times S}{C} \times 128 \text{ oz.} = \text{quantity of liquid in ounces}$$

Where: A = amount finished spray (gallons)
S = percent spray mix desired
C = % concentration liquid product

Example: To make 100 gallons of a 0.06% spray mix from a 12% EC

$$\frac{100 \times 0.6}{12} \times 128 = 0.5 \times 128 = 64 \text{ oz. or 4 pints}$$

Pesticide Suggestions

Pest	Pesticide	Formulation	Minimum days from last application to slaughter	Remarks and safety restrictions

Beef Cattle and Non-Lactating Dairy Cattle

Pest	Pesticide	Formulation	Minimum days from last application to slaughter	Remarks and safety restrictions
Cattle Grub	**Note:** Systemic pesticides for cattle grub control may be administered as dips, sprays, pour-ons, injectables or spot-ons. Administer treatments between May and September 1, preferably soon after May 1 for best results. Animals should not be treated for grub control and internal parasites with certain products on the same day. In addition to restrictions listed below, follow all precautions and restrictions listed on the product label.			
1. Dips	Coumaphos (Co-Ral®)	25% WP 42% flowable	0	Agitate dip vat thoroughly before use. Do not apply to non-lactating dairy animals within 14 days of freshening. Do not treat animals less than 3 months old. Do not treat sick, convalescent or stressed livestock. Also controls horn flies, lice and ticks.
	Phosmet (GX-118®)	11.6% EC	21	Agitate dip vat solution thoroughly before use. Do not treat dairy animals. Do not treat calves less than 3 months old. Do not treat sick or debilitated animals. Also controls horn flies.
2. Sprays	Note: Thoroughly wet the animals to skin with spray from a high pressure sprayer using up to 1 gallon of finished formulation per animal.			
	Coumaphos (Co-Ral®)	25% WP 11.6 EC	0	Spray restrictions same as for Coumaphos above. Also do not spray animals for 10 days before or after shipping or weaning, or after exposure to contagious and infectious disease. Also controls horn flies, ticks and lice.
	Phosmet (Prolate®) (GX-118®) (Delphos®) (Lintox-HD)	11.6% EC	21	Do not treat dairy animals. Do not spray more than every 7 days. Do not treat calves less than 3 months old. Do not treat sick or debilitated animals. Also controls horn flies.
3. Pour- ons	Note: Under certain conditions, some pour-ons may cause minor skin irritation and scurfing. Show animals should be treated at least several weeks in advance of show time to allow any unsightliness to disappear.			
	Famphur (Warbex®)	13.2%	35	Use with caution on Brahman animals. Do not use on dairy cows or within 21 days of freshening. Do not treat calves less than 3 months old. Do not treat sick or stressed animals. Also controls horn flies and aids in louse control.
	Fenthion (Tiguvon®)	3.0%	35-45	Do not treat dry animals within 28 days of freshening. Do not treat animals less than 3 months old. Do not treat sick or stressed animals. Do not treat within 10 days of shipping or weaning. Also controls lice.
	Avermectin (Ivomec®) (Eprinex®)	0.5% ready-to-use ready-to-use	48 0	Do not treat animals within 48 days of slaughter. Do not treat dairy cattle of breeding age. Apply 1 ml. per 22 lbs. of body weight.
	Phosmet (Prolate®) (GX-118®) (Delphos®)	11.6% pour-on	21	Same restrictions as for Phosmet above.

Pesticide Suggestions (*Continued*)

Pest	Pesticide	Formulation	Minimum days from last application to slaughter	Remarks and safety restrictions
Cattle Grub (Cont.)				
4. Spot-ons	Fenthion (Spotton®)	20% ready-to-use	45	Do not treat dairy cattle of breeding age; calves less than 3 months old; or sick, convalescent or severely stressed livestock. Do not treat within 10 days of shipping or weaning.
5. Injectables	Avermectin (Ivomec®)	1% ready-to-use	35	Use subcutaneous injection only. Not for intravenous or intramuscular use. Do not exceed 200 micrograms of avermectin per each kilogram (2.2 lbs.) of animal weight. No more than 10 mls. of Ivomec® should be used on animals over 1,100 lbs. (See label for specific instructions.)
	(Ivomec®)	injectable		
	(Dectomex®)	1% injectable		Subcutaneous or intramuscular injection. Do not treat animals within 35 days of slaughter. 1 ml/110 lbs. of body weight. Do not use on dairy cattle over 20 months of age.
Horn Fly	Cyfluthrin (Cutter Gold®)	10% ear tag	0	Use 2 tags per head.
	(CyLence®)	1% ready-to-use		
	Coumaphos (Co-Ral®)	1% dust 11.6% EC 42% ELI	0	Do not apply to dry animals within 14 days of freshening.
	Diazinon (Cutter 1®)	40% ear tag	0	Use 1-2 tags per head when horn flies exceed 250-300 per head.
	(Terminator®)	20% ear tag	0	
	(Optimizer®)	20% ear tag	0	
	Dichlorvos (Vapona®)	21.8% EC	0	DO NOT exceed recommended labeled rates.
	Ethion (Commando®)	36% ear tag	0	Use 1-2 tags per animal.
	Fenthion (Lysoff®)	7.6% pour-on	21-35	Do not treat calves less than 3 months old, or sick, convalescent or stressed live-stock. Do not treat non-lactating dairy cattle within 28 days of freshening.
	(Cutter Blue®)	20% ear tag	0	Apply 2 per animal.
	Fenvalerate (Ectrin®)	8% ear tag	0	Use 1-2 tags per animal.
	(Eartag Plus®)	8% ear tag	0	Use 1-2 tags per animal.
	Lambda-cyhalothrin (Saber Extra Ear Tag®)	10% ear tag	0	Use 1-2 tags per animal.
	Methoxychlor (Marlate®)	50% WP	0	Do not apply to dry dairy animals within 14 days of freshening. Use only where pyrethroid resistance is not suspected.

Pesticide Suggestions (*Continued*)

Pest	Pesticide	Formulation	Minimum days from last application to slaughter	Remarks and safety restrictions
Horn Fly	Permethrin			
(cont.)	(Duraset®)	1%	0	Contains Forapearl.
	(Brute®)	10% pour-on	0	Can use on dairy cows.
	(Gardstar®)	40% EC	0	
	(GardStar®)	10% ear tag	0	Apply 1-2 tags per animal.
	(Ectiban®)	0.25% dust	0	Use at 14-day intervals.
	(Anchor® Permectrin II)	10% EC	0	Spray at 14- to 21-day intervals.
	Permectrin CD	10% pour-on	0	Ready-to-use.
	Permectrin CD5	7.4% pour-on	0	Ready-to-use.
	(Atroban®)	11 EC	0	Spray at 14- to 21- day intervals.
		10% ear tag	0	Apply 1-2 tags per animal.
	(Ectiban)	5.7% EC	0	Spray at 14- to 21- day intervals.
	Phosmet (Prolate®) (GX-118®) (Delphos®)	11.6% EC	21	Follow the same restrictions given for cattle grubs in preceding section.
	Pirimiphos methyl (Dominator®)	20% ear tag	0	Use 1-2 tags per animal.
	S-cyanomethyl carboxylate (Python®)	10% ear tag	0	Use 1-2 tags per animal.
	Stirofos (Rabon®)	50%WP	0	Use 1/2 to 1 gal. dilute spray per animal.
	Stirofos + Dichlorvos (Ravap®)	23.0%+5.3%EC	0	Beef cattle only. Do not treat more often than every 10 days. Apply as a coarse spray.
Ticks	Amitraz (Taktic®)	12.5% EC	0	Use 1 quart in 100 gal. water.
	Coumaphos (Co-Ral®)	5.8% LIS 25% WP 42% flowable 11.6% EC	0	Do not apply to dry dairy animals within 14 days of freshening.
	Permethrin (Anchor® Permectrin II)	10% EC	0	Use 1/4 to 1/2 gal. per animal; spray at 14- to 21-day intervals.
	(Atroban®)	11% EC	0	Spray at 14- to 21-day intervals.
	(Ectiban®)	5.7% EC	0	Spray at 14- to 21-day intervals.
	(Ectiban®)	0.25% dust	0	Dust at 14-day intervals.
	Stifofos + Dichlorvos (Ravap®)	23.0% + 5.3% EC	0	Beef cattle only. Do not treat more often than every 10 days.

Pesticide Suggestions (*Continued*)

Pest	Pesticide	Formulation	Minimum days from last application to slaughter	Remarks and safety restrictions
Lice	Amitraz (Taktic®)	12.5% EC	0	Use 1 qt. in 100 gals. water.
	Coumaphos (Co-Ral®)	5.8% LIS 11.6% ELT 1% dust	0	Do not apply to dry dairy animals within 14 days of freshening.
	Fenthion (Lysoff®)	7.6 % pour-on	35-40	Do not treat calves less than 3 months old, or sick, convalescent or stressed livestock. Do not treat non-lactating dairy cattle within 28 days of freshening.
	(Spotton®)	20% ready-to-use	45	Do not treat calves less than 3 months old, or sick, convalescent or stressed livestock.
	Avermectin (Ivomec®)	0.5% pour-on	48	Do not treat animals within 48 days of slaughter. Do not treat dairy cattle of breeding age. Apply 1 ml. per 22 lbs. of body weight.
	Permethrin (Anchor® Permectrin II)	10% EC	5	Use 1/2 to 1 gal. per animal. Repeat at 2-week intervals.
	(Atroban®)	11% EC	5	Use 1/2 gal. spray mix per animal. Repeat at 2-week intervals.
	(De-Lice®)	1% pour-on	0	Ready-to-use. Do not dilute. Apply 1/2 fl. oz. per 100 lbs. body weight, or a maximum of 5 fl. oz. per animal.
	(Ectiban®)	5.7% EC	0	Spray to thorough coverage; repeat application in 2 weeks.
	Avermectin (Ivomec®)	1% injectable	35	Use subcutaneous injection only. 200 micrograms/kilogram of body weight. Not recommended for chewing lice.
	(Detomax®)	1% injectable	35	Subcutaneous or intramuscular injection. Do not treat animals within 35 days of slaughter. 1 mi/110 lbs. of body weight. Do not use on dairy cattle over 20 months of age. Not recommended for chewing lice.
	(Cyfluthrin) (CyLence®)	1% pour-on	0	Ready-to-use. 4 ml/400 lbs. of body weight. Maximum of 12 ml.
		0.25% dust	0	Rub into coat; repeat for lice at 14 days.
	Phosmet (Delphos®) (Prolate®) (GX-118®)	11.6% EC 11.6% EC	21	
	Stirofos + Dichlorvos (Ravap®)	23.0% + 5.3% EC	0	Repeat in 14 days but not in less than 1 week.

Pesticide Suggestions (*Continued*)

Pest	Pesticide	Formulation	Minimum days from last application to slaughter	Remarks and safety restrictions
Gulf Coast Tick and Spinose Ear Tick	Coumaphos (Co-Ral®)	5% dust 3% spray foam	0	Follow carefully all instructions and precautions on label.
	Fenvalerate (Ectrin®)	8% ear tag	0	Use a tag in both ears.
	Permethrin (Atroban®) (GardStar®) (Anchor® Permectrin II)	10% ear tag 10% EC	0 0	For beef and dairy cattle. Use a tag in both ears. Apply 1/2 oz. oil or water mix per ear or 2-4 oz. per face or 12-18 oz. down back line. Read label for preparation of spot-on mixes.
Screwworm and Other Blow Fly Larvae	Treat wounds and surrounding area thoroughly, but do not use excessive amounts. Treat twice first week and weekly thereafter until healed.			
1. Wound Treatment	Coumaphos (Co-Ral®)	5% dust 3% spray foam	0 0	Follow carefully all instructions and precautions on labels.
2. Preventive Spray or Wound Treatment	Coumaphos (Co-Ral®)	25% WP 11.6% ELI 42% flowable	0	Do not apply to dry dairy animals within 14 days of freshening.
Mange and Scab Mites	Amitraz (Taktic®)	12.5% EC	0	Two treatments 7-10 days apart are required for scabies mites.
	Coumaphos (Co-Ral®)	25% WP 42% ELI	0	Repeat in 10 to 14 days.
	Avermectin (Ivomec®)	1% injectable 5% pour-on	35 48	Use subcutaneous injection only. Not for intravenous or intramuscular use. Do not exceed 100 micrograms per kilogram (2.2 lbs.) of body weight. No more than 10 mls. of 1% should be used on animals over 1,000 lbs. Apply 1 ml. per 22 lbs. of body weight.
	(Dectomax®)	1% injectable	35	Subcutaneous or intramuscular injection. 1 ml/110 lbs. of body weight. Do not use on dairy cattle over 20 months of age.
	Lindane	10% EC	30-60	Can be used as a spray or dip.
	Permethrin (Anchor® Permectrin II) (Atroban®) (Ectiban®)	10% EC 11 EC 5.7% EC	0 0 0	Spray to run-off; repeat in 2 to 3 weeks. Repeat application in 2 to 3 weeks. Repeat application in 2 to 3 weeks.

Lactating Dairy Cattle

NOTE: Dairymen must use good judgment in selection and application of pesticides. Certain materials may be used safely if they are applied correctly, but others are not recommended because they may contaminate the milk. Milk entering interstate commerce can be confiscated by the Environmental Protection Agency if it contains illegal pesticide residues. Consequently, careless use of pesticides may be very costly to the milk producer.

One important source of milk contamination with pesticides is hay or forage which the animal consumes. In purchasing baled hay or similar feed material, be sure pesticide residues do not exceed established tolerances.

Pest	Pesticide	Formulation	Minimum days from last application to slaughter	Remarks and safety restrictions
Lice	Coumaphos (Co-Ral®)	5.8% LIS 11.6% EC 25% WP	0	Follow carefully all instructions and precautions on labels. Spray animals to run-off to achieve coverage.
		1% dust	0	Apply over head, neck, shoulders, back and tail head.
	Permethrin (Anchor® Permectrin II)	10% EC	0	Use 1/2-1 gal. per head of dilute spray; repeat in 14 to 21 days.
	(Atroban®)	11% EC	0	Use 1/2 gal. per head of dilute spray; repeat in 14 to 21 days.
	Permectrin CD	10% pour-on	0	Ready-to-use.
	Permectrin CDS	7.4% pour-on	0	Ready-to-use.
	(Ectiban®)	5.7% EC	0	Use 1/2-1 gal. per head of dilute spray; repeat in 14 to 21 days.
		0.25% dust	0	Rub into coat; repeat in 14 days.
	Cyfluthrin (Cylence®)	1% pour-on	0	Ready-to-use. 4ml/400 lb of body weight. Maximum of 12 ml.
	Pyrethrins + Synergist	0.03 + 0.25	0	Apply as a fine mist.
Horn Fly	In addition to dust bags and backrubbers, certain automatic mist sprayers can be used for daily fly control. Consult the product label, local veterinarian, professional entomologist, county Extension agent or supplier representative for methods of using your selected product.			
	Coumaphos (Co-Ral®)	1% dust	0	Carefully follow all instructions and precautions on label.
	Cyfluthrin (CyLence®)	1% pour-on	0	Ready-to-use. 4 ml/400 lbs. of body weight. Maximum of 12 ml.

Pesticide Suggestions (*Continued***)**

Pest	Pesticide	Formulation	Minimum days from last application to slaughter	Remarks and safety restrictions
Horn Fly (Cont.)	Dichlorvos (Vapona®)	21.8% EC	0	Carefully follow all instructions and precautions on label.
	Methoxychlor (Marlate®)	5% dust 50% WP	0	Do not use in conjunction with or following permethrin.
	Permethrin (Artroban®) (Brute®) (Ectiban®) (GardStar®) (Atroban® Permectrin II) Permectrin CD Permectrin CD5 (Ectiban®) (Ectiban® D)	 10% tag 11% EC 1.2 grams/ tape 10% ear tag 40% EC 11% EC 10% pour-on 7.4% pour-on 5.7% EC 0.25% dust	 0 0 0 0 0 0	 Use 1-2 tags per animal. Use 1-2 tapes per animal. Use 1-2 tags per animal. Use 1/2 gal. of dilute spray per cow. Use 1/2-1 gal. of dilute spray per cow. Use no more than 2 oz. per animal; rub into coat.
	Pyrethrins + Synergist	0.5% + 5% ready-to-use	0	Apply daily as a mist spray.
Stable Fly & House Fly	Dichlorvos (Vapona®)	21.8%	0	Do not exceed 2 oz. diluted spray mix per animal. Do not contaminate dairy feed.
	Permethrin (Anchor® Permectrin II) (Atroban®) (Ectiban®)	 10% EC 11% EC 5.7% EC	 0 0 0	 Use 1/2-1 gal. diluted mix per animal. Use 1/2-1 gal. diluted mix per animal. Spray dilute mix for thorough coverage.
	Pyrethrins (Ortho Dairy and Horse Fly Spray)	0.03% ready-to-use	0	Apply enough spray to wet ends of hair but not hide.
Screwworm & Other Blow Fly Larvae	Treat wound and surrounding area twice the first week and then weekly until healed.			

Sheep & Non-Lactating Goats

Pest	Pesticide	Formulation	Minimum days from last application to slaughter	Remarks and safety restrictions
Lice, Ticks & Keds	Coumaphos (Co-Ral®)	25% WP 5% dust (Keds)	0 0	Use 0.06% spray or dip for lice or 0.125% for ticks or keds. Do not use on lactating milk goats or dry animals within 14 days of freshening. Agitate dip fluid before using. For spot treatment application.
	Diazinon (Dryzon®)	50% W	14	Use as spray or sprinkler can treatment for sheep only.

Pesticide Suggestions (*Continued*)

Pest	Pesticide	Formulation	Minimum days from last application to slaughter	Remarks and safety restrictions
Lice Ticks & Keds (Cont.)	Fenvalerate (Ectrin) (Vet-Shack®)	10% WDL	0	Apply 2 pts. of 0.025% spray per animal after shearing or up to 4 oz. of a pour-on down backline. Consult label for specific mixing instructions for sprays and pour-ons.
	Lindane	10% EC	30-60	Do not treat milk goats. Do not treat animals less than 3 months old.
	Methoxychlor (Marlate®)	50% WP	0	Apply 0.25% dip or 0.5% spray for lice. Do not apply to lactating milk goats.
		5% dust (lice)	0	Work thoroughly into wool or hair.
	Permethrin (Ectiban®)	5.7% EC	0	Use 1-2 qts. per animal (sheep or goats) of 0.05% spray or 1-2 oz. per animal of the 1 qt. formulation per 2.5 gallons of water mix.
	(DeLice®)	1% ready-to-use	0	Apply 1/2 oz. per 100 lbs. of body wt.
Nose Bots	Avermectin (Ivomec®)	0.08% drench	11	Apply 3 ml per 26 lbs. of body weight as an oral drench.
Screwworm & Other Wound Infesting Larvae	NOTE: Treat wound twice the first week and then weekly until healed.			
1. Wound Treatment	Coumaphos (Co-Ral®)	5% dust	0	Dust wound and surrounding area thoroughly.
		3% K.R.S Spray foam	0	Cover wound thoroughly with foam.
2. Preventive Spray or Wound Treatment	Coumaphos (Co-Ral®)	25% WP	3	Do not use on lactating dairy goats or dry animals within 14 days of freshening. Immerse or spray thoroughly. Repeat as needed.
Fleece-worm or Wool Maggot	Coumaphos (Co-Ral®)	25% WP	3	Do not use on lactating dairy goats or dry animals within 14 days of freshening. Immerse or spray thoroughly. Cover infested area.
		3% spray foam or 5% dust	0	For spot treatment application.

Pesticide Suggestions (*Continued*)

Pest	Pesticide	Formulation	Minimum days from last application to slaughter	Remarks and safety restrictions
		Swine		
Lice	Note: Treat thoroughly; amount depends on animal's size and amount of hair. Do not treat sick or stressed animals. Do not treat for external parasite control and vaccinate on the same day. Repeat application after 2 to 3 weeks.			
	Amitraz (Taktic®)	12.5% EC	1	Mix 1 pint in 25 gals. water.
	Coumaphos (Co-Ral®)	25% WP 11.6% ELT 5% LIS 1%	0 0 0	Spray animal thoroughly. Spray animal thoroughly Do not apply dust more often than every 10 days. Dust may be used simultaneously with 1% dust bedding treatment for severe infestations.
	Fenthion (Tiguvon®)	3% ready-to-use	14	May be used on gestating and lactating sows.
	Fenvalerate (Ectrin®)	10% WDL	1	Wet animals thoroughly; repeat in 14 days if necessary.
	Avermectin (Ivomec®)	1% injectable 0.27% injectable	18	Subcutaneously inject 1 ml. of material for each 75 lbs. of body weight. For pigs, subcutaneously inject 0.5 ml. per 10 lbs. of body weight.
	Permethrin (Atroban®) (Ectiban®) (Ectoban® D)	11% EC 5.7% EC 0.25% dust	5 5 5	Thoroughly soak animal; repeat in 14 days. Rub into hair; repeat in 14 days.
	Phosmet (Prolate®) (GX 118®) (Delphos®)	11.6% EC	1	Use 0.125% spray mix only. Wet skin thoroughly using approximately 1 qt. per head on mature animals.
Sarcoptic Mange Mite	Amitraz (Taktic®)	12.5 EC	1	Spray with a coarse nozzle; mix 1 pt. in 25 gals. water.
	Fenvalerate (Ectrin®)	10% WDL	1	Wet animals thoroughly; repeat at 14-day intervals.
	Avermectin (Ivomec®)	1% injection	18	Subcutaneously inject 1 ml. (cc) for each 75 lbs. of body weight.
	Lindane	10% EC	30-60	Do not treat animals less than 3 months of age. Do not treat sows within 3 weeks after farrowing.
	Phosmet (Prolate®) (Delphos®)	11.6% EC	1	Use 0.125% spray mix only. Wet thoroughly using approximately 1 qt. per head on mature animals.

Pest	Pesticide	Formulation	Minimum days from last application to slaughter	Remarks and safety restrictions
Horses				
Bots	Dichlorvos (Horse Wormer®)	17.5%		Several formulations are available. Some are for use only by or upon order of licensed veterinarians; others may be administered by owner. Check product label for use restrictions on the particular product.
	Avermectin (Zimecterin®) (Equimectrin®) (Eqvalan®)	1.87% oral paste		Refer to specific instructions on syringe usage.
	Trichlorfon (Combot®)	40% oral paste 12.3% liquid		Do not treat foals less than 4 months old or mares in last month of pregnancy. Do not treat sick or debilitated horses. Do not treat horses to be used for food. Single oral dose in feed 1 month after killing frost. Do not repeat within 30 days.
Lice, Horn Fly, Stable Fly, Ticks & Mosquitoes	Numerous products are available for use. The following list includes examples.			
	Coumaphos (Co-Ral®) Spray	11.6% ELI 5.8% LIS 42% flowable		Do not treat animals less than 3 months old. Do not treat sick or stressed animals. Do not use in conjunction with oral drenches or other internal parasite medications or with pyrethroids or their synergists or other organic phosphates. Repeat as necessary.
		1% dust (horn fly)		Dust lightly in ears for ticks.
		5% dust		For screwworms, treat wound thoroughly.
		3% spray (foam)		Cover thoroughly. Spray wound.
	Fenvalerate (Ectrin®)	10% WDL		Apply 8 oz. of mix per animal as a light spray. Do not treat animals for slaughter.
	Pyrethrin + (Repel-X®) (Wipe®)	ready-to-use ready-to-use		Repeat as necessary. For horn flies and mosquitoes.
	Permethrin (Actroban®)			
	(Anchor®	11% EC		
	Permectrin II)	10% EC		Wet horses thoroughly.
	(Ectiban®)	11% EC		Sponge animal thoroughly with 2 qts.
	(Gardstar®)	40% EC		of mix.

Pesticide Suggestions (*Continued*)

Pest	Pesticide	Formulation	Minimum days from last application to slaughter	Remarks and safety restrictions
Lice, Horn Fly Stable Fly, Ticks & Mosquitoes (Cont.)	Stirofos + Pyrethrin + Piperonyl butoxide	1.27% ready-to-use		Repeat as necessary. For horn flies and mosquitoes.

Poultry

Pest	Pesticide	Formulation	Minimum days from last application to slaughter	Remarks and safety restrictions
House Fly & Soldier Fly	Cyromazine (Larvadex®)	1% premix	3	Labeled for house fly only. Use as a feed additive to control house fly larvae in manure. Follow label directions.
	Carbaryl (Sevin®)	5% dust or 50% WP	7	Use 1 lb. of 5% dust per 100 birds or 1.2 oz. of 50% WP in 1 gal. of water per 100 birds. Bird treatment is used as a supplement to roost and building treatment.
		5% dust (litter)	7	Use 1 lb. per 40 square feet of floor, roost or interior surface.
		5% dust box	7	Treat litter evenly and thoroughly. Mix evenly in top layer of dust box contents. Use 2.5 lbs. of 5% dust per 50 birds in an 18x12x3-inch dust box.
	Permethrin (Anchor® Permectrin II)	10% EC	0	Use 1-2 oz. per bird; cover vent thoroughly.
	(Artroban®)	11% EC	0	Apply to birds thoroughly, particularly to vent.
	(Ectiban®)	5.7% EC	0	Use 1 gal. spray per 100 birds; cover vent areas thoroughly.
	(Ectiban® D)	0.25% dust	0	Dust thoroughly around vent of each bird.
	Stirofos (Rabon®)	50% WP	0	For caged birds, apply as a 0.5% spray to vent and fluff areas from below. For floor-managed birds, spray lightly while treating litter surface. Repeat as necessary, but not more often than every 14 days.
		1% roost paint or spray	0	Spray or paint roost thoroughly.
	Stirofos + Dichlorvos (Ravap®)	23% WP + 5.3% EC	1	Spray vent and fluff areas with 0.6% spray. Do not repeat more often than every 14 days.
Fowl Tick	Carbaryl (Sevin®)	50% WP	7	Treat roosts and buildings only.
		80 S	7	
	Stirofos (Rabon®)	50% WP	0	Apply 1% spray to walls, ceiling, floor cracks and crevices.
	Stirofos + Dichlorvos (Poultry Spray & Larvicide®)	23% WP + 5.3% EC	0	Thoroughly cover walls, ceilings, cracks and crevices with 1.25% spray.

Pesticide Suggestions (*Continued*)

Pest	Pesticide	Formulation	Minimum days from last application to slaughter	Remarks and safety restrictions
Northern Fowl Mite	Carbaryl (Sevin®)	5% dust	7	Use 1 lb. per 100 birds. Do not contaminate feed or drinking water. Bird treatment is used as a supplement to roost and building application. Do not repeat application within 4 weeks.
		5% dust (dust box)	7	Use 2.5 lbs. of 5% dust per 50 birds in an 18x12x3-inch dust box.
		50% WP	7	Refer to labels for specific instructions and precautions.
		80 S	7	
	Stirifos (Rabon®)	50% WP	0	For birds in wire cages or on floor, use 1 gal. of 0.5% spray per 100 birds or 1 oz. per bird. For caged birds, apply to vent and fluff areas from below. For floor-managed birds, spray birds lightly while treating litter surface. Repeat as necessary, but not more often than every 14 days. and/or
		50% WP	0	For litter treatment, use 1 to 2 gals. of 0.5% spray per 1,000 sq. ft. Apply to litter, walls, roosts, cracks and crevices. and/or
			0	Use 1 pt. of 1% mix per 100 ft. of roost.
		50% WP	0	Dust 2.5 oz. per 100 sq. ft. of litter. Treat litter evenly and thoroughly. and/or
			0	Use 2.5 oz. per 50 birds. Mix evenly in top layer of dust box contents.
	Permethrin (Ectiban®)	5.7% EC	0	1 qt. to 25 gals. of water. Use 1 gal. spray per 100 birds, paying particular attention to vents.
	(Atroban®)	11%	0	1 pt. to 25 gals. of water.
	(Permethrin II®)	10% EC	0	1 qt. to 50 gals. of water. Use 1-2 oz. per bird or 1 gal. per 100 birds directed to vent areas.
	(Gardstar®)	40% EC	0	1-4 fl. oz in 3.75 gals. of water.
Chiggers Infesting Area	Chlorpyrifos (Dursban®)	50W		Do not apply directly to turkeys. Spray soil in pens using 100-150 gals. of water per area.
Depluming Mite	Sulfur Dust	Elemental sulfur		Use 25-50 lbs. of elemental sulfur per area.
	Sulfur-soap mixture	2 oz. sulfur and 1 oz. soap in 1 gal. water	0	Dip birds thoroughly, wetting feathers.

Pest	Pesticide	Formulation	Procedures for application	Remarks and safety restrictions

Premises

(Inside or outside of animal quarters)

Pest	Pesticide	Formulation	Procedures for application	Remarks and safety restrictions
House Fly Stable Fly	Cyfluthrin (Countdown®)	20% WP	Cover total area	For "crawling and flying" pests.
	Diazinon®	50% WP	cover resting areas thoroughly	Remove animals from buildings prior to spraying. Keep them out for at least 4 hours.
	Dichlorvos (Vapona®) (Feedlot®)	21.8%	Direct 0.5%-1.0%	Avoid direct application to exposed feed and water.
		40.2%	Mist over entire area where where flies congregate	Do not use where milk is processed. Do not use during milking time when milk and utensils may become contaminated.
		18.6% pest strip	One strip per 1,000 cubic ft.	Most effective in spaces with little air movement.
	Dimethoate (Cygon®)	23.4% EC	Thoroughly spray interior and exterior surfaces	Remove animals from building before spraying. Do not apply to milk rooms.
	Fenvalerate (Ectrin®)	10% WDL	Apply to fly resting areas	Do not contaminate feed or water.
	Lambda Cyhalothrin (Grenade®)	10% WP	Mix with water for treatment	Do not contaminate feed or water.
	Methoxychlor (Marlate®)	50% WP	Cover resting surfaces thoroughly with 2.5-5% spray	Remove dairy cattle from building prior to spraying.
	Methomyl (Golden Malrin®) (Apache®)	ready-to-use bait	Scatter in fly breeding areas	Do not use in poultry operations except with caged layers.
	Permethrin (Atroban®)	11% EC 25% WP	Apply to fly resting areas	Do not contaminate feed or water.
	(Anchor® Permectrin II)	10% EC	Apply to fly resting areas	Do not contaminate feed or water.
	(Ectiban®)	5.7% EC 25% WP	Apply to fly resting areas	Do not contaminate feed or water.
	Gardstar®	40% EC	Apply to hands and resting areas	
	Stirofos (Rabon®)	50% WP	Apply 1% spray to ceilings and walls to the point of run-off	Do not contaminate feed, water, utensils or equipment.
	Stirofos + Dichlorvos (Ravap®)	2.3% +5.3%	Apply 1.25-2.5% spray to surfaces to the point of run-off	Formulation and dosage will vary with the type of surface.

Insecticides and Corresponding Trade Names

Chemical Name	Trade Name
Amitraz	Taktic®
Avermectin	Ivomec®
	Zimectin®
	Eqvalan®
	Dectomax®
	Eprinex®
Carbaryl	Sevin®
Chlorpyrifos	Dursban®
Coumaphos	CoRal®
	Spray Foam
Cyfluthrin	Cutter Gold®
	Cylence®
Cypermethrin/Chlorpyrifos	Max Con®
Cyromazine	Larvadex®
Diazinon	Countdown®
	Diazinon
	Dryzon
	Terminator®
	Cutter 1®
Diazinon/Chlorpyrifos	Warrior®
Dichlorvos	Horse Wormer®
	Vapona®
Dimethoate	Cygon®
Ethion	Commando®
Famphur	Warbex®
	Cutter Blue®
	Lysoff®
	Spotton®
	Tiguvon®
Fenvalerate	Ectrin®
	Ear Tag Plus®
Lambda cyhalothrin	Saber®
	Grenade®
Lambda cyhalothrin/ Pirimiphos methyl	Double Barrell®
Lindane	Lindane
Lime-Sulphur	Lime-Sulphur
Methomyl	Golden Malrin®
	Apache®
Methoxychlor	Marlate
Pyrethrin	Repel®
	Wipe®
Permethrin	Anchor® Permectrin II
	Atroban®
	Patrot®
	GardStar®
	Insecta-Gard®
	Delice®
	Duraset®
	Brute®
	Permectrin CD®
	Permectrin CDS®
Pirimiphos-methyl	Dominator®
Phosmet	GX-118
	Prolate®
	Delphos®
	Lintox HD®
S-Cyanomethyl Carboxylate	Python®
Stirofos	Rabon®
Stirofos + Dichlorvos	Ravap®
Trichlofon	Combot®

The information given herein is for educational purposes only. Reference to commercial products or trade names is made with the understanding that no discrimination is intended and no endorsement by the Cooperative Extension Service is implied.

Policy Statement for Making Pest Management Suggestions

The information and suggestions included in this publication reflect the opinions of Extension entomologists based on field tests and use experience. Our management suggestions are a product of research and are believed to be reliable. However, it is impossible to eliminate all risk. Conditions or circumstances which are unforeseen or unexpected may result in less than satisfactory results even when these suggestions are used. The Texas Agricultural Extension Service will not assume responsibility for such risks. Such risks shall be assumed by the user of this publication.

Suggested pesticides must be registered and labeled for use by the Environmental Protection Agency and the Texas Department of Agriculture. The status of pesticide label clearances is subject to change and may have changed since this publication was printed. County Extension agents and appropriate specialists are advised of changes as they occur.

USERS are always responsible for the effects of pesticide residues on their livestock and crops, as well as problems that could arise from drift or movement of the pesticide from their property to that of others. Always read and follow carefully the instructions on the container label.

Other information

For additional details on livestock parasites, refer to the following Texas Agricultural Extension Service publications, available from your county Extension agent.

B-1088 Poultry Pest Management
B-6063 The Livestock Insecticide Label Notebook (For sale only).

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AgriLIFE EXTENSION
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Recognizing and Handling Calving Problems

CONTENTS

Recognizing and Handling Calving Problems

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Calving difficulty (dystocia) is a concern of every cattleman because it is a major cause of calf deaths and is second only to rebreeding failures in reducing calf crop percentages. Cows that have difficulty during calving have significantly lower fertility at rebreeding.

Prevention through good heifer management and proper bull selection is the best treatment for calving difficulties. Even with the best management, though, a certain percentage of young heifers will experience difficulty to some degree, and even older cows occasionally have difficulty. Watching a good heifer or cow go through the agonies of a problem birth is not an uncommon experience for anyone in the cattle business. Probably the most frustrating aspect is trying to decide when and how to assist and whether or not professional attention is needed.

Many cattlemen attempt to correct problems that they have neither the instruments nor the knowledge to handle, while others refuse to intervene in even the simplest dystocia problems. Neither approach is good. The rancher and veterinarian should cooperate to deal with problems.

All cattlemen should be able to recognize early signs of dystocia and determine when or if professional help is needed. Time lost waiting for help may jeopardize the calf's life. The following guidelines can help cattlemen reduce calf losses when dystocia problems occur.

NECESSARY EQUIPMENT

Veterinarians use a variety of instruments and drugs in handling severe calving problems, but certain basic supplies are needed by all cattlemen. Having the proper equipment may mean the difference between saving or losing a problem calf.

Use a maternity stall when available. This is an enclosed area approximately 4 x 8 feet, preferably with side and rear exits. It should be well bedded and sanitized thoroughly between calvings. Following delivery, move calves directly to clean pasture areas. If calves are allowed to stay in or near the delivery area, scour problems may develop. Also, move cows to clean pastures after calving since constant contact of the fetal membranes to contaminated premises may lead to serious uterine and general infections.

Other basic equipment includes obstetrical chains for use when traction is needed to extract the calf and obstetrical handles that attach to the chains to aid in applying traction (Fig. 1). Mechanical calf pullers also can be used; they may be attached to the chains in forced extractions (Fig. 2).

Obstetrical chains are preferred for applying traction because they are cleaned and sanitized more easily. Disinfect chains between uses by boiling in mineral oil. This prevents the spread of disease. After boiling, wrap the chains in a clean cloth until they are needed again.

Figure 1. Obstetrical chains and handles used in forced extractions of the calf. Chains are available in 10-, 21-, 30- and 60-inch lengths.

Boiling chains in water or placing them in a pressure cooker is satisfactory, but causes rusting. Chains also may be disinfected by placing them in a brown paper bag in a 400 °F oven for 30 minutes. Nylon obstetrical straps of varying lengths may be used in place of chains or in combination. Nylon straps may be easier to manipulate than chains; however, as with chains, clean and disinfect the straps after each use. Cotton rope is not recommended unless the rope is discarded after use. Used repeatedly, rope becomes contaminated and can be a source of infection to other cows.

When manipulations are necessary, heavily lubricate the fetus, birth canal and operator's arms. Various obstetrical soaps are available, but a satisfactory lubricant can be made by dissolving a mild soap in warm water. The solution forms a gel when cool, but can be shaken and poured into a bucket for use. Keep a fresh supply of lubricant separate and uncontaminated. Use other lubricants such as mineral oil or mild soaps for a substitute; however, avoid detergents as they can cause severe irritations.

Keep some drugs on hand, including 1 to 3 grams of a broad-range antibiotic such as oxytetracycline or chlorotetracycline in a 200- to 500-milliliter solution of physiological saline. Or, furacin boluses may be used. Both preparations are used as intrauterine medications. Most authorities feel that sulfa drugs are of questionable value. Have tincture of iodine (2 1/2 percent) available for treating the navel cord of the calf following delivery.

Keep surgical needles and suture material available, but cases requiring extensive surgical attention become quite complex and should be handled by a veterinarian.

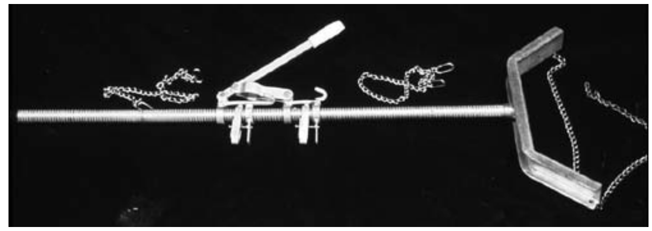

Figure 2. A mechanical calf extractor or puller which permits additional traction in pulling the calf in difficult births. It is designed to span the rear of the pelvis and insures pulling the calf at the correct angle and tension to avoid unnecessary injury to the cow and calf.

THE CALVING PROCESS

To reduce calving losses, cattlemen must understand the progressive stages of birth and the time interval of each stage. This knowledge can be gained by frequently observing the birth process. Familiarity with each stage of birth as well as the skeletal structure of the cow (Figs. 3 and 4) helps one to determine when and how assistance may be provided.

Parturition is best described by stages:

STAGE 1 OR PREPARATORY STAGE starts when the uterus begins contracting and the cervix dilates, ending with the movement of fetal parts into the birth canal. Generally, few signs of labor are evident at this time, but the positioning of the calf causes discomfort to the cow.

Early labor symptoms vary greatly in cows during this stage. Many older cows that have had several calves may show almost no signs of labor, and only close observation and attention may give any indications of approaching birth. Subtle signs of this stage in older cows might include the animal lying in a slightly abnormal position or the fact that the cow is a little more alert than other cows. Conversely, heifers may be very restless and show signs of abdominal pain up to 24 hours before cervical dilation is detectable. Signs of approaching birth may include standing with the tail raised and back arched, tail twitching and general restlessness and discomfort which may include kicking at the stomach area. In a normal labor, this period lasts from 2 to 6 hours, but may be only 30 minutes or as long as 24 hours. Stage 1 is normally longer in heifers.

Uterine contractions during this stage recur at about 15-minute intervals and push the water-filled allantochorion (Fig. 5) against the cervix, causing it to dilate. As the cervix dilates and uterus contracts, the allantochorion water bag passes through the cervix and often ruptures. In about half of normal births the allantochorion membrane passes through the vagina and reaches the vulva

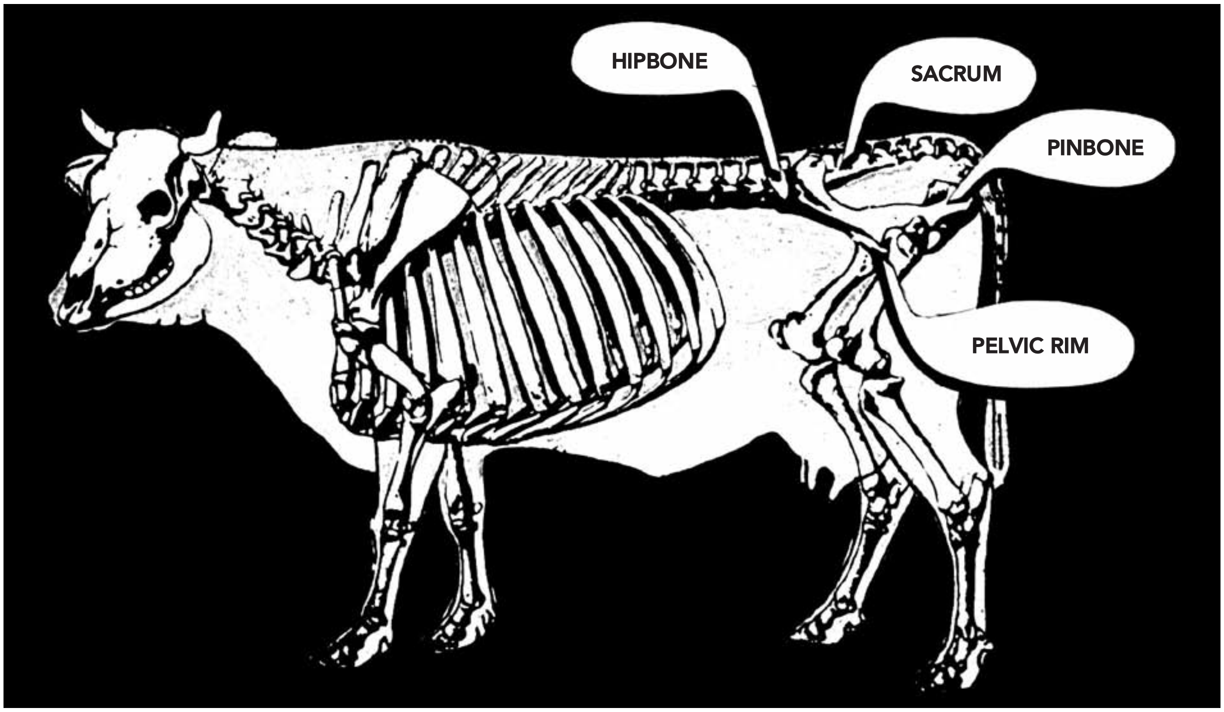

Figure 3. Skeletal structure of the cow.

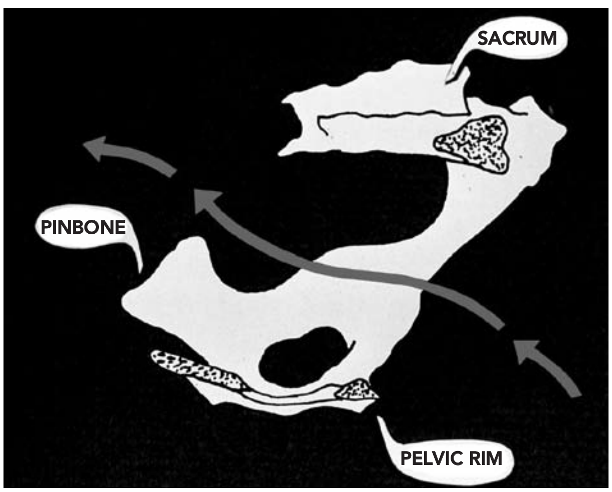

Figure 4. Side view of the pelvic bone of the cow. Arrows indicate the guiding line or pelvic axis followed by the calf at birth.

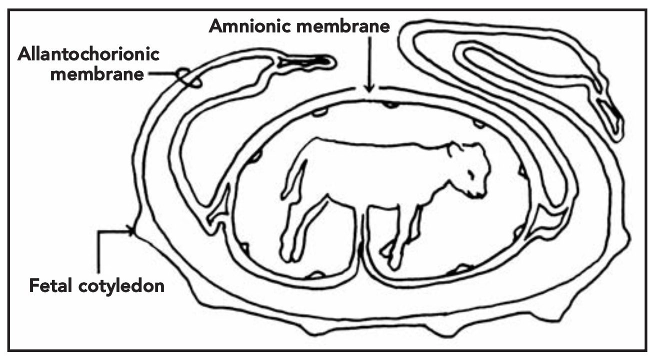

Figure 5. A young calf enclosed in the complete fetal membranes. Note the amnion immediately surrounding the calf and the allantochorion which covers the amnion and extends throughout both horns of the uterus. Spots on the surface of the allantochorion are villi of the fetal cotyledons which pull away from the maternal caruncles when the fetus is removed from the uterus.

intact. It may protrude as a water bag filled with dark amber fluid. Occasionally the membrane breaks before it becomes visible. Then it is observed simply as a sudden and large expulsion of straw-colored fluid rushing from the vagina. This is followed by the amnion or water sac, which is the membrane immediately surrounding the calf. The amnion is a white, clear membrane, in comparison with the allantochorion which is a darker color. Appearance of the amnion or feet beginning to protrude through the vulva marks the beginning of the delivery stage. Ordinarily, birth occurs within 30 minutes to 4 hours after the amnion or feet are first visible. Although the time limits specified for stage 2 are accepted norms, remember that if a cow is moved during early labor or in the early stages of active labor she may actually delay calving. Excitement and nervousness in cows may temporarily weaken uterine contractions. Thus, when observing cows during stage 2, consider any movement or undue excitement of the cows when determining the length of delivery.

STAGE 2 OR DELIVERY STAGE is the time of expulsion and actual delivery of the calf. In normal deliveries, this stage lasts from 30 minutes to 4 hours, but may be longer in young heifers. Early symptoms are recognized easily. The second stage begins with the movement of the calf's head and feet into the birth canal and the entrance of the calf into the cervix. During this time, uterine contractions occur at about 2-minute intervals and each contraction lasts about 1 $^1/_2$ minutes. When the calf enters the cervix, abdominal straining, commonly called the abdominal press, occurs. At this time the behavior of the cow changes markedly from being alert to becoming almost oblivious to her surroundings and concentrating on the uterine contractions.

The cow may be lying down or standing, but definite and prolonged periods of straining are demonstrated. After the straining, the amnion or, in some instances, the calf's feet appear within 1 to 2 hours. It is important not to hurry the cow at this time, but be prepared to help. The extra time allows the vulva to dilate further and prevents tearing of the tissues. Pressure of the fetal parts further stimulates contractions that push the calf out. The calf's life usually is not in danger at this point, since the membranes remain attached to the uterus of the cow until after the calf is born. In the mare and sow, there are few points of placental attachment; these are broken soon after fetal expulsion begins. Thus, birth must be rapid or the newborn will suffocate. In the cow there are numerous points of attachment (placentomes, commonly called buttons), and since the membranes remain attached, there is a continuous supply of oxygen from the cow even if labor is prolonged. A calf can survive in the uterus for 8 to 10 hours if delivery does not progress beyond the early phases of stage 2. However, delivery should be completed within 2 hours after the water sac or feet first appear.

STAGE 3 OR MEMBRANE EXPULSION STAGE is the final expulsion of the fetal membranes after the calf is born. The fetal membranes or placenta usually are expelled without complication within 30 minutes to 8 hours following delivery. If membranes are retained more than 12 hours, they are considered pathological and may require attention.

EXAMINING THE COW

If problems arise, they generally show up after the water sac appears. Should labor go on for 2 to 3 hours with no apparent progress, or if the water sac appears and delivery is not complete within 2 hours, a pelvic examination is in order to determine the problem. Although it is difficult to actually determine if a cow will calve within the next 12 hours without performing a pelvic examination, there is one external indication that may be used with some reliability to predict the actual time of birth. The most useful external evidence is the texture of the posterior or back border of the sacro-sciatic ligament. This ligament is located on either side of and below the tailhead where it joins the pelvic bone. When the edge of this ligament becomes very relaxed one can reasonably predict that birth will begin within approximately 12 hours. Several studies have demonstrated that the softening of this ligament, which often coincides with some elevation in the tailhead, occurs simultaneously with the relaxation and dilation (enlargement) of the cervix.

Assuming labor has continued for 2 to 3 hours with no progress, make all decisions based on an actual pelvic examination. Since the presence of the calf's feet and head in the birth canal stimulates abdominal pressing, a normal press will not occur in abnormal deliveries. If the calf's head and/or feet are turned back or if it is a breech birth (Fig. 6), contractions may be weak or nonexistent. Thus, it is imperative that cows making little progress be examined as early as possible to determine the problem. This allows time for repositioning the calf.

A careful examination of the cow is possibly the most critical step in assisted deliveries. Before the examination remember that sanitation is of utmost importance to prevent the introduction of infectious organisms into the reproductive tract and that the arm should be well lubricated to facilitate the examination and minimize the trauma to delicate reproductive tissues.

The first step in examining the cow is to examine the cervix for dilation. If the cervix will admit only two to three fingers, the case is probably one of nondilation of the cervix or possibly uterine torsion. At this point one must have some idea of how long the cow has been in active labor. If the cervix has not dilated, one may be interfering too soon; if labor has been going on for 2 to 3 hours with no progress, professional help may be needed. Dilation of the cervix begins on the internal extremity of the cervix and continues toward the external extreme over a period of 6 to 12 hours. When the cervix is dilated completely it is approximately 6 to 7 inches wide. At this time the cervix and the vagina become a continuous canal and in most instances are tightly engaged by the stretched fetal membranes.

The next step in examining the cow is to check for life signs in the unborn calf, because this determines the urgency and type of assistance needed. If the calf is alive, pulling or pinching the foot causes movement of the leg, pinching the eyes causes movement of the head, and placing the fingers in the calf's mouth elicits sucking or movement of the tongue. With posterior or breech presentations, inserting the finger into the anus causes constriction of the anal sphincter. Absence of the vital signs, sloughing of the hair or foul odors may indicate the calf is dead.

As the next step in the examination, determine the presentation, position and posture of the calf.

Presentation describes the relative direction of delivery. The calf may be presented frontwards, backwards or crosswise to the pelvic opening.

Position describes how the calf is lying. The calf may be upside down, right side up, or have its back to either side of the pelvic canal of the cow.

Posture indicates the location of the legs, head and neck. If the calf is presented frontwards, one or both forelegs may be turned back or the head may be down and the feet in correct position. A fetus in a backwards presentation may have one or both hindlegs flexed at the hock or hips.

Figure 6. Posterior presentation with rear legs extended under the calf's body (breech presentation). May be corrected by pushing the calf forward and grasping the legs one by one. As each leg is drawn into the birth canal, keep the hock pointed toward the cow's flank and the hoof to the midline (see detail in Figure 9).

Figure 8. Posterior presentation of the calf. Delivery may often proceed without complications. Assistance may be important if labor is prolonged. Death of the calf can occur due to rupture of the navel cord and subsequent suffocation.

Figure 7. Normal anterior presentation, position and posture of the calf before delivery.

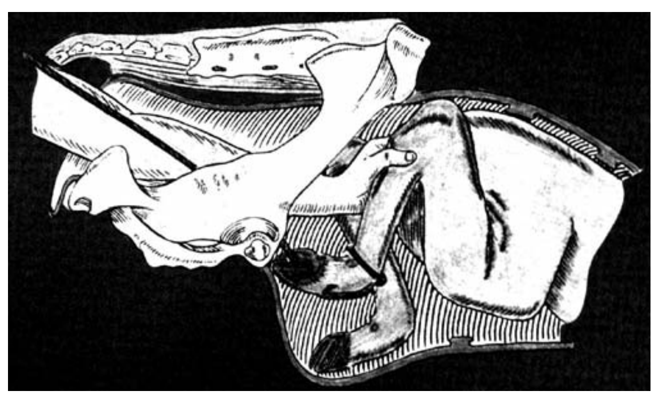

Figure 9. Correction of the hock flex in posterior presentation. The calf is first pushed forward. The hand grasps and cups the calf's foot, then draws it back as the hock is flexed. The foot in the cupped hand is lifted over the pelvic rim and into the vagina. An alternated method in more difficult cases is to place a snare around the pastern, attached at the front of the leg. The snare is then pulled between the digits of the foot so that when traction is applied the fetlock and pastern are flexed. The calf is pushed forward and the foot is guided over the pelvic rim as an assistant pulls the snare.

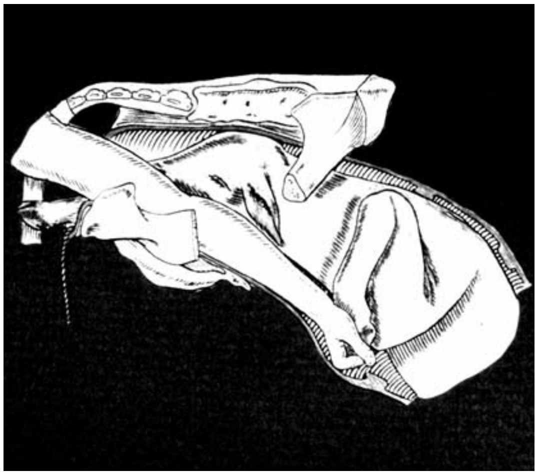

Figure 10. Correction of a simple leg flexion in an anterior presentation. The calf is first pushed forward and the retained foot is grasped in the cupped hand. The foot is carried outwards and then forward in an arc over the pelvic rim. More difficult cases may require that a snare be attached to the retained fetlock to help extend the leg.

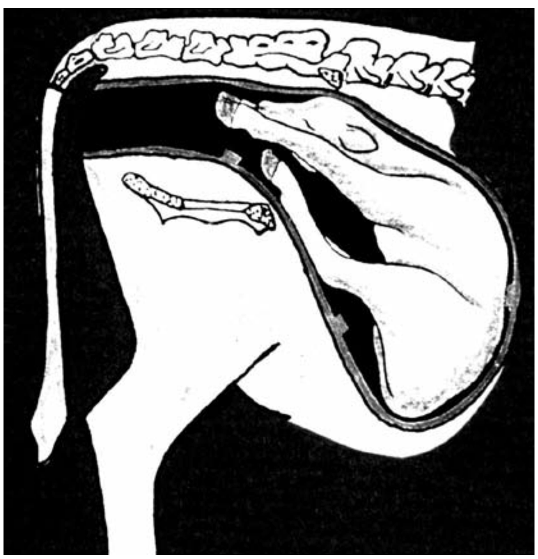

Figure 11. Anterior presentation with the rear legs extended beneath the body (dogsitting posture). A very serious type of malpresentation. If allowed to progress into advanced labor, fetal death may result. Early professional attention may be required.

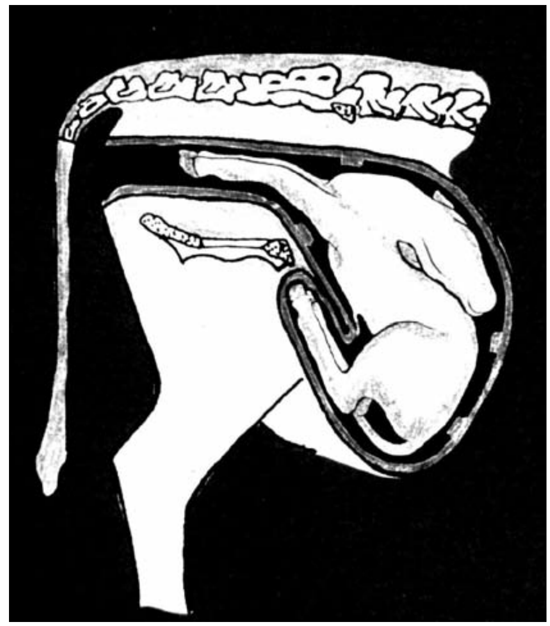

Figure 12. Anterior presentation with the head and neck turned back over the body. Secure the legs with chains. Push the calf back into the body. This often brings the head into normal position (see Fig. 13).

The normal presentation of the calf (Fig. 7) is frontwards. Although a calf can be pulled in a backwards presentation (Fig. 8), there is some danger. The normal position of the calf is back side up. Never pull a calf in any other position because the chances of killing both the cow and calf are great. The correct posture of the fetus is with both front legs outstretched in the birth canal and with the head and neck extended along the legs. Correct any deviation from this posture before the calf is extracted (Figs. 9 through 16). About 95 percent of all births occur with normal presentation, position and posture.

Determining the relative size of the calf and birth canal is the next step in examination. This is a critical judgment and requires some experience. Forcing a large calf through a small pelvic opening almost invariably results in death of the calf as well as injury, paralysis or even death of the cow. If it is fairly certain the cow will have serious calving difficulties, call a veterinarian. Once

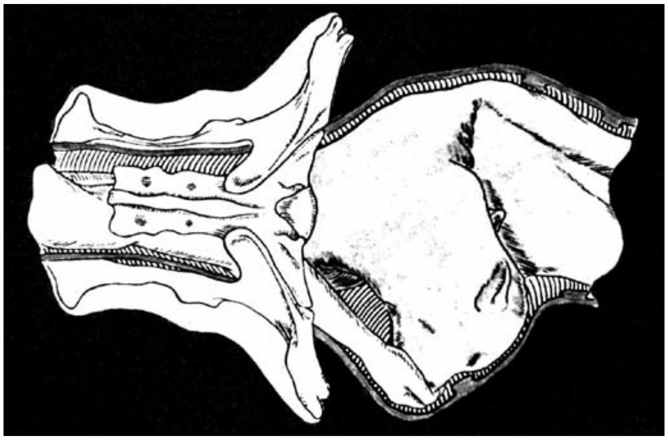

Figure 13. Correction of head and neck deviation in anterior presentation. Correcting difficult cases may require pulling the head and neck around with the hand. The calf is first pushed forward and the hand quickly moved to grasp the calf's muzzle. The head is pulled around and in line with the birth canal. In some cases it may be necessary to apply a snare to the lower jaw for additional traction. Avoid excessive pressure, as the jaw is not strong and will fracture easily. A safer and more common practice is to loop the obstetrical chain around the poll, under the ears and through the mouth in a "war bridle" manner (see Fig. 14).

Figure 15. Posterior presentation with fetus in an upside down position. This situation can be caused by twisting of the uterus or rotation of the calf. Never attempt delivery in this position. Professional assistance often is required.

Figure 14. An alternate means of correcting a head and neck deviation in an anterior presentation. In difficult extractions, a safe and more common practice is to loop an obstetrical chain around the pole of the calf under the ears and through the mouth in a "war bridle" manner. This attachment permits greater traction than can be used in the jaw snare. Exercise care, however, since this arrangement permits the calf's mouth to gape and can cause the calf's sharp incisor teeth to cut the birth canal. To avoid this, guide the hand underneath the calf's jaw as traction is applied.

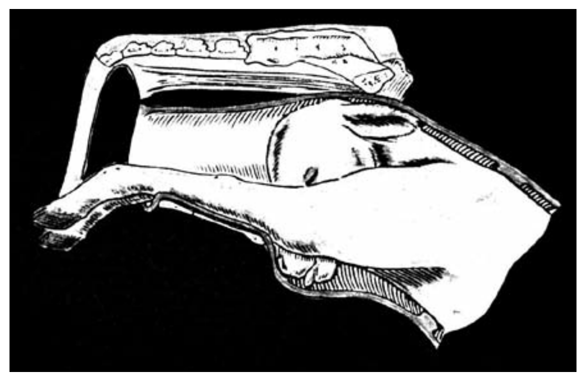

Figure 16. An anterior presentation with a vertex posture of the head. The vertex posture occurs when the bridge of the nose is impacted against the floor of the cow's pelvis. This causes the pole of the calf to be presented first. Repelling the body of the calf usually makes sufficient room to correct the problem. In such cases of dystocia, the fetus is often dead; a living fetus usually moves enough to prevent this type of entrapment of the head.

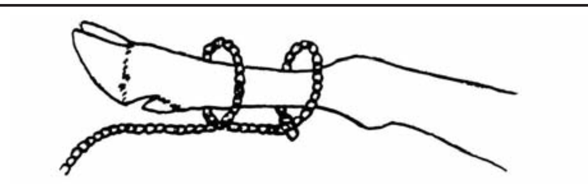

Figure 17. Correct application of an obstetrical chain to the foreleg. Position the first loop of the chain about 4 inches above the ankle joint and dew claw. Close and secure the chain at the back of the leg to avoid injury. Form a second loop (half hitch) 2 to 3 inches below the first loop above the ankle joint. Positioning the second loop below the ankle joint and dew claws may result in breaking the ankle or pulling the hoof off. Using the double loop, as described, distributes pressure from the chain and avoids excessive pressure at any one location as would occur with a single loop.

the calf's feet and head are outside the cow's body, the veterinarian has lost the option of doing a Caesarean section.

GIVING ASSISTANCE

If it is determined that professional help is not needed, but that the calf requires adjustment and/or extraction, there are some important points to remember. If, after giving assistance for 30 to 40 minutes, no progress has been made in the delivery, the situation has probably been misjudged and professional help is needed.

Assistance is first begun by attaching the obstetrical chains to the front legs. Don't put a single loop of the chain around both front legs. Instead, use a double loop on each leg (Fig. 17). Place the first loop about 4 inches above the ankle joint and dew claws. Next, form a half hitch about 2 to 3 inches down the leg, but above the ankle joint. If the chain is around the ankle below the dew claw a leg may be broken or a hoof pulled off. Be sure to position the loops so that one pulls from the back of the legs. A chain on the front or sides causes a twisting action that may break bones. Normally in forced extractions, the force exerted by one or two persons in pulling a calf is safe and sufficient. Never use fence stretchers, tractors, trucks or other devices which may apply extreme force. If additional extractive forces are necessary, a mechanical calf extractor is the only safe means.

It usually is best to pull both legs with even pressure. If the pelvic opening of the cow or heifer is small, pull the legs alternately until the shoulders are eased through the birth canal. Then continue applying pressure to both legs. Don't hurry the cow. As the calf moves through the birth canal, the cow's natural body mechanisms are helping by letting this area dilate.

One cause of calf deaths and damage to heifers is hiplock. This is a situation in which the calf's hips won't pass through the cow's pelvic opening. Some cases of hiplock may require veterinary assistance. Proper traction often prevents or eases this problem by keeping the calf's hips high as they pass through the pelvic opening, thus taking advantage of the widest horizontal part of the cow's pelvis. Pull the calf out and down at a 45° to 60° angle. As the front legs come through the vulva, increase the traction in a downward direction with the calf's legs practically parallel with the cow's legs.

If this does not help, release the calf puller or tension on the chains and push the calf back far enough to relieve the lock up. Then rotate the calf clockwise or counter-clockwise to get a new angle for the hips to pass through the cow's pelvis. This technique works because the vertical axis of the pelvis is greater than the horizontal axis (Fig. 18).

Another method used for hiplock is to rotate the calf and then swing the shoulders and front feet to the cow's side. Put the pulling chains around the calf's barrel and pull gently to avoid injuring the calf's spinal cord. This procedure often allows one hipbone at a time to ease through the cow's pelvis. In this procedure the barrel of the calf is pulled to the rear and down while the front feet are swung up and to the side.

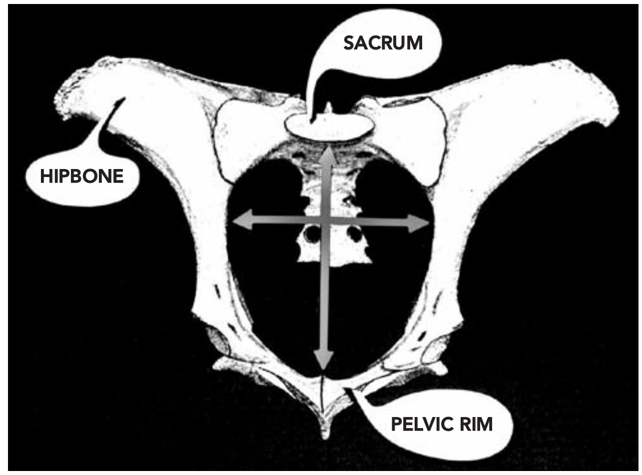

Figure 18. Front view of the pelvic bone of the cow. Notice that the vertical width exceeds the horizontal width of the birth canal.

HELPING THE CALF

As the calf is delivered, it passes through the vulva and the short umbilical or navel cord usually breaks. Survival is then dependent upon functioning of the calf's lungs and initiation of body activity. Once the navel cord is broken, the placental supply of oxygen is cut off. Oxygen in the blood of the calf drops rapidly and the carbon dioxide level increases. These changes stimulate the respiratory centers of the brain and cause the calf to struggle and gasp. As the calf gasps, the lungs fill with air and oxygen deficiency is rapidly overcome.

Occasionally a calf has trouble breathing after delivery. In such instances it is important to quickly clear the mouth and nose of mucus. If the calf continues to have trouble breathing, pick him up by the hind legs and swing him back and forth or around to dislodge the mucus. This procedure may sound harsh, but can be very effective. Rubbing or scratching the inside of the calf's nostrils with a straw irritates the delicate tissues and often causes the calf to sneeze or cough, thereby clearing out the breathing passages.

Artificial respirators are available and can be of great assistance, especially for producers of valuable registered stock. If no respirator is available, clean off the calf's muzzle and blow your own breath into the calf's nostril. Another alternative is to place a short section of 3/4-inch garden hose in one nostril. The mouth and other nostril are then clasped so that air can enter and leave the calf only through the nose. Blow into the nose and allow the air to be exhaled. Repeat every 6 to 7 seconds until the calf starts breathing, or until his heart stops beating. It is important to remember that the baby calf's lungs are considerably smaller than a human's and care should be taken not to over inflate and rupture the lungs. Results of these resuscitation methods can be very dramatic.

CARING FOR THE COW

One of the rancher's main concerns about the heifer or cow is the possibility of retained placenta. Usually the fetal membranes are expelled within 8 to 12 hours. Leave the cow alone until this occurs. Research shows that manual removal of the placenta, regardless of how professionally and carefully done, can cause complications that would not occur otherwise.

In one of several studies, cows that received antibiotic treatments without removal of the membranes had a 79 percent conception rate at first rebreeding. Manual removal of the membranes without any drugs dropped the figure to only 39 percent. When drugs were given and membranes removed manually, the rebreeding rate was also 39 percent. Cows receiving no drugs and no assistance increased to 50 percent. Thus, removal of the membranes seems to be the deterring factor in uterine recovery and rebreeding.

Reports indicate that retained membranes occur in 5 to 15 percent of births in healthy herds. Retained placenta is common in premature and multiple births and when birth has been induced. Research also indicates that retained membranes occur more frequently in cows producing bull calves. Once retention of the membranes has occurred, there is about a 20 percent chance of its recurring. A high incidence of retained membranes may be associated with disease conditions in the herd and may require professional attention. Most authorities agree that if a cow retains the membranes, you should not initiate treatment until 48 to 72 hours after birth, unless the cow loses appetite or has an elevated temperature or other signs of septicemia. Treatment generally consists of infusing the uterus with an inseminating pipette placed through the cervix. Uterine infusion of 50 to 100 milliliters of an oxytetracycline or chlorotetracycline solution is the preferred treatment. In addition, injections of penicillin/streptomycin are commonly given for 3 to 5 days. Females showing serious signs of septicemia should be treated by a veterinarian.

MAKING THE DECISION

When deciding whether or not to assist with calving, consider the circumstances. With mature cows it's better to wait than to start assistance too early because the cow usually takes care of her own problems. With heifers it may be different. Their immature bodies are not fully developed and pelvic openings may simply be too small. A minor problem may be created by assisting a heifer too early, but if one waits too long, any problem will be a major one.

Calving problems are most common in heifers giving birth to their first calves. Only about 3 percent of mature cows have any trouble, but for heifers the figure may be 50 percent or more. Table 1 illustrates the hourly return to ranchers for time spent observing and assisting at calving. Notice that observation frequency is the key to saving a high percentage of calves. A single check for problems is scarcely worth the effort, but returns per hour of time increase significantly as the cattle are observed more frequently.

In Texas, approximately 8 to 10 percent of all calves born in beef cow herds die at or soon after birth. Approximately three-fourths of these deaths are due to calving difficulties. Losses due to calving difficulty cost the cattle industry three to four times more annually than costs resulting from abortions, and are second only to losses from cows failing to conceive. The only way to reduce such losses is through good management of heifers from weaning until first calving, frequent observation, and being ready to help when problems arise.

Table 1. Cost and returns for checking a beef breeding herd at calving time for 50-cow herds.*

	Number of times checked each day			
	1	2	3	4
Total hours expended per cow	.8	.9	1.0	1.2
Returns from additional calves**	$153.60	$307.20	$460.80	$614.40
Total labor cost***	$240.00	$270.00	$300.00	$360.00
Returns per hour	(-$2.16)	$0.83	$3.22	$4.24

*Research data adapted from Ohio Agricultural Experiment Station Circular 103.

**Calf value at weaning – $384 for a 480-pound calf.

***Labor valued at $6.00 per hour.

SUGGESTED READING

B-1077 Determining Pregnancy in Cattle

B-1213 Management of Replacement Heifers for a High Reproductive and Calving Rate

(both available at the Texas AgriLife Bookstore, *http://agrilifebookstore.org*)

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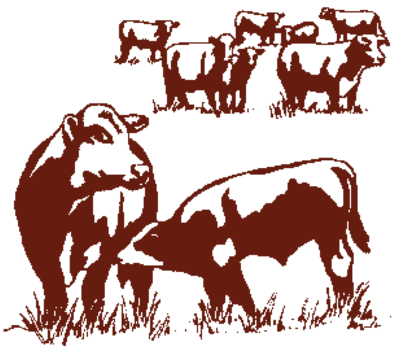
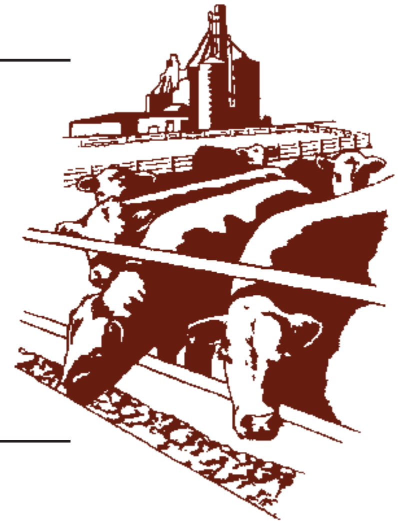


Beef Cattle Handbook



BCH-2010 Product of Extension Beef Cattle Resource Committee

Reproductive Tract Anatomy and Physiology of the Bull

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The reproductive tract of the bull consists of the testicles and secondary sex organs, which transport the spermatozoa from the testicle and eventually deposits them in the female reproductive tract. These organs are the epididymis, vas deferens and penis, plus three accessory sex glands, the seminal vesicles, prostate and Cowper's gland. This basic anatomy is illustrated in figure 1 as a greatly simplified diagrammatic sketch.

The testicle has two very vital functions: (1) producing the spermatozoa; and (2) producing the specific male hormone, testosterone. The testicles are located outside of the body cavity in the scrotum. This is essential for normal sperm formation since this occurs only at a temperature several degrees below normal body temperature. However, very cold temperatures could damage the testicle. The scrotum, therefore, must help protect the testicle against both of these extremes of temperature. This is done by means of a temperature sensitive layer of muscle (cremaster muscle) located in the walls of the scrotum, which relaxes when hot, and contracts when cold. Relaxation increases the relative length of the scrotum thus moving the testicles away from body heat. In cold weather, the reverse happens—the scrotum shortens and the testicles are held close to the warm body.

Occasionally, one or both testicles fail to descend into the scrotum during embryological development, and are retained in the body cavity. Such male are referred to as cryptorchids. Since body heat can destroy sperm producing ability, no sperm are produced by the retained testicle. The testicle in the scrotum will function normally and usually produces enough sperm so that the male will be of near normal fertility. However, since this condition appears to have a hereditary basis, such males should not be used for breeding. If both testicles are retained, the male will be sterile.

Usually, hormone production is near normal in the cryptorchid testicle and the male develops and behaves like a normal male. If the retained testicle is not removed at time of castration, the male will develop the secondary sex characters of an uncastrated male. This operation is not as simple, nor as safe, as removing testicles that are in the scrotum. Thus, it is recommended to select against this trait by culling cryptorchid males.

In addition to cryptorchidism, there are other circumstances which may cause sterility by raising the temperature of the testicle. Examples of such conditions are: excessive fat deposits in the scrotum; several days of very high fever; and exposing the males for extended periods to very high environmental temperatures. Usually, if a male was producing sperm prior to exposure to such conditions, and the period of exposure is not too prolonged, the resulting sterility is only temporary (6 to 10 weeks) and, if the conditions are corrected, normal fertility will eventually return.

The testicle contains many long tiny, coiled tubules, the seminiferous tubules, within which the sperm are formed and mature. Scattered throughout the loose connective tissue which surrounds the seminiferous tubules are many highly specialized cells, the interstitial cells of Leydig which produce the male hormone.

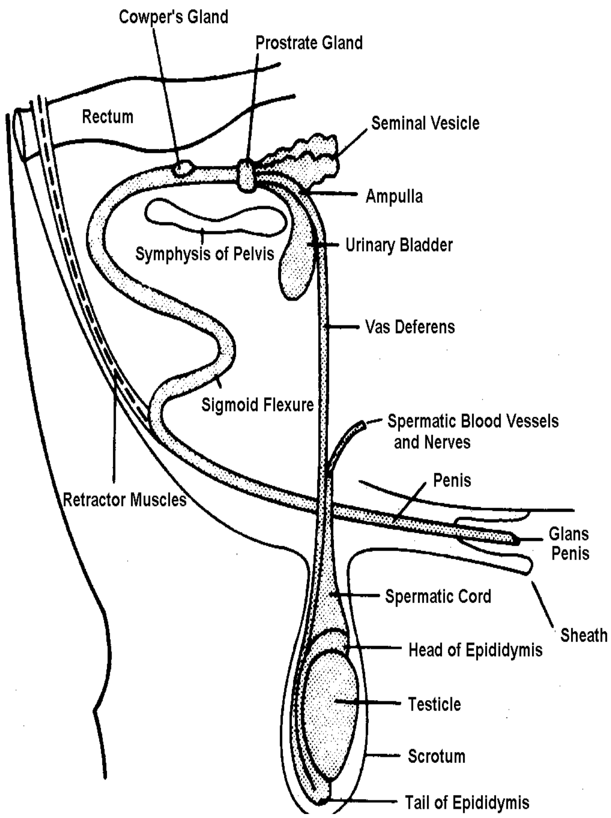

Figure 1. Diagramatic Drawing of the Reproductive Tract of the Bull.

There are many hundreds of individual seminiferous tubules in the testicle. However, they unite with one another until, eventually, some dozen tubules pass out of the testicle into the head of the epididymis.

The epididymis is a compact, flat, elongated structure closely attached to one side of the testicle. In it the dozen or so vasa efferentia from the testicle are combined into a single tubule some 130 to 160 feet in length, but which is packed into the relatively short epididymis. Eventually, this tubule emerges from the tail of the epididymis as a single straight tubule (the vas deferens) and passes, as part of the spermatic cord, through the inguinal ring into the body cavity.

It requires 45 to 50 days for sperm to be formed in the seminiferous tubules and move through the epididymis where they mature for ejaculation. About one week of this time is spent in the epididymis, a period of time that appears to be necessary for the sperm cells to mature into fertile sperm. The sperm in the epididymis are much more resistant to damage from heat than are the sperm that have already been formed and are stored in the epididymis. This may result in a slight delay between the time a male is exposed to some unfavorable condition and the time his fertility is reduced. However, this period of reduced fertility may last for the 45 to 50 days required for producing a new sperm cell. This may explain why a male may settle females for a week or so after recovering from a high fever and then go through a infertile period of several weeks.

Since the epididymis is a single tube which serves as an outlet for all the sperm produced in the testicle, any blockage of this tube is a serious matter. Sometimes, there is a temporary blockage due to swelling following an injury or infection (epididymitis). However, occasionally this swelling or infection results in the formation of scar tissue in the tubule, permanently blocking it and preventing the passage of sperm.

The spermatic cord includes, in addition to the vas deferens, the blood vessels and nerves supplying the testicle and the supporting muscles and connective tissue. Males may be sterilized by an operation called vasectomy in which the vas deferens are cut so sperm cannot pass to the outside of the body. If only the vas deferens are cut, the testicle continues to function normally producing both sperm and male hormone. However, if the blood vessels of the spermatic cord are cut or blocked, shutting off the blood supply, the testicle will stop functioning and waste away.

One of the weak spots of the male anatomy is the inguinal ring, the opening through which the spermatic cord passes into the body cavity. If it enlarges, usually as a result of an injury, a loop of the intestine can pass into the scrotum, resulting in a scrotal hernia. Since predisposition to injury at this point appears to have a hereditary basis, males with scrotal hernias should not be used for breeding even though they may be of normal fertility.

The two vas deferens eventually unite into a single tube (the urethra), the channel passing through the penis. The urethra serves as the common passage way for the excretory products of the two male tracts—semen of the reproductive tract and urine of the urinary tract.

Two of the accessory glands are found in the general region where the vas deferens unite to become the urethra. These glands produce the secretions that make up most of the liquid portion of the semen of the bull. In addition, the secretions activate the sperm to become motile.

The largest of these, and the one producing the largest fraction of the seminal fluid, is the seminal vesicles. They consist of two lobes about 4 to 5 inches long each connected to the urethra by a duct. The other accessory gland in this region is the prostrate gland, located at the neck of the urinary bladder where it empties into the urethra. The prostate is poorly developed in the bull and does not produce a very large volume of secretion.

The third accessory gland, the Cowper's glands are small, firm glands located on either side of the urethra. It is believed that one of the chief functions of their secretion is to cleanse the urethra of any residue of urine which might be harmful to spermatozoa. The clear secretion that often drips from the penis during sexual excitement prior to service is largely produced by these glands.

Occasionally, one of the accessory glands may become infected, resulting in semen samples that are yellow and cloudy and which contain many pus cells. In bulls it is not uncommon for the seminal vesicles to be so affected (seminal vesiculitis).

The sigmoid flexure is an anatomical structure which provides the means by which the penis is held inside the body and sheath, except during time of service. Strong retractor muscles serve to hold the penis in the "S" shaped configuration. Occasionally, these muscles are too weak to function properly and a portion of the penis and sheath lining protrude at all times. This exposes the male to the danger of mechanical injury, particularly in rough brushy country, or on ranges where there is considerable cactus and prickly pear.

The penis is the organ of insemination. In all domestic animals it consists of two, and in man three, cylindrical bodies called the corpora cavernose penis. The spaces of the corpora cavernosa become filled with blood during sexual excitement, resulting in erection of the organ. The end of the penis is the glans penis. The glans penis is richly supplied with nerves and is the source of the sensations associated with copulation.

Semen

Semen consists of the spermatozoa and a liquid portion composed largely of the secretions of the accessory glands. The volume of semen and numbers of sperm ejaculated by different bulls varies considerably. However, most bulls will ejaculate 3 to 5cc of semen containing about 1 billion sperm per cc or 3 to 5 billion sperm per ejaculate.

Once sexual maturity is reached in farm animals, sperm production is continuous throughout the remainder of reproductive life. During periods of sexual rest old sperm in the upper part of the tract die, degenerate and are absorbed. For this reason, the first sample collected after a long period of sexual inactivity may appear to have a high percentage of dead and abnormal sperm. Therefore, semen evaluation of a bull should not be made on one collection alone.

Semen evaluation is being practiced more and more. However, it should be realized that its primary value lies in detecting males that have very definite semen deficiencies such as: either no sperm, or a very low number of sperm cells; poor motility; excessively large numbers of abnormal sperm; a large percentage of dead sperm; and the presence of large amounts of pus. Males producing semen of this sort will usually, at best, be of low fertility. However, there is a wide range of semen quality in males of normal fertility, and it is usually difficult, if not impossible, to accurately predict the level of fertility of a male that does not have grossly deficient semen.

Hormonal Regulation of the Male Reproductive System

The normal functioning of the male in reproduction is largely controlled by hormones. A hormone is a specific chemical substance produced by a specialized gland, called an endocrine gland, which passes into the body fluids (blood and lymph) and is transported to various parts of the body where it exerts some specific effect.

The testicle functions as an endocrine gland because of the production of the male hormone, testosterone, by the interstitial cells. Testosterone has several major effects:

(1). It is largely responsible for the development and maintenance of the male reproductive tract.
(2). It causes the development and maintenance of the secondary sex characters of the male. These are those characteristics associated with "masculinity," such as: growth of beard and change of voice in man; the spur and comb of the rooster; the tusks of the boar; and the crest and heavily muscled shoulders of the bull.
(3). It is a major factor in normal sex drive and behavior of the male.
(4). It increases muscular and skeletal growth.
(5). It is essential for normal sperm formation.

The testicle is, in turn, under the influence of hormones produced by other glands in the body. The primary hormones regulating the testicle are the gonadotropic hormones produced by the anterior lobe of the pituitary gland . The pituitary gland is a small gland located under the brain at the base of the skull. The pituitary hormones regulating reproduction in both the male and the female, (by stimulating the testes or ovaries) are called gonadotropic hormones.

Not only is the hormal production by the testicle regulated by hormones released by the anterior pituitary but the reverse is true. The level of testosterone in the blood regulates the secretion of the gonadotropic hormones by means of a feedback mechanism.

Either purified preparations of gonadotropic hormones described or preparations with a similar physiological action are available for use by veterinarians. They can be useful in treating some cases of reproductive failures, but only if the trouble is caused by a deficiency of that hormone.

Because of the feedback mechanism controlling hormone release, normal functioning depends on a proper balance of the hormones and too much can be just as undesirable as too little. The use of hormone therapy should not be routinely carried out, but should be done only by qualified persons, and with the expectation that they may not be of benefit.

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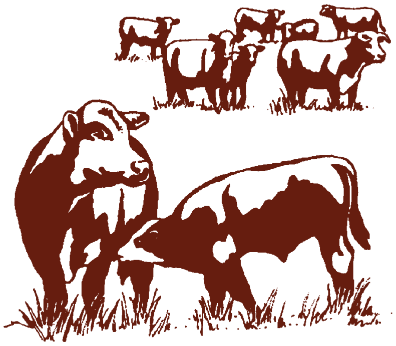

Beef Cattle Handbook

BCH-2200 Product of Extension Beef Cattle Resource Committee

Reproductive Tract Anatomy and Physiology of the Cow

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Anatomy

A diagrammatic sketch of the reproductive tract of the cow is presented in Figure 1. The female reproductive tract of various farm animals have similar parts to those shown for the cow, but with major differences in the shape of the uterus.

The *ovary* is the primary reproductive organ of the female and has two important functions: (1) production of the female reproductive cell, the *egg* or *ovum* and (2) production of two hormones, *estrogen and progesterone*. Each of the two ovaries of the cow are oval to bean-shaped organs 1 - $1\frac{1}{2}$ inches long, located in the abdominal cavity.

The secondary sex organs are, in effect, a series of tubes which receive the semen of the male, transport the sperm to the egg so it can be fertilized, nourish the fertilized egg (*embryo*), and expel the offspring. These organs include the *vagina, cervix, uterus, uterine horns,* and *oviducts* (also called *Fallopian tubes*) which have a funnel shaped opening called the *infundibulum.*

The ovary produces the egg by a process called *oogenesis*. In contrast to spermatogenesis in the bull, which is continuous, oogenesis is cyclic. This cycle, (called the *estrual cycle*), is of a characteristic length, depending on the species, and consists of a definite sequence of events, both of a physiological and a

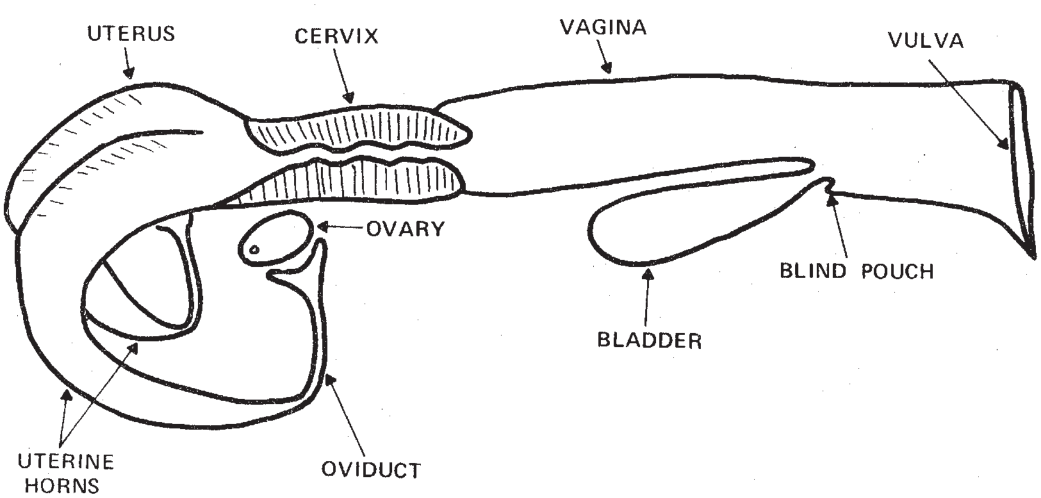

Figure 1. Diagrammatic Sketch of the Reproductive Tract of the Cow.

behavioral nature.

The ovary contains several thousand tiny structures, called *primary follicles*, which consist of a germ cell surrounded by a layer of cells. This germ cell has the potential to mature into an egg if the follicle completes development. However, most of the primary follicles never complete development. Rather they die, are absorbed by the ovary and replaced by newly formed primary follicles.

The relatively few primary follicles which complete development do so through a series of developmental phases. Many layers of cells are added to the single layer of cells surrounding the egg in the primary follicle, and a central cavity forms. As the follicle and the cavity grow larger, the egg is attached by a stalk of cells to the back side of the follicle opposite the site of ovulation. As the follicle continues to grow rapidly, the side opposite the egg bulges from the surface of the ovary and becomes very thin. This follicle is then mature and called a *Graafian follicle*. At ovulation, the thin portion ruptures to release the contents of the follicle, including the egg.

Following ovulation, the cells that developed within the follicle differentiate to form the *corpus luteum*. The corpus luteum has the very important function of producing progesterone.

The released egg is caught by the infundibulum and moves into the oviduct where fertilization occurs if viable sperm are present. The egg remains capable of fertilization for only a few hours; thus, it is very important that fertile sperm be present near the time of ovulation. The egg moves through the oviduct into the uterus within the next 3 - 4 days. If it is fertilized, it begins embryological development in the uterus. If it is not fertilized, it degenerates and disappears.

The body of the uterus of the cow, as well as that of the ewe and sow, is short and poorly developed while the uterine horns are relatively long and well developed. The embryo develops in the uterine horns in these species. In the mare the uterine horns are poorly developed and embryological development occurs in the body of the uterus. Wherever it occurs, the fetus develops within a layer of membranes, called the *placenta*, through which nourishment from the mother diffuses, since there is no direct blood connection between fetus and mother.

The cervix is, in effect, the neck of the uterus. It has thick walls and a small opening that is difficult to penetrate in the cow because of overlapping or interlocking folds. It serves as a passageway for sperm deposited in the vagina and for the fetus at the time of birth. During pregnancy it is usually filled with a thick secretion which serves as a plug to protect the uterus from infection entering from the vagina.

The vagina serves as the receptacle for the male penis during service. In the cow, the semen is deposited in the vagina near the cervix, although in some other species the cervix may be penetrated. The urinary bladder opens to the exterior through the urethra which opens into the vagina. This region of the cow's vagina is restricted in size because of sphincter muscles associated with the urethral opening. The region posterior to the external urethral orifice is called the *vestibule* and is a common passage way for both the urinary and the reproductive systems. The external opening of the vagina is called the vulva.

Hormonal Regulation of the Female Reproductive Tract

Normal reproduction in the female depends upon hormones, which are specific chemical substances produced by specialized glands, called *endocrine glands*. These secretions pass into the body fluids (blood and lymph) and are transported to various parts of the body where they exert several specific effects.

The female hormone, *estrogen*, is produced by the Graafian follicle. A second hormone of the ovary is *progesterone* produced by the corpus luteum. Each has an important role in the female reproductive process.

Estrogen has varied effects:

(1) responsible for the development and functioning of the secondary sex organs, (2) responsible for the onset of heat, *estrus*, the period of sexual receptivity, (3) affects rate and type of growth, especially the deposition of fat, and (4) primes or prepares the prepuberal heifer and post-partum cow for onset of sexual activity.

Progesterone is the hormone of pregnancy. It suppresses the further development of follicles and secretion of estrogen. While progesterone is being produced, the female does not come into heat. Progesterone is necessary for preparing the uterus to receive the fertilized egg and maintains the proper uterine environment for the maintenance of pregnancy.

Estrogen and progesterone are not completely separate in their effects since both are necessary for complete development of important organs. The deveopment of the uterus is initiated by estrogen and completed by progesterone. The fertilized egg will not implant and survive in the uterus unless that tissue has been properly prepared by the action of estrogen, and then of progesterone. Estrogen causes rhythmic contractions of the uterus. Progesterone, on the other hand, has a quieting effect on the uterus, so there are no contractions which might disturb pregnancy.

Complete development of the mammary gland is also dependent upon both hormones. Estrogen promotes the growth of the duct system and progesterone is necessary for the development of the clusters of milk-secreting alveoli on the ducts.

Thus, it can be seen that, in general estrogen makes things happen and progesterone calms them down.

As in the male, the production of the hormones of the ovary is under the direct influence of the *gonadotrophic hormones* of the anterior pituitary gland, located at the base of the brain. The names follicle stimulating hormones (FSH) and *luteinizing hormone* (LH) were given because of the effects of these hormones on the female. FSH stimulates the growth, development and function of the follicle, while LH causes the rupture of the follicle and development of the corpus luteum.

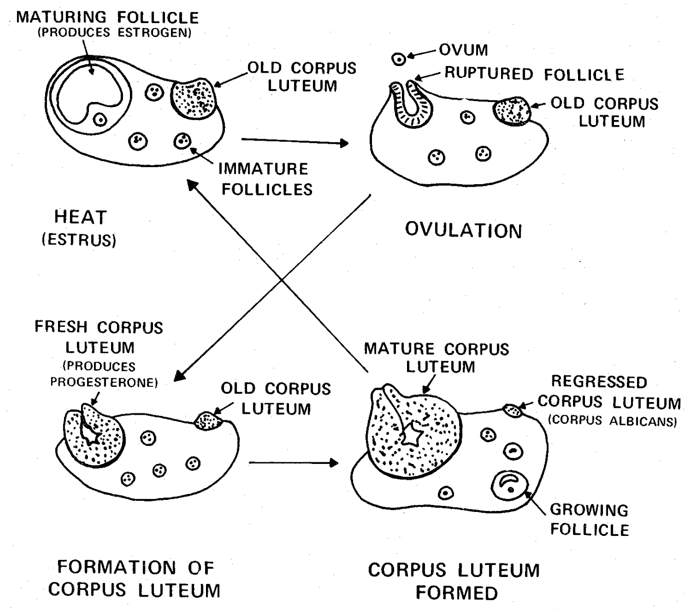

Figure 2. The Sequence of Events in a Typical 21-day Estrous Cycle in Which Pregnancy Does Not Occur

The Estrual Cycle

The reproductive cycle of the cow consists of a series of events which occur in a definite order over a period of days. The estrual cycle in the cow averages 21-days (range is 17 - 24) and is concerned with preparing the reproductive tract for *estrus* or *heat* (the period of sexual receptivity) and *ovulation* (the release of the egg). Figure 2 outlines the sequence of events and hormones involved for a typical 21-day cycle in which pregnancy does not occur.

Day 0: The cow is in estrus (standing heat). Near the end of the standing heat, the mature *Graafian follicle* ovulates (ruptures) in response to a surge of LH released by the pituitary gland.

Day 1-2: The cells that formerly lined the follicle change and become the lutein cells of the corpus luteum. This change in cell form is caused by hormonal action, primarily the action of LH.

Day 2-5: The corpus luteum grows rapidly in both size and function. At this stage, numerous follicles may be seen on the ovary but by day 5 they have begun to regress.

Days 5-16: The corpus luteum continues to develop and reaches its maximum growth and function at about day 12. It secretes the hormone progesterone which inhibits (blocks) LH release by the pituitary gland. During this period, the ovaries are relatively inactive except for the functional corpus luteum. No follicles reach maturity and/or ovulate because of the existence of the high levels of progesterone.

Days 16-18: The corpus luteum regresses rapidly due to some luteum activity of the uterus (prostaglandin).

Days 18-19: The corpus luteum is almost nonfunctional and this releases the blocking action of progesterone. Of the several follicles that commence growth, one becomes more prominent by a surge in rapid growth and activity. As the Graafian follicle grows, it secretes increasing amounts of estrogen. The remainder of the follicles regress.

Days 19-20: With the increase in estrogen release by the Graafian follicle and a corresponding decrease in progesterone by the regressing corpus luteum, estrus or heat will occur (cycle has now returned to day 0). The high estrogen level in the blood triggers a release of LH near the end of heat. Following this surge in blood levels of LH, the mature follicle ruptures to release the egg and the cellular tissue left behind becomes *luteinized* in response to the stimulation of a hormonal complex to form a new corpus luteum (cycle has now returned to day 1-2). Progesterone again becomes the dominant hormone.

It must be appreciated that the timing given for the preceding events is only approximate, and would differ for different cycle lengths.

Also, the discussion of events occurring during the estrous cycle was based on a full cycle in which pregnancy does not occur. If the egg is fertilized and begins development in the uterus, the corpus luteum does not regress but continues to function by secreting progesterone. No follicles develop to maturity and heat does not occur. Progesterone keeps the uterus quiet and thus provides the most favorable conditions for the developing fetus.

Any condition that prolongs the period of time that blood levels of progesterone remain high (such as implanting, injecting or feeding progestin materials for estrus synchronization) will have the same effect as does pregnancy. Occasionally, the corpus luteum does not regress normally even though the animal does not become pregnant. This requires the diagnosis and treatment of a veterinarian.

Occasionally, abnormally short estrous cycles (7 - 11 days) occur and this condition appears to be caused by, either no corpus luteum being formed, or if one is formed, it is nonfunctional as progesterone levels remain low.

Most animal species, including all farm livestock, are *spontaneous ovulators*, which means ovulation occurs at a certain time during the estrous cycle whether mating occurs or not. Females from some species are *induced ovulators* and ovulation occurs only following the stimulus of mating. Included in this group are the rabbit, cat, and mink. In these species it has been established that ovulation is the result of LH secretion in response to nerve impulses resulting from the mating act. Thus, both hormonal and nerve pathways are important factors in the reproductive process.

There are wide differences between the species of mammals in the various characteristics of the estrual cycle. Some species have only one heat period each year and are called *monoestrous.* The cow is in a group that exhibit heat more than one time per year and is called *polyestrous.* There is considerable variation in the latter group, however, from those having estrus continuously throughout the year to those that have only a few cycles during a restricted season. Most wild animals and sheep among the domestic animals are said to be *seasonal breeders*. The non-breeding period is called anestrus.

Species that are considered to be continuous breeders (such as the cow) are not without periods of anestrus during which the estrous cycles stop. For example, anestrus is commonly observed in cows, especially young cows, when nursing calves and subsisting on low planes of nutrition.

Estrus is not always accompanied by ovulation, nor ovulation by estrus. Heat without ovulation (*anovulatory heat*) will not result in pregnancy even though the female is bred. Ovulation without the external signs of heat (*quiet or silent heats*) is not uncommon in cows, especially the first few weeks after calving. Such females will not accept service .

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BCH-2200 Reproductive Tract Anatomy and Physiology of the Cow

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Reproductive Diseases in Cattle

EDITED BY L. R. SPROTT AND ROBERT W. FIELD*

DISEASES OF the reproductive organs in cattle usually develop so gradually that they go unrecognized until the disease is well established in the herd. Infected animals usually are not dying; in most cases, especially in males, they do not even appear ill. Some animals never show symptoms of the disease, yet remain a major threat to the rest of the herd because they carry disease organisms.

To prevent reproductive diseases, producers must always be on guard and practice good management techniques such as isolating newly acquired cattle and vaccinating when needed. They also should work closely with veterinarians to keep their cattle healthy.

The most common reproductive diseases in cattle are brucellosis (Bang's disease); leptospirosis; infectious bovine rhinotracheitis (IBR) and bovine virus diarrhea (BVD) complexes; vibriosis; and trichomoniasis.

Brucellosis (Bang's disease)

Although most states are now brucella-free, brucellosis still causes abortion and infertility in some regions. It is important to understand that not all brucellosis-infected cows abort, produce weak calves, retain placenta or have trouble breeding back. A brucellosis reactor cow may be normal in every observable aspect. However, each time she calves or produces a genital discharge, millions of brucella organisms may be present on the surface of the placenta, calf or discharge. The discharges then contaminate the pasture and other feeds, such as hay, threatening other cattle. If susceptible animals ingest these bacteria, they are likely to become infected.

Although infection usually occurs via the digestive tract, a susceptible animal may also pick up bacteria through the skin or eye. Contaminated feed, bedding, water or the premises may remain infective for a few days up to a few weeks, depending on environmental conditions.

The infection is spread mainly when infected cattle are introduced into the herd, either through purchase or when they break into a pasture with "clean" cattle. To keep your herd "Bang's free," maintain a closed herd by raising all your own replacements if possible. If you must buy replacement cattle, know the seller's reputation. Be sure that all cattle you buy originate from clean herds, and that the females were vaccinated as calves and are negative to the Bang's test if they are of testable age.

Isolate breeding stock for 30 to 60 days upon arrival at the farm and retest at the end of the isolation period. A lot of trouble? Yes, but not if a lifetime's effort is risked in building a quality herd. At the same time, test the new animals for other reproductive diseases as recommended by the local veterinarian.

It is recommended to have an accredited veterinarian vaccinate all heifers between 4 and 12 months old. The calves should be properly identified, with an official ear tag and tattoo in the right ear.

Be sure that bulls are free of brucellosis and all reproductive diseases. Although brucellosis is rarely spread through breeding, it is still dangerous for a bull to breed an

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infected cow and then breed a clean cow soon thereafter. Bulls occasionally become infected; this is usually exhibited by a swollen testicle or scrotum. Producers using artificial insemination should avoid semen from brucellosis-infected bulls. Their semen can infect cows.

Leptospirosis

Leptospirosis is a widespread problem in the South, especially in unvaccinated herds. It causes repeat breeders, low-grade uterine infections, abortions, mastitis and occasionally systemic infection. Of the five or more strains of the organism, the three most common causing problems in cattle are *Leptospira pomona, Leptospira hardjo* and *Leptospira grippotyphosa*.

Leptospirosis can build up unrecognized in a herd. Closely confined cattle are particularly susceptible. Droplets of urine from infected cows can infect normal cows after contact with the eye or mucous membranes of the nose or mouth. The disease infects more cattle each day, preventing cows from settling and lengthening their calving intervals.

To prevent leptospirosis:

- Vaccinate cattle with bacterins containing three or five serotypes every six months;
- Drain stagnant bodies of water; and
- Eliminate rodents, especially rats, from any barns or sheds where cattle congregate.

IBR and BVD complexes

Infectious bovine rhinotracheitis (IBR) and bovine virus diarrhea (BVD) complexes are virus-caused diseases responsible for many abortions and possibly respiratory infections, “pinkeye”-type lesions and foot lesions. Temporary infertility may follow IBR because of vaginitis and/or a mild uterine infection.

Because these diseases are so complex, be careful when using IBR and BVD vaccines. Some vaccines may result in abortions. Before vaccinating, consult a veterinarian for advice on the vaccination procedure for a particular herd.

Vibriosis

Vibriosis is a venereal disease causing infertility and, occasionally, abortion. It is caused by the bacterium *Campylobacter fetus*, which lives in the crevices of a bull’s prepuce (foreskin), but usually does not become established in the bull until it is about 4 years old or older.

Vibriosis is spread from an infected bull to a cow during the breeding act. Bulls also may be infected by breeding infected cows. Although semen from reputable bull studs is usually “clean” because of proper health examinations of the bulls and treatment of semen, this disease can be transmitted through artificial insemination if these precautions are not taken.

Untreated, infected bulls can remain carriers for a long time. They also can be “clean” yet transmit the germ from an infected cow to a “clean” cow.

Vibriosis in females causes endometritis (infection of the inner lining of the uterus), resulting in failure to conceive or death of the embryo. Affected cows may conceive and not return to heat 21 days later. However, the newly formed embryo may then die, become absorbed by the cow and then she may exhibit estrus from 27 to 53 days after breeding. Abortions late in gestation can occur, but are unusual.

Diagnosis is difficult and depends on identifying cultures of the organism from the genitalia of the infected cow or bull, or from the abomasum (fourth stomach chamber) of an aborted fetus. Prevent vibriosis by vaccinating cattle, using artificial insemination, treating infected animals, or combining all three.

Trichomoniasis

A protozoan organism, *Trichomonas fetus*, causes trichomoniasis. It is also a venereal disease. Symptoms include occasional abortions and pyometra (pus in uterus) that impairs breeding efficiency. Pyometra develops after the infected cow’s embryo dies.

To treat the female, treat any uterine infection and provide sexual rest. Usually a 90-day period of sexual rest eliminates the organisms from the uterus. Vaccination is also an option in cows.

Before use, test bulls, except virgins, through culture methods at least three times at weekly intervals. Using clean semen from reputable bull studs also prevents infection. Frozen semen containing the organism can cause infection if put into the uterus.

Diseases Causing Abortions in Cattle

Diseases	Organism	How spread	State of gestation at abortion	Samples needed for diagnosis	Vaccination	Remarks
Brucellosis	Bacterial (Brucella abortus)	Aborted fetuses, fetal membranes	6-9 months	Blood sample from aborting cow; fetus; placenta	Live vaccine in heifers at 4-12 months.	Cull infected animals. Do not vaccinate bulls.
Leptospirosis	Bacterial (At least 5 serotypes)	Urine of infected animals, aborted fetuses	Any stage, usually 6-9 months	Sample 10 percent of herd	Every 6 months at 2-4 weeks before breeding.	Laboratory should determine the type of lepto causing infection.
Red nose (IBR)	Viral	Contagious from cow to cow	6-9 months	Fetus; placenta; blood samples	Killed or modified live vaccine. See veterinarian.	Abortion may or may not be associated with illness in cows.
Virus diarrhea (BVD)	Viral	Contagious from cow to cow	Variable, usually early in gestation	Two blood samples, 3 weeks apart	Killed or modified live vaccine. See veterinarian.	Calves born with disease (loss of hair, brain damage)
Vibriosis	Bacterial (Campylobacter fetus venerealis)	Venereal disease spread by infected bulls	Early abortion, repeat breeding	Vaginal mucus from infected cow, cervical mucus; fetus; preputial washings from the bull	Two injections of vaccine the first year, 30-60 days before breeding. Bulls and cows should be vaccinated.	Also causes few abortions
Vibriosis	(Campylobacter fetus intestinals)	Ingested	+6 months	Fetus	None	Sporadic abortions
Trichomoniasis	Protozoal (Trichomonas fetus)	Venereal disease spread by infected bulls	2-4 months	Preputial washings from infected bulls; uterus from cull cows	1st dose: 60 days prebreeding. 2nd dose: 30 days prebreeding. Single booster annually.	Treatment consists of sexual rest of cows for 90 days; artificial inseminations; cull infected bulls and open cows.

This information was prepared for the Southern Regional Beef Cow-Calf Handbook by John E. McCormack, Extension Veterinarian, University of Georgia. Editorial comments were given by Dr. Robert W. Field, College of Veterinary Medicine, Texas A&M University.

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People Helping People

BEEF CATTLE NUTRITION

The Cow's Digestive System

Whitney Rounds and Dennis B. Herd*

Digestion in cattle is similar to digestion in man and certain other animals, except that, in cattle, foods are first subjected to microbial fermentation in the reticulo-rumen. Cattle can utilize roughages and other fiberous feedstuffs only through the action of microorganisms which are normally ingested on feed or obtained from other animals. Microorganisms in the rumen have the unique ability to break down fiberous feedstuffs to obtain the simple nutrients required for their growth. In this process, various microbial by-products of no value to the microbe, such as volatile fatty acids and B vitamins, are produced. These by-products are absorbed into the blood and are used as sources of nutrients by the animal. The microorganisms also pass from the rumen to the lower digestive tract, where they are digested and their constituent protein, vitamins and other nutrients are absorbed and utilized by the animal. The relationship of the microbes with the host cow is mutually beneficial.

DIGESTIVE TRACT ANATOMY

Man, dogs, poultry and swine have simple or monogastric stomachs (see Figure 1). The monogastric stomach is a pouch-like structure containing glands which secrete hydrochloric acid and digestive enzymes. Monogastric animals do not produce enzymes capable of breaking down cellulose, the main source of energy in forages. Forage consuming species, such as cattle and sheep, have intestinal differences which enable them to digest large amounts of fiberous material. In cattle and sheep, rumen microbes supply the digestive enzymes necessary for the breakdown of plant cellulose and hemicellulose. The cow has the stomach volume and properties necessary to assist with the microbial digestion. The ruminant digestive tract and the ruminant stomach are shown in Figure 1.

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The ruminant stomach is divided into four compartments: the rumen; reticulum; omasum; and abomasum. Digesta can flow freely between the first two compartments, the rumen and reticulum. The reticulo-rumen contains more than 50 percent of the total digestive tract capacity and most of the microbial activity takes place here. After sufficient time in the reticulo-rumen, digesta flows into the omasum. The omasum has many folds of tissue, similar to a partially open book, and contains from 6 to 8 percent of the total digestive tract capacity. The omasum is thought to aid in the reabsorption of water from digesta flowing through it, and to assist in reducing particle size. Upon leaving the omasum, digesta passes into the abomasum, which is frequently referred to as the true stomach. Like the stomach of monogastric animals, the abomasum secretes digestive enzymes which prepare digesta for absorption in the small intestines. Approximately 6 to 8 percent of the total digestive tract is taken up by the abomasum.

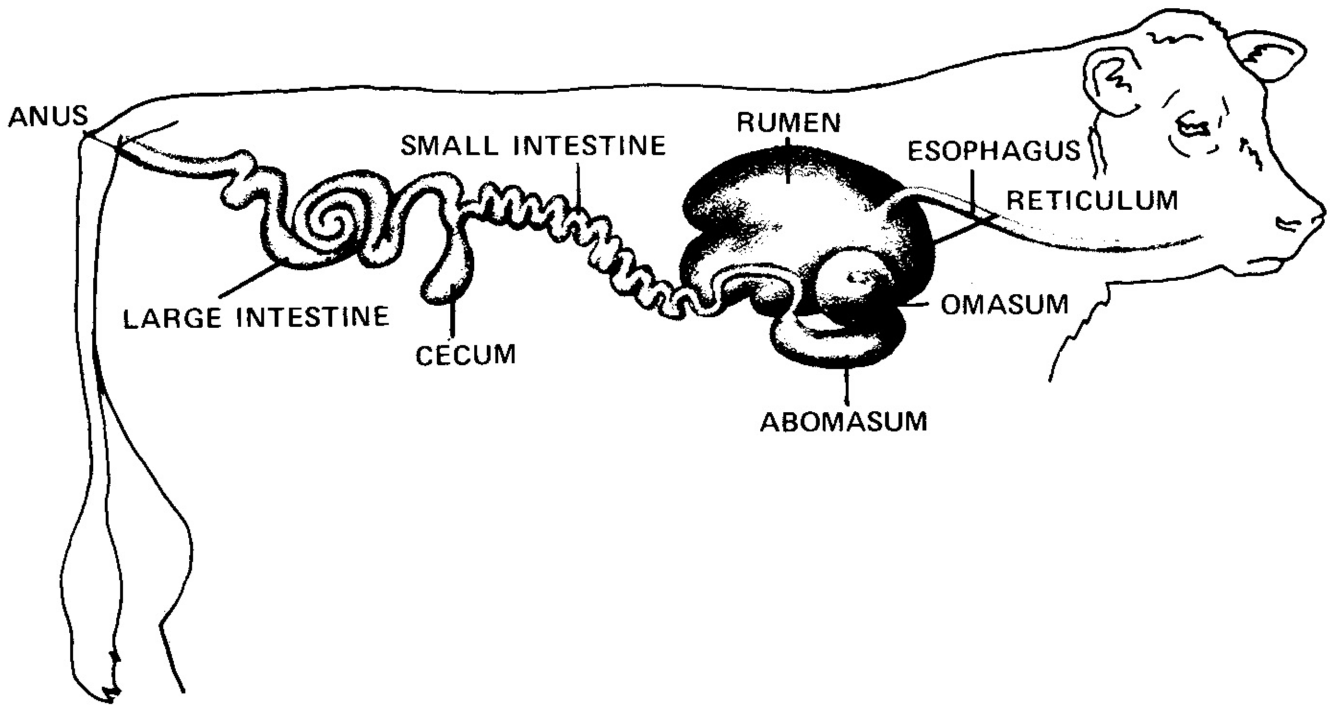
Feeds broken down to their component parts during passage through the ruminant stomach are largely absorbed in the small intestines. Absorption of protein, vitamins, simple carbohydrates, fats and amino acids takes place here. Undigestable material which will not be absorbed passes into the large intestines, where excess moisture is reabsorbed and form is given to what will become the fecal droppings.

RUMEN FERMENTATION

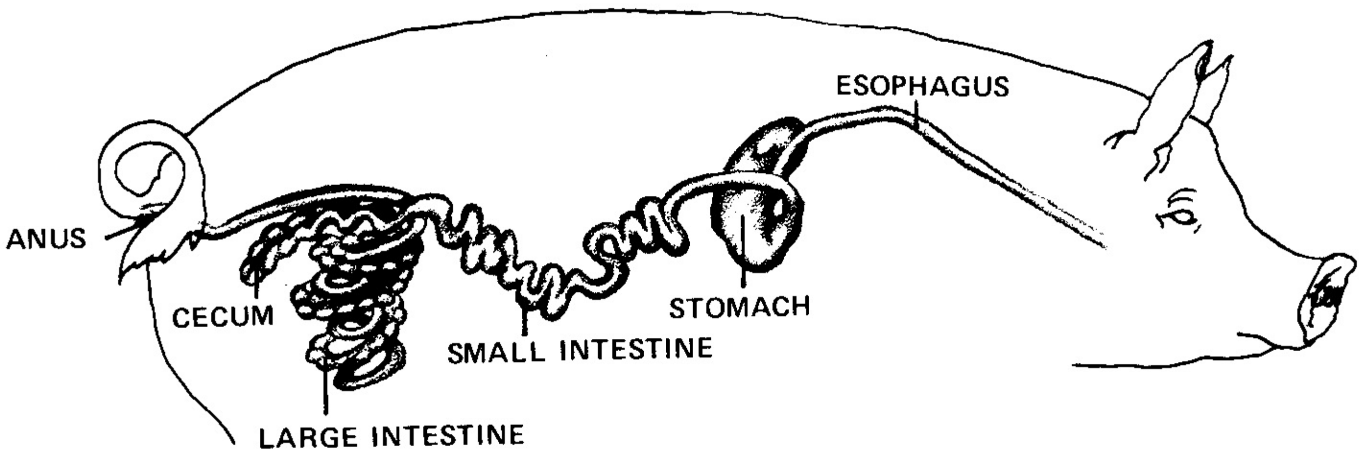
Fermentation in the rumen is made possible by a very stable environment for microbial growth. The normal pH ranges from 5.5 to 7.0; temperature ranges from 37 to 40 degrees centigrade. And food is continuously available in the rumen of properly fed animals. End products of fermentation are continuously removed, either by eructation, by absorption across the rumen wall or by passage out of the rumen to the lower digestive tract. Feed does not just "sit" in the rumen. There is continuous mixing of rumen contents

FIGURE 1.

RUMINANT DIGESTIVE TRACT



MONOGASTRIC DIGESTIVE TRACT



as digestive tract muscles contract. The mixing action helps expose food to microbial action and pass digesta through the system.

Rumen Microbes. Rumen bacteria have been classified according to the type of food they utilize or the end products they produce. Included are bacteria which digest cellulose, hemicellulose, starch, sugar, organic acids, protein and fat, as well as bacteria which produce ammonia or methane or synthesize vitamins.

Protozoa found in the rumen are larger than bacteria, and are classified according to cell morphology. Protozoa species are known to vary with the type of diet, time of year and geological location. Protozoa have been known to consume rumen bacteria. Bacteria and protozoa have food value to the cow. Dried microbes contain from 40 to 50 percent crude protein which is over 75 percent digestible.

Microbial Metabolism. Microbes in the cow's digestive tract use a portion of the nitrogen and energy from the feed for their own growth and reproduction. As they grow, microbes manufacture microbial protein and store energy in their cells. Microbes themselves become an important source of food (particularly protein) for the cow. During fermentation the microbial population converts a large portion of the feed carbohydrates (sugars, starches, cellulose and hemicelluloses) to volatile fatty acids which are the cow's main source of energy (Figure 3).

The composition of the volatile fatty acids produced in the rumen varies according to the different rations fed. Normally, acetic acid would make up 60 percent, propionic 22 percent and butyric 16 percent of the total acid production. In general, high roughage rations will contain a higher percentage of acetic acid whereas high concentrate rations will result in slightly higher levels of propionic acid. Ideally, decreasing acetic and butyric acids and increasing propionic would lead to more efficient beef production. However, high acetate levels are desired for milk fat production. High grain to roughage ratios, some feed processing techniques and certain feed additives promote propionate production at the expense of acetate.

FOOD PASSAGE THROUGH THE DIGESTIVE TRACT

The time required for food passage through the digestive tract ranges from 1 to 3 days depending upon characteristics of the food and the specific nutrient involved.

In the mouth, chewing breaks the food into smaller particles. Digestive enzymes in saliva are mixed with food before it passes down the esophagus into the reticulo-rumen (Figure 1). Although most of the feed undergoes fermentation, small amounts may pass unchanged through the rumen into the omasum and abomasum. Some of the larger food particles will be regurgitated, chewed again and reswallowed. This "chewing of the cud" is important because cattle do not initially chew their food to the extent that monogastrics do.

Protein. Protein in the diet is subjected to degradation (partial or extensive) by ruminal microorganisms (Figure 2). Microbes degrade plant proteins to various degrees and use the resulting ammonia in the synthesis of microbial protein. The extent of protein degradation varies with the type and solubility of the protein. This degradation and resynthesis process has advantages and disadvantages. Some high quality proteins may be degraded, thus reducing the quantity of essential amino acids available to the animal. (Heat and acid treatment to reduce protein solubility are currently being studied as methods of preventing degradation, thus saving the amino acids for use by the animal.) On the other hand, extremely low quality plant proteins may be upgraded during digestion to a higher quality microbial protein. Plant proteins not degraded in the rumen along with microbial protein are passed to the lower tract. Digestive enzymes secreted in the abomasum break both plant and microbial protein into their component amino acids which are absorbed from the small intestines.

Non-protein nitrogen can be used as a substitute for plant nitrogen. Rumen microbes can use the non-protein nitrogen in the synthesis of microbial protein.

Carbohydrates. Carbohydrates in the diet also are degraded by rumen microorganisms (Figure 3). Volatile fatty acids and gases (methane and carbon dioxide) are the end products of this process. Volatile fatty acids produced by rumen microbes are absorbed directly from the rumen. Gases are eliminated through eructation.

Fiber, a complex carbohydrate, is composed of lignin, cellulose and hemicellulose. Lignin is very resistant to microbial attack, therefore little of it is digested. Cellulose is more readily digested than lignin, and hemicellulose is the most digestible of the three. Starches and sugars also are readily converted to acids and gases. Unfermented feed residues and microbial cells are left to pass through the omasum to the abomasum. In the abomasum, the secretion of digestive enzymes prepares the foodstuffs for absorption in the small intestine.

Fats. Some hydrogenation (addition of hydrogen) of unsaturated acids takes place in the rumen (Figure 4). Unsaturated dietary fat (soft fat) subjected to microbial action in the rumen is transformed to a hard or a saturated fat. Most fats are passed to the abomasum and small intestine where absorption occurs.

FIGURE 2. DIGESTION AND UTILIZATION OF PROTEIN BY CATTLE

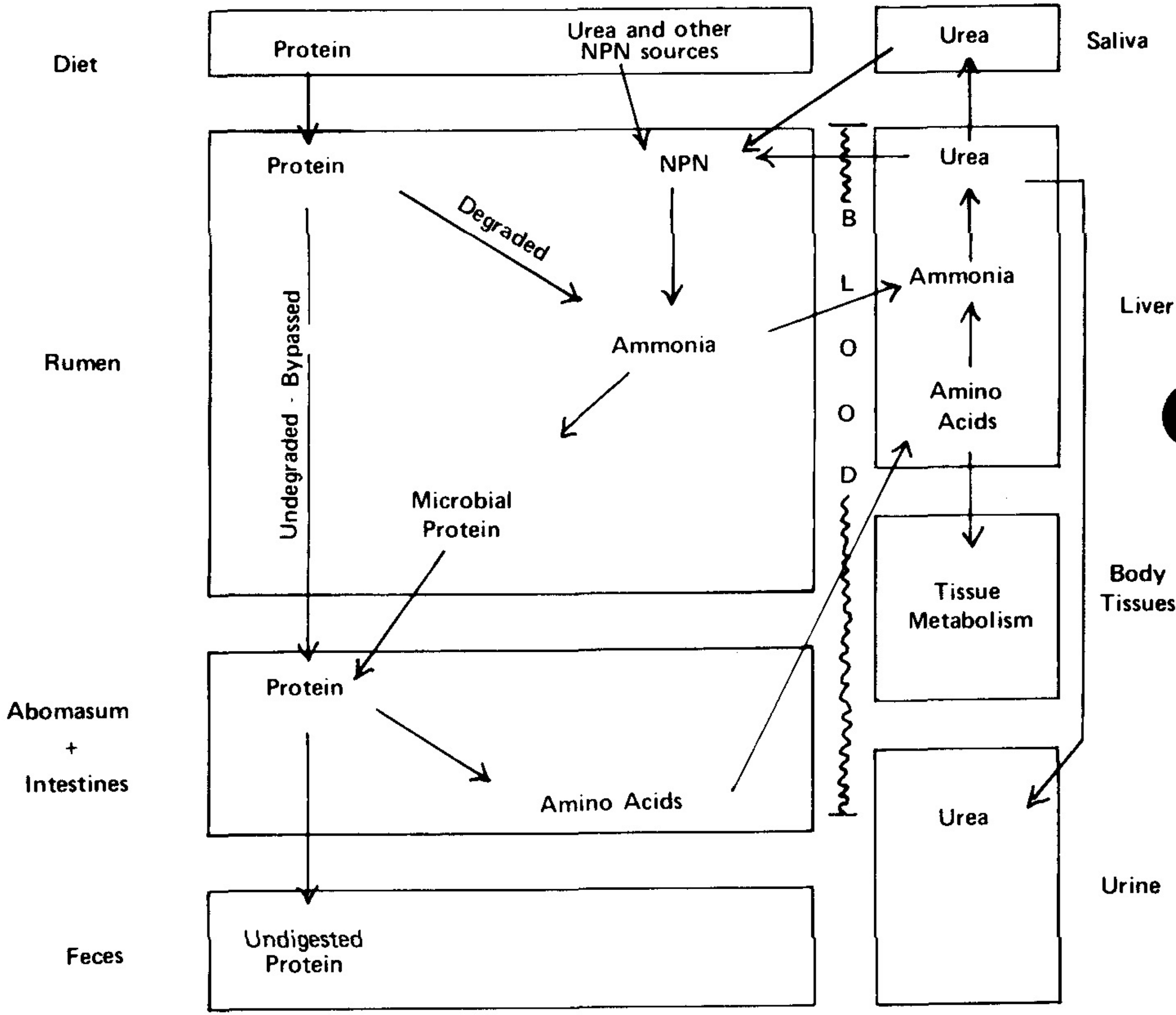


FIGURE 3. DIGESTION AND UTILIZATION OF CARBOHYDRATES

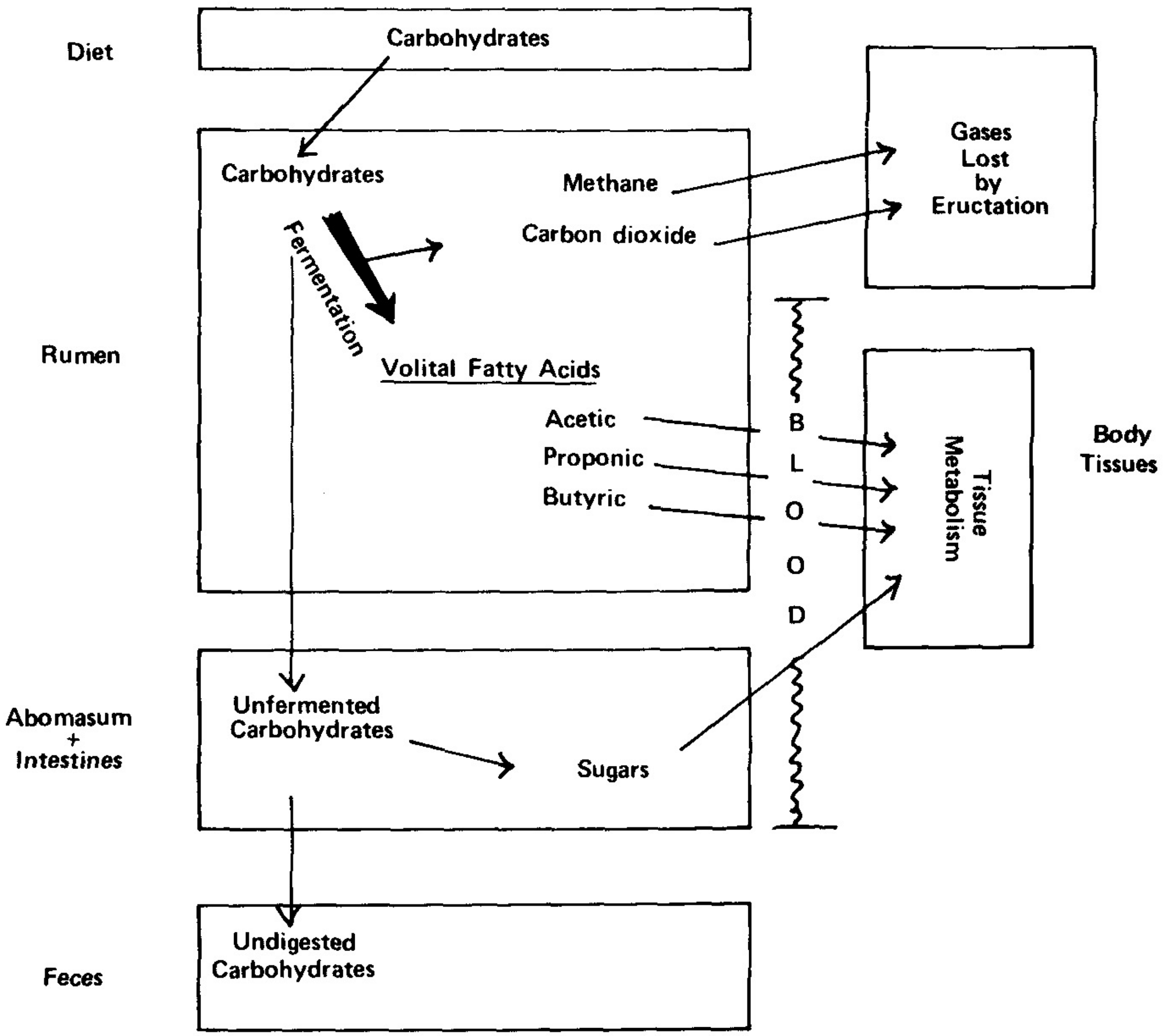
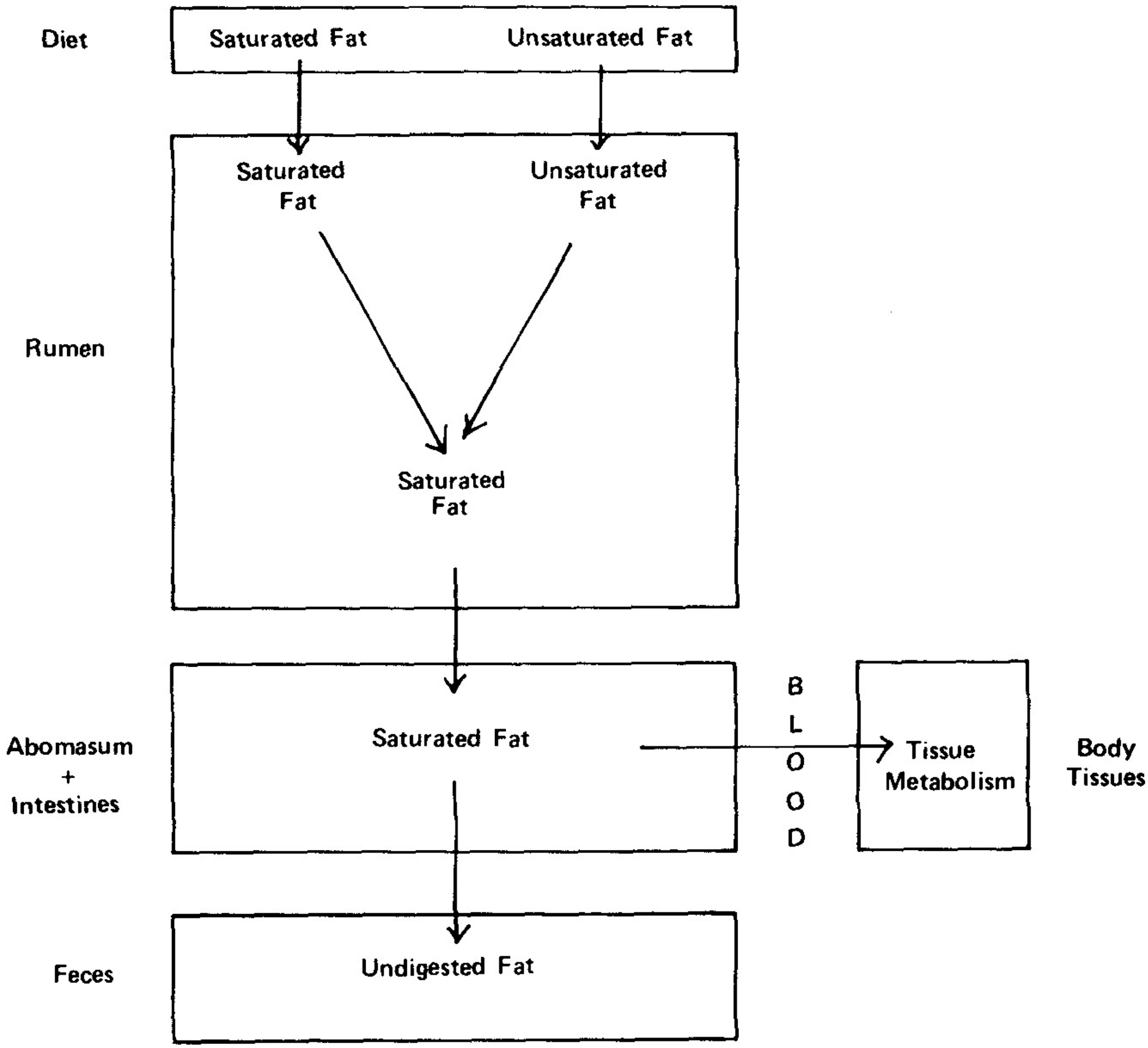


FIGURE 4. DIGESTION AND UTILIZATION OF FAT BY CATTLE



ADVANTAGES OF RUMEN FERMENTATION

Fermentation by the rumen microorganisms gives the ruminant animal several unique capabilities:

1. Forage Utilization

   Forage and roughage account for a large quantity of the total world feed resources. Rumen microorganisms, through the production of enzymes, allow the ruminant animal to use the fiberous portion of these roughages as an energy source.

2. Non-Protein Nitrogen Utilization

   Rumen microorganisms can manufacture protein from non-protein nitrogen. This microbial protein is later digested and supplies the animal with needed amino acids. Nonruminants must obtain essential amino acids directly from their diets.

3. Vitamin Synthesis

   Rumen microorganisms can synthesize the B-complex vitamins and vitamin K. Dietary supplementation is not required, except in sick animals where rumen function is impaired.

DISADVANTAGES OF RUMEN FERMENTATION

Fermentation in the rumen and reticulum may cause inefficient conversions of dietary constituents:

1. Waste Gas Production

   Carbon dioxide and methane are by-products of the breakdown of carbohydrates, and are eliminated from the rumen. Sugars and starches would be of more benefit if they could be passed to the lower digestive tract for absorption as sugar.

2. Wasted Protein and Nitrogen

   Ammonia and organic acids are the end result of protein breakdown. Some of the resulting ammonia is recombined to form microbial protein. However, under some conditions ammonia is lost, absorbed across the rumen wall and excreted in the urine. The loss of ammonia in the digestive process is inefficient.

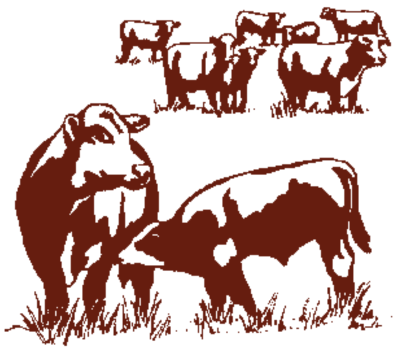
3. Heat of Fermentation

   Rumen microbes breaking down feedstuffs and reforming them generate heat. This heat of fermentation is a disadvantage in most instances. In cold environments, however, this heat will help meet the animal's maintenance energy requirement.

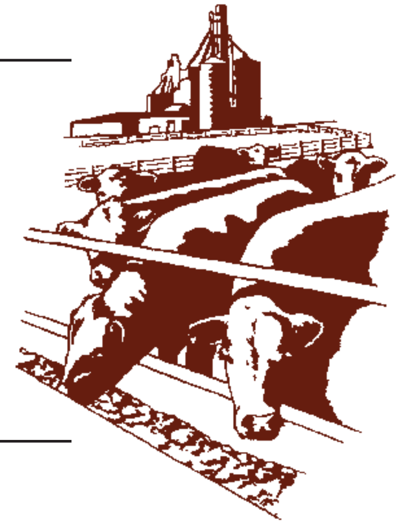
4. Digestive Disturbances

   Bloat and acidosis are cases of rumen malfunction. Bloat results when fermentation gases are produced faster than they can be disposed of. Acidosis is the result of an excessive breakdown of readily available carbohydrates. In feedlot cattle, acidosis usually leads to an erosion of the rumen wall and liver abscesses.

The ruminant animal is unique because of the mutually beneficial symbiotic relationship that exists with the microbes living in its digestive tract. Through the action of these microbes, high-fiber feed sources become assets. Non-protein nitrogen compounds can be used by the ruminant in the production of microbial protein. Animals with simple stomachs cannot use cellulose or non-protein nitrogen.



Beef Cattle Handbook



BCH-3000

Product of Extension Beef Cattle Resource Committee
Adapted from the Cattle Producer's Library

Vital Signs in Animals: What Cattle Producers Should Know About Them

Edward A. Le Viness, Area Livestock Specialist, University of Arizona

Disease may be defined as "any abnormal structural or functional change in the tissues of the body." Though diseases have many direct and indirect causes, such as trauma (wound or injury), parasites, congenital (present at birth), viruses, and others, they all affect to some degree the vital signs of the body. In animal physiology, the term "vital signs" pertains to the temperature, respiration rates, and pulse of the body. Obviously, there are other important functions in the body, but these three are fundamental for the maintenance of life. Without them all else is secondary.

Animal owners need not only to recognize changes in the condition and appearance of their animals, but also to learn to what extent an abnormality may be reflected in the vital signs of the body. Usually, the first signs of disease are slight and may go unnoticed. The observant individual who detects the early symptoms and initiates the proper action can play a big role in disease control. The vital signs of the body, what they might mean and how they may aid the stockman in describing symptoms to the veterinarian, are described in the following.

Temperature

Temperature is defined as "the degree of heat of a living body." An animal's temperature is actually the result of the balance between heat produced by the basal metabolism1 and muscular activity of the body, and the heat lost from the body. Approximately 85 percent of heat loss is through the skin, the remainder is lost by the lungs and through digestive and urinary secretions. The actual regulation of body temperature is accomplished mainly through thermoregulatory centers located in the brain.

An animal's abnormal temperature may play a part in the veterinarian's ultimate diagnosis of a disease, and the visual symptoms of abnormal temperature are often the first noticeable clue the owner may detect. When an animal's temperature is above normal limits, it's considered to have a fever; if it's below normal, it's called hypothermia. Domestic animals do not have constant normal temperatures and considerable variations will be found in the temperature of normal animals under different conditions. In general, animal temperatures will vary, depending on physical activity, stage of pregnancy, the time of day, and environmental surroundings.

In the United States, body temperature is measured with a clinical Fahrenheit thermometer. The thermometer has a scale ranging from 94° to 200°F, and each degree is divided into fifths. The procedure for taking an animal's temperature is: (a) shake the mercury column into the bulb end of the thermometer; (b) moisten or lubricate the tube; and (c) insert the bulb end through the anus into the rectum. Insert the full length of the tube into the rectum, and leave the thermometer in the rectum for about 3 minutes. Note: Most animals object to insertion of the thermometer in the anus, so be sure to use an appropriate restraint on the animal. The normal temperatures for different animals are as follows:

Species	Degrees Fahrenheit
Horse	99.5 to 101.3
Foal	99.5 to 102.2
Cattle	100.4 to 103.1
Sheep and goats	102.2 to 104.9
Swine	100.4 to 104.0

When the body temperature increases by at least 1°F over the normal upper limit, the animal is considered to have a fever. In most fevers, the temperature usually rises rapidly, reaches a peak, and then falls to a lower level. Generally, the height of the temperature indicates the height of the fever. Four categories of fever are distinguished here:

	Degrees Fahrenheit	
	Horse	Cow
Mild fever	101.3-103.0	103.1-104.6
Moderate fever	103.0-104.8	104.6-105.8
High fever	104.8-106.0	105.8-107.0
Very high fever	106.0-110.0	107.0-110.0

Usually the temperature never exceeds 106°F in horses or 107°F in cows—even in severe infectious diseases. However, in all animals suffering from heat stroke, the temperature may exceed 110°F.

Although the measurement of temperature is one of the most characteristic and reliable methods to judge the degree of fever, it does not always have a direct relationship in animals, especially in cattle. You must also consider other symptoms, such as chill, uneven distribution of the external temperature, pulse and respiration rates, appetite, digestion, morbidity, etc.

Subnormal temperature (hypothermia) may or may not indicate disease. It occurs in a variety of ailments, such as chemical poisoning, indigestion, and calving paralysis. Subnormal temperatures are much less frequent than fever temperatures.

Pulse

The pulse may be defined as "the rhythmic, periodic thrust felt over an artery in time with the heartbeat." The important factors to note in taking the pulse are: (1) frequency, (2) rhythm, and (3) quality. Frequency is determined by counting the number of heartbeats occurring in one minute. Rhythm typifies a normal pulse seen in a series of rhythmic beats that follow each other at regular intervals. Quality is best described as the tension on the arterial wall; it is an indication of the volume of blood flow.

The pulse can be palpated (touched with fingers) in superficial arteries when they are in soft tissue and can be pressed against a hard or bony structure. When you have located an artery, hold it steady with the fingers and apply gentle pressure. To determine the rate accurately, count the pulse for one full minute. Judge the rhythm and quality by alternating pressure on the artery for another full minute.

The pulse in cattle and horses can be felt in approximately the same location: where the external maxillary artery crosses the lower edge of the mandible, just in front of the masseter muscle (Fig. 1).

When you place your fingers flat on the cheek in front of the masseter muscle and move them back and forth, you can easily feel the artery. In horses, pulse may also be taken on the inside of the forearm (radial bone)

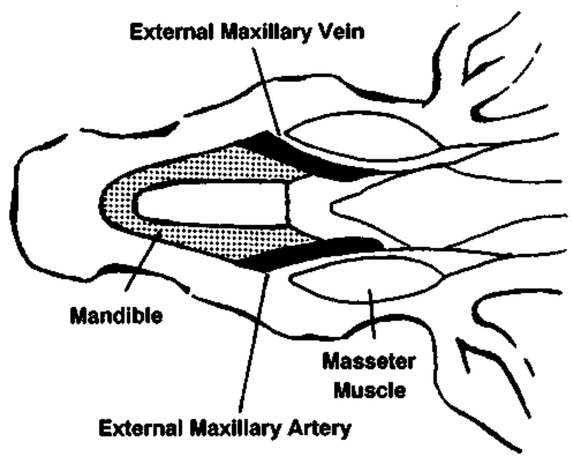


Fig. 1. Ventral view showing location of the external maxillary artery in cattle.

where the radial artery travels down the bone. In sheep and goats, the saphenous artery, which runs down the inside of the hind leg, is the most accessible location. In swine, the pulse cannot be felt at all. With this animal, the heart itself must be palpated directly.

The normal pulse frequency varies in different species and individual animals. Age, size, sex, breed, atmospheric conditions, time of day, exercise, eating, and excitement are all factors that influence variations in the pulse rate. The average pulse frequency, or the normal pulse rate, for large domestic animals is:

	Heart beats per minute
Adult horses	28 to 40
Newborn foals	100
Foals (6 to 12 months)	45 to 60
Cattle	40 to 70
Sheep and goats	60 to 90
Swine	60 to 100

The terms used to define pulse frequency are frequent (quick or rapid) and infrequent (slow).

Respiration

Respiration is the act of breathing, or more specifically, the acts of taking in oxygen, using it in the body tissues, and giving off carbon dioxide. The respiratory system is frequently subjected to primary and secondary disease, so stock owners must consider the area affected when an animal is not normal. A long list of serious diseases that affect all classes of farm animals eventually spread and settle in areas of the respiratory system.

In observing the respiratory system of an animal, begin at the nostrils and work rearward. Note anything abnormal in respiration, breath, nasal discharge, nasal cavities, sub-maxillary lymph nodes, cough, larynx and trachea, surface of thorax (chest), and ausculation of thorax (sounds in chest). Although the average stock owner is neither trained nor equipped to examine all these areas, he can make some intelligent observations concerning many of them.

Respiration consists of (1) inspiration, or the expansion of the chest or thorax—the part of the body between the neck and abdomen containing the heart and lungs; and (2) expiration, or the expulsion of air from the lungs. In examining respiration in an animal, check movement and sound at the nostrils and in the chest area. Give attention to the following factors:

a. Rate –number of inspirations per minute.
b. Depth – the intensity or indication of straining.
c. Character – normal breathing involves an observable expansion and relaxation of the ribs (costa) and abdominal wall. Any interference in breathing that may show more or less effort in either of these areas affects the character of the breathing.
d. Rhythm – change in duration of inspiration and expiration.
e. Sound – normal breathing is noiseless except when the animal is exercising or at work. Snuffling, sneezing, wheezing, rattling, or groaning may indicate something abnormal.
f. Dyspnea – labored or difficult breathing.

Variations in rate of respiration can be caused by many factors including body size, age, exercise, excitement, environmental temperature, atmospheric conditions, pregnancy, and fullness of the digestive tract. If variations in respiration rates are encountered and environmental conditions are suspected as being a possible cause, it's a good idea to check the rate of two or three other animals for comparative purposes. The normal range in respiratory rate in mature animals at rest is:

Horse	8 to 16 per minute
Beef cow	10 to 30 per minute
Dairy cow	18 to 28 per minute
Sheep and goat	12 to 20 per minute
Pig	8 to 18 per minute

Adapted from CATTLE PRODUCER'S LIBRARY CL610

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BCH-3000 Vital Signs in Animals: What Cattle Producers Should Know About Them

Texas Agricultural Extension Service
The Texas A&M University System

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Water quality: Its relationship to livestock

Floron C. Faries Jr., John M. Sweeten and John C. Reagor*

Safe supplies of water are absolutely essential for livestock. If livestock do not drink enough safe water every day, intake of feed (roughages and concentrates) will drop, production will fall and the livestock producer will lose money.

Water constitutes 60 to 70 percent of the body of livestock. Consuming water is more important than consuming food, the amount depending on the weather and the character of food consumed. Animals should be given all the water they can drink. Those that do not drink water may suffer stress or even dehydration.

Dry cows need about 8 to 10 gallons of water daily. Cows in their last 3 months of pregnancy may drink up to 15 gallons a day. Those in milk need about five times as much water as the volume of milk produced. And calves require much more water after weaning than before. Ignoring this fact may result in a growth check in calves from which they may never fully recover.

Livestock may have health problems resulting from substandard quality water. They may drink less or may ingest mineral or organic contaminants, which can cause poor performance and nonspecific disease conditions, although no major livestock health problems associated with water quality have been reported.

When evaluating the quality of water for livestock, consider whether livestock performance will be affected; whether water could serve as a carrier to spread disease; and whether the acceptability or safety of animal products for human consumption will be affected.

Several elements found in water seldom offer problems to livestock because they do not occur at high levels in soluble form, or because they are toxic only in excessive concentrations. Examples are iron, copper, cobalt, zinc, iodide and manganese. These elements do not seem to accumulate in meat or milk to the extent that they would cause a problem.

The most common water quality problems affecting livestock production are:

- High concentration of minerals (excess salinity);
- High nitrogen content (nitrates, nitrites);
- Bacterial contamination;
- Heavy growths of blue-green algae; and
- Accidental spills of petroleum, pesticides and fertilizers.

Livestock tolerance of minerals in water depends on many factors: kind, age, diet and physiological condition of the animal; season; climate; and kind of salts in the water. Livestock may drink less if the water tastes

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Table 1. Recommended limits of concentration of some potentially toxic substances in drinking water for livestock.

Substance	U.S. EPA[a] (for humans) Safe upper limit of concentration (mg/l)		NAS[b]	CAST[c]
	Primary	Secondary		
Arsenic	0.05		0.2	0.5
Barium	1.0		Not established	
Boron				5.0
Cadmium	0.01		0.05	0.5
Chromium	0.05		1.0	5.0
Chloride[e]		250		
Cobalt			1.0	1.0
Copper		1.0	0.5	0.5
Fluoride	4.0	2.0	2.0	3.0
Iron		0.3	Not established	No limit[d]
Lead	0.05		0.1	0.1
Manganese		0.05	Not established	No limit
Mercury	0.002		0.01	0.01
Molybdenum			Not established	No limit
Nickel			1.0	
Nitrate-N	10.0		100	300
Nitrite-N			10	10
Salinity			See Table 2	
Selenium	0.01			
Silver	0.05			
Sulfate[e]		250		
Total Dissolved Solids[e]		500		
Vanadium		0.1		1.0
Zinc	5.0	25.0		25.0

[a] U.S. Environmental Protection Agency

[b] National Academy of Sciences

[c] Council for Agricultural Science and Technology

[d] Data available are not sufficient to made definite recommendations.

[e] The Texas Department of Health has different values.

From: Herrick, J.B., *Water Quality for Animals*

bad. Livestock restricted to waters with high salt content may suffer physiological upset or death.

Common compounds found in waters of excess salinity include sodium, chloride, calcium, magnesium, sulfate and bicarbonate. Bicarbonates and carbonates may contribute heavily to alkalinity (pH) levels. When feed also is high in salt, lower water salinity would be desirable. Moreover, animals consuming high-moisture forage can tolerate more saline waters than those grazing dry brush or scrub. Hard water without high salinity does not harm animals.

Sources of nitrates and nitrites include decaying animal or plant protein, animal metabolic waste, nitrogen fertilizers, silage juices and soil high in nitrogen-fixing bacteria. Nitrates and nitrites are water-soluble and may be leached away to the water table or into ponded water. Tables 1 and 2 give limits of concentrations of specific substances in water for livestock. Levels may be affected by runoff or by concentration caused by water evaporation from a pond or storage tank.

All surface waters must be assumed to carry bacteria. Keep livestock from contaminated water that has not been adequately oxygenated because of bacterial pathogens living there.

Most surface water sources have problems with algae growth as a result of high nutrient loading in runoff water. Avoid using waters bearing heavy growths of blue-green algae, as several species can produce animal toxins (poisons). To control algae in storage tanks, reduce the introduced organic pollution and exclude light. Disinfect water storage tanks by adding 1 ounce of chlorine bleach per 30 gallons of water, holding for 12 hours before draining, and then refilling with clean water. Chlorination can also control certain bacteria.

To evaluate water quality in relation to livestock health problems, it is imperative to obtain a thorough history, make accurate observations, ask intelligent questions and submit suspected water and properly prepared tissue specimens without delay to a qualified laboratory. Obtain assistance from a local veterinarian, county Extension agent or the Texas Veterinary Medical Diagnostic Laboratory in College Station or Amarillo.

Livestock grazing operations may influence stream water quality where cattle are watered in or along the streams or drainage features. Livestock manure accumulations around water wells, ponds and stock pens, and agricultural chemicals or containers at spray pens, dipping vats and disposal sites are in some cases potential sources of localized groundwater contamination.

Other potential nonpoint pollution sources require careful site selection and management. They include open, unpaved feedlots; wastewater holding ponds; lagoons; manure stockpiles; silos; dead animal disposal sites; and onsite sewage treatment systems.

Fertilizers, including manure and wastewater, should be carefully selected and applied to land in strict accordance with soil and crop requirements. This will help prevent contaminating underlying aquifers with such nutrients as nitrate, ammonia, potassium or such salts as chloride. Always apply pesticides at rates recommended on the label. Do not apply them to vulnerable sites or during unfavorable climatic conditions that can increase environmental risks.

Locate wells at least 150 to 300 feet from livestock corrals, septic tanks, manure treatment lagoons and runoff holding ponds. To prevent infiltration, case and grout wells down to a restrictive layer or to the water table, and seal around the wellhead with a concrete pad. Wellhead protection measures are specified in water well drillers' guidelines.

Generally speaking, animal health problems usually are NOT caused by poor water quality. Water-related health problems in livestock are usually stress problems caused by an inadequate water supply or by unpalatable water with a high level of dissolved substances.

Protect livestock from dangerous drinking water by providing alternative sources of safe water. Adequate rain dilutes dangerous surface waters. Livestock producers should provide sufficient safe water for animals by preventing contamination, minimizing evaporation and providing enough sources of supply year-round.

Table 2. Guide to using saline waters for livestock.

Total soluble salts content of waters (mg/l)	Comments
Less than 1,000	These waters have a relatively low level of salinity and should present no serious burden.
1,000 to 2,999	These waters should be satisfactory. They may cause temporary and mild diarrhea in livestock unaccustomed to them, but they should not affect their health or performance.
3,000 to 4,999	These waters should be satisfactory, although they may cause temporary diarrhea or be refused at first by animals unaccustomed to them.
5,000 to 6,999	These waters can be used with reasonable safety. It may be well to avoid using those approaching the higher levels for pregnant or lactating animals.
7,000 to 10,000	Considerable risk may exist in using these waters for pregnant or lactating livestock, the young of these species, or for any animals subjected to heavy heat stress or water loss. In general, their use should be avoided, although older livestock my subsist on them for long periods under conditions of low stress.
More than 10,000	The risks with these highly saline waters are so great that they cannot be recommended for use under any conditions.

From: NAS, *Nutrients and Toxic Substances in Water for Livestock and Poultry*

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