2024 COMMERCIAL STEER STUDY GUIDE

Please contact the Competitive Events Office if you have any questions.

Phone: (210) 225-0575

Email: livestock@sarodeo.com

Updated October 2021

Table of Contents

L-2282
1-02

AgriLIFE EXTENSION
Texas A&M System

Proper Usage of Drugs and Chemicals in Food Animals

F.C. Faries, Jr.
Associate Professor and Extension Program Leader for Veterinary Medicine
The Texas A&M University System

Federal regulations exist to ensure the proper distribution and usage of veterinary drugs and to prevent adulteration of the food supply with illegal drug residues through drug misuse in food producing animals.

The Food and Drug Administration (FDA) and the Food Safety and Inspection Service (FSIS) of the United States Department of Agriculture (USDA) enforce regulatory laws under the Food, Drug and Cosmetic (FDC) Act, enacted in 1906 with subsequent amendments. Anyone who causes, by an act of omission or commission, violative residues in livestock and poultry (by irresponsible and illegal distribution and use of drugs) violates state and federal laws. When FSIS inspectors detect violative drug residues in food products derived from animals, they report the violation to the FDA, the producer and the state authorities. FDA then initiates an on-site investigation of the suspect producer. If the evidence shows a flagrant violation of the law, the producer may face criminal charges. The convicted producer can be fined and possibly imprisoned for this crime. Animals with residues above established tolerances are condemned by FSIS.

To be in compliance with the law, a producer must follow precisely the instructions on the drug or chemical label. This means the producer must use only those veterinary drugs, chemicals or feed additives approved by the FDA and administer them only by the recommended route, at the approved dosage rate, and for the specific usage(s) or treatment of condition(s) indicated on the label.

Even the use of approved drugs and chemicals within the established withdrawal times prior to marketing is illegal. Drug and chemical residues are human health hazards. There is no question that producers must be more judicious in the use of chemicals and drugs in food animals. Producers are advised to read and follow directions on all drug labels with respect to dosage and withdrawal recommendations as mandated by federal law. This will ensure that consumers receive safe, high quality animal food products.

Extra-label distribution, prescription and use of veterinary drugs in food producing animals are regulated by FDA. The FDA policy requires all extra-label drug usage to be under the control of a licensed veterinarian. Extra-label usage must be in accordance with a veterinarian/client/patient relationship; a careful medical diagnosis; and a determination by the attending veterinarian that available labeled products have been found clinically ineffective. There must be assurances that treated animals have been adequately identified and that extended withdrawal periods have been established before marketing. There must also be a procedure to ensure that these policies will be met. A legitimate veterinarian/client/patient relationship exists when the veterinarian has assumed the responsibility of making medical judgments, and the client has agreed to follow the instructions of the veterinarian.

Use of an unapproved drug in food animals by a producer without a legitimate veterinarian/client/patient relationship is extra-label drug usage and is

illegal. Use of an approved drug via a route of administration not specified on the label, or at a dosage rate not specified on the label, or for treatment of a condition not specified on the label without a legitimate veterinarian/client/patient relationship, is illegal.

An important role of the Texas Agricultural Extension Service is to educate and advise food animal producers on correct usage of drugs and chemicals, problems of drug and chemical residues, and the litigation that may result from intentional or unintentional abuse or misuse of these substances in food producing animals. All persons involved in the industry must work together to bring about proper usage of drugs and chemicals in food animals.

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

Issued in furtherance of Cooperative Extension Work in Agriculture and Home Economics, Acts of Congress of May 8, 1914, as amended, and June 30, 1914, in cooperation with the United States Department of Agriculture. Edward G. Smith, Director, Texas AgriLife Extension Service, The Texas A&M University System.
2M, Reprint

Texas A&M AgriLife Extension

E-580
09-09

Basics of Cattle Immunity

Tom Hairgrove and
Steve Hammack*

When establishing a vaccination program it is important to understand how animals naturally protect themselves from infection and how vaccination and other management practices enhance that protection.

There are three major ways the body defends itself against infectious organisms.

1. The first method is physical barriers, such as skin, normal microorganisms, and self-cleaning procedures such as coughing, sneezing, vomiting and diarrhea. Organisms that penetrate the body are often eliminated by these procedures. Animals must be adequately hydrated and nourished for these barriers to work effectively.
2. The second method of body defense is native or innate immunity. The native immune system controls invading organisms with chemicals and/or by ingesting them. The native immune system lacks memory, so each infection is treated in the same manner. The immune system needs adequate nutrition (including energy, protein and minerals) to function at a maximum level. Stress reduces the efficiency of the native immune system.
3. The third method is the acquired immune system, which responds to vaccines. This system can recognize and destroy specific invaders. With acquired immunity, the body remembers specific invaders and can respond more intensely if stimulated by those invaders later. While physical barriers and the native immune system respond rapidly, the acquired immune system takes days to weeks to become effective. When the acquired immune system is compromised, as in human AIDS patients and cattle with bovine viral diarrhea (BVD), other diseases can rapidly overcome the animal's defenses.

Acquired immunity may involve the production of a specific antibody (humoral immunity); or, it may involve the rapid recognition and destruction of specific foreign cells (cell-mediated immunity). The humoral immune response is relatively easy to measure and it is the most common way immune responses to vaccine and/or disease are detected. Cell-mediated response is much more difficult to quantify. The body reacts to specific diseases with either an antibody or a cell-mediated response. Organisms that attack the outsides of cells usually respond to antibodies. Organisms that invade the cell, such as all viruses and some bacteria (including brucellosis), often are better controlled with a cell-mediated immune response.

Vaccines made from modified live products are usually more efficient at protecting against diseases such as brucellosis or BVD that infect the insides of cells. Modified live vaccines replicate in the animal and usually do not require boosters. However, these vaccines are easily degraded and made ineffective by exposure to chemicals or extremes of light or temperature.

Vaccines made from killed products are usually more efficient at destroying organisms that attack the outsides of cell, such as those that cause blackleg or tetanus. Killed

*Program Coordinator for Livestock and Food Animal Systems and Professor Emeritus and former Extension Beef Cattle Specialist, The Texas A&M System.

products do not replicate, so boosters are usually needed for good protection. Killed products can give undesirable results if shaken excessively or frozen.

All vaccines should be handled according to manufacturers' recommendations.

A vaccination program is simply a tool in a total health program. Animals must have adequate nutrition for their immune systems to work properly. Animals also should be protected from environmental and social stressors and parasites, which may decrease an animal's natural response to disease and the effectiveness of vaccines.

Administering too many vaccines, or vaccines that are not compatible, also can lower the immune response. Some vaccines should not be administered to pregnant animals because they may cause reproductive loss. Vaccines may not be effective when given to calves with high levels of maternal antibodies. All of these factors are reasons why you should consult with your veterinarian when designing vaccination programs.

Vaccines are not always effective under field conditions, so producers should have reasonable expectations of vaccine programs. A vaccine program to prevent unborn calves from becoming persistently infected with BVD might be quite different from one to control BVD in a group of stocker calves.

Always consult with your veterinarian, who is familiar with disease patterns in your area and can recommend the most effective vaccination program.

References

Tizzard, I.R. 2009. Veterinary Immunology: an Introduction, 8th ed. Saunders Elsevier.

Abul, A.K. and A.H. Lichtman. 2009. Basic Immunology: Functions and Disorders of the Immune System, 3rd ed. Sanders Elsevier.

Roth, J.R. 2009. Basic Immunology and Principles of Vaccination. Institute for International Cooperation in Animal Biologics.

Texas A&M AgriLife Extension Service

AgriLifeExtension.tamu.edu

More Extension publications can be found at *AgriLifeBookstore.org*

Produced by Texas A&M AgriLife Communications

Texas Cooperative EXTENSION
The Texas A&M University System

L-5289
10-05

CATTLE VACCINES

Floron C. Faries, Jr.*

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

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

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

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

NONINFECTIOUS VACCINES

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

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

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

*Professor and Extension Program Leader for Veterinary Medicine, The Texas A&M University System.

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

INFECTIOUS VACCINES

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

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

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

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

HANDLING VACCINES

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

PROPER VACCINATION PROCEDURES

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

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

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

Produced by Agricultual Communications, The Texas A&M University System

Extension publications can be found on the Web at: *http://tcebookstore.org*

Visit Texas Cooperative Extension at *http://texasextension.tamu.edu*

Issued in furtherance of Cooperative Extension Work in Agriculture and Home Economics, Acts of Congress of May 8, 1914, as amended, and June 30, 1914, in cooperation with the United States Department of Agriculture. Edward G. Smith, Director, Texas Cooperative Extension, The Texas A&M University System.

2,000 copies, Reprint

Texas Agricultural Extension Service
The Texas A&M University System

L-5295
4-99

Immunizing Beef Calves

A Preconditioning Immunization Concept

Floron C. Faries, Jr.*

Infectious diseases cause sickness and death in calves, before or after they are born. Unborn and nursing calves are at high risk to fatal diseases during the time of year when a beef rancher is calving cows, moving and mixing these cows, and bringing in bulls to them. Newborn calves can have low immunity and be highly susceptible to many diseases. They are exposed to germs shed by stressed cows, calves and bulls in the cow herd.

If sickness and death occur in weanling calves, the source of disease must be determined. Is the disease the result of dormant infections, now breaking out and shedding, in improperly immunized calves previously exposed in the herd? Is it the result of incubating infections in improperly immunized calves recently exposed in commingled, stressed and shedding calf groups? By properly vaccinating the entire herd, including pregnant cows, calves, replacement heifers and bulls, outbreaks caused by both dormant and incubating infections can be prevented.

This calf preconditioning immunization concept for beef herds provides protection against infectious diseases through passive and active acquired immunity for unborn, nursing and weanling calves. It involves giving immunizations before and after the calves are born. The immunizations for the vaccination schedules for a beef herd should be determined by a veterinarian. This determination is based on how often infectious diseases occur in the beef herd, how widespread they become, and the risks of exposures to disease both inside and outside the herd.

Preconditioned weanlings are destined to be stockers, feeders and replacements.

Vaccinate Pregnant Cows, Replacement Heifers, Bulls

Unborn and nursing calves are protected against diseases by immunizing pregnant cows and pregnant replacement heifers during the last trimester of pregnancy. A cow herd that calves year around is vaccinated routinely every 6 months. Bulls and replacement heifers are vaccinated before introduction into the herd.

*Associate Professor and Extension Program Leader for Veterinary Medicine, The Texas A&M University System.

These immunizations properly use noninfectious vaccines of various types: killed, subunit, inactivated toxins or intramuscular, temperature sensitive, modified live.

Table I: Cow Herd Vaccines

Precalving Vaccination of Cows and Heifers
(7 to 9 months of pregnancy or twice a year)

1. 4-way Viral BRD Vaccine
2. Pasteurella Bacterin & Leukotoxoid
3. Haemophilus Bacterin
4. 5-way Lepto Bacterin
5. 7-way or 8-way Blackleg Bacterin
6. Scour Vaccine
7. Vibrio Bacterin
8. Trich Vaccine

Prebreeding Vaccination of Replacement Heifers and Bulls
(3 to 6 weeks before breeding)

1. 4-way Viral BRD Vaccine
2. Pasteurella Bacterin & Leukotoxoid
3. Haemophilus Bacterin
4. 5-way Lepto Bacterin
5. 7-way or 8-way Blackleg Bacterin
6. Vibrio Bacterin
7. Trich Vaccine (Heifers)
8. Anaplas Vaccine

Stress at the time of calving reduces resistance to disease. Infectious microorganisms of bovine respiratory disease (BRD viruses and pasteurella and haemophilus bacteria) can break out of dormancy and be shed. However, the active immunity provided by regular vaccinations is expected to suppress shedding of disease agents from the calving cows to the nursing calves of the current year's calf crop. The active immunity also provides protection for the following year's calf crop against abortion diseases.

Cows are vaccinated during the last trimester of pregnancy.

Immunized cows provide passive immunity to calves through the colostrum (first milk). Calves are protected until 2 to 3 months of age against nursing calf diseases. Passive immunity is expected to minimize infection and shedding of disease agents and prevent development of sickness and death. Susceptible baby calves are those that do not receive an adequate amount of good-quality colostrum during the first 24 hours after birth.

A calf should receive an amount equivalent to 2.5 percent of its body weight in the first 6 hours after birth, and again over the next 18 hours. An 80-pound calf needs 2 quarts of colostrum from an immunized cow during the first 24 hours of life to receive protective immunity.

Vaccinate Nursing Calves

Nursing calves are vaccinated at 2 to 3 months of age against calf diseases. The immunizations are noninfectious vaccines and are repeated 2 to 4 weeks later. The first vaccination is a priming,

Table 2: Calf Herd Vaccines

Postcalving Vaccination of Nursing Calves
(2 to 3 months of age)

1. 4-way Viral BRD
2. Pasteurella Bacterin & Leukotoxoid
3. Haemophilus Bacterin
4. 5-way Lepto Bacterin
5. 7-way or 8-way Blackleg Bacterin

Preweaning Vaccination of Nursing Calves
(3 weeks before weaning)

1. 4-way Viral BRD Vaccine
2. Pasteurella Bacterin & Leukotoxoid
3. Haemophilus Bacterin
4. 5-way Lepto Bacterin
5. 7-way or 8-way Blackleg Bacterin
6. Bang's Vaccine (Heifers)

sensitizing dose that provides no protection or a low protection for 1 to 4 months. The second vaccination is a required booster dose, recommended within 2 to 4 weeks, but acceptable within 4 months. It should precede weaning by at least 3 weeks. Duration of the immunity following the second dose is 6 to12 months.

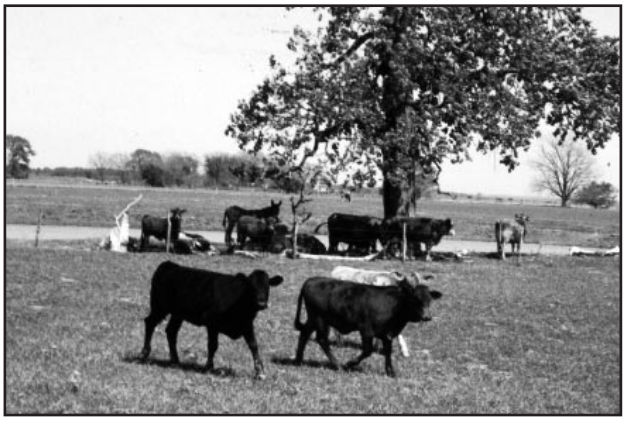
Immunizations precondition calves by providing immunity to nursing and weanling calves destined to be stockers, feeders and replacements. Heifer calves selected for replacements are immunized against venereal diseases at the time of boosters within 3 to 6 weeks before breeding.

The active immunity developed by the nursing calves is expected to minimize infection and shedding and prevent sickness and death from disease caused by exposures before and after weaning. Immunity might suppress shedding of BRD viruses and pasteurella and haemophilus bacteria at times of stress during hot or cold weather, weaning, selling and hauling. Dormant infections in calves not immunized with two vaccinations prior to weaning commonly break out and cause shedding, sickness and death in calves with weakened immunity at weaning.

Nursing calves receive a priming vaccination at 2 to 3 months of age.

If the required booster vaccines are not given before weaning, they must be given at 3 weeks after weaning. Because the first dose is noninfectious, the second dose in weanling calves also is a noninfectious vaccine. An infectious vaccine (modified live) usually is ineffective following a noninfectious vaccine because it prevents the desired infection of the modified live vaccine from being established.

Nursing calves in a cow herd with low risk to bovine virus diarrhea (BVD) and bovine respiratory syncytial virus (BRSV) are not given the priming and booster four-way viral BRD vaccinations. An infectious bovine rhinotracheitis/parainfluenza-3 (IBR/PI_3) infectious vaccine (intranasal, temperature sensitive, modified live) is administered as a nasal spray at 2 to 3 months of age. At weaning, an infectious IBR, PI_3, BVD, BRSV vaccine is administered intramuscularly. The four-way viral BRD vaccine does not contain intramuscular, temperature sensitive, modified live IBR virus. Immunity induced by the infectious four-way viral BRD vaccine will last a lifetime in properly vaccinated weanling calves. When the desired infections of the BRD viruses are established, repeated modified live infectious vaccinations become unnecessary.



Nursing calves receive a booster vaccination at least 3 weeks prior to weaning.

Background Weanling Calves

Weaning is traumatic to a calf and one of the greatest stresses it undergoes. Other stressful procedures should precede or follow weaning by at least 3 weeks. It is best to perform castration and dehorning at birth or before the calf reaches 3 months of age.

Nursing and weanling calves are dewormed for stomach worms in the spring, summer and fall. In the spring and fall, deworming occurs as larvae develop following recent optimum transmission time. In the summer, deworming occurs during larval inhibition that follows optimum transmission in June.

Before selling or shipping, weanling calves are *backgrounded* for a minimum of 3 weeks. They are kept on grass or fed hay and concentrates, given supplements to provide nutrition, and are kept separated from other groups to prevent suppression of immunity, reduce stress and prevent commingling. Calf groups, whether from inside the herd or outside, are not commingled. During backgrounding, activities are kept to a minimum. No noninfectious vaccinations, castrations, dehorning, selling or hauling are performed.

Additional Reading

Additional information can be found in the following Texas Agricultural Extension Service publications: *Cattle Vaccines*, L-5289, and *Common Cattle Parasites*, L-2333.

Produced by Agricultural Communications, The Texas A&M University System

Extension publications can be found on the Web at: http://agpublications.tamu.edu

Issued in furtherance of Cooperative Extension Work in Agriculture and Home Economics, Acts of Congress of May 8, 1914, as amended, and June 30, 1914, in cooperation with the United States Department of Agriculture. Chester P. Fehlis, Deputy Director, Texas Agricultural Extension Service, The Texas A&M University System.

5M, New VM

TEXAS A&M AGRILIFE EXTENSION

E-348
06-05

Recognizing and Managing Common Health Problems of Beef Cattle

Floron C. Faries, Jr.
Professor and Extension Program Leader for Veterinary Medicine, The Texas A&M University System

Many health problems in beef cattle can be managed successfully if they are detected early. Cattle owners can prevent or minimize losses by taking steps to keep the problems from recurring or spreading to the rest of the herd.

Below are common problems found in beef cattle as well as the probable causes of those conditions and suggested measures to prevent recurrence.

"My cows' eyes are cloudy and runny."

When cattle have cloudy, runny eyes, the inflamed and painful eyeballs and eyelids are probably infected with a virus or bacterium or damaged from sunlight or cancer. These conditions include pink eye, IBR virus eye, cancer eye or photo eye.

Specific diagnosis and proper treatment may require close observation, available history, laboratory testing and professional assistance.

Pink eye (infectious keratoconjunctivitis)

Although sporadic cases of eye diseases occur in all seasons of the year, this highly contagious bacterial disease is most common during the summer.

Observations: The onset of pink eye is sudden, beginning with an excessive flow of tears. The animal holds the eye partially closed, rubs the eye and seeks shaded areas. Soon an ulcer develops in the central area of the cornea and an opaque ring develops around the ulcer. Within 48 hours of onset, the entire cornea becomes cloudy.

Next, the lining of the eyelids becomes red with mucus and pus. As the ulcer deepens and extends completely through the cornea, the eye ruptures and loses fluid, and the eyeball collapses. The infection may affect one or both eyes.

Management: The infected cattle must be isolated and treated immediately by a veterinarian to eliminate the infection and prevent spread to other cattle.

IBR virus eye (infectious bovine rhinotracheitis)

The IBR virus is transmitted through the air and can spread rapidly through the herd. It causes upper respiratory infections, and it is most prevalent in the fall and winter.

Observations: In the early acute stage, a few cattle may develop cloudy corneas, similar to pink eye. The opacity spreads inward from the outer edge of the cornea, and there is no ulceration.

Management: Isolate the affected animals until the viral infection runs its course, and vaccinate the whole herd and purchased replacements.

Cancer eye (squamous cell carcinoma)

Cancer often appears as smooth plaques on the eyeball and ulcers or horn lesions on the eyelids. It occurs more often in cattle with no eye pigment and those that are constantly exposed to bright sunlight.

Observations: As in cases of pink eye, cancer eye causes an excessive flow of tears. This cancer can be identified by the appearance of the lesions on and near the eye. The cancerous growths develop on the third, upper and lower eyelids and eyeball, and they spread to internal lymph nodes and organs.

Management: Early detection is necessary for heating or freezing therapies or for surgical removal of the tumor alone. In chronic cases with more extensive involvement, the entire eyeball and eyelids must be removed.

Photo eye (photosensitization)

This noninfectious condition is a hypersensitivity to sunlight after ingestion of various plants or administration of certain drugs.

Observations: In addition to cloudiness of the cornea, signs of photo eye include sunburn of nonpigmented eyelids, nose, teats, vulva and areas of the head, body and legs. If the affected cattle are exposed to sunlight for prolonged periods, blindness and severe skin damage will result.

Management: Protect the animal from sunlight until its eyes and skin have healed. Shelter it during the day and allow it to graze on pasture at night.

"My calves have areas of hair loss with skin lesions."

Calves commonly become infected with ringworm fungus and wart virus. These two infectious, contagious conditions are easily recognized and differentiated by the appearance of localized hair loss with skin lesions.

In cases where there is generalized hair loss with skin lesions, possible causes other than ringworm or warts include photosensitization, dietary deficiencies, infections of worms and infestations of horn flies and lice.

Ringworm fungus (dermatophytosis)

In the early stages, a fungus infection of the skin often goes unnoticed because the affected areas are small and slightly raised with roughened hair. Infected cows often serve as sources of the fungus, which is transferred by direct contact to calves.

Observations: After several weeks of the fungus infiltrating the hair follicles, the hair falls out, leaving distinct circumscribed, grayish lesions. The scaly lesions coalesce to form large patches of hair loss at least 3 inches in diameter. They are often located on the face and neck and are more common in young cattle.

Management: Although the infection tends to clear up spontaneously after several months, separate and treat the affected calves with a prescribed medication to prevent transmission to the others.

Warts (papillomatosis)

Warts are fibrous tumors of the skin and mucous membranes and are caused by many strains of the papilloma virus. The virus is usually transmitted to calves by direct contact from infected cows. It also can be

transmitted by contaminated instruments that puncture the skin and by biting flies such as horn flies and stable flies.

Observations: The cauliflower-type growths occur primarily on the head, neck and shoulders, in the mouth and vagina, and on the teats, vulva and penis.

Management: To prevent transmission to other calves, isolate those with warts. Over a period of 3 to 12 months, the affected calves build immunity against the virus in the warts and skin. Once the immunity kills the viruses, the warts dry and slough.

"Every winter, my cows rub their heads, necks and shoulders."

Even though lice are known in the winter to cause cattle to itch and rub on objects such as fences, posts, trees and barns, another common cause of itching and rubbing is the aftermath of the allergic dermatitis produced during the previous summer and fall by a horn fly infestation.

Horn fly allergy (allergic dermatitis)

During the horn fly season, cattle often develop a skin allergy to the saliva of the biting horn flies. After several weeks, an inflammatory reaction occurs in the skin, and many hair follicles are destroyed.

Observations: Before the damaged hair falls out during the winter, the retained hair causes an itch sensation, and the cattle rub their faces, necks and shoulders from December through March. As a result of rubbing these areas, the hair coat becomes sparse, and irritated skin lesions develop.

Once the dead hair is removed by rain and rubbing, a normal hair coat returns. If no crawling lice are on the skin or lice eggs are glued to the hairs, the diagnosis is based on a history that the cows had a horn fly infestation the previous year.

Management: To prevent recurrence of this cold-season problem, take steps to reduce the horn fly population during the warm seasons.

"I have occasionally a cow or a bull crippled on one foot."

A cow or bull with a lame foot should be examined closely. Pick up the foot with a rope, and wash and examine between the toes carefully, looking for a foot crack, a corn, swelling, heat or a discharge. You will need professional assistance to differentiate some of the other abnormal conditions of the foot.

Unobservable problems inside the foot include bruises, abscesses, fractures and foot founder, or laminitis. The lameness may also be related to long toes as well as joint inflammation of the leg, including the hip on the rear and shoulder on the front.

Foot crack (web tear)

This condition often occurs after cattle walk on rough terrain or when a bull places its weight on the foot when mounting for breeding. These actions commonly spread the toes wide apart and cause the skin to tear. Also, long toes predispose to the likelihood of excessive spreading of toes.

Observations: If the problem is not a corn or foot rot, check for signs of foot crack, along with swelling and heat of the foot. The web of skin between the toes is also likely to be cracked deeply into sensitive tissue.

Management: The damaged tissue must heal from the inside out. To prevent further tearing, the cow or bull must be confined for a few weeks to limit walking and the toes trimmed and taped together.

Foot rot (necrotic pododermatitis)

If the problem is not foot crack, the likely problem is foot rot, a bacterial disease of the foot. During warm, wet weather, the bacteria in manure mixed with mud

commonly gain entry through tiny cracks and abrasions of the skin between the toes and heel bulb, causing swelling and dead tissue.

Observations: The signs of foot rot include a hot, swollen and painful foot with pus discharge and a dead odor, fever and loss of appetite and body weight. The infection may spread to the skin of the pastern and fetlock and to bone joints inside the foot.

Management: Because the pus discharge contains bacteria and serves as a source of new infections, segregate the cow or bull from the rest of the herd for proper antibiotic treatment. To prevent occurrence of more cases, the unsanitary conditions leading to this condition must be corrected.

Corn (interdigital hyperplasia)

The development of scar tissue, or corns, in cattle is thought to be caused by stretched skin folds between the toes in heavy, splay-toed breeds.

Observations: A painful and hard, tumor-like, vertical mass develops in the web of skin between the toes.

Management: The mass must be removed surgically and the toes bandaged closely together.

"One of my cows coughs, protrudes her tongue and breathes with her mouth open."

The cow obviously has a lung disease in which inflammation elicits an irritated cough, and reduced air space encourages open-mouthed breathing. Because several infectious and noninfectious causes are possible, professional assistance will be needed to make a specific diagnosis by physical and laboratory examinations.

A common infectious lung disease is pneumonia; a common noninfectious condition is fog fever.

Infectious lung disease (pneumonia)

Pneumonia is a highly complex, contagious disease and may be caused by one of several viruses in concert with various bacteria. Pneumonia caused by bacteria is generally serious.

Observations: Fever, coughing and labored breathing are caused by inflammation and swelling of the lungs and the accumulation of mucus, blood and pus that interfere with airflow in the air passages. The animal tries to get more air by stretching out its head and neck and protruding its tongue.

Management: When you see signs of pneumonia, isolate the sick cow for antibiotic treatment. Laboratory tests are needed to identify the specific viruses or bacteria involved to develop an effective vaccination plan for the herd. The plan should include vaccinating the cows, nursing calves, bulls and replacements with the proper vaccines.

Because stress can contribute to the occurrence of this disease by lowering an animal's resistance, cattle owners need to minimize adverse conditions of cold or hot weather to prevent pneumonia in the herd.

Fog fever (pulmonary emphysema and edema)

Fog fever is caused by a toxic reaction in the lungs after the cow ingests a large quantity of an amino acid in lush, green grass in spring or fall. Diagnosis is based on a history of the cows being moved within the previous 10 days from a dry, brown pasture to a lush, green pasture.

Observations: Fever is not present; coughing is minimal; and the onset of symptoms is sudden. Breathing is obviously difficult, with the animal breathing through its mouth, extending its tongue and drooling saliva.

Management: The affected cow should be treated by a veterinarian and handled carefully to prevent death by suffocation brought about by exercise. Move the herd from the lush pasture and gradually return it over 3 weeks by feeding hay and limiting grazing time.

"My calves have runny, snotty noses."

Runny, snotty nose can be associated with pneumonia if the calves have fever, are coughing and have labored breathing. Otherwise, the calves may simply have an inflammation of the sinuses of the head, which is called sinusitis.

Runny, snotty nose (sinusitis)

Nasal drainage in calves may be the normal discharge of mucus from the sinuses of the head. On extremely hot, cold or windy days, inflamed sinuses can discharge excess drainage, even if there is no infection. Also, irritants and allergens in the environment such as dust, pollen and mold cause inflammation of the sinuses.

Observations: When viruses and bacteria infect the sinuses, they produce a head cold and cause a nasal discharge that is a clear, mucus or pus type. Often the infection is limited to the head and does not involve the lungs.

Management: Do not use antibiotics if there is no or only a low-grade fever; allow the condition to run its course. Respiratory vaccines may lack the specific antigens to prevent recurrence.

"Some of my cows got the staggers, went down and are unable to rise."

Cows that cannot rise must be checked by a professional, who will conduct physical examinations and evaluate their diet and environment. Although the cause may be one of many poisonous plants, it is more often the result of grazing on Dallisgrass. In chemical poisoning cases, the cause is often the consumption of toxic amounts of lead or arsenic from batteries or lubricating grease of vehicles or machinery. If the cause is dietary, it is likely that the cattle have a common metabolic disorder such as polio, ketosis or grass tetany.

Polio (polioencephalomalacia)

Cows with polio are thin and usually have been on a diet high in sulfate and low in protein and roughage. They probably have been confined and fed a grain diet without roughage.

Observations: As an affected downer cow attempts to stand, the ankles remain flexed or knuckled over.

Management: Immediate treatment by a veterinarian to relieve swelling of the brain is necessary to prevent permanent brain damage. Adequate roughage must be fed with grain concentrates.

Range ketosis (acetonemia, hypoglycemia)

Cows with range ketosis are usually thin, on a low-carbohydrate, low-energy diet and likely are stressed from cold weather or calving and nursing.

Observations: In addition to the incoordination before going down, the cows are observed pressing against walls, posts and trees, bellowing and tongue wallowing and licking.

Management: Immediate treatment by a veterinarian is directed to raise the blood sugar and improve glucose metabolism.

Grass tetany (hypomagnesemia)

The affected cows are thin, grazing lush pasture high in nitrogen and potassium and likely are stressed from cold, cloudy weather or calving and nursing.

Observations: In addition to staggers, signs in cattle include tossing the head, bellowing and galloping before going down with convulsions.

Management: Immediate treatment by a veterinarian is directed to raise the blood magnesium.

"I have occasionally a thin, downer cow."

Dietary deficiencies are the most common cause of weakness and weight loss in cattle. Enteric bacteria and parasites may be contributing factors.

Observations: Tipoffs to problems in the diet include weakness and loss of weight.

Management: Evaluate the nutritional intake, comparing it to the protein and energy requirements of the herd. Make adjustments if necessary.

If the problem is limited to an individual cow instead of affected the entire herd, seek professional assistance to identify the cause, such as infections of body cavity linings (pleurisy, peritonitis) and abscesses and cancers of internal lymph glands and organs.

"I continue every year to have cows prolapse and retain afterbirth."

It is common for a cow that has difficulty in calving to bruise her uterus. A thin, weak cow may have a prolonged calving process that commonly causes a bruised uterus.

Observations: The inflamed, swollen uterus quite often causes straining with prolapse of the vagina, cervix or uterus. If prolapse does not occur, the placenta may be retained because of bruising inflammation.

Management: Treatment by a veterinarian is directed to replace the prolapse and expel the retained placenta.

"I have low conception rates, repeat breeders and abortions in my cowherd."

Dietary deficiencies and stresses of hot weather and malnutrition in cows continue to be major causes of reproductive failures. Abnormal ovaries and uterus and starvation of the embryo or fetus are commonly associated with inadequate intake of protein, energy, minerals or vitamins. These reproductive problems occur in stressed cows on poor quality or short grazing without provisions of hay and nutrient supplements.

Observations: The herd has an unusually high number of abortions, repeat breeders and low conception rates that cause a large percentage of open cows.

Management: If the problem is caused by poor nutrition, evaluate the nutritional intake and take corrective measures. Professional assistance is essential to diagnose infectious diseases, including testing of fetuses, placenta and blood samples.

"I had several calves suddenly die that before dying were rapidly breathing, weak and feverish."

Many infectious causes of rapid breathing, weakness and fever, followed by sudden death of calves are possible. Ask a veterinarian to perform a necropsy on one of the dead calves and make a specific diagnosis by physical and laboratory examinations. Two common diseases that cause sudden death in calves are lepto and blackleg.

Lepto (leptospirosis)

Lepto is caused by one of five strains of bacteria. The bacteria are shed with urine from infected animals, such as cattle, raccoons, skunks, opossums, rodents, deer, swine and dogs. The bacteria may be shed for many months.

For calves, the likely exposures are from the urine from carrier cows that were stressed at calving and from diseased and convalescent calves. Cows may have the disease but show no signs of it. Calves are infected with the bacteria when they ingest contaminated urine on teats, hair, grass and hay and in water. Newborn calves are the most susceptible to the acute disease.

Observations: The acute form of the disease causes high fever, rapid and difficult breathing, depression, bloody urine, incoordination and death. Lepto calves are often mistakenly diagnosed and treated for pneumonia. Because the bacteria can kill unborn calves as well as nursing calves, it is suggested that cattle owners evaluate the cow herd's pregnancy rate and look for aborted fetuses.

Management: For a closed herd, the most effective approach for control is annual vaccination of all cattle; for an open herd, vaccinate twice yearly. If you time the vaccination in the cow herd during the last trimester of pregnancy, it will provide immunity to the newborn calves through the colostrum.

Use polyvalent killed vaccines containing three or five common serovars. Different vaccines vary in effectiveness, and vaccine failures may occur.

Blackleg (clostridial disease)

When the cause of sudden death of a calf is blackleg bacterial toxins (poisons), the first point to make is that the calf swallowed blackleg spores from the soil. This means the ground is contaminated with the spores that never die. During rains, these spores are normally concentrated by surface water in various spots in the ground, and drought or rains will cause them to surface from the soil.

When ingested by a calf, the spores go to the muscles and remain dormant. A trigger breaks them out of dormancy, sometimes months or years later. Then the bacteria multiply rapidly and produce toxins in the muscles, killing the muscles (black dead muscles), causing blood poisoning and sudden death.

The most common trigger is fast growth. Another trigger is muscle exertion, such as that caused during working, weaning and hauling. Affected calves may be infected at an early age and die of blackleg at a later age. When blackleg occurs, the transmission was not necessarily recent, but possibly months ago.

Observations: Sudden death and rapid, gaseous decomposition are the most common signs of blackleg.

Management: The death is so rapid that treatment is normally ineffective. All dead calves should be burned with untreated wood products to keep from contaminating the ground.

Because other calves can have the bacteria in dormancy, guard against triggers such as stress and rapid growth. Vaccinate the remaining calves. If these calves die, they were already infected with the dormancy of blackleg bacteria before vaccination. Vaccination after exposure will not prevent the dormancy from breaking out.

The seven-way blackleg vaccine should be used because other strains in addition to blackleg that also cause sudden death can be present. The seven strains can be diagnosed only in a dead calf by necropsy and laboratory tests. In addition to blackleg, the other six clostridial diseases that cause sudden death are black neck, black liver, malignant edema, and B, C, D enterotoxemia.

A proper vaccination program includes annual vaccination of the entire herd (calves, cows, heifers, bulls), not just calves. Grown cattle die from four of the seven different blackleg-type bacteria. Cows should be vaccinated during last 3 months of pregnancy or twice a year.

"Some of my calves are rapidly breathing, weak, feverish, scouring and dying."

Because several infectious causes are possible, professional assistance is required to make a specific diagnosis. Fresh feces from live calves must be submitted for laboratory testing, and one of the dead calves must be submitted for necropsy and physical and laboratory examinations. Results of these examinations commonly reveal the presence of tissue damage in the small intestine (enteritis) and large intestine (colitis) and bacteria in the blood (septicemia).

Scours (enteritis-colitis septicemia)

Nursing calves are at high risk to fatal diseases such as scours from the day they are born and continuing during the time of the year when one is calving cows and heifers, moving and mixing these cows and heifers, and bringing in bulls to them. At this time, the baby calves can have low immunity and be highly susceptible to diseases. They can die from scours by dehydration and from septicemia by systemic infections.

Scours are caused by bacteria (*E. coli* and *C. perfringens* B, C, D), viruses (rotovirus and coronovirus), and protozoa in the intestines (cryptosporidia and coccidia). Scours and dehydration worsen when affected calves nurse natural or artificial milk and receive oral antibiotics.

The sources of these deadly germs in the pasture include contaminated ground and fecal shedding from the cows, heifers and bulls. When a pasture trap is used year after year for close observation of calving cows and heifers, the ground becomes heavily contaminated with germs from manure. This contamination is long standing during cool, wet weather by a build up of manure from the calving cows and heifers and scouring calves.

Observations: Calves infected with these germs breathe rapidly and are weak, feverish and scouring. Death also may result.

Management: To correct the dehydration, the affected calves must be removed from nursing and given oral electrolytes until the scours have stopped.

Preventive measures include increasing the level of immunity in colostrums and having all calves nurse the first day of birth. Calf scours can be controlled by vaccines containing *E. coli*, rotavirus, coronavirus and *C. perfringens* B, C, D. Establish an annual vaccination program to provide immunity for the newborn calf though the cow's colostrum. The pregnant cows and heifers need to be vaccinated late in pregnancy to be in colostrums and provide the protective immunity against the fatal baby calf diseases.

Other preventive measures include reducing the level of exposures to infectious organisms during calving and breeding seasons. To reduce the calf mortality related to scours and septicemia in a cow herd calving over a period of several months, use more than one pasture trap to provide clean maternity areas.

Texas A&M AgriLife Extension Service
AgriLifeExtension.tamu.edu

More Extension publications can be found at *AgriLifeBookstore.org*

TEXAS A&M AGRILIFE EXTENSION

L-5506
09-08

Biosecurity for Beef Cattle Operations

By Jason Cleere, Assistant Professor and Extension Beef Cattle Specialist
Ron Gill, Professor and Extension Livestock Specialist
Angela Dement, Extension Assistant, Veterinary Medicine
The Texas A&M System

For beef cattle, biosecurity involves a system of management practices that prevent diseases from infecting a herd. Although biosecurity is often associated with foreign animal diseases, the term also applies to common diseases that affect herds, such as blackleg and bovine viral diarrhea. Vaccines can help prevent disease, but other management practices can be even more important. By developing biosecurity protocols that protect cattle from the common diseases, producers are establishing a safety net against a possible outbreak of a foreign animal disease in the United States.

How Disease Is Spread

Disease spreads directly—from an infected animal to a susceptible animal—or indirectly, from an infected animal to an object or equipment, and then to a susceptible animal. For example, feeding a calf with a bottle that has not been properly sterilized can be a way of indirect transmission.

Disease is transmitted in seven primary ways:

- Aerosol: Disease pathogens are carried in the air on moisture droplets from sneezing or coughing.
- Direct contact: Disease pathogen contacts an open wound, saliva, blood or mucous membranes, or is passed from nose to nose, by rubbing and biting.
- Oral: Susceptible animals consume disease-causing

pathogens in contaminated feed and water or lick or chew contaminated objects.
- Reproductive: Disease pathogens are spread during mating or gestation.
- Vehicles: Contaminated objects, such as needles, trailers, trucks or clothing, transfer the disease-causing pathogen from an infected animal to a susceptible animal.
- Vector-borne: A living insect, animal or human carries the disease from an infected animal to a susceptible animal.
- Fomites: Diseases are transmitted through contaminated soil, water and food.

Immunity

Immunity allows the animal to resist a disease by preventing the pathogen's development or by counteracting the effects of its toxins. Immune animals have antibodies, which destroy a specific pathogen before it causes an illness. Immunity is natural, active or passive.

Natural immunity is provided by the body's natural defenses, such as the skin and nasal passages, which help keep disease pathogens out of the body. Some cells in the body also attack disease-causing foreign particles. Fetuses can acquire antibodies *in utero* through placental transfer.

Passive immunity comes through the transfer of antibodies from one animal to another, such as through colostrum in the mother's milk shortly after birth. Newborns must receive about 10 percent of their body weight in colostrum within the first 24 hours after birth to ensure some protection against diseases.

Active immunity is provided by protective vaccinations or by the body's fight against an infection. Both modified-live and killed vaccines cause the body to produce antibodies without actually acquiring the disease. Booster vaccinations may be necessary to maintain immunity.

Vaccinations

Total disease prevention is not possible; therefore, any ranch biosecurity plan requires a sound vaccination program that targets diseases the cattle may be exposed to.

Vaccines are only as effective as the animal's immune response; injecting cattle with vaccine does not guarantee the herd's immunity. Factors such as nutritional, shipping, social and weather stress can decrease the level of immune response. Minimizing animal stress will improve the disease protection within the herd. Handling and administering vaccines according to the manufacturer's label is important in maintaining the integrity of vaccine and providing protection against the targeted disease.

When handling and working with vaccines:
- Read the label and/or medication insert before vaccinating animals.
- Observe the expiration date and storage information.
- Keep refrigerators at the proper temperature to maintain vaccine effectiveness, usually between 36 degrees F and 46 degrees F.
- Protect vaccines from sunlight.
- Give the right vaccine to the right species. If the label indicates it is for use in swine, do not use it in cattle. This extra-label use is illegal unless done under the supervision and recommendation of a veterinarian.
- Give the proper dose in the appropriate area on the animal, using the recommended technique.
- Do not insert a used needle back into an open bottle. Always use a sterile needle.
- Use a transfer needle or a sterile needle to reconstitute modified-live vaccines.
- Use boiling water, not chemical sterilants, to disinfect syringes.
- Mix only the quantity of modified-live vaccine that will be used within 1 hour.
- Dispose of the remaining opened vaccine properly after completing the day's inoculations because the vaccine does not keep well once the bottle seal has been punctured.
- Give booster vaccinations when the label requires it.
- Keep a record of all vaccinations and treatments.
- Follow withdrawal periods.

Consult a veterinarian to ensure proper timing and implementation of a vaccination schedule. Even under ideal conditions, vaccinations are not 100 percent effective. Take extra care in handling and administering vaccines to achieve the highest possible level of immunity.

Evaluate the cost-benefit ratio of any biosecurity management practices. Do the benefits outweigh the costs? For example, if a weaned calf is worth about $550, the loss of that calf can cost the ranch $550 in lost revenue. If a vaccination routine that costs $1.50 per animal, including new needles for each, is implemented on a 40-cow herd, the total cost for this biosecurity practice may be as low as $60. If the result is one more calf, the net benefit is $490.

Procedures for Handling Incoming Cattle

Almost every ranch eventually must add new breeding animals to the operation. Some stocker or feedlot operations continuously add new cattle. These new cattle can bring disease to the ranch. Minimize this risk by:

- Defining the level of disease risk for the new cattle. For example, yearling virgin bulls from a purebred breeder with a strict health protocol may be low risk, while cows from an unknown source may be high risk.
- Isolating new animals from the rest of the herd for at least 3 weeks, and possibly at a location off the ranch
- Watching the isolated animals closely for symptoms of illness, such as elevated temperature and abnormal behavior
- Consulting a local veterinarian to determine which diseases to test quarantined animals for
- Vaccinating cattle according to ranch protocols

Limiting Unauthorized Access to Pastures and Cattle

Unauthorized visitors may introduce diseases to the ranch, increase the risk of theft and cause liability issues. To help prevent this:

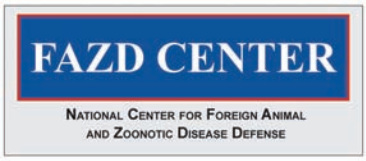
- Keep doors and gates locked at all times.
- Post "No Trespassing" signs.
- Conduct random security checks and look for signs of unauthorized activity or entry.
- Maintain good perimeter fences.
- Know your neighbors and set up a crime watch program.
- Secure pesticides, fertilizers, feed and nutrients.
- Secure water sources and identify alternative sources.

General Biosecurity Practices

Consider these additional general management tips:

- Disinfect reusable equipment, including tattooers, implant guns, ear notchers, dehorners and castration knives, between animals. Sterilize equipment that has been used off the ranch before it is brought back to the ranch.
- Identify cattle and maintain current records.
- Watch cattle for adverse health symptoms or behavior; sudden and unexplained deaths; large numbers of sick animals; unusual ticks or maggots; blisters around an animal's nose, teats, mouth or hooves; difficulty rising and walking; a drop in milk production; and a large number of dead insects, rodents or wildlife. Contact a veterinarian immediately if these symptoms occur.
- Keep cattle away from exotic wildlife that may harbor disease.

- Develop a carcass disposal plan.
- Remove animals that are "reservoirs" for certain diseases such as Johne's, trichomoniasis or bovine viral diarrhea. These animals continue to shed the pathogen and infect other animals.
- Avoid fecal and urine contamination of feed and water sources.
- Control pest populations and limit access to feedstuffs.
- Create an emergency contact list of resource people within the community. Post copies near telephones and on bulletin boards. Have employees enter these numbers into their cell phones.



Texas A&M AgriLife Extension Service

AgriLifeExtension.tamu.edu

More Extension publications can be found at *AgriLifeBookstore.org*

The Texas A&M University System, U.S. Department of Agriculture, and the County Commissioners Courts of Texas Cooperating.

Produced by Texas A&M AgriLife Communications

FEEDLOT MANAGEMENT

Feedlot Health Series: Part I – Receiving

Bethany Lovaas, DVM, and Nicholas DiLorenzo, MS
University of Minnesota Beef Team

So…the cows have been preg checked, and you've decided what to do with the opens. Now it's time to think about the calves. Which do you keep for replacements, which do you send to the feedlot. What happens to these calves will be the focus of a three part feedlot series: feedlot receiving, respiratory disease management, and acidosis and bloat in the feedlot.

As a feedlot owner, there are many management considerations involved with purchasing feeder calves. How the calves are handled at the farm of origin plays a major role in how those calves are received into the feedyard. Ideally, all calves entering a feedlot would be the "low risk," preconditioned calves, however, that is not realistic. This article will address some of the important management considerations for both "high risk" and "low risk" feeder calves.

SHIPPING

Moving cattle is a very stressful event, and therefore cattle are immunosuppressed and are more susceptible to developing respiratory disease. Commingling also adds stress to already stressed animals. The group has to establish a social hierarchy, and cattle brought together from multiple sources are likely to carry different strains of pathogens. The combination of high stress levels and a smorgasbord of pathogens presents every feeder calf with a great opportunity to get sick.

HIGH RISK VS LOW RISK CATTLE

"Low risk" cattle are preconditioned cattle. They have been vaccinated and weaned at least 30 days, and are bunk broke. These cattle are under a lower amount of stress because all of the major changes that occur in a calf's life have already taken place. These cattle are ready to get on full feed and start growing. There are many different names for various preconditioning programs, many of which are sponsored by pharmaceutical companies. They all have a few key requirements in common: deworming/delousing, vaccination with booster using a modified live vaccine, and calves must be weaned prior to shipment. These calves can generally command a higher monetary value, depending on demand, than can higher risk cattle. The feedyard owner/manager knows that there will be a much lower incidence of disease in preconditioned calves, and therefore, lower treatment costs, in terms of labor and drugs. He/she also knows that calves that remain healthy throughout the feeding period are more likely to attain a higher carcass quality grade at closeout.

"High risk" cattle are those that have had no vaccinations, do not know what feed is, and were weaned on the truck on the way to the sale barn. These calves are under significant amounts of stress, which results in significant immunosuppression. There is a very good chance that these calves will get

sick, regardless of how carefully they are handled upon arrival at the feedyard. Buyers likely won't pay as much for these cattle as they would for cattle that have been preconditioned.

METAPHYLAXIS

It is fairly common practice to add a feed-grade antibiotic to the ration when starting calves on feed. One of the challenges this presents is that the calves must, on their own, ingest enough of the antibiotic to have its desired effect. This can be a problem because sick calves, those that would benefit the most from the antibiotic, are generally not eating. Therefore, metaphylactic therapy with a long acting injectable antibiotic is a more reliable, consistent option to feeding antibiotics. There are many choices on the market now, with durations of activity ranging from 3 days to 8 days and possibly beyond.

VACCINATIONS

All calves that arrive at a feedyard should be vaccinated. Cattle that have been preconditioned should be boostered with a single dose of a modified live viral vaccine. Those cattle that have not been preconditioned should receive two doses of a modified live vaccine 2 weeks apart. The non-preconditioned calves should also receive a dose of a clostridial vaccine (7-way or 8-way, depending on geographical location).

Calves should not be worked off the truck. They should be allowed a chance to get comfortable with their surroundings prior to any handling. All of the procedures performed on calves received into a feedlot should be performed 12-24 hours after arrival.

DEWORMING/DELOUSING

In the case of backgrounding/preconditioning programs, deworming/delousing may be a required part of the program. However, if the calves you are receiving into your feedlot are "high risk" type calves, those that have not received any vaccinations or have not been weaned. It is especially important for you to treat these calves with some type of dewormer upon arrival to your feedlot. By eliminating any parasite burden they may be carrying, you will increase gains and efficiency, and decrease the stress that the calves experience during their feedout.

IMPLANTING

Implants are probably one of the most effective technologies used in the beef industry, not only in the finishing phase but also in the backgrounding/stocker phase. Implants' return on the investment has been long proven ranging from $4 to $10 per $1 invested. Considering the beneficial effects on rate of gain (typical improvements in backgrounding are around 0.25 lb/hd/d) and feed efficiency, the use of implants could translate in an additional income of $30 to about $50 per head. Total improvements over non-implanted animals of up to $67 per head may be obtained due to increased carcass value (greater rib eye area with less fat deposition) however whether you take advantage of this extra income or not will depend on your marketing strategy (finish your own animals, retained ownership, live or grid marketing, etc).

When we look at those figures and facts the question really becomes why should I not use implants? Perhaps the only case where you may not want to use them would be if you are planning on keeping any replacement heifers. Even though results are inconsistent, studies conducted implanting replacement

heifers showed that this may affect their later reproductive performance to some extent depending on age, type of implant and nutritional status.

Typically we hear that using implants in a backgrounding operation may hurt subsequent feedlot implants effectiveness, however several studies show that is not always the case.

It doesn't matter how well balanced your diet is if nobody is going to eat it … That statement may sound trivial, but reflects what the number 1 priority is in newly arrived cattle: to get them to eat. Stressed animals will eat less and also will tend to have greater incidence of diarrhea, thus nutritional management in the first 2-4 weeks after arrival is critical in any feedlot or stocker cattle operation.

In the first 4 hours after arrival, the animals should have access to good quality grass hay, avoiding feeding any grain or supplement. Also withholding water during these first 2-4 hours will prevent overdrinking and incidence of diarrhea. After these initial hours it is critical to provide clean water, clean bedding and enough bunk space (1 ft/head initially, then 9 in/hd after adaptation period). These practices will reduce morbidity and mortality associated with the first hours upon arrival.

During the first week, grass hay should be offered free choice to stimulate intake. After that, increasing amounts of grain should be introduced gradually to reach 50-75 % of the diet at about 7 to 10 days after arrival. Common sources of grain to be used are corn grain or barley. Try to stay away from sources of energy that ferment rapidly in the rumen such as high-moisture corn, steam flaked corn or wheat. Using corn silage is also a good option; however, you may have to include it in as high as 40 to 50 % of your diet to be able to supply enough energy. A vitamins and minerals supplement should be included to prevent morbidity associated with deficiencies of these nutrients.

Remember: if we can get the newly arrived animals to eat and prevent diarrhea (by feeding grass hay) we'll improve the overall health status and reduced morbidity and mortality. Those are the first key steps towards the economical success in feedlot operations.

FEEDLOT MANAGEMENT

Feedlot Health Series: Part II – Respiratory Disease Management

Bethany Lovaas, DVM, University of Minnesota Beef Team

COMMON PROBLEM, BIG PROBLEM

Respiratory disease is one of the biggest thieves of profits in the beef industry. It is the cause of approximately 75% of all illness in feedlot cattle. It also is responsible for about 50% of deaths in the feedlot. And those are only the cattle that are caught sick. One particular feedlot study (Wittum et al, 1996) showed 38% of calves were pulled and treated for bovine respiratory disease. However, at the processing plant, 72% of the cattle in the study had lung lesions consistent with pneumonia. So, approximately 68% of untreated cattle had gone through a bout of respiratory disease, and were not picked up by visual observation.

EFFECTS OF RESPIRATORY DISEASE

Why is it important to get a good handle on bovine respiratory disease (BRD)? The cost of BRD goes far beyond just the cost of treatment of sick animals and the cost of dead animals. Cattle that develop BRD have notable decreases in growth performance. Studied vary the in the total loss in average daily gain (ADG) from 0.17 lb/day to 0.30 lb/day, which translates to 30-54 lbs over a 180 day feeding period. With the cost of feeder calves these days, this unrealized weight may mean the difference between profit and loss.

Not only does BRD have a significant impact on growth performance, there is also a big decrease in carcass quality of cattle that are affected by BRD. One particular study (2002 Iowa Tri-County Steer Carcass Futurity), showed a 7.4% decrease in the percentage of cattle that graded choice when they were treated once for BRD. They also showed a 12.3% decrease in percent of cattle that graded choice after 2 treatments (as opposed to no treatments at all). This is especially important with a large choice-select price spread, as is typically seen in the early summer months (late May, June), when the market is flooded with fat cattle.

PREVENTION

The key to successfully combating BRD is prevention. Vaccination is an absolutely necessary part of effective prevention of respiratory disease in feedlot calves. Another important component of prevention is stress reduction. The best prevention for feedlot respiratory disease is by purchasing calves that have been properly preconditioned (which included weaning and bunk-breaking). One study has shown up to a 16% decrease in feedlot morbidity related to respiratory disease in calves that have been properly preconditioned prior to entry to the yard. Another study, published in the Journal of the American Veterinary Medical Association, showed that preconditioned calves were nearly 2 times less likely do develop

respiratory disease and were nearly 5 times less likely to require treatment.

ACIDOSIS AND BRD

Acidosis and BRD go hand in hand, because acidosis is actually a form of stress that the feedlot cattle have to deal with. If your calves are on too hot a ration, you will start to notice some coughing among the calves. Depending on how hot the ration is, you may start to see depressed calves, and when pulled, they have fevers. If you are starting to treat a bunch of calves from one pen, it may be prudent for you to back that group of calves off feed a bit, until they start to turn around again. It is important, not only to decrease the stress that the calves are experiencing from the acidosis, but sick calves aren't eating, and what feed they were supposed to be consuming, is now being eaten by the healthier calves in the pen, which is pushing them to a more severe state of acidosis.

WHAT TO DO IN AN OUTBREAK?

Pull cattle off feed for 12-24 hours and feed them decent quality, dry hay. This will decrease or eliminate the stress of acidosis that the calves may be experiencing.

Check temperatures of affected animals as well as a few random, apparently healthy cattle. In a "wreck", the majority of the calves will have a temperature over 104 0 F. If more than 20-30% of the cattle have a temperature over 104 0 F, treat all of the cattle in the pen with a long acting antibiotic, such as Tetradure®, Micotil®, Excede®, Draxxin®, or the long acting dose of Nuflor® or Baytril®. It may also be advantageous to administer a dose of flunixin meglumine (i.e. Banamine®) to the calves with extremely high fevers. This will decrease their temperature and help them feel better. Also, always remember to follow label withdrawal times to ensure food safety.

In some cases, revaccination may not be helpful. If there is only one pen in the yard that is having major problems with BRD, it may be prudent to revaccinate the calves in neighboring pens, as they are next in line for the spread of disease, and will be facing a fairly significant pathogen load through fence-line contact. However, the goal of vaccination is to simulate an immune response, and the cattle currently fighting respiratory disease are already at peak immune system simulation. Often, revaccination is credited with resolution of a respiratory disease outbreak, when, in reality, the majority of the calves were already on the down swing of the disease curve, and the vaccine actually did very little in the way of effectively curing the calves.

FEEDLOT MANAGEMENT

Feedlot Health Series: Part III – Bloat

Nicholas DiLorenzo, MS, University of Minnesota Beef Team

Now, the animals have been stepped-up to the high-grain diets and they are close to their maximum intake capacity. We have already overcome the plague that respiratory diseases are in those newly arrived. Also the stress of the first days on feed, diarrhea, lack of appetite and hopefully deaths associated with newly arrived cattle problems are past history. Then we are ready to take advantage of the already transitioned digestive tract environment (rumen bugs are adapted to the presence of grain and digest it efficiently) and we are ready to start putting weight on these animals… however, one more hurdle needs to be jumped: feedlot bloat.

WHAT IS FEEDLOT BLOAT?

In simple terms, feedlot bloat can be defined as a disruption in the rumen function that promotes the formation of stable foam impairing the normal elimination of the gas produced during the digestive processes. The consequences of feedlot bloat can range from a minor reduction in feed intake to sudden death by impaired respiration resulting from the pressure from the expanded rumen on lungs and diaphragm.

Even though the obvious impact of feedlot bloat is an increased mortality, cattle death is not the only economic loss. Perhaps the greatest impact of bloat on feedlots' profitability is due to reduction in animal performance (reduced intakes), increased culling due metabolic disorders and increased treatment costs of bloaters.

WHAT CAUSES FEEDLOT BLOAT?

Feedlot bloat can be caused by several factors and the interaction of them. Typically feedlot bloat is associated with the intake of large amounts of grain, specially those types of grain that ferment rapidly in the rumen such as wheat or barley. Even though the presence of large amounts of grain in the diets is a triggering factor, management and animal factors contribute to the development of bloaters. When the grains enter the rumen they are fermented by the rumen microbes producing large amounts of gas. Normally those gases are released by waves of rumen contractions followed by eructation, but under certain conditions such as: excessive amounts of gas produced, reduced rumen contractions, obstructions in the upper gastro intestinal tract, etc, bloat can occur.

Contribution from the rumen microbes cannot be ignored. The viscosity of the rumen fluid can be increased by the formation of slime by the rumen bugs, which will contribute to the formation of stable froth. Proliferation of certain types of microbes in the rumen triggers the produce of slime, and those types of bacteria are usually the ones that grow fastest under high-grain diets. This serves as another example (besides the excess production of gases) of how high-grain diets can prompt the incidence of bloaters.

TYPES OF FEEDLOT BLOAT

Bloat can be classified in two types: free-gas bloat and frothy bloat. Free gas bloat is of rapid onset and often lethal. The animals presenting free-gas bloat usually die suddenly as a result of an obstruction in the esophagus impairing the elimination of gases. These obstructions can be caused by undigested feed particles or partially chewed feeds that can block the esophagus. Free-gas bloat can also be caused by chronic pneumonia or hardware disease as they may affect rumen motility by damaging key nerves involved in those mechanisms. Free-gas bloat can be relieved by removing the obstruction or making a rumen fistula (minor surgery creating a hole from the rumen to the outside) allowing gas escape. Free-gas bloat does not happen as frequently, but its often lethal consequences sure gives them more press than frothy bloat.

Frothy bloat is the most common type of bloat and rarely leads to death. Animals with frothy bloat present a stable mix (bubbles) of gas and liquid at the top of the rumen that traps feed particles and prevents gas release. In frothy bloat caused by pastures, legumes such as alfalfa or red clover are responsible for the formation of stable foam. In the case of feedlot frothy bloat the responsible agents for the formation of foam are the rumen microbes.

Even though feedlot bloat has been associated with acidosis, resulting from high-grain diets and intake variations, both types of metabolic disorders can occur independently from each other.

HOW CAN WE PREVENT IT?

The causes are complex and often hard to predict. The use of grains has been indicated as the factor always associated with bloat; however, reducing the amount of grain to be fed is usually not an option, as animal performance would be reduced. Fed management strategies are probably the most common and cost-effective tools to prevent feedlot bloat.

Replacing the use of highly fermentable grains in the rumen such as wheat or barley in finishing rations for other sources such as corn is a viable alternative. Also the processing method will play a key role in bloat prevention as may limit the amount of starch that will be degraded in the rumen. Whatever is not digested in the rumen does not mean that will be wasted. The small intestine still will use part of that starch without risk of bloat. In general, the smaller is the particle size of the grain, the greater the chances of developing bloat, as more surface will be exposed to the microbes for digestion.

Feed additives such as ionophores and bloat preventives have been widely used. Ionophores such as monensin and salinomycin prevent bloat by inhibiting specific types of microbes or reducing feed intake. Bloat preventives such as poloxalene are most commonly used in pasture bloat and are low-foam detergents that reduce foam stability in the rumen.

In summary, bloat is a metabolic disorder that can harm the economic success of your beef operation; however, a set of tools, management practices and good amount of information are available to prevent or minimize feedlot bloat incidence and enhance animal performance.

BEEF QUALITY GRADING

Beef quality grades are an indicator of overall palatability of an individual piece of meat. To determine a quality grade of a particular carcass, evaluations of maturity and marbling must be made.

Step 1: Determining the Maturity Group

A combination of two methods of maturation evaluation are utilized to determine the final quality grade. These are dentition and skeletal maturity. As an animal matures, the front incisors begin to protrude through the gum indicating an increase in age and this protrusion is utilized to classify the carcass as either over or under 30 months of age. This method of age verification is useful in determining the 30-month threshold due to its lack of interference by stress factors that can adversely impact skeletal maturity.

For skeletal maturity, the cartilaginous (soft, white, pliable) connective tissue of the skeletal system is changed into bone (hard, dense, spongy) via the ossification process as the animal ages. Such changes occur in a definite sequence so that the relative degree of ossification (cartilage to bone) is a reliable indicator of maturity. Beef carcasses are divided into five maturity groups (A, B, C, D and E) based on the ratio of cartilage to bone, with A- maturity being the youngest classification. For example, A^{30} means that the maturity is 30% across the range within A maturity. The following descriptions of each age group might be useful:

1. A maturity- a young carcass about 9- 30 months of age at slaughter.
2. B maturity- a fairly young about 30- 42 months at slaughter.
3. C maturity – the youngest carcasses to be considered “old”. These carcasses will be about 42- 72 months at slaughter.
4. D maturity- a fairly old carcass about 72- 96 months at slaughter.
5. E maturity- the oldest age classification. These carcasses are older than about 96 months at the time of slaughter.

Lean maturity is another indicator of maturity. Lean maturity is based on the color and texture of the exposed ribeye. Lean maturity also is divided into five groups (A, B, C, D, and E). A carcass in the A- lean maturity group has a bright, cherry red color of lean with a very fine texture, while a carcass in the E- lean maturity group has a dark, almost brown- colored lean with an extremely coarse texture.
To classify carcasses into one of these groups, we use three basic locations for bone (sacral, lumbar and thoracic vertebrae) and two criteria for lean (color and texture). In cases where clear decisions cannot be made from these criteria, other maturity factors should be considered. These other factors are color, shape and texture of the ribs; and condition of the split chine bones.

Each of the vertebrae in the carcass consists of a body and dorsal spinous process. The vertebral column is divided into five sections (caudal, sacral, lumbar, thoracic and cervical). As an animal matures, distinct changes occur in the cartilage at the tips of each dorsal process in the sacral, lumbar and thoracic sections. The guidelines for beef carcass maturity evaluation in Table 9 should be learned and used for determining maturity scores.

Table 9. Beef carcass maturity guidelines

Maturity Score	Age, mo.	Best single indicator	Other factors
A^{30}	9-16	Sacral (distinct separation)	Lean color & texture
A^{50}	16-23	Lumbar (partial separation)	"
A^{70}	23-30	Lumbar (70% ossified)	"
B^{00}	30-34	Upper 3 thoracic (0-10%)	Lean color & texture ribs
B^{50}	34-38	Upper 3 thoracic (20%)	"
B^{100}	38-42	Upper 3 thoracic (35%)	Upper 3 thoracic
C^{20}	42-48	Upper 3 thoracic (40%)	Lean color and texture, ribs, evaluate hindquarter & chine bones
C^{50}	48-72	Upper 3 thoracic (40%)	Other thoracic vertebrae, lean color color & texture ribs
D^{00}	72-76	Upper 3 thoracic (70%)	"
E^{00}	>96	Upper 3 thoracic (90%)	"
E^{100}	>96	Upper 3 thoracic (100%)	Lean color & texture

A majority of carcasses possess similar bone and lean maturity scores (i.e., a carcass of B^{50} bone maturity is likely to have a lean maturity score of B^{50}). However, a discussion of beef carcass maturity would not be complete without a complete listing of the rules for determination of overall maturity.

Rule 1: If skeletal maturity is C^{00} or greater, the overall carcass maturity cannot be less than C^{00} regardless of lean maturity score

Rule 2: If skeletal maturity is B^{85} to B^{100} and lean maturity is C^{50} or greater, overall carcass maturity is C^{00}

Rule 3: If skeletal and lean maturity vary by 40% or less of one score, overall carcass maturity is the arithmetic average of the skeletal and lean maturity scores. Always balance towards the bone score to avoid an odd final maturity score.

Rule 4: If skeletal and lean maturity vary by more than 40% of one score, then overall carcass maturity is the arithmetic average of the skeletal and lean maturity scores plus a 10% adjustment toward the skeletal score.

Rule 5: If the skeletal and lean maturity vary by more than two full maturity scores, overall carcass maturity cannot vary by more than one full score from the skeletal score.

Table 10 Examples of balancing skeletal and lean maturity scores

Rule	Skeletal Maturity	Lean Maturity	Overall Maturity
1	C^{50}	A^{30}	C^{00}
1	C^{20}	A^{60}	C^{00}
1	B^{100}	A^{40}	$B^{20} + 10 = B^{30}$
2	B^{85}	C^{40}	B^{100}
2	B^{85}	D^{50}	C^{00}
3	A^{90}	B^{30}	B^{10}
3	C^{50}	C^{20}	C^{40}
4	B^{60}	A^{80}	$B^{20} + 10 = B^{30}$
4	A^{50}	C^{50}	$B^{50} - 10 = B^{40}$
4	E^{50}	D^{50}	$E^{00} + 10 = E^{10}$
5	C^{00}	E^{50}	D^{00}
5	E^{50}	C^{20}	D^{50}

Step 2: Determing the Marbling Score

Marbling is the deposition of the intramuscular fat within the exposed surface of the ribeye muscle. Increased marbling is associated with increased overall palatability of cooked beef because of greater juiciness, tenderness and flavor. Because of this relationship, the final grade assigned to a beef carcass greatly depends on the amount and distribution of the marbling observed by the grader. As true of any scale, a continuum of scores can be established by using ten basic names for amounts of marbling. The specific scores in order of increasing marbling are: Devoid, Practically Devoid, Traces, Slight, Small, Modest, Moderate, Slightly Abundant, Moderately Abundant and Abundant.

Step 3: Determining the Final Quality Grade

Following a thorough understanding of the maturity and marbling scores discussed above, a grader must master the concept of balancing these scores for determination of the final quality grade along with dentition. One must first commit to memory the following rules and charts (Table 10 and 11).

Rule 1: First check dentition to determine if the animal is over 30-months or not by teeth protrusion

Rule 2: Carcasses deemed to be less than 30 months of age by dentition, with skeletal maturity of less than D00, are eligible for USDA Prime, Choice, Select and Standard Grades. (skeletal maturity of A, B, and C when dentition is under 30 months are all considered A Maturity and follow the grading scale for A maturity outlined in Table 11)

Rule 3: Any carcass that has a D00 skeletal maturity or higher, regardless of dentition, is considered "old" and are only eligible for USDA Commercial, Utility, Cutter and Canner grades (as outlined in Table 11 for D and E maturity carcasses)

Rule 4: Carcasses deemed to be over 30 months of age by dentition will be classified using the skeletal, lean and overall maturity to determine a quality grade as outlined in Table 11

Rule 4A: If dentition indicates that the carcass is over 30 months and the overall maturity is B^{00} to B^{100} and the marbling score is Small or Slight, the overall quality grade is High Standard.

Rule 4B: If dentition indicates that the carcass is over 30 months and the overall maturity is C00 or higher the carcass is considered "old" and is only eligible for USDA Commercial and Utility grades (as outlined in Table 11 for C, D and E maturity carcasses)

Table 11. Relationship between maturity and marbling in determining final USDA quality grade for carcasses over 30 months by Dentition

	Maturity				
Marbling	**A**	**B**	**C**	**D**	**E**
Abundant					
Moderately Abundant	**Prime**				
Slightly Abundant			**Commercial**		
Moderate					
Modest	**Choice**				
Small					
Slight	**Select**		**Utility**		
Traces	**Standard**				
Practically Devoid					

Table 12. Marbling needed for hard-boned carcasses for dentition over 30 months

	Maturity		
Grade	**C**	**D**	**E**
High Commercial	Md	SlAb	MdAb
Average Commercial	Mt	Md	SlAb
Low Commercial	Sm	Mt	Md
High Utility	Sl	Sm	Mt
Average Utility	Tr	Sl	Sm
Low Utility	Pd	Tr	Sl

BEEF YIELD GRADES

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Step-Wise Procedure for Yield Grading Beef Carcasses

1. Determine the preliminary yield grade (PYG).

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

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

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

2. Adjust for carcass weight deviations from 600 pounds.

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

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

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

3. Adjust for percentage KPH deviations from 3.5 percent.

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

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

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

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

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

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

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

Example yield grade problem using the short cut method:

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

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

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

Glossary of Terms

Abscess: A swollen, inflamed area in body tissue in which pus gathers.

Accuracy: A measure of reliability associated with an Expected Progeny Difference (EPD). The measure ranges from 0 to 1, with values closer to 1 indicating greater reliability because of the inclusion of more information.

Active ingredient: The specific drug component part of a chemical compound.

Additive: An ingredient or substance added to a basic feed mix, usually in small quantities for the purpose of fortifying it with certain nutrients, stimulants and/or medications.

Animal unit: Common animal denominator based on feed/forage consumption.

Anthelmintic: A drug or chemical that kills or expels worms.

Antibiotic: A class of drugs, such as penicillin, used to control or cure disease. Antibiotics are used to treat both human and animal diseases caused by bacteria.

Antiseptic: A substance that reduces or stops growth of organisms in or on living tissue.

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

Average daily gain: Measurement of an animal's daily body weight change.

Backcross: The mating of a crossbred (F1) animal back to one of its parental breeds (for example, a Hereford-Angus crossbred mated to an Angus bull).

Beef Quality Assurance (BQA): Begun in 1987, the beef industry's BQA program includes training for cattle producers aimed at ensuring beef safety from conception to the consumer's dinner plate. It includes instruction on everything from proper vaccination procedures and withdrawal times to monitoring feed ingredients for potential chemical contaminants.

Bloat: A digestive disorder of ruminants usually characterized by an abnormal accumulation of gas in the rumen. Usually seen on the animal's upper left side.

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

Bos indicus: These are Zebu (humped) cattle that originated in India. Includes breeds like the Brahman breed in the United States.

Bos taurus: British and European/Continental breeds are derived from this species.

Bovine Spongiform Encephalopathy (BSE): It is an extremely rare, chronic degenerative disease affecting the central nervous system of cattle. It was first identified in Great Britain in 1986. Based upon USDA surveillance efforts, there are no documented cases of BSE in the United States.

Breed: Animals with a common origin and common characteristics that distinguish them from other groups of animals within that same species.

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

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

Breed type: The combination of characteristics that makes an animal better suited for a specific purpose.

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

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

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

Carcass merit: Desirability of a carcass relative to quantity of components (muscle, fat, and bone), USDA Quality Grade and potential eating qualities.

Carcass yield: The carcass weight as a percentage of the live weight.

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

Clinical disease: Visible signs of poor health due to the presence of invading organisms.

Colostrum: The milk secreted by mammalian females for the first few days before and following parturition, which is high in antibodies and laxative.

Compensatory gain: Gain from cattle that have been nutritionally deprived for part or all of their lives. When fed feedlot rations, they compensate for the earlier restriction of feed by gaining very rapidly and efficiently.

Composite or Combination breed: A breed formed from a combination of two or more breeds.

Concentrate: A broad classification of feedstuffs that are high in energy and low in crude fiber (less than 18%).

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

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

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

Continental breeds: Breeds that originate from Europe (other than British Isles).

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

Creutzfeldt-Jakob Disease (CJD): It is a human disease of a class of rare degenerative brain diseases called Transmissible Spongiform Encephalopathies (TSE), some of which affect humans and some of which affect animals. While the agents which cause CJD are poorly understood, CJD occurs spontaneously at a consistent rate worldwide of one case per million persons per year. (Also see new variant CJD.)

Crossbreeding: The mating of animals of one breed or breed combination to dams of another breed or breed combination. Crossbreeding usually results in positive heterosis (hybrid vigor).

Culling: The process of eliminating cattle from a herd, especially because of low productivity or less desirability.

Cutability: An estimate of the percentage of salable meat (muscle closely trimmed of external fat) from the high-valued cuts (round, loin, rib, and chuck) vs. percentage of waste fat. Percentage of retail yield of carcass weight can be estimated by a USDA prediction equation that includes hot carcass weight, ribeye area, fat thickness and estimated percent of kidney, pelvic and heart fat. Also estimated by USDA Yield Grade.

Dark cutter: Refers to the dark appearance of the lean muscle tissue in a carcass and is usually caused by stress (excitement) of the animal prior to harvest.

Dioxin: An organic compound found throughout the world in air, soil, water, and food. It is the by-product of natural events like forest fires and man-made processes, such as manufacturing and vehicle exhaust. Humans are exposed to dioxins through the air they breathe and the water they drink. Humans can also be exposed to dioxins in the food they eat. Due to the efforts of many industries, including beef, human dioxin levels have declined more than 72% during the past 20 years.

Disinfectant: A chemical capable of destroying disease-causing microorganisms or which inactivates viruses.

Dressing percent: (Hot carcass weight divided by live weight) x 100.

Dry matter basis: A method of expressing the level of a nutrient contained in a feed on the basis that the material contains no moisture.

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

Ear notching: Makings slits or perforations in an animal's ears for identification purposes.

***E. coli* 0157:H7:** A class of bacteria commonly found in the environment. *E. coli* 0157:H7 is a virulent strain

of this bacteria found in the intestinal tract and feces in animals and humans. While *E. coli* 0157:H7 can cause food poisoning, thorough cooking destroys the bacteria. The beef industry continues to develop new technologies and procedures aimed at reducing the risk of *E. coli* 0157:H7.

Energy feeds: Feeds that are high in energy and low in fiber (less than 18%), and usually contain less than 20% protein.

Environment: All external (non-genetic) conditions, not just climate, that influence the reproduction, production, and carcass merit of cattle.

Established safe level: Concentration of drug metabolite in tissue considered to be without hazard to consumers and below which the FDA normally will not take regulatory action.

Estrous: The female reproductive cycle, averaging 21 days in cattle.

Estrus: Regularly recurrent state of sexual excitability during which the female (cow or heifer) will accept the male (bull). Also called heat.

Estrus synchronization: Causing a group of cows or heifers to exhibit estrus together at one time by artificial manipulation of the estrous cycle.

European Hormone Ban: A ban instituted in 1989 by the European Community (now called the EU) on imported meat and meat products treated with hormones. While the EU continues to argue that the ban is based on health risk, there is no scientific evidence to support their claims. The United States views the ban as an artificial trade barrier erected by the EU to keep imported meat from competing with EU member countries who had created huge surpluses of domestic meat when the ban was initiated.

Expected Progeny Difference (EPD): The difference in performance to be expected from future progeny of an individual, compared with that expected from future progeny of another individual. EPD is an estimate of one-half of the transmittable breeding value of an animal.

Extra-label usage: Administering a drug or other substance in a manner not specified on the label. Can be performed or authorized only by a licensed veterinarian.

F1: Offspring resulting from the mating of a purebred (straightbred) bull to purebred (straightbred) females of another breed.

Fat thickness: Depth of fat in tenths of inches over the ribeye muscle between the 12th and 13th rib interface. It consists of a single measurement at a point 3/4 of the lateral length of the ribeye muscle from the split chine bone.

FDA: The Food and Drug Administration is part of the U.S. Department of Health, Education and Human Services. It is charged with the responsibility of safeguarding American consumers against injury, unsanitary food, and fraud.

Feed conversion (feed efficiency): Units of feed consumed per unit of weight gained; also, the production (meat, milk) per unit of feed consumed.

Fed cattle: Steers and heifers that have been fed concentrates prior to harvest.

Feeder cattle: Young, underfinished animals that will be placed on feed for slaughter.

Frame Score: An estimate of relative skeletal size based on height measured over the hips.

Frame Size: A subjective evaluation of differences in skeletal size, related to estimated slaughter weight at 0.5 inches external fat over the ribeye (predicted to result in low-Choice quality grade).

Freemartin: Female twin born with a male twin calf. Approximately 9.8 out of 10 of these female twins will not be fertile.

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

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

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

Genotype x environment interaction: Variation in the relative performance of different genotypes from one environment to another. For example, the "best" cattle (genotypes) for one environment may not be the "best" for another environment.

Gestation: The period of pregnancy or the period of time from conception until birth.

Hazard Analysis and Critical Control Points (HACCP): A systematic, science-based approach to assuring the production of safe food. The USDA Food Safety and Inspection Service requires all U.S. meat and poultry processing facilities to implement the system.

Heredity: The transmission of genetic factors from parent to offspring.

Heritability: The proportion of the difference among cattle, measured or observed, that is transmitted to the offspring. Heritability varies from 0 to 1. The higher the heritability of a trait, the more accurately does the individual performance predict breeding value and the more rapid should be the response due to selection for that trait.

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

Heterosis (hybrid vigor): Amount by which measured traits of the crossbreds exceed the average of the purebreds mated to produce the crossbreds.

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

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

Hormones: Naturally occurring chemical substances in all animals that affect such things as growth and development. Hormones are present naturally in virtually all foods of plant or animal origin. Growth-promoting hormones utilized by the U.S. beef industry to produce leaner beef more efficiently have the same effect as naturally occurring hormones. Neither naturally occurring hormones nor growth-promoting hormones used in beef production pose any sort of health risk to consumers.

Hot carcass weight: Weight of a carcass before chilling.

Immunity: The ability of an animal to resist or overcome an infection to which most members of its species are susceptible.

Immunization: The process and procedures involved in creating immunity (resistance to disease) in an animal. Vaccination is a form of immunization.

Implants: All growth-promoting hormone products used in the U.S. beef industry are manufactured as implants, which are placed beneath the skin on the back side of an animal's ear.

Intramuscular fat: Fat within the muscle, or marbling.

Intramammary: Placement of drugs and other substances directly into the udder, usually through the teat opening.

Intramuscular injection (IM): An injection into the muscle.

Intrauterine: Placement of drugs and other substances directly into the uterus.

Intravenous injection (IV): Injection of a drug or other substance directly into a vein.

Irradiation: The non-injurious exposure of food to low levels of radiation to eliminate harmful microbes. It destroys fungi, parasites, and insects in and on food.

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

Labeling: Written information detailing the content, intended use, instructions for use, withholding times and other specifics attached to the drug container and/or on a separate sheet accompanying the container.

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

Lesion: The change in the structure or form of an animal's body caused by disease or an injury.

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

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

Medicated feed: Any feed which contains drug ingredients intended or represented for the cure, mitigation, treatment, or prevention of diseases of animals.

Metritis: Inflammation of the uterus.

Microorganism: A living creature, such as a virus or bacterium, capable of being seen only under a microscope.

Microflora: Microbial life characteristic of a region, such as the bacteria and protozoa populating the rumen.

Morbidity: A state of sickness or the rate of sickness.

Mortality: Death or death rate.

Mycotoxins: Toxic metabolites produced by molds during growth, sometimes present in feed materials.

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

Natural beef: A USDA label used by some beef purveyors. By definition (minimally processed and without food additives), all beef produced in the United States qualifies for the natural label.

New variant CJD (nvCJD): A new form of Creutzfeldt-Jakob Disease (CJD) identified in Great Britain. Some scientists believe it is related to Bovine Spongiform Encephalopathies (BSE), but it is clearly different from normal CJD. There are no documented cases of nvCJD in the United States.

Non-fed cattle: Animals slaughtered without a finishing period, usually cull cows and bulls sold for slaughter.

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

Offal: All organs or tissues removed from the carcass.

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

Oral: Placement of a drug or other substance into an animal through its mouth.

OTC: Drugs and other substances that can be bought by anyone over the counter because adequate instructions for safe and effective use by laymen can be printed on the label.

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

Pathogen: A type of bacteria, such as Salmonella or *E. coli* 0157:H7, that causes foodborne illnesses.

Palatability: Overall eating satisfaction to be sufficiently agreeable in tenderness, texture, and taste.

Parturition: The act of giving birth or calving.

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

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

Performance data: Records of individual animals for reproduction, production, and carcass merit. Traits include things like birth, weaning and yearling weights, calving ease, milk production, marbling, etc.

Pesticide: A broad class of crop protection compounds used to combat insects, fungus, and rodents.

Phenotype: The visible or measurable expression of a character; for example, weaning weight, postweaning gain, reproduction, etc. Genotype and environment influence phenotype.

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

Polled: Naturally hornless cattle.

ppb: Parts per billion.

ppm: Parts per million.

Postpartum: After the birth of an individual.

Preconditioning: A way of preparing the calf to withstand the stress and rigors of leaving its mother, learning to eat new feeds, and being shipped to a stocker or feedyard operation.

Preweaning gain: Weight gained between birth and weaning.

Prion: A protein molecule found in the membrane of brain cells. Prions are hypothesized by some researchers as the responsible agents for rare degenerative neurological diseases called Transmissible Spongiform Encephalopathies.

Progeny: The offspring of the parents.

Progeny records: Lifetime performance records of progeny of sires and dams.

Progeny testing: Comparison, under the same conditions, of the progeny of more than one parent for purposes of estimating relative breeding value.

Protein supplements: Products that contain more than 20% protein or protein equivalent.

Puberty: The age at which reproductive organs become functionally operating and secondary sex characteristics begin to develop.

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

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

Quality Grade: An estimate of palatability based primarily on marbling and maturity, and to a lesser extent on color, texture, and firmness of lean.

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

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

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

Replacement females: Females entered into a herd to replace loss of numbers from culling or death. May be heifers produced in the herd or animals brought in from outside.

Residues: Remnants of the compounds in drugs and other substances found in fluid, tissues, and feeds.

Retained ownership: Refers to cow-calf producers maintaining ownership of their cattle beyond weaning for growing and/or finishing.

Ribeye area (REA): Area of the longissimus muscle measured in square inches at the 12th rib interface on the beef forequarter.

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

Route of administration (ROA): The method by which a drug or other substance is given to an animal (oral, subcutaneous, intramuscular, topical, etc.).

Rx (prescription drugs): Drugs that must be prescribed by a licensed veterinarian.

Salmonella: A family of bacteria that includes more than 2,000 strains, 10 of which are responsible for most cases of reported illness associated with the bacteria. Salmonella can be found on any raw food of animal origin. Thorough cooking destroys the bacteria.

Sanitary: Clean. Absence of organisms that can cause disease or ill health.

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

Seedstock: Breeding animals.

Seedstock breeders: Producers whose primary role is to produce breeding animals for other producers.

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

Sibs: Brothers and sisters of an individual.

Sire summary: Published comparative results of sires from a breed's national cattle evaluation programs.

Stockers: Calves and yearlings, both steers and heifers, intended for eventual finishing and harvesting, which are being fed and cared for in such a manner to produce growth, rather than finishing. Stockers are usually younger than feeder cattle.

Stress: Any physical or emotional factor to which an animal fails to make a satisfactory adaptation. May be caused by excitement, temperament, fatigue, shipping, disease, hot or cold weather, nervous strain, number of animals together, previous nutrition, breed, age or management. The greater the stress, the more exacting the nutritional requirements.

Subcutaneous (SQ): An injection under the skin.

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

Terminal sires: Sires used in a breeding system where all their progeny, both male and female, are marketed. For example, F1 crossbred dams could be bred to sires of a third breed and all calves marketed. This system allows maximum heterosis and breed complementary, but replacement females must come from outside the herd.

Therapy: Treatment of disease or health disorders.

Tolerance: Maximum legally allowable level or concentration of a drug or chemical in a food product at the time the milk is marketed, or the animal is slaughtered.

Topical: Application of a drug or other substance to the skin surface or an external membrane, usually concentrated in a small area.

Transmissible Spongiform Encephalopathies (TSE): A class of rare, degenerative brain diseases that affect both animals and humans. Human TSEs include Creutzfeldt-Jakob Disease and Fatal Familial Insomnia. Animal TSEs include Bovine Spongiform Encephalopathy in cattle and scrapie in sheep.

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

Yield Grade: Estimate of carcass cutability categorized into numerical categories with 1 being the highest in lean-to-fat ratio and 5 being the lowest.

Vaccination: An injection of vaccine, bacterin, antiserum or antitoxin to produce immunity or tolerance to disease.

Vaccine: A preparation containing microorganisms controlled in such a way as to create a response by the recipient animal's body that results in increased protective immunity.

VCPR: Valid veterinarian-client-patient relationship, in general, meaning that the veterinarian knows and regularly sees the animals and the individual responsible for authorizing medical treatment for those animals agrees to follow the veterinarian's instructions.

Variance: Variance is a statistic that describes the variation we see in a trait. Without variation, no genetic change is possible.

Weaning rate: Number of calves weaned divided by number of cows exposed to a bull.

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

Withdrawal time: The time required between the application or feeding of a drug or additive and the harvest of the animal to prevent any residue of the drug from remaining in the carcass. Withdrawal times are legally specified by the FDA.

Zero-Tolerance: The standard to which U.S. beef processors must adhere when it comes to fecal and ingesta carcass contamination. In layman's terms, no visible contamination is allowed on beef carcasses. (Executive Summary of the National Non-Fed Beef Quality Audit, 1994. National Cattlemen's Beef Association. Englewood, CO.)

AS1161 (Revised May 2018)

Cattle Producer's Guide to Feedlot Terminology

Greg Lardy
Department Head
Animal Sciences Department

This publication is intended to familiarize cow-calf producers with the terminology that feedlot managers may use when discussing custom feeding and feedlots.

Portions adapted from:
R.C. Albin and G.B. Thompson. 1996. Cattle Feeding: A Guide to Management. Trafton Printing Inc., Amarillo, Texas.

Acidosis

An acute or chronic disease condition in feedlot cattle. Results from overconsumption or too rapid consumption of grain (starch). Acute cases generally result in death. Chronic cases are common and result in erratic intakes and/or reduced feed intake but probably are hidden by pen intakes, which tend to make average consumption look normal. It is one of the most costly problems in the feedlot industry. Subacute cases are difficult to diagnose, but symptoms include poor performance and poor conversions.

ADG

Average daily gain. The amount of gain divided by the number of days in the feeding period.

As-is Basis

Feed is sold "as is," with no adjustments for moisture content. *Also see Dry-matter Basis*.

Bawling Calves

Calves that are taken directly off the cow and weaned at the feedlot, requiring additional labor and a greater degree of health management by the feedlot.

Beta Agonists

Feed additives improve efficiency by partitioning energy away from fat accumulation and toward muscle growth in feedlot cattle. Weight gain, rib-eye area and total red meat yield are increased when they are used. Beta agonists approved for use in the U.S. include Actogain 45 from Zoetis, Optaflex from Elanco Animal Health and Zilmax from Intervet Inc. However, Zilmax was removed voluntarily from the marketplace in 2013.

Breakeven

The sale price ($/hundredweight, or cwt) at which the customer or owner of the cattle does not make or lose money.

NDSU | EXTENSION

North Dakota State University
Fargo, North Dakota

Buller(s)
Steers that are ridden by other steers in the pen (as with cows or heifers that are "bulling"). If problems persist, animals usually are removed from the pen to prevent bruising, injury and reduction in performance of the other cattle.

Buller Pen
Pen in which bullers are kept.

Bunk Call or Bunk Reading
Deciding how much feed should be delivered and when it should be delivered

Bunk Management
The philosophy the feedlot manager uses to determine the amount of feed to offer. *Also see Slick Bunk Management*.

Bunk Reader
The person at the feedlot who is responsible for deciding the daily amount of feed delivered to the cattle. This person is critical to the successful feeding of high-concentrate diets. *Also see Bunk Call, Feed Call, Missing the Call*.

Byproducts or Coproducts
Feed ingredients produced during the production of human food products (for example, corn sweetener, flour, cooking oils, sugar) or industrial products (for example, ethanol, industrial oils). These byproducts are used as ingredients in some growing and finishing diets. *Also see Wet Distillers Grains, Wet Corn Gluten Feed*.

Byproduct or Coproduct Inclusion
The amount of byproduct or coproduct included in the diet on a dry-matter basis.

Calf-feds
Cattle that are placed on feed as calves and finished at less than 16 months of age. Calf-feds may be on feed from 150 to as long as 300 days, depending on the production system. These cattle usually are placed in the feedlot directly following weaning. *Also see Yearlings*.

Carry Cattle
Cattle that are held at the packing plant during a holiday or weekend. These cattle may be penned at the plant for 36 to 84 hours before being slaughtered. These cattle generally are offered feed and water if held for more than 36 hours.

Charging the Bunk
Condition resulting from errors in bunk calls, feed delivery or inclement weather. Cattle will rush to the bunk when the feed truck comes because they are hungry and overeat, resulting in problems such as acidosis, founder and other digestive disturbances.

Chronic(s)
Cattle that fail to respond to treatment. *Also see Realizer and Railer*.

Chute Charges
A fee charged by some feedlots each time cattle are worked through the chute.

Clean Bunk Management
Refers to the bunk management style in which cattle clean up all the feed offered every day. Feed call is increased if cattle have "slicked the bunk." *Also see Charging the Bunk, Bunk Management and Slicked Up*.

Close-outs
A detailed description of pen performance, feed intake, death loss, and profit or loss. A close-out is generated each time a pen of cattle is sold. Can be calculated on a "deads-in" or "deads-out" basis.

Company Cattle
Cattle that are owned and fed by the feedlot. *Also see Customer Cattle*.

Consulting Nutritionist, Feed Company
A nutritionist employed by a feed company who assists the feedlot with professional opinions on rations, supplements, feed additives and management practices. The feed company provides these services when the feedlot purchases supplements or other feed ingredients from the feed company. *Also see Consulting Nutritionist, Private*.

Consulting Nutritionist, Private
A private nutritionist hired by the feedlot to give professional opinions on rations, supplements, feed additives and management practices. Usually paid on a retainer plus a per-head fee. *Also see Consulting Nutritionist, Feed Company*.

Consulting Veterinarian
A veterinarian hired by the feedlot to consult on animal health-related issues such as vaccines and treatments. Usually paid on a retainer plus a per-head fee.

Corn Syrup or Corn Condensed Distillers Solubles (CCDS)
A liquid byproduct of the ethanol industry. It contains relatively high levels of protein and fat and can be used in feedlot diets to control dust and improve palatability.

Cost of Gain
Total of all feedlot-related costs (feed, yardage, processing, medicine, interest and death loss) divided by total gain during the feeding period. Can be calculated on a "deads-in" or "deads-out" basis.

Custom Feed Yard

A feed yard that feeds, manages and markets cattle for customers. Fees are charged for feed, pharmaceuticals and other services.

Customer Cattle

Cattle that are owned by an investor, rancher or other client of the feedlot and fed and managed for a fee. *Also see Company Cattle*.

Dark Cutter(s)

Carcasses with muscle tissue that is dark colored rather than the desirable cherry red. Usually the result of depletions in muscle glycogen stores. Can be influenced, cattle handling techniques, weather, sex of cattle and implant strategy.

Days on Feed

The number of days the cattle are fed.

Deads In/Deads Out

Refers to the methods used to calculate close-outs, cost of gains and breakevens. These can be calculated with the "deads in" or "deads out" of the calculations. "Deads in" refers to leaving the dead cattle in the calculations, while "deads out" refers to leaving the dead cattle out of the calculations.

Digestive

A death resulting from a digestive disorder.

Distillers Dried Grains Plus Solubles (DDGS)

A byproduct of the dry milling (ethanol) industry. Commonly used as an ingredient in feedlots in proximity to dry milling plants. Can be produced from a variety of grains (corn, milo, barley, wheat). Contains 10 to 12 percent moisture. *Also see Byproducts or Coproducts*.

Dressing Percent

Carcass weight divided by final live weight times 100. (Typically ranges from 62 to 65 percent for slaughter cattle.) Live weights may be adjusted for pencil shrink at the feedyard, local scale, or live weight at the plant.

Drunk Cattle

Cattle that are experiencing acidosis due to overconsumption or too rapid consumption of high-grain diets.

Dry-matter Basis

Feed is sold on a "dry" basis following adjustments for variations in moisture content. *Also see As-is Basis*.

Dry Rolling

Grain processing method in which grain is rolled without steaming.

Dry Supplement

Supplement that is fed in a dry form in a mixed ration. Can be pelleted or in a meal form.

Eared Cattle

Cattle with significant Bos indicus (Brahman) breeding.

Earlage

Ensiled corn grain, cobs and, in some cases, husks and a portion of the stalk (depends on the harvest method). Earlage typically is harvested with a forage harvester much like corn silage would be harvested. Earlage is higher in energy than corn silage and has similar protein content, but it has lower energy than dry or high-moisture corn grain.

Feed Additive Combinations

Feed additives such as antibiotics and other products may be fed only in combination when expressly noted on the feed additive label published by the Food and Drug Administration (FDA). The FDA has responsibility and authority related to the use of various combinations of feed additives. Feeding products in combination when not noted on the label is prohibited.

Feed Alley

The road used by the feed trucks to deliver feed to the pen.

Feed Call

The amount of ration that is fed to a particular pen. *Also see Missing the Call, Bunk Call*.

Feed Conversion

The amount of feed consumed by an animal per unit of body weight gain. Expressed as pounds of feed per pound of gain. *Also see Feed Efficiency*.

Feed Cost of Gain

Total feed costs divided by total pounds of gain. *Also see Cost of Gain*.

Feed Efficiency

The amount of feed consumed by an animal per unit of body weight gain. *Also see Feed Conversion*.

Feed Markup

The amount the feedlot marks up the feed charges. Charges vary from feedlot to feedlot. Feed markup can be charged as a percentage of the feed bill or as a flat fee per ton of feed.

Finisher or Final Finisher

The final diet cattle will be fed during the feeding period. Usually contains 5 to 10 percent roughage, but it may be an all-concentrate (no roughage) diet, depending on the feedlot.

Flaker
A mill that steam flakes grain.

Gluten or Gluten Feed
See Wet Corn Gluten Feed.

Grass Cattle
Cattle that were grown on pasture prior to placement in the feedlot. *Also see Yearlings.*

Green Cattle
Cattle that are relatively thin, with only small amounts of body condition. *Also see Soggy Cattle.*

Grid(s)
A method of pricing slaughter cattle that offers premiums and discounts for cattle. Cattle that are leaner and have a higher quality grade receive the premiums. Grids generally have other specifications for carcass weight and dark cutters as well.

Grow Yard
An operation that grows or backgrounds cattle for a period of time before they enter the feedlot for finishing. May be used to wean calves because the operations generally have a higher ratio of employees to cattle and can give sick calves extra attention.

Haylage
Forage that has been ensiled for the purposes of preservation. A variety of forages may be classified as haylage, including alfalfa, oats, rye, triticale and wheat. Haylage typically is harvested by swathing or windrowing, allowing the forage to dry to 45 to 60 percent moisture, chopping with a forage harvester and storing in an oxygen-limiting silo.

Heiferettes
Heifers placed on feed following the loss of a calf or open heifers placed on feed following the breeding season.

High-moisture Corn
Corn that is harvested when moisture levels are 22 to 32 percent. Generally, this corn is ground or rolled and stored in pit or bunker silos. It also can be stored whole and processed before feeding. *Also see Pit Corn.*

Hospital Pen
Place where sick cattle are treated before being returned to the home pen. *Also see Sick Pen.*

In the Beef
Method of sale that refers to selling the cattle on a carcass weight basis rather than live weight. Usually carcass weight times carcass price with no discounts for Choice or Select. *Also see Live.*

Ionophore
Antibiotic that enhances feed efficiency in cattle by altering ruminal fermentation. (Rumensin, monensin; Bovatec, lasalocid; and Cattlyst, laidlomycin propionate are the Food and Drug Administration-approved ionophores used in diets for finishing cattle).

Inventory Gain/Loss
The amount of gain or loss in feed inventory due to storage, milling and processing feed.

Limit Feeding
Limiting feed intake to achieve a desired rate of gain during the growing period. Used in growing and backgrounding situations to have cattle ready for market at a specific point in time. *Also see Programmed Feeding.*

Liquid Supplement
Liquid supplement based on molasses that contains urea or another nonprotein nitrogen (NPN) source. Used to provide supplemental protein in a finishing diet. May also contain supplemental phosphorus, salt, ionophores and other feed additives. Most liquid supplements contain a suspension agent to keep the ingredients and feed additives in suspension during storage.

Live
Method of sale in which the cattle are sold to the packer "live" at the feedlot. At times, the packer is responsible for transporting the animals to the slaughter facility. *Also see In the beef.*

Liver Abscesses
Disease condition of the liver in which rumen microflora infect the liver due to breaks in the rumen wall caused by acidosis. In severe cases, liver function is impaired and performance reduced.

Long Yearlings
Yearlings that have had an extended period of grazing. Usually placed on feed in the fall following a full summer grazing season. Fed for 120 days or less. *Also see Short Yearlings or Yearlings.*

Melengesterol Acetate (MGA)
A steroidal feed additive that is used to suppress estrus or cyclic activity in feedlot heifers.

Metaphylaxis or Mass Medication
The practice of treating a whole herd or pen of cattle with antibiotics if they are at risk of suffering an outbreak of infectious disease due to exposure to pathogens or unfavorable host or environmental conditions. *See prophylaxis.*

Micro Machine
Machine that adds micro ingredients such as ionophores, antibiotics and other ingredients to the diet in a water-based slurry.

Mill Man
Employee in charge of the feed mill.

Missing the Call
Making a mistake in reading the bunk. *Also see Bunk Call, Feed Call.*

Modified Wet Distillers Grains Plus Solubles (MWDGS)
A byproduct of the dry milling (ethanol) industry. Commonly used as an ingredient in feedlots in proximity to dry milling plants. Can be produced from a variety of grains (corn, milo, barley, wheat). Contains approximately 50 percent moisture. *Also see Byproducts or Coproducts.*

NPN
Abbreviation for nonprotein nitrogen. Urea is a common source of NPN. *Also see Liquid Supplement.*

Overeaters
Cattle that eat too much on a high-grain diet.

Pay Weight
Shrunk live weight of an animal at the time of sale. Usually 4 percent. *Also see Pencil Shrink.*

Pen Deads
Cattle that are found dead in the pen. Cause of death is usually unknown.

Pen Rider
Employee who rides through the pens to look for sick cattle.

Pencil Shrink
An arithmetic deduction of weight from the live weight of an animal to account for fill, usually 3 percent for cattle off pasture and 4 percent for off-feed weights of fed cattle. *Also see Pay Weight.*

Pit Corn
High-moisture corn that has been ground and stored in a bunker or pit silo. *Also see High-moisture Corn.*

Processing
Vaccinating, treating for internal and external parasites, ear tagging, and other procedures such as implanting, dehorning and castration that are done soon after cattle arrive at the feedlot.

Programmed Feeding
A feeding routine that is used to achieve a specific rate of gain and limit feed intake. Used in growing and backgrounding situations to have cattle ready for market at a specific date. *Also see: Limit Feeding.*

Projections
Projecting the days on feed, cost of gain and breakeven for a particular pen of cattle. This is done when the pen is placed in the lot. Generally, this is the responsibility of the manager or assistant manager.

Prophylaxis
Treating an individual animal for a disease condition or injury. *See metaphylaxis.*

Pulls
Cattle that have been pulled from their home pen for treatment. *Also see Pulling Cattle.*

Pulling Cattle
Removing cattle from the pen for treatment. *Also see Pulls.*

Put-together Cattle
Cattle that have been assembled by an order buyer from small lots.

Quality Grade
A grade placed on each carcass by the U.S. Department of Agriculture inspector at the packing plant. Quality grade is based on the degree of marbling and degree of maturity. Color, texture and firmness of lean also are used in the final quality grade determination.

Rail-out
A carcass that has been placed on a special rail in the packing plant so that the USDA inspector can make a more detailed inspection of the carcass.

Railer(s)
Cattle that fail to respond to treatment. *Also see Chronic or Realizer.*

Realizer(s)
Cattle that fail to respond to treatment. *Also see Chronic or Railer.*

Receiving
Getting new cattle into the feedlot.

Reimplanting
Giving cattle their second implant (usually done only with calf-feds or long-fed yearlings).

Respiratory
A death resulting from pneumonia or related respiratory disease.

Roughage or Forage Dry Matter
The amount of roughage or forage included in the diet on a dry-matter basis.

Short Yearlings
Cattle placed on feed after being weaned. Usually placed on feed March through July. Fed for 120 to 160 days. *Also see Yearlings or Long Yearlings.*

Show List
The pens of cattle the manager is offering for sale to packer buyers during a particular week.

Shrink
See Pencil Shrink or Inventory Gain/Loss.

Sick Pen
Pen where sick animals and animals recovering from treatment are kept. *Also see Hospital Pen.*

Slicked Up
Refers to the fact the cattle have cleaned up their feed or "slicked the bunk." Cattle have "slicked the bunk" with saliva. Bunks that are "slick and wet" have just been slicked. Bunks that are "slick and dry" have been slicked for some time. *Also see Bunk Management or Clean Bunk Management.*

Soggy Cattle
Cattle from a backgrounding or growing operation that are fleshy or overly conditioned. *Also see Green Cattle.*

Steam Flaker
Grain processing method in which grain is subjected to steaming before rolling or flaking.

Step-ups
The rations used to acclimate cattle to high-grain diets. Length of time that cattle are fed these diets varies. Generally, the amount of concentrate is increased gradually. The first week in the feedlot, the cattle may be fed a 45 percent roughage diet, the second week a 35 percent roughage diet, etc., until the cattle are on the final finisher.

Storm Diet
A diet fed during periods of stormy weather to help keep cattle on feed. Usually contains more roughage.

Surfactant
An additive used to aid in grain processing.

Terminal Implant Window
The days between when the final implant is administered and the day the cattle are marketed to the slaughter plant.

Trenbolone Acetate (TBA)
Active ingredient in some implants approved for use in feedlot cattle.

Veterinary Feed Directive (VFD)
The veterinary feed directive is a set of rules recently implemented by the Food and Drug Administration. The rules govern the use of feed-grade antibiotics in food animals. Among other things, the VFD requires a valid veterinary client patient relationship to be in place prior to prescribing antibiotics. Visit *https://tinyurl.com/UnderstandingVFD* for more information on the VFD.

Warmed-up Cattle
Cattle that have been grown in a backgrounding yard prior to being placed on feed.

Wet Corn
See High Moisture Corn or Pit Corn.

Wet Corn Gluten Feed
A byproduct of the wet corn milling industry that is made by blending corn bran and corn steep liquor. A common ingredient in finishing rations in Iowa, eastern Nebraska, southeastern South Dakota and southern Minnesota. *Also see Byproducts or Coproducts.*

Wet Distillers Grains Plus Solubles
A byproduct of the dry milling (ethanol) industry. Commonly used as an ingredient in feedlots in proximity to dry milling plants. Can be produced from a variety of grains (corn, milo, barley, wheat). Typically contains 65 to 70 percent water. *Also see Byproducts or Coproducts.*

Yardage
Charges incurred each day that the cattle are in the feedlot. These charges vary depending on the lot. Usually on a cents per head per day basis.

Yearlings
Cattle that are placed on feed at greater than 1 year of age. Generally fed for 80 to 150 days. *Also see Calf-feds, Short Yearlings or Long Yearlings.*

Yield Grade
A numerical grade placed on each carcass by the USDA inspector at the packing plant that estimates differences in the yield of boneless, closely trimmed retail cuts from the round, rib, loin and chuck. Factors determining yield grade include fat thickness at the 12th rib, rib-eye area, hot carcass weight, and the amount of kidney, pelvic and heart fat. Lower yield grades (1) indicate leaner carcasses, while higher yield grades (5) indicate fatter carcasses.

web-3-13; web-5-18

Understanding the Ruminant Animal Digestive System

Ruminant livestock include cattle, sheep, and goats. Ruminants are hoofed mammals that have a unique digestive system that allows them to better use energy from fibrous plant material than other herbivores. Unlike monogastrics such as swine and poultry, ruminants have a digestive system designed to ferment feedstuffs and provide precursors for energy for the animal to use. By better understanding how the digestive system of the ruminant works, livestock producers can better understand how to care for and feed ruminant animals.

Ruminant Digestive Anatomy and Function

The ruminant digestive system uniquely qualifies ruminant animals such as cattle to efficiently use high roughage feedstuffs, including forages. Anatomy of the ruminant digestive system includes the mouth, tongue, salivary glands (producing saliva for buffering rumen pH), esophagus, four-compartment stomach (rumen, reticulum, omasum, and abomasum), pancreas, gall bladder, small intestine (duodenum, jejunum, and ileum), and large intestine (cecum, colon, and rectum).

A ruminant uses its mouth (oral cavity) and tongue to harvest forages during grazing or to consume harvested feedstuffs. Cattle harvest forages during grazing by wrapping their tongues around the plants and then pulling to tear the forage for consumption. On average, cattle take from 25,000 to more than 40,000 prehensile bites to harvest forage while grazing each day. They typically spend more than one-third of their time grazing, one-third of their time ruminating (cud chewing), and slightly less than one-third of their time idling where they are, neither grazing nor ruminating.

The roof of the ruminant mouth is a hard/soft palate without incisors. The lower jaw incisors work against this hard dental pad. The incisors of grass/roughage selectors are wide with a shovel-shaped crown, while those of concentrate selectors are narrower and chisel-shaped. Premolars and molars match between upper and lower jaws. These teeth crush and grind plant material during initial chewing and rumination.

Saliva aids in chewing and swallowing, contains enzymes for breakdown of fat (salivary lipase) and starch (salivary amylase), and is involved in nitrogen recycling to the rumen. Saliva's most important function is to buffer pH levels in the reticulum and rumen. A mature cow produces up to 50 quarts of saliva per day, but this varies, depending on the amount of time spent chewing feed, because that stimulates saliva production.

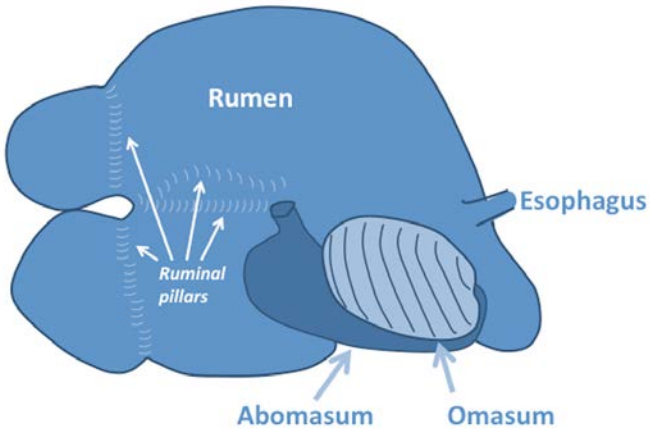
Forage and feed mixes with saliva containing sodium, potassium, phosphate, bicarbonate, and urea when consumed, to form a bolus. That bolus then moves from the mouth to the reticulum through a tube-like passage called the esophagus. Muscle contractions and pressure differences carry these substances down the esophagus to the reticulum.

Ruminants eat rapidly, swallowing much of their feedstuffs without chewing it sufficiently (< 1.5 inches). The esophagus functions bidirectionally in ruminants, allowing them to regurgitate their cud for further chewing, if necessary. The process of rumination or "chewing the cud" is where forage and other feedstuffs are forced back to the mouth for further chewing and mixing with saliva. This cud is then swallowed again and passed into the reticulum. Then the solid portion slowly moves into the rumen for fermentation, while most of the liquid portion rapidly moves from the reticulorumen into the omasum and then abomasum. The solid portion left behind in the rumen typically remains for up to 48 hours and forms a dense mat in the rumen, where microbes can use the fibrous feedstuffs to make precursors for energy.

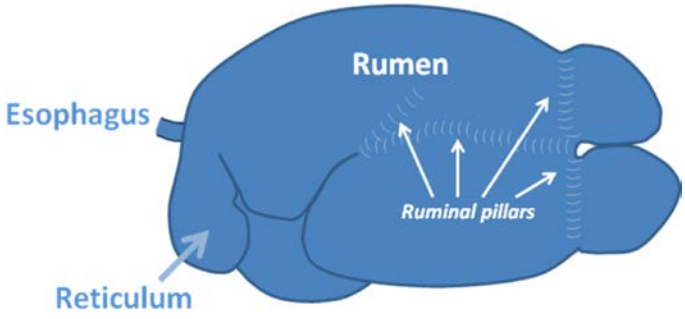
True ruminants, such as cattle, sheep, goats, deer, and antelope, have one stomach with four compartments:

the rumen, reticulum, omasum, and abomasums. The ruminant stomach occupies almost 75 percent of the abdominal cavity, filling nearly all of the left side and extending significantly into the right side. The relative size of the four compartments is as follows: the rumen and reticulum comprise 84 percent of the volume of the total stomach, the omasum 12 percent, and the abomasum 4 percent. The rumen is the largest stomach compartment, holding up to 40 gallons in a mature cow.

The reticulum holds approximately 5 gallons in the mature cow. Typically, the rumen and reticulum are considered one organ because they have similar functions and are separated only by a small muscular fold of tissue. They are collectively referred to as the reticulorumen. The omasum and abomasum hold up to 15 and 7 gallons, respectively, in the mature cow.



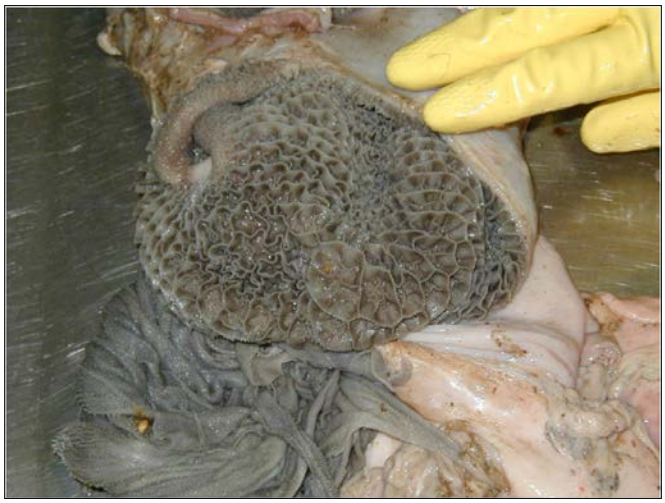
Right-sided view of ruminant digestive tract.



Left-sided view of ruminant digestive tract.

The reticulorumen is home to a population of microorganisms (microbes or "rumen bugs") that include bacteria, protozoa, and fungi. These microbes ferment and break down plant cell walls into their carbohydrate fractions and produce volatile fatty acids (VFAs), such as acetate (used for fat synthesis), priopionate (used for glucose synthesis), and butyrate from these carbohydrates. The animal later uses these VFAs for energy.

The reticulum is called the "honeycomb" because of the honeycomb appearance of its lining. It sits underneath and toward the front of the rumen, lying against the diaphragm. Ingesta flow freely between the reticulum and rumen. The main function of the reticulum is to collect smaller digesta particles and move them into the omasum, while the larger particles remain in the rumen for further digestion.



"Honeycomb" interior lining of the reticulum in an 8-week-old calf.

The reticulum also traps and collects heavy/dense objects the animal consumes. When a ruminant consumes a nail, wire, or other sharp heavy object, it is very likely the object will be caught in the reticulum. During normal digestive tract contractions, this object can penetrate the reticulum wall and make its way to the heart, where it can lead to hardware disease. The reticulum is sometimes referred to as the "hardware stomach." Hardware disease is discussed in detail in Mississippi State University Extension Publication 2519 *Beef Cattle Nutritional Disorders*.

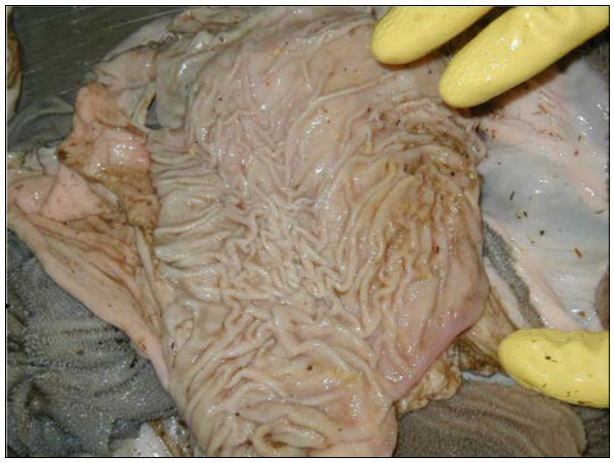
The rumen is sometimes called the "paunch." It is lined with papillae for nutrient absorption and divided by muscular pillars into the dorsal, ventral, caudodorsal, and caudoventral sacs. The rumen acts as a fermentation vat by hosting microbial fermentation. About 50 to 65 percent of starch and soluble sugar consumed is digested in the rumen. Rumen microorganisms (primarily bacteria) digest cellulose from plant cell walls, digest complex starch, synthesize protein from nonprotein nitrogen, and synthesize B vitamins and vitamin K. Rumen pH typically ranges from 6.5 to 6.8. The rumen environment is anaerobic (without oxygen). Gases produced in the rumen include carbon dioxide, methane, and hydrogen sulfide. The gas fraction rises to the top of the rumen above the liquid fraction.

Interior lining of the rumen, revealing papillae in an 8-week-old calf.

The omasum is spherical and connected to the reticulum by a short tunnel. It is called the "many piles" or the "butcher's bible" in reference to the many folds or leaves that resemble pages of a book. These folds increase the surface area, which increases the area that absorbs nutrients from feed and water. Water absorption occurs in the omasum. Cattle have a highly developed, large omasum.

Interior lining of the omasum, revealing the "many piles" tissue folds in an 8-week-old calf.

The abomasum is the "true stomach" of a ruminant. It is the compartment that is most similar to a stomach in a nonruminant. The abomasum produces hydrochloric acid and digestive enzymes, such as pepsin (breaks down proteins), and receives digestive enzymes secreted from the pancreas, such as pancreatic lipase (breaks down fats). These secretions help prepare proteins for absorption in the intestines. The pH in the abomasum generally ranges from 3.5 to 4.0. The chief cells in the abomasum secrete mucous to protect the abomasal wall from acid damage.



Interior lining of the abomasum, the "true stomach," in an 8-week-old calf.

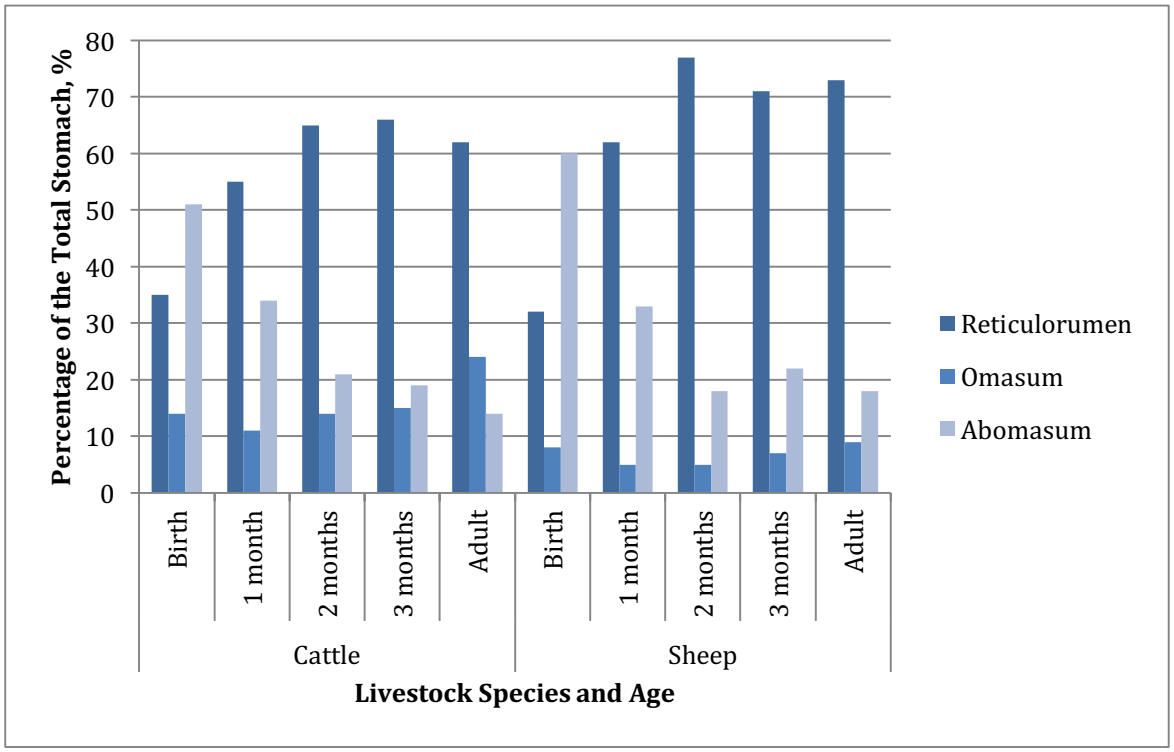
The small and large intestines follow the abomasum as further sites of nutrient absorption. The small intestine is a tube up to 150 feet long with a 20-gallon capacity in a mature cow. Digesta entering the small intestine mix with secretions from the pancreas and liver, which elevate the pH from 2.5 to between 7 and 8. This higher pH is needed for enzymes in the small intestine to work properly. Bile from the gall bladder is secreted into the first section of the small intestine, the duodenum, to aid in digestion. Active nutrient absorption occurs throughout the small intestine, including rumen bypass protein absorption. The intestinal wall contains numerous "finger-like" projections called villi that increase intestinal surface area to aid in nutrient absorption. Muscular contractions aid in mixing digesta and moving it to the next section.

The large intestine absorbs water from material passing through it and then excretes the remaining material as feces from the rectum. The cecum is a large blind pouch at the beginning of the large intestine, approximately 3 feet long with a 2-gallon capacity in the mature cow. The cecum serves little function in a ruminant, unlike its role in horses. The colon is the site of most of the water absorption in the large intestine.

Ruminant Digestive Development

Immature ruminants, such as young, growing calves from birth to about 2 to 3 months of age, are functionally nonruminants. The reticular groove (sometimes referred to as esophageal groove) in these young animals is formed by muscular folds of the reticulum. It shunts milk directly to the omasum and then abomasum, bypassing the reticulorumen. The rumen in these animals must be inoculated with rumen microorganisms, including bacteria, fungi, and protozoa. This is thought to be accomplished through mature ruminants licking calves and environmental contact with these microorganisms.

Immature ruminants must undergo reticulorumen-omasal growth, including increases in volume and muscle. In a calf at birth, the abomasum is the largest compartment of the stomach, making up more than 50 percent of the total stomach area. The reticulorumen and omasum account for 35 percent and 14 percent of the total stomach area in the newborn calf. As ruminants develop, the reticulorumen and omasum grow rapidly and account for increasing proportions of the total stomach area. In mature cattle, the abomasum encompasses only 21 percent of the total stomach capacity, whereas the reticulorumen



Relative proportions of stomach compartments in cattle and sheep at various ages.

and omasum make up 62 and 24 percent, respectively, of the total stomach area. Rumen papillae (sites of nutrient absorption) lengthen and decrease in numbers as part of rumen development.

Because immature ruminants do not have a functional rumen, feeding recommendations differ for developing ruminants compared with adult ruminants. For instance, it is recommended immature ruminants are not allowed access to feeds containing non-protein nitrogen such as urea. Developing ruminants are also more sensitive to gossypol and dietary fat levels than mature ruminants. Design nutritional programs for ruminants considering animal age.

Ruminant Feeding Types

Based on the diets they prefer, ruminants can be classified into distinct feeding types: concentrate selectors, grass/roughage eaters, and intermediate types. The relative sizes of various digestive system organs differ by ruminant feeding type, creating differences in feeding adaptations. Knowledge of grazing preferences and adaptations amongst ruminant livestock species helps in planning grazing systems for each individual species and also for multiple species grazed together or on the same acreage.

Concentrate selectors have a small reticulorumen in relation to body size and selectively browse trees and shrubs. Deer and giraffes are examples of concentrate selectors. Animals in this group of ruminants select plants and plant parts high in easily digestible, nutrient dense substances such as plant starch, protein, and fat. For example, deer prefer legumes over grasses. Concentrate selectors are very limited in their ability to digest the fibers and cellulose in plant cell walls.

Grass/roughage eaters (bulk and roughage eaters) include cattle and sheep. These ruminants depend on diets of grasses and other fibrous plant material. They prefer diets of fresh grasses over legumes but can adequately manage rapidly fermenting feedstuffs. Grass/roughage eaters have much longer intestines relative to body length and a shorter proportion of large intestine to small intestine as compared with concentrate selectors.

Goats are classified as intermediate types and prefer forbs and browse such as woody, shrubby type plants. This group of ruminants has adaptations of both concentrate selectors and grass/roughage eaters. They have a fair though limited capacity to digest cellulose in plant cell walls.

Carbohydrate Digestion

Forages

On high-forage diets ruminants often ruminate or regurgitate ingested forage. This allows them to "chew their cud" to reduce particle size and improve digestibility. As ruminants are transitioned to higher concentrate (grain-based) diets, they ruminate less.

Once inside the reticulorumen, forage is exposed to a unique population of microbes that begin to ferment and digest the plant cell wall components and break these components down into carbohydrates and sugars. Rumen microbes use carbohydrates along with ammonia and amino acids to grow. The microbes ferment sugars to produce VFAs (acetate, propionate, butyrate), methane, hydrogen sulfide, and carbon dioxide. The VFAs are then absorbed across the rumen wall, where they go to the liver.

Once at the liver, the VFAs are converted to glucose via gluconeogenesis. Because plant cell walls are slow to digest, this acid production is very slow. Coupled with routine rumination (chewing and rechewing of the cud) that increases salivary flow, this makes for a rather stable pH environment (around 6).

High-Concentrate Feedstuffs (Grains)

When ruminants are fed high-grain or concentrate rations, the digestion process is similar to forage digestion, with a few exceptions. Typically, on a high-grain diet, there is less chewing and ruminating, which leads to less salivary production and buffering agents' being produced. Additionally, most grains have a high concentration of readily digestible carbohydrates, unlike the more structural carbohydrates found in plant cell walls. This readily digestible carbohydrate is rapidly digested, resulting in an increase in VFA production.

The relative concentrations of the VFAs are also changed, with propionate being produced in the greatest quantity, followed by acetate and butyrate. Less methane and heat are produced as well. The increase in VFA production leads to a more acidic environment (pH

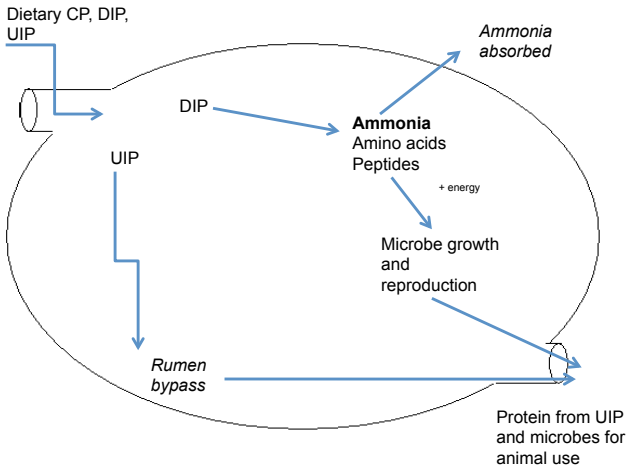
5.5). It also causes a shift in the microbial population by decreasing the forage using microbial population and potentially leading to a decrease in digestibility of forages.

Lactic acid, a strong acid, is a byproduct of starch fermentation. Lactic acid production, coupled with the increased VFA production, can overwhelm the ruminant's ability to buffer and absorb these acids and lead to metabolic acidosis. The acidic environment leads to tissue damage within the rumen and can lead to ulcerations of the rumen wall. Take care to provide adequate forage and avoid situations that might lead to acidosis when feeding ruminants high-concentrate diets. Acidosis is discussed in detail in Mississippi State University Extension Service Publication 2519 *Beef Cattle Nutritional Disorder*s. In addition, energy as a nutrient in ruminant diets is discussed in detail in Mississippi State University Extension Service Publication 2504 *Energy in Beef Cattle Diets*.

Protein Digestion

Two sources of protein are available for the ruminant to use: protein from feed and microbial protein from the microbes that inhabit its rumen. A ruminant is unique in that it has a symbiotic relationship with these microbes. Like other living creatures, these microbes have requirements for protein and energy to facilitate growth and reproduction. During digestive contractions, some of these microorganisms are "washed" out of the rumen into the abomasum where they are digested like other proteins, thereby creating a source of protein for the animal.

All crude protein (CP) the animal ingests is divided into two fractions, degradable intake protein (DIP) and undegradable intake protein (UIP, also called "rumen bypass protein"). Each feedstuff (such as cottonseed meal, soybean hulls, and annual ryegrass forage) has different proportions of each protein type. Rumen microbes break down the DIP into ammonia (NH3) amino acids, and peptides, which are used by the microbes along with energy from carbohydrate digestion for growth and reproduction.



Protein digestion in the ruminant

Excess ammonia is absorbed via the rumen wall and converted into urea in the liver, where it returns in the blood to the saliva or is excreted by the body. Urea toxicity comes from overfeeding urea to ruminants. Ingested urea is immediately degraded to ammonia in the rumen.

When more ammonia than energy is available for building protein from the nitrogen supplied by urea, the excess ammonia is absorbed through the rumen wall. Toxicity occurs when the excess ammonia overwhelms the liver's ability to detoxify it into urea. This can kill the animal. However, with sufficient energy, microbes use ammonia and amino acids to grow and reproduce.

The rumen does not degrade the UIP component of feedstuffs. The UIP "bypasses" the rumen and makes its way from the omasum to the abomasum. In the abomasum, the ruminant uses UIP along with microorganisms washed out of the rumen as a protein source. Protein as a nutrient in ruminant diets is discussed in detail in Mississippi State University Extension Service Publication 2499 *Protein in Beef Cattle Diets*.

Importance of Ruminant Livestock

The digestive system of ruminants optimizes use of rumen microbe fermentation products. This adaptation lets ruminants use resources (such as high-fiber forage) that cannot be used by or are not available to other animals. Ruminants are in a unique position of being able to use such resources that are not in demand by humans but in turn provide man with a vital food source. Ruminants are also useful in converting vast renewable resources from pasture into other products for human use such as hides, fertilizer, and other inedible products (such as horns and bone).

One of the best ways to improve agricultural sustainability is by developing and using effective ruminant livestock grazing systems. More than 60 percent of the land area in the world is too poor or erodible for cultivation but can become productive when used for ruminant grazing. Ruminant livestock can use land for grazing that would otherwise not be suitable for crop production. Ruminant livestock production also complements crop production, because ruminants can use the byproducts of these crop systems that are not in demand for human use or consumption. Developing a good understanding of ruminant digestive anatomy and function can help livestock producers better plan appropriate nutritional programs and properly manage ruminant animals in various production systems.

References

Church, D. C. ed. 1993. The Ruminant Animal Digestive Physiology and Nutrition. Waveland Press, Inc. Prospect Heights, IL.

Oltjen, J. W., and J. L. Beckett. 1996. Role of ruminant livestock in sustainable agricultural systems. J. Anim. Sci. 74:1406-1409.

Parish, J. A., M. A. McCann, R. H. Watson, N. N. Paiva, C. S. Hoveland, A. H. Parks, B. L. Upchurch, N. S. Hill, and J. H. Bouton. 2003. Use of non-ergot alkaloid-producing endophytes for alleviating tall fescue toxicosis in stocker cattle. J. Anim. Sci. 81:2856-2868.

Van Soest, P. J. 1987. Nutritional Ecology of the Ruminant. Cornell University Press. Ithaca, NY.

Publication 2503 (POD-12-17)

By **Jane A. Parish**, PhD, Professor and Head, North Mississippi Research and Extension Center; **J. Daniel Rivera**, PhD, Associate Extension/Research Professor, South Mississippi Branch Experiment Station; and **Holly T. Boland**, PhD, former Assistant Research/Extension Professor, Animal and Dairy Sciences. Photos of ruminant digestive system courtesy of Stephanie R. Hill, PhD, former Assistant Research Professor, Animal and Dairy Sciences.

Produced by Agricultural Communications.

Extension Service of Mississippi State University, cooperating with U.S. Department of Agriculture. Published in furtherance of Acts of Congress, May 8 and June 30, 1914. GARY B. JACKSON, Director

B-1575

Texas Agricultural Extension Service

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.

*Former Extension livestock specialist and Extension beef cattle specialist-nutrition, The Texas A&M University System.

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.

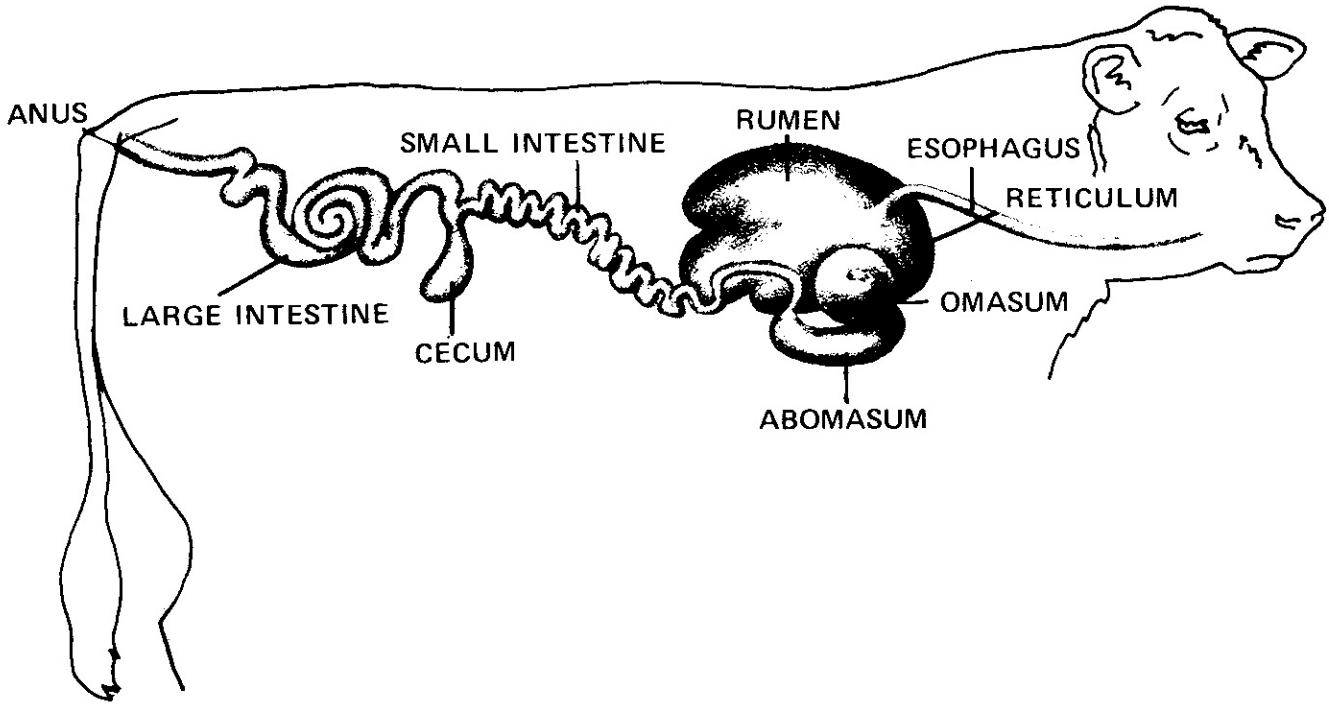
RUMEN FERMENTATION

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

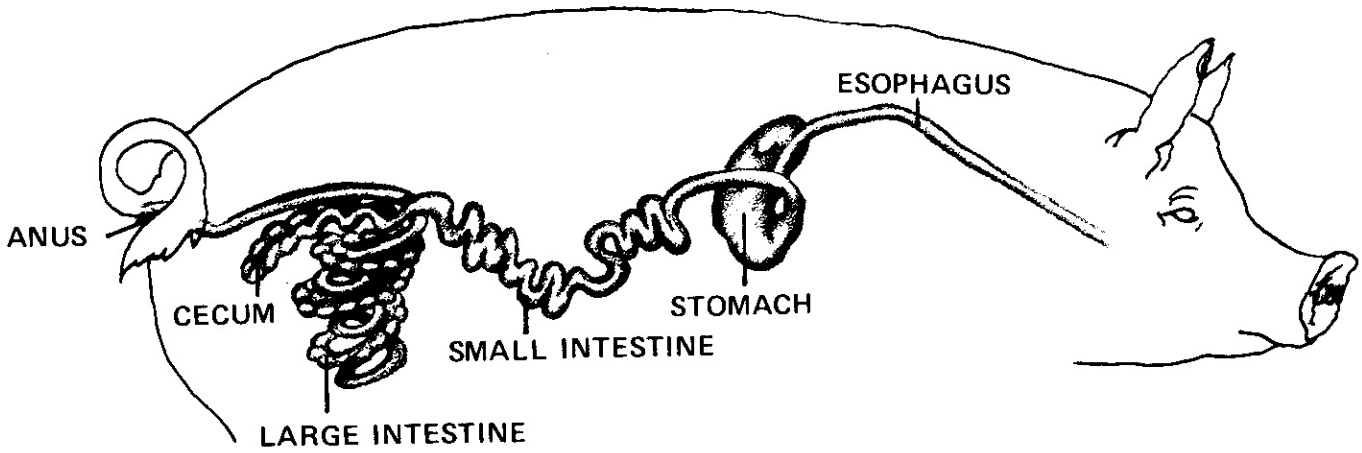
Texas Agricultural Extension Service • Zerle L. Carpenter, Director • The Texas A&M University System • College Station, Texas

FIGURE 1.

RUMINANT DIGESTIVE TRACT



MONOGASTRIC DIGESTIVE TRACT



2

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

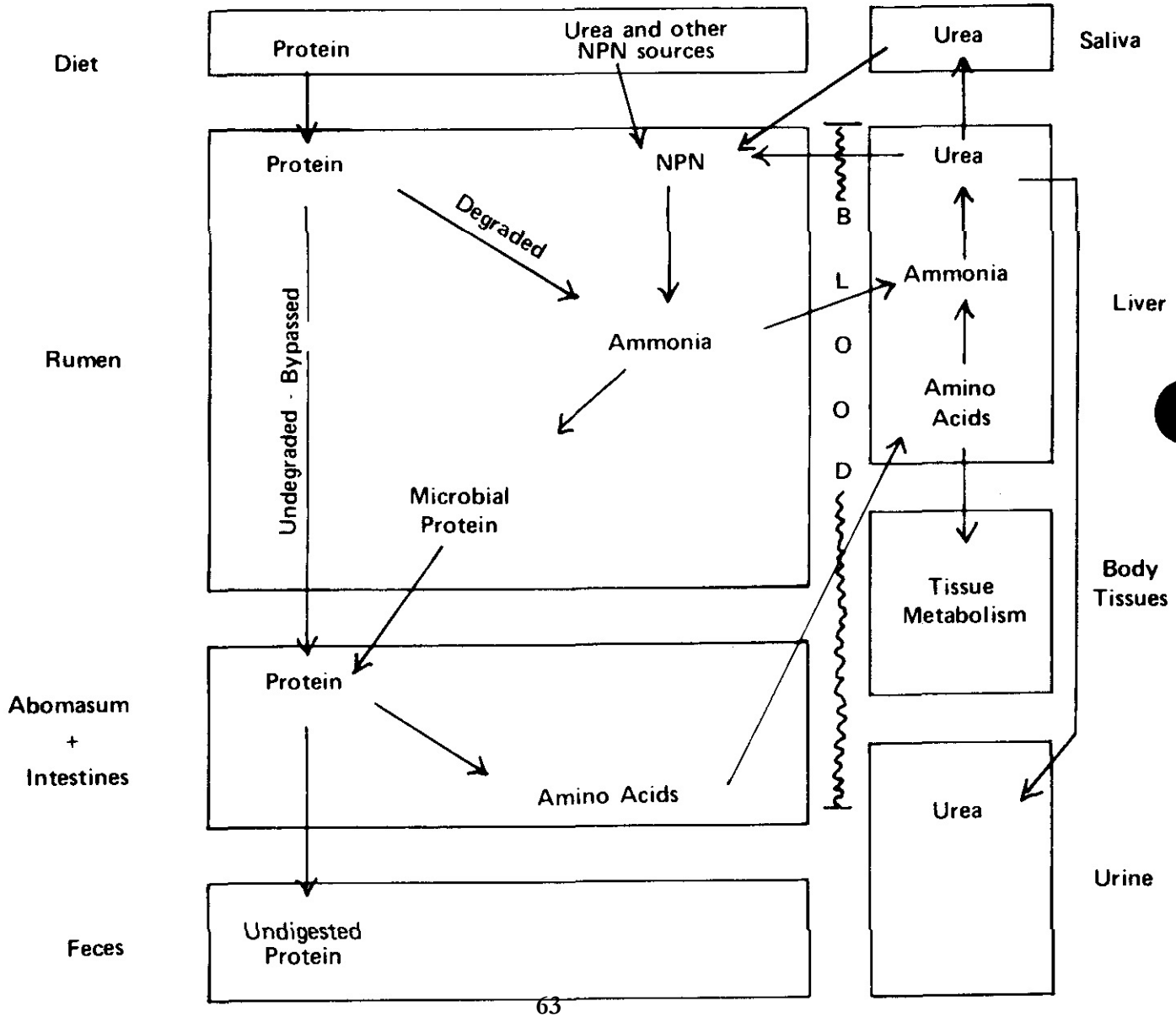


FIGURE 3. DIGESTION AND UTILIZATION OF CARBOHYDRATES

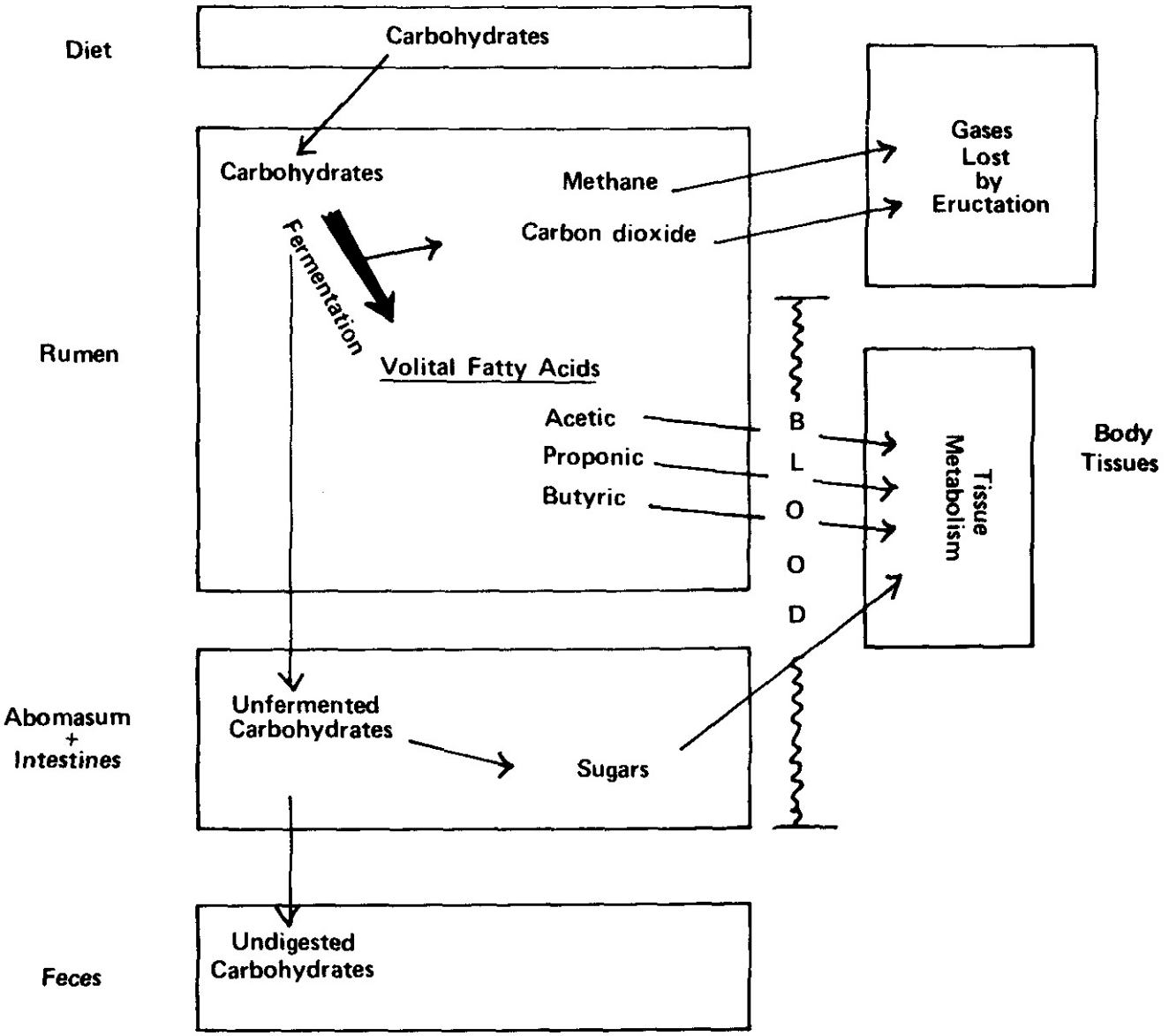
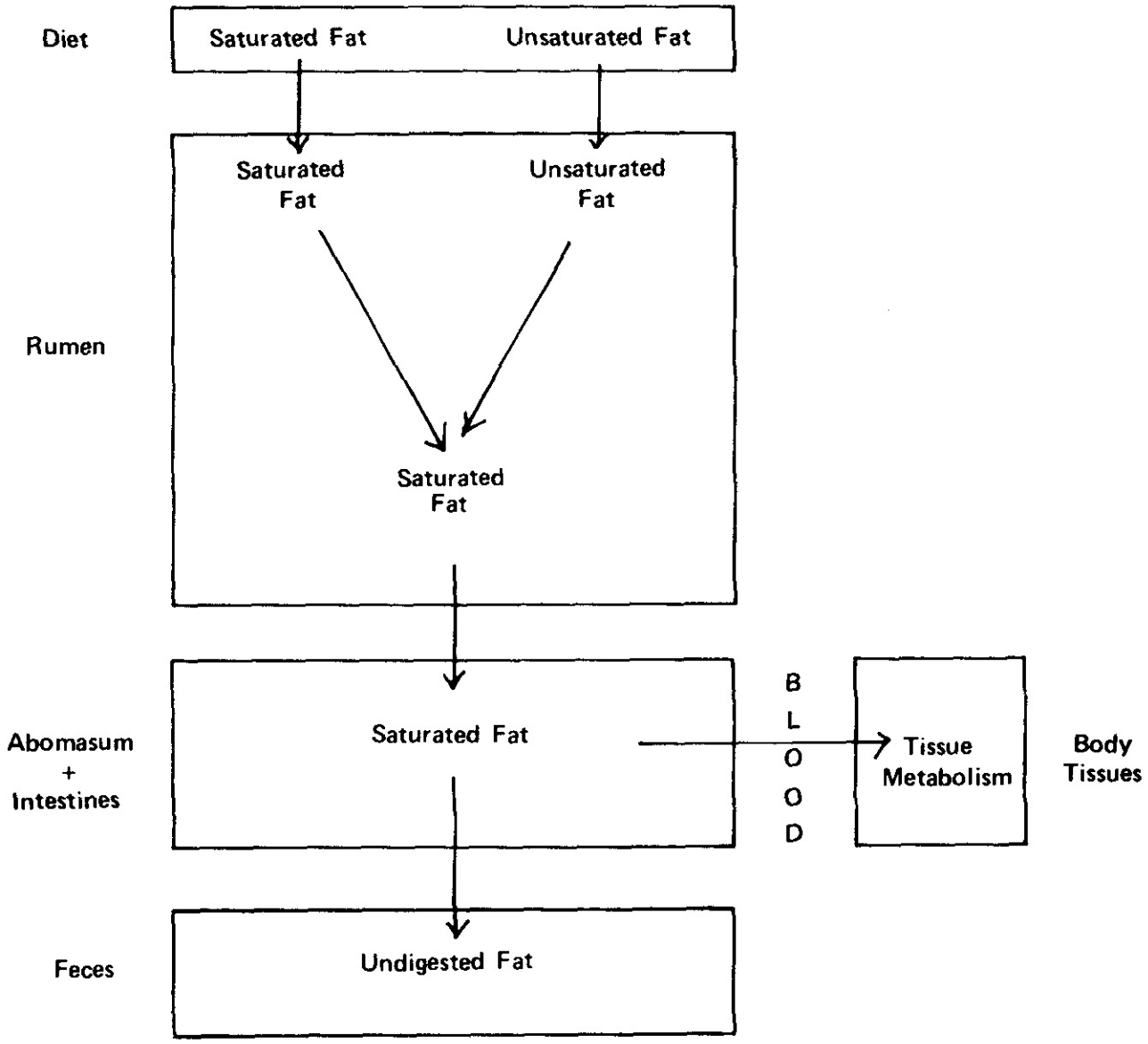


FIGURE 4. DIGESTION AND UTILIZATION OF FAT BY CATTLE



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.

Texas A&M AgriLife Extension

E-192
04/09

Texas Adapted Genetic Strategies for Beef Cattle X:
Frame Score, Frame Size, and Weight

Stephen P. Hammack and Ronald J. Gill*

Body size is an important genetic factor in beef cattle production. Historically, size was first estimated by measurements such as height or length. As scales were developed, weight became more common as a measure of size. Although measurement and weight are related, their rates of maturity differ. By 7 months of age, cattle reach about 80 percent of mature height but only 35 to 45 percent of mature weight. At 12 months, about 90 percent of mature height is reached, compared with only 50 to 60 percent of mature weight.

Frame scores

Beef Improvement Federation (BIF) Frame Scores, a method of estimating skeletal size based on hip height, are shown in Table 1. Frame scores represent differences in height at the same age of about 2 inches. Values in the chart represent averages of thousands of cattle, but individual animals may vary in how they change in height while growing.

Heights should be determined on the topline directly over the hips or hooks (Fig. 1). The most common device for determining height is a measuring stick, available through some livestock supply companies. It consists of a cross-arm (with a bubble level) attached in a 90-degree angle to an upright containing a rule. Figure 2 depicts measuring hip height with such a device.

The chart lists only six scores but may be expanded either way for individuals outside the listed values. Formulas in the chart can be used to calculate scores for animals

*Professor and Extension Beef Cattle Specialist Emeritus, and Professor and Extension Livestock Specialist, The Texas A&M System

Texas Adapted Genetic Strategies

Table 1. Cattle Frame Scores based on hip height in inches[1].

Males[2]							Females						
	Frame Score[3]							Frame Score[3]					
Age in months	3.0	4.0	5.0	6.0	7.0	8.0	Age in months	3.0	4.0	5.0	6.0	7.0	8.0
5	37.5	39.5	41.6	43.6	45.6	47.7	5	37.2	39.3	41.3	43.4	45.5	47.5
6	38.8	40.8	42.9	44.9	46.9	48.9	6	38.2	40.3	42.3	44.4	46.5	48.5
7	40.0	42.1	44.1	46.1	48.1	50.1	7	39.2	41.2	43.3	45.3	47.4	49.4
8	41.2	43.2	45.2	47.2	49.3	51.3	8	40.1	42.1	44.1	46.2	48.2	50.2
9	42.3	44.3	46.3	48.3	50.3	52.3	9	40.9	42.9	44.9	47.0	47.0	51.0
10	43.3	45.3	47.3	49.3	51.3	53.3	10	41.6	43.7	45.7	47.7	49.7	51.7
11	44.2	46.2	48.2	50.2	52.2	54.2	11	42.3	44.3	46.4	48.4	50.4	52.4
12	45.0	47.0	49.0	51.0	53.0	55.0	12	43.0	45.0	47.0	49.0	51.0	53.0
13	45.8	47.8	49.8	51.8	53.8	55.8	13	43.6	45.5	47.5	49.5	51.5	53.5
14	46.5	48.5	50.4	52.4	54.4	56.4	14	44.1	46.1	48.0	50.0	52.0	54.0
15	47.1	49.1	51.1	53.0	55.0	57.0	15	44.5	46.5	48.5	50.5	52.4	54.4
16	47.6	49.6	51.6	53.6	55.6	57.5	16	44.9	46.9	48.9	50.8	52.8	54.8
17	48.1	50.1	52.0	54.0	56.0	58.0	17	45.3	47.2	49.2	51.1	53.1	55.1
18	48.5	50.5	52.4	54.4	56.4	58.4	18	45.6	47.5	49.5	51.4	53.4	55.3
19	48.8	50.8	52.7	54.7	56.7	58.7	19	45.8	47.7	49.7	51.6	53.6	55.5
20	49.1	51.0	53.0	55.0	56.9	58.9	20	46.0	47.9	49.8	51.8	53.7	55.6
21	49.2	51.2	53.2	55.1	57.1	59.1	21	46.1	48.0	50.0	51.9	53.8	55.7
Mature	52.3	54.1	55.9	58.0	60.0	62.0	Mature[4]	48.2	50.0	52.0	53.9	55.8	57.5
Frame Score (5–21 months) = 0.4878 (ht) - 0.0289 (days of age) + .00001947 (days of age)^2 + 0.0000334 (ht) (days of age) - 11.548							Frame Score (5–21 months) = 0.4723 (ht) - 0.0239 (days of age) + 0.0000146 (days of age)^2 + 0.0000759 (ht) (days of age) -11.7086						
Steer slaughter weight[5]	1,000	1,100	1,200	1,300	1400	1,500	Heifer slaughter weight[5]	900	1,000	1,100	1,200	1,300	1,400
Mature bull weight[6]	1,570	1,730	1,890	2,050	2,200	2360	Mature cow weight[7]	1,000	1,100	1,200	1,300	1,400	1,500

[1]Approved by the Beef Improvement Federation.
[2]Steers continue growth longer than bulls, being about ½ to 1 inch taller at 18 to 21 months.
[3]USDA Medium Frame Size is a Frame Score of approximately 4.0 to 5.5.
[4]If calved first at 2 years old. Add 1 inch if calved first at 3 years.
[5]At 0.5 inch fat cover.
[6]At 12 months, bulls weigh 50 to 60% of this mature weight, under most development programs.
[7]Moderate body fatness, cow Body Condition Score 5 (where 1 = extremely thin and 9 = obese; cow weight varies 7% to 8% per condition score and up to 10% for extremes in muscling). For breeding at 14 to 15 months, heifers should weigh 60 to 65% of this mature weight.

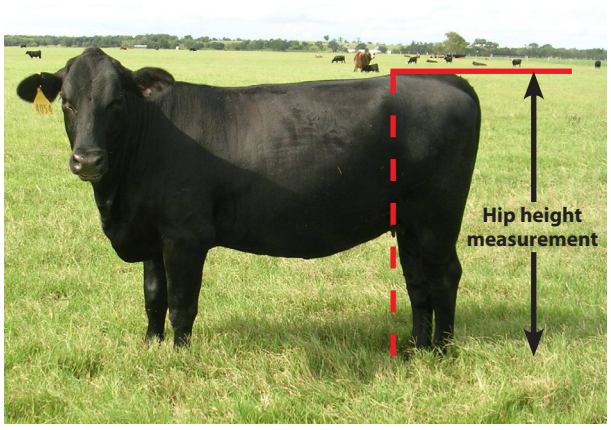


Figure 1. Determine height by measuring to the topline directly over the hip or hooks.

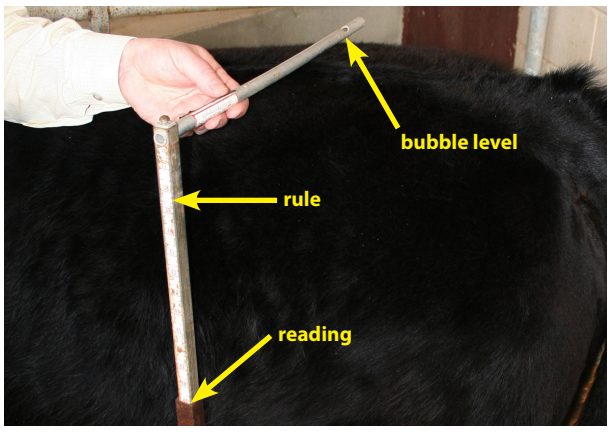


Figure 2. A measuring stick is the most common tool for determining height.

5 to 21 months of age, although 12 months is probably most useful for determining Frame Score. Variation in angularity of skeletal junctions influences height, so Frame Score is not an exact measure of skeletal dimension. But Frame Score is the simplest, most useful method for estimating relative skeletal size.

Frame size

The U. S. Department of Agriculture–Agriculture Marketing Service Standards for Grades of Feeder Cattle include evaluation of frame (skeletal) size, body thickness, and thriftiness (evidence of health). A depiction of Frame Size by the USDA is shown in Figure 3. Frame Size relates to projected weight after finishing to carcass fat cover at the

Figure 3. Frame Size can differ among cattle of the same age.

12th rib of 0.5 inch. According to the standards, Medium Frame steers are projected to finish at 1,100 to 1,250 pounds. Small Frames are projected to finish below that range and Large Frames above. Heifers are projected to finish at 100 pounds less than their genetically equivalent steer mates.

Skeletal size, body weight, and composition

Weight is often used to characterize body size. But a mature cow weighing 1,200 pounds in medium fatness or body condition weighs about 900 pounds when extremely thin and 1,600 pounds when extremely fat. So, if weight is to be used as an accurate measure of size, it must include consideration of body condition.

When Frame Scores were first developed in the 1970s, some guidelines related it to weight. The most common figure was that a finished steer with a Frame Score of 5 (at 0.5 inch fat) weighed 1,200 pounds, with a change of 100 pounds for each variation in Frame Score. The weight of mature cows in medium body condition (those with a Body Condition Score of 5) averages about the same as that of genetically equivalent steers with 0.5 inch fat. Mature bulls weigh about 55 to 60 percent more than cows of the same Frame Score. For a complete discussion of the body condition 1 through 9 scoring system, consult Texas AgriLife Extension publication B-1526, *Body Condition, Nutrition and Reproduction of Beef Cows.*

Research is limited relating Frame Score to weight. Iowa State University reported results on over 4,000 records of females contained in the American Angus Association database. In their analysis, a mature (4- to 7-year-old) cow with mid-5 Frame Score in mid-5 BCS averaged 1,245 pounds. Weight varied about 95 pounds for each Frame Score from 4 to 7.

The U. S. Meat Animal Research Center analyzed data from 5-year-old cows of 12 breed groups ranging from 4 to 6 in Frame Score. Angus cows of mid-5 Frame, mid-5 BCS averaged 1,222 pounds. However, across the entire 12 breed groups, the average was 1,282 pounds, with a range of 113 pounds per Frame Score.

In addition to variation in body condition, muscularity affects weight at a particular Frame Score. As an example, in the Meat Animal Research Center study, mid-5 Frame, mid-5 BCS Limousin weighed 1,365 pounds. Also, cattle can have relatively shorter legs (or longer) in relation to their body size, which affects the relationship of Frame Score and weight.

Overall, mature cows with mid-5 Frame Scores in mid-5 BCS appear to weigh on average about 1,250 pounds (or 1,200 pounds for Frame Score 5.0) with about a 100-pound variation per Frame Score. Since USDA Medium-Frame slaughter steers weigh 1,100 to 1,250 pounds, this equates to Frame Scores of probably low 4 to mid 5. Small-Frame steers weighing 950 to 1,100 pounds are probably mid Frame Score 2 through 3. And Large-Frame steers weighing 1,250 to 1,400 pounds are probably upper Frame Score 5 through 6. Frame Score 7 and higher should probably be called Very Large.

The most useful measure of body size is weight at a particular level of fatness or condition, which also accounts for differences in muscling, a shortcoming of the Frame Score system. Frame Score is perhaps most useful as a **predictor** of future weights at slaughter, puberty, and maturity rather than as a measure of body size.

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* or the Texas A&M Animal Science Extension Web site *http://beef.tamu.edu*.

Texas A&M AgriLife Extension Service
AgriLifeExtension.tamu.edu

More Extension publications can be found at *AgriLifeBookstore.org*

Produced by Texas A&M AgriLife Communications

Beef Calf Preconditioning Programs

Preconditioning programs are implemented around weaning time. Preconditioning typically consists of weaning calves at least 45 days before a sale, training calves to eat feed from a bunk and drink from a water trough, and following an appropriate vaccination program. It should also include castrating bull calves and ensuring that horned cattle are dehorned or tipped back to the hairline (the animals should have time to fully heal).

Effective preconditioning programs increase the value of weaned calves by promoting calf growth, enhancing immune system function, and minimizing calf stress. Demand for preconditioned feeder calves continues to increase in the beef industry. This demand has grown along with the expansion of value-based marketing and information flow.

Preconditioning requires more labor, management, and expense for cow-calf producers. However, it also offers potential advantages, like developing a reputation for high-quality cattle, adding value to home-raised calves, and increasing income through retained ownership. Producers planning to retain ownership of calves through the stocker phase may also benefit from preconditioning management practices.

Markets for Preconditioned Calves

Target Markets

Start by identifying target markets for preconditioned feeder calves. Marketing alternatives may develop over time as a producer's reputation and quality of cattle become more widely known. Some producers develop relationships directly with cattle buyers, while others participate in organized feeder calf marketing efforts with other producers. For more information on feeder calf marketing alternatives, see Extension Publication 2552 *Marketing Feeder Calves*.

Requirements differ among various preconditioned feeder calf sales, and documentation of preconditioning practices may be necessary. It is important to know a program's specific requirements to qualify calves for sale. Acceptable documentation may include herd health product or veterinary invoices or receipts, calf weaning records, and completed certification forms.

Preconditioning program guidelines often include ownership requirements. Often, a producer must have owned a set of calves for a minimum time in order for them to qualify for the program. Individual calf identification is critical for proper record-keeping and can be accomplished in several ways. Unique ear tags are a common form of identification, but because ear tags can be lost, some producers choose to permanently identify cattle using tattoos or brands.

Preconditioning Cost-Effectiveness

Preconditioning requires more time, labor, and expense than traditional weaning programs. It must be profitable so producers will want to retain calves through a preconditioning period. Some producers feel the buyer receives most of the benefits and cow-calf producers are not adequately compensated for the added value. However, Mississippi feeder calf board sale results show that, if cattle are marketed in a way that advertises the management they received, they will bring a premium over the average market price.

Develop a budget before deciding to implement a preconditioning program. Estimate expected costs, returns, and production levels, and then monitor them throughout the preconditioning period. To be profitable, producers must keep cost of gain to a reasonable level while providing a nutritional program that produces acceptable weight gains. A reasonable feed cost of gain must be lower than breakeven feed cost of gain to be profitable.

Manage veterinary and other health costs for profitable preconditioning. The cost-effectiveness of a preconditioning program varies according to market and production conditions. Weight gains alone may not offset feed and overhead cost. In cases where added returns from weight gains alone do not cover preconditioning costs, calves must return an adequate premium at sale for preconditioning to be profitable.

Weaning

Wean calves at least 45 days before a sale or according to the requirements of the specific preconditioning program. Weaning is extremely stressful. Use techniques that minimize calf stress during this time to improve health and growth performance. Stress at weaning can increase the likelihood of calves developing respiratory infections.

Sorting and hauling freshly weaned calves to the sale facility the day before the auction can result in increased shrink compared to preconditioned calves. Preconditioning calves can minimize shrink and add additional sale weight. Additional stress results when calves are introduced to unfamiliar surroundings post-weaning. Give calves access to the weaning area a few days before weaning. Corrals, drylots, or small pastures can serve as weaning facilities. Good fences will prevent calves from returning to their mothers to nurse. Small lots may reduce fence walking or pacing, but dust or mud can become problems in dry or wet conditions.

Fenceline weaning, where calves remain in sight of and close to their mothers, may reduce weaning stress. Cows will graze close to their calves, gradually moving farther away during the days after weaning. One weaning technique involves initial nose-to-nose contact between cows and calves, followed by gradual increases in separation distance by moving electrified wires or tapes farther from each side. Train cattle to respect electric fencing before weaning to facilitate the process.

Fenceline weaning also allows high-quality pastures to be used as weaning facilities instead of dusty drylots. Allow calves to creep-graze into these high-quality pastures before weaning to give them time to become familiar with their surroundings. Close the creep gate at weaning. Fenceline contact with dams minimizes losses in weight gain in the days following separation. Calves totally and abruptly separated from their dams do not compensate for losses in weight gain even by 10 weeks post-weaning. Properly weaned calves are "bawled out" and readily consuming feed and water well before the preconditioning period ends.

Preconditioning Nutrition Programs

The profitability of a preconditioning program depends largely on calf weight gains during the preconditioning period. The nutrition program makes up the majority of the preconditioning budget, and adequate weight gains are needed to recover these costs. Producers must choose the nutritional approach that best meets rate of gain and budget targets. Decisions on a desired rate of gain might involve:

- achieving delivery weight targets
- optimizing cattle condition
- minimizing digestive disorders and disease risk
- obtaining reasonable cost of gain
- marketing home-raised feedstuffs through the preconditioning program
- optimizing labor and equipment investment

Rate of gain falls into general categories: low average daily gains (less than 1.5 pound per day), moderate average daily gains (1.5 to 2.5 pounds per day), or high average daily gains (greater than 2.5 pounds per day). A low rate of gain may be desired when cattle will enter stockering programs with low levels of nutrition or where potential buyers may discount overly fleshy calves. When cattle are destined for high-quality pasture or feedlot programs, higher rates of gain may be appropriate.

Calves typically lose weight in the first week after weaning but will often regain that weight within 2 weeks. Health, stress, previous nutrition, diet composition and quality, feed additives, and implants impact weight gains. The benefits of a concentrate (grain-based) feeding program include:

- supplies calves with the needed dietary nutrient density
- facilitates delivery of feed additives such as ionophores and coccidiostats
- teaches eating from a feed bunk
- makes health monitoring easier

Feeding at least once daily forces producers to observe cattle often and may help identify cattle feeding behaviors that indicate health problems, such as sudden changes in appetite or reluctance to feed.

Preconditioning feeds need to be highly palatable and nutrient-dense with minimal fines and dust. Familiarity with specific feedstuffs or exposure to feeds before weaning (creep feeding) can encourage consumption. These feeds should contain protein from natural sources and adequate amounts of key minerals and vitamins including copper, zinc, selenium, potassium, and vitamin E.

An effective nutritional program provides a desirable level of growth performance during the preconditioning period. Consider feedstuff availability and cost when developing feed supplementation programs. Design economical nutrition programs around forage systems. Forage nutrient analysis is critical for determining forage quality and matching a supplementation program to the forage program. Using forage nutrient analysis results to balance a diet helps ensure that calf nutrient needs will be met.

Design supplementation programs to target specified levels of weight gain. Because nutrient requirements change with increasing body weight, measure weights throughout the preconditioning period to accurately estimate nutrient requirements. Calves weighing less than 400 pounds warrant special feeding considerations.

Feed Bunk and Water Trough Training

During weaning, calves must transition from a milk diet to forage- and concentrate-based diets. Calves that have used feeding bunks and water troughs before weaning may go on feed faster after weaning. Some calves leave the ranch having never seen a feed bunk or water trough.

Take specific steps to train calves to use a feed bunk or watering trough.

- Remove water until calves fill up on hay.
- Cattle may drink faster if they can hear the water, so use a temporary drip system.
- Small troughs that are frequently refilled with cool, clean water are often more attractive to calves during hot weather than larger troughs containing warmer water.
- Position feed bunks perpendicular to fence lines so calves will find the feed bunk faster when they walk the fence.
- Make feed bunks and water troughs highly visible and accessible.
- Provide adequate bunk space (at least 18 to 24 linear inches per head) to prevent crowding.
- Give calves access to clean water and adequate mineral supplements at all times.

Weigh feed to ensure accurate feed offerings. To keep cattle consuming consistent feed quantities each day, do not increase feed until feed bunks are completely emptied 2 days in a row. Likewise, do not decrease the feed amount unless 25 percent or more of the feed remains. Never increase or decrease the feeding amount by more than 10 percent at once. Feed cattle and observe feed bunks at the same time each day for accurate bunk management.

Management Practices to Improve Calf Value

Calf Uniformity

Using a controlled calving season results in calves of similar age at preconditioning time. This also facilitates the feeding program. Groups and load lots of uniform calves command market premiums by reducing transaction expenses for buyers to fill orders. Age of the calf is not the only factor in uniformity. Also consider weight, frame size, sex, and hide color.

Uniform calf age also can make it easier to age-, source-, and process-verify a group. Age-, source-, and process-verification require a third-party evaluation of herd records such as calving dates, tagging procedures, and management and production records. This verification is required for some export markets. Verified cattle sometimes bring premiums because they are competing in smaller markets and have a higher demand.

Castration

Although bulls typically gain faster than steers, most feeders are not interested in feeding bulls. Steers with growth implants typically produce gains similar to those of intact bulls. Castration reduces behavioral problems and prevents unwanted pregnancies in post-weaning production programs. If weaned bull calves are sold, the cow-calf producer pays the next owner to castrate the calves via discounts for intact bull calves. According to a 2005 Arkansas livestock auction survey, bulls were discounted $6.27 per hundredweight on average compared to steers. A 2009 USDA NAHMS survey of cow-calf management practices revealed that 25.5 percent of operations did not castrate bull calves before they were sold.

Castration becomes increasingly stressful as bulls get older. Younger bulls experience less bleeding, infection, and weight-gain depression than older bulls. Calves castrated later in life may exhibit an undesirable “staggy” appearance. Seedstock producers often wait until weaning to decide which bull calves to castrate and which to develop as future breeding stock.

In a commercial cow-calf operation, castrate bull calves as early in a calf’s life as possible. Restraining and handling younger calves is easier than working older, larger bulls. An ideal time to castrate nursing bull calves is during the first 36 hours of life.

Many producers prefer to wait and castrate large groups of calves at once. In this case, all calves should be castrated at 3 months of age or earlier. To reduce infection risk, avoid castration during fly season and on wet days when the calf may lie in mud. Table 1 lists various castration methods, and Figure 1 shows castration equipment.

Dehorning

Cattle buyers discount calves with horns. Results from a 2005 Arkansas livestock market survey indicate that polled or dehorned feeder calves sold for an average of $3.70 per hundredweight more than horned cattle. Horn-related injuries may occur during shipping and in the feedlot, so cattle feeders prefer dehorned calves.

Table 1. Calf castration options.

Castration Method	Instruments	Procedure	Advantages	Disadvantages
Surgical	Newberry knife, scalpel, emasculator	Open the skin of the scrotum with large incisions or removal of the bottom third of the scrotum to promote adequate drainage. Grasp and slowly pull the testicles downward until the spermatic cord muscle separates. Do not "dig" for the testicles. In young calves, pull out the testicles until the cord breaks. In older calves, use emasculators to crush the spermatic cord or a dull knife to scrape the cord in a shaving motion. Do not cut the cord, because excessive bleeding may occur. Treat wounds with fly repellant. Release surgically castrated calves to a clean, dry area.	Certainty of complete castration	Blood loss Infections may result if there are drainage problems or irritation from flies. Slower to perform than banding
Emasculatome	Burdizzo, clamps	Move one testicle to the bottom of the scrotum. Locate the spermatic cord above the testicle, and move it to the side of the scrotum. Place the emasculatome over the cord about two inches above the testicle. Pinch the spermatic cord through the skin of the scrotum. The instrument should be one-third of the way across the width of the scrotum and never across the middle of the scrotum. The cord should snap apart. Hold the instrument with jaws closed for 30 seconds. Double clamping can increase success rate.	Bloodless Used for older, larger calves	Slow, difficult Sometimes unreliable (stags) Emasculatomes eventually wear out and become ineffective. Do not store an emasculatome in the closed position.
Banding	Elastrators, EZE, Callicrate banders	Place the band on the instrument and press the handles to stretch the band. Hold with the prongs pointed upward. Close the handles to open the band. Slip the band up and over the scrotum. Make sure both testicles are below the band. Allow the band to close on the neck of the scrotum. Pull the instrument out from under the band. Repeat if not done correctly. Administer tetanus and blackleg shots well before banding.	Bloodless Used for older, larger calves Easy to perform; newer banders adjust bands to proper tension levels	Potential for missed testicles Band may break or not cut off all circulation to testicles Infections (tetanus, Clostridial)

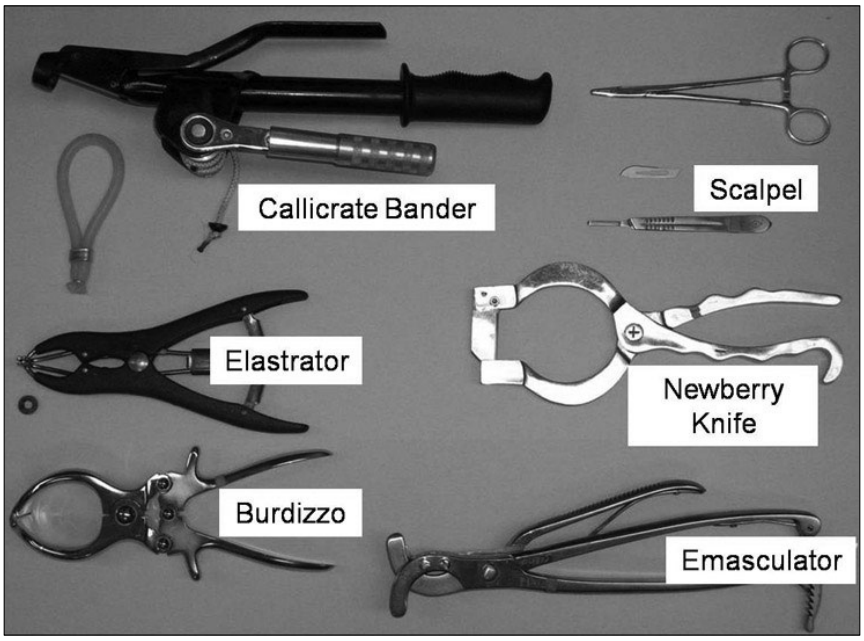


Figure 1. Castration tools.

A 2009 USDA NAHMS survey of cow-calf management practices determined that only 49.7 percent of horned calves in the Southeast United States were dehorned before being sold. The national average was 61.1 percent. The average age for dehorning was 130 days. Results of the 2005 National Beef Quality Audit indicate that 22.3 percent of cattle evaluated on the harvest floor had horns, down from 32.2 percent in 1995.

One way to produce calves without horns is to use a homozygous polled herd sire. Several options are also available for physically removing horns from cattle (Table 2). Dehorning methods differ by animal age and stage of horn development. Horn tissue is formed in specialized cells in a small ring around the horn button. Perform bloodless dehorning methods before significant horn growth to destroy this ring of cells.

Mechanical dehorning can be performed at any age or animal size. It involves physically removing the horn, along with a small ring of skin surrounding it. Minimize stress and complications by dehorning at a young age, preferably younger than 1 month.

Use sharp, disinfected dehorning instruments when dehorning adult cattle (Figure 2). Because damaged bone tissue may be more susceptible to infection, cut bone tissue rather than crushing it. Problems with infection are rare, except in situations where dehorning leaves an opening into the sinuses.

Use disinfectants on dehorning instruments to prevent wound infections and the spread of infectious diseases. Dehorn outside of fly season to reduce infection. Treat wounds with blood coagulant powder and fly deterrent.

As with castration, ensure that calves are properly restrained for physical dehorning. Dehorning requirements for preconditioning programs may involve complete dehorning or only tipping horns back to the hairline. In either case, dehorned calves should be fully healed before shipment.

Table 2. Calf dehorning options.

Dehorning Method	Procedure	Advantages	Disadvantages
Chemical	Apply caustic paste to horn button at 1 day to 3 weeks of age. Cut hair from around horn button before application. Apply petroleum jelly around the area of caustic paste application to minimize chemical burns. Keep the calf separated from its dam until the paste has dried.	Works well on young calves Bloodless	Caustic paste application before a rain can cause eye injury
Hot iron	Heat irons with fire or electricity. Place hot iron over the horn and hold in place with firm pressure. Twist the iron evenly to distribute heat. Apply long enough (usually 20 seconds) to kill all horn cells at the base. The skin should appear copper or bronze. If not, reapply for 10 seconds.	May use after the horn button appears up to 4 months of age Works best in calves younger than 2 months of age with less than 1 inch of horn growth Bloodless	Must be done when calves are young and horns are small
Tube or spoon dehorners	Cut around the horn and surrounding skin and scoop out.	Effective on very small horns less than 1½ inch long Multiple intstrument sizes available	Not bloodless
Barnes dehorners	Select an instrument size large enough to remove the horn and a ¼- to ½-inch circle of skin at the horn base. Press the instrument firmly against the calf's head. Quickly open and twist the handles. Stop any bleeding by cauterizing with a hot iron or pulling arteries with forceps.	May use on calves up to or slightly past weaning Multiple instrument sizes available	Not bloodless
Saws, wires, keystone dehorners	Remove a ½-inch circle of skin along with the horn base to prevent regrowth. Stop any bleeding by cauterizing with a hot iron, pulling arteries with forceps, or using coagulant powder. Observe the wound for infection for an extended period of time.	For use in older cattle with large horns	Not bloodless Exposed sinus may become infected

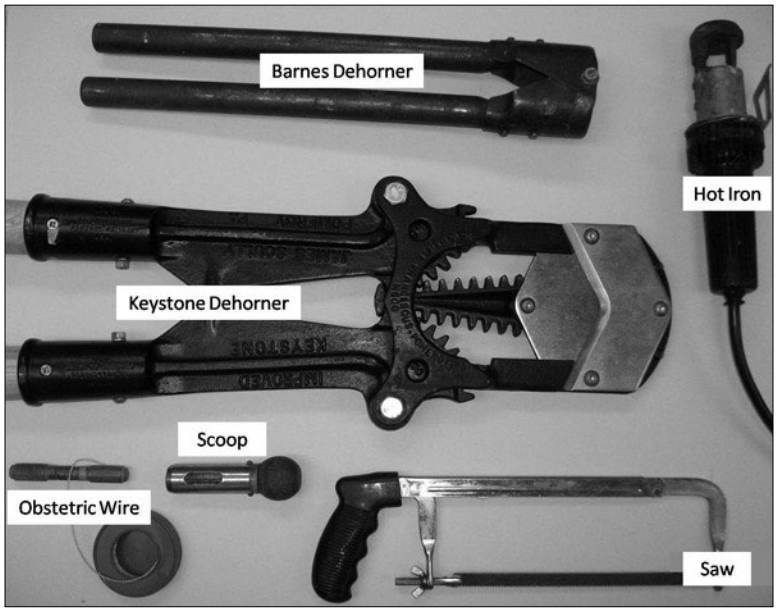


Figure 2. Dehorning tools.

Preconditioning Health Programs

Value to Cattle Buyers

Preconditioned calves have fewer post-weaning health problems. Data from the Mississippi Farm to Feedlot Program and similar programs in surrounding states demonstrate the dramatic effects of health and medicine costs on cattle finishing profitability. Mississippi Farm to Feedlot Program results indicate that sickness in the feedlot reduces a calf's ability to grade USDA Choice.

A 2001 USDA-APHIS study of U.S. feedlots with at least a 1,000-animal capacity found 14.4 percent of cattle were affected with bovine respiratory disease. The associated treatment cost was estimated at $12.59 per animal. In a 2007 survey, APHIS reported that 60 percent of cow-calf operations did not vaccinate calves for respiratory disease before selling them.

Certain buyers are willing to pay premiums for preconditioned calves. This is because they understand the extra cost of a preconditioned calf may be more than offset by reduced sickness, lower medicine costs, decreased labor requirements, improved performance, and enhanced beef quality. Three years of data on 56,000 head of calves sold in the Oklahoma Quality Beef Network program (with known health and preconditioning protocols) demonstrate buyers' willingness to pay $5.85 more for preconditioned calves. More recent marketing programs in Mississippi (the Homeplace Producers' and Cattlemen's Exchange board sales) also demonstrate a significant increase in the value of preconditioned feeder calves sold in truckload lots.

Vaccinations

If the chosen market outlet does not specify a vaccination program, consult with a veterinarian to design a preconditioning vaccination protocol. Some producers choose to vaccinate calves 2 to 4 weeks before weaning and administer booster injections at weaning. Other producers administer the first vaccines at weaning with boosters administered 2 to 4 weeks after the initial injections. Some vaccines can be purchased in combination to reduce the number of injections.

Know the required vaccination protocol and specifications of the targeted preconditioning sale. Many preconditioned calf sales require individual identification. Many also require a licensed veterinarian's certification of health and vaccination program. Some will accept certification through receipts for animal health products along with producer affidavits. Some sales may require heifers to be vaccinated against bruscellosis (Bang's or calfhood vaccinations).

Parasite Control

Treat calves with a deworming product to manage parasite loads. Ideally, treat for internal and external parasites at the same time. Many pour-on and injectable products will treat internal parasites as well as lice, mange mites, and horn flies.

Beef Quality Assurance Training

The Mississippi Beef Quality Assurance (BQA) program educates producers about breeding and management factors that affect beef quality. Many producers promote BQA certification when marketing their calves. While BQA certification may not be a requirement of some preconditioned sales, it can add value to calves. The Mississippi BQA certification process is voluntary and certifies cattle producers instead of individual animals.

Summary

Preconditioned feeder calves should be healthy, adapted to feed and water, castrated, dehorned, and ready to start eating and gaining weight when they arrive at the stocker operation or feedlot. Properly preconditioned calves may command a premium that more than pays for the cost of the preconditioning program. Yet under certain conditions, preconditioning may not be cost-effective.

Management strategies can improve the chances for profitable preconditioning. These include the following:

- dehorning and castrating at a young age instead of near weaning
- minimizing weaning stress
- getting calves onto feed and water rapidly
- implementing effective and economical nutrition and herd health programs

Although cost-effectiveness of preconditioning varies with market fluctuations and input costs, the potential benefits to the cattle buyer remain. Know what it costs to precondition a set of calves to determine if preconditioning is an attractive marketing option.

A successful preconditioning program maintains a reasonable cost of gain and utilizes a market that is willing to pay for the added value. These management techniques can increase calf value and are vital to an effective preconditioning program:

- Limit stress at weaning by effectively managing castration, dehorning, and weaning strategies.
- Develop a nutritional program based around on-farm forage resources targeting a desired rate of gain at a sensible cost.
- Implement proper vaccination and other herd heath management practices.

For more information on calf preconditioning or related topics, contact your local MSU Extension office.

References

APHIS. 2001. *Treatment of respiratory disease in U.S. feedlots*. October 2001 Information Sheet. Animal and Plant Health Inspection Service. United States Department of Agriculture. Fort Collins, CO.

Barham, B. L., & Troxel, T. R. (2005). Factors affecting the selling price of feeder cattle sold at Arkansas livestock auctions in 2005. *Journal of Animal Science*, *85*, 3434–3441.

Barnes, K., Smith, S., & Lalman, D. (1999). *Managing shrink and weighing conditions in beef cattle*. Oklahoma Cooperative Extension Service. F-3257. Stillwater, OK.

Lalman, D., Gill, D., Highfill, G., Wallace, J., Barnes, K., Strasia, C., & LeValley, B. (2002). *Nutrition and management considerations for preconditioning home raised beef calves*. Oklahoma Cooperative Extension Service. F-3031. Stillwater, OK.

NAHMS. (2009). *Reference of beef cow-calf management practices in the United States, 2007–08*. National Animal Health Monitoring System. Veterinary Services, Animal and Plant Health Inspection Service. United States Department of Agriculture.

NCBA. (2005). *National beef quality audit*. National Cattlemen's Beef Association. Denver, CO.

Pate, F. M., & Crockett, J. R. (2002). *Value of preconditioning beef calves*. University of Florida Extension. Institute of Food and Agricultural Sciences. Bulletin 799. Gainesville, FL.

Price, E. O., Harris, J. E., Borgwardt, R. E., Sween, M. L., & Connor, J. M. (2003). Fenceline contact of beef calves with their dams at weaning reduces the negative effects of separation on behavior and growth rate. *Journal of Animal Science*, *81*, 116–121.

Yates, W. D. G. (1982). A review of infectious bovine rhinotracheitis, shipping fever pneumonia, and viral-bacterial synergism in respiratory disease of cattle. *Canadian Journal of Comparative Medicine*, *46*, 225.

Publication 2578 (POD-12-20)

Reviewed by **Brandi Karisch**, PhD, Associate Extension/Research Professor, Animal and Dairy Sciences. Written byy **Jane A. Parish,** PhD, Professor and Head and Interim Head, North Mississippi Research and Extension Center; **Justin D. Rhinehart,** former Assistant Extension Professor, Animal and Dairy Sciences; and **Holly T. Boland**, former Assistant Research/Extension Professor, Prairie Research Unit.

Texas Agricultural Extension Service
The Texas A&M University System

L-2291
4-98

Implanting beef calves and stocker cattle

F.T. McCollum III
Extension Beef Cattle Specialist
The Texas A&M University System

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.

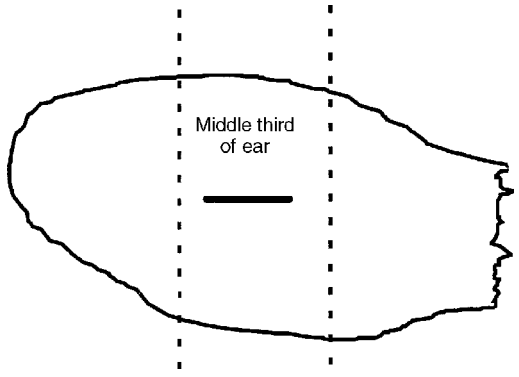


Figure 1. Proper implant placement on the backside of the ear.

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.

References

Kuhl, Gerry L. 1997. Stocker cattle responses to implants. pp. 51-62. In: Symposium: Impact of implants on performance and carcass value of beef cattle. Oklahoma Agricultural Experiment Station P-957.

Preston, R.L. 1997. Rationale for the safety of implants. pp. 199-203. In: Symposium: Impact of implants on performance and carcass value of beef cattle. Oklahoma Agricultural Experiment Station P-957.

Selk, Glenn. 1997. Implants for suckling steer and heifer calves and potential replacement heifers. pp. 40-50. In: Symposium: Impact of implants on performance and carcass value of beef cattle. Oklahoma Agricultural Experiment Station P-957.

Produced by Agricultural Communications, The Texas A&M University System

Issued in furtherance of Cooperative Extension Work in Agricultural and Home Economics, Acts of Congress of May 8, 1914, as amended, and June 30, 1914, in cooperation with the United States Department of Agriculture. Edward A. Hiler, Interim Director, Texas Agricultural Extension Service, The Texas A&M University System.

10,000 copies—Revised AS

Growth-Promoting Implants for Beef Cattle

Growth-promoting implants offer beef cattle producers a safe and effective way to increase calf weight gains. Implants increase production of muscle tissue and often reduce body fat production. This results in significant improvements in both growth rate and feed efficiency. Despite the proven benefits of implant use, only 11.9 percent of beef cattle operations surveyed by the National Animal Health Monitoring Service (NAHMS) implanted calves before or at weaning.

When used properly, growth-stimulating implants can enhance average daily gain in suckling calves by 4 to 8 percent, in growing calves by 10 to 20 percent, and in finishing cattle by 15 percent. In addition, feed efficiency is expected to improve by 6 to 8 percent in growing cattle and by 8 to 10 percent in finishing cattle.

Adequate nutrition is needed for an implant to enhance calf growth performance. Implants will not make up for poor nutrition. Calf gains must be at least 1.3 pounds per day for implants to be effective at improving growth. Expected return on investment for implant use under proper management is often 10 to 1.

Implants are available for sucking, stockering, and finishing phases of beef cattle production. While implanting may be beneficial for an individual production phase, it is important to consider implant impacts on later production phases, particularly with respect to marketing and retained ownership. Implant effects on quality grade and palatability of the end product must be considered. In some instances, aggressive implanting protocols can reduce quality grade of beef end products. Responsible and strategic implanting programs can make best use of implants while maintaining acceptable end-product quality. For instance, altering the timing of implant administration in relation to harvest can reduce the effects of implanting on quality grade.

Available Implants

The U. S. Food and Drug Administration (FDA) approves and regulates the use of growth-promoting implants for beef cattle. Implants should be administered only in the FDA-approved location in beef cattle, which is between the skin and cartilage in the middle one-third of the backside of the ear.

Implants are typically small pellets impregnated with specific growth promotants. Some implants also contain an antimicrobial, such as oxytetracycline or tylosin tartrate, to provide a local antibacterial effect. Implants are designed for sustained, slow release of the active ingredients and are administered under the skin (subcutaneously) on the backside of the ear midway between the ear tip and base.

Implants can be classified as either estrogenic (hormones affecting female characteristics) or androgenic (hormones affecting male characteristics), based on the specific growth promotants contained in the implants. Estradiol, progesterone, and zeranol are estrogenic. Androgenic implants often contain trenbolate acetate (TBA), which is chemically related to testosterone, alone or in combination with other active ingredients. Using only TBA in the final implant in feedlot cattle may reduce risk of animal health or carcass problems. When more than one implant was used, feedlots surveyed by NAHMS administered an androgenic implant as their final implant to most feedlot cattle.

Table 1. Currently approved implants for sucking beef calves and stocker cattle in the United States.[1]

Commercial Product Name	Marketer	Active Ingredient(s)	Target Animal(s)	Claim
SYNOVEX® C	Pfizer Animal Health	100 mg progesterone 10 mg estradiol benzoate	Suckling beef calves up to 400 pounds; steers weighing more than 400 pounds and fed in confinement for slaughter when used as part of a re-implant program in which an initial Synovex C implant is followed at approximately 70 days by Synovex S; not for use in veal calves, calves less than 45 days old, or bull calves intended for reproduction	Increase rate of weight gain
SYNOVEX® S	Pfizer Animal Health	200 mg progesterone 20 mg estradiol benzoate	Steers weighing 400 pounds or more; for use in steers only; not for use in veal calves	Increase rate of weight gain and improve feed efficiency
SYNOVEX® H	Pfizer Animal Health	200 mg testosterone priopionate 20 mg estradiol benzoate	Nonreplacement heifers weighing 400 pounds or more; for use in heifers only; not for use in veal calves	Increase rate of weight gain and improve feed efficiency
SYNOVEX® CHOICE	Pfizer Animal Health	100 mg trenbolate acetate 14 mg estradiol benzoate	Steers fed in confinement for slaughter; for use in calf-fed and yearling feeding programs; not for use in veal calves	Increase rate of weight gain
SYNOVEX® Plus™	Pfizer Animal Health	200 mg trenbolate acetate 28 mg estradiol benzoate	Steers and heifers fed in confinement for slaughter; not for use in veal calves	Increase rate of weight gain and improve feed efficiency in steers; increase rate of weight gain in heifers
RALGRO®	Intervet/ Schering-Plough Animal Health	36 mg zeranol	Suckling beef calves, including replacement heifers between 1 month of age and weaning, weaned beef calves, growing beef cattle, feedlot steers, and feedlot heifers; not for use in breeding herd replacements or lactating dairy cattle	Increase rate of weight gain and improve feed efficiency
RALGRO® MAGNUM™	Intervet/ Schering-Plough Animal Health	72 mg zeranol	Steers fed in confinement for slaughter	Increase rate of weight gain and improve feed efficiency
REVALOR®-200	Intervet/ Schering-Plough Animal Health	200 mg trenbolate acetate 20 mg estradiol	Steers fed in confinement for slaughter; not for use in breeding herd replacements or lactating dairy cattle; not for use in veal calves	Increase rate of weight gain and improve feed efficiency
REVALOR®-G	Intervet/ Schering-Plough Animal Health	40 mg trenbolate acetate 8 mg estradiol	Pasture cattle, including slaughter, stocker, and feeder steers and heifers; not for use in breeding herd replacements or lactating dairy cattle; not for use in veal calves	Increase rate of weight gain
REVALOR®-H	Intervet/ Schering-Plough Animal Health	140 mg trenbolate acetate 14 mg estradiol	Heifers fed in confinement for slaughter; not for use in breeding herd replacements or lactating dairy cattle; not for use in veal calves	Increase rate of weight gain and improve feed efficiency
REVALOR®-IH	Intervet/ Schering-Plough Animal Health	80 mg trenbolate acetate 8 mg estradiol	Heifers fed in confinement for slaughter; not for use in breeding herd replacements or lactating dairy cattle; not for use in veal calves	Increase rate of weight gain

REVALOR®-IS	Intervet/ Schering-Plough Animal Health	80 mg trenbolate acetate 16 mg estradiol	Steers fed in confinement for slaughter; not for use in breeding herd replacements or lactating dairy cattle; not for use in veal calves	Increase rate of weight gain and improve feed efficiency
REVALOR®-S	Intervet/ Schering-Plough Animal Health	120 trenbolate acetate 24 mg estradiol	Steers fed in confinement for slaughter; not for use in breeding herd replacements or lactating dairy cattle; not for use in veal calves	Increase rate of weight gain and improve feed efficiency
REVALOR®-XS	Intervet/ Schering-Plough Animal Health	200 trenbolate acetate 40 mg estradiol	Steers fed in confinement for slaughter; not for use in breeding herd replacements or lactating dairy cattle; not for use in veal calves	Increase rate of weight gain and improve feed efficiency for up to 200 days
FINAPLIX®-H	Intervet/ Schering-Plough Animal Health	200 mg trenbolone	Heifers fed in confinement for slaughter; not for use in breeding herd replacements or lactating dairy cattle; not for use in veal calves	Increase rate of weight gain and improve feed efficiency
COMPUDOSE®	Elanco Animal Health	25.7 mg estradiol 0.5 mg oxytetracycline	Suckling and pastured growing steers; finishing steers and heifers; not for use in breeding herd replacements; not for use in veal calves	Increase rate of weight gain in suckling and pastured growing steers; increase rate of weight gain and improve feed efficiency in confined steers and heifers; effective daily dose of estradiol for at least 200 days
ENCORE®	Elanco Animal Health	43.9 mg estradiol 0.5 mg oxytetracycline	Suckling and pastured growing steers; finishing steers and heifers; not for use in breeding herd replacements or dairy animals; not for use in veal calves	Increase rate of weight gain in suckling and pastured growing steers; increase rate of weight gain and improve feed efficiency in confined steers and heifers; effective daily dose of estradiol for at least 400 days
COMPONENT® E-C[2]	Elanco Animal Health	100 mg progesterone USP 10 mg estradiol benzoate	Suckling beef calves up to 400 pounds; not for use in breeding herd replacements; not for use in veal calves, calves less than 45 days old, or bull calves intended for reproduction	Increase rate of weight gain
COMPONENT ® E-H[2]	Elanco Animal Health	200 mg testosterone propionate USP 20 mg estradiol benzoate	Heifers weighing 400 pounds or more; not for use in breeding herd replacements or dairy animals; not for use in veal calves	Increase rate of weight gain and improve feed efficiency
COMPONENT® E-S[2]	Elanco Animal Health	200 mg progesterone USP 20 mg estradiol benzoate	Steers weighing 400 pounds or more; not for use in breeding herd replacements or dairy animals; not for use in veal calves	Increase rate of weight gain and improve feed efficiency
COMPONENT® TE-G[2]	Elanco Animal Health	40 mg trenbolate acetate 8 mg estradiol USP	Pasture cattle including slaughter, stocker, and feeder steers and heifers; not for use in breeding herd replacements or dairy animals; not for use in veal calves	Increase rate of weight gain
COMPONENT® TE-H[2]	Elanco Animal Health	140 mg trenbolate acetate 14 mg estradiol USP	Heifers fed in confinement for slaughter; not for use in breeding herd replacements or dairy animals; not for use in veal calves	Increase rate of weight gain and improve feed efficiency
COMPONENT® TE-IH[2]	Elanco Animal Health	80 mg trenbolate acetate 8 mg estradiol	Heifers fed in confinement for slaughter; not for use in breeding herd replacements or dairy animals; not for use in veal calves	Increase rate of weight gain

COMPONENT® TE-S[2]	Elanco Animal Health	120 mg trenbolate acetate 24 mg estradiol	Steers fed in confinement for slaughter; not for use in breeding herd replacements or dairy animals; not for use in veal calves	Increase rate of weight gain and improve feed efficiency
COMPONENT® TE-IS[2]	Elanco Animal Health	80 mg trenbolate acetate 16 mg estradiol	Steers fed in confinement for slaughter; not for use in breeding herd replacements or dairy animals; not for use in veal calves	Increase rate of weight gain and improve feed efficiency
COMPONENT® T-H[2]	Elanco Animal Health	200 mg trenbolate acetate	Feedlot heifers; not for use in breeding herd replacements or dairy animals; not for use in veal calves	Increase rate of weight gain and improve feed efficiency
COMPONENT® TE-200[2]	Elanco Animal Health	200 mg trenbolate acetate 20 mg estradiol	Steers and heifers fed in confinement for slaughter; not for use in breeding herd replacements or dairy animals; not for use in veal calves	Increase rate of weight gain and improve feed efficiency

[1]U.S. Food and Drug Administration approved as of April 2011.
[2]Available with 29 mg Tylan®, tylosin tartrate, as a local antibacterial.

Situations Where Implant Use Is Not Appropriate

As a general rule, do not implant breeding cattle, including bull and replacement heifer calves. Implanting bulls can result in problems in reproductive organ development and sterility. Implanting does not improve growth rate or efficiency in bulls. While some implants are labeled for use in replacement heifers, heifers can develop adequately without implants. It is advisable to implant only heifers to be marketed as feeders or stockers.

Side effects from implant use may include bulling, vaginal and rectal prolapses, udder development, and raised tailheads. Side effects are rare, of little economic significance in most cases, and not a reason to avoid implant use. These situations are often the result of improper implanting technique. Crushed implants may contribute to these conditions.

Some marketing programs specify that no implants be used on cattle in order for cattle to qualify for the programs. For example, "natural" programs may include such implant restrictions. Know the specifics of the targeted marketing program before using implants.

Implant Handling and Administration

Always use best management practices, including Beef Quality Assurance-compliant practices for implant use in beef cattle. Start by reading label directions on specific implant products. Label directions include information on the age, weight, and/or sex of cattle for recommended use of specific implants. Some implants require refrigerated storage or protection from light. Others require cool, dry storage, and still others should be stored at room temperature without excessive heat or humidity. The needed storage conditions will be indicated on the label. Review label instructions before implant storage and use. Check the product expiration date, and use implants before expiration.

Make sure the appropriate implant applicator (often called an implant gun) is on hand for use with the specific implant chosen. Manufacturers make implant guns specifically designed for certain implants. Match implants to the correct implant guns to minimize implant defects. Load the implant gun according to label directions. Use only sharp needles in implant applicators. Dull or burred implant applicator needles increase the risk of tissue damage and infection at the implant site. Burrs on needles can also damage implants. Check periodically for clogged implant applicator needles. Wash clogged needles with water and then disinfectant, and allow to dry before reuse.

Effective animal restraint makes implant administration easier and more likely to be done properly. Catching cattle in a head gate just behind the ears is ideal when implanting. With horned cattle, nose tongs can provide additional animal restraint and handler safety. Once a calf is properly restrained, select an appropriate ear for implanting. Select the ear with fewer ear tags, tattoos, and ear notches. If ears are tagged during the same cattle working event, then administer tags before implants. Try to tag calves in the opposite ear from the implant site. When possible, choose the same ear to implant in all calves worked together. This helps in monitoring implants later.

Find the proper implant location on the ear. Proper implant placement is under the skin on the backside of the ear (**Figure 1**). Administer them in the middle third of the ear between the skin and cartilage. The needle insertion site should be a point toward the tip of the ear at least a needle's length away from the intended deposition site. Never place an implant in the cartilage ribs of the ear and never closer to the head than the edge of the cartilage ring farthest from the head. If the implant site is contaminated with mud or manure, scrape the site with a dull serrated knife, and clean the site with disinfectant before implanting. Do not contaminate the site with dirty hands. For reimplantation, place the second implant parallel to but not in contact with the previous implant or in the unimplanted ear.

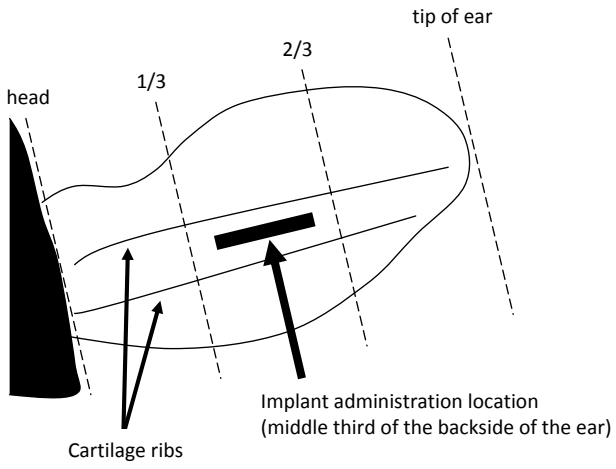


Figure 1. Proper implant administration location in beef cattle between the cartilage and skin.

Grasp the ear to be implanted with one hand, and position the loaded implant applicator parallel to the backside of the ear. With the tip of the needle, prick and lift the skin to completely insert the needle under the skin, avoiding major blood vessels. The needle should form a canal between the skin and cartilage for deposit of the implant. Be careful to avoid gouging or piercing the cartilage. Needle resistance may indicate that the needle is gouging the cartilage. Once the needle is completely inserted, back it up slightly (about one-eighth to one-fourth of an inch). Some implant guns have retractable needles that eliminate the need for pulling the needle back slightly. Depress the trigger of the implant gun, and withdraw the needle slowly and steadily. Implant pellets should be deposited in a row. Gently palpate the ear to make sure the implant was properly inserted. Pellets should not be bunched or crushed, and the full dosage of implant pellets should have been deposited.

Improper implant administration can make the implant less effective or ineffective. Never sacrifice proper implant administration and sanitation for speed. Make sure everyone administering implants is trained in acceptable implant handling and administration techniques. Select the most conscientious crew member to administer implants. Periodically check implant technicians to make sure they are using good implanting technique. There are several common potential causes for implant failure. Many, if not all, of these causes are preventable.

Table 2. Potential causes for growth-promoting implant failure in beef cattle.

Missing implant (through the ear)
Partial implant (due to implant gun failure or poor technique)
Crushed or bunched implant pellets
Improper implant site (in the cartilage)
Abscess (due to poor sanitation or implanting technique)
Inadequate implant storage (moisture, refrigeration)
Inappropriate implant timing or target animal

Abscesses often result from infected implant sites. Abscesses may wall off the implant, preventing absorption, or push implant pellets out of the implant site. Adequate sanitation during implanting can help prevent abscess development. Thoroughly disinfect implant needles between animals. Wipe implant applicator needles with cotton or gauze moistened with a suitable disinfectant. Consider fly control measures when implanting during fly season.

Keep thorough and accurate implanting records. Record the date of administration, product administered, location of administration, and unique animal identification. An animal health processing map may be useful for these records. Keep the records, and inform buyers or future managers of past implant management. This helps prevent poor implanting decisions in later production phases.

Beef Safety

The FDA requires no withdrawal period before harvest of implanted cattle. Beef from implanted cattle has very low levels of estrogenic activity compared to many other common foods. Many commonly consumed foods, including vegetables and vegetable products, have much higher estrogenic activity than beef. In addition, the potential amount of estrogen consumed in beef is extremely low in comparison to that produced daily in the human body.

Table 3. Estrogenic activity of common foods.

Food	Estrogenic activity, nanograms per pound of food
Soybean oil	908,000
Eggs	15,890
Cabbage	10,896
Ice cream	2,724
Peas	1,816
Beef from a pregnant cow	636
Milk	59
Beef from implanted cattle	10
Beef from nonimplanted cattle	7

Adapted from Preston, 1997.

Table 4. Estrogen produced in various animals.

Item	Estrogen produced, nanograms per day
Pregnant woman	90,000,000
Nonpregnant woman	5,000,000
Adult man	100,000
Prepubertal children	40,000
3 ounces beef from implanted cow	1.9

Adapted from Preston, 1997.

For more information on growth-promoting implant use in beef cattle production, contact your local MSU Extension office.

References

Duckett, S. K. & J. G. Andrae. 2001. Implant strategies in an integrated beef production system. *Journal of Animal Science 79*(E. Suppl.):E110–E117.

FDA. 2011. Food and Drug Administration approved animal drug products database. Available at: ***http://www.fda.gov/AnimalVeterinary/Products/ApprovedAnimalDrugProducts/default.htm***.

Preston, R. 1997. Implants for suckling steer and heifer calves and potential replacement heifers. Symposium: Impact of implants on performance and carcass value of beef cattle. Oklahoma Agri. Exp. Station. P-957.

U.S. Department of Agriculture. 2009. National Animal Health Monitoring System BEEF 2007–08. Washington, D.C.

Publication 2485 (POD-01-18)

By **Jane A. Parish**, PhD, Professor and Head, North Mississippi Research and Extension Center; and Justin D. Rhinehart, PhD, former Assistant Extension Professor, Animal and Dairy Sciences.

Produced by Agricultural Communications.

Extension Service of Mississippi State University, cooperating with U.S. Department of Agriculture. Published in furtherance of Acts of Congress, May 8 and June 30, 1914. GARY B. JACKSON, Director

Texas Cooperative EXTENSION
The Texas A&M University System

ASWeb-120
6-05

Value Added Calf (VAC) - Management Program

Produced by the TAMU Department of Animal Science Extension Beef Cattle Specialists

Genetic content is a major factor in determining the value of a calf. Genetics can not be changed by nutrition, health, or general management. But these non-genetic factors do influence value.

The majority of beef cow operations sell fresh-weaned calves through a local auction, where buyers generally know nothing about the history of what they're buying. Texas A&M Ranch to Rail, numerous research projects, and field observations have shown that well-designed health, nutrition, and management programs increase value. Calves going through such programs tend to have lower sickness and death, gain faster and more efficiently, and yield more valuable carcasses. These traits can result in higher prices received by the cow/calf producer, if calves are effectively marketed. Or if ownership is retained, the producer benefits directly from better performance as stockers or feeders and greater carcass value.

Calves are stressed in two ways if they are weaned and shipped right off the cow. The trauma of weaning in itself is stressful. Movement to another location adds additional stresses, including the effects of hauling, new surroundings, different nutrition, and exposure to disease. Weaning and backgrounding on the ranch or farm before shipping separates these two types of stresses, resulting in healthier calves.

HEALTH

Backgrounded or not, calves are healthier when immunized against common diseases. There are effective immunization programs to fit different management and marketing systems. Programs are available for application before, at the time of, and after weaning, for marketing at weaning or after backgrounding, and for purchased calves. These alternatives are discussed in detail in Texas A&M Department of Animal Science publication ASWeb-076, "Value Added Calf (VAC) - Vaccination Management", which can be accessed on this website (http://animalscience. tamu.edu). Specific vaccination regimes should be recommended by your herd health professional or beef cattle veterinarian.

GENERAL MANAGEMENT

The American beef industry is characterized by the use of steers and not intact males. Generally, to receive highest price, all bull calves should be castrated. Delayed castration, especially beyond 400 pounds, increases chances of sickness and death and reduces weight gain and feed efficiency. Also, late castration may reduce eating quality of beef.

Dehorning is another factor that adds value. Horned cattle can cause bruising of carcasses. To reduce stress, horns should be removed as early as feasible, usually at "working" (two to four months of age). Creating genetically polled calves removes the stress of dehorning.

Growth implants increase value to the cow-calf producer through heavier sale weights. One implant at working to steers and market heifers has been shown to increase weight gain to weaning by an average of 10 to 15 percent, and subsequent stocker/feeder performance is not affected. Growth implants do not compensate for poor nutrition, and response improves with good nutrition.

Another factor that can affect sale weight is internal and external parasitism. Calves may benefit from parasite control, often applied at working, when conditions indicate. Some special backgrounded sales require treatment for internal and external parasites.

Many producers brand calves at working. If so, brands should be placed so that value of processed hides will not be reduced, in such locations as the rear hip, shank, or thigh. Large brands on the side, in particular, will reduce the value of hides.

If calves are backgrounded or retained for other purposes, weaning should be designed to reduce stress as much as possible. Some research and field observation has shown reduced stress from "fence-line" weaning, where calves are weaned across a fence from their dams. Weaning should be done in a secure lot or trap with shade, with fresh water and good-quality hay and supplement, if needed, or a good receiving ration provided for a limited time. Calves should be watched closely for 10-14 days for sickness and therapeutically treated as needed.

PREWEANING NUTRITION

Good nutrition increases sale weight. A basic part of a good nutrition program is minerals. Cows and calves should be provided with salt, adequate levels of the macro minerals phosphorous and magnesium, and any trace minerals likely to be deficient, especially copper, selenium, and zinc.

Calves gain weight most efficiently and economically when nursing dams of adequate milking ability, grazing good-quality range or pasture. Supplement can be provided when these components are lacking. For highest efficiency, supplement should be provided directly to calves. This is accomplished most practically by creep feeding.

Traditional creeps (fed free choice, containing 10 to 15 percent crude protein and moderate to high energy) usually increase weaning weight. A summary of 47 research studies showed that calves on traditional creeps for around five months averaged almost 60 pounds heavier than non-creeped calves. However, on average, almost 10 pounds of feed were required for each added pound of gain. In these studies, feed efficiency was best when forage was limited or of lower quality and dams were poor in milking ability. But with good-quality forage and good-milking dams, feed efficiency was reduced.

Larger-framed calves gain most efficiently on creep feed and are less likely to be over-fleshed at weaning. Fleshy calves are usually discounted on price, which reduces the value of extra weight.

An alternative to traditional creeps is limit-feeding about a pound a day of a high-protein feed, when grazing is low in protein (below 10 % CP). Feed conversion in this case is generally excellent, in the range of two to three lb feed/lb gain. Calves should consume at least 0.5 lb/day for adequate gain and not over 1.2 lb/day for best feed efficiency.

Creep grazing is another alternative to provide supplemental nutrition. This involves growing small quantities of high-quality forage (such as winter small grains or high-quality summer annuals) adjacent to pastures grazed by cow-calf pairs. Calves are allowed exclusive access to these pastures through creep gates. Calf performance must be weighed against costs of growing these temporary pastures.

BACKGROUNDING NUTRITION

Nutrition and time are key factors in backgrounding. Based on Texas A&M Ranch to Rail data, the optimum period for backgrounding appears to be about 45 days. Shorter periods generally do not produce enough weight gain to offset fixed costs, immunization may not be complete, and calves may not have fully recovered from the stress of weaning. Longer periods may result in excessive flesh, resulting in price discounts. Optimum weight gain during backgrounding is mostly in the range of 1.0 to 1.5 lb/day.

Good grazing generally produces the most economical weight gains, with high-quality hay ranking next. If needed, forages may be supplemented with limited amounts of about 2 lb/day of a 40% CP source (such as cottonseed meal pellets), if forage is lacking primarily in protein, or 4 lb/day of a 20% CP feed (such as breeder cubes), if forage is deficient in both protein and energy. Other useful feeds, depending on prevailing cost and availability, may include various byproducts such as brewers grains, corn gluten feed, distillers grains, rice bran, soybean hulls, wheat mids, and whole cottonseed.

ADDED VALUE FROM BACKGROUNDING

The object of good backgrounding should be to create weaned, properly immunized, "dried-out" calves in moderate flesh that will perform well when stockered or fed. If this is accomplished, value is increased. To be feasible, some of this added value should accrue to the cow-calf producer and some to the stocker or feeder operator.

Properly backgrounded calves are worth more and should command a higher price. The cow-calf producer generally can not realize higher prices for backgrounded calves when they are marketed individually through most local auctions. But higher prices may be received when marketing through methods such as special backgrounded sales, video auctions, and private treaty to buyers willing to pay for proper backgrounding. A recent summary of sales conducted over a year's time by one video auction company showed a premium of $6.69/cwt for calves properly backgrounded for at least 45 days.

Cow-calf producers can realize some benefit from backgrounding besides higher prices. Weight gain during backgrounding represents value to the producer, but it must be done efficiently with low-cost nutrition in order to be profitable. Fresh-weaned calves lose significant weight, even if offered feed and water after hauling. That weight shrink costs the producer when calves are sold at weaning. Backgrounded calves generally shrink considerably less, if they have access to feed and water after hauling. All factors involved in backgrounding, both negative and positive, should be considered before implementing this practice.

SUMMARY

Whether calves are sold at weaning, backgrounded, or retained for other purposes, the various management tools discussed here can add value. Each producer should weigh the cost of a practice against potential economic benefit before deciding to implement. Some practices are more financially rewarding but also can be more costly to implement. In addition, different marketing situations will dictate different values at different times. Knowledgeable producers take advantage of benefits, minimize drawbacks, and secure as much added value as possible in order to maximize profit.

Cattle Handling Pointers

R. Gill, Ph.D and R. Machen, Ph.D., Professors and Extension Livestock Specialists

Safe and effective cattle handling has always been important. In the last few years there has been a move toward what has been called low-stress handling or as we prefer to call it a return to sound effective stockmanship. The animal industries cannot afford to allow any form of abusive behavior or handling of livestock. The culture of handling on any operation originates from upper management and is expressed by the workers on the ground.

Most cattle handlers, and it does not matter if you are a "cowboy, buckaroo, cow hand, cow man, farm hand or stockman", have learned by watching someone else work stock. Everyone thinks they know how to "work cattle" because they have always been able to get the job done. The moment you admit you do not know everything is the moment you can start to get better.

If you have had a thought similar to this one "that stupid ole' cow" you have room to improve your abilities as a stockman. Cattle are not stupid and usually do what they are asked to do. However, if ask incorrectly cattle will not necessarily do what you want or need them to do. When this happens we have come to rely on facilities, equipment or manpower to force them to do what is needed. This results in increased stress on cattle and hands and results in cattle getting more difficult to handle over time.

In a very simple explanation of stress… *If you decide to do something it is not stressful, if you are forced to do something it will be stressful*. Sound stockmanship allows one to get an animal to decide to do what you want them to do. Force does not come into play and stress is reduced.

The job of a stockman is to teach an animal to accept and tolerate pressure and stress for short periods of time. Effective stockmanship skills are based on pressure and release. An animal will quickly learn to accept pressure and not develop stress if they perceive a way for pressure to be released.

The role of a stockman is to create movement in cattle and then use position to control and manage that movement to the desired result. When cattle loose movement they become reluctant to work. When movement is lost excessive pressure, force and driving aids are more likely to be used. Creating and managing movement is key to achieving effective stockmanship.

There are five basic principles of cattle behavior that when used properly can improve the ease and speed of working cattle while reducing stress and increasing efficiency. Those principles are:

1. **Cattle want to see you.**
   Understanding how cattle see is basic to getting cattle to respond to your position. Cattle can see everywhere but directly behind them or a small blind spot in front of them. When working from behind, it is important to keep moving side to side to prevent cattle from turning in an effort to keep you in their line of sight.

2. **Cattle want to go around you.**
   This allows you to position yourself such that, when they do go around you, they are pointed directly at the gate or destination you had in mind. They'll think it was their idea to go there!

3. **Cattle want to be with and will go to other cattle.**
   A herding instinct is natural among 'prey' animals. As stockmen we can take advantage of this natural instinct as we work from the front of cattle. If you start the front the back will follow.

4. **Cattle want to return to where they have been.**
   The natural instinct of a cow is to return to the last safe or comfortable place they were. The simple principle of the return box or "Bud Box" helps capture and use this principle. It also works great in sorting and moving cattle from one corral to another.

5. **Cattle can only process one main thought at a time.**
   If cattle are thinking about anything other than what you are asking them to do you will need to change their mind first before putting pressure on them.

There are three basic means of communicating with livestock. Very simply they are:

- **Sight**
- **Sound**
- **Touch**

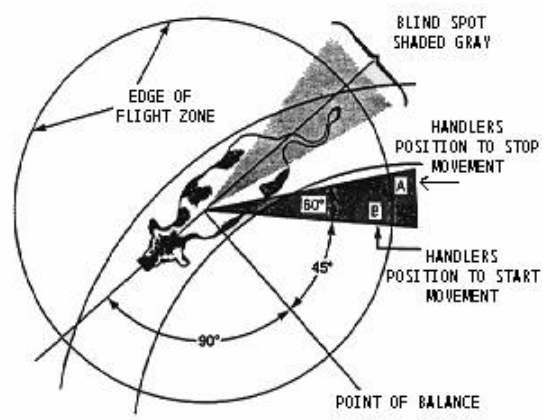
Cattle prefer to communicate through line of sight. Sound coming from a human for the most part is stressful and marginally successful in getting the desired result. Sound should be used as a secondary method and only used when sight is not adequate. Sound can often lead to distracting the line of sight away from the desired direction. Touch is really only useful in situations where animals are confined and additional stimulus is needed to get cattle to move or respond. Touch does not refer to use of driving aids such as hotshots or sorting sticks or paddles.

Keeping these behavioral principles and methods of communicating in mind, following is a list of ten handling pointers to keep in mind and a few suggestions that will improve the ease of handling cattle, whether they are being gathered from the pasture or processed through the corrals.

1. **"The only way to work cattle quickly is slowly."**
   (from a humorous book entitled *Don't Squat With Your Spurs On*.) Patience is a great virtue when gathering and working cattle. When we get in a hurry, inevitably we put excessive or incorrect pressure on cattle, which usually results in an unintended reaction from the cattle.

2. **Work from the front to draw cattle to you.**
   This goes back to the basic principle #1. Cattle can be easily controlled from the front if they are not afraid of a human. (If they are afraid you are a long way away from being able to handle cattle using low stress principles). Working from the front helps keep cattle from wanting to turn in an effort to keep you in their line of sight. By moving in and out of the flight zone and point of balance, cattle can be easily drawn forward and past you to get them to go where you need them to go.

   The most important point to remember about the flight zone is not the flight zone, it is the area before the flight zone where a stockman must get skilled at managing. When approaching an animal it is important to be able to predict the response to your entering the flight zone. If the desired movement is not going to occur you need to back out reposition and approach at a different angle.



   Where each animals point of balance falls varies greatly and is influenced by pressure from front or behind, draw of cattle ahead or behind them and whether or not they are comfortable going by the handler. Suffice it to say that the point of balance on any given animal is not where it is drawn on this diagram. The point of balance is actually related the position you are in relative to the eye.

3. **Apply pressure when cattle have a place to go.**
   Low stress livestock handling is not about handling cattle with no pressure. In fact the success of handling cattle correctly depends on knowing when and where to apply pressure and how much pressure to apply. The other key component to effective stockmanship is setting the cattle up to go where you want them to go before you apply pressure. Just as important is to release the pressure as soon as the desired result is achieved.

4. **Pressure from the side.**
   This relates back to working from the front and down the side of an animal and not working from directly behind.

5. **Cattle must be comfortable to go by you and stay straight.**
   If cattle are not comfortable going by you, they will not work for you very well. Working from the front requires you to get the cattle able to pass you without balking or spooking. This simple principle facilitates penning, sorting and processing cattle.

The further forward you can make an animal's point of balance the easier it is to work and sort cattle. That is why using the draw of other cattle makes it easier to work and sort cattle in an alley or from one corral to another.

6. **Pressure cattle from behind only when absolutely necessary.**
   Like any 'prey' animal, cattle cannot see directly behind themselves. If you assume a position directly behind cattle (in their blind spot), they will turn to one side or the other in order to see you. To 'drive' cattle in a straight line, assume a position behind their point of balance (shoulder) and off to either side. You can also work in a zig-zag fashion behind the cattle causing them to switch eyes and move straight forward.

7. **When working cattle, move in triangles.**
   Sounds odd, but it works. Move in straight lines. For example, if you work in an arch pattern behind the cattle, you will find them being drawn from side to side (and consequently walking in a zig-zag pattern) as they follow your movement. Move into their flight zone to create or correct movement. Retreat from their flight zone to slow or stop movement.

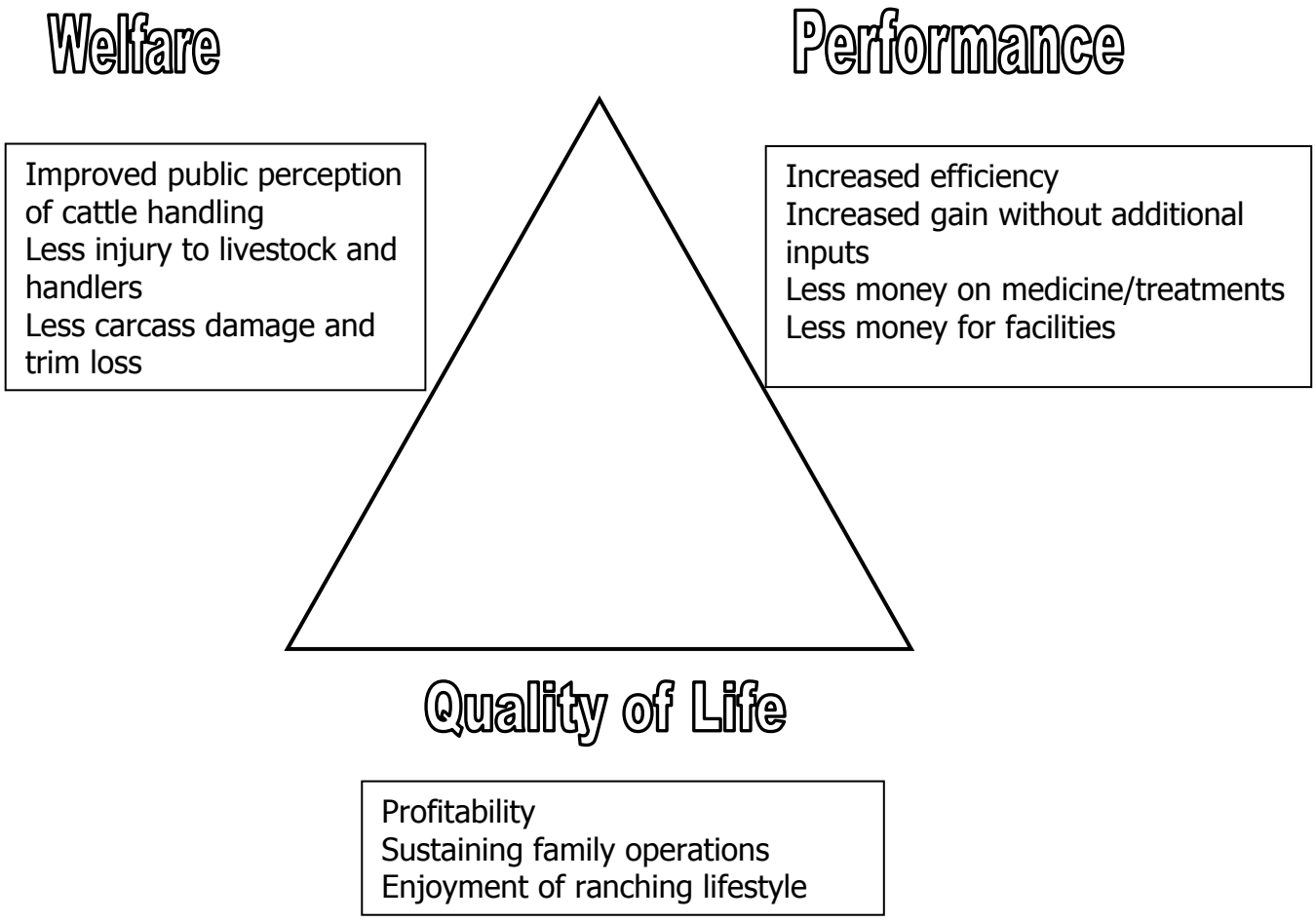
8. **Going with the flow of cattle slows them down or stops their movement.**
   It's all about that point of balance – as you move in the same direction cattle are traveling, when you approach a position parallel to their point of balance, they will slow down, and as you pass the point of balance they will stop. The important part in this process is to get the cattle to stop without reversing their direction. Teach them to stop straight and stay in the position they were headed.

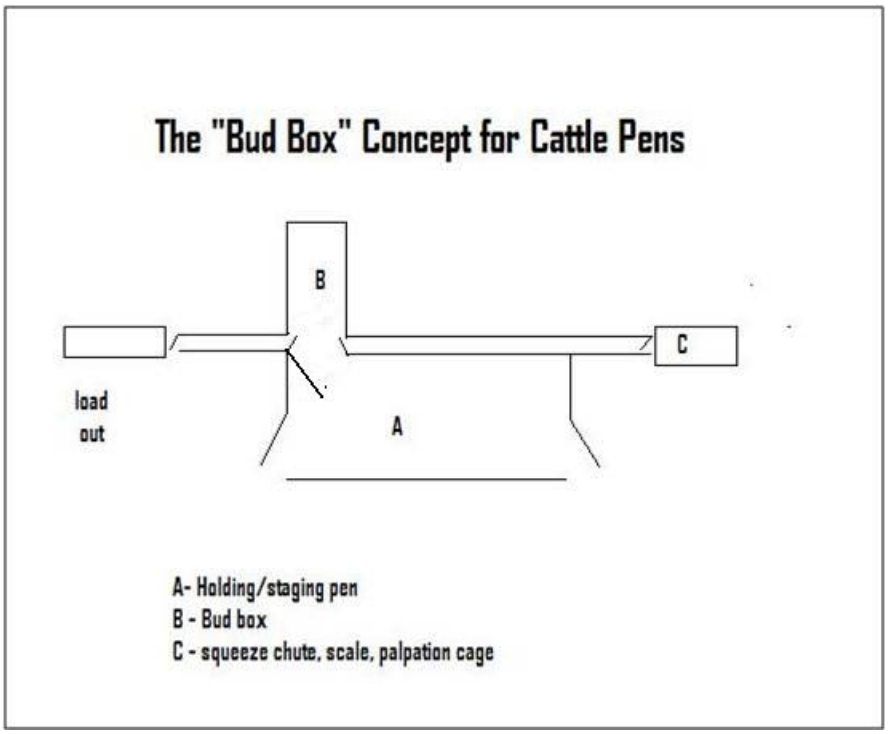
9. **Going against the flow of cattle initiates or accelerates their movement.**
   The opposite of pointer # 8. Ever filled the chute, then pressured the last animal in line to move the others forward? It's likely he or she had no place to go and nothing happened. Next time, try leaving their flight zone, walk up ahead of the line, then re-enter the flight zone of the first in line and walk alongside the chute, front to back, and see what happens. We suspect that as you pass their point of balance, they will step forward. The one in the front will 'pull' the others forward.

10. **Cattle work best when *they* are ready - You have to get them there.**
    Cattle are not mind readers. You have to teach, condition and prepare them. Unfortunately, today's cattle owners are short on time and experienced labor, and consequently, don't spend time with their cattle as did the stockmen of days gone by. Perhaps there's not time to educate the entire existing herd, but quality time spent with replacement heifers will pay dividends for years to come. Spend time with heifers (in both the pasture and the pens) when you *want* to, not just when you *have* to.

Numerous others will handle your cattle after they have left your care. Bad habits and unruly behavior in cattle and humans is learned. When working correctly shouting, whistling, poking and prodding cattle is unnecessary and counterproductive. In fact, they distract cattle from what you really want them to do. Development of effective stockmanship skills is about improving worker safety, animal performance and increasing income on each individual operation.

WHY THIS IS IMPORTANT
To YOU and the BEEF CATTLE INDUSTRY





There is nothing magical about a "Bud Box" or Return Box. The simplicity of the box is that it makes you, as a stockman, do things correctly. If you do not, cattle will not work any better out of a box than they will a tub. When handled correctly, however, they will work better out of a box than they will a tub system. If a box does not work **you** are doing something wrong! For more details on designing and using a Bud Box go to http://animalscience.tamu.edu/academics/beef/publications/index.htm and download ***Designing a Bud Box***

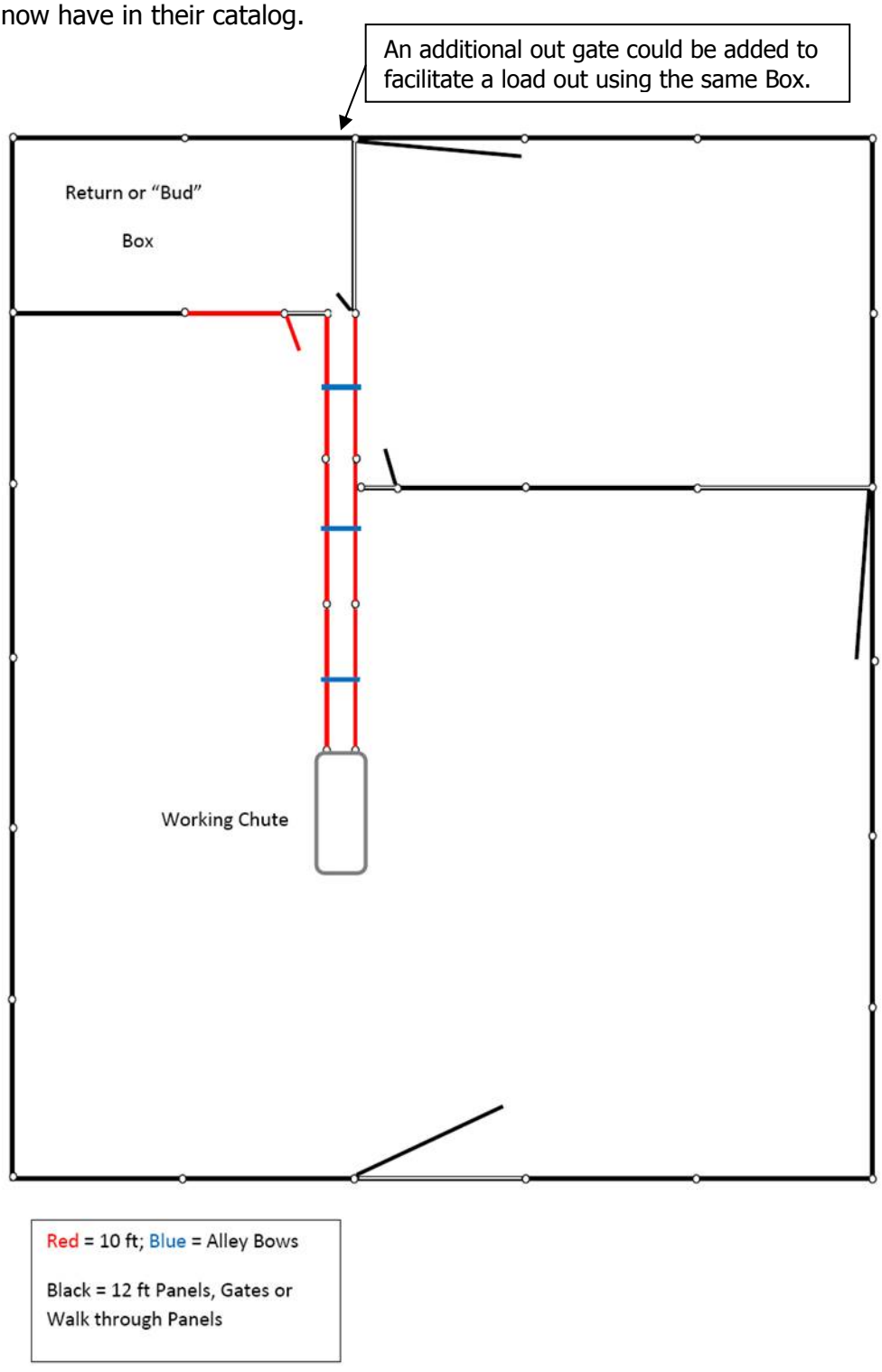
The reason the box works is that it takes advantage of all five basic principles of behavior. As cattle enter the box they come to the back of the box and transition to go back to where they came from (5), they can then easily see you (1), they can move around you (2), the draw of the leaders pull the rest of the cattle into the crowd alley (3) and this all occurs without force so they are free to think about what you are wanting them to do (4) without being distracted. It is that simple.

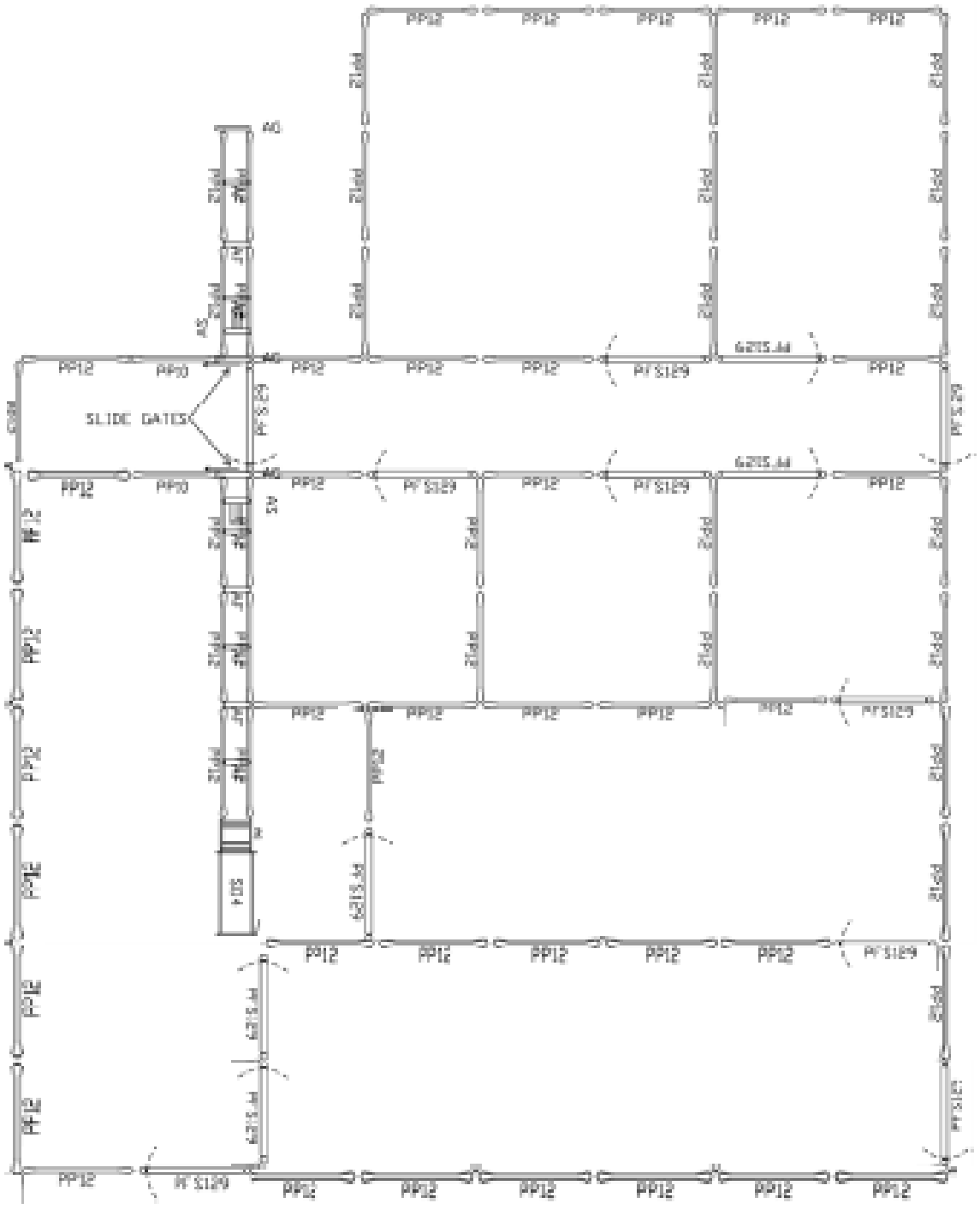
We encourage you to improve your skills as a stockman. For more information and additional training opportunities go to: http://www.ranchtv.org or http://www.effectivestockmanship.com

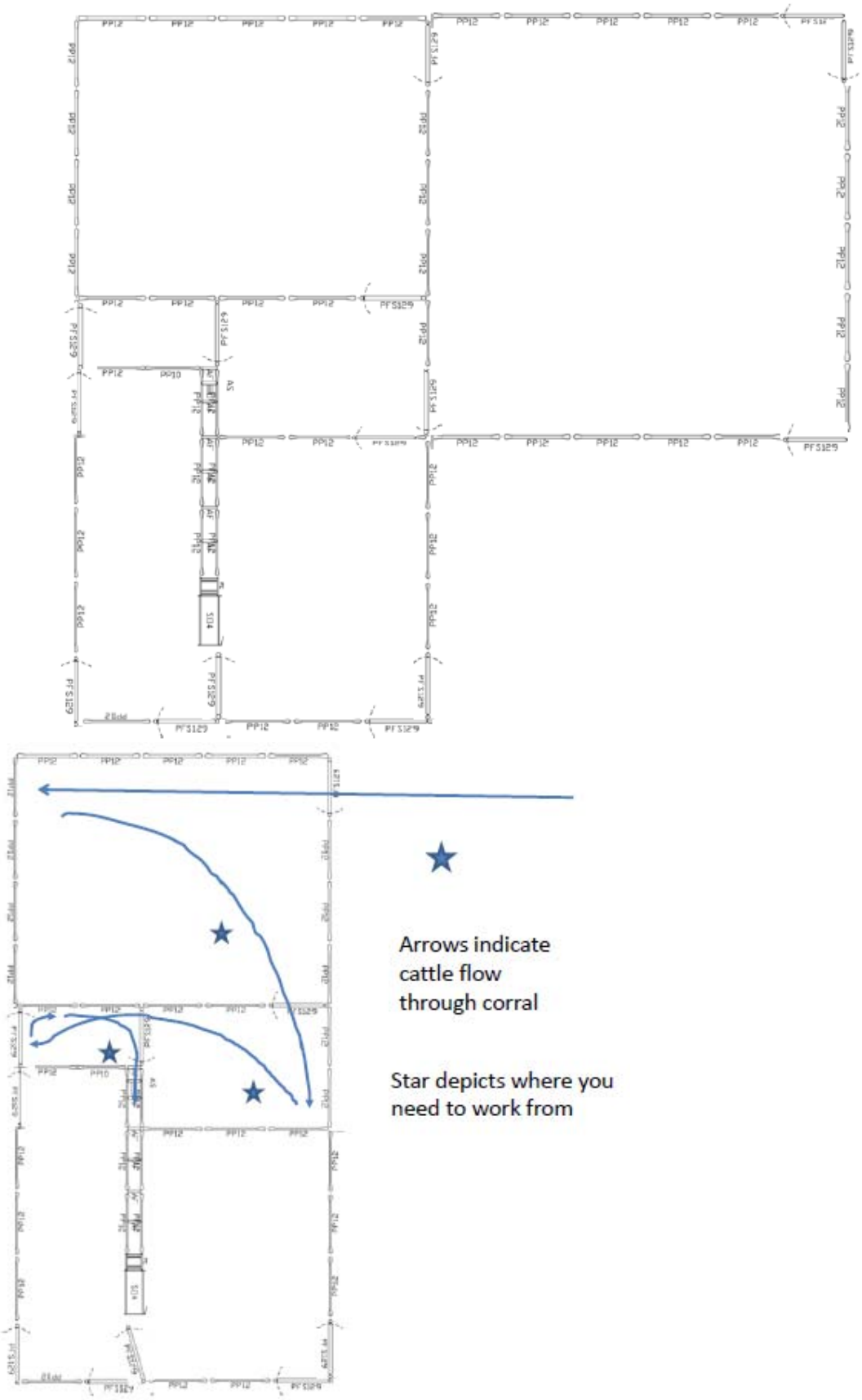
Contact information:

Ron Gill, Ph.D., Prof. and Livestock Specialist, Texas AgriLife Extension Service. College Station, Texas, Texas A&M System: Email: RGill@ag.tamu.edu Website: http://beef.tamu.edu.
Rick Machen, Ph.D. Prof. and Livestock Specialist, Texas AgriLife Extension Service. Uvalde, Texas, Texas A&M System: Email: RMachen@ag.tamu.edu Website: http://beef.tamu.edu.

Other corral designs and layouts to consider. The latter two are expanded versions of the ones Priefert now have in their catalog.




SLIDE GATES


Arrows indicate cattle flow through corral
Star depicts where you need to work from

Beef Quality Assurance℠

CATTLE CARE & HANDLING GUIDELINES

Funded by the Beef Checkoff.

A SAFE, WHOLESOME AND HEALTHY BEEF SUPPLY

Beef cattle producers take pride in their responsibility to provide proper care to cattle.

The Code of Cattle Care below lists general recommendations for care and handling of cattle:

- Provide necessary food, water and care to protect the health and well-being of animals.
- Provide disease prevention practices to protect herd health, including access to veterinary medical care.
- Provide facilities that allow safe, humane, and efficient movement and/or restraint of cattle.
- Use appropriate methods to humanely euthanize terminally sick or injured livestock and dispose of them properly.
- Provide personnel with training/experience to properly handle and care for cattle.
- Make timely observations of cattle to ensure basic needs are being met.
- Minimize stress when transporting cattle.
- Keep updated on advancements and changes in the industry to make decisions based upon sound production practices and consideration for animal well-being.
- Persons who willfully mistreat animals will not be tolerated.

CATTLE CARE & HANDLING GUIDELINES

INTRODUCTION

Cattlemen have long recognized the need to properly care for livestock. Sound animal husbandry practices, based on decades of practical experience and research, are known to impact the well-being of cattle, individual animal health and herd productivity. Cattle are produced in very diverse environments and geographic locations in the United States. There is not one specific set of production practices that can be recommended for all cattle producers. Personal experience, Beef Quality Assurance (BQA) training and professional judgment can serve as a valuable resource for providing proper animal care. The following information is to be used as an educational resource, all production practices should be adapted to specific needs of individual operations.

FEEDING AND NUTRITION

Diets for all classes of beef cattle should meet the recommendations of the National Research Council (NRC) and/or recommendations of a nutritional consultant. For local recommendations and advice, contact your state agricultural extension as a potential resource.

- Cattle must have access to an adequate water supply. Estimated water requirements for all classes of beef cattle in various production settings are described in the National Academy of Sciences NRC Nutrient Requirements of Beef Cattle.
- Provide adequate feed. Avoid feed and water interruption longer than 24 hours.
- Feedstuffs and feed ingredients should be of satisfactory quality to meet nutritional needs.
- Under certain circumstances (e.g., droughts, frosts, and floods), test feedstuffs or other dietary components to determine the presence of substances that can be detrimental to cattle well-being, such as nitrates, prussic acid, mycotoxins, etc.
- Producers should become familiar with potential micronutrient deficiencies or excesses in their respective geographical areas and use appropriately formulated supplements.
- Use only USDA, FDA and EPA approved products for use in cattle. These products must be used in accordance with the approved product use guidelines.

Feeding Guidelines for Beef Cows

Body condition scoring of beef cows is a scientifically approved method to assess nutritional status. Body condition scores (BCS) range from 1 (emaciated) to 9 (obese).

- A BCS of 4-6 is most desirable for health and production. A BCS of 2 or under is not acceptable and immediate corrective action should be taken.
- During periods of prolonged drought and widespread shortages of hay and other feedstuffs, the average BCS of cows within a herd may temporarily decline. This is not desirable, but may be outside the cattle owner's control until drought relief is achieved.
- During periods of decreasing temperature, feeding plans should reflect increased energy needs. *See additional Cold Stress proceedures (pg. 20)*

Feeding Guidelines for Stocker Cattle

- Stockers are raised on a wide variety of forages (native pasture, annuals, improved pasture) with minimal additional nutrient supplementation.
- On growing forages, stocking rates should be established that meet production goals for growth and performance.
- On dormant pastures, supplement cattle as needed to meet maintenance or growth requirements for the animal's weight, breed, and age as established by NRC guidelines and targeted production goals of the operation.

Feeding Guidelines for Feeder Cattle

Feedyard cattle can eat diverse diets, but the typical ration contains a high proportion of grain(s) (corn, milo, barley, grain by-products) and a smaller proportion of roughages (hay, straw, silage, hulls, etc.). The NRC lists the dietary requirements of beef cattle (based on weight, weather, frame score, etc.) and the feeding value of various commodities included in the diet.

- Consult a nutritionist (private consultant, university or feed company employee) for advice on ration formulation and feeding programs.
- Avoid sudden changes in ration composition or amount of ration offered.
- Monitor changes in weight gain, feces, incidence of digestive upsets (acidosis or bloat) and foot health to help evaluate the feeding program.
- A small percentage of cattle in feedyards develop laminitis or founder. Mild cases do not affect animal welfare or performance; however, hooves that are double their normal length compromise movement. In these instances, the individual animal should be provided appropriate care and marketed as soon as possible.

DISEASE PREVENTION, HEALTH CARE, AND CATTLE MANAGEMENT PRACTICES

Like other species, cattle are susceptible to infectious diseases, metabolic disorders, toxins, parasites, neoplasia and injury. Control programs should be based on risk assessment and efficacy of available products. Economic losses are reduced by early intervention through health management programs. Healthy herds are more productive. Management programs should be science-based and common-sense driven.

The producer should work with a veterinarian to determine the risk of infectious, metabolic and toxic diseases and to develop effective management programs when designing a herd health plan. A Veterinary/Client/Patient Relationship (VCPR) is strongly encouraged.

Producers and their employees should have the taining and ability to recognize common health problems and know how to properly utilize animal health products and other control measures.

When prevention or control measures are ineffective, the producer should promptly contact a veterinarian for a diagnosis and treatment program to reduce animal suffering and animal losses.

A Producer's Guide for Judicious Use of Antimicrobials in Cattle

1. **Prevent Problems:** Emphasize appropriate husbandry, management, hygiene, routine health examinations, and vaccinations.
2. **Select and Use Antibiotics Carefully:** Consult with your veterinarian on the selection and use of antibiotics. Have a valid reason to use an antibiotic. Therapeutic alternatives should be considered prior to using antimicrobial therapy.
3. **Avoid Using Antibiotics Important In Human Medicine As First Line Therapy:** Avoid using, as the first antibiotic, those medications that are important to treating strategic human or animal infections.
4. **Use the Laboratory to Help You Select Antibiotics:** Cultures and susceptibility test results should be used to aid in the selection of antimicrobials, as neccessary.
5. **Combination Antibiotic Therapy Is Discouraged Unless There Is Clear Evidence The Specific Practice Is Beneficial:** Select and utilize an antibiotic to affect a cure.
6. **Avoid Inappropriate Antibiotic Use:** Confine therapeutic antimicrobial use to appropriate clinical indications, avoiding inappropriate uses such as for viral infections without bacterial complication.
7. **Treatment Programs Should Reflect Best Use Principles:** Regimens for therapeutic antimicrobial use should be optimized using current pharmacological information and principles.
8. **Treat the Fewest Number of Animals Possible:** Limit antibiotic use to sick or at risk animals.
9. **Treat for the Recommended Time Period:** This will minimize the potential for bacteria to become resistant to antimicrobials.
10. **Avoid Environmental Contamination with Antibiotics:** Steps should be taken to minimize antimicrobials reaching the environment through spillage, contaminated ground run off or aerosolization.
11. **Keep Records of Antibiotic Use:** Accurate records of treatment and outcome should be used to evaluate therapeutic regimens and always follow proper withdrawal times.
12. **Follow Label Directions:** Follow label instructions and never use antibiotics other than as labeled without a valid veterinary prescription.
13. **Extra-label Antibiotic Use Must follow FDA Regulations:** Prescriptions, including extra label use of medications must meet the Animal Medicinal Drug Use Clarification Act (AMDUCA) amendments to the Food, Drug, and Cosmetic Act and its regulations. This includes having a valid Veterinary/Client/Patient Relationship (VCPR).
14. **Subtherapeutic Antibiotic Use Is Discouraged:** Antibiotic use should be limited to prevention or control disease.

Cows

- It is desirable for cows to have a BCS of at least 4 before the calving season.
- During the calving season, cows should be checked regularly for calving difficulties. First-calf heifers may require more frequent observation and care.
- Producers should consider contacting a veterinarian for advice or assistance if cows or heifers have calving difficulties that cannot be corrected by the producer within a reasonable amount of time.
- Cows with mild lameness, early eye problems, mastitis or loss of body condition should be examined to determine well-being and promptly marketed as appropriate.

Calves

Castration and dehorning are done for the protection of the animal, other cattle in the herd and people who handle the cattle. In all cases producers may seek guidance from a veterinarian and advisability of analgesia or anesthesia for castration and dehorning of beef cattle, particularly in older animals, where development is more advanced.

- Where practical, cattle should be castrated before the age of 3 months (90 days), or at the first available handling opportunity beyond this age.
- Where practical, cattle should be dehorned while horn development is still at the horn bud stage, or at the first available handling opportunity beyond this age. This is because at this stage in development the procedure involves less tissue trauma. The selection of polled cattle is an alternative for horn management.
- Weaning can be less stressful by castrating and dehorning calves early in life, vaccinating against respiratory diseases prior to weaning, and providing proper pre-weaning nutrition.

Stocker and Feeder Cattle

- In all cases producers may seek guidance from a veterinarian on the advisability of vaccination protocols for incoming stocker and feeder cattle based on environmental and rearing conditions. The use of vaccines and parasite control should be based on risk assessment and efficacy of available animal health products.
- Producers may seek guidance from a veterinarian on the availability and advisability of analgesia or anesthesia for dehorning of beef cattle, particularly in older animals, where horn development is more advanced.
- A local anesthetic should be used when heifers are spayed using the flank approach.
- High risk cattle should be checked at least daily for illness, lameness or other problems during the first 30 days following arrival.

- Pregnancy in immature heifers can result in calving difficulties and subsequent trauma to the birth canal, paralysis or death of the heifer. For these reasons it is often more humane to abort pregnant heifers. This should be done under the direction of a veterinarian.
- If heifers in the feedyard or a stocker operation deliver a full-term, healthy calf, it should be allowed to nurse to obtain colostrum. At all times, these calves must be handled humanely and provided proper nutrition. Compromised calves or fetuses should be promptly euthanized and disposed of according to local regulations.
- "Bulling" is a term to describe aggressive riding of a steer by one or more penmates. Bullers should be promptly removed from the pen to prevent serious injury.
- Tail docking is not recommended. Increasing space per animal and proper bedding are effective means in preventing tail tip injury and necrosis.

IDENTIFICATION

Branding, ear-tagging, ear-notching, and radio frequency identification devices (RFID) are methods of identifying cattle.

- If cattle are hot iron or freeze branded, it should be accomplished quickly, expertly and with the proper equipment. BQA guidelines recommend branding on the hip area.
- Feeder cattle should not be re-branded when entering a feedlot unless required by law.
- Brands should be of appropriate size to achieve clear identification.
- Cattle should never be branded on the face or jaw.
- Ear notching may be used to identify cattle.
- Wattling, ear splitting and other surgical alterations for identification are strongly discouraged.

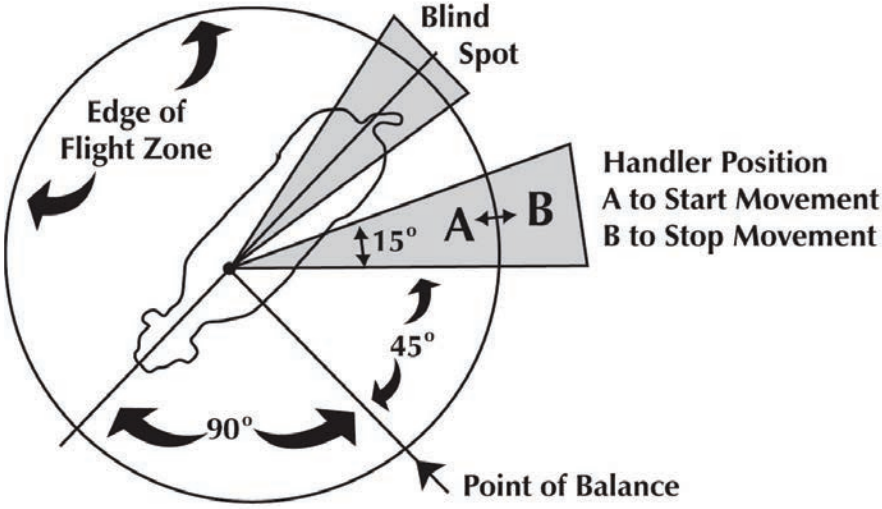
SHELTER AND HOUSING

- Cattle in backgrounding facilities or feedyards must be offered adequate space for comfort, socialization and environmental management.
- Pen maintenance, including manure harvesting, will help improve pen conditions.
- Mud is more of a problem in the winter with low evaporation rates or improper drainage conditions. Accumulation of mud on cattle should be monitored as a measure of pen condition and cattle care in relation to recent weather conditions.
- Feedyards should use dust reduction measures to improve animal performance.
- Floors in housing facilities should be properly drained and barns and handling alleys should provide adequate traction to prevent injuries to animals and handlers.
- Handling alleys and housing pens should be free of sharp edges and protrusions to prevent injury to animals and handlers.
- Design and operate alleys and gates to avoid impeding cattle movement. When operating gates and catches, reduce excessive noise, which may cause distress to the animals.
- Adjust hydraulic or manual restraining chutes to the appropriate size of cattle to be handled. Regular cleaning and maintenance of working parts is imperative to ensure the system functions properly and is safe for the cattle and handlers.
- Mechanical and electrical devices used in housing facilities should be safe.

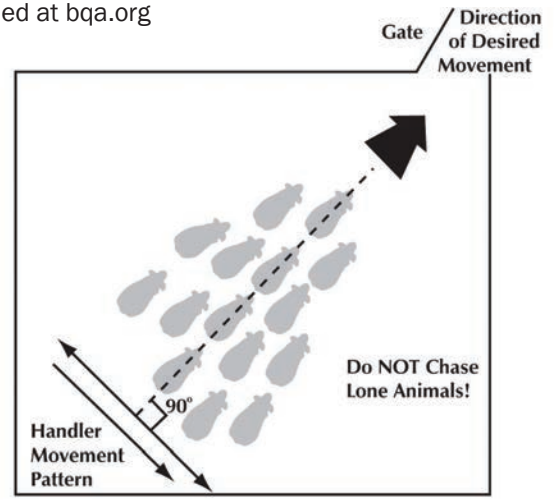
CATTLE HANDLING

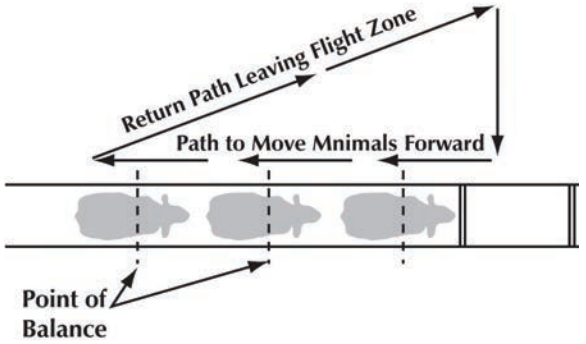
Abuse of cattle is not acceptable under any circumstances.

- Cattle should not be whipped or hit with objects that could cause injury, pain, or harm.
- Kicking, prodding, or any other forceful actions should not be used on non-ambulatory cattle.
- The use of sharp or hard solid objects to move cattle is not acceptable.
- Avoid slippery surfaces, especially where cattle enter a single file alley leading to a chute or where they exit the chute. Grooved concrete, metal grating (not sharp), rubber mats or deep sand can be used to minimize slipping and falling. Quiet handling is essential to minimize slipping. Under most conditions, no more than 2% of the animals should fall outside the chute. A level of more than 2% indicates a review of the process may be of value, including asking questions such as: is this a cattle temperament issue, has something in the handling area changed that is affecting cattle behavior, etc.?
- Take advantage of cattle's flight zone and point of balance to move them. For safety and welfare reasons, minimize the use of electric prods. Non-electric driving aids, such as plastic paddles, sorting sticks, flags or streamers (affixed to long handles) should be used to quietly guide and turn animals. When cattle continuously balk, cattle handlers should investigate and correct the reason rather than resort to overuse of electric prods.



- Under desirable conditions, 90% or more of cattle should flow through cattle handling systems without the use of electric prods.
- When cattle prods must be used, avoid contact with sensitive areas including the eyes, rectum, genitalia and udder.
- Driving aids powered by AC current should never be used unless manufactured and labeled specifically for that purpose.
- Some cattle are naturally more prone to vocalize, but if more than 5% of cattle vocalize (after being squeezed but prior to procedures being performed) it may be an indication that chute operation should be evaluated.
- If more than 25% of cattle jump or run out of the chute there should be a review of the situation and questions asked such as: is this a result from cattle temperament or prior handling issue, was the chute operating properly, etc.?
- Properly trained dogs can be effective and humane tools for cattle handling. Insure that barking or impeding cattle flow is minimized.
- Cattle handling facilities can be evaluated using the BQA Assessment tools provided at bqa.org





MARKETING CATTLE

The overwhelming majority of cattle are marketed in good health and physical condition. Compromised cattle should not enter intermediate marketing channels because of animal welfare concerns. Depending upon the severity of the condition, processing plant policy, and state or USDA regulations, cattle healthy enough to enter the food supply should be sold directly to a processing plant. Non-ambulatory animals should be humanely euthanized (see Humane Euthanasia section).

TRANSPORTATION

- Knowingly inflicting physical injury or unnecessary pain on cattle when loading, unloading or transporting animals is **not acceptable.**
- Cattle sorting and holding pens should allow handling without undue stress, be located near the loading/unloading facility and be suitable for herd size.
- Provide properly designed and maintained loading facilities for easy and safe animal movement. Proper design of loading chutes as well as personnel that are knowledgeable of their proper use can assure the safety of both cattle and cattle handlers. Ramps and chutes should be strong and solid, provide non-slip footing, and have sides high enough to keep cattle from falling or jumping off. A ramp angle of 25 degrees or less will improve cattle movement.
- All vehicles used to transport cattle should provide for the safety of personnel and cattle during loading, transporting and unloading.

- Strictly adhere to safe load levels with regard to animal weight and space allocation.
- Producers hauling cattle in farm and ranch trailers must ensure that adequate space is provided so that cattle have sufficient room to stand with little risk of being forced down because of overcrowding.
- Cattle that are unable to withstand the rigors of transportation should not be shipped.
- When the vehicle is not full, safely partition cattle into smaller areas to provide stability for the cattle and the vehicle.
- No gap which would allow injury to an animal should exist between the ramp, its sides, and the vehicle.
- Vehicle doors and internal gates should be sufficiently wide to permit cattle to pass through easily without bruising or injury.
- Cattle should be loaded, unloaded, and moved through facilities with patience and as quietly as possible to reduce stress and injury.

NON-AMBULATORY (DOWNER) CATTLE

- Marketing cattle promptly before this issue occurs will promote better quality of life for the animal and be more efficient for the operation.
- A prompt diagnosis should be made to determine whether the animal should be humanely euthanized or receive additional care.
- Provide adequate feed and water to non-ambulatory cattle at least once daily.
- Move downer animals very carefully to avoid compromising animal welfare. Acceptable methods of transporting downers include a sled, low-boy trailer or in the bucket of a loader. Dragging downer animals is unacceptable. Likewise, animals should not be lifted with chains onto transportation conveyances. Animals should not be "scooped" into a frontloader bucket, but rather should be humanely rolled into the bucket by caretakers.
- When treatment is attempted, cattle unable to sit up unaided (i.e. lie flat on their side) and which refuse to eat or drink should be humanely euthanized within 24-36 hours of initial onset.
- **Even though signs of a more favorable prognosis may exist, cattle that are non-ambulatory must not be sent to a livestock market or to a processing facility.**

HUMANE EUTHANASIA

Euthanasia is humane death occurring without pain and suffering, it should be utilized when an animal's condition is such that additional treatment options will not be effective. The decision to euthanize an animal should consider the animal's welfare. The producer will most likely perform on-farm euthanasia because a veterinarian may not be immediately available to perform the service. Persons who perform this task must be technically proficient and have an understanding of the relevant anatomical landmarks and the protocols used for humane euthanasia of animals. When euthanasia is necessary, an excellent reference is the BQA Euthanasia of Cattle and Calves guidelines.

Reasons for euthanasia include:

- Fractures of the legs, hip or spine that are not repairable and result in immobility or inability to stand
- Emergency medical conditions that result in excruciating pain that cannot be relieved by treatment
- Animals that are too weak to be transported due to debilitation from disease or injury
- Paralysis from traumatic injuries or disease that result in immobility
- Disease conditions where no effective treatment is known, prognosis is terminal, or a significant threat to human health is present.

Methods of Euthanasia in Cattle

Acceptable methods for conducting euthanasia in cattle include gunshot and penetrating captive bolt with a secondary step to insure death.

Firearms for Conducting Euthanasia in Cattle

Gunshot is the most common method used for on-farm euthanasia of cattle. Effectiveness depends upon selection of the appropriate caliber of firearm, type of bullet or shot/shell, and accuracy of aim.

Animal/ Firearm	**Handgun**	**Rifle**	**Shotgun**
Calves	.32 to .45 caliber Solid-point bullet	.22 LR caliber or larger Solid-point bullet	.410 to 12 gauge #4-6 birdshot or slug
Adult	.38 to .45 caliber Solid-point bullet	.22 magnum or higher caliber[1] Solid-point bullet	20 to 12 gauge #4-6 birdshot or slug (within 3 feet)

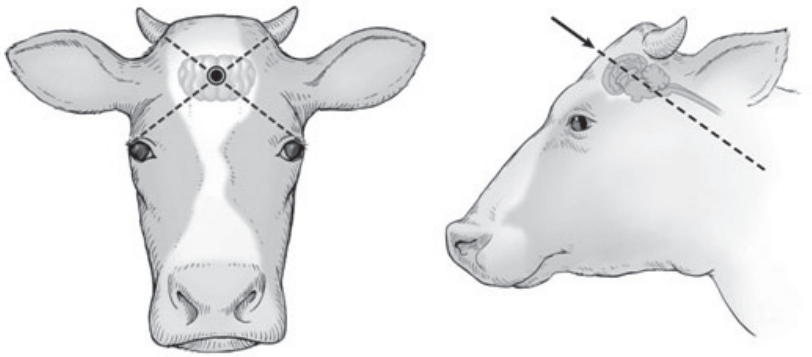
[1] .22 LR is discouraged for use in euthanasia of adult cattle because it lacks sufficient ballistic energy to yield consistent results. Higher caliber rifles should be avoided as bullets may exit the body and place by-standers in danger.

Penetrating Captive Bolt for Conducting Euthanasia of Cattle

Captive bolt guns are designed to cause damage to the brain sufficient to cause an immediate loss of consciousness. However, death is not certain in all cases. Therefore use of penetrating captive bolt should be followed with a secondary step to assure death. Methods used to assure death include a second or third shot if necessary, exsanguination (bleeding out), or use of a pithing rod.

Anatomical Landmarks

Current information for adult cattle and calves indicates that the point of entry of the projectile should be at (or slightly above) the intersection of two imaginary lines, each drawn from the outside corner of the eye to the center of the base of the opposite horn. If a firearm is used it should be used within 3 feet of the target when possible and positioned so that the muzzle is perpendicular to the skull to avoid ricochet. When using penetrating captive bolt, operators are advised to restrain the head so that the captive bolt may be held flush with the skull.



Indications of Unconsciousness

When conducting euthanasia procedures one should always observe animals for the following behaviors:

- Animal collapses immediately when shot and makes no attempt to right itself
- Body and muscles become rigid immediately upon collapse followed by relaxation of the body, brief tetanic spasms and eventually uncoordinated hind limb movements
- An absence of vocalization
- An absence of eye reflexes and eyelids remain open facing straight forward
- Immediate and sustained cessation of rhythmic breathing

These signs should be observed and monitored in all animals for which euthanasia procedures have been applied. Animals that attempt to right themselves, vocalize, blink with their eyes or begin rhythmic breathing are likely returning to a conscious state. In these cases one should immediately recheck the anatomical site used and re-shoot or re-apply the captive bolt. Confirmation of Death Criteria to be used for confirmation of death include lack of pulse, breathing, lack of corneal reflex, response to firm toe pinch (as with a hoof tester), failure to detect/hear respiratory sounds or heart beat by use of a stethoscope, graying of the mucous membranes, and rigor mortis. None of these signs alone, with exception of rigor mortis, confirms death. Rechecking of the animal for these parameters after a period of 20 minutes is a very useful method for confirmation of death.

HEAT STRESS PROCEDURES

- During periods of high heat and humidity and little wind, actions should be taken to minimize the effects of heat stress as cattle are processed and managed.
- Provide adequate water.
- If possible, avoid handling cattle when the risk of heat stress is high. The final decision must consider temperature, humidity, wind speed, phenotype and cattle acclimation. If cattle must be handled, a general rule is to work them before the Temperature Humidity Index (THI) reaches 84, if possible. As an example, when the temperature is 98° F and the humidity is 30%, the THI is 83. At a constant temperature, the THI increases as the relative humidity increases. Each one mile per hour increase in wind speed decreases the THI by approximately one point.
- Work cattle more prone to heat stress first, earlier in the day or later if conditions moderate. For example, larger cattle should be processed during periods of lower THI.
- Limit the time cattle spend in handling facilities where heat stress may be more significant.
- Heat management tools, such as shades and sprinklers, should be considered if sufficient natural shade is not available.

PASTURE CATTLE HEAT STRESS PROCEDURES

- During summer, the THI in parts of the United States can be high.
- Breeding programs should consider cattle's heat tolerance and ability to adapt to their regional environment.
- Trees are abundant on most farms and ranches, providing natural shade and relief from heat. Cattle instinctively use shade and ponds for cooling when the THI is high.

Beef Cattle Temperature Humidity Index

Temperature (°F) \ Relative Humidity (%)	30	35	40	45	50	55	60	65	70	75	80	85
100	84	85	86	87	88	90	91	92	93	94	95	97
98	83	84	85	86	87	88	89	90	91	93	94	95
96	81	82	83	85	86	87	88	89	90	91	92	93
94	80	81	82	83	84	85	86	87	88	89	90	91
92	79	80	81	82	83	84	85	85	86	87	88	89
90	78	79	79	80	81	82	83	84	85	86	86	87
88	76	77	78	79	80	81	81	82	83	84	85	86
86	75	76	77	78	78	79	80	81	81	82	83	84
84	74	75	75	76	77	78	78	79	80	80	81	82
82	73	73	74	75	75	76	77	77	78	79	79	80
80	72	72	73	73	74	75	75	76	76	77	78	78
78	70	71	71	72	73	73	74	74	75	75	76	76
76	69	70	70	71	71	72	72	73	73	74	74	75

Temperature Humidity Index (THI)

Normal <75	Alert 75-78	Danger 79-83	Emergency >84

When heat stress is extreme:

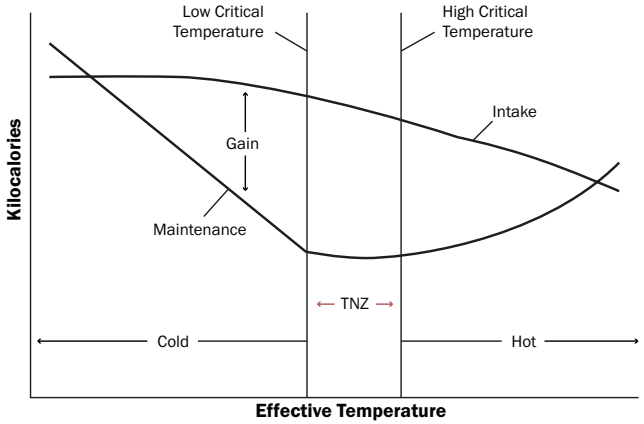
- Ensure adequate drinking water is available.
- Move or process cattle during the cooler part of the day.
- Heat management tools, such as shades and sprinklers, should be considered if sufficient natural shade is not available.

COLD STRESS PROCEDURES

Cattle exposed to cold require more energy for maintenance, and performance will be reduced if action is not taken to provide for it. Some suggestions for reducing winter stress and maintaining production in cold weather are:

- Adjust feed and energy rations to match performance requirements when cattle reach low critical temperature.
- Provide wind breaks and shelters to reduce wind, moisture, and mud.
- Construct feedlots and buildings in a manner that reduces winter stress due to temperature and moisture.
- Provide bedding in severe conditions to allow cattle to lie down without direct contact with frozen ground.

Cattle will voluntarily seek protection from severe weather conditions if it is available. Modest protection by either natural or manmade structures can greatly reduce effects of extreme cold by allowing exposure to be intermittent rather than continuous.



Effect of temperature on rate of feed intake, maintenance energy requirement, and gain. Source: Ames (1980).

Estimated Low Critical Temperatures for Beef Cattle

Coat Description	Low Critical Temperature
Summer coat or wet	59°F
Fall coat	45°F
Winter coat	32°F
Heavy winter coat	18°F

TRAINING AND EDUCATION

Management practices should be informally assessed every day to ensure that animal welfare is not compromised. Regardless, producers are encouraged to implement a system to verify efforts directed towards animal care and handling. This can be accomplished by:

- Establishing a network of resources on cattle care
- Following the *Cattle Care and Handling Guidelines*
- Record training and education activities
- Conducting self-audits or external audits of animal care and handling procedures
    - Self-assessment guides are available online at bqa.org
- BQA training and certification programs
    - For more information go to *bqa.org*
- Informal self-reviews should be periodically conducted by those involved with cattle feeding and care.

Training of those who handle cattle should include:

- An understanding of the animal's point of balance and flight-zone
- Avoiding sudden movements, loud noises or other actions that may frighten cattle
- Proper handling of aggressive/easily excited cattle to ensure the welfare of the cattle and safety of cattle handlers
- Proper use of handling and restraining devices
- Recognizing early signs of distress and disease
- How to properly diagnose common illnesses and provide proper care
- Judicious use of animal health products and how to responsibly perform routine animal health procedures
- Recognizing signs associated with extreme weather stress and how to respond with appropriate actions
- Basic feeding/nutritional management of beef cattle

SELF EVALUATION

Self-evaluation is critical to continuous improvement. Producers are encouraged to utilize the BQA Self Assessments most relevant to their operation. Self Assessment guides can be found online at **www.bqa.org**.

CONTACTS

Name _____ Phone _____

Email _____

Name _____ Phone _____

Email _____

Name _____ Phone _____

Email _____

Name _____ Phone _____

Email _____

Name _____ Phone _____

Email _____

Name _____ Phone _____

Email _____

Name _____ Phone _____

Email _____

Name _____ Phone _____

Email _____

Name _____ Phone _____

Email _____

Name _____ Phone _____

Email _____

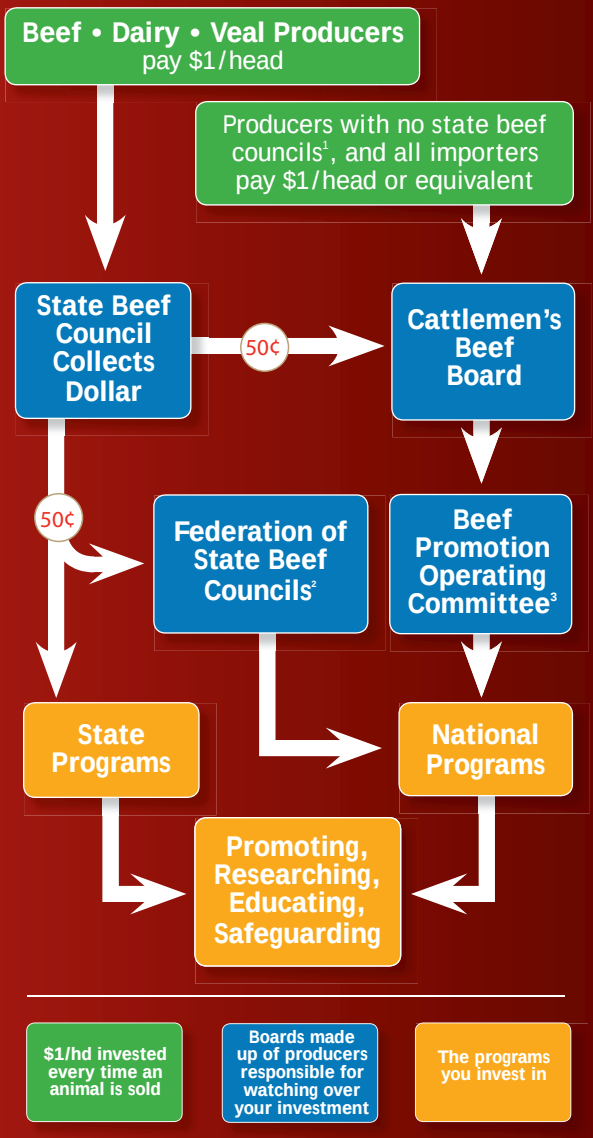
Name _____ Phone _____

Email _____

Name _____ Phone _____

Email _____

Your Beef Checkoff Dollar — From Investment to Results



[1]Producers in the six states with no beef councils — Alaska, Connecticut, Maine, Massachusetts, New Hampshire and Rhode Island — and all importers.
[2]States may invest a portion of their 50 cents in national programs through the Federation of State Beef Councils.
[3]The Beef Promotion Operating Committee has 10 members from the Cattlemen's Beef Board and 10 members from Qualified State Beef Councils. By law, the Operating Committee must contract with national industry-governed organizations to administer checkoff programs. Some of the primary contractors include National Cattlemen's Beef Association (NCBA), American National CattleWomen (ANCW), the U.S. Meat Export Federation (USMEF), National Livestock Producers Association (NLPA) and the Meat Importers Council of America (MICA).

For more information visit:
www.bqa.org

qualityassurance@beef.org
303.694.0305
9110 East Nichols Avenue
Centennial, Colorado 80112

Funded by the Beef Checkoff.

AgriLIFE EXTENSION
Texas A&M System

ASWeb – 116
12-10

Improving Lives. Improving Texas.

The Facts about Optaflexx™: Ractopamine for Cattle

Jason Cleere Ph.D., Beef Cattle Specialist, Texas AgriLife Extension

Competition is tough at junior livestock shows across the U.S. and cattle exhibitors are always looking for ways to gain that "extra edge" needed to be competitive in the show ring. Many products are available that contain any combination of vitamins, minerals, probiotics, fat, etc. and all claim they can help improve the nutritional status of your steer or heifer. However, we all realize that while these products may help eliminate deficiencies in the diet, they cannot take the place of good management and care. Starting out with a good quality animal is the foundation of any successful exhibitor. The second most important part is your calf's basic nutritional needs, which are met with a high quality feed. Finally, the amount of time and effort you invest in your steer or heifer project will ultimately determine how successful your project is.

On January 28, 2004 Elanco Animal Health made Optaflexx™, a new medicated feed additive for finishing cattle, commercially available. The active ingredient in Optaflexx™ is Ractopamine Hydrochloride which is the same compound in Paylean™ (labeled for use only in swine). Optaflexx™ has been shown in numerous research trials to increase rate of weight gain, improve feed efficiency, increase rib eye area, and increase red meat yield in cattle fed in confinement. Research scientists also noticed a slight increase in muscle conformation (visual assessment of muscling in the sirloin and round). Optaflexx™ cannot turn an average calf into a champion, but it may help improve the performance of your calf and slightly increase muscle conformation. The effects of the product occur at the cellular level and do not affect the hormonal status of the animal (not a steroid). The product is a medicated feed additive that is labeled only for use in steers or market heifers (not breeding heifers or bulls) during the last 28-42 days on feed.

The following questions address many of the common questions that may surface about feeding Optaflexx™ to show cattle. Much of the information was adapted from Elanco Animal Health educational materials.

- **How does Optaflexx™ work?** Optaflexx™ repartitions nutrients targeted for fat deposition as the animal approaches maturity to protein synthesis, which results in increased size of muscle fibers, and therefore more lean meat yield.

- **How will Optaflexx™ affect the performance of my steer?** Steers fed Optaflexx™ during the last 28-42 days of the feeding period have shown improved live weight gains by 10 to 21 pounds and improved feed efficiency by 14 to 21 percent.

- **How will Optaflexx™ affect the carcass of my steer?** Optaflexx™ has been shown to increase rib eye area up to 0.5 square inch, has no effect on backfat thickness, and does not affect marbling score or quality grade.

- **Are there any possible negative effects of Optaflexx™ on my steer?** Researchers have not observed any negative effects on animal conformation. However, in cattle with poor skeletal structure (post legged, straight fronted), the added muscle mass could cause these problems to be more evident.

- **Why is Optaflexx™ labeled for use late in the feeding period?** As cattle begin to mature during the final days of the feeding period, market steers or market heifers begin to deposit additional fat and less muscle. The active ingredient in Optaflexx™ increases muscle deposition and reduces the amount of fat deposition during the last 28-42 days of the finishing period. Young growing cattle will demonstrate little or no response when fed Optaflexx™ because most of their nutrients are already directed to protein synthesis rather than fat synthesis. Furthermore, feeding young cattle Optaflexx™ is off-label and illegal.

- **Why is Optaflexx™ not labeled to be fed for more than 42 days?** Research trials have shown that the effect of Optaflexx™ decreases rapidly after the first 35 days of feeding. Performance returns to the level prior to using Optaflexx™. The body essentially will become desensitized to the active ingredients in Optaflexx™. Most importantly, feeding longer than is recommended on the label is illegal!

- **What happens to my market steer or heifer when I stop feeding Optaflexx™?** Approximately 4-8 days after Optaflexx™ is removed from the diet of the animal, performance begins to return to the level prior to using the product. The animal will begin to shift more to fat synthesis rather than muscle synthesis.

- **Can I feed more than the recommended dosage?** More is not better when feeding Optaflexx™! Research trials have shown that feeding Optaflexx™ at higher levels show little or no effect on animal performance or muscle deposition. Additionally, this would be off label use and illegal!

- **What is the withdrawal period of Optaflexx™?** There is no withdrawal period.

- **Can I also use Optaflexx™ in my pigs, lambs, goats, etc.?** NO! Optaflexx™ is approved by the FDA for use in cattle only. Any use in species other than cattle is illegal.

- **Is Paylean™ different than Optaflexx™?** Paylean™ is labeled for use in swine and Optaflexx™ is labeled for use in cattle. Both contain ractopamine hydrochloride but at much different concentrations. Remember it is illegal to feed either product to species other than what is listed on the label.

- **Can I feed my show heifer or bull Optaflexx™?** NO. The product is not approved for use in breeding animals. Studies have not been conducted to determine the effect Optaflexx™ may have on reproduction. Additionally, this would be off label use and illegal!

***All medicated feed additives are to be used in accordance with the FDA approved label. Extra-label use of medicated feed additives is strictly prohibited by federal law and no one has the authority to adjust the dose as labeled, including veterinarians.**

This publication is an educational resource for market steer and market heifer exhibitors and does not serve as an endorsement by Texas AgriLife Extension. If you have additional questions please feel free to contact Jason Cleere at (979) 845-6931 or jjcleere@ag.tamu.edu . Additional information is also available from Elanco Animal Health 1-800-428-4441.

Feedstuffs for Beef Cattle

Mississippi beef cattle producers have an abundance of productive, high-quality forage systems available. Yet achieving a year-round supply of adequate forage yields with acceptable nutrient composition is challenging. Commodity feeds serve as a nutritional option for beef cattle operations to supplement grazing and stored forage.

A wide variety of commodity-derived feedstuffs are used in ruminant animal production systems. Whole cottonseed, cottonseed hulls, cottonseed meal, soybean meal, soybean hulls, corn gluten feed, hominy feed, dried distillers grains, and rice mill feed are examples of commodity feedstuffs common in Mississippi. Decisions about which feedstuffs to incorporate into a nutritional program and their appropriate dietary inclusion levels should be based on several key considerations.

Evaluating Feedstuffs

Supply

Practical and cost-effective availability of specific commodity feeds varies throughout Mississippi. Consider whether or not a reliable supply of a certain feedstuff is available. Feeding program modifications will be necessary if stored supplies of desired feedstuffs are depleted and cannot be replenished as needed. Developing working relationships with reliable suppliers is invaluable when relying on commodity feeds in beef cattle nutritional programs. Seasonality of feedstuff supplies impacts both availability and price. It is not uncommon for trucks to wait for extended periods (often half a day or more) in line to be loaded with commodity feeds during periods of tight supplies relative to demand.

Physical Characteristics

Handling capabilities and producer preferences for feedstuff handling may determine whether a particular feedstuff is a viable option for a particular beef cattle operation. Ability to flow through an auger is one important physical characteristic that affects the usefulness of a feedstuff. Fuzzy, whole cottonseed is a classic example of a feedstuff that does not flow readily through a typical feed auger. Coating cottonseed with cornstarch, however, can alleviate this problem.

Flow characteristics determine the type of truck necessary for hauling a specific feedstuff and the type of storage facilities needed. Some feedstuffs are conducive to storage in upright bins, whereas other feedstuffs require storage areas such as commodity shed bays. The bulkiness and associated storage space required for a given volume of feedstuff varies greatly among these products. Particle size and other mixing characteristics affect the flexibility of including a specific feedstuff as part of a mixed feed. On-farm feed delivery systems also determine the viability of using various feedstuffs. For example, if feedstuffs are likely to cake in self-feeders, then alternative feedstuffs must be selected or alternative feeding methods implemented. Mississippi State University Extension Service Publication 2570 *Feedstuff Handling, Storage, and Feeding Systems for Livestock* provides additional detail on this topic.

Storage life is another important consideration in feedstuff selection. Wet distillers grain is an example of a feedstuff with a relatively short effective storage life. The humid and often warm Mississippi environment is not conducive to lengthy

storage of feeds that rapidly mold or spoil. Be aware of physical characteristics of feedstuffs, such as high moisture content, that increase risk of or accelerate the onset of quality losses, deterioration, or spoilage.

Value

The value of individual feedstuffs is best expressed in terms of price per quantity of nutrients delivered. Nutrients of interest in beef cattle nutritional programs include total digestible nutrients (TDN) or alternative energy values (net energy system, NE), crude protein (CP), fat (which ideally should not exceed 6 percent of the total diet in mature cattle or 4 percent in growing cattle), fiber (crude fiber, neutral detergent fiber, acid detergent fiber), and mineral levels (e.g., ratio of calcium to phosphorus, excessive levels of sulfur, etc.). Knowing the moisture content of a feedstuff and whether the nutrient levels are specified on an as-fed (as-received, moisture content included) or dry matter (DM) basis is critical in assessing the feedstuff's value.

Although certain by-products may be cheap in terms of dollars, they may not necessarily be a good value. The nutritional makeup of feeds and what they contribute to beef cattle performance determine their true value (**Table 1**). Feedstuffs are generally classified as energy, protein, or roughage feeds based on nutrient

Table 1. Nutrient content of selected beef cattle feedstuffs on a dry matter basis.[1]

Feedstuff	Dry matter %	Total digestible nutrients %	Crude protein %	Crude fiber %	Crude fat %	Calcium %	Phosphorus %
Energy feeds							
Whole shelled corn	90	90	9	2	4	0.03	0.32
Hominy feed	90	91	11	7	8	0.06	0.58
Soybean hulls	91	77	12.1	40.1	2.1	0.49	0.21
Oats	89	75	13	12	5	0.05	0.35
Wheat middlings	89	69	18.4	8.2	4.9	0.13	0.99
Rice bran	90	70	16	12	15	0.10	1.73
Cane molasses	75	72	5.8	0	0.1	1	0.11
Grain screenings	88-90	70-91	14.2	9-13	5	0.48	0.43
Citrus pulp	90	80	6.5	13	4	1.90	0.13
Peanut skins	94	65	17.4	12.6	25.5	0.19	0.20
Beet pulp	91	78	9.7	19.8	0.6	0.69	0.10
Protein feeds							
Corn gluten feed	90	80	22	9	3.2	0.10	0.82
Whole cottonseed	92	96	23	24	20	0.21	0.64
Cottonseed meal	92	76	41	13	3	0.18	1.21
Soybean meal	90	84	49	7	1.5	0.30	0.68
Peanut meal	92	77	52.3	10.8	1.4	0.29	0.68
Dried distillers grains	92	86	27	12	10	0.26	0.83
Brewers grains	21	66	25.4	14.9	6.5	0.30	0.55
Roughages							
Cottonseed hulls	91	45	4.1	47.8	1.7	0.15	0.09
Cotton gin trash	90	44	7.4	36.7	1.7	0.65	0.12
Peanut hulls	91	22	8	63	1.5	0.20	0.07
Corn stalks	85	50	6.6	34	2	0.50	0.10
Soybean stubble	88	40	5	44	2	1.00	0.06
Wheat straw	89	44	3.6	41.6	1.8	0.18	0.50

[1]The nutrient values presented are intended as a general guide to nutrient qualities of feedstuffs. Significant variation in nutrient values exists among different feed sources. Laboratory analysis of a representative sample of a feedstuff is recommended to determine nutritive value.

content and intended use. Some feedstuffs, such as whole cottonseed, arguably fit well within multiple classifications.

Comparing feedstuffs on nutrient makeup in terms of dollar value is accomplished using economic replacement values. The basic idea behind this concept is that the nutritional makeup of a feedstuff and what it contributes to beef cattle performance determines the feedstuff's true value. The relative value of feeds is compared in terms of dollar value for TDN and crude protein content as compared to base feeds. Corn is often used as the base energy feedstuff and soybean meal as the base protein feedstuff for comparison purposes. This method does not account for roughage levels needed in the diet or other feeding considerations, but it is useful in quick, overall comparisons of feed prices and nutrient replacement values.

Economic replacement value calculators are available to assist in comparing feedstuffs for nutrient content and price. When ranking the value of individual feedstuffs in a nutritional program, consider the nutrient composition of each feedstuff. For instance, an inexpensive, high-fiber feedstuff with low TDN and CP levels may rank above other feedstuffs for economic replacement value calculated based on TDN and CP levels per unit price, but may not contain adequate concentrations of TDN or CP for the class of cattle to be fed at expected intake levels. Compare energy supplements to energy supplements and protein supplements to protein supplements.

Table 2 shows prices at which selected co-product feedstuffs are relatively equivalent to corn and soybean meal at the given prices. Being able to purchase feedstuffs for less than these relative values would be a

Table 2. Relative value ($/ton) of by-product feeds with selected corn and soybean meal prices.[1,2]

	Corn price, $/ton					
Feed	**175**	**200**	**225**	**250**	**275**	**300**
	207	225	243	261	280	298
Whole cottonseed	220	238	256	274	293	311
	233	251	269	288	306	324
	82	94	105	117	128	140
Cottonseed hulls	83	94	106	117	129	140
	83	94	106	117	129	140
	149	167	185	203	221	239
Soybean hulls	153	171	189	207	225	243
	157	175	193	211	229	247
	182	196	210	224	238	251
Corn gluten feed	197	210	224	238	252	266
	211	225	239	252	266	280
	166	188	210	232	254	276
Hominy feed	167	189	212	234	256	278
	169	191	213	235	258	280
	209	223	237	251	265	279
Dried distillers grains	227	241	255	269	283	298
	245	259	273	288	302	316
	172	189	205	222	238	255
Wheat middlings	182	198	215	231	248	264
	191	208	224	241	257	274
	142	156	170	185	199	213
Rice bran	149	163	177	192	206	220
	155	170	184	198	213	227
	104	120	136	152	168	184
Cane molasses	103	119	134	150	166	182
	102	117	133	149	165	181

[1]Top, middle, and bottom values are estimated based on soybean meal costing $450/ton, $500/ton, and $550/ton, respectively.
[2]These comparisons consider only feedstuff moisture, total digestible nutrients, and crude protein concentrations and do not account for differences in fat, fiber, minerals, etc.

good deal compared to feeding corn and soybean meal base diets at the given prices. Calculators are available from the Mississippi State University Extension Service to calculate economic replacement values.

Feeding Limitations and Restrictions

Both physical and chemical characteristics of feedstuffs determine their appropriateness for various classes of cattle. These traits also dictate appropriate feeding rates and risks, such as acidosis potential. Some feeds may be safely fed free-choice in self-feeders, whereas others require daily hand-feeding. Because each feed has its own unique feeding advantages and limitations, it is worthwhile to visit with someone who is competent in formulating beef cattle diets to reduce the risk of nutritional problems or disorders in the herd.

Appropriate feeding levels of specific feedstuffs are limited by certain nutrient levels. For example, feeding levels of feedstuffs with high fat content may be limited by maximum recommended fat levels in the diet. High fat levels in cattle diets cause scouring (diarrhea) and feed intake fluctuations. Avoid feeding more than 1 pound of added fat per mature cow per day. Also avoid using feedstuffs at feeding levels at which toxic or performance-reducing levels of minerals, chemicals, or other components within the feedstuffs are reached. Also impose feed intake limitations when using feedstuffs known to induce bloat, acidosis, or other nutritional disorders. When initiating changes in cattle diets, it is critical to adapt cattle slowly to dietary changes in small increments over several weeks. Do not change diet composition and/or feed quantities on consecutive days or in large steps.

Always stay informed of current legal restrictions on feedstuff use. The federal ban on ruminant by-products in ruminant diets is a well-known legal restriction that directly impacts beef cattle operations. If commodity production results in chemical residues in by-product or co-product feedstuffs, then follow label-specified feeding restrictions. Stay informed of feeding restrictions, and always adhere to label restrictions on all feedstuffs.

Ruminant animals are capable of using a wide variety of feedstuffs, and many different feedstuffs are available to livestock operations in Mississippi. These feedstuffs offer the option of a broad range of feeding program possibilities for beef cattle operations. With nutritional costs representing significant proportions of both cow-calf and stocker cattle operating budgets in the region, it is worthwhile to investigate commodity feeds as a source of supplemental nutrients for both effective and cost-effective feeding programs on traditional forage-based diets.

Concentrate Feedstuffs

Concentrate feedstuffs are generally the non-roughage component of animal feed. They are grain-based products and co-products of grain production. These feedstuffs usually contribute notable energy and protein to the ration, as energy and protein are "concentrated" in these feedstuffs. The following sections give attributes of commonly encountered concentrate feedstuffs.

Corn

Corn is typically considered the gold standard energy feed for beef cattle and is heavily used in beef cattle diets, particularly in finishing diets. Corn is a relatively high-energy feed due to its high starch content. It has roughly 9 percent CP and 88 percent TDN. Because of its high starch content, cattle must be adapted slowly to corn or rations containing high levels of corn. Because starch is rapidly digestible in the rumen, too much corn at one feeding can result in acidosis and, in some cases, death. Processing (cracking, grinding, steam-flaking) corn can further enhance the digestibility of starch and result in greater potential for acidosis. Due to these limitations, it is recommended that corn never be used as a sole feed source.


Whole corn


Cracked corn

Corn is very palatable to cattle. It contains low calcium and high phosphorus levels like most feed grains. Feeding high levels of corn (greater than 0.5 percent of bodyweight) can cause some depression of forage digestibility. In a situation where a producer is trying to maximize forage use, low levels of corn are suggested.

Grain Sorghum (Milo)


Milo

Grain sorghum is a cereal grain that is sometimes used as cattle feed. It contains slightly less energy than corn and slightly more protein in percentage terms. Grain sorghum is a palatable feed that is typically grown in areas too dry for corn production. Due to its physical nature (hard endosperm), it often requires processing

(cracking, rolling, steaming) before its total nutrient content can be used. As with feeding corn, use caution when feeding grain sorghum. Adapt cattle slowly to high-starch diets to prevent acidosis.

Corn Gluten Feed


Corn gluten feed pellets

Corn gluten feed is a co-product of the corn milling process, which produces high-fructose corn syrup used as a sweetener. It consists primarily of the bran and meal remains from the grain after starch removal. Corn gluten has good protein content, but protein quality is considered subpar for poultry and swine diets. Due to the nature of the extraction process, the protein content of corn gluten feed is highly digestible and rapidly degraded in the rumen. When fed as the bulk of a ration, rumen undegradable (bypass) protein may be deficient. At feeding levels of 0.5 percent of body weight or less on high-forage diets, the TDN value is about equal to corn's. Because of its relatively high nutrient levels, corn gluten feed works as both a protein and energy supplement in beef cattle diets and often prices in as a cost-effective feed ingredient.

As a general guideline, corn gluten feed should not make up more than 50 percent of daily dry matter intake. Like other grain-based feedstuffs, it is relatively low in calcium. Corn gluten feed can contain high sulfur levels that necessitate mixing it with other feeds to dilute sulfur concentrations in the overall diet to avoid problems with polioencephalomalacia, particularly in growing calves.

Corn gluten feed is sometimes fed in self-feeders along with hay or pasture; however, caking is possible in humid conditions. Excessive processing or heating lowers corn gluten's feed value and palatability and darkens its color. Use of the wet form is only practical in areas relatively close to corn mills.

Grain Screenings


Grain dust pellets

Grain screenings are a co-product of grain processing. They are typically available from elevators or mills that handle whole grains. This feedstuff includes the chaff and smaller particles that were "cleaned" off of the final grain product. Due to the nature of the screening process, where the fibrous hull of the grain is most readily abraded off, grain screenings typically contain greater concentrations of fiber and lesser concentrations of energy and protein than whole grains. This means that grain screenings are usually poorer in nutritive value than the grains themselves.

If coming from a plant that processes a variety of grains, grain screenings may lack consistency in nutrient content because their make-up varies even daily. Due to inconsistent quality, it is not recommended to use grain screenings if a desired rate of gain or specific nutrient target is required unless each lot is analyzed for nutritive value. They often come in pelleted form and are sometimes referred to as "grain dust pellets." Grain screenings are useful to help supplement mature cattle rations, but if not managed properly, there is a high risk of acidosis.

Distillers Grains

Distillers grains are a co-product from the fermentation of grain to produce alcohol (e.g., ethanol). They are an excellent source of rumen bypass protein and energy for beef cattle and can be fed as a majority of the total diet for mature beef cattle. They are relatively high in digestible fiber concentration and so are a relatively safe feed from a rumen health standpoint. However, due to the excessive sulfur content from the distillation process, take care when feeding distillers grains. Stocker diets may benefit from inclusion levels of up to 15 to 25 percent of the total diet. Levels greater than 50 percent of the diet may result in sulfur toxicity. Also, because of the relatively high level of phosphorus in distillers grains, it is recommended that a mineral supplement with an adequate level of calcium be offered along with distillers grains.

Drying aids in storage, transportation, and handling of distillers grains. The wet form is roughly 75 percent water and has a limited storage life in Mississippi, particularly during hot conditions. Depending on the time of year and the physical location of the plant, the grain used (typically corn or sorghum) may vary. This leads to some changes in the nutrient content of the feed, as well as physical properties such as color. Most plants provide purchasers with a nutrient analysis of the current product leaving the plant.


Dried distillers grains with solubles


Spray-dried distillers syrup

Hominy Feed


Hominy feed

Hominy feed is made up of the corn bran, germ, and part of the starchy portion of the corn kernel from degermed corn meal production. It is roughly equal to ground corn in energy feeding value and is very palatable. Hominy feed typically contains greater protein levels than corn grains. The fat content is usually 6 percent or more, and the low-fat form provides less energy. It is a finely ground product suitable for mixing with other feeds. Hominy feed is stored, handled, and fed similarly to ground corn. It is best to use up hominy feed supplies in 1 month or less to avoid a stale smell.

Whole Cottonseed

Whole cottonseed is a major co-product of the cotton ginning process. It is an excellent beef cattle feed with relatively good energy and protein levels. Two pounds of cottonseed roughly equals 1 pound each of corn and cottonseed meal for nutritive value. Whole cottonseed is readily available in cotton-producing areas such as the Mississippi Delta. The gossypol and relatively high fat content limits its use levels to 25 percent or less of total dry matter intake. Feed no more than 0.5 percent of body weight per head per day (about 5 to 6 pounds per head per day) to mature cattle, and no more than 0.33 percent of body weight per head per day (about 1.5 to 3 pounds per head per day) to weaned calves. Do not feed it at inclusion levels of more than 20 percent of the diet for cattle in stocker or finishing programs.

There is some evidence of temporary fertility problems in bulls fed whole cottonseed due to its free gossypol content. This may be less of a concern with upland cotton, the type of cotton predominating production in Mississippi and other Southeastern states, compared with pima cotton, which is more commonly grown in the western United States. A precautionary approach to preventing gossypol-induced fertility problems is to avoid feeding whole cottonseed to bulls 60 to 90 days before the start of the breeding season.


Fuzzy, whole cottonseed


EasiFlo whole cottonseed


Delinted whole cottonseed

Cottonseed must be hand-fed and not used in self-feeders. Whole, fuzzy cottonseed has flow limitations in feeding bins and equipment and is difficult to auger or gravity flow. EasiFlo cottonseed is coated lightly with cornstarch and flows freely and augers through traditional grain handling equipment. Acid delinted cottonseed is also available.

Cottonseed Meal


Cottonseed meal

Cottonseed meal is a co-product of the cottonseed oil milling process. It is an excellent locally available protein source that is high in quality and is often substituted for soybean meal. Cottonseed meal works well in what is commonly referred to as a "hot mix" or "range meal," in which it is mixed with salt and possibly corn and offered free-choice.

Free gossypol content is usually much less in cottonseed meal than whole cottonseed and varies by processing method. In many instances, feeding 3 to 5 pounds of cottonseed meal per day to bulls is not likely to expose them to enough gossypol to cause reproductive problems, but this depends upon the free gossypol level of the cottonseed meal. There is potential for enough free gossypol in cottonseed meal to limit this maximum feeding recommendation to 0.5 pound per bull per day. Some producers may choose to err on the side of caution and feed bulls a protein source other than cottonseed meal in the 2 to 3 months leading up to the breeding season.

Cottonseed Hulls


Cottonseed hulls

Cottonseed hulls are another co-product of the cotton industry. They are extremely palatable and may be added to rations to improve consumption. Cottonseed hulls are relatively high in crude fiber concentration, have low digestibility, and can be used as the sole roughage source in cattle diets. Cottonseed hulls make a good hay replacer diet ingredient or alternative to chopped hay in mixed feeds. They are bulky with excellent mixing qualities at low levels in concentrate diets. The bulkiness of cottonseed hulls means that more space is needed for their storage compared with less bulky feedstuffs. Cottonseed hull feeding levels should not exceed 10 to 25 percent of the diet for growing or finishing cattle. They are often an expensive but useful ingredient for cattle diets.

Cotton Gin Trash

Cotton gin trash is a co-product of the cotton ginning process. Gin trash contains boll residues, leaves, stems, and lint. Its composition varies depending on whether it is a product of picker or stripper cotton harvesting methods. Cotton gin trash is a relatively bulky, dusty, lowly palatable, high-fiber, and low-energy feedstuff. It is typically an inexpensive feed, but it has limited uses. The most practical use is in hay-replacer diets when mixed with other feeds. Due to its inexpensive nature, it can also be used as a filler to cheapen rations. However, both poor nutritive value (typically very poor TDN and variable CP concentrations) and physical properties limit its use. Beware of metal fragments or other "trash" that may harm cattle consuming cotton gin trash.

Cotton Gin Mote


Cotton gin mote

Cotton gin mote is the cotton extracted by a gin's lint cleaner during the cotton ginning process. It is similar to cotton gin trash in that it is a relatively high-fiber, low-energy feed; however, palatability is usually not a problem. It is typically offered in loose form or as 4-by-4-by-5-foot bales. The baled form is handled and fed with the same equipment used for moving large, round hay bales. Dust is a major concern when handling and feeding. The most practical use for cotton gin mote is in hay replacer diets with other supplemental feeds. Although it is used to stretch hay supplies, cotton gin mote should not be used as the sole roughage source in cattle diets and should be limited in proportion of the total diet so that it does not dilute overall nutrient levels below cattle requirements.

Oats


Whole oats

Oats are a cereal grain used primarily as an energy source in cattle diets, but their low production levels and high cost often limit their use in cattle feeds. They are not produced in as large quantities as corn or sorghum. Oats have the least digestible energy concentrations of these grains, as well as the lightest weight per volume. Many "sweet feeds" for livestock are mixtures containing oats coated with molasses for additional palatability. Demand for oats for horse feed often drives the price to uneconomical levels for cattle feed. Weaned calf diets, in which palatability and nutrient concentrations are of great importance, are a reasonable use for oats in cattle nutritional programs.

Brewers Grains


Brewers grains

Brewers grains are the co-products or used grains from the fermentation of grains for alcohol (typically beer) production. Barley is most commonly used, but some corn, rice, and other grains may be in the mix depending upon the brewery. The nutrient concentrations of this product vary slightly, especially if a brewery makes several different types of beer. It is recommended that a sample of brewers grains be submitted for nutrient analysis prior to use.

Brewers grains are a relatively good source of rumen bypass protein. Phosphorus and protein concentrations are similar to that found in distillers grains. But, due to the makeup of the grains used, brewers grains typically have less energy and slightly greater calcium concentrations than the whole grains. Still, they tend to contain lower calcium and greater phosphorus percentages than animal requirements, so it is recommended that a mineral with an adequate level of calcium be incorporated into cattle diets that include significant quantities of brewers grains. Additionally, because brewing beer does not involve the harsh chemical used to produce ethanol, brewers grains contain lower sulfur percentages than distillers grains. As the product of the brewery is "thrown away," brewers grains are typically sold "as is," and often availability is not widespread. The materials can be fed wet or dried, with a similar nutrient content between the two, as long as the wet product is fed shortly after production.

Peanut Hulls

Peanut hulls are co-products of the peanut-shelling process. They are extremely bulky and difficult to handle. Peanut hulls are relatively high in fiber concentration but extremely low in energy and protein concentrations. This limits their reasonable inclusion rates in livestock diets to avoid diluting energy concentrations below acceptable levels. The availability of peanut hulls depends upon proximity to a peanut-shelling plant. Practical uses for peanut hulls include being an ingredient in hay-replacer diets and an extender in stocker concentrate diets.


Peanut hulls


Peanut hull pellets

Make sure that any peanut hulls fed to livestock are whole. Finely ground or pelleted peanut hulls lose their effectiveness as a fiber source and can irritate the digestive tract and pose a health risk to cattle. Feeding these processed forms can damage the rumen wall of cattle over time.

Peanut Meal


Peanut meal

Peanut meal is the ground portion of shelled peanuts. This includes the kernel, hull, and some oil. Peanut meal is very high in protein concentration compared to other feedstuffs, even exceeding that of soybean meal. Another advantage to peanut meal is that it is very palatable to cattle. However, it is usually expensive compared to other feedstuffs. Peanut meal use in cattle diets is not widespread because of cost concerns.

Peanut Skins


Peanut skins

Peanut skins are removed from the peanut kernel. They have very limited potential in beef cattle diets. Peanut skins are difficult to handle because they are lightweight, bulky, and easily blown by wind. This can lead to flow problems in augers and machinery. Peanut skins have moderate protein and energy levels compared to other concentrate feedstuffs. They also have relatively greater tannin levels that reduce protein digestibility and decrease palatability. Do not use peanut skins at levels of more than 10 percent of dietary dry matter.

Raw Peanuts

Raw, whole peanuts are a relatively high-quality feed source in terms of nutritive value. Despite this, they are not often included in livestock diets because they are more valuable in foods for human consumption. Peanuts have very good energy and protein levels, but their high fat content limits feeding levels. Feed mature cattle a maximum of 4 pounds per head per day, and introduce peanuts to cattle gradually to avoid digestive problems. Check aflatoxin levels in peanuts before feeding. Do not exceed 300 parts per billion of aflatoxin in finishing cattle diets, 100 parts per billion in breeding cattle diets, or 20 parts per billion in dairy or immature cattle diets.

Rice Bran

Rice bran is a co-product of the rice milling process. It is a finely ground material, which makes handling and storage in bins challenging. Blending rice bran with other feed ingredients can improve flow through machinery and augers. Rice bran has moderate protein levels and is high in fat concentration, unless defatted. Rice bran has a relatively high phosphorus content compared with forages, as is the case with most other feed grain products, which means calcium supplementation is necessary. Rice bran has substantially less energy than soybean hulls, even with its high fat levels. Full fat rice bran is more susceptible to rancidity in warm weather and less palatable than defatted rice bran. Limit rice bran to no more than one-third of the total diet for beef cattle.


Rice bran

Rice Hulls

Rice hulls are a co-product of the rice milling process and may contain floor sweepings. They are extremely low in nutritional value for beef cattle diets but are sometimes included in least-cost formulations as a filler ingredient. The high silica content in rice hulls can lead to digestive tract irritation and bloody stools in cattle, particularly calves. Rice hulls are not recommended in large quantities for beef cattle.


Whole rice hulls


Ground rice hulls

Rice Millfeed


Rice millfeed

Rice millfeed is a co-product of the rice milling process. It consists of a finely ground material that is a combination of rice hulls and rice bran. The nutritive value of rice millfeed is intermediate to its two component ingredients. Rice millfeed is often highly variable in composition and nutritive value. Founder is possible when feeding rice millfeed at high levels. Rice millfeed has handling characteristics similar to rice bran, but it is typically less expensive and has a longer storage life.

Soybean Meal

Soybean meal is a co-product of the soybean oil milling process. It serves as an excellent protein source

for beef cattle diets and is often the "gold standard" protein supplement to which other supplements are compared. It can be mixed with salt (and sometimes corn) in a "hot mix" or "range meal" for limit feeding. Soybean meal is a major ingredient in poultry and swine diets, so ruminant producers must compete for this input.


Soybean meal

Soybean Hulls

Soybean hulls are a co-product of the soybean oil milling process and are a very palatable, digestible feedstuff. They are widely used in Mississippi beef cattle diets. Soybean hulls are a relatively good energy source, particularly on forage-based diets. At feeding levels of 0.5 percent of body weight or less on high-forage diets, soybean hulls are roughly equal to corn as a supplement in terms of nutritive value. Protein concentration of soybean hulls varies widely from load to load. The high fiber content in soybean hulls is considered digestible fiber and not effective fiber. This means that an adequate roughage source is also needed when feeding soybean hulls. They are a good source of calcium but low in phosphorus concentration as noted for other grain-based feedstuffs.

When fed in self-feeders along with hay or pasture, it is important to monitor soybean hull intake. Soybean hulls are conducive to bloat when fed at high levels (over 7 pounds per head per day) or to cattle with a tendency to bloat. Cattle have also been known to choke on pelleted soybean hulls when consuming them rapidly. Soybean hulls are bulky and dusty, so they are best used pelleted or mixed with silage or molasses to reduce dust.


Loose soybean hulls


Soybean hull pellets

Wheat

Wheat is a highly fermentable feedstuff and should be mixed with other ingredients to reduce the risk of acidosis. Feed wheat at no more than 0.5 percent of animal body weight (5 pounds per day for a 1,000-pound cow, 6 pounds per day for a 1,200-pound cow, etc.). Coarsely cracked or rolled wheat is more digestible than whole grain wheat. Wheat is not commonly used as a feed grain in Mississippi.

Wheat Middlings

Wheat middlings (midds) result from the wheat milling process. They generally have good energy and protein concentrations and are moderately palatable. Like most grain-based feedstuffs, wheat midds have high phosphorus levels relative to calcium levels.


Wheat middlings

Wheat midds are available as loose meal or pellets. The pelleted form cannot be stored for any extended length of time during hot, humid weather. Practical use of wheat midds in Mississippi is only during winter. Wheat midds are readily fermented upon consumption by livestock, so they should be combined with other ingredients to reduce the risk of acidosis, founder, and bloat. Limit wheat midd feeding amounts to 50 percent or less of total dietary dry matter intake.

Beet Pulp

Sugar beet pulp is a co-product of the process used to extract sugar from sugar beets. The most common use for beet pulp is in show cattle diets or in horse feeds. Beet pulp is a good source of highly digestible fiber. It can be used as a source of supplemental energy in beef cow diets or as a fiber source in backgrounding and finishing rations.


Dried sugar beet pulp

Citrus Pulp

Citrus pulp is made by shredding, liming, pressing, and drying the peel, pulp, and seed residues from citrus fruit. Citrus pulp is an excellent feedstuff, but availability and cost-effectiveness is limited in Mississippi. Citrus pulp is a good energy supplement. It is a relatively digestible, low-protein, high-fiber feedstuff. The best deals on citrus pulp usually occur midwinter. Limit citrus pulp to one-third or less of dietary dry matter for growing beef cattle. Initial palatability problems with calves are generally quickly overcome. Citrus pulp is often pelleted to facilitate transportation. Darkening toward a black color indicates product overheating.


Citrus pulp

Cane Molasses

Cane molasses is a co-product of sugar manufacturing. It is extremely palatable to cattle and an excellent energy source. Cane molasses is commonly blended with vitamins and minerals. However, cane molasses is relatively low in protein concentration and

should not be used as the sole feedstuff. It does work as an effective treatment for poor-quality hay to improve intake. It is commonly used to cut down on dustiness and improve palatability of stocker cattle diets.


Dried molasses

Bakery Products

Some human food waste can be incorporated into cattle diets. Bakery meal (bakery waste) is an example. It consists of various combinations of breads, crackers, chips, cookies, cakes, and doughnuts that are usually dried and ground together. Bakery waste is quite palatable to cattle. It is generally higher in energy (TDN) and crude protein than corn but very low in fiber concentration. Bakery waste is classified as energy feed, but not as a protein or roughage feed. Therefore, protein and roughage need to be supplied to cattle from other feeds and forages when feeding bakery waste.


Chips co-product

The energy in bakery waste is primarily in the forms of starch and fat. Starches are rapidly digested by cattle and can drop the pH of the rumen leading to acidosis. The fat level in bakery waste is 10 percent on a dry matter basis, which is comparable to the fat level in dried distillers grains. Bakery waste also tends to depress milk fat content when fed at high levels.

Due to acidosis risk, scouring, and feed intake concerns with high-fat feeds, restrict bakery waste feeding levels to no more than 20 to 25 percent of a grain ration on forage-based feeding programs (grazing cattle or cattle supplied with free-choice hay), 10 percent of the total diet (including forage), or 6 pounds per head per day (introduced slowly) for mature cattle. If stockers (growing bulls, steers, or heifers) are fed bakery meal, limit intake of it to 2 to 3 pounds per head per day. Do not allow free-choice intake of bakery waste, and do not double the feeding amounts listed here to feed every other day.

Cereal co-product is another example of one of the many bakery industry co-products that are potential feedstuffs for beef cattle. Cereal co-products are generally available out of Memphis, Tennessee. They are a highly variable product with a high starch content that may promote acidosis or founder in cattle. This product should, therefore, be blended with other feeds and fed at low dietary inclusion rates, not to exceed 10 percent of total dietary dry matter intake.


Cereal co-product

Candy

Candies used for cattle feed are those that did not make the grade for human consumption or were pulled from retail shelves for passing product expiration dates. They vary from hard candies to chocolates to gums and sometimes include packaging materials such as aluminum foil, paper, or plastic wraps. Feedstuff nutritive value varies considerably depending on the candy used. Although they generally provide an excellent energy source (sugar), they are not typically adequate in protein content to meet cattle needs alone.

Often, candies are "special deals" that occur infrequently. Therefore, it is not recommended that a feeding program be based upon candy availability. As with other human food waste products turned livestock feedstuffs, use a conservative approach. Incorporate candy into no more than 10 percent of the total cattle diet on a dry matter intake basis. More specifically, large quantities of chocolate are not recommended for cattle because of the theophylline and theobromine content. In addition, milk chocolate may contain up to 28 percent fat, so limit the amount fed to cattle.

Conclusions

A wide variety of feedstuffs are available for use in cattle diets. This includes both forages and grain-based feeds. Evaluate feedstuff characteristics when considering them for inclusion in cattle diets. Adhere to appropriate feeding guidelines to achieve desired animal performance and avoid digestive problems. Consult a qualified cattle nutritionist for specific feedstuff questions and diet formulation instructions. For more information on feedstuffs for beef cattle or related topics, contact an office of the Mississippi State University Extension Service or visit ***msucares.com/livestock/beef***.

Reference

National Research Council. 2000. Nutrient Requirements of Beef Cattle. 7th Revised Edition, 1996: Update 2000. National Academy Press. Washington, D.C.

The information given here is for educational purposes only. References to commercial products, trade names, or suppliers are made with the understanding that no endorsement is implied and that no discrimination against other products or suppliers is intended.

Publication 2834 (POD-05-14)

By **Jane A. Parish**, Research/Extension Professor, Prairie Research Unit; **Brandi B. Karisch**, Assistant Extension/Research Professor, Animal and Dairy Sciences; and **J. Daniel Rivera**, Associate Research/Extension Professor, South MS Branch Experiment Station.

Produced by Agricultural Communications.

Extension Service of Mississippi State University, cooperating with U.S. Department of Agriculture. Published in furtherance of Acts of Congress, May 8 and June 30, 1914. GARY B. JACKSON, Director

Mineral and Vitamin Nutrition for Beef Cattle

Minerals and vitamins account for a very small proportion of daily dry matter intake in beef cattle diets and can sometimes be overlooked in a herd nutritional program. Although minerals and vitamins are needed as a very small percentage of dietary nutrients, they are very important in beef cattle nutritional programs for proper animal function, such as bone development, immune function, muscle contractions, and nervous system function. Cattle growth and reproductive performance can be compromised if a good mineral program is not in place.

A good mineral and vitamin supplementation program costs approximately $30 to $55 per head per year. With annual cost of production per cow generally being several hundred dollars, the cost of a high-quality mineral and vitamin supplement program is a relatively small investment. Many free-choice mineral and vitamin mixes are formulated for 2- or 4-ounce daily consumption rates. For illustration purposes, if a beef cow consumes 4 ounces (1/4 pound) of a supplement per day for 365 days, then she consumes 91.25 pounds of the supplement in a year. Many mineral and vitamin supplements are packaged in 50-pound bags, so a beef cow consumes almost two 50-pound bags of this supplement annually at the 4-ounce daily consumption rate. Doubling the price of one of these bags of mineral and vitamin supplement approximates the annual cost of the supplement on a per-head basis.

Macrominerals and Microminerals

Beef cattle require at least 17 different mineral elements in their diets. Required minerals are classified as either macrominerals (major minerals) or microminerals (trace minerals), based on the quantities required in beef cattle diets. Macrominerals are required in larger quantities (grams per day) than microminerals (milligrams or micrograms per day).

Macrominerals required by beef cattle include calcium, magnesium, phosphorus, potassium, sodium, chlorine, and sulfur. Required microminerals include chromium, cobalt, copper, iodine, iron, manganese, molybdenum, nickel, selenium, and zinc. Nutrient requirements of specific mineral elements vary, depending on animal age, weight, stage of production, lactation status, breed, stress, and mineral bioavailability (the degree to which a mineral becomes available to the target tissue after administration) from the diet.

Macromineral requirements are typically expressed as a percentage (%) of the total diet, while micromineral requirements are generally expressed as milligrams per kilogram (mg/kg), which is the equivalent of parts per million (ppm). To convert percent to ppm, move the decimal four places to the right (for example 0.2500% = 2500 ppm).

Macromineral Requirements in Beef Cattle

Mineral*, %	Requirement			
	Growing and Finishing Cattle	Stressed Calves**	Dry, Gestating Cows	Lactating Cows
Calcium	0.31	0.6-0.8	0.18	0.58
Magnesium	0.10	0.2-0.3	0.12	0.20
Phosphorus	0.21	0.4-0.5	0.16	0.26
Potassium	0.60	1.2-1.4	0.60	0.70
Sodium	0.06-0.08	0.2-0.3	0.06-0.08	0.10
Sulfur	0.15	0.15	0.15	0.15

*Research data are inadequate to determine chlorine requirements.
**Suggested range.

Source: NRC, 2000. Adapted from NRC Nutrient Requirements of Beef Cattle, 7th revised edition.

Micromineral Requirements in Beef Cattle

Mineral*, ppm	Requirement			
	Growing and Finishing Cattle	Stressed Calves**	Dry, Gestating Cows	Lactating Cows
Cobalt	0.10	0.1-0.2	0.10	0.10
Copper	10.00	10.0-15.0	10.00	10.00
Iodine	0.50	0.3-0.6	0.50	0.50
Iron 50.00	100.0-200.0	50.00	50.00	
Manganese	20.00	40.0-70.0	40.00	40.00
Selenium	0.10	0.1-0.2	0.10	0.10
Zinc 30.00	75.0-100.0	30.00	30.00	

*Research data are inadequate to determine chromium, molybdenum, and nickel requirements.
**Suggested range.

Source: NRC, 2000. Adapted from NRC Nutrient Requirements of Beef Cattle, 7th revised edition.

Dietary mineral sources include forages, concentrate feedstuffs, mineral supplements, and water.

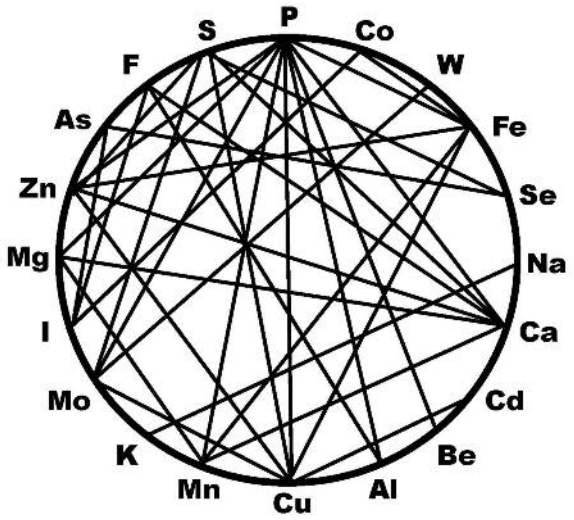
Mineral and Vitamin Levels of Feedstuffs Commonly Utilized in Mississippi

Feedstuff	Calcium, %	Phosphorus, %	Magnesium, %	Potassium, %	Sulfur, %	Copper, ppm	Zinc, ppm	Vitamin A, 1000 IU/kg
Bahiagrass pasture	0.46	0.22	0.25	1.45	0.00	0.00	0.00	304.20
Bahiagrass hay	0.50	0.22	0.19	0.00	0.00	0.00	0.00	0.00
Bermudagrass pasture	0.26	0.18	0.13	1.30	0.21	9.00	20.00	136.20
Ladino clover hay	1.45	0.33	0.47	2.44	0.21	9.41	17.00	33.00
Tall fescue hay	0.51	0.37	0.27	2.30	0.18	0.00	22.00	0.00
Corn silage	0.25	0.22	0.18	1.14	0.12	4.18	17.70	18.00
Cracked corn	0.03	0.32	0.12	0.44	0.11	2.51	24.20	1.00
Corn gluten feed	0.07	0.95	0.40	1.40	0.47	6.98	73.30	1.00
Cottonseed meal, 41% CP	0.20	1.16	0.65	1.65	0.42	16.50	74.00	0.00
Cottonseed hulls	0.15	0.09	0.14	0.87	0.09	13.00	22.00	0.00
Dried distillers grains with solubles	0.32	1.40	0.65	1.83	0.40	83.90	94.80	1.20
Soybean hulls	0.53	0.18	0.22	1.29	0.11	17.80	48.00	0.00
Soybean meal, 44% CP	0.40	0.71	0.31	2.22	0.46	22.40	57.00	0.00
Whole cottonseed	0.16	0.62	0.35	1.22	0.26	7.90	37.70	0.00

Source: NRC, 2000. Adapted from NRC Nutrient Requirements of Beef Cattle, 7th revised edition.

Mineral Interactions

Minerals interact with each other in the body. The many interactions can result in mineral elements' tying up or making other mineral elements unavailable for essential body functions. In practical beef cattle nutrition programs, the interaction between calcium and phosphorus is the classic example of two minerals that affect the required levels of each other in the diet. Calcium and phosphorus recommendations are commonly expressed as a ratio (Ca:P) of calcium to phosphorus.



Potential Mineral Element Interactions

Macrominerals

Calcium (Ca)

Calcium is the most abundant mineral in the body and is involved in many vital body functions, including bone formation and maintenance, development and maintenance of teeth, blood clotting, membrane permeability, muscle contraction, nerve impulse transmission, heart regulation, milk secretion, hormone secretion, and enzyme activation and function.

Most calcium supplies in the body are found in the bones and teeth. Bones can supply short-term dietary deficiencies of calcium. However, long-term dietary calcium deficiencies can cause severe production problems. Vitamin D is required for calcium absorption. Diets high in fat can reduce calcium absorption.

Calcium deficiency interferes with normal bone growth in young cattle and can cause rickets (weak, soft bones that are easily fractured) and retarded growth and development. In adult cattle, calcium deficiency can cause osteomalacia, a condition characterized by weak and brittle bones. Milk fever, a condition usually associated with dairy cattle, can also occur in beef cattle as a result of calcium deficiency and leads to cows that go down soon after calving. Milk fever is described in detail in the nutritional disorders section of this publication.

Forages are generally higher in calcium concentrations than concentrate (grain-based) feedstuffs, with legumes (such as clovers and alfalfa) typically providing higher calcium levels than grasses. Calcium content in forages varies with species, plant part, maturity, quantity of calcium available in the soil for plant uptake, and climate.

Cattle can tolerate high concentrations of dietary calcium if other mineral levels are adequate in the diet. Calcium recommendations are expressed in terms of a calcium to phosphorus ratio (Ca:P), where approximately 1.6:1 is ideal, with a range of 1:1 to 4:1 being acceptable.

Supplemental calcium sources include calcium carbonate, feed-grade limestone, dicalcium phosphate, defluorinated phosphate, monocalcium phosphate, and calcium sulfate. Feed-grade limestone is approximately 34 percent calcium and is commonly added to beef cattle diets to increase the calcium levels of the diet. Dicalcium phosphate is approximately 22 percent calcium and 19.3 percent phosphorus and is added to beef cattle diets to help balance the calcium to phosphorus ratio. It adds both calcium and phosphorus to the diet.

Phosphorus (P)

Similar to calcium, most phosphorus is in the bones and teeth, but some phosphorus is in soft tissues as well. Phosphorus is required for skeletal development and maintenance, normal milk secretion, muscle tissue building, cell growth and differentiation, energy use and transfer, efficient food use, membrane formation, function of many enzyme systems, osmotic and acid-base balance maintenance, and rumen microorganism growth and metabolism. Most phosphorus losses are through the feces, while urinary phosphorus losses are lower but increase on high-concentrate diets.

Phosphorus requirements are often presented in terms of the calcium to phosphorus ratio described earlier. The most critical aspect is that phosphorus

levels meet cattle requirements. Most phosphorus losses are through the feces, while urinary phosphorus losses are lower but increase on high-concentrate diets. Excessive phosphorus intake can lead to increased fecal output of phosphorus into the environment and have environmental implications. Too much phosphorus in the diet can also result in urinary calculi, a condition detailed in the nutritional disorders section of this publication.

Phosphorus deficiency has tremendous implications for beef cattle performance. Not meeting animal phosphorus requirements reduces growth and feed efficiency, decreases dry matter intake, lowers reproductive performance, depresses milk production, and causes weak and fragile bones. Mature cattle can draw on phosphorus reserves in bones when needed, but skeletal phosphorus supplies must be replenished to avoid a phosphorus deficiency situation.

Forages are generally low in phosphorus as compared to concentrate feedstuffs such as cereal grains and oilseed meals (cottonseed meal, soybean meal). Drought conditions and increased forage maturity further deplete forage phosphorus concentrations. This suggests that higher phosphorus supplementation may be needed to supply increased dietary phosphorus levels when grazing or feeding stored mature forages or during periods of drought. Dicalcium phosphate, defluorinated phosphate, monoammonium phosphate, and phytate phosphate are sources of supplemental phosphorus for ruminants. Recommended phosphorus levels in a mineral supplement are generally from 4 to 8 percent, largely depending on forage conditions and other levels of dietary sources of phosphorus.

Magnesium (Mg)

Approximately 65 to 70 percent of magnesium in the body is found in bone, 15 percent in muscle, 15 percent in other soft tissues, and 1 percent in extracellular fluid. Magnesium is important for enzyme activation, glucose breakdown, genetic code transmission, membrane transport, nerve impulse transmission, and skeletal development.

In general, magnesium toxicity is not a problem in beef cattle, with concentrations up to 0.4 percent being tolerated. Yet excessive magnesium intake can result in severe diarrhea, sluggish appearance, and reduced dry matter digestibility.

Magnesium deficiency, on the other hand, can be severe in beef cattle. Signs of magnesium deficiency include excitability, anorexia, increased blood flow, convulsions, frothing at the mouth, prolific salivation, and soft tissue calcification. Young cattle can mobilize large amounts of magnesium from bone, but mature cattle are unable to do this, and they must receive regular and adequate magnesium supplies from the diet. Grass tetany, a condition common among lactating beef cows grazing lush forages, is characterized by low magnesium levels. Grass tetany is discussed in detail in the nutrition disorders section later in this publication.

Forage magnesium concentrations depend on plant species, soil magnesium levels, plant growth stage, season, and environmental temperature. Legumes usually contain higher magnesium levels than grasses. Cereal grains contain approximately 0.11 to 0.17 percent magnesium, and plant protein sources contain roughly double these amounts. Magnesium sulfate and magnesium oxide serve as good supplemental sources of magnesium. Recommendations for magnesium supplementation are magnesium offered at 2 to 4 percent of the supplement when cattle consume low and intermediate forages, respectively. Raise this level to at least 10 percent of the supplement to avoid grass tetany on lush forages.

The USDA's National Animal Health Monitoring System (NAHMS) reported in a 1996 survey that, by U.S. geographic region, beef cattle operators in the southeastern U.S. were most likely to supplement magnesium to their beef cattle herds than any other region. Seventy-four and a half percent of southeastern beef cattle operators reported supplementing magnesium compared to the U.S. average of 63.5 percent. The production of lush forages in the southeast coincides with calving season on many southeastern U.S. cattle operations, and many producers recognize these conditions as increasing grass tetany risk. Increasing magnesium supplementation is a common producer action to prevent grass tetany.

Potassium (K)

The third most abundant mineral in the body is potassium. Potassium is in intracellular fluid and is involved in acid-base balance, osmotic pressure regulation, water balance, muscle contractions, nerve impulse transmission, oxygen and carbon dioxide transport in the blood, and enzyme reactions. Potassium prevents tetany, convulsions, and unsteady gait.

Potassium deficiency is indicated by reduced feed intake, depraved appetite, lowered weight gains, rough hair coat, and muscle weakness. Body stores of potassium are low, so potassium deficiency can

begin quickly. Potassium is mainly excreted in the urine of cattle, and potassium secretion in milk is relatively high.

Forages are good sources of this mineral, often ranging from 1 to 4 percent potassium. Potassium content can be very high in lush pasture, potentially contributing to grass tetany onset. Mature and stockpiled forage contain lowered concentrations of potassium.

Cereal grains are typically low in potassium content, while oilseed meals are generally good sources. High-concentrate diets likely require potassium supplementation if forage or protein sources containing adequate potassium levels are not provided. Generally, potassium supplementation on pasture is not critical. Supplemental potassium sources include potassium chloride, potassium bicarbonate, potassium sulfate, and potassium carbonate, which are all readily available dietary forms for beef cattle.

Sodium (Na) and Chlorine (Cl)

Sodium and chlorine are components of common white salt. Sodium and chlorine are each in the body in extracellular fluid. They are important for maintaining osmotic pressure, controlling water balance, regulating acid-base balance, contracting muscles, transmitting nerve impulses, and carrying glucose and amino acids. Sodium is necessary for the operation of some enzyme systems. Heart action and nerve impulse transmission depend on some sodium and potassium. Chlorine is needed for hydrochloric acid production in the abomasum (true ruminant stomach) and activation of amylase, an enzyme critical for normal starch digestion. Chlorine also aids in respiratory gas exchange.

Cattle crave sodium and will consume more salt than needed when it is supplied free choice. High concentrations of salt are sometimes used to regulate feed intake. Cattle consume approximately 0.1 pound salt per 100 pounds of body weight in salt-limited feeds (0.5 pounds per day for a 500 lb. calf; 1.1 pounds per day for a 1100 lb. cow). These high dietary intake levels of salt are generally tolerated by cattle when adequate water is available. Dietary salt levels of 6.5 percent have been shown to reduce feed intake and growth. The maximum tolerable concentration for total dietary salt is estimated at 9 percent. Recommended salt content of a mineral and vitamin supplement is in the range of 10 to 25 percent of the supplement.

When salt is present in the drinking water of cattle, salt toxicity risk increases. Salt concentrations in drinking water of 1.25 to 2.0 percent can result in anorexia, reduced weight gain or increased weight loss, lowered water intake, and collapse. Even lower levels of salt in drinking water can result in reduced feed and water intake, decreased cattle growth, digestive disturbances, and diarrhea.

In Mississippi, beef cattle producers in coastal regions should be particularly cautious of fresh water supplies for cattle that may become contaminated with salt in the aftermath of a tropical storm or hurricane.

A chlorine deficiency is not probable under most production conditions. Sodium deficiency signs include reduced and abnormal feed intake, retarded growth, and decreased milk production.

Forage sodium content varies considerably, and cereal grains and oilseed meals are typically not good sources of sodium. Sodium can be supplemented as sodium chloride or sodium bicarbonate, both of which are highly available forms for beef cattle.

Sulfur (S)

Sulfur is a building block in several amino acids (methoinine, cysteine, and cystine) and B vitamins (thiamin and biotin) along with other organic compounds. Sulfur functions in the body in detoxification reactions and is required by ruminal microorganisms for growth and normal cell function.

Sulfur toxicity is characterized by restlessness, diarrhea, muscle twitching, and labored breathing. In protracted cases, inactivity and death may follow. High sulfur levels are associated with polioencephalomalacia, a condition discussed in detail in the nutritional disorders section of this publication.

Lower sulfur intakes can reduce feed intake, depress growth, and decrease copper levels. Lowered feed and water intake can occur when high levels of sulfur are consumed in drinking water. Reported sulfur deficiency signs are anorexia, weight loss, weakness, emaciation, profuse salivation, and death. Less severe sulfur deficiencies can reduce feed intake, digestibility, rumen microorganism numbers, and microbial protein synthesis. Lactate accumulation in the rumen and blood can then develop with disruption of rumen microbe populations.

Sulfur in feedstuffs is found largely as a component of protein. In diets containing high levels of sorghum forages, mature forages, forages produced in sulfur-deficient soils, corn silage, rumen-bypass proteins, or where urea or other non-protein nitrogen sources replace plant protein sources, dietary sulfur requirements or supplementation needs may be increased. Potential sulfur supplements include sodium sulfate, ammonium sulfate, calcium sulfate, potassium sulfate, magnesium sulfate, or elemental sulfur.

Microminerals

Chromium (Cr)

Chromium is a trace mineral involved in glucose clearance. Immune response and growth rate in stressed cattle has been shown to improve with chromium supplementation. Chromium can be supplemented as chromium picolinate or chromium polynicotinate. However, beef cattle producers do not need to be concerned about chromium supplementation under normal circumstances.

Cobalt (Co)

Cobalt functions as a component of vitamin B12 (cobalamin). The microbes of ruminants are able to synthesize vitamin B12 if cobalt is present.

Cattle can tolerate approximately 100 times their dietary requirement for cobalt, so cobalt toxicity is not likely unless a mineral supplement formulation error is made. Cobalt toxicity signs include decreased feed intake, reduced weight gain, anemia, emaciation, abnormal increase in the hemoglobin content of red blood cells, and weakness.

Young, growing cattle appear to be more sensitive to cobalt deficiency than mature cattle. Initial cobalt deficiency signs are depressed appetite and reduced growth performance or weight loss. In cases of severe cobalt deficiency, cattle display severe unthriftiness, swift weight loss, liver breakdown, and anemia. Cobalt deficiency has also been demonstrated to compromise immune system problems and disruption of microorganism production of propionate (a volatile fatty acid important for glucose production).

Legumes are usually higher in cobalt than grasses. Soil pH is a major determinant of cobalt availability in the soil. Cobalt sulfate and cobalt carbonate are examples of supplemental cobalt sources for beef cattle diets. For a mineral supplement with an expected 4-ounce daily intake, the supplement should include 15 ppm cobalt.

Copper (Cu)

Copper is an essential component of many enzymes including lysyl oxidase, cytochrome oxidase, superoxide dismutase, ceruloplasmin, and tyrosinase.

Supplementing with too much copper or contaminating feeds with copper could result in copper toxicity. Copper accumulates in the liver before toxicity occurs. Large releases of copper from the liver cause red blood cell breakage; elevated methemoglobin levels in the blood, impairing oxygen transport; abnormally high hemoglobin content in the urine; jaundice; widespread tissue death; and, finally, death. Young cattle are more susceptible to copper toxicity than older cattle. Cattle with a mature rumen do not absorb copper well, but the liver can store significant quantities of copper. Molybdenum, sulfur, and iron levels in the diet affect copper levels required to induce toxicity.

Copper deficiency is a widespread problem in U.S. beef cattle herds. Cattle experiencing copper deficiency exhibit anemia, reduced growth, loss of pigmentation in hair, changes in hair growth and appearance, heart failure, easily fractured bones, diarrhea, compromised immune system function, and impaired reproduction, particularly estrous cycle disruption. Breed composition of cattle also affects copper requirements. For example, Simmental and Charolais require more copper than Angus, and copper supplement levels may need to be increased by as much as 25 to 50 percent for these breeds. In cattle grazing toxic endophyte-infected tall fescue, tall fescue toxicosis may be confused for copper deficiency, based on hair coat changes. In some cases, these conditions can occur together.

Copper is more available in concentrate diets than in forage diets. Forages vary greatly in copper content and may contain variable levels of molybdenum, sulfur, and iron, which reduce usable copper levels. Molybdenum, sulfur, iron, and zinc reduce copper status in the body can impact copper requirements. Legumes typically contain higher copper concentrations compared to grasses. In addition, oilseed meals generally contain higher levels of copper than cereal grains. Copper supplements include sulfate, carbonate, oxide, and organic forms. Copper oxide is poorly available compared with other the copper forms listed. General copper supplementation recommendations are 1250 ppm copper for a supplement consumed at a rate of four ounces per day.

Iodine (I)

Iodine is a key component of thyroid hormones involved in energy metabolism rate regulation in the body. Iodine is rarely deficient in cow herds in the Southeast U.S. Calves born hairless, weak, or dead; irregular cycling, reduced conception rate, and retained placenta in breeding age beef females; and depressed libido and semen quality in bulls are classic iodine deficiency signs. Onset of deficiency signs may be delayed well beyond the actual initial period of iodine deficiency.

Iodine deficiency is characterized by enlargement of the thyroid (goiter). Goitrogenic substances in feeds suppress thyroid function and can affect iodine requirements. In white clover, thiocyanate is derived from cyanate and impairs iodine uptake by the thyroid. Some Brassica forages, such as kale, turnips, and rape, contain glucosinolates with goitrogenic effects, but most reports of problems are in sheep and goats. Soybean meal and cottonseed meal are also reported to have goitrogenic effects.

Iodine toxicity affects cattle by reducing weight gain, lowering feed intake, and causing coughing and undue nasal discharge.

Dietary iodine supplement sources include calcium iodate, ethylenediamine dihydroiodide (EDDI), potassium iodide, and sodium iodide. The calcium iodate and EDDI forms of iodine are very stable and have high bioavailability in cattle, while the potassium and sodium iodide forms are relatively unstable and can break down when exposed to other minerals, heat, light, or moisture. A supplementation rate of 50 ppm iodine in a 4-ounce per day intake mineral supplement is recommended.

The EDDI form is an organic form that has been used for foot rot prevention. Levels of EDDI necessary for foot rot control are much higher than nutrient requirement levels. Currently, the maximum legal supplementation rate of EDDI is 50 mg per head per day. This level is not effective for foot rot control, and the Food and Drug Administration (FDA) does not allow claims of EDDI supplements to treat or prevent any animal disease.

Iron (Fe)

Iron is a critical component of hemoglobin and myoglobin, two proteins involved in oxygen transport and use. More than half of the iron in the body is in hemoglobin. This element is also an essential component of several cytochromes and iron-sulfur proteins involved in the electron transport chain. In addition, some enzymes either contain or are activated by iron.

Iron toxicity manifests as diarrhea, acidosis (digestive tract disturbance), hypothermia (lower than normal core body temperature), reduced weight gain, and depressed feed intake. Iron depletes copper in cattle and can contribute to copper deficiency if copper supplementation levels are not adjusted to compensate for copper losses. Iron deficiency causes anemia, lethargy, lowered feed intake, reduced weight gain, pale mucous membranes, and shriveling of the raised tissue structures on the tongue. Conditions that cause chronic blood loss, such as severe parasite infestations, can lead to iron deficiency. Evidence suggests iron requirements are higher for young cattle than for mature cattle. Calves raised in confinement exclusively on milk diets are more prone to iron deficiency.

Iron sources include forages, cereal grains, oilseed meals, water, and soil ingestion. However, forage iron content varies greatly, and bioavailability of iron from forages is low relative to supplemental sources. Common supplemental sources include ferrous sulfate (iron sulfate), ferrous carbonate (iron carbonate), and ferric oxide (iron oxide or "rust"). Bioavailability rank of these iron sources from most to least available is sulfate, carbonate, and then oxide form. Iron oxide has very little nutritional value. Iron is generally not needed from sources other than those provided by other mineral compounds commonly found in complete mineral supplements.

Manganese (Mn)

Manganese usefulness in the body is as a constituent of the enzymes pyruvate carboxylase, arginase, and superoxide dismutase and as an activator for many other enzymes, including hydrolases, kinases, transferases, and decarboxylases. Manganese is important for normal skeletal development, growth, and reproductive function.

At extremely high levels of manganese intake, growth performance and feed intake are reduced. Cattle deficient in manganese exhibit skeletal abnormalities, including stiffness, twisted legs, joint enlargement, and weak bones in young cattle. Older cattle display depressed or irregular estrus, low conception rate, abortion, stillbirths, and light birth weights when manganese intake is inadequate.

Forage manganese levels vary with plant species, soil pH, and soil drainage, but forages usually contain adequate manganese levels. Corn silage manganese content is generally low. Feed-grade manganese forms include manganese sulfate, manganese oxide, manganese methionine, manganese proteinate, manganese polysaccharide complex, and manganese amino acid chelate. Bioavailability ranking from most to least available is manganese methionine, manganese sulfate, and, lastly, manganese oxide. A recommended manganese level is 2000 ppm in a 4-ounce daily intake mineral supplement.

Molybdenum (Mo)

The enzymes xanthine oxidase, sulfite oxidase, and aldehyde oxidase contain molybdenum. This element may improve microbial activity in the rumen under certain conditions.

There is no proof cattle experience molybdenum deficiency under normal production circumstances, so molybdenum supplementation is not a practical concern. Molybdenum toxicity, on the other hand, results in diarrhea, anorexia, weight loss, stiffness, and hair color alterations. Other potential effects of molybdenum toxicity include increased heifer age at puberty, decreased weight of heifers at puberty, and reduced conception rate. Calf growth performance is also slowed by excessive molybdenum levels. Copper and sulfur work against molybdenum in the body. Molybdenum contributes to copper deficiency, and copper can reduce molybdenum toxicity.

Forage molybdenum concentrates fluctuate with soil type and soil pH. Increased soil moisture, organic matter, and pH improve forage molybdenum levels. Molybdenum content in cereal grains and protein sources is more consistent.

Nickel (Ni)

The function of nickel in cattle is unknown. Yet nickel deficiency has been experimentally induced in animals. Nickel plays a role in ureolytic bacteria function as an essential component of the urease enzyme that breaks down urea (a common nonprotein nitrogen source in cattle diets). In general, nickel supplementation is not a concern on beef cattle operations under normal circumstances.

Selenium (Se)

Selenium is an important part of the enzymes glutathione peroxidase and iodothyronine 5′-deiodinase. Glutathione peroxidase helps prevent oxidative damage to tissues. The latter enzyme is involved in thyroid hormone metabolism. The functions of vitamin E and selenium are interrelated. Diets low in vitamin E may require selenium supplementation.

Signs of chronic selenium toxicosis include lameness, anorexia, emaciation, sore feet, cracked and deformed hooves, liver cirrhosis, kidney inflammation, and tail hair loss. In severe toxicity cases, difficulty breathing, diarrhea, muscle incoordination, abnormal posture, and death from respiratory failure are observed.

Selenium deficiency can lead to white muscle disease, a condition discussed in detail later in the nutritional disorders section of this publication. Calves may experience compromised immune response even when no other clinical signs of selenium deficiency are present. Unthriftiness, weight loss, and diarrhea are other deficiency signs.

Feed-grade selenium is often supplied as sodium selenite or sodium selenate, while selenomethionine is the common form in most feedstuffs. Selenium yeast is also a selenium source approved for use in cattle feed. Because of the high toxicity of selenium, it should be supplemented in a premixed form only. The FDA allows sodium selenate or sodium selenite as sources of selenium for selenium supplementation of complete feeds at a level not more than 0.3 ppm. The FDA permits up to 120 ppm selenium to be included in a salt-mineral mixture for free-choice feeding. Selenium injections are another way to provide selenium.

In some regions of the U.S., chronic selenium toxicity (alkali disease) occurs as a result of cattle's consuming forages grown on high selenium soils. Other regions of the U.S., including the southeastern U.S., are predisposed to selenium deficiency risk based on low soil and forage selenium content. In selenium-deficiency-prone areas, use the maximum legal selenium supplement level in the feed and note that when purchasing feedstuffs from areas known to be deficient in selenium, selenium supplementation may need to be considered.

Zinc (Zn)

Zinc is a crucial component of many important enzymes and is also needed to activate other enzymes. These enzymes function in nucleic acid, protein, and carbohydrate metabolism. Zinc plays an important role in immune system development and function as well.

Quantities of zinc needed to cause toxicity are much greater than animal requirements. Signs of zinc toxicity include reduced weight gain, feed intake, and feed efficiency. Severe cases of zinc deficiency include listlessness, excessive salivation, testicular growth reduction, swollen feet, scaly lesions on feet, tissue lesions (most often on the legs, neck, head, and around the nostrils), slow healing of wounds, and hair loss. Less dramatic zinc deficiencies can cause decreased growth and lower reproductive performance.

Similar to several other minerals, zinc concentrations in forages depend on many factors, and zinc concentration in legumes is greater than in grasses. Plant proteins are typically higher in zinc levels than cereal grains. Supplemental sources of zinc include oxide, sulfate, methionine, and proteinate forms. The oxide and sulfate forms appear to have similar bioavailabilities, indicating no advantage to using zinc sulfate over zinc oxide. Zinc should be supplemented at a rate of 4000 ppm in a supplement designed for 4 ounces of intake per head per day.

Nutritional Disorders Related to Mineral Imbalances

Mineral imbalances (toxicities or deficiencies) can trigger nutritional disorders such as grass tetany, urinary calculi, polioencephalomalacia, white muscle disease, and milk fever in cattle. While these disorders can produce dramatic signs in affected cattle, mineral imbalances are often overlooked because only subclinical signs are present.

In the NAHMS 1996 survey, relatively few operations (5.2 percent) reported any known mineral deficiencies in the previous five years. However, these percentages likely severely underestimate the true magnitude of mineral deficiencies in cow-calf herds. A 1993 cow-calf study indicated that the extent of marginal and severe deficiency for copper and selenium is much more widespread.

In the absence of clinical signs, a mineral imbalance may be suspected if blood and tissue sample analysis or forage and diet mineral analysis suggests a problem. Compare levels of dietary mineral sources with cattle requirements detailed earlier in this publication to identify significant potential mineral imbalance problems. These are not always definitive for identifying mineral imbalances, though. It is important to be alert for "red flags" in animal behavior and appearance to catch a problem early and minimize losses. Veterinarians should be familiar with mineral-related disorders common in their areas and can assist with prevention and treatment. Reduced cattle performance from mineral imbalances is preventable with a good mineral nutrition program.

Grass Tetany

Cause. Grass tetany is associated with low levels of magnesium or calcium in cattle grazing annual ryegrass, small grains (such as oats, rye, wheat), and cool-season perennial grasses (such as tall fescue) in late winter and early spring. Grass tetany in Mississippi usually occurs February through April, when spring-calving cows graze on lush annual ryegrass or tall fescue. During this time of the year, there is often a flush of new forage growth. This is also the time of year many spring calves are born and nursing. Grass tetany most commonly affects lactating cattle, particularly the highest-milking animals in the herd. Magnesium and calcium requirements of lactating cattle are far greater than those of nonlactating cattle. This predisposes cattle to grass tetany during lactation. Grass tetany results when magnesium and calcium levels in forages are too low to meet the requirements of cattle and cattle do not get enough magnesium and calcium supplementation. Clinical signs of grass tetany include nervousness, muscle twitching around the face and ears, staggering, and reduced feed intake. An affected animal may go down on its side, experience muscle spasms and convulsions, and die if not treated.

Prevention. Forages grown on soils deficient in magnesium, wet soils, or soils low in phosphorus but high in potassium and nitrogen may contain very low levels of magnesium and calcium. Lime magnesium-deficient pastures with dolomitic lime, which contains magnesium. This may not prevent grass tetany on waterlogged soils, because plants may not be able to take up enough magnesium under wet conditions.

Phosphorus fertilization may also improve forage magnesium levels. However, environmental concerns associated with excessive soil phosphorus levels should be considered. High levels of nitrogen and potassium fertilization are associated with increased grass tetany, so fertilization plans should consider this. Legumes are often high in magnesium and may help reduce the risk of grass tetany when included in the forage program. The most reliable method of grass tetany prevention is supplemental feeding of magnesium and calcium during the grass tetany season. Both can be included in a mineral mix as part of a mineral supplementation program. Initiate high-magnesium (at least 10 percent Mg and preferably 13 to 14 percent Mg) mineral feeding at least one month before grass tetany season.

Urinary Calculi or "Water Belly"

Cause. Urinary calculi (kidney stones) are hard mineral deposits in the urinary tracts of cattle. Affected cattle may experience chronic bladder infection from tissue damage produced by the calculi. In more serious cases, calculi may block the flow of urine, particularly in male animals. The urinary bladder or urethra may rupture from prolonged urinary tract blockage, resulting in release of urine into the surrounding tissues. The collection of urine under the skin or in the abdominal cavity is referred to as "water belly." Death from toxemia may result within 48 hours of bladder rupture. Signs of urinary calculi include straining to urinate, dribbling urine, blood-tinged urine, and indications of extreme discomfort, such as tail wringing, foot stamping, and kicking at the abdomen. Phosphate urinary calculi form in cattle on high grain diets, while silicate urinary calculi typically develop in cattle on rangeland.

Prevention. Strategies to prevent problems with urinary calculi in cattle include lowering urinary phosphorus levels, acidifying the urine, and increasing urine volume. To lower urinary phosphorus levels, avoid diets high in phosphorus. Maintain a dietary calcium-to-phosphorus ratio of 2:1. This ratio is preferred over the previously mentioned 1.6:1 ratio in situations where urinary calculi risk is of concern. Acid-forming salts such as ammonium chloride may be fed to acidify the urine. Ammonium chloride may be fed at a rate of 1.0 to 1.5 ounces per head per day. Urine volume may be increased by feeding salt at 1 to 4 percent of the diet while providing enough water.

Polioencephalomalacia

Cause. Polioencephalomalacia is caused by a disturbance in thiamine metabolism. Thiamine is required for a number of important nervous system functions. This disease most commonly affects young, fast-growing cattle on a high concentrate diet and may result from a thiamine-deficient diet, an increase in thiaminase (an enzyme that breaks down thiamine) in the rumen, or an increase in dietary sulfates.

A thiamine-deficient diet is usually associated with an increase in the dietary-concentrate-to-roughage ratio. When concentrates (feed grains such as corn) are increased and roughage (forage, cottonseed hulls, etc.) are decreased in the diet, rumen pH drops. This increases the numbers of thiaminase-producing bacteria in the rumen. Thiaminase breaks down the form of thiamine the animal normally could use. Some species of plants produce thiaminase and can cause a decrease in the useable amount of thiamine when consumed. Examples of these plants include kochia, bracken fern, and equisetum.

A high sulfate diet can also inhibit an animal's ability to properly use thiamine. Feeds such as molasses, corn gluten feed, and dried distillers grains are often high in dietary sulfates. Some water sources can also contain a high amount of sulfur (such as "gyp" water). When these are consumed in excessive amounts, clinical signs of polioencephalomalacia can occur.

Affected cattle usually show several signs of generalized neurological disease. These signs can include but are not limited to blindness, inconsistent and uncoordinated movements, head pressing, "goose" stepping, lying with full body contact with the ground with the head and legs extended, tetany (muscle spasms), convulsions with paddling motions, and death. These signs usually begin suddenly, with the animals typically having normal temperatures and rumen function.

Prevention. Preventative strategies should focus on the diet. Avoid risk factors such as high concentrate diets or high sulfate diets, if possible. Thiamine can also be added to a feed ration or a free-choice mineral supplement at 3 to 10 ppm, but this may not be cost effective.

White Muscle Disease

Cause. "White muscle disease" (enzootic nutritional muscular dystrophy) most commonly affects cardiac or skeletal muscle of rapidly growing calves. It results from vitamin E and/or selenium deficiency and causes muscle breakdown. This metabolic imbalance can be because of dietary deficiency or because of calves' being born to dams that consumed selenium-deficient diets during gestation.

Two distinct conditions of this disease are a cardiac form and a skeletal form. The cardiac form of the disease usually comes on quickly, with the most common clinical sign's being sudden death. At first, animals may exhibit an increased heart rate and respiratory distress, but they usually die within 24 hours. The skeletal form of the disease generally has a slower onset. Calves affected by the skeletal form exhibit stiffness and muscle weakness. Although these animals usually have normal appetites, they may not be able to stand for long periods and have trouble breathing if their diaphragm or chest muscles are involved. Some animals may show signs of difficulty swallowing and possible pain while swallowing if the muscles of the tongue are also affected.

Necropsy of an affected animal often reveals pale discoloration of the affected muscle. The texture of the muscle is dry with white, chalky, streaked sections representing the fibrosis and calcification of the diseased tissue. Hence, the name "white muscle disease."

Prevention. Supplementing vitamin E and selenium controls this disease. Salt/mineral mixtures can supplement the deficiencies. A free-choice mineral supplement with an expected intake of four ounces/head/day should contain 27 ppm of selenium. In known selenium deficient areas, it is recommended to administer 25 mg of selenium and 340 IU of vitamin E intramuscularly approximately four weeks before calving.

Milk Fever

Cause. Milk fever (parturient paresis or hypocalcemia) is generally associated with older, high-producing dairy cattle, but it may also occur with beef cattle. Milk fever occurs shortly after calving and the onset of milk production. Milk fever occurs when the lactating cow

cannot absorb enough calcium from the diet or has not started mobilizing bone calcium to meet the increased calcium demand of lactation. Calcium losses from lactation coupled with inadequate supply results in a drop in blood calcium level. Because calcium is needed for muscle contraction, cows suffering from milk fever often lose their ability to stand.

Prevention. Numerous steps can be taken to prevent milk fever. The first is to raise the calcium and phosphorus levels of the diet. Too much dietary calcium in late pregnancy could leave the cow unprepared to absorb or mobilize enough calcium from bone to meet elevated requirements when lactation starts. This sometimes occurs with feeding poultry litter because of the high calcium content of the litter.

Feeding low calcium diets a month or two before calving was once thought to be the best prevention because the body would be geared to mobilizing bone calcium. This approach has had limited success and is difficult with high forage diets.

If milk fever is a common problem in the herd, feeding an anionic pre-partum diet (a negative dietary cation-anion difference, DCAD) helps prevent milk fever. Adequate vitamin D is also important in preventing milk fever but is not typically a problem with beef cattle on pasture.

Mineral Elements and Levels Toxic to Cattle

Some minerals beef cattle do not require or require only in very small quantities can be toxic when consumed above threshold toxicity levels. The National Research Council defines the maximum tolerable concentration for a mineral as "that dietary level that, when fed for a limited period, will not impair animal performance and should not produce unsafe residues in human food derived from the animal."

Mineral Maximum Tolerable Concentrations in Beef Cattle Diets

Mineral Element	Maximum Tolerable Concentration
Aluminum	1000 ppm
Arsenic	50 ppm (100 ppm for organic forms)
Bromine	200 ppm
Cadmium	0.5 ppm
Chromium	1000 ppm
Cobalt	10 ppm
Copper	100 ppm
Fluorine	40 to 100 ppm
Iodine	50 ppm
Iron	1000 ppm
Lead	30 ppm
Magnesium	0.4%
Manganese	1000 ppm
Mercury	2 ppm
Molybdenum	5 ppm
Nickel	50 ppm
Potassium	3%
Selenium	2 ppm
Strontium	2000 ppm
Sulfur	0.4%
Zinc	500 ppm

Source: NRC, 2000. Adapted from NRC Nutrient Requirements of Beef Cattle, 7th revised edition.

Vitamin Nutrition

Vitamins are classified as either water soluble or fat soluble. Water soluble vitamins include the B complex and vitamin C. Fat soluble vitamins include A, D, E, and K. Rumen bacteria can produce the B complex vitamins and vitamin K in cattle. Vitamin supplementation is generally not as critical as mineral supplementation for beef cattle grazing actively growing forages. However, increased rates of vitamin A and E supplementation may be necessary when feeding dormant pastures or stored forages. For practical purposes, vitamins A and E should receive the most attention when planning cattle vitamin nutritional programs.

Fat Soluble Vitamins

Vitamin A

Vitamin A (retinol) is the vitamin most likely to be deficient in beef cattle diets. It is essential for normal vision, growth, reproduction, skin tissue and body cavity lining cell maintenance, and bone development. It is not in plant material, but its precursors (alpha carotene, beta carotene, gamma carotene, and cryptoxanthin) are present. These cartotene and carotenoid precursors are converted to vitamin A in

the animal. Vitamin A and beta carotene play a role in disease protection and immune system function.

Exposure to sunlight, air, and high temperatures destroys carotene. Ensiling can help preserve carotene supplies. Corn is one of the few grains that contains appreciable amounts of carotene. High quality forages, on the other hand, contain large amounts of vitamin A precursors. When forage supplies are limited or low quality, vitamin A supplementation becomes critical. While the liver can store vitamin A, at most two to four months of reliance on these stored liver supplies can ward off vitamin A deficiency.

In practical production scenarios, vitamin A toxicity is rare. Rumen microorganisms can break down vitamin A, and this helps prevent vitamin A toxicity. Vitamin A deficiency is more probable when cattle are fed high concentrate diets; bleached pasture or hay during drought conditions; feeds excessively exposed to sunlight, heat, and air; heavily processed feeds; feeds mixed with oxidizing materials such as minerals; or feeds stored for long periods. Calves not receiving adequate colostrum and stressed calves are at highest risk of vitamin A deficiency.

Vitamin A deficiency shows up as reduced feed intake, rough hair coat, fluid accumulation in joints and brisket, excessive tear production, night blindness, slow growth, diarrhea, seizures, poor skeletal growth, blindness, low conception rates, abortion, stillbirths, blind calves, low quality semen and infections in cattle. Night blindness is unique to vitamin A deficiency. Vitamin A can be supplied by injection or through the consumption of vitamin A precursors in green, leafy forages. In deficiency situations, injections may be more effective.

Vitamin D

Vitamin D forms include ergocalciferol (vitamin D2) found in plants and cholecalciferol (vitamin D3) found in animals. Vitamin D is needed for calcium and phosphorus absorption, normal bone mineralization, and calcium mobilization from bone. It may also function in immune response. Toxicity signs include calcification of soft tissues, bone demineralization, decreased appetite, and weight loss. Vitamin D deficiency causes rickets where bones do not use calcium and phosphorus normally. Stiff joints, irritability, anorexia, convulsions, brittle bones, decreased appetite, digestive problems, labored breathing, and weakness are deficiency signs. Cattle do not maintain body reserves of vitamin D. Yet cattle rarely require vitamin D supplementation because vitamin D is made by cattle exposed to sunlight or fed sun-cured forages.

Vitamin E

Vitamin E is in feedstuffs as alpha-tocophorol. It serves as an antioxidant in the body and is important in membrane formation, muscle structure, and muscle function. Disease resistance is tied to Vitamin E levels. Selenium is closely linked with this vitamin. Vitamin E requirements depend on concentrations of antioxidants, sulfur-containing amino acids, and selenium in the diet. And high dietary concentrations of polyunsaturated fatty acids found in corn oil and soybean oil can dramatically increase vitamin E requirements. High moisture feeds lose vitamin E quicker than drier feeds, and many other factors contribute to vitamin E breakdown in feeds.

There is less toxicity risk with vitamin E than with vitamins A and D. The margin of safety with vitamin E appears to be great. Signs of vitamin E deficiency, however, are characteristic of white muscle disease described earlier. Cattle displaying deficiency signs often respond to either vitamin E or selenium supplementation. Both may be needed in some instances.

Vitamin Supplementation

Vitamins A, D, and E are often added to mineral mixes or feed supplements as an A-D-E premix package. Many commercial mineral mixes have vitamins A, D, and E added at sufficient levels. However, it is important to review the mineral tag to be sure, particularly when actively growing forage is not available to cattle. Vitamin quantities are expressed as International Units (IU), which are set amounts defined for each specific vitamin form. Reasonable rates of vitamin supplementation for cattle consuming a 4-ounce daily intake vitamin supplement are: Vitamin A, 100,000 to 200,000 IU; Vitamin D, 7,500 to 20,000 IU; and Vitamin E, 50 to 100 IU. Vitamins can degrade over time, so supplements purchased and stored for several months before being used may not supply adequate vitamin levels.

Vitamin Requirements in Beef Cattle

Mineral	Requirement			
	Growing and Finishing Cattle	Stressed Calves*	Dry, Gestating Cows	Lactating Cows
Vitamin A, IU/kg	2200	4000-6000	2800	3900
Vitamin D, IU/kg	275	275	275	275
Vitamin E, IU/kg**	15-60	75-100	–	–

**Vitamin E requirements depend upon concentrations of antioxidants, sulfur-containing amino acids, and selenium in the diet. The growing and finishing cattle requirement presented here is an estimate.

Source: NRC, 2000. Adapted from NRC Nutrient Requirements of Beef Cattle, 7th revised edition.

Interpreting Mineral and Vitamin Tags

Though the amount of information on a mineral and vitamin supplement tag may seem overwhelming at first, the tag contains valuable information about a mineral mix. There are several common sections on most mineral tags.

1. Product name – When a single number is present in the product name, the number represents the phosphorus content. For example, "Pro 8" would contain 8 percent phosphorus. When two numbers are present in the name, the first number typically represents the calcium content, while the second number represents the phosphorus content. In most cases, if the calcium to phosphorus ratio is higher than 3:1, cattle will have to eat an excessive amount to get the phosphorus they need. Phosphorus is usually the most expensive component of a mineral supplement. Phosphorus is also very important in beef cattle diets, particularly when grazing low quality pastures. Instead of purchasing a supplement based on price alone, try to buy a reasonably-priced supplement that provides adequate levels of phosphorus and other important minerals.

2. Approved animals – This indicates the species and classes of livestock for which the product is intended.

3. Drug claim – Some labels describe the purpose of any drugs in the product. Consider whether or not the drug is needed and if it is the right time of year to use it. For instance, it may not be worthwhile to include fly control compounds in a mineral mix outside of fly season.

4. Active drug ingredient statement – This tells the name of the drug and the level added to the product.

5. Guaranteed analysis – This lists the amounts of individual minerals and vitamins in the supplement. These levels can be compared to cattle requirements to determine if the product matches up well with animal needs. Remember that the percentage or amounts of minerals and vitamins listed on a supplement tag indicate the quantities in the supplement. To compare mineral requirements with supplement amounts effectively, consider the total dietary mineral and vitamin intake. For example, while the phosphorus requirement of lactating cows is listed as 0.26 percent in the table at the top of page 2, low quanlity forage may need to be supplemented with a mineral mix containing 6 percent phosphorus at 4-ounce daily supplement intake rate to achieve the required phosphorus level in the total diet. Make sure the mineral supplement contains enough macrominerals (calcium, phosphorus, magnesium, potassium, sodium, chlorine, sulfur), trace minerals (chromium, cobalt, copper, iodine, iron, manganese, molybdenum, nickel, selenium, and zinc), and vitamins A and E.

6. Ingredients – This lists product ingredients in order from the highest to lowest amounts. Look for specific ingredients. For instance, copper oxide is not an ideal copper source, but copper sulfate and copper chloride are typically better sources for copper supplementation. As a general rule, the bioavailability (nutritional value considering the degree of availability to the body tissues) of inorganic mineral sources follows this order: sulfates = chlorides > carbonates > oxides. Organic mineral sources include chelated minerals. Chelated minerals are minerals bound to amino acids. Some researchers have reported greater bioavailability of organic mineral sources as compared to inorganic forms. However variable bioavailability values have been reported with the trace mineral chelates and complexes, suggesting no advantages in using organic forms.

7. Feeding directions – This lists expected intake, feeding instructions, and the length of any required withdrawal times for specific livestock classes. The mineral and vitamin concentrations in a 2-ounce daily intake rate supplement should be double those in a 4-ounce daily intake rate supplement to achieve the same intake of specific minerals and vitamins from the supplement.

8. Caution – This warning indicates potential problems, such as feeding an ionophore to horses, a high copper level to sheep, or selenium levels over legal limits.

Mineral and Vitamin Supplement Feeding Problems and Solutions

Fine particle size and the need to mix small quantities into bulk feed supplies make mixing a mineral and vitamin supplement with commodity-based feedstuffs difficult or impractical in some feed mixing scenarios. Unless feed mixing equipment can create a consistent mix and there is not a significant likelihood of the smaller particles in the mineral and vitamin supplement settling out of the finished feed, then consistently supplying a separate free-choice loose mineral mix or top-dressing feed may be more practical for mineral and vitamin supplement delivery in cattle diets.

Excessive intake can be a problem with mineral and vitamin supplements and can be an unnecessary expense. Cattle sometimes over consume a mineral and vitamin mix when they are first exposed to it but then drop supplement intake to appropriate levels after an adjustment period. Also, if cattle are allowed to run out of mineral and vitamin supplement, they may over compensate by increasing consumption when it is put out again. If intake does not drop to recommended levels after a month of feeding a continuous supply of mineral and vitamin supplement, try adding salt to the mineral and vitamin mix or moving the supplement feeder farther away from water sources.

Inadequate mineral and vitamin intake, on the other hand, can be addressed by adding dry molasses to the mineral and vitamin mix or by moving the supplement feeder closer to a water source or area where cattle congregate. Make sure not to provide salt separately from a free-choice mineral supplement, because cattle may consume the salt supplement and avoid the complete mineral and vitamin mix. Changing mineral mixes is another option that sometimes corrects excessive or inadequate mineral consumption.

One mineral and vitamin supplement formulation may not be ideal year-round. Mineral and vitamin supplements can be used to deliver beneficial drugs, antibiotics, and parasite control ingredients to cattle diets. Adding these products may increase the price of the mineral and vitamin supplement. In addition, these products may need only to be supplied to cattle for defined periods of time or during certain times of year. It is advisable to reformulate the mineral and vitamin supplement to remove these products when they are not needed. Mineral and vitamin composition of supplements should also be adjusted for forage conditions. For example, increased magnesium supplementation is justified during grass tetany season but should be reduced during other periods to match cattle nutrient needs better and avoid unnecessary reductions in supplement palatability often associated with high levels of magnesium.

Many mineral supplements cake and harden when allowed to get wet, causing mineral intake to drop. Magnesium supplements are particularly prone to this problem. Using covered feeders that protect from rain can help minimize mineral hardening. Commercial mineral supplements are available that better withstand rain damage and wind losses. Mineral and vitamin supplement selection should consider mineral and vitamin composition and price of the supplement as first priorities over weather protection. It is a good idea to check the mineral and vitamin supplement supply at least weekly. Break up hardened mineral as much as possible. Checking the mineral supply on a regular basis is also important in monitoring consumption and making sure cattle do not run out.

Many different mineral and vitamin supplement feeder designs are available. Examples are shown below. Consider differences in protection of the supplement from the environment, quantity of supplement the feeder can contain, ease of moving the feeder, and feeder durability. Strategic placement and positioning of open-sided mineral and vitamin supplement feeders can lessen weather effects on the supplement. For illustration, if precipitation most often falls and blows from one direction, then turning open sides of mineral and vitamin supplement feeders away from this direction is warranted.

Examples of mineral and vitamin supplement feeder designs.

Mineral and Vitamin Supplementation Summary

Appropriate intake of key minerals and vitamins is essential for beef cattle productivity and health. Many different commercially available mineral and vitamin supplements are marketed to beef cattle producers. Custom blends of minerals and vitamins are another option for mineral and vitamin supplementation. Not all available mineral and vitamin supplements contain enough of the minerals and vitamins beef cattle need. In selecting a mineral and vitamin supplement, consider the class of cattle being supplemented; forage conditions; mineral and vitamin levels in feedstuff and water sources; and expected intake levels of forages, feeds, and mineral and vitamin supplements. Investing in a good mineral and vitamin nutrition program and properly managing mineral and vitamin feeding is highly recommended for both beef cow-calf and stocker operations. For more information on mineral and vitamin nutrition for beef cattle, contact an office of the Mississippi State University Extension Service.

References

Ahola, J. K., D. S. Baker, P. D. Burns, R. G. Mortimer, R. M. Enns, J. C. Whittier, T. W. Geary, and T. E. Engle. 2004. Effect of copper, zinc, and manganese supplementation and source on reproduction, mineral status, and performance in grazing beef cattle over a two-year period. J. Anim. Sci. 82:2375–2383.

Ammerman, C. B., D. H. Baker, and A. J. Lewis. 1995. Bioavailability of Nutrients for Animals: Amino Acids, Minerals, and Vitamins. Academic Press, San Diego, CA.

Arthington, J. D., F. M. Pate, and J. W. Spears. 2003. Effect of copper source and level on performance and copper status of cattle consuming molasses-based supplements. J. Anim. Sci. 81:1357-1362.

Ball, D. M., C. S. Hoveland, and G. D. Lacefield. 2002. Southern Forages. 3rd ed. Potash and Phosphate Institute and Foundation for Agronomic Research. Norcross, GA.

Cao, J., P. R. Henry, R. Guo, R. A. Holwerda, J. P. Toth, R. C. Littell, R. D. Miles, and C. B. Ammerman. 2000. Chemical characteristics and relative bioavailability of supplemental organic zinc sources for poultry and ruminants. J. Anim. Sci. 78:2039–2054.

Gadberry, S. 2004. Mineral and Vitamin Supplementation of Beef Cows in Arkansas. FSA 3035. Univ. Arkansas Cooperative Extension. Little Rock, AR.

Mullis, L. A., J. W. Spears, and R. L. McCraw. 2003. Effects of breed (Angus vs Simmental) and copper and zinc source on mineral status of steers fed high dietary iron. J. Anim. Sci. 81:318–322.

National Research Council. 2000. Nutrient Requirements of Beef Cattle. 7th Revised Edition, 1996: Update 2000. National Academy Press. Washington, D. C.

Olson, P. A., D. R. Brink, D. T. Hickok, M. P. Carlson, N. R. Schneider, G. H. Deutscher, D. C. Adams, D. J. Colburn and A. B. Johnson. 1999. Effects of supplementation of organic and inorganic combinations of copper, cobalt, manganese, and zinc above nutrient requirement levels on postpartum two-year-old cows. J. Anim. Sci. 77: 522-532.

Spears, J. W. 1989. Zinc methionine for ruminants: Relative bioavailability of zinc in lambs and effects of growth and performance of growing heifers. J. Anim. Sci. 67:835–843.

U. S. Department of Agriculture. 1997. National Animal Health Monitoring System BEEF '97. Washington, D. C.

U. S. Food and Drug Administration. 2000. Compliance Policy Guide. Washington, D. C.

Ward, J. D., J. W. Spears, and G. P. Gengelbach. 1995. Differences in copper status and copper metabolism among Angus, Simmental and Charolais cattle. J. Anim. Sci. 73:571–577.

Wedekind, K. J., A. E. Hortin, and D. H. Baker. 1992. Methodology for assessing zinc bioavailability: Efficacy estimates for zincmethionine, zinc sulfate, and zinc oxide. J. Anim. Sci. 70:178–187.

Publication 2484 (POD-10-14)

By **Dr. Jane Parish**, Associate Extension/Research Professor; and **Dr. Justin Rhinehart**, former Assistant Extension Professor; Animal and Dairy Sciences.

TEXAS A&M AGRILIFE EXTENSION

E-526

Mineral Supplementation of Beef Cows in Texas

Dennis B. Herd*

The proper balance of protein, energy, vitamins and all nutritionally important minerals is needed to make a successful nutrition program, one that's productive yet economical. Nutrient balance is the key to any effective nutrition program, especially where trace minerals are concerned. **Today, there is concern that the trace elements may be limiting production in better managed herds to a much greater extent than generally recognized.** Simple starvation or hollow belly is still the primary limiting factor in many less well managed herds. Supplementation programs cannot economically overcome the negative effects of overgrazing. Be sure you have your nutritional management priorities in the proper order. It won't make you money to furnish cattle 150 percent of their mineral needs if they're only receiving 85 percent of their protein and energy needs or vice versa.

Historical, But Still Relevant Phosphorus Research

The importance of phosphorus supplementation in Texas has been realized ever since research studies in the 1930s and '40s at the King Ranch. In Trials 1 and 2, percent calf crop weaned increased 40 and 41 percent, weaning weight increased 69 and 49 pounds, and calf weight weaned per cow exposed increased 156 and 165 pounds, respectively, with phosphorous supplementation (Appendix Table 1). Return per dollar invested in phosphorus, at today's prices, ranged from $3.95 to $12.35 depending on the method and amount of supplementation (Appendix Table 2). As a result of these studies, it became a goal of many cattlemen to supplement 6.0 pounds of actual phosphorus per cow per year. Six pounds of supplemental phosphorus intake/cow/year is still a reasonable goal for cows grazing on native, unfertilized pastures with little or no protein or energy supplementation. Educators and cattlemen mistakenly assumed that cows grazing improved fertilized pastures also needed as much as 6 pounds of phosphorus/cow/year. More is now known about the effect of forage type on mineral content and appropriate supplementation.

Please see Table 4, page 7, for detailed information on Recommendations on Mineral Supplements.

Recent Field Experience

Since 1986, direct field experience has occurred with more than 50 ranchers (most but not all in Texas) who were experiencing trace mineral nutrition problems in their herds. Production losses ranged from slight to severe. In one herd the calf crop fell to 55 percent after having run from 85 to 95 percent for years. In another herd, 10 out of the first 20 calves died soon after birth. In numerous herds, cattle often appeared wormy, but did not respond to deworming. The worst problems were always found in purebred continental breeds of cattle. Most problems involved the trace mineral copper and sometimes zinc and selenium. Mineral imbalances, rather than simple mineral

*Professor and Extension Beef Cattle Nutritionist, The Texas A&M University System

deficiencies, were frequently found. Sulfur (>.3 percent) and iron (>250 PPM) levels were often high in diets which are antagonistic to copper and selenium utilization. Molybdenum, a well-known copper antagonist, was not extremely high, but would reach 2 to 3 PPM which is a problem when combined with high sulfur. This publication deals with a systematic approach to mineral supplementation based on experiences with these problem herds and data from research literature. Performance in these problem herds returned to acceptable levels with mineral supplementation practices described in this publication.

Need for Minerals

Maintenance, growth, lactation, reproduction and animal health cannot be optimized where mineral intake is not properly balanced. A full discussion of the functions and deficiency symptoms of all required minerals is beyond the scope of this paper. Libraries are filled with books on the subject. This discussion will center around mineral supplementation practices.

Increasing Emphasis on Trace Minerals

Trace mineral supplementation needs are greater today than ever before because:

1. More is known about their essential functions and production losses, resulting from marginal deficiencies which often existed in the past but were not recognized. In some cases requirements are simply more accurately defined today.
2. Genetic potential for performance and productivity of cattle has probably increased requirements. Today cattle are pushed to perform much nearer their genetic potential. Generally, a good job with protein and energy supplementation is practiced, but trace mineral nutrition hasn't kept pace.
3. In cattle, sheep and humans, **genetics can greatly influence copper requirements and susceptibility to toxicity**. For years it has been well-established that breeds of sheep vary in their susceptibility to copper toxicity and requirements for copper. Recent research indicates Simmental and Charolais cattle require more copper in their diet than Angus. Field experiences suggest that Simmental, Maine Anjou, Limousine and Charolais cattle all benefit from 1.5 times the copper intake normally defined for traditional breeds. On the other hand, it appears that Jersey cattle are much more susceptible to copper toxicity (possibly as low as 40 PPM of the diet compared to the normally accepted 100 PPM) than Holsteins. Brahman cattle may be more susceptible to copper toxicity than other beef breeds. Thus, you must carefully evaluate the needs of your particular breed of cattle. Genetic differences quite likely exist within all breeds.
4. Wherever yields of crops have been increased with nitrogen, phosphorus and potash fertilizers without accompanied repletion of trace elements, the content of many of the trace elements in feedstuffs has decreased over time. The decrease is especially true for shallow rooted crops.
5. Liming, fertilization practices and/or industrial pollution may be altering the composition or proportion of minerals in forages in certain areas.

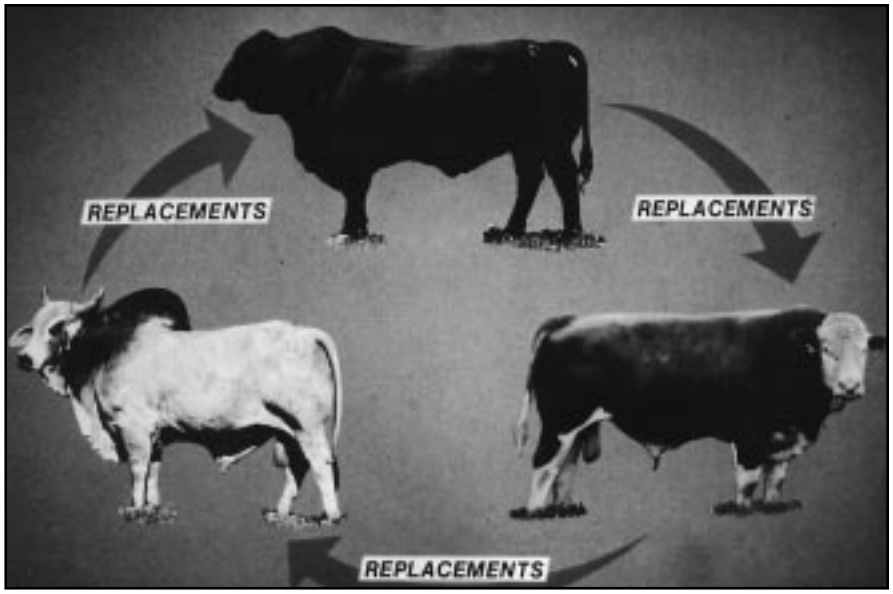


Figure 1. Various breeds have advantages and disadvantages in crossbreeding. Breed also has an influence on the amount of copper needed for reproduction and good health.

6. It has become evident in recent years that trace mineral deficiencies are the root cause or contributing factor for health problems and failures of commonly accepted disease treatments. Research with rats and mice over the last 10 to 15 years has established many of the biological mechanisms by which the body fights disease. Although other minerals may be involved, much work with copper, zinc and selenium has shown them to be essential to the immune system and the body's disease defense mechanisms (2)(3)(4)(5). On a more practical basis, research studies and numerous field cases reported by practicing veterinarians have related deficiencies of specific trace minerals to the frequency and severity of such problems as **mastitis, retained placenta, stillbirths, embryo mortality, general reproductive failure, weak calves and dummy calves at birth without good nursing reflexes, calf scours, abomasal ulcers in calves, pneumonia, and apparent vaccine failures**.
7. There is good evidence that a higher level (possibly 25 to 50 percent) of some trace minerals may be needed for good health than for normal growth. The appropriate levels remain to be defined, but there is work ongoing in this area.

Recommended Approach To Mineral Supplementation: "Balance Their Rations"

Successful commercial poultry, swine, dairy and feedlot operations all balance the rations for their livestock! Don't you think it's time ranchers do too?

Admittedly, a rancher can't balance the diet of a range cow as easily or as accurately as the manager of a confinement operation. However, the only way to solve mineral problems where excesses and deficiencies occur simultaneously is to make an effort to balance the ration.

The mineral-related performance problems in the herds mentioned earlier were solved by obtaining the necessary information and balancing the cattle's rations.

Information Needed

To balance rations, you must have the following information:

1. The nutrient requirements of the particular class of cattle: Include insurance levels desired to account for factors such as breed, genetic potential and inherent variation in feed composition.
2. The nutrient content of the feeds they eat:
   a) Book values are reasonably accurate for concentrate feeds and values are constantly being updated with new data. However, a recent report (Larry Berger, 1994 Florida Ruminant Nutrition Symposium, p.1) indicates that book values often overestimate the level of trace minerals in many common feedstuffs listed in the U.S. - Canadian Tables of Feed Composition. Copper content was often only 15 to 50 percent of commonly used book values for feeds such as corn silage, alfalfa, brewers and distillers grains, whole cottonseed, and cottonseed hulls. Zinc and manganese were usually within 70 percent of reported values or even higher than reported values in some feeds.
   b) Forage testing for minerals is often needed for grazing and hay crops. When sampling pastures, collect only the plants and parts of plants you observe the animals grazing. Available book values (National, State, Region, County) are a good place to start, but are often lacking or not accurate enough to be helpful since forages are quite variable in their nutrient contents compared to concentrates.
3. Mineral content of water: Water may frequently supply beneficial or detrimental levels of minerals such as sodium, chlorine, sulfur and iron. Some indicators include a salty taste for salt (sodium chloride), rust for iron and a bad taste or rotten egg smell for sulfur. However, water can contain significant levels of sulfur and not give off the rotten egg sulfur odor. If performance problems exist in the cattle and you're not sure about the quality of water, have the water analyzed.
4. An estimate of feed intake:
   a) Many guides to feed dry matter intake are available. A rough guide would be 1.5 percent of body weight for very coarse poor forage, 2.0 percent for average and 2.5 percent for good forage. Feed intake is almost always reduced with deficiencies of any mineral or excesses of minerals such as sulfur and molybdenum.

b) For small amounts of supplement (<.2 percent body weight), add the supplement intake to the forage intake. For supplement levels of 0.3 to 1.0 percent of body weight, decrease forage dry matter 0.6 pounds/pound of supplement dry matter intake.

Mineral Requirements

Table 1 contains a list of generally accepted mineral requirements and tolerances for beef cows. Considering possible increased requirements for health, increased performance, breed differences and variation in feeds, you will note many nutritionists "formulate" to levels above those considered minimal requirements. The amount of additional "insurance mineral" will vary with the specific mineral, its cost and the potential detrimental effects an excess may cause.

Many minerals interfere with the utilization of other minerals at levels well below the "maximum tolerable level." For example, it will usually be beneficial to increase the level of copper above that listed as the requirement any time molybdenum exceeds 2 PPM, sulfur exceeds 0.3 percent, iron exceeds 250 to 300 PPM or some combination exists. All minerals can be involved in interactions, but **the effect other minerals have on the need for copper appears more specific and unique** than with many of the other minerals.

When determining the level of total dietary mineral desired, and thus supplemental intake and formulation, keep in mind the following points:

1. Moderately higher levels of mineral intake, for up to six weeks, may be needed and safe for cattle with severe deficiencies, but should not be continued once their mineral status has returned to normal.
2. Relationships in cows have been well established between stage of production and requirements for major minerals, protein and energy; this is not true for trace minerals. Contrary to the generally higher requirements for protein, energy, calcium, etc., during lactation, **the requirement for copper and selenium may be equally high or even higher in late pregnancy than during lactation**. Since milk is low in copper, the cow must build the fetal liver concentration of copper

Table 1. Diet Formulation Guidelines

Mineral	1996 Beef NRC Requirements		Common Formulation		Maximum Limit
	Dry Cow	Lactating Cow	Dry Cow	Lactating Cow	
Calcium, %	0.25	0.25-0.36	1.6 X P[a]	1.6 X P[a]	2[b]
Phosphorus, %	0.16	0.17-0.23	0.17	0.24	1[b]
Potassium, %	0.6	0.7	0.7	0.8	3
Magnesium, %	0.12	0.2	0.15	0.22	0.4
Sodium, %	0.07	0.1	0.1	0.15	-
Chlorine, %	0.2[b]	0.25[b]	0.25	0.3	-
Sulfur, %	0.15	0.15	0.17	0.2	0.4
Iron, PPM	50	50	87	87	1,000
Manganese, PPM	40	40	70	70	1,000
Zinc, PPM	30	30	60	60	500
Copper, PPM[c]	10	10	17	17	100
Iodine, PPM	0.5	0.5	0.6	0.6	50
Selenium, PPM	0.1	0.1	0.2	0.3	2
Cobalt, PPM	0.1	0.1	0.2	0.2	10
Molybdenum, PPM	-	-	-	-	5

[a] p =phosphorus
[b] From 1989 Dairy NRC
[c] Copper requirements are highly variable (from 10 to 30 PPM). Levels of copper up to 30 PPM may be needed with some breeds of cattle where molybdenum is >2-3 PPM, sulfur is >.3%,iron is >300 PPM in the diet, or some combination exists. Include iron and sulfur from water. **Remember that high copper levels are toxic to sheep.** The Continental breeds of cattle have higher requirements and some breeds are more susceptible to toxicity, e.g., Jerseys and possibly Brahmans.

to about 3 times that of the adult level to get the newborn past the milk-only phase of growth. Newborns with low liver reserves of copper, selenium and other nutrients are subject to many of the health problems mentioned earlier.

More research is needed concerning the effects of minerals on fertility and health. There **are important trace mineral needs during pregnancy**, which if not met can lead to sometimes serious and prolonged problems in the offspring.

Forage Mineral Content

Forage testing is the foundation for establishing the need for and the amount of supplemental minerals. **Soil testing** can help explain forage composition, but is not reliable in directly evaluating the mineral status of the animal. Likewise, blood testing and liver analyses on any dead animals can add information on a herd's mineral status. However, **knowledge of estimated dietary mineral intake from both feed and water provides the basis for correcting deficiencies or adjusting for mineral excesses. Even crude estimates are more helpful than complete guesses**.

The results of approximately 12,000 analyses of forages submitted to the Texas A&M University Forage Testing Lab during 1988-92 are shown in Table 2. When comparing the results of improved bermudagrass to native grasses, two important points become apparent: (1) bermudagrasses tend to contain higher levels of phosphorus, potassium, sulfur and manganese but lower levels of iron. (2) The same mineral supplement is not appropriate for both forage types. Bermudagrasses, on average, contain twice the level of phosphorus of native grasses. If 6 pounds of phosphorus/cow/year is appropriate for cows grazing native forage, as suggested by the King Ranch phosphorus trials, then half that level, or 3 pounds of phosphorus/cow/year, should be adequate for cows grazing average or better bermuda pasture or hay.

Complete mineral analyses are lacking for many grazing environments. Generally, the native grass data would be expected to represent forages from native rangelands, and fertilized bermudagrasses should be typical of various grasses when fertilized or grown on soils with high fertility.

Many forbs and browse plants are higher in phosphorus than native grasses so the supplementation needed may fall between the native and bermuda examples.

An estimated average mineral content for annual forages, such as **wheat**, **oats** and **ryegrass**, is presented in Table 3. There is limited information for winter annuals and variation should be expected. However, moderate calcium and high phosphorus and potassium levels are typical.

Supplement Formulation

Once you have a good feel for the mineral content of the diet (both feed and water), compare the levels to those desired and develop a supplement to make up any deficiencies. Where

Table 2. Variation in Forage Mineral Composition[a]

	Bermudagrass		Native Grasses	
	Average	Commonly[b] Observed	Average	Commonly[b] Observed
Calcium, %	0.43	0.28 - 0.58	0.48	0.29 - 0.67
Phosphorus, %	0.21	0.15 - 0.27	0.10	0.04 - 0.16
Magnesium, %	0.17	0.12 - 0.22	0.12	0.07 - 0.17
Potassium, %	1.59	1.13 - 1.95	0.91	0.28 - 1.54
Sodium, %	-	0.02 - 0.05	-	0.02 - 0.05
Chlorine, %	-	0.2 - 0.6	-	0.2 - 0.6
Sulfur, %	0.34	0.22 - 0.46	0.13	0.07 - 0.19
Iron, PPM	115	31 - 199	205	43 - 367
Manganese, PPM	86	35 - 137	50	25 - 75
Zinc, PPM	23	15 - 31	21	13 - 29
Copper, PPM	6.4	4 - 9	5	3 - 7

[a]Approximately 12,000 samples analyzed by the Texas A&M University Forage Testing Lab 1988 - 1992. Includes both hay samples and pasture clippings.
[b]Equal to the average + or - one standard deviation.

Table 3. Assumed Forage Composition for Recommendations Made in Table 4

Mineral	High Quality Summer Pasture or Hay, Well Fertilized	Bermuda Pasture or Hay, Fertilized	Native Pasture or Hay, Non-Fertilized	Grass Tetany Prevention, Annual Winter Pasture
Calcium, %	0.45[a]	0.43[b]	0.48[b]	0.35[a]
Phosphorus, %	0.28	0.21	0.1	0.35
Potassium, %	1.8	1.59	0.91	3.0
Magnesium, %	0.2	0.17	0.12	0.15
Salt, % -	-	-	-	
Sulfur, %	0.25	0.34	0.13	0.3
Iron, PPM	115	115	205	150
Manganese, PPM	50	86	50	60
Zinc, PPM	22	23	21	22
Copper, PPM	6	6	5	6
Iodine, PPM[c]	0.1	0.1	0.1	0.1
Selenium, PPM[c]	0.1	0.1	0.1	0.1
Cobalt, PPM[c]	0.1	0.1	0.1	0.1

[a]All values in this column are from unpublished data except for footnote[c].
[b]All values in this column are from Table 2 except for footnote c.
[c]These values are assumed from very limited data.

mineral content of the diet is unknown, formulate the trace mineral supplement to provide 50 to 100 percent of the National Research Council requirement for trace minerals. For many forages in Texas, supplementing 50 to 100 percent of the NRC requirement results in trace mineral levels in the total diet similar to those in Table 1 under "Common Formulation." If the mineral content of the supplement is kept in general proportion to animal requirements, it tends to pull the total diet mineral (forage + water + supplement) toward balance. This approach works well when forage mineral content is unknown.

Where you are comfortable that you know dietary mineral intake, probably from a combination of book values, feed analysis, guaranteed supplement analyses, and other facts, adjust individual mineral levels to meet your formulation goals. It is often good to keep a minimal level (e.g., 30 percent of the requirement) of some minerals in the supplement even though forage levels appear adequate, since the bioavailability of trace minerals in forage is often low. Use only forms and sources of minerals known to be reasonably high in digestibility, absorbability and bioavailability.

Supplement Intake

A 50 pound sack of 12 percent phosphorus mineral will provide a cow 6 pounds of actual phosphorus per year—a reasonable level for cows on native pasture. Three pounds of phosphorus from 50 pounds of a 6 percent mineral should be adequate for cattle on average or better bermuda forage, hay or pasture. Decrease expected mineral supplement intake appropriately for each pound of phosphorus supplied from protein-energy supplements. One pound of phosphorus is contained in 100 pounds of a protein supplement with a 1 percent phosphorus content.

Fifty pounds per cow per year averages 2.2 ounces per day. It is common for lactating cows to consume 2 to 2.5 times more mineral when lactating than when dry. Cows consumed an average 4.2 grams of phosphorus/day during their 3 months' dry period, 6.2 grams during a 2 month transition period at calving and 9.2 grams during a 7 month lactation in the King Ranch study. This equates to 1.25, 1.85 and 2.75 ounces, respectively, for the 3 periods or a ratio of .68, 1.0 and 1.48, respectively. Daily and weekly consumption levels will be even more variable. Numerous factors affect mineral consumption, including genetic potential of the cattle, forage mineral and moisture content, levels in water, palatability of the supplement, salt levels, mineral intake from protein-energy supplements, feeder location relative to water and loafing areas, etc. Cattle will normally consume more salt on high moisture diets. **Mineral consumption must be monitored**

and managed monthly so that appropriate adjustments can be made to arrive at an appropriate seasonal and annual intake.

General Mineral Supplement Recommendations

Four separate mineral supplements are outlined in Table 4 for cows grazing varying forage types. Keep in mind that alternative formulation can easily be obtained by mixing in various proportions of the four basic supplements. Recommendations in Table 4 were based on forage composition shown in Table 3.

Supplementation Practices

Some points to consider include the following:

1. Do not trust cattle to eat minerals if they need them and leave them if they don't. Cattle have certain "nutritional wisdom" relative to their need for salt and they will crave bones when phosphorus is deficient, but not necessarily phosphorus minerals. You have to manage the mineral nutrition of your cattle just as you do protein and energy. Mineral deficient cattle will normally consume several times the recommended level for a given supplement. Allow cattle excess consumption for 10 to 14 days before taking steps to regulate intake. Some salt normally encourages supplement intake, but there are areas where either grass, water or both are salty and salt discourages supplement intake. High levels of salt in the supplement will decrease intake. Molasses, grain, cottonseed meal, etc., at 5 to 15 percent of the supplement, will encourage intake. Coating minerals with vegetable

Table 4. Recommendations on Mineral Supplement Composition for Beef Cows with Varying Forage Types Based on Mineral Contents Shown in Table 3.

Mineral	High Quality Summer Pasture or Hay, Well Fertilized + Trace Mineral Salt	Bermuda Pasture or Hay, Fertilized + 15:6:5 Mineral	Native Pasture or Hay, Non-fertilized + 12:12:4 Mineral	Grass Tetany Prevention Annual Winter Pastures + 16:2:10 Mineral
Intake, oz/cow/day=	1	2.2[a,b,h]	2.2[a,c,h]	2.5
Calcium, %	-	15[d]	12	16
Phosphorus, %	-	6	12	2
Potassium, %	-	-	-[e]	-
Magnesium, %	-	5	4	10
Salt, %	80+	<15[f]	<15[f]	15-25
Sulfur, %	-	-[g]	2-3[e]	0-3
Iron, %	-[g]	-[g]	-[g]	-[g]
Manganese, %	0.5	0.3000	0.4000	0.4000
Zinc, %	1.6	0.8000	0.8000	0.8000
Copper, %	0.5	0.2500	0.2000	0.2500
Iodine, %	0.016	0.0100	0.0100	0.0100
Selenium, %	0.01	0.0040	0.0040	0.0040
Cobalt, %	0.007	0.0030	0.0030	0.0030

[a] 50 lb/cow/year, consumption will vary from 0 to 4.5 oz/cow/day - see discussion in text.
[b] 3 lb phosphorus/cow/year.
[c] 6 lb phosphorus/cow/year.
[d] Higher calcium is recommended to offset the detrimental effects of high sulfur.
[e] include in protein supplement when needed in order to obtain adequate intake.
[f] Provide additional salt if consumption is excessive.
[g] Add none above that are contained in other mineral compounds used.
[h] If vitamins are included, levels of vitamin A of 200,000 to 400,000 I.U. and levels of vitamin D of 15,000 to 40,000 I.U./pound of mineral supplement are reasonable assuming high quality, stable sources of vitamins and an average 2.2 ounces of mineral consumption/day.

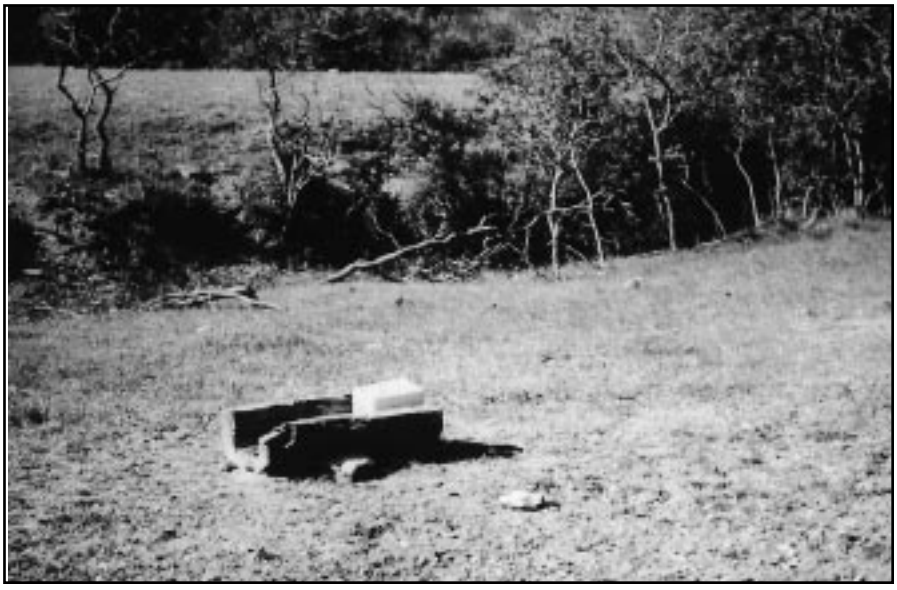


Figure 2. A salt block will not contain all of the supplemental minerals needed by most herds of cattle.

oils to reduce immediate chemical reaction on the cattle's tongue will enhance palatability. Manufacturing processes such as prilling will also aid palatability by reducing mineral dust.

2. If supplementing protein and/or energy, include minerals in the protein energy supplement. Copper deficiency in cow herds can occur when self-limiting feed supplements containing salt and phosphorus are fed. Cattle quit eating high copper mineral supplements, and the feed supplement is usually too low in copper to act as a copper supplement. This same scenario could apply to other trace elements.
3. Mineral feeders should be low enough so calves can reach the mineral. Minerals formulated for cows will work for replacement heifers when consumed at slightly lower levels. However, it would be better to use a mineral supplement formulated for stocker cattle where ionophore feed additives, etc., may be included.

Pricing Supplements

Do not be fooled by a mistaken concept that "the higher the concentration of minerals in a supplement, the better it is." For example, consider supplement A (cost $500/ton, phosphorus 12 percent, copper 0.2 percent and consumption 2 ounces/cow/day) and supplement B (cost $250/ton, phosphorus 6 percent, copper 0.1 percent and consumption 4 ounces/cow/day), to be equal. Just because supplement A contains twice as much phosphorus and copper doesn't make it better when the cows will eat only half as much and it costs twice as much. It is the actual amount of each mineral consumed by the cow that counts, not the percentage or proportion of mineral in the supplement. To determine supplemental mineral consumption, look at both the supplement intake and the concentration of mineral in it. A reasonable minimal amount of the various minerals must be in a supplement, but making supplements too concentrated sometimes causes palatability problems, especially with minerals like magnesium.

Bioavailability

As a general rule, the bioavailability of inorganic mineral sources follows this order: **sulfates = chlorides > carbonates > oxides**. Recent research indicates **copper oxide is a very poor source of copper** for use in mineral supplements. Because of a much longer

Figure 3. Minerals are important in the development of young animals, as well as for the cow. Be sure mineral supplements are accessible by calves.

retention time in the gut for absorption, copper oxide needle boluses are effective copper sources. Iron oxide, which is used as a red coloring agent for minerals, is poorly available but may still act as an antagonist to copper absorption.

At this time, confusion reigns about the role of organic forms of trace minerals (proteinates, complexes and chelates). Evidence is accumulating that specific products may be absorbed by different pathways and transported and metabolized by different routes making them more effective in specific situations. However, specific situations are not well-defined so one can carefully consider the economic consequences of using organic sources versus inorganic sources.

The organic forms of some of the trace minerals may be of greater value when an animal is under nutritional, disease or production stress. Since organic forms cost more than traditional inorganic forms, increased production must be obtained for a profit to be realized.

Mineral chelates, complexes and proteinates are not chemically equal. Mineral proteinates will be more variable in their chemical structure, and possibly their physiological function, than a specific amino acid-mineral complex, e.g., zinc methionine. Much work remains to be done to sort out the chemistry, digestibility, bodily function, quality control or product consistency, and economic benefit of the organic forms of trace minerals which are available today. **In the meantime, use a systematic step-wise approach to mineral supplementation.**

Figure 4 outlines an approach to the selection of mineral products. There are areas and times when forages provide all the minerals the cattle need, especially if the level of production is low (point A in Figure 4). However, this situation is not widespread. For many cow-calf operations, using a well-formulated inorganic mineral supplement containing only the cheaper and readily available sulfate, chloride or carbonate forms in adequate amounts will work very well (point C in Figure 4). There is no place for using nondescript supplements (point B in Figure 4) with imbalanced mineral levels, frequently containing the less available oxide forms and with cost approaching that of the well-formulated inorganic supplements.

Many beef herd managers use inorganic mineral supplements where performance is excellent so it is hard to visualize a potential for increased profit by spending more money with little opportunity for increased production.

On the other hand, when dealing with nutritional stress such as high sulfur, molybdenum and iron, occasionally, responses to inorganic mineral supplements may not be satisfactory. Extremely high levels of production, flushing a donor cow, frequent collection of an A.I. bull, weaning, transition to high energy rations, excess fat on cows, calving and nutritional insults from unbalanced diets, molds, etc., may all constitute stress.

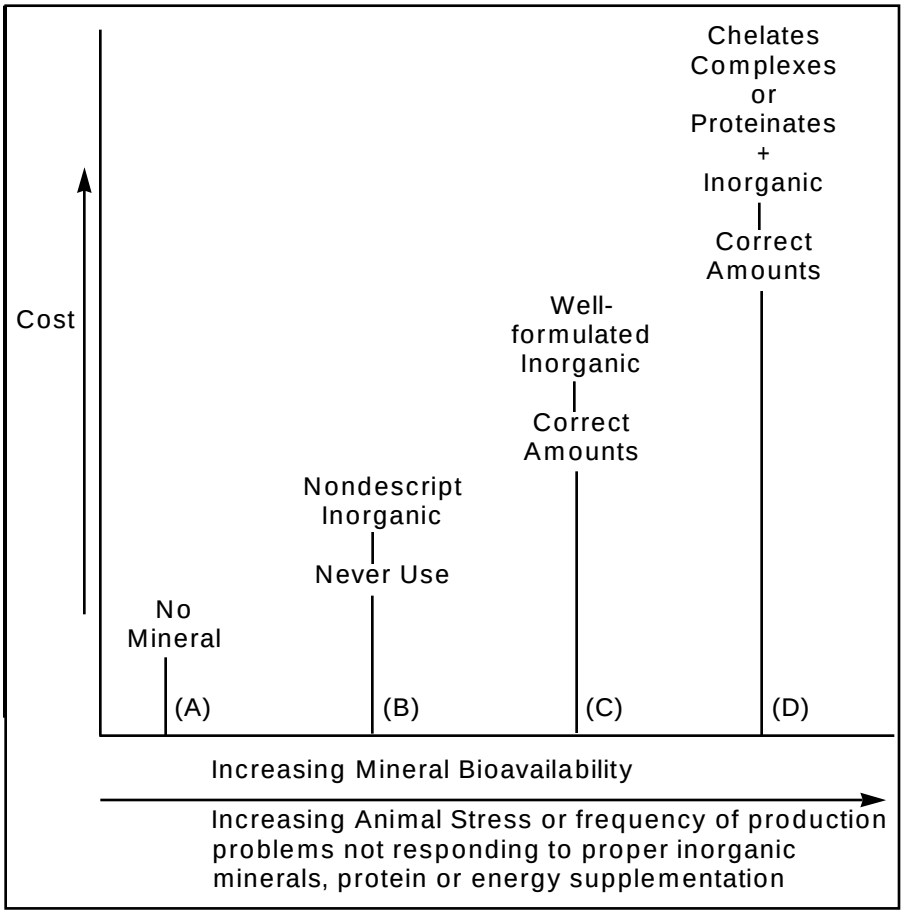


Figure 4. Systematic selection of trace mineral supplements.

What is suggested to the producers is an orderly progression of mineral supplement selection. If you haven't supplemented minerals previously, do so with a good inorganic but inexpensive supplement. **Make sure you have managed for appropriate intake of various minerals before you assume they are not working (point C in Figure 4).** If you have done this, and still have problems, go to a combination of inorganic and organic sources (point D in Figure 4). Where problems exist, pay something extra to fix them, especially when reproduction is involved.

Year-round use of organic mineral sources generally cannot be economically warranted. In some herds, targeting specific periods such as precalving and breeding may be warranted. Consider therapeutic use as opposed to routine use. This paper has outlined some of the factors you will need to evaluate in order to make an organized decision.

Summary

The old adage **"if it's not broke, don't fix it"** is especially appropriate when considering changes in a mineral supplementation program. Research and observations from the field emphasize, more than ever, the delicate balance among minerals which is necessary if biological efficiency is to be realized. It's easy to consider only one mineral at a time without giving due attention to interactions among minerals which affect individual mineral utilization and requirements.

On the other hand, we shouldn't become apathetic and defeatist just because the problem is complex and we don't have all the answers. We have more answers today than ever and more are being discovered all the time. **Minerals are no more important in good nutrition today than they've ever been, but today we recognize problems in production, especially in the areas of health and possibly, reproduction that can be corrected, with proper mineral supplementation.**

References and Articles for Further Study

1. Nutrient Requirements of Beef Cattle. 7th Edition. 1996. National Academy of Sciences. Washington, D.C.
2. Spears, Jerry W. 1988. Trace Minerals and the Immune System. Plains Nutrition Council Symposium. Trace Minerals in Beef Cattle Nutrition. Amarillo, Texas.
3. Selenium and Copper Deficiency in Cattle. 1988. Sponsored by Schering Animal Health. Published by Vet. Med. Publishing Co. Lenexa, Kansas.
4. Mertz, Walter. 1987. Trace Elements in Human and Animal Nutrition. 5th Edition Vol. 1 and 2. Academic Press.
5. Mayland, H.F. et al. 1987. Trace Elements in the Nutrition and Immunological Response of Grazing Livestock. Proceedings, Grazing Livestock Nutrition Conference, Univ. of Wyoming.
6. Mills, C.F. 1987. Biochemical and Physiological Indicators of Mineral Status in Animals: Copper, Cobalt, and Zinc. J. Anim. Sci. 65:1702.
7. Cunha, T.J. et al. 1964. Minerals for Beef Cattle in Florida. Univ. of Florida. Bulletin 683.
8. Dent, Elmer. 1988. Copper Deficiency A Treatise on Symptoms, Functions, Corrective Action. Loose Change Publications. St. Banos, California.
9. Block, Elliot. 1984. Manipulating Dietary Anions and Cations for Prepartum Dairy Cows to Reduce Incidence of Milk Fever. J. Dairy Sci. 67:2939
10. Fredeen, A.H. et al. 1988. Characterization of Acid-Base Disturbances and Effects on Calcium and Phosphorus Balances of Dietary Fixed Ions in Pregnant Does. J. Anim. Sci. 66:159.
11. Graham, T. W. 1991. Trace Element Deficiencies in Cattle. Veterinary Clinics of North America: Food Animal Practice 7 (1) 153.
12. Corah, L. R. and S. Ives. 1991. The Effect of Essential Trace Minerals on Reproduction in Beef Cattle. Veterinary Clinics of North America: Food Animal Practice 7(1)41.

Appendix Table 1
Results of Phosphorus Supplementation

Phosphorus Supplementation:

Trial 1 King Ranch 1938-41, (2 yr./avg.)
- *increase calves born from 64 to 85%, + 21 calves/100 cows
- *increase calves weaned from 58 to 81%, + 23 calves/100 cows
- *increase of cows calving in two consecutive years from 30 to 73%
- *increase weaning weight 69 lbs. (425 to 494)
- *increase weaning weight/cow 156 lbs. (244 to 400)

Trial 2 King Ranch 1942-46, (4yr./avg.)[a]
- *increase calves weaned from 64 to 90%, + 26 calves/100 cows
- *decrease calving interval from (459 to 366), - 93 days
- *increase weaning weight 49 lbs. (489 to 538)
- *increase wean weight/cow 165 lbs. (319 to 484)

[a]Average of bonemeal and water treatment vs. control

Appendix Table 2
Return on Investment In Phosphorus Supplementation[a]

Treatment	Cost[b]	Increased[c] Income	Return/ $ Invested
Control	—-	___	___
Bonemeal, TM (4.5)[d]	7.97	98.40	12.35
Bonemeal (10.1)	17.88	75.60	4.23
DiNa PO_4 (10.1)	17.88	105.60	5.91
Bonemeal (5.6)	9.91	89.40	9.02
DiNa PO_4 (6.4)	11.33	108.60	9.59
P Fertilizer (79)	47.40	187.20[e]	3.95

[a]In the 1938-41 trial, cattle were manually fed (1) bonemeal with trace minerals to supplement 6.5 grams of phosphorus/cow/day all year long (4.5 lb. P/year), (2) bonemeal to supply 6.5 grams during dry period and 14.3 grams during lactation (10.1 lb P/year), or (3) disodium phosphate at the 6.5 - 14.3 (10.1 lb. P/year) rate. In the 1942-46 trial (1) bonemeal was self fed, (2) disodium phosphate was added to the water (1.08 grams P/gallon) and (3) pastures were fertilized with 200 pounds of triple superphosphate (96 lb P_2O_5) per open acre (88% of total acres) one time for 5 years.

[b]P@$1.77/lb. = $425/ton for 12% P mineral - Fertilizer P @ $.60/lb

[c]Calf weight @ $.60/lb

[d]( )lb.P/cow/year

[e]1.5 X more cows/unit of grazing land

Texas A&M AgriLife Extension Service
AgriLifeExtension.tamu.edu

More Extension publications can be found at *AgriLifeBookstore.org*

The Texas A&M University System, U.S. Department of Agriculture, and the County Commissioners Courts of Texas Cooperating.

Considerations for Retained Ownership of Feeder Cattle

Retaining ownership of feeder cattle beyond the traditional time of sale at or near weaning is an option some cow-calf producers may consider.

Two options for management of weaned calves include moving directly to feedlots for finishing or to a backgrounding operation with grass or high forage diets. There are advantages and disadvantages to retained ownership:

- the opportunity exists to take advantage of superior growth and(or) carcass genetics
- carcass data may be made available to assess a breeding and nutritional program
- partnerships may be forged with cattle feeders or backgrounders for economic advantage
- there are excellent local markets for finished cattle
- marketing can be accomplished in a larger window of time for backgrounded cattle
- the herd health program can be assessed
- unused facilities can be put to use
- grain and other commodities on the farm can be marketed through cattle
- there is higher risk of ownership due to death loss, sickness, and commodity prices
- profitability is cyclical and determined largely by grain prices
- cattle will normally be transported at least once prior to sale
- small groups (less than 45,000 lbs. of like animals) are often difficult to place with a custom operator
- cash flow will be altered

As noted above, there are some good reasons for retaining ownership of feeder calves. One opportunity that does not exist for all retained cattle is higher profits. Many calf producers consider retaining ownership when calf prices are low in the hope of higher profits on the calf crop. However, one of the reasons the price of calves is lower is because there is a lower expectation of profit in the cattle feeding enterprise, which is driving down the price of calves. Secondly, the price of feed grains is an important driver for the price of feeder cattle. When corn prices are edging higher, as they are now in the late summer of 2002, this will reduce demand and price for calves. Many custom feedlots price their services by selling the calf owner feed at a marked up price, plus additional costs for the use of their facilities and labor. Therefore, the cost of feeding the calves, and the profit risk, will be borne by the calf owner.

One of the main reasons calf producers can profit from retained ownership is to take advantage of an excellent genetic program in their herd. Most custom feeding enterprises price the cost of gain based on industry average feed efficiencies and daily weight gains. When genetically superior cattle actually have better feed efficiency and weight gain, the price can be lower. However, this feature will only be true when custom feeding is priced on feed intake and grain price. If the custom feeder is pricing his services strictly on the cost of weight gain, the advantage of genetically superior cattle is lost since owners of highly efficient cattle will be paying the same price as one with poor gains and feed efficiency.

A good preconditioning program will be essential to success of retaining ownership. It has been shown in numerous demonstrations and research studies that cattle that get sick in the feedlot will have lower weight gains, lower feed efficiency, and lower quality grades than those that remain well. Secondly, the cost of treatment is usually higher than the cost of vaccine to prevent disease, particularly when the calf owner has to pay the custom operator or his vet to treat sick cattle. The essential parts of a good program include vaccinations and boosters for IBR, BVD, PI3, BRSV, and pasturella at least two weeks prior to moving cattle to a new location. If they are to be commingled with other producer's cattle in the same pen, some good insurance includes the use of intranasal IBR vaccine as well. The next most important feature is to have the calves weaned, eating a small amount of grain from a bunk, and drinking from an automatic waterer starting at least a month prior to shipping.

Why would a calf owner consider retained ownership? The following table from South Dakota shows the returns to retained ownership over several years.

Year	Ave. Return ($/head)	Best return ($/head)	Lowest return ($/head)
1990-91	38.49	131.21	-56.57
1991-92	27.94	98.54	-53.01
1992-93	113.67	176.41	51.75
1993-94	-87.84	-20.63	-173.03
1994-95	-12.03	33.74	-115.10

Table 1. Returns for retained ownership of steer calves

Wagner, et. al (1995)

Profitability from retained ownership is obviously highly variable, and can change dramatically from one year to the next. Therefore, calf owners must sharpen their pencil and use realistic values to assess the potential for profit. A sample budget is shown in Table 2 that can be used as a benchmark to evaluate retained ownership. However, care must be taken to insert individual costs and expectations for each farm or herd situation.

The same method can be used to budget a backgrounding scenario, except, of course, the sale weights, cost of gain, and sale prices will be different. The data in Table 2 shows very clearly that the “average” calf under these conditions will not be profitable. Again, the calf producer who has above average cattle for weight gain and efficiency can reduce feed, interest, and yardage costs, while an excellent health program can contribute to a lower death loss. Assuming your cattle are above average can be dangerous. There should be some good evidence of excellence prior to assuming anything but average performance.

Item	Calculation	Cost or value per head
Finished Steer	1200 lbs @$.65/lb.	$780.00 (a)
Feeder Calf Value	550 lbs. @$.85	$467.50 (b)
Feeding margin	a - b	$312.50

Table 2. Sample budget for retaining ownership of feeder calves

Costs	Calculation	Cost or Value per head
Feed	7.5 lbs. feed/lb.gain@$.06/lb.	$292.50
Yardage	$.30/day for 232 days @ 2.8lbs./day gain	$69.64
Trucking		$10.00
Vet/Med		$12.00
Interest	Value of feeder calf ($467.50) for 232 days @ 6%	$17.80
Death loss	1% of feeder calf value	$4.67
Total Costs		$406.61

Returns to retained ownership $312.50 - $406.61 = ($94.11)

How can a Pennsylvania calf producer take advantage of retained ownership? One of the objectives of the Blueprint for Success cattle feeders initiative is to identify and support custom feeding in Pennsylvania. Contact the PA Beef Council office at 717-939-7000 to help identify a custom feeder.

Prepared by: Dr. John Comerford, Retired Extension Beef specialist, Penn State

extension.psu.edu

Penn State College of Agricultural Sciences research and extension programs are funded in part by Pennsylvania counties, the Commonwealth of Pennsylvania, and the U.S. Department of Agriculture.

Where trade names appear, no discrimination is intended, and no endorsement by Penn State Extension is implied.

This publication is available in alternative media on request.

FEEDLOT MANAGEMENT

Economic Evaluation of Strategies to Reduce Feed Cost of Gain in the Feedlot

A. DiConstanzo, J. C. Neiske, H. Chester-Jones
University of Minnesota

INTRODUCTION

Two indices drive feedlot profitability. One, average daily gain, is associated with days on feed and mainly affects nonfeed cost of gain. The other, DM required/lb gain, is more closely associated with feed cost of gain. Because, under most condition, feed cost of gain is greater than nonfeed cost of gain, small changes in feed cost have a greater impact than similar changes in daily gain. For instance, a feed additive that improves feed efficiency (reduces DM required/lb gain) by 10% may be used. On the other hand, another feed additive that improves daily gain by 10% without affecting feed efficiency may be used. At a given daily gain of 3 lb/d and DM required/lb gain of 6.5, increasing daily gain 10% will reduce days on feed for 500 lb gain by 15 days. For 500 lb gain in this scenario, feed needs will be 3250 lb DM. At a nonfeed daily cost/head of $.25, the savings will be $3.75. Feed bill will be $130 when feed DM is priced at $.04/lb. On the other hand, given a daily gain of 3 lb/d and DM required/lb gain of 6.5, reducing DM required/lb gain by 10% will not affect days on feed, but will reduce feed needs to 2925 lb DM. Therefore, the feed bill will be $117, a savings of $13 relative to the first scenario, assuming no change in feed price/lb DM. Because changing feed efficiency did not affect daily gain, net savings will be $9.25/steer under this scenario.

This paper will focus on factors that affect feed cost of gain. It will also provide a system to evaluate alternative feed sources, feed storage or feed processing methods based on a cost benefit analysis.

IMPROVING COST OF GAIN THROUGH USE OF ALTERNATIVE FEEDS

Corn milling byproducts. Corn gluten feed (CGF) is a byproduct of the milling of corn for starch, germ meal and sugar production. Corn gluten feed is comprised mainly of corn bran which contains some germ meal and starch with some steep liquor added. This combination results in a feedstuff that is high in fiber and protein. However, the fiber portion of CGF digests rapidly; therefore, energy value of CGF is better than expected from its high fiber content.

Studies with CGF indicate that wet or dry CGF fed at 20 to 50% diet DM in corn silage-based diets has a similar energy value as corn silage (.52 Mcal NEg/lb DM; Table 1). Although an increase of 8% in DM required/lb gain resulted when DCGF replaced corn silage (80% diet DM) in some instances, the price of DCGF relative to corn silage may permit reductions in cost of gain. In finishing diets, value of wet or dry CGF approaches that of corn grain when CGF constitutes up to 50% of the diet

DM (Table 1). Addition of DCGF over 50% of diet DM causes increases in DM required/lb gain; however, price of DCGF relative to corn grain may permit reductions in cost of gain.

Some negative interactions exist when wet or dry CGF is fed with corn silage in high corn grain diets. When CGF was fed dry at 30%, or wet at 50 or 70%, of the diet DM and either 15 or 10% corn silage in DCGF or WCGF diets, respectively, DM required/lb gain was increased from 3 to 16% over the control diet (Table 1). This may be the result of negative associative effects resulting from digestion of fiber components from both CGF and corn silage in the presence of corn grain (DiCostanzo et al., 1990). Thus, it is important to recognize that when either wet or dry CGF is used, addition of corn silage may negatively affect feed efficiency.

Distillers byproducts include fiber, protein and lipid fractions derived from the milling of corn for ethanol production. Studies conducted with distillers byproducts normally involve some distiller grains and solubles. These may be either dried before marketing, or sold as a mash which must be fed quickly because of potential spoilage.

Most studies with dry or wet distillers byproducts demonstrate that these byproducts contain an energy value equal to or greater than corn grain (Table 1). Increasing concentration of dietary wet distiller byproduct reduced DM required/lb gain as much as 17%. Further evaluation of these data indicate that steers consuming increasing amounts of wet distiller byproduct consumed less dry matter but gained more weight than those fed the control corn grain diet (Table 1). Based on these results, Klopfenstein and Stock (1983) indicate that the energy value of wet distiller byproduct approximates .97 Mcal/lb DM. Data reported by Firkins et al. (1985) support this observation (Table 1).

Feeding dry distillers byproduct may cause some concern because of the increased probability for damaging protein fraction during the drying process. However, data reported by Klopfenstein and Stock (1993) demonstrated that, for dry distillers byproduct diets (40% of diet DM) with a range in acid detergent insoluble nitrogen between 9.7 and 28.8% of CP, DM required/lb gain was 90 to 92% that of the control diet. Dry matter required/lb gain for a wet distiller byproduct diet (40% diet DM) fed during this trial was 84% that of the control diet, thereby indicating that, although some reduction in energy value was caused by drying this byproduct, its energy value was yet greater than that of corn.

Table 1. Feed efficiency of steers fed various corn milling byproducts.

Weight	Control diet	Diet NE_g, Mcal/lb	Byproduct	Byproduct, %DM	Ratio of F/G value relative to control diet
550 [a]	Corn silage	49	DCGF	20	101.2
550 [a]	Corn silage	49	DCGF	50	100.9
550 [a]	Corn silage	49	DCGF	80	107.7
600 [b]	Corn silage	50	WCGF	35	84.3
600 [b]	Corn silage	50	DCGF	35	88.7
600 [b]	Corn silage	50	DDG	17	73.9
850 [a]	Corn grain	62	DCGF + CS	30 + 15	116.0
850 [a]	Corn grain	62	DCGF	50	102.2
850 [a]	Corn grain	62	DCGF	70	118.1
780 [a]	Corn grain	62	DCGF + CS	30 + 15	109.2
780 [a]	Corn grain	62	DCGF	50	95.8
780 [a]	Corn grain	62	DCGF	70	106.8
720 [b]	Corn grain	62	WCGF	50	103.9
720 [b]	Corn grain	62	DCGF	50	114.3
670 [b]	Corn grain	65	WCGF + CS	50 + 10	102.6
670 [b]	Corn grain	65	WCGF	50	101.2
670 [b]	Corn grain	65	WCGF + CS	70 + 10	110.0
670 [b]	Corn grain	65	WCGF	70	101.1
670 [b]	Corn grain	65	WCGF	90	103.7
615 [c]	Corn grain	62	WDG + TS [d]	5	98.1
615 [c]	Corn grain	62	WDG + TS [d]	13	94.5
615 [c]	Corn grain	62	WDG + TS [d]	40	87.6
748 [c]	Corn grain	62	WDG + TS [d]	5	95.4
748 [c]	Corn grain	62	WDG + TS [d]	13	91.2
748 [c]	Corn grain	62	WDG + TS [d]	40	83.3

WCGF = Wet corn gluten feed
DCGF = Dry corn gluten feed
DDG = Dry distillers grain
WDG = Wet distillers grain
CS = Corn silage
TS = Thin stillage

[a] DiCostanzo et al., 1990.
[b] Firkins et al., 1985.
[c] Klopfenstein and Stock, 1993.
[d] 63:37 ratio.

Use of sound or moldy small grains. In some areas of the country, small grains may present an opportunity to replace corn in finishing diets. Although both wheat and barley contain similar energy/lb DM as corn, their rate of fermentation in the rumen is faster than that of corn. Therefore, strategies for utilizing small grains in finishing rations require careful bunk management and price considerations.

Compared to corn grain, dry rolled barley supported similar feed efficiencies (Table 2), but steers fed barley gained 5 to 7% less weight, and consumed 4 to 6% less feed daily than those fed corn

grain. Thus, although feed cost of gain may be reduced by utilizing barley, additional time in the feedlot must be evaluated against the cost of feed savings.

Table 2. Feed efficiency of steers fed various small grains.

Weight	Control diet	Diet NE_g, Mcal/lb	Grain	Grain, %DM	Ratio of F/G value relative to control
512 [a]	Corn grain	62	Barley	70	100.8
660 [b]	Corn grain	63	Barley	68	102.7
670 [c]	Corn grain	62	Wheat	15	103.5
670 [c]	Corn grain	62	Wheat	30	102.6
670 [c]	Corn grain	62	Wheat	45	98.4

[a] Windels et al., 1976.
[b] Windels et al., 1994.
[c] Anderson et al.. 1992.

Compared to corn grain, increasing amounts of dry rolled wheat from 15 to 45% of diet DM permitted similar feed efficiencies (Table 2), but steers gained 2 to 6% less weight than those fed corn grain. Increased time in the feedlot must be considered when evaluating potential reduction in cost of gain by using wheat.

Be aware that a source of low priced wheat or barley may be grain that is contaminated with mycotoxins, specifically vomitoxin (deoxynivalenol). Studies conducted to date (DiCostanzo et al., 1994) and current studies at the University of Minnesota (Table 3) indicated that vomitoxin concentrations as high as 21 ppm did not affect feed efficiency. Therefore, some additional reductions in feed cost of gain may be realized when low priced vomitoxin-contaminated wheat or barley are included in feedlot diets at a reduced price.

Table 3. Feed efficiency of steers fed sound or vomitoxin-contaminated barley.

Weight	Control diet	Diet NE_g, Mcal/lb	Vomitoxin, ppm	Ratio of F/G value relative to control
914 [a]	Sound barley	58	6	103.3
914 [a]	Sound barley	58	12	99.3
914 [a]	Sound barley	58	18	97.4
870 [b]	Sound barley	61	7	99.3
870 [b]	Sound barley	61	14	99.8
870 [b]	Sound barley	61	21	100.1

[a] DiCostanzo et al., 1995.
[b] Windels et al., 1995.

MANIPULATING FEED EFFICIENCY THROUGH PROCESSING OR STORAGE METHODS.

Most feedlots in the Upper Midwest must face the question of what method to store grains or whether to process them. Because of weather or facilities, high moisture grains may need to be utilized. Similarly, because of feedlot size, design of facilities or feed delivery method, grinding or

rolling grain may be considered. Some results of trials conducted in the Upper Midwest and their main conclusions are included in the discussion below.

Processing method. It is well established that small grains should be processed to permit proper digestion in the rumen. The question is, "to what extent should they be processed?" Apparently, rolling may be sufficient to permit proper digestion and fermentation in the rumen because excessive grain processing affected feed effeciency negatively (Table 4). Grinding barley resulted in a 4.6% increase in DM required/lb gain. This increase was a direct result of increased feed intake without an increase in daily gain (Windels et al., 1970).

Results of comparisons between whole and rolled or cracked corn are included in Table 4, and are just a sample of the immense data found in the literature on this subject. From these data, it is difficult to generalize about a given trend for either rolled or whole corn. In most instances, differences in feed efficiency do not amount to more than 5%. Therefore, the decision to roll or crack corn must be made on the basis of price and(or) complications of the feeding routine associated with processing or not processing corn.

Storage method. Utilizing high moisture feeds will generally improve feed intake; however, a similar increase in daily gain must follow to prevent an increase in DM required/lb gain. For small grains with an inherently fast fermentation rate, high moisture content may affect feed efficiency negatively. Indeed, inclusion of high mositure rolled barley instead of dry rolled barley increased DM required/lb gain 7 to 24% (Table 4). In both instances feed intake increased, but daily gain was either not improved or was decreased (Kennelly et al., 1988).

In contrast, replacing dry rolled or cracked corn with high moisture shelled or rolled corn did not affect, or tended to improve feed efficiency (Table 4). Because of a slower fermentation rate, corn fermentation may be improved by moisture content. Feedlot operators in the Upper Midwest may take advantage of this feature because of short growing seasons, the potential for reduced harvest costs, or both.

Table 4. Effect of grain storage or processing method on feed efficiency

BW	Control diet	Diet NE_g, Mcal/lb	Alternative storage or processing method	Ratio of F/G value relative to control
Processing Method				
783 [a]	Rolled barley	61	Ground barley	104.6
660 [b]	Rolled corn	63	Whole corn + hay	104.3
NA [c]	Rolled corn	63	Whole corn + hay	101.4
NA [c]	Rolled corn	63	Whole corn + haylage	100.0
702 [d]	Cracked corn	66	Whole corn + 5% hay	99.2
702 [d]	Cracked corn	64	Whole corn + 10% hay	98.0
702 [d]	Cracked corn	62	Whole corn + 20% hay	88.4
793 [e]	Rolled corn	62	Whole corn + silage	97.5
Storage Method				
778 [f]	Ground barley	62	High moisture rolled barley	90.6
477 [g]	Rolled barley	56	High moisture rolled barley	107.2
785 [g]	Rolled barley	62	High moisture rolled barley	123.8
443 [h]	Rolled corn	62	High moisture rolled corn	100.4
456 [i]	Rolled corn	62	High moisture rolled corn	99.8
722 [j]	Cracked corn	63	High moisture shelled corn	95.7
780 [k]	Rolled corn	65	High moisture rolled corn	97.2

[a] Windels et al., 1970. [e] Hansen et al., 1984. [i] Gharib et al., 1971.
[b] Brink et al., 1984. [f] Windels et al., 1974. [j] Hanke et al., 1981.
[c] Poppert and Mader, 1989. [g] Kennelly et al., 1988. [k] Dexheimer et al., 1971.
[d] [h]

EVALUATING USE OF ALTERNATIVE FEEDS OR PROCESSING AND STORAGE METHODS.

As feedlot operators prepare to make decisions on whether to utilize alternative feed sources or what effects storing or processing will have on feed cost of gain, it is important that they consider potential benefits and costs associated with an alternative. Worksheet 1 was generated based on the concept of optimizing use of feeds or storage and processing methods. Data to be included in the worksheet are ingredients, amounts fed daily of the current diet, their cost and dry matter content, and a projected or observed average daily gain. Feed costs must include any handling or processing costs (real cost delivered to the bunk). Dry matter contents of feedstuffs must be measured regularly to estimate dry matter intake accurately. In addition, cost, desired amount to feed (from Tables 1 through 4, or other sources), potential change in feed DM required/lb gain (from Tables 1 through 4, or other sources), and dry matter content of alternative feed must be considered. Cost must include handling and processing costs (real cost delivered to the bunk).

The worksheet will permit calculation of alternative diet breakeven cost (cost at which there is no additional economic benefit to include alternative feed). This worksheet can be used to evaluate whether it pays to roll corn, what the expected cost of gain will be with a lower quality feedstuff

that must be used, or what price an alternative feed should be to maintain profitability. To complete the worksheet follow these simple steps:

Under current diet fed section.

1. Fill in ingredients and amounts fed on an as-fed basis under columns 1 and 2, respectively, in lines provided (lines 1 through 6).

2. Fill in the price/lb as fed under column 3 in lines corresponding to step 1.

3. Multiply values in column 2 by values in column 3 and enter results under column 4 in lines corresponding to step 1.

4. Enter each ingredient DM content (from your lab printout) under column 5.

5. Calculate DM fed from each ingredient under column 6 by multiplying values in column 2 by those in column 5.

6. Determine totals for columns 2, 4 and 6 by adding values within each column.

7. Calculate diet DM by dividing total for column 6 by total for column 2. Enter result in box 1.

8. Calculate diet cost/lb by dividing total for column 4 by total for column 2. Enter result in box 2.

9. Calculate diet cost/lb DM by dividing total for column 4 by total for column 6. Enter result in box 3.

10. Enter an observed or projected average daily gain (in pounds) in box 4.

11. Calculate feed required/lb gain by dividing total in column 2 by value in box 4. Enter result in box 5.

12. Calculate DM required/lb gain by dividing total in column 6 by value in box 4. Enter result in box 6.

13. Calculate feed cost of gain/lb by multiplying value in box 5 by value in box 2. Enter result in box 7.

Under alternative diet section.

1. Fill in ingredients and amounts to be fed (DM basis) under columns 1 and 2, resepctively.

2. Enter the ingredient DM content (from your lab printout) under column 3.

3. Calculate ingredient amounts to be fed (as fed basis) by dividing values in column 2 by those in column 3. Enter results under column 4 in lines corresponding to step 1.8

4. Fill in the price/lb as fed under column 5 in lines corresponding to step 1.

5. Multiply values in column 4 by values in column 5 and enter results under column 6 in lines corresponding to step 1.

6. Determine totals for columns 2, 4 and 6 by adding values within each column.

7. Calculate diet DM by dividing total for column 2 by total for column 4. Enter result in box 8.

8. Calculate diet cost/lb by dividing total for column 6 by total for column 4. Enter the result in box 9.

9. Calculate diet cost/lb DM by dividing total for column 6 by total for column 2. Enter result in box 10.

Under breakeven diet cost determination section.

1. Enter value from box 5 in box 11 (current feed cost/lb gain, $).

2. Enter expected change in DM required/lb gain relative to current diet (from Tables 1 through 4, or any other source) in box 12 (expected change in DM required/lb gain).

3. Multiply value in box 11 by that in box 12. Enter result in box 13 (expected DM/lb gain).

4. Determine new maximum allowable diet cost/lb DM by dividing value in box 11 by that in box 13. Enter result in box 14 (maximum new diet cost, $/lb DM).

5. Enter new diet DM from box 8 in box 15 (new diet DM, %).

6. Multiply value in box 14 by that in box 15. Enter result in box 16 (new diet breakeven cost, $/lb). **THIS IS THE DIET BREAKEVEN COST (MAXIMUM COST OF ALTERNATIVE DIET) FOR INCLUSION OF THE ALTERNATIVE FEED AS ENTERED UNDER DIET TO FEED SECTION.** Compare this diet cost with alternative diet cost (box 9). For an alternative feed to be a profitable venture, this cost should be higher than the value in box 9.

Based on this method, a simulation was for inclusion of an alterntative ingredient to substitute for 100% of an originial ingredient (fed at 75% of diet DM) of similar dry matter content in a diet that permits a feed-to-gain ratio (DM) of 6.5 (Table 5). This simulation evaluated diet costs between $.02 and .06/lb ($40 to 120/ton) and changes DM required/lb gain between .85 and 1.15 relative to the original diet. Results are presented as price of alternative feed relative to price of original feed for the alternative diet to be feasible.

Table 5. Price an alternative ingredient must have for an alternative diet cost to breakeven with original feed cost of gain given 100% substitution of an original ingredient fed a 75% of diet DM.[a]

Expected relative change in DM required/lb gain	Diet cost, $/lb ($/ton)				
	.02 (40)	.03 (60)	.04 (80)	.05 (100)	.06 (120)
	---------Alternative ingredient price relative to original ingredient price---------				
0.85	132	125	123	121	120
0.90	119	116	114	113	113
0.95	110	108	107	106	106
1.05	92	93	94	94	94
1.10	83	87	88	89	89
1.15	76	82	83	84	85

[a] Original diet permits 6.5 lb DM/lb gain efficiency.

It is evident that as the alternative ingredient reduces DM required/lb gain, the price/lb that can be paid increases up to 32% relative to the original ingredient. Similarly, if inclusion of the alternative ingredient increases DM required/lb gain to 1.15 times, the price of the alternative ingredient should be 24% below the original ingredient. It is also evident that within a given diet price, a change in DM required/lb gain of 5 percentage points will be compensated by a change in ingredient price of 6 to 7 percentage points. Thus, for a given diet utilizing an alternative

ingredient that increases DM required/lb gain by 10 percentage points, the alternative ingredient must be priced 14% below the original ingredient used to make the diet feasible.

Table 5 can be used to determine the feasibility of feeding rolled corn vs feeding it whole. If it is assumed that a decrease of .95 in DM required/lb gain will result from feeding rolled corn, then a person paying $76.2/ton for rolled corn ($5.6/ton for rolling) is not realizing any economic benefits for rolling corn when whole corn is priced at $70.6/ton (diet cost = $60/ton). Any rolling costs below $5.6/ton will favor rolling vs whole corn feeding in this scenario. Similarly, Table 5 can be used to consider the feasibility of substituing barley for corn grain. With corn priced at $70.6/ton, and considering that barley feeding may increase DM required/lb gain by 1.05, barley price should be 93% that of corn, or $65.66/ton.

Table 5 and the worksheet from which it was derived aid in determining the cost-benefit relationship due to changes in DM required/lb gain only. A prudent feedlot operator should consider other effects of using alternative feeds or alternative storage or processing methods such as changes in feedlot period length and carcass characteristics.

LITERATURE CITED

Anderson, P.T., D.P. O'Connor, M.T. Lewis, and B.J. Johnson. 1992. Inclusion of wheat in typical Minnesota feedlot diets. MN Beef Cattle Res. Rep. B-389.

Brink, D.R., O.A. Turgeon, Jr., D.L. Harmon, R.T. Steele, T.L. Mader, and R.A. Britton. 1984. Effects of additional limestone of various types on feedlot performance of beef cattle fed high corn diets differing in processing method and potassium level. J. Anim. Sci. 59:791.

Dexheimer, C.E., J.C. Meiske, and R.D. Goodrich. 1971. Comparison of ensiled high moisture and artificially dried shelled corn for finishing yearling steers. B-158.

DiCostanzo, A., L. Johnston, H. Chester-Jones, J.C. Meiske, M. Murphy, R. Epley, and L. Felice. 1995. Effects of feeding vomitoxin-contaminated barley on performance of feedlot steers. MN Cattle Feeder Rep. B-418.

DiCostanzo, A., L. Johnston, and M. Murphy. 1994. Feeding vomitoxin and mold-contaminated grains to cattle. In: Proc. 55th MN Nutr. Conf. and Roche Tech. Symp. Sept 19-21, Bloomington, pp 193-216.

DiCostanzo, A., H. Chester-Jones, S.D. Plegge, T. M. Peters, and J.C. Meiske. 1990. Energy value of maize gluten feed in starter, growing or finishing steer diets. Anim. Prod. 51:75.

Firkins, J.L., L.L. Berger, and G.C. Fahey, Jr. 1985. Evaluation of wet and dry distillers grains and wet and dry corn gluten feeds for ruminants. J. Anim. Sci. 60:847.

Gharib, F.H., R.D. Goodrich, J.C. Meiske, and H.A. Cloud. 1971. Comparison of corn stored at 11.5% moisture or 16.1% moisture in a steel bin with aeration. MN Cattle Feeder Rep. B-160.

Hanke, H.E., R.E. Smith, R.D. Goodrich, and J.C. Meiske. 1981. Type of corn (dry corn vs high mositure corn grain) and nitrogen supplement (urea vs soybean meal) for yearling steers. MN Cattle Feeder Rep. B-271.

Hanson, S., S.D. Plegge, and J.C. Meiske. 1984. Influence of feeding whole or rolled corn to Holstein steers. MN Cattle Feeder Rep. B-320.

Kennelly, J.J., G.W. Mathison, and G. de Boer. 1988. Influence of high-moisture barley on the performance and carcass characteristics of feedlot cattle. Can. J. Anim. Sci. 68:811.

Klopfenstein, T.J. and R.A. Stock. 1993. Feeding wet distillers and gluten feed to ruminants. In: Proc. 54th MN Nutr. Conf. and National Renderers Symp. Sept 20-22, Bloomington, pp 53-61.

Malone, D., D.B. Faulkner, G.F. Cmarik, R. Johnson, and D.F. Parrett. 1986. Factors influencing the feeding value of whole shelled corn. IL Beef Cattle Res. Rep. 53-54.

Miller, K.P., E.C. Frederick, J.C. Meiske, and R.D. Goodrich. 1971. Performance of Holstein steers fed corn stored and processed by three methods. MN Cattle Feeder Rep. B-159.

Poppert, G.L. and T.L. Mader. 1989. Roughage source and corn processing for step-up and finishing diets. NE Beef Cattle Rep. MP 54, pp 43-44.

Windels, H.F., A. DiCostanzo, M. Murphy, and R.D. Goodrich. 1995. Effect of deoxynivalenol from barley on performance and health of large frame crossbred steers. MN Cattle Feeder Rep. B417.

Windels, H.F., B.W. Woodward, J.C. Meiske and R.D. Goodrich. 1994. The effect of combined use of trenbolone acetate and estradiol implants on response of large-frame crossbred steers to dietary energy sources. MN Cattle Feeders Rep. B-410.

Windels, H.F., R.D. Goodrich, and J. C. Meiske. 1976. Comparison of corn or barley, corn silage or alfalfa haylage + corn silage and housing systems for growing finishing cattle. MN Cattle Feeder Rep. B-220.

Windels, H.F., R.D. Goodrich, and J.C. Meiske. 1974. Comparison of housing systems and dry or high moisture barley for feedlot cattle. MN Cattle Feeder Rep. B-198.

Windels, H.F., J.C. Meiske, and R.D. Goodrich. 1970. Dry rolled vs. ground barley for finishing cattle. MN Cattle Feeder Rep. B-147.

Worksheet 1. *Determination of breakeven diet cost to evaluate feasibility of using alternative feeds.*

Current diet fed

	Column				
1 Ingredient	2 1b/hd/d	3 Price, $/lb	4 $/d	5 Ingredient DM, %	6 DM fed, lb
#					
#					
#					
#					
#					
#					
TOTAL					

Box 2 Cost, $/lb = _____ Box 1 Diet DM, % = _____

Box 3 Cost, $/lb DM = _____ Box 4 Current ADG, lb = _____

Box 5 Feed/ lb gain, as fed = _____

Box 6 Feed DM/ lb gain = _____

Box 7 Cost/ lb gain, $ = _____

New diet to feed

	Column				
1 Ingredient	2 DM fed, lb	3 Ingredient DM, %	4 lb/hd/d	5 Price, $/lb	6 $/d
#					
#					
#					
#					
#					
#					
TOTAL					

Box 8 New diet DM, % = _____ Box 9 New cost, $/lb = _____

Box 10 New cost, $/lb DM = _____

Breakeven diet cost determination

Box 11 Current feed cost/lb gain, $ = _____ Box 12 Expected change in DM required/lb gain = _____

Box 13 Expected DM/lb gain = _____ Box 14 Maximum new diet cost, $/lb DM = _____

Box 15 New diet DM, % = _____ Box 16 New diet breakeven cost, $/lb = _____

Fact Sheet 1 in the Series: Tough Questions about Beef Sustainability

How does the carbon footprint of U.S. beef compare to global beef?

Ashley Broocks, Kimberly Branham, Sara Place, Megan Rolf, and Michelle Calvo-Lorenzo
Oklahoma State University

The production of food in all forms results in emissions of greenhouse gases. Carbon footprints are a measure that quantify the greenhouse gas emissions that result from the production of any given food item, or for a given product, activity, or industry. A carbon footprint refers to all the greenhouse gas emissions produced and are expressed as carbon dioxide (CO_2) equivalent emissions to account for the different greenhouse gases' potential to trap heat in the earth's atmosphere. For beef production, a carbon footprint refers to CO_2 equivalent emissions per unit of beef.

Comparing the U.S. beef industry's carbon footprint to other nations is challenging for two main reasons: 1) the methodologies used in different published studies to calculate carbon footprints within and across nations vary in ways that can influence their estimated carbon footprint, and 2) the efficiency of practices in how beef cattle are raised varies greatly across countries (i.e. productive use of resources to maximize the total amount of beef produced), and efficiency is a key driver of beef's carbon footprint. To overcome these challenges, one can examine the results from individual studies that use the same methodology to estimate CO_2 equivalent emissions across the wide range of beef production systems found in the world.

In two recent analyses of global livestock systems,[1,2] North American beef production systems (including the U.S.) were found to have some of the lowest carbon footprints. As seen in **Figure 1**, when CO_2 equivalent emissions are expressed per kg of protein, the U.S. and other developed nations have lower carbon footprints (**10 to 50 times lower**) as compared to many nations in sub-Saharan Africa and the Indian subcontinent.[2]

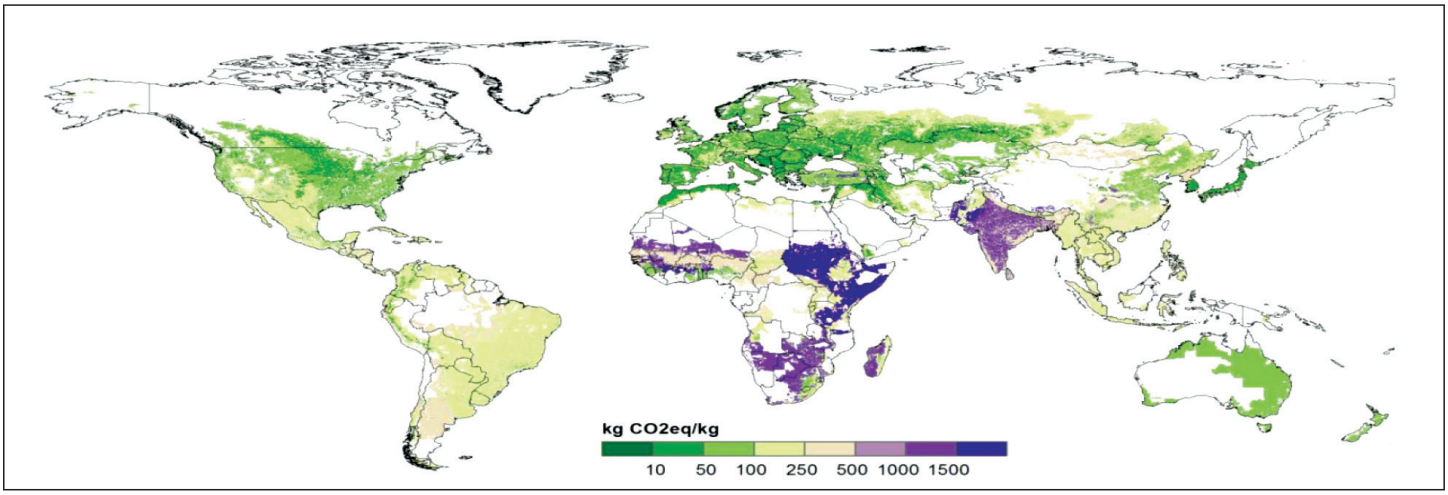


Figure 1. Greenhouse gas emissions from beef production expressed as kg of CO_2 equivalents per gram of protein. From reference 2: Herrero et al., 2013 PNAS 110: 20888-20893.

The lower CO_2 equivalent emissions per kg of protein for beef production systems in the developed world are driven by higher-quality (more digestible) feeds, lower impacts of climate stress (heat) on animals, improved animal genetics, advancements in reproductive performance, and the reduced time required for an animal to reach its slaughter weight as compared to regions with higher carbon footprints.[1,2] Combined, all of the above mentioned factors drive improvements in the efficiency of beef production while decreasing the use of natural resources and production of environmental emissions per unit of beef produced.

Furthermore, it is these factors that are responsible for reducing the U.S. carbon footprint of beef by an estimated 9-16% from the 1970's to the present day.[3,4] Using management techniques and technologies developed through scientific research is key to achieving improvements in beef production efficiency and further reducing beef's carbon footprint.

Bottom line: **The U.S. beef industry has one of the lowest carbon footprints in the world due to cattle genetics, the quality of cattle feeds, animal management techniques, and the use of technology.**

Literature Cited

1 Opio, C., P. Gerber, A. Mottet, A. Falcucci, G. Tempio, M. MacLeod, T. Vellinga, B. Henderson, and H. Steinfeld. 2013. Greenhouse gas emissions from ruminant supply chains – A global life cycle assessment. Food and Agriculture Organization of the United Nations (FAO), Rome.

2 Herrero, M., P. Havlík, H. Valin, A. Notenbaert, M.C. Rufino, P. K. Thornton, M. Blümmel, F. Weiss, D. Grace, and M. Obersteiner. 2013. Biomass use, production, feed efficiencies, and greenhouse gas emissions from global livestock systems. Proc. Natl. Acad. Sci. 110: 20888-20893.

3 Capper, J.L. 2011. The environmental impact of beef production in the United States: 1977 compared with 2007. J. Anim. Sci. 89:4249-4261.

4 Rotz, C.A., B.J. Isenberg, K.R. Stackhouse-Lawson, and E.J. Pollak. 2013. A simulation-based approach for evaluating and comparing the environmental footprints of beef production systems. J. Anim. Sci. 91(11):5427-5437.

For more information, contact:

National Cattlemen's Beef Association
Contractor to the Beef Checkoff Program
9110 East Nichols Avenue
Centennial, CO 80112
303.694.0305

Fact Sheet 2 in the Series: Tough Questions about Beef Sustainability

Does Beef Really Use That Much Water?

Ashley Broocks, Justin Buchanan, Sara Place, Megan Rolf, and Michelle Calvo-Lorenzo
Oklahoma State University

When looking for an answer to the question, "How much water is required to produce beef?" one may find a variety of answers. Water use estimates, or water footprints (defined as the amount of water used per unit of product), are available in the scientific literature and indicate that water footprints range from 317[1] up to 23,965[2] gallons per pound of boneless beef.

Why is the range so large? The range in estimates is mostly due to the methodology used by researchers. For example, some have counted all precipitation that falls on croplands, pastures, and rangelands towards the total water use of beef. Others have left out precipitation as it would fall on the land regardless of whether it was used for beef production or not. However, irrigation water use is always considered towards the total water use of beef.

Regardless of methodology, the production of feed for cattle is the single largest source of water consumption in the beef value chain (~95% of the water used to produce a pound of beef). The relative importance of this water use is highly dependent on location, because unlike greenhouse gas emissions, water use and access is a highly regionalized environmental issue. For example, in the southern High Plains approximately 30% of cropland is irrigated with water from the Ogallala aquifer.[3] In some, but not all cases, water is being drawn from the aquifer at a faster rate than it is being recharged.[3] Clearly, the use of a unit of water in such an area would be viewed and valued differently than a unit of water used in an area that primarily relies on precipitation water for agricultural production. As a result, one must be cautious about generalizing water footprints for beef or any other product on a national scale.

However, there are examples of innovative systems that integrate beef and crop production in the southern High Plains to more efficiently use water. In a four-year experiment, researchers compared a wheat-cotton crop rotation with one that integrated beef cattle, rye, wheat, and old world bluestem (a perennial warm season grass) in the High Plains of Texas. They found that the integrated beef cattle and crop system used 23% less irrigation water than the system with crops only.[4] The increase in irrigation water use efficiency was mostly due to the incorporation of perennial warm season grass into the farming system.[4] Perennial grasses would not be as valuable to sustainable farming systems without cattle that have the ability to digest such grasses because humans cannot directly consume and digest grass. While this is one example, it demonstrates that beef cattle can play a key role in water conservation.

Though the U.S. beef industry reduced its water use by 3% from 2005 to 2011,[5] many opportunities exist to further improve water use across the beef value chain (**Figure 1**). One area that is often overlooked and is important to all aspects of sustainability, not just water use, is reducing food waste. Food waste has an impact on the amount of water required to produce food for the nourishment of people. If prepared beef is thrown away and not consumed, all of the water use from feed production, cow-calf and stocker operations, feedlots, packing plants, retailers, foodservice, and the consumer has been used but has not contributed to human nourishment. Reducing food waste can help reduce the water footprint of beef and all other foods.

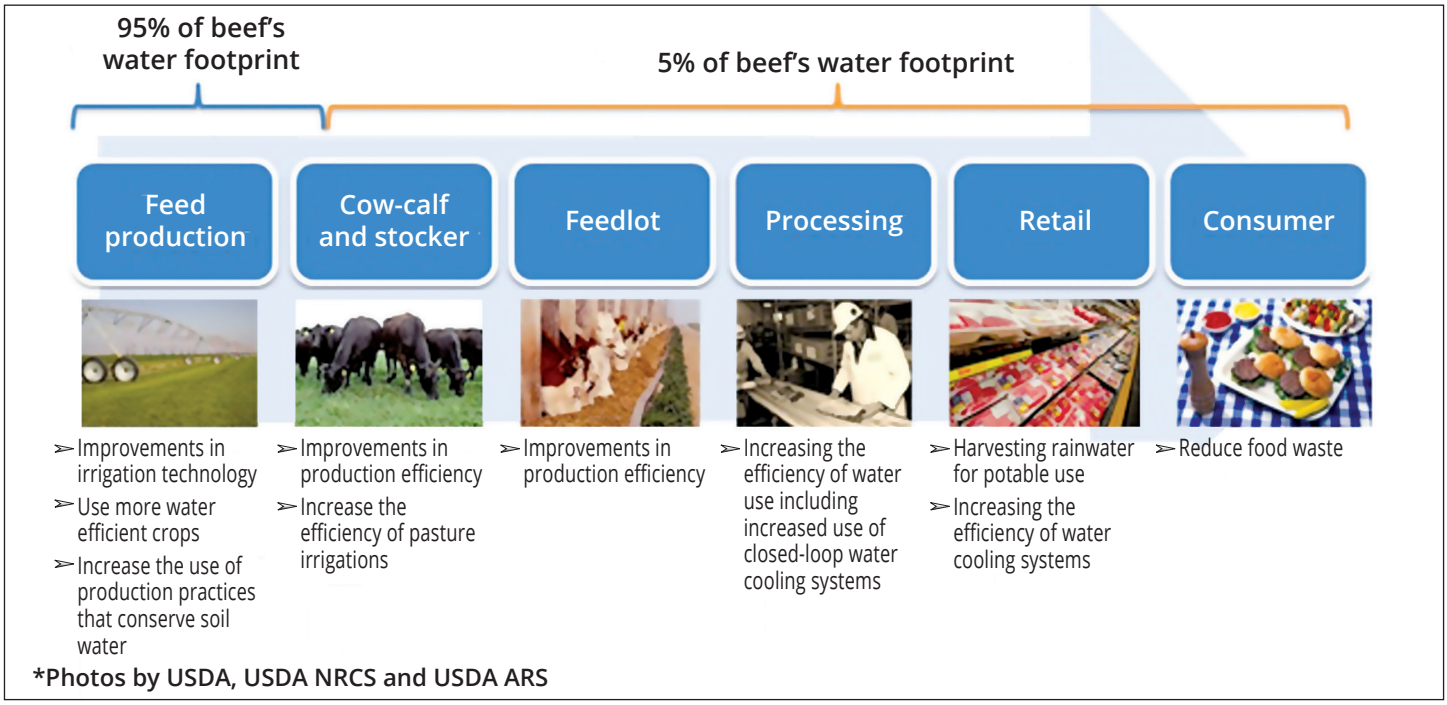


Figure 1. Examples of opportunities to reduce the water footprint of beef throughout the beef value chain.*

Bottom line: **The estimated water required for beef production greatly depends on the methodology used in scientific calculations, especially when considering whether or not precipitation water is included in water footprints. U.S. specific estimates put beef water use at 317[1], 441[6] and 808[7] gallons per pound of boneless beef when precipitation water is not accounted for in calculations.**

Additionally, the water footprint of beef greatly depends on the amount of feed consumed by cattle because of the reliance on irrigation to produce crops (~95% of beef's water footprint). As with all food production, reducing food waste and efficiently utilizing irrigation water, particularly in water-stressed regions, is an important aspect of beef sustainability and water use.

[1] Capper, J.L. 2011. The environmental impact of beef production in the United States: 1977 compared with 2007. J. Anim. Sci. 89:4249-4261.

[2] Pimentel, D. J. Houser, E. Preiss, O. White, H. Fang, L. Mesnick, T. Barsky, S. Tariche, J. Schreck, and S. Alpert. 1997. Water resources: Agriculture, the environment, and society. BioSci. 47: 97-106.3

[3] Scanlon, B.R., C. C. Faunt, L. Longuevergne, R. C. Reedy, W. M. Alley, V.L. McGuire, and P.B. McMahon. 2012. Groundwater depletion and sustainability of irrigation in the US High Plains and Central Valley. Proc. Natl. Aca. Sci. 109: 9320-9325.

[4] Allen, V. G., C. P. Brown, R. Kellison, E. Segarra, T. Wheeler, P. A. Dotray, J. C. Conkwright, C. J. Green, and V. Acosta-Martinez. 2005. Integrating cotton and beef production to reduce water withdrawal from the Ogallala aquifer in the Southern High Plains. J. Agron. 97: 556-567.

[5] Battagliese, T., J. Andrade, I. Schulze, B. Uhlman, C. Barcan. 2013. More sustainable beef optimization project: Phase 1 final report. BASF Corporation. Florham Park, NJ.

[6] Beckett, J.L. and J.W. Oltjen. 1993. Estimation of the water requirement for beef production in the United States. J. Anim. Sci. 71:818-826.

[7] Rotz, C.A., B.J. Isenberg, K.R. Stackhouse-Lawson, and E.J. Pollak. 2013. A simulation-based approach for evaluating and comparing the environmental footprints of beef production systems. J. Anim. Sci. 91(11):5427-5437.

For more information, contact:

National Cattlemen's Beef Association
Contractor to the Beef Checkoff Program
9110 East Nichols Avenue
Centennial, CO 80112
303.694.0305

Fact Sheet 7 in the Series: Tough Questions about Beef Sustainability

If we fed corn to humans instead of cattle, would land use be more sustainable?

Ashley Broocks, Megan Rolf and Sara Place
Oklahoma State University

Corn grain is used in beef cattle production because of its advantages in improving the efficiency of growth.[1] However, corn grain typically does not make up a large portion of cattle diets until the end of their life cycle in a period called "finishing" when cattle are often housed in a feedlot (**Figure 1**). The majority of a beef animal's life in the U.S., regardless of whether they are grain- or grass-finished, will be spent on grass consuming forages (whole plants). Depending on the region of the country and the prices and availability of different feeds, corn grain may make up 60-85% of a grain-finished animal's diet during the finishing phase. The other 15-40% of the animal's diet will be made up of forages or roughages (e.g., hay), by-products (e.g., distiller's grains), and minerals and vitamins. In addition to improving growth efficiency, corn grain is fed to cattle in the finishing phase because it increases carcass quality grades by increasing fat deposition (especially intramuscular or "taste" fat), which results in a more desirable product for consumers. Cattle on grass, including grass-finished beef, can also require supplementation of energy or protein-dense feeds that may contain corn grain in order to meet their nutrient requirements when the nutritional quality of the grass is low.

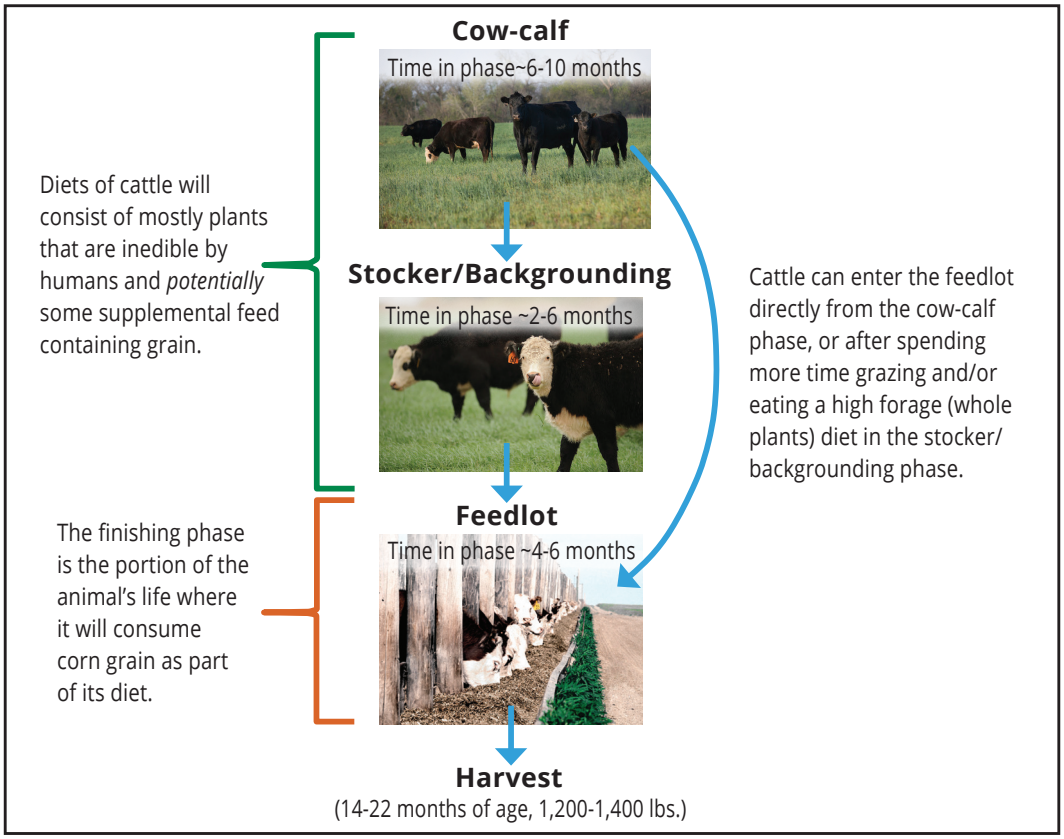


Figure 1. Typical life cycle of beef cattle in the United States.

While the diet provided to finishing cattle in feedlots relies on some human-edible inputs (i.e., corn grain), the forages and by-products fed to cattle throughout their lives are largely inedible to humans.[2] For example, once the entire lifetime feed intake of cattle is accounted for (meaning all the feed they consume from birth to harvest), corn only

accounts for approximately 7% of the animal's diet.[3] The other 93% of the animal's lifetime diet will consist largely of feed that is inedible to humans, and thus not in direct competition with the human food supply. Unlike humans, cattle can efficiently digest fiber and convert human-inedible feeds into nutritious, human-edible foods.

One of the major human-inedible by-products fed to beef cattle is distiller's grains, which is a by-product of alcohol production from corn (either for fuel or human consumption). The amount of distiller's grains fed to beef cattle has increased in recent years as the production of fuel from corn has increased. As **Table 1** demonstrates, the proportion of corn used for fuel production in the United States relative to animal feed has dramatically increased in recent years. In contrast, the percentage of corn used for human food has been relatively unchanged.

Table 1. Domestic uses of U.S. corn grain as a percentage of total domestic use in recent decades.

Year	Human food, seed, and industrial uses	Alcohol for fuel use (Ethanol)	Animal feed* and residual use
1980	12.8%	0.7%	86.5%
1990	18%	6%	76%
2000	17%	8%	75%
2010	13%	45%	43%
2015	12%	44%	45%

*Animal feed includes all types of domestic animals in the U.S., not just beef cattle (e.g., dairy cattle, swine, chickens, turkeys, horses, etc.). Data from USDA-ERS, 2015.[4]

Using recent data as a guide, one can predict that land used to grow corn for animal feed would likely be shifted to grow corn for fuel use if less corn grain were fed to beef cattle, and would not shift towards human consumption. Altering the lifetime consumption of corn grain by cattle, which is only approximately 7% of an average animal's total lifetime feed intake,[3] would likely have a very minor impact on the sustainability of land use.

Corn production, like all crop production, does have an environmental sustainability impact. Thus, reducing corn's environmental impact through better production practices and using new technologies would improve land use sustainability regardless of the corn's end use (human food, animal feed, or fuel). Such improvements include no-till or conservation tillage practices to reduce soil erosion and increase soil organic carbon,[4] winter cover crops to reduce nutrient run-off,[5] and precision agriculture techniques to apply fertilizer at variable rates across a field to minimize nutrient emissions to the environment while improving corn yields. Indeed, past improvements in crop yields, including corn, have contributed to reducing environmental impacts per unit of beef 12% from 1970 to 2011.[7]

Bottom Line: **Regardless of the type of beef production system, the majority of beef cattle's nutrient requirements over a lifetime are met with human inedible feeds. Only 7% of beef cattle's lifetime feed intake is corn grain. Improvements in corn production efficiency (minimizing environmental impacts relative to corn yield) will help improve land use sustainability regardless if corn is used for human consumption, beef cattle consumption, or fuel use.**

Literature Cited

[1]Bradford, G.E. 1999. Contributions of animal agriculture to meeting global human food demand. Livest. Production Sci. 59:95-112.

[2]Council for Agricultural Science and Technology (CAST). 1999. Animal agriculture and global food supply. Task Force Report. No. 135.

[3]Capper, J.L., L. Berger, M.M. Brashears, and H.H. Jensen. 2013. Animal feed versus human food: Challenges and opportunities in sustainable animal agriculture toward 2050. CAST. 53:1-16.

[4]USDA-ERS. 2015. Corn – Background. Accessed December 10, 2015 from http://www.ers.usda.gov/topics/crops/corn/background.aspx.

[5]Kumar, S., A. Kadono, R. Lal and W. Dick. 2012. Long-term no-till impacts on organic carbon and properties of two contrasting soils and corn yields in Ohio. Soil Sci. Soc. Am. J. 76(5):1798-1809.

[6]Dabney, S.M., J.A. Delgado, and D.W. Reeves. 2001. Using winter cover crops to improve soil and water quality. Commun. Soil Sci. Plan.32(7-8):1221-1250.

[7]Battagliese, T., J. Andrade, I. Schulze, B. Uhlman, C. Barcan. 2013. More sustainable beef optimization project: Phase 1 final report. BASF Corporation. Florham Park, NJ.

For more information, contact:

National Cattlemen's Beef Association
Contractor to the Beef Checkoff Program
9110 East Nichols Avenue
Centennial, CO 80112
303.694.0305

Fact Sheet 8 in the Series: Tough Questions about Beef Sustainability

Is local beef more sustainable?

Ashley Broocks, Megan Rolf and Sara Place
Oklahoma State University

Consumer interest in locally produced food has increased dramatically over the past few decades. While there is no single formal definition of local food, the term local food commonly means food grown or raised between 100-400 miles of where it is purchased, or simply food produced within the same state.[1] However, local can mean different things to different people, especially if we consider the size of different states (take Rhode Island vs. Texas as an example). It is important to note that local does not imply one production system was used over another, it simply means that the product was produced within a certain distance of where it is being sold.

From an environmental sustainability perspective, the primary difference between local and non-local products is the type of transportation used in moving post-harvest beef from processors to consumers, as shown in **Figure 1**. Measuring and comparing GHG emissions

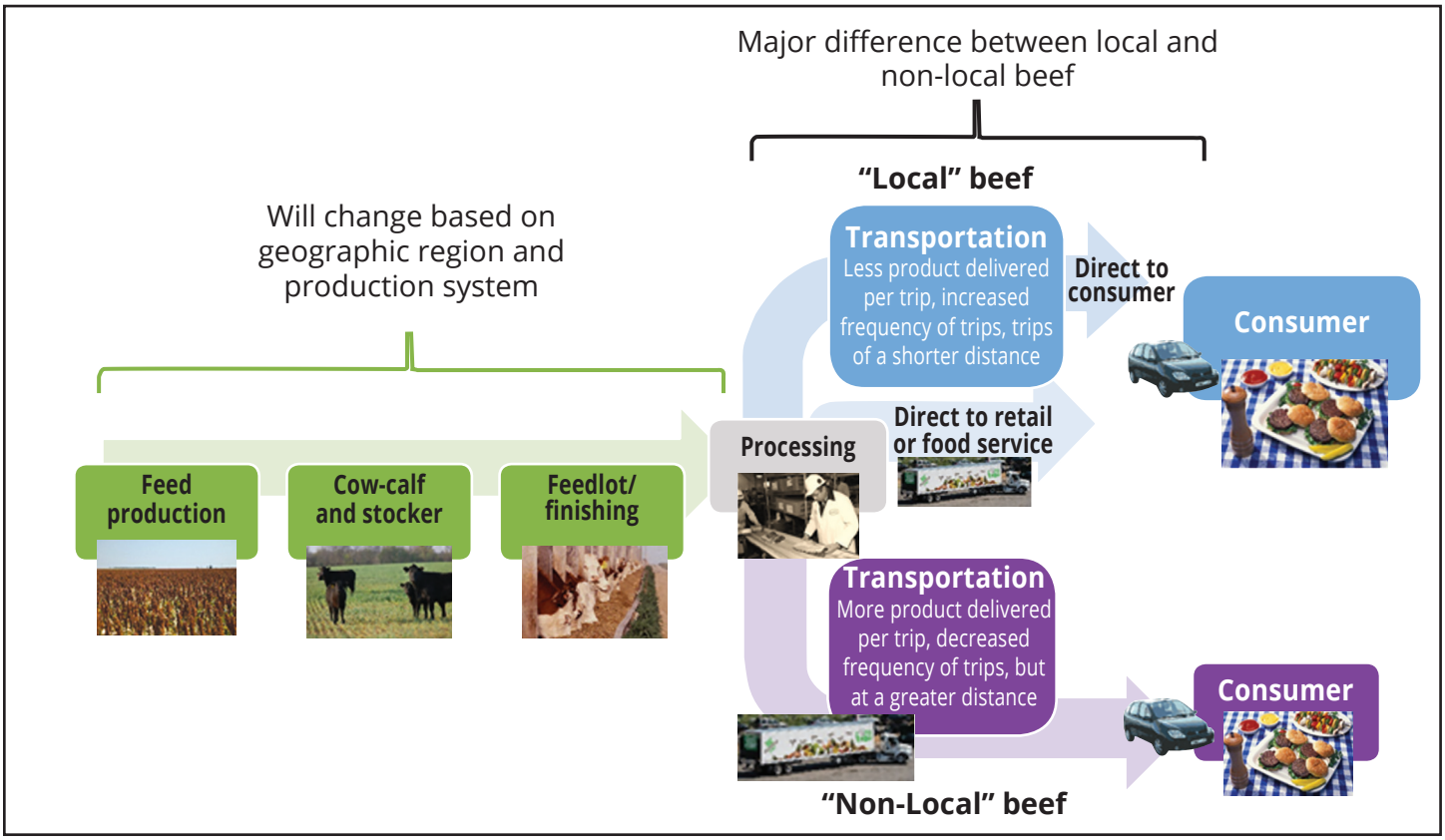


Figure 1. Major differences in the beef value chain between local and non-local beef are primarily due to transportation.*

*Photos courtesy of Oklahoma State University, USDA-ARS, USDA-NRCS, and openclipart.org

due to transportation of beef from local and national locations is difficult because mode of transportation, load sizes, fuel type, distance to market, and frequency of trips are rarely similar.[1] However, approximately 80% of GHG emissions occur in the beef value chain before the animal is harvested[2] and approximately 1-3% of GHG emissions occur due to transportation of beef to the consumer.[3,4] Local food, including beef, is either marketed directly to consumers, or marketed to foodservice (e.g., restaurants) and retailers and then purchased by consumers. The appeal of purchasing local foods is often associated with perceived reductions of greenhouse gases (GHGs) because the product travels shorter distances from the producer to the consumer, thereby reducing what is known as "food miles." However, there is a tradeoff between the increased frequency of trips and smaller load sizes versus the distance traveled per trip in local beef systems as compared to the mainstream beef transportation system. This is because more beef moved per trip will translate into lower fossil fuel energy use and lower GHG emissions per unit of beef transported.[1] Consequently, even if transportation distances were cut significantly for local beef, the impacts on GHG emissions are likely minimal.

While the environmental benefits of local beef (strictly considering transportation differences) may be minimal, many consumers that purchase local beef and other food products do so for social reasons, such as wanting to support their local economy and wanting to know where their food comes from.[5] To consumers that weigh those factors heavily in their purchasing decisions, local beef may be viewed as their most desirable choice. However, the effects of purchasing local food, including beef, on the local economy are not clear-cut nor are any economic benefits evenly distributed across communities (e.g., if a consumer shifts from purchasing at a retailer to a farmers market, the local owner(s) and operator(s) of the retailer will likely be negatively impacted).[1,6]

Additionally, it is unlikely that all U.S. consumers will have access to local beef if it is defined as within 100-400 miles of where one lives, due to land use constraints. For example, in highly populous cities, it would be unlikely that the land immediately surrounding the city would be able to support enough beef production to make local beef accessible to all consumers in that city. In more rural areas, rising land costs due to competition with crop production and expansion of residential housing may limit the ability to produce enough local beef to feed the population.

Regardless of where beef is produced, beef producers and researchers are continuously working toward improving the sustainability of beef production. As more of the environmental impact of beef production can be attributed to the raising of cattle and the feed fed to the cattle, focusing on improving the production efficiency of beef will have a far greater impact on environmental sustainability than reducing food miles. Sustainable beef production is not limited to a single production system, so all beef production systems (e.g., local, non-local, organic, conventional, grass-finished, grain-finished) can be sustainable if they are committed to constant improvement in all aspects of sustainability, including environmental impact, societal acceptance, and economic viability of production systems.[2]

Bottom Line: **The term "local" simply reflects the distance a product has been transported before being marketed and does not necessarily reflect differences in production practices or sustainability. The environmental sustainability benefit of purchasing local beef products are likely minimal as, 1) transportation accounts for only 1-3% of GHG emissions per unit of beef, and 2) local beef products can decrease transportation distance, but often at the expense of increased frequency of shorter distance trips due to smaller beef delivery sizes; therefore, GHG emissions from the burning of fossil fuels per unit of beef may not be greatly impacted.**

Literature Cited

[1]Martinez, S., M. Hand, M. Da Pra, S. Pollack, K. Ralston, T. Smith, S. Vogel, S. Clark, L. Lohr, S. Low, & C. Newman. 2010. Local food systems: concepts, impacts, and issues. USDA ERS 97: 1-87.

[2]Battagliese, T., J. Andrade, I. Schulze, B. Uhlman, C. Barcan. 2013. More sustainable beef optimization project: Phase 1 final report. BASF Corporation. Florham Park, NJ.

[3]Weber, C. and H.S. Matthews. 2008. Food miles and the relative climate impacts of food choices in the United States. Environ. Sci. Tech. 42: 3508-3513.

[4]Sanders, K.T., and M.E. Webber. 2014. A comparative analysis of the greenhouse gas emissions intensity of wheat and beef in the United States. Environ. Res. Lett. 9: 1-9.

[5]Brain, R. 2012. The local food movement: Definitions, benefits & resources. Utah State University Extension. Available at: https://extension.usu.edu/files/publications/publication/Sustainability_2012-09pr.pdf Accessed December 18, 2015.

[6]Born, B. and M. Purcell. 2006. Avoiding the local trap: Scale and food systems in planning research. J. Plan. Educ. Res. 26:195-207.

For more information, contact:

National Cattlemen's Beef Association
Contractor to the Beef Checkoff Program
9110 East Nichols Avenue
Centennial, CO 80112
303.694.0305

FEEDLOT MANAGEMENT

Feed Bunk Management for Maximum Consistent Intake

Pete Anderson, Beef Cattle Extension Specialist, and
Dan O'Connor, Graduate Student
University of Minnesota

INTRODUCTION

Managing feed intake is critical for successful cattle feeding. The goal of every cattle feeder should be attaining maximum consistent intake. Feedbunk management, or the broader area of intake management, is a critical part of this.

INTAKE MANAGEMENT INCLUDES:

Diet formulation Starting on feed

Ingredient quality Managing stress

Ingredient variation Reacting to weather changes

Ingredient processing Feeding frequency

Diet conditioners Waterer management

Diet mixing (time, process) Time of day fed

Quantity offered Bunk space

Other considerations

The benefit of maximizing intake is obvious, more feed consumption means more performance. Increased feed consumption above maintenance will increase energy available for growth and maximize gain. Table 1 shows that increasing feed intake by only .5 lb DM/d can reduce a feeding period by as much as 10 days.

Benefits of consistent intake are less obvious but just as important. Reduced day-to-day variation in feed intake will result in minimal ruminal pH variation. As a result, long-term rumen health is improved. Problems such as acidosis, sudden death, bloat, liver abscesses and founder are reduced.

To understand this, remember that rumen bacteria ferment various types of starch and sugar to volatile fatty acids (VFA). VFA diffuse through the rumen wall into the bloodstream and are used by cattle as a source of energy. Acid production in the rumen is an important, beneficial process. Indeed, the ability to turn forage carbohydrates into a useful source of energy is the primary

advantage of digestion and fermentation by rumen bacteria. However, when high energy diets are fed, too much (or too rapid) VFA production can cause problems because the pH of the rumen and/or the bloodstream decreases too far. If intake of high energy diets is consistent from day to day, and well-spaced throughout the day, cattle will adjust to the quantity of acid produced and rumen health will be maintained. If intake is variable, high levels of acid production following rapid consumption of a large quantity of feed could exceed the buffering capacity of the rumen. This could lower rumen pH to dangerous levels. Since acid simply diffuses through the rumen wall into the bloodstream, blood pH could be lowered dramatically. In addition, this drop in pH favors bacteria that produce lactic acid, which is less useful as an energy source and is the compound that actually causes acidosis. While variation in acid production and rumen pH is unavoidable, training cattle to handle these changes, and minimizing their magnitude is essential. Figure 1 illustrates typical and hazardous changes in rumen pH, based on evenly spaced, consistent consumption or inconsistent consumption.

Inconsistent intake can be magnified by inconsistent ionophore consumption. Since ionophore use can reduce feed intake, over or underconsumption of the ionophore can affect subsequent feed consumption.

Consistent intake can easily be obtained at low levels of feed intake, but this would result in poor growth. The challenge is to obtain consistent intake at high levels of consumption. If this challenge can be met, cattle performance will be high and incidence of rumen disorders low. Preventing rumen disorders altogether is possible but may not be the best alternative. Regardless of consistency, maintaining a high level of feed intake will induce some subacute acidosis and liver abscesses. Indeed, those cattle with no liver abscesses usually perform no better than, and may perform poorer than cattle with a low level of liver abscesses (table 2), which are apparently being challenged metabolically. The job of the cattle feeder is to walk the fine line between reducing rumen disorders at the expense of performance, and maximizing performance while risking acidosis, bloat, liver abscesses and sudden death. Thus the goals of maximum intake and consistent intake must both be met for optimum performance and health.

FEEDBUNK MANAGEMENT = INTAKE MANAGEMENT

Achieving these goals requires proper feedbunk management, which actually means managing the intake of the cattle. Every day is important because consumption one day often reflects the previous days consumption. For instance, if a steer reduces his feed consumption by 50% for one day, he is likely to be hungry and overeat the next day. This overeating will result in increased acid production,3 which will cause the steer to feel sick and reduce consumption on the third day. This up and down "roller coaster" pattern of inconsistent feed intake is easily started and difficult to break. The key is to prevent it, rather than hoping to cure it. Preventing inconsistent feed intake involves starting cattle on feed properly and keeping them on feed. Researchers at Oklahoma State University analyzed close outs and feed sheets describing the performance of 38,614 cattle in 331 pens in a commercial feedyard and observed that feed consumption during days 8 to 28 was a useful predictor of performance for the entire feeding period. An effective strategy is to "stay ahead of the cattle", meaning that cattle are offered feed so that they are hungry and approach the bunk aggressively when the next feeding occurs. Doing this properly requires multiple feeding throughout the day but will improve rumen health and enhance performance and efficiency over the entire feeding period. Proper starting on feed procedures will be a topic for

another Update; however, the importance of starting cattle properly, and the contribution of bunk/intake management to proper starting cannot be overstated.

INTAKE MANAGEMENT INCLUDES: WHAT, HOW MUCH, HOW AND WHEN CATTLE ARE FED

Intake management includes what cattle are fed (ingredient quality and diet formulation and mixing), how much cattle are fed (feed calling), how (feed delivery) and when cattle are fed. WHAT: Ingredient quality, diet formulation and mixing. The importance of ingredient quality and consistency cannot be overstated. If identical diet composition could be guaranteed from one day to the next, other aspects of intake management would become much easier. Daily variations in dry matter, contaminant and nutrient content of feedstuffs, as well as variation in mixing, contribute to dietary changes that can affect intake. While daily analysis of feed is impractical, and variation is unavoidable, some steps can be taken to minimize variation. Forage feeds are more variable than grain. Much of the variation can be avoided by harvesting and storing corn silage, hay or haylage at the proper stage. There is no substitute for quality forage preparation.

Forage must be properly processed and mixed. Chopping or grinding hay too fine will defeat the purpose of adding it to the diet and can contribute to bloat problems. Although diets containing 2- to 3-in. hay are more difficult to feed than those with shorter cuts, this length provides optimal rumen stimulation and digestibility with minimal sorting.

The quantity of forage in the diet is another consideration. Reducing forage increases the energy density of the diet, increasing performance at any level of intake, but also increasing the risk of metabolic disorders. Table 3 includes data that describe performance of cattle fed diets with 0, 5, 10 or 15% forage. In this study, inclusion of 5 or 10% forage produced the most rapid gains and the greatest energy intake. Inclusion of forage did not decrease liver abscesses; in fact, condemned livers increased as feed consumption, which was greatest for the high forage diet, increased.

Some Minnesota cattle feeders place round bale feeders in feedlot pens, away from the bunk, with no forage placed in the bunk. This allows timid cattle or those not interested in grain to consume hay away from the bunk. However, there is no way to know if all cattle are consuming forage, or how much any of them are consuming. Leaving forage out of the bunk promotes digestive disorders4 because forage intake will not be consistent; some cattle will consume little or no hay under this system. Also, some cattle will consume little of the grain component of the diet and their performance will be poor. Roughage is not included as a nutrient in feedlot diets, rather it is used for rumen stimulation and health. It is important that all cattle consume the proper amount of forage and including it in the bunk, mixed in the total diet, is the only way to guarantee this.

If by-products such as sweet corn silage, bakery waste, etc. are used, variation is unavoidable. The keys to making these feedstuffs work are fine tuning diets daily so that variation is minimized, and including them in the diet at a rate low enough that expected variation will not throw cattle completely off feed. These feedstuffs are more suited to growing or backgrounding diets than to finishing diets.

Proper diet mixing is essential. All too often the time allotted for mixing is based on the time required to drive to the bunk. Mixing should be complete, so that every mouthful of feed is as uniform as possible. Mixing for too long, in some types of mixers, can result in finer particles

sifting to the bottom. Remember that the most expensive components of the diet (medication, ionophores, vitamins, etc.) may have the smallest particle size. Order of addition is also important. The smallest component of the diet (volume basis) should not be added first or last. Any liquid components should be added before dry supplements are added. The effects of ionophores on feed intake make proper mixing even more critical when cattle are fed ionophores.

Diet conditioners, such as fat or molasses, which reduce dustiness in low moisture diets, should be mixed long enough to ensure that wetting of dry ingredients occurs. Fat and molasses serve several purposes including increasing the energy density of the diet and improving palatability due to flavor (Table 4). Inclusion of up to 4% of fat and/or molasses is common in some commercial feedyards. If a diet with less than 20% moisture is used, especially if highly processed grains are fed, inclusion of fat or molasses is probably a good idea.

Use of high moisture grains or silage increases the importance of proper bunk management since these feeds have limited bunk life, especially in extreme weather. Mixtures of high moisture and dry grain offer the palatability and starch availability advantages of high moisture grain, along with improved bunk stability. Performance of cattle fed a mixture of dry and high moisture grain will exceed that of cattle fed dry or high moisture grain alone (Table 5).

HOW MUCH: Feed calling. One of the most important decisions that a cattle feeder makes each day is how much feed should be placed in the bunk. If that decision is not carefully considered, it is likely that problems will occur. If daily feed offering is not recorded accurately, or records are not used, problems will likely not be noticed. The most effective way to induce long-term rumen health disorders is to repeatedly offer the wrong quantity of feed.

Feed offered must be matched to feed consumed. If cattle are overfed slightly on consecutive days, they will likely increase consumption briefly to match feed offered (sort of like Thanksgiving weekend for you or me) but will then reduce consumption to a greater extent after two or three days. The net effect is reduced consumption over a period of several days, along with increased potential for rumen5 disorders. This also results in eventual bunk build-up of leftover or stale feed, which reduced diet palatability. If cattle are underfed slightly for several consecutive days, some may gorge themselves when re-fed. If bunk space is limited, the timid cattle in a pen may have consumption reduced by 50% while others are not affected by inadequate feed offering. Consider the effects of weather and other possible stresses when determining how much feed should be offered.

Although few things are as important as getting cattle on full feed of the finishing diet rapidly, increases in feed offered and changes in the diet must be made gradually. Abrupt changes in the quantity or type of feed offered will almost surely throw cattle off feed and start the roller coaster consumption pattern. While each situation differs, some general rules of thumb can be considered. Feed offered should not be increased on consecutive days -- 3-day intervals may be safest, but will slow progress toward full feed. Feed (DM basis) offered should never be increased by more than .4% of body weight (2 lb of DM/d for 500 lb caves) at any one time; use of .2% may be safer. If quantity offered is increased, the diet should not be changed at the same time, and vice versa. After changing the diet or quantity offered, observe cattle closely.

Every cattle feeder has a different system of determining how much feed should be fed. Some like to see bunks empty just prior to feeding while others look for a consistent, low level of leftover feed. Either way can work. If bunks are empty just prior to feeding and cattle are quiet, feed

offered is probably about right. This is a low risk, high reward system. On the other hand, if bunks are empty and wet from licking and cattle are restless and appear hungry, feed should probably be increased. Determining how much feed should be fed is a job for the most experienced employee or family member in the operation. This determination should be made at the same time (or better yet, the same times) each day by the same person.

HOW: Feed delivery. Whether using feed trucks, feed wagons or conveyor-type feed delivery systems, delivering feed properly is essential. Feed should be placed evenly throughout the bunk --avoid piles or bare spots. Use the entire bunk, do not leave the first few feet empty or run out of feed a few feet before the end of the bunk. Cattle become accustomed to eating in the same space in the bunk each time. If their space is empty, they may choose not to eat instead of eating in another space. This is especially true of timid cattle. If a group is to be uniform when marketed, the challenge is to get the timid cattle to eat as much as the bold ones.

Use of conveyor-type feeding systems can be easier than use of trucks or wagons but it is just as critical that even distribution throughout the bunk be maintained. A system that is not distributing feed evenly should be overhauled so that it does.

WHEN: Timing of feeding. Cattle are creatures of habit, they enjoy doing the same thing at the same time every day, without changes in their schedule. Feeding groups of cattle at the same time(s) each day can make eating a habit and help to maintain consistency in feed consumption. In a once-per-day feeding program, full-fed cattle will eat when feed is offered. Then, after several hours of rumination and digestion, they will eat again. In between two or three major meals, cattle will eat small meals, perhaps at 90-minute intervals. If the initial feed delivery is earlier than usual, cattle may not be hungry6 enough to consume typical amounts. Since feed is freshest when first offered, they will eat less later in the day, after the feed has been in the bunk for some time. Thus, offering feed earlier than usual will reduce intake for the day. If feed is offered later than usual, cattle may overeat at the first meal due to hunger, resulting in the problems described previously.

Cattle fed two or three times daily become even more creatures of habit than those fed once daily. These cattle are likely to consume 75 to 100% of their daily feed in the two or three meals associated with feed delivery. With this type of feed consumption pattern, changes in rumen pH during a day are more dramatic than with once a day feeding. In this case, offering feed at the same time each day, and to appetite, becomes even more critical.

BUNK SPACE

Ideal bunk space varies with type of facility, cattle and diet, as well as season and feeding frequency. If calves with no horns are fed a low moisture diet two or three times per day, 6 to 8 in. of bunk space per head are adequate. If yearlings with horns are fed predominately silage diets once daily, 15 to 18 in. may be more appropriate. For typical situations, 9 to 12 in. are adequate. If bunk space is limited, timid cattle will be unable to eat when feed in presented. Intake and performance of these cattle will suffer and uniformity of the group will become poorer.

CLEANING BUNKS AND WATERERS

Sometimes the most mundane jobs are the most important; cleaning bunks and waterers fits that description. Cattle simply will not consume maximum levels of feed if the bunk is dirty. Never

expect cattle to clean their own bunks by eating feed that they have refused once. Stale or moldy feed should be removed daily and should not be re-fed. Offering fresh feed on top of old feed will result in reduced consumption and feed wastage. Feed should never be placed on top of standing rain water or snow. Silage cobs or other types of feed that have been sorted should be removed. Cattle can be forced to clean up these types of feed, but consumption of the desired diet will be reduced. If high moisture diets are fed, bunk life of the diet can be short. These diets may freeze in cold weather or in hot weather, secondary fermentation can result in heating and spoilage in these diets are left in the bunk too long. These feeds will become stale and less palatable prior to onset of spoilage. Bunks should be checked daily and cleaned if necessary. If cattle are limit-fed (see below) bunks will remain relatively clean and may only require cleaning when feeding after rain or snow.

Cleaning waterers can be just as important. Cattle need unlimited access to clean, fresh water. It is important to scrub waterers with a brush to remove the build-up of green slimy stuff that can occur, simply draining them is not enough. A dirty waterer will reduce appetite for feed as quickly as a dirty bunk. Also, stray voltage around waterers can reduce intake. This should be considered whenever reductions in intake occur that cannot be explained by disease, weather, etc.

FEEDING FREQUENCY

Most feedlots in Minnesota feed once daily but two or three times a day feeding should be considered. Frequency of feeding is a significant difference between small and large feedlots. Feeding more than once will increase feed intake by 2 to 5% and reduce rumen health problems. If feeds with short bunk life are fed, or in bad weather, increased feeding frequency may help keep fresh feed in front of cattle. Starting cattle on feed, especially highly stressed calves, is another situation in which feeding more than once daily is highly recommended. While feeding two or three times per day will likely improve performance and feed conversion, costs such as repair and depreciation of equipment, energy and labor may limit practicality.

LIMIT (CONTROLLED) FEEDING

Research at the University of Minnesota (table 6) has shown that limit feeding can improve efficiency. Offering cattle up to 8% less than ad libitum consumption improves feed conversion. While limit feeding is an interesting concept, it may have limited practical value. The difficulty lies in determining what 92 or 96% of ad libitum consumption is, if no group is fed to appetite. In a research atmosphere, control pens can be used to determine appetite and experimental pens fed accordingly. On the farm, however, this is impractical, or even impossible. Researchers at Oklahoma State University have devised a means to get the advantages of limit feeding that can be applied to production situations. The solution is programmed feeding. Feeding cattle for a specific, less than maximum rate of gain is programmed feeding. Use of programmed feeding strategies requires understanding of the Net Energy System, precise diet formulation, consistent feedstuffs, precise weighing and accurate records. Advantages are shown below.

ADVANTAGES OF CONTROLLED FEED INTAKE

Improved feed conversion	Reduced feed wastage
Easier bunk management, cleaning	Reduced feed delivery

Reduced labor cost	Reduced manure
Greater control of feed inventory	Improved projections

From Hicks et. 1990 (JAS 68:233).

A possible advantage not listed by these authors is increased use of forage or by-products in some situations. An easier method of obtaining some advantages of limit feeding would be delivering quantities of feed that result in bunks being clean prior to feeding. This strategy should only be used when cattle are fed high energy finishing diets and requires that bunks be carefully examined several times per day. The benefit is that this strategy will probably provide the best possible feed conversion.

SELF FEEDERS

Self feeding systems are common in Minnesota, especially among feeders of dairy breed steers. Use of a self feeder does not make bunk management less important. In fact, managing intake properly I more important when self feeders are used than in other situations. It is also more difficult. To manage intake with a self feeder, feed consumption must be estimated on a daily basis and measures must be taken to ensure that all cattle are eating every day. If these steps are not taken, fluctuations in intake cannot be prevented and will not be observed. Proper management is possible with a self feeder, but a self feeder is not a substitute for proper management.

Use of a self feeder limits the types of diets that can be fed. Bulky, high moisture or high roughage diets will not work well. All concentrate diets with pelleted supplements are most suited to self feeder use. The importance of intake management is magnified when all concentrate diets are used.

INTAKE MANAGEMENT SUGGESTIONS

Maintain adequate bunk space.

Match feed offered to feed consumed.

Increase feed offered gradually.

Do not increase feed offered on consecutive days.

Do not increase and change diet on the same day.

KEEP AND USE ACCURATE RECORDS.

Match diet type to season and cattle type.

Include all roughage in the bunk.

Pay attention to changes in ingredients.

Process feed similarly each day.

Choose optimum particle size.

Mix feed completely but do not overmix.

Add ingredients in proper order.

Use the entire bunk.

Clean bunks frequently.

Feed at the same time each day.

Consider effects of weather on feed in bunks.

Keep waterers clean and thawed.

Table 1. Effect of increasing ADGI by 0.5 lb

Item	Typical	Increased
ADFI, lb	17.0	17.5
NEm, Mcal/d	6.89	6.89
NEg, Mcal/d	6.62	6.95
ADG, lb	2.75	2.89
Feed from 600 – 1200 lb		
Days on feed	218	208
Total feed, lb	3709	3633

Table 2. Relationship between performance and liver abscess score

	Experiment 1			
	Liver abscess severity[a]			
	0	A-	A	A+
No. of steers	131	18	15	9
Days on feed	134	130	129	133
ADFI, lb	17.6	18.2	17.6	17.5
ADG, lb	2.95	3.13	2.95	3.02
Adj. ADG, lb[b]	2.91	3.11	2.82	2.93
F/G	5.9	5.7	6.0	5.7
Adj. F/G[b]	6.0	5.8	6.2	6.0
	Experiment 2			
	0	A-	A	A+
No. of steers	139	29	17	62
Days on feed	127	135	129	130
ADFI, lb	18.7	18.4	18.3	17.8
ADG, lb	2.62	2.75	2.73	2.49
Adj. ADG, lb[b]	2.60	2.69	2.64	2.25
F/G	7.0	6.6	6.8	7.1
Adj. F/G[b]	7.1	6.8	6.9	8.0

[a]0 = unabscessed liver; A- = 1 or 2 small abscesses; A = 2 to 4 small, active abscesses; A+ = 1 or more large, active abscesses

[b]Calculated from carcass weight

Brink et al. 1990 (JAS 68:1201).

Table 3. Effect of roughage level on performance of steers

	Roughage, %			
	0	5	10	15
ADG, lb	2.95	3.35	3.46	3.37
ADFI, lb	18.9	19.8	20.1	20.4
F/G	6.4	5.9	5.8	6.1
Liver abscesses, %	58	55	63	71
A + livers, %	32	42	38	52
	Dietary NE, Mcal/lb			
Maintenance				
Calculated	0.96	0.94	0.92	0.90
Observed	0.86	0.90	0.91	0.88
Percentage	90	96	99	97
Gain				
Calculated	0.66	0.64	0.62	0.60
Observed	0.59	0.61	0.61	0.59
Percentage	90	95	99	98

Crossbred steers (736 lb) fed 120 days.
Steam-rolled wheat diets.
Roughage souce was 50% corn silage, 50% alfalfa hay.
A+ liver = 3 or more active abscesses.
Kreikmeier et al. 1990 (JAS 68:2130).

Table 4. Effect of supplemental fat source on performance of steers

	Supplemental fat source			
	Control	Soy Oil	Tallow	Y. Grease
ADG, lb	3.13	3.39	3.30	3.50
ADFI, lb	19.6	19.6	19.1	20.1
F/G	6.3	5.8	5.7	5.7
Dietary NE				
NEm, Mcal/lb	0.93	0.97	0.98	0.98
NEg, Mcal/lb	0.63	0.66	0.67	0.67

Milo (80%) diets contained 6% added fat or molasses.
Crossbred steers (806 lb) fed 117 o 127 days.
Brandt and Anderson, 1990 (JAS 68:2208).

Table 5. Effect of mixing high moisture and dry grain

	HMC:DRC or DRGS			
	100:0	75:25	50:50	0:100
First 28d				
ADFI, lb	20.7	20.2	20.6	20.7
ADG, lb	3.24	3.37	3.33	3.11
F/G	6.3	5.9	6.1	6.5
To slaughter				
ADFI, lb	20.5	20.5	21.0	22.2
ADG, lb	2.91	3.00	3.00	2.84
F/G	7.0	6.7	7.0	7.8
Associative effect, %		7.4	5.5	

Stock et al. 1987 (JAS 65:290).

Table 6. Effects of limit feeding on feedlot performance of crossbred yearling steers (average of 2 trails)

	Feed offered		
	Ad libitum	96% of Ad libitum	92% of Ad libitum
ADG, lb	3.40	3.32	3.26
ADFI, lb DM	19.4	18.6	17.9
DM/gain	5.74	5.58	5.53

Plegge et al. 1986 (MN Cattle Feeders Report p 1)

Fact Sheet 3 in the Series: Tough Questions about Beef Sustainability

Would removing beef from the diet actually reduce greenhouse gas emissions?

Ashley Broocks, Emily Andreini, Megan Rolf and Sara Place

Some have proposed that simply removing beef from the human diet could significantly lower greenhouse gas (GHG) emissions. However, upon examination of the scientific evidence, completely removing beef from the diet would likely not result in huge declines in GHG emissions, and would likely have negative implications for the sustainability of the U.S. food system.

One must first consider the amount of beef consumed by Americans. The current U.S. Dietary Guidelines for Americans recommends 5.5 ounces of lean protein per day for a person consuming a 2,000-calorie diet.[1] Beef is one of the most common sources of lean protein in the United States, with 1.8 ounces of beef per day available to U.S. consumers in 2013, as reported in USDA's Economic Research Service (ERS) Loss-Adjusted Food Availability Data Series.[2] The ERS Loss-Adjusted Food Availability Data Series is derived from ERS's food availability data by adjusting for food spoilage, plate waste, and other losses to closely approximate actual intake. Per capita beef availability (loss adjusted) has actually been declining in the United States over the past 35 years (**Figure 1**) due in part to beef production not keeping pace with U.S. population growth. Along with being a significant source of lean protein, beef provides key nutrients such as iron, zinc, and B vitamins. Removing beef from the food chain would result in consumers having to seek alternative protein and micronutrient sources.

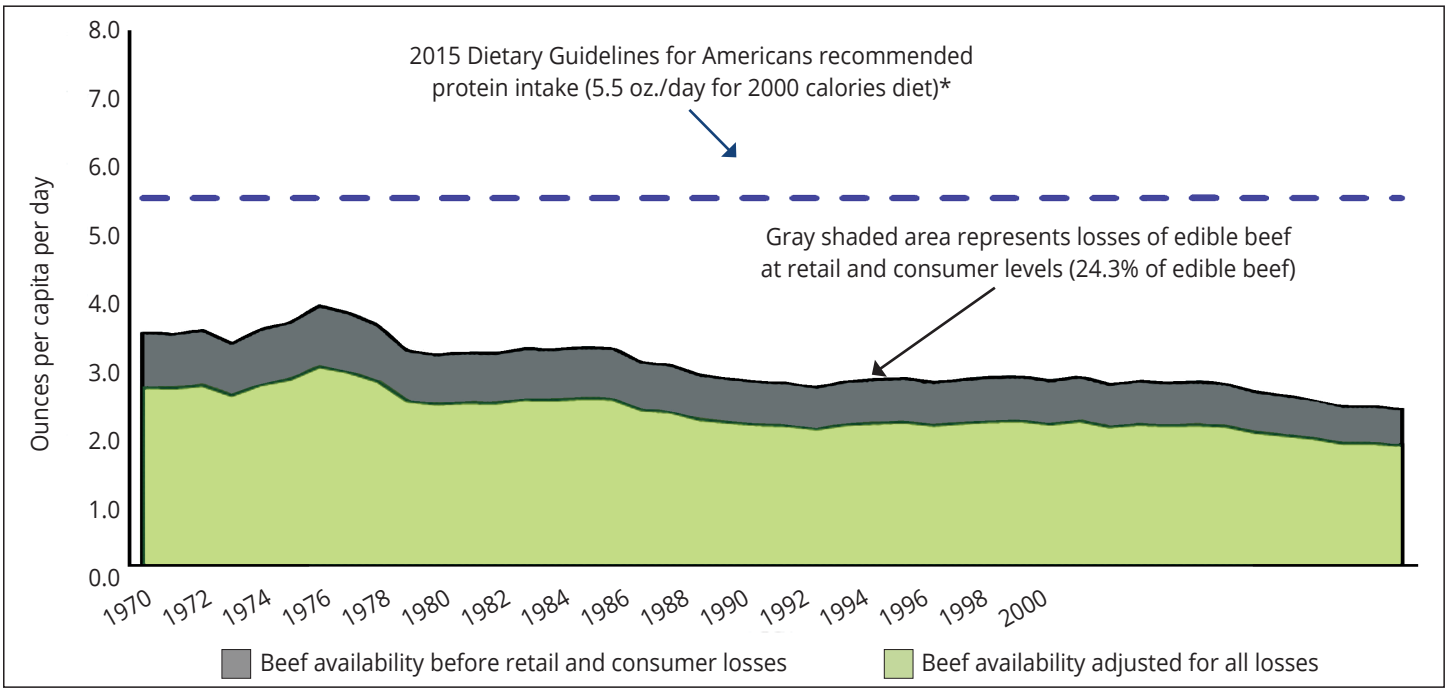


Figure 1. U.S. boneless beef availablitiy per capita[2] compared to U.S. Dietary Guidelines protein recommendations.[1]
Source: USDA-ERS. *Protein intake recommendation includes: meats, poultry, eggs (3.7 oz. - eqld),seafood (1.1 oz. - eqld), nuts, seeds, soy products (0.7 oz. - eqld).

According to the U.S. Environmental Protection Agency (EPA), beef cattle production was responsible for 1.9% of total U.S. GHG emissions in 2013.[3] By comparison, GHG emissions from transportation and electricity accounted for 25.8% and 30.6% of total U.S. GHG emissions in the same year (**Table 1**).[3] Comparing food production (essential for human life) to transportation and electricity (non-essential for human survival, but important to our modern lifestyles) is problematic. However, the comparison is instructive because though electricity and transportation produce much of the GHG emissions in the United States, most people do not call for the elimination of electricity or transportation. Rather, efforts are made to lower the GHG emissions produced to provide the same energy and transportation services (e.g. switching to renewable energy sources for electricity generation). Using this frame of reference, another way to consider GHG emissions from beef production would be, "How can the same amount of human nutritional value be produced by the beef system while producing fewer GHG emissions?" Studying the different ways inputs (feed, water, and land) can be used more efficiently throughout the beef value chain to reduce GHG emissions per pound of beef would provide the means to maintain the same level of food production while reducing GHG emissions. Over time, beef production has made impressive advances to meet the protein demands of a growing population while reducing the amount of natural resources required to produce a pound of beef.[4,5,6] For example, due to improved genetics (of cattle and the plants they consume), animal nutrition, management, and the use of growth promoting technologies, the U.S. beef industry has decreased its GHG emissions per pound of beef 9-16% from the 1970s to today.[5,7] Further improvements in the efficiency of beef production are being continuously evaluated and researched at universities and research institutions, in the United States and globally.

Another key component of reducing GHG emissions from the whole beef system is the role of the consumer. Over 20% of edible beef is wasted at grocery stores, restaurants, and in the home (**Figure 1**).[8] As with other foods, the amount of non-renewable resources used and the environmental impacts that went into producing the portions of beef that are being sent to a landfill are often overlooked. Consumers could improve beef sustainability by 10% if beef waste were reduced by half.[8]

Beef production makes many positive contributions to the sustainability of our food system that are often overlooked by analyses of GHG emissions' impact of removing beef from the diet. Cattle have the ability to utilize forages (e.g., grass) and by-products (e.g., distillers grains) that are unfit for human consumption. Specifically cattle can utilize cellulose, one of the world's most abundant organic (carbon containing) molecules, that is indigestible by humans.[6] Consequently, U.S. beef producers feed their cattle feed sources that are not in direct competition with humans and/or would have gone to waste (by-products).[6] Cattle can also convert low-quality feeds into high-quality protein from land not suited for cultivation, thereby reducing soil erosion and enhancing soil carbon storage.[6] Furthermore, integrated crop and beef systems (e.g., using cattle to graze crop residues and cover crops) can lead to many positive environmental sustainability outcomes including increased soil water-holding capacity and enhanced nutrient cycling.[9]

Bottom Line: **Beef is a valuable asset to the human diet; it is an affordable, nutrient-dense source of lean protein. As with the production of all foods, the production of beef results in GHG emissions; however, direct emissions from the U.S. beef industry are only estimated to be 1.9% of the total U.S. GHG emissions.[3] Thus, even without consideration of the unintended consequences and impacts of alternative protein sources, completely removing beef from the U.S. diet would likely have**

Table 1. U.S. EPS GHG Emissions Inventory for 2013

Item	CO2-eq emissions (Million Metric Tons)	Percent of U.S. total CO2-eq emissions
Enteric Methane Emissions from Beef Cattle (from their digestive tracts)	117.1	1.75%
Beef Cattle Manure Nitrous Oxide Emissions	7.6	0.11%
Beef Cattle Manure Methane Emissions	3.0	0.04%
Total Direct Emissions from U.S. Beef Cattle	**127.7**	**1.9%**
Burning fossil fuels for transportation carbon dioxide emissions	1,718.4	25.8%
Burning fossil fuels for electricity generation carbon dioxide emissions	2,039.8	30.6%
All other GHG sources	**2,787.8**	**41.7%**
2013 U.S. Total CO2-eq Emissions	**6,673**	**100%**

Source: U.S. EPS Executive Summary 2015

a minimal impact on GHG emissions. However, as historical progress has demonstrated (GHG emissions per lb. of beef have been reduced 9-16% since the 1970s[5,6]), there are opportunities to reduce beef's impact, chief among them being reducing consumer waste.

Literature Cited

[1]USDA. 2015. Dietary Guidelines for Americans. Available from: http://health.gov/dietaryguidelines/2015/guidelines/

[2]USDA. 2014. Food Availability (Per Capita) Data System. Available from: http://www.ers.usda.gov/data-products/food-availability-%28per-capita%29-data-system/readings.aspx

[3]EPA. 2015. U.S. Greenhouse Gas Inventory Report: 1990-2013. Available from: http://www.epa.gov/climatechange/ghgemissions/usinventoryreport.html

[4]Capper, J.L. and D.J. Hayes. 2012. The environmental and economic impact of removing growth-enhancing technologies from U.S. beef production. J. Anim. Sci. 90:3527-3537

[5]Capper, J.L. 2011. Environmental impact of beef production in the United States: 1977 compared with 2007. J. Anim Sci. 89:4249-4261.

[6]Oltjen, J.W. and Beckett, J.L. 1996. Role of ruminant livestock in sustainable animal agricultural systems. J. Anim. Sci. 74:1406-1409.

[7]Rotz, C.A., B.J. Isenberg, K.R. Stackhouse-Lawson, and E.J. Pollak. 2013. A simulation-based approach for evaluating and comparing the environmental footprints of beef production systems. J. Anim. Sci. 91:5427-5437.

[8]Beef Checkoff. 2014. Sustainability Executive Summary. Available from: http://www.beefboard.org/news/files/FY2015/SustainabilityExecutiveSummaryWeb1.pdf

[9]Sulc, R. M. and A. J. Franzluebbers. 2014. Exploring integrated crop-livestock systems in different ecoregions of the United States. Europ. J. Agronomy. 57:21-30.

For more information, contact:

National Cattlemen's Beef Association
Contractor to the Beef Checkoff Program
9110 East Nichols Avenue
Centennial, CO 80112
303.694.0305

Fact Sheet 5 in the Series: Tough Questions about Beef Sustainability

Do growth promotants reduce environmental impact?

Ashley Broocks, Megan Rolf and Sara Place

Increasing the efficiency of beef production is one way to reduce environmental impact. Growth promotants (GP) play an important role in increasing the efficiency of beef production through increasing the conversion of the feed cattle eat into beef. While some types of growth promotants can be utilized earlier in an animal's life, they are primarily utilized during the finishing phase, which is approximately the last 120-140 days before the animal is harvested. Three commonly used types of GPs in beef production are: growth implants, ionophores, and β-adrenergic agonists (βAA). Beef production systems that use GP technologies are typically referred to as "conventional," whereas production systems that never use any of the three technologies are usually referred to as "natural" beef production systems.

Growth implants are small capsules that are placed in the backside of the animal's ear, which release a small amount of either natural or synthetic hormones over time. They work in conjunction with the animal's natural hormones to increase growth and typically consist of synthetic estrogen, testosterone, or progesterone.

Ionophores are feed additives used to alter rumen bacterial fermentation, allowing for improved feed efficiency and decreased methane (a greenhouse gas, or GHG) emissions. Ionophores can be utilized in any phase of the beef animal's life cycle (e.g., when they are raised on grass or in the feedlot during finishing), and can often be found in protein or energy supplements provided to beef cows to help them meet their nutrient requirements while grazing low-quality grasses.

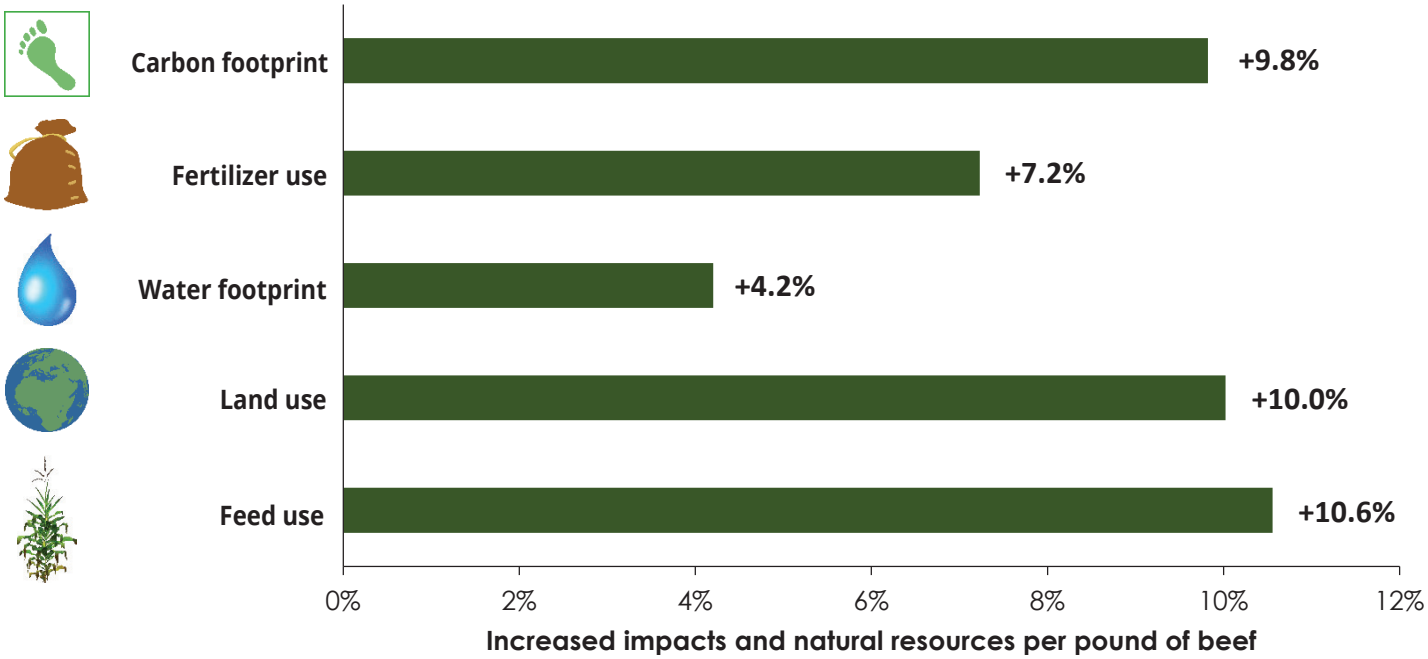


Figure 1. Increase in environmental impacts per unit of beef if no growth promoting technologies were used in U.S. beef production systems.

Finally, βAA are also a feed additive, but are restricted to the final 20-40 days of finishing. β-adrenergic agonists increase lean muscle mass while decreasing fat deposition, which means for every pound of body weight an animal gains when fed βAA, a higher proportion of the body weight gain will be protein than a similar animal not fed βAA[1]. Each GP works individually to improve feed efficiency but combining the three GPs can dramatically improve production efficiency, especially during the finishing phase, and can decrease GHG emissions per pound of body weight gain by 28% when compared to beef production systems not using GPs[2].

While ionophores can directly reduce methane emissions produced by individual beef cattle, in general, GPs reduce both GHG emissions produced and natural resources required per unit of beef (**Figure 1**) by decreasing the length of time required for an individual animal to reach harvest and the number of animals required to produce a given amount of beef.[2,3] For example, research has shown that in beef production systems using GP technologies, each animal will produce enough beef to feed approximately 1.66 more U.S. citizens as compared to animals in beef production systems that do not use those technologies **(Figure 2**).[4] Research utilizing both live animals[1,2,4] and computer models[3,5] has consistently shown a decrease in the environmental impact of beef production with the use of GP technologies. Some consumers prefer to purchase beef not produced in systems that use GP technologies (i.e., "natural" beef), which is a recognized food choice; however, there are negative environmental sustainability consequences for not using GP technologies in U.S. beef production.

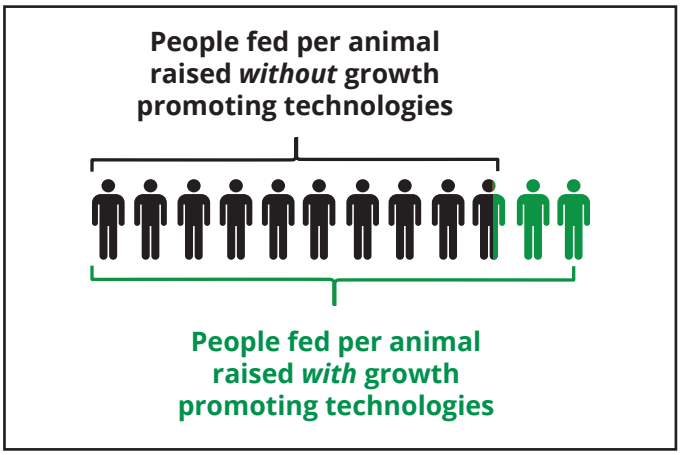


Figure 2. People fed per beef animal for one year per animal for beef production systems that use no growth promoting technology (black) as compared to beef systems that use growth promoting technology (black plus green).

Bottom Line: **Growth promoting technologies can reduce the environmental impact of beef production by decreasing the number of cattle required to produce a given amount of beef. Additionally, growth promoting technologies allow farmers and ranchers to feed more U.S. citizens with each beef animal that is raised under their care.**

Literature Cited

[1]Stackhouse-Lawson, K.R., M.S. Calvo, S.E. Place, T.L. Armitage, Y. Pan, Y. Zhao, and F.M. Mitloehner. 2013. Growth promoting technologies reduce greenhouse gas, alcohol, and ammonia emissions from feedlot cattle. J. Anim. Sci. 91:5438-5447.

[2]Cooprider, K.L., F.M. Mitloehner, T.R. Famula, E. Kebreab, Y. Zhao, and A.L. Van Eenennaam. 2011. Feedlot efficiency implications on greenhouse gas emissions and sustainability. J. Anim. Sci. 89:2643-2656.

[3]Capper, J.L. and D.J. Hayes. 2012. The environmental and economic impact of removing growth-enhancing technologies from U.S. beef production. J. Anim. Sci. 90:3527-3537.

[4]Maxwell, C.L., C.R. Krehbiel, B.K. Wilson, B.T. Johnson, B.C. Bernhard, C.F.O'Neill, D.L. VanOverbeke, G.G. Mafi, D.L. Step, and C.J. Richards. Effects of beef production system on animal performance and carcass characteristics. 2014. J. Anim. Sci. 92:5727-5738.

[5]Battagliese, T., J. Andrade, I. Schulze, B. Uhlman, C. Barcan. 2013. More sustainable beef optimization project: Phase 1 final report. BASF Corporation. Florham Park, NJ.

For more information, contact:

National Cattlemen's Beef Association
Contractor to the Beef Checkoff Program
9110 East Nichols Avenue
Centennial, CO 80112
303.694.0305

Fact Sheet 6 in the Series: Tough Questions about Beef Sustainability

Does grass-finished beef leave a lower carbon footprint than grain-finished beef?

Ashley Broocks, Emily Andreini, Megan Rolf and Sara Place

Even though cattle live the majority of their lives on pasture, the type of finishing system does impact the carbon footprint of beef. The carbon footprint for beef is all the greenhouse gas emissions yielded during the production of beef divided by the total amount of beef produced by the system. Beef production consists of three main phases: cow-calf, stocker/backgrounding, and finishing (**Figure 1**). The first phase of the animal's life is spent nursing and grazing on pasture along with its mother. After calves are weaned, they typically spend additional time grazing crop residue that remains after harvesting grain or grazing forage pastures and grasslands. During this time, known as the stocker or backgrounding phase, they gain additional weight as they prepare to enter the finishing phase. The finishing phase is the final stage before cattle are sent for harvest. Cattle entering the finishing phase are typically 12 to 16 months old, and remain in this phase until they have achieved a level of marbling that will provide a positive eating experience for consumers. The main difference in carbon footprints between grass- and grain-finished beef occurs as a result of the time spent in the finishing phase, the type of feed consumed, and the ending body weight of the cattle in the finishing phase.

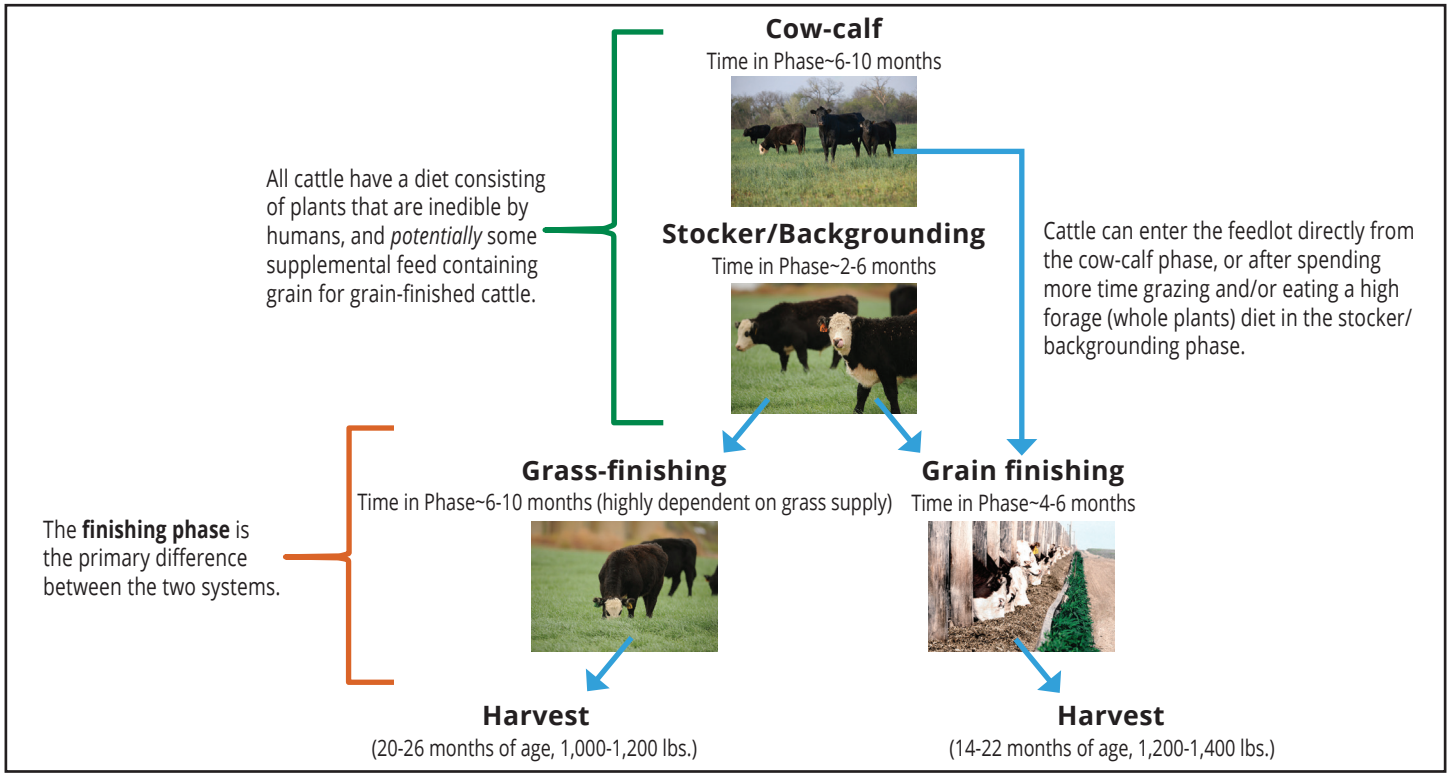


Figure 1. Beef cattle life cycle in the United States for grass-finished and grain-finished beef.

Cattle entering the feedlot for finishing eat a diet that contains corn along with by-products (such as distillers grains leftover after ethanol production), vitamins and minerals, and forage or roughage (such as hay). Grain-finished cattle remain in the feedlot for approximately four to six months and are sent for harvesting at 14 to 22 months of age. Grain-finished cattle reach market weight faster than grass-finished[1,2] because the diet the animals receive is higher in energy, which results in more efficient weight gain. In contrast, grass-finished cattle gain at a slower rate due to the forage-based diet they eat and typically go to harvest at 20-26 months of age and at a lower weight than grain-finished animals. Grass-finished cattle may finish either faster or slower than this age range depending on the forage and grass resources available to the beef producer (e.g., the growing season is shorter in northern U.S. states, which may shorten the finishing period and lead to lighter weights at harvest). The difference in harvest weights translates into different numbers of U.S. citizens that could be fed per animal (**Table 1**). Utilizing forage as the primary source of feed also contributes to an increased carbon footprint for grass-finished beef,[2] because high forage diets (e.g., grass) produce more methane emissions from the animal's digestive tract than higher-energy, grain-based diets. The combination of consuming a higher energy, lower forage diet, shorter time spent on feed during finishing, and heavier carcass weights translate into a 18.5 to 67.5% lower carbon footprint for grain-finished beef as compared to grass-finished beef.[1,2]

Even though grass-finished beef has a higher carbon footprint, it does have some sustainability advantages. Grass-finished animals utilize plants that are inedible by humans as the primary source of energy and nutrients for their entire lifetimes. In contrast, 82% of feed intake per unit of carcass weight for conventional animals occurs from grazing forage, pasture or rangeland.[5] Beef cattle can utilize forage grown on land not suitable for crop production, and thus produce human edible food from a resource that could not otherwise be used to produce food. Additionally, grasslands and pastures can sequester carbon dioxide from the atmosphere, which can help to mitigate global climate change. Research has shown an advantage for grass-finished beef production over grain-finished beef production when expressing feed conversion as human edible energy returned per unit of human edible energy consumed by the cattle.[2,6]

Accounting for carbon sequestration of grass-finished beef that is finished on pastures could lower the carbon footprint of grass-finished beef by 42%.[2] Ultimately, tradeoffs exist between the two beef production systems; however, beef producers using either system can sustainably meet consumer demand for beef by utilizing the resources they have in their part of the country.

Bottom Line: **Tradeoffs occur in different aspects of sustainability when comparing grain-finished and grass-finished beef production systems. Grain-finished beef has a lower carbon footprint than grass-finished beef due to more efficient utilization of feed in the finishing phase, fewer days on feed, and greater amount of beef produced per animal. However, grass-finished beef contributes to sustainable beef production by utilizing forage resources during finishing to produce food from plants that are inedible by humans.**

Table 1. U.S. citizens fed for one year per animal for grass-finished and grain-finished beef.

Finishing system	Harvest live weight, lbs.	Dressing %	Carcass Weight per animal, lbs.	U.S. citizens fed per animal*
Grass-finished	1,100	58%	638	8.0
Grain-finished	1,300	64%	832	10.4

*Assuming 80.1 lbs. of carcass weight availability per capita in 2013[4]

Literature Cited

[1]Capper, J.L. 2012. Is the grass always greener? Comparing the environmental impact of conventional, natural and grass-fed beef production systems. Animals. 2:127-143.

[2]Pelletier, N., R. Pirog, and R. Rasmussen. 2010. Comparative life cycle environmental impacts of three beef production strategies in the Upper Midwestern United States. Agric. Sys. 103:380-389.

[3]IPCC. 2013. Climate change 2013: The physical science basis. Contribution of working group I to the fifth assessment report of the IPCC. Cambridge University Press. Cambridge, UK.

[4]USDA. 2014. Food Availability (Per Capita) Data System. Available from: http://www.ers.usda.gov/data-products/food-availability-%28per-capita%29-data-system/readings.aspx

[5]Rotz, C.A. S. Asem-Hiablie, J. Dillion, and H. Bonifacio. 2015. Cradle-to-farm gate environmental footprints of beef cattle production in Kansas, Oklahoma, and Texas. J. Anim. Sci. 93:2509-2519.

[6]Wilkinson, J.M. 2011. Re-defining efficiency of feed use by livestock. Animal. 5:1014-1022.

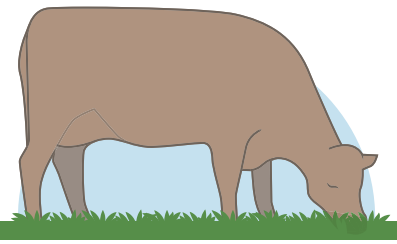
For more information, contact:

National Cattlemen's Beef Association
Contractor to the Beef Checkoff Program
9110 East Nichols Avenue
Centennial, CO 80112
303.694.0305

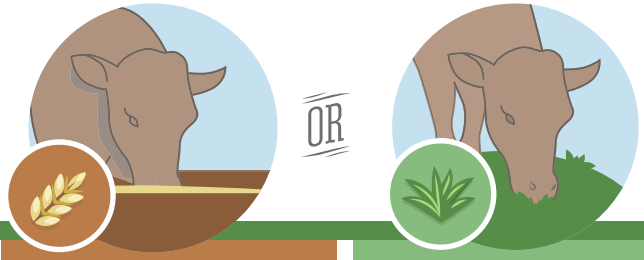
GRASS-FINISHED OR GRAIN-FINISHED BEEF?

Both are nutritious, you choose

There are nearly over one million beef farmers and ranchers throughout the United States. They often use the diverse local resources available to produce nutritious, safe and delicious beef. That means there are a variety of beef choices including grain-finished and grass-finished. **No matter the choice, there is a delicious and nutritious beef option for you.**



All cattle spend the majority of their lives eating grass on pastures.



DID YOU KNOW?

Monounsaturated fat, the type of fat found in avocado and olive oil, **makes up about half of all fat found in beef.**

Not all grass-finished beef is organic. In order to be organic, the beef product must meet the U.S. Department of Agriculture's National Organic Program regulations, including the requirement that the animal grazes exclusively on certified organic pastures.

Grain-finished beef actually has a lower carbon footprint than grass-finished beef. Cattle fed grain produce less methane and reach market weight more quickly, thus using fewer natural resources.

A grain-finished ration may include a variety of local feedstuffs, for example other industries' by-products like distillers grains and orange peels.

NUTRIENTS

Per 100g of beef, approximately 3.5oz

	GRAIN-FINISHED	GRASS-FINISHED
Protein A powerful nutrient that helps strengthen and sustain the body	22.2g	21.8g
Zinc An important nutrient that helps maintain a healthy immune system	3.8mg	3.7mg
Iron An essential nutrient that helps your body transport and use oxygen to power through the day	1.6mg	1.8mg
Total Fat	5.2g	2.9g
Saturated Fat Aim for less than 10% of total caloric intake.	1.3g	0.7g
Stearic Acid About 1/3 of beef's saturated fat is stearic acid, a fatty acid found in chocolate, that research shows does not raise cholesterol levels.	0.6g	0.4g
Monounsaturated Fat The type of fat found in avocado and olive oil	1.9g	0.9g
Polyunsaturated Fat	0.2g	0.1g
Omega-3 Found in flax seed, some nuts, salmon and other fatty fish	0.02g	0.05g
Omega-6 Found in vegetable oils and some nuts and seeds.	0.13g	0.06g

WHAT DOES IT MEAN?

Choose from today's variety of nutritious and delicious beef options based on your own personal preferences.

Beef contributes 10% or less of saturated fat and total fat to the American diet.

Lean beef— whether it's grass-finished or grain-finished —can be part of a heart-healthy diet.

All beef options are a natural source of more than 10 essential nutrients including protein, zinc and iron.

REFERENCES

- Van Elswyk & McNeill. Impact of grass/forage feeding versus grain finishing on beef nutrients and sensory quality: the U.S. experience. Meat Sci 2014; 96:535-40.
- USDA and HHS. Dietary Guidelines for Americans, 2010.
- Hunter et al. Cardiovascular disease risk of dietary stearic acid compared to trans, other saturated, and unsaturated fatty acids: a systematic review. Am J Clin Nutr 2010;91:46-63.
- Zanovec et al. Lean beef contributes significant amounts of key nutrients to the diets of US adults: National Health and Nutrition Examination Survey 1999-2004. Nutr Res 2010;30:375-81.
- Capper. The environmental impact of beef production in the United States: 1977 compared with 2007. J Anim Sci 2011; 89:4249-61.

BEEF

Funded by the Beef Checkoff.

TEXAS A&M AGRILIFE EXTENSION

L-5356
(RM 1-9.0)
5-00

Beef Cattle Marketing Alliances

James D. Sartwelle, III, Ernest E. Davis, James Mintert and Rob Borchardt*

Ever-tightening profit margins and recurring cyclical downturns in cattle and calf markets have forced many cattle producers to search for ways to make their operations more profitable. Of course, cutting the costs of production is one way. However, a new concept called "strategic alliance," a way to increase revenues through vertical affiliations, is being widely discussed as a route to a more financially stable ranching operation.

Alliance is defined by Webster as "an association to further the common interests of the members." In the past 10 years many producer groups have worked to secure marketing agreements with beef packers. Many of these agreements, or alliances, are available to many beef cattle producers.

Beef carcass alliances (BCAs) can be grouped into three broad categories: breed association-sponsored, commercial, and natural/implant-free. In addition to these categories, two types of beef carcass targets have emerged. One is a high quality grade target with an acceptably muscled carcass. The other target includes animals that excel in red meat production with acceptable quality grades. BCAs will be identified here by category and the appropriate carcass target.

Carcass Alliances Endorsed by Breed Associations

Several purebred cattle associations have established programs to encourage commercial cattlemen to use their breed's bulls by providing additional marketing angles for their progeny. This category was dominated by British breeds (Angus, Hereford, Red Angus) for several years; recently, however, some Continental breeds have entered the field. Most of these programs target high quality beef production.

The American Hereford Association (Certified Hereford Beef), American-International Charolais Association (Beef-Charolais), Red Angus Association of America (Red Angus Feeder Cattle Certification Program/Supreme Angus Beef), American Gelbvieh Association (Gelbvieh Alliance), and North American Limousin Foundation (Limousin Grid) all offer direct access to carcass pricing devices that are at least partially negotiated by association personnel. (For a sample carcass pricing grid and a more detailed introduction to the concept, please see "Fed Cattle Grid Pricing," RM1-11.0 in this series.)

Certified Angus Beef (CAB, established by the American Angus Association in 1978) is one of the oldest and best known of the BCAs. This program is dissimilar from most breed association programs in that CAB doesn't directly price cattle on a grid system. Rather, it identifies carcasses that meet several criteria for CAB designation and allows other value-oriented marketing programs to use CAB as a valuation tool.

In addition to fed cattle marketing programs, most beef breed associations have developed commercial marketing programs that range from listing feeder cattle for sale to sponsoring group marketing ventures such as special sales. Judging from the proliferation of marketing services launched in the past few years, stiffening competition among

*Extension Program Specialist-Risk Management, and Professor and Extension Economist, The Texas A&M University System; Extension Agricultural Economist, Kansas State University; and Extension Program Specialist-Risk Management, The Texas A&M University System.

breeds for commercial bull buyers will ensure a healthy array of options in the future.

Commercial Carcass Alliances

Many firms now offer BCAs to cattle producers. These firms offer grids or marketing arrangements that fit the high quality beef target and/or the red meat yield target. Most of these firms create their niche with cattlemen who are likely to produce certain types of carcasses and beef procurers who merchandise that type of beef. The firms that put such alliances together are usually paid for this service by producers, with fees for feedlot performance information and/or carcass quality information.

Firms/alliances in this category include Angus America, Angus GeneNet, Farmland Supreme Beef Alliance, HiPro Producer's Edge, U.S. Premium Beef, and Western Beef Alliance. In addition to providing access (for a fee) to a beef processor's carcass pricing mechanism, some of the firms/alliances offer other services to members. These include discounted semen or bull purchases from carcass-proven sires, members-only replacement heifer and feeder cattle sales, and listings of "approved" feedyards.

Natural/Implant-Free Carcass Alliances

BCAs that target all-natural, implant-free beef production were among the first programs. Many of them have been in existence more than 10 years. Their business has greatly increased in recent years and many of their innovations have been adopted by other programs. While these alliances are all offered by commercial interests, their "all-natural" orientation places them in a different classification. Generally, these agreements aim for the red meat yield target. Examples of these alliances are Coleman's Natural Meats, Laura's Lean Beef, Maverick Ranches Beef, and B3R Country Meats.

Common features of these marketing programs are prohibitions against various commonly used medications or growth enhancers (implants). Some programs also ban the use of ionophores and other feed additives.

Targeting health-conscious consumers, the grid pricing structures encourage the production of lean carcasses. Significant premiums are given for Yield Grade 1 and 2 carcasses. Some programs even discount carcasses that grade USDA Prime.

What Else Could Alliances Offer?

While most alliances have concentrated on marketing and price enhancement strategies, producer groups might also organize input procurement, production cost analysis, performance data analysis, and improved herd management programs. Producers might work together to cut production costs and effect an even greater change in profitability. For example, some alliance managers are developing connections between seedstock producers and commercial cow-calf operators who market cattle through their alliances. One program has offered bonus coupons worth $3 per head for each source-verified animal, consigned and fed on a retained ownership basis, that grades Prime and/or qualifies for the Certified Angus Beef program. Those bonuses can be used toward the purchase of bulls at an alliance-affiliated seedstock sale. Services such as these will likely be common in the future.

The Future of Beef Carcass Alliances

One difficulty with natural/implant-free BCAs is the trade-off between "all-natural" beef production and feedlot performance. The producer who joins one of these BCAs must weigh increased animal morbidity and mortality (because of the prohibition of antibiotics) and decreased feedlot gain and feed efficiencies (because of the lack of growth-promoting implants and/or feed additives) against potential carcass premiums for the cattle that actually fulfill alliance specifications.

USDA has recently mandated that entities claiming to market a source-verified product must file and maintain a Product Quality Control protocol. This requirement could affect BCAs that market breed-specific products. Breed association-sponsored BCAs would seem to have the upper hand in verifying the parentage of individual animals. In time, BCAs that require (or limit) a certain percentage of different breeds or breed types will have to prove to the USDA that they can verify the sources of their participating cattle.

Although the number of head currently slaughtered under alliance programs is a very small portion of the total slaughter, most alliance marketing managers report that the number of cattle enrolled in their programs is increasing. BCAs that consistently return higher prices than cash markets to participating producers will most likely continue to expand. However, most, if not all, BCAs rely on the regular production of sufficient quantities of cattle that meet narrow live and carcass specifications and, in turn, satisfy supply quotas with the packer. If a producer is to prosper in the long run by marketing cattle under these types of premium and discount schedules, he must be able to fine tune the genetic makeup of the cowherd to "hit the specs" with a degree of regularity while maintaining flexibility in the cowherd to adjust to

changing trends. More consistent, improved genetics does not come without a cost, and producers must weigh these costs against the potential benefits of participating in these programs.

Advice to the Producer: Maintain Flexibility

Many producers have the attitude that they will produce specific cattle for specific carcass targets if, and only if, there are clear economic incentives. Other producers are refining their herds' genetic makeups with full faith that carcass price premiums already exist. One fact upon which all producers can agree is that formula pricing systems, whether based on quality or red meat yield, are constantly changing. Genetic change, however, does not happen quickly. The average producer will turn only six or seven generations in his herd in his lifetime. Producers cannot be expected to constantly change the genetics of their herds in hopes of hitting some specification marketing program that may or may not exist in the future.

Producers must maintain flexibility while developing the herd genetics that appears to be the most economically viable in the short term. In short, producers might be best served by developing cattle that can produce progeny for either the high quality target or the red meat yield target, as situations dictate. This is not contradictory. On the Great Plains, for example, a producer could develop a cowherd of moderate framed, Angus x Hereford Black Baldy females selected for maternal and fertility traits. On the Gulf Coast, a producer could develop a Brahman x Hereford or Brahman x Angus based herd. If market trends indicate premiums for high quality targets, either producer could breed those cows to British bulls with high marbling traits. If the signals indicate premiums for cattle that excel in lean, red meat production, the producers could breed the same cows to heavy muscled, Continental sires. With at least a 2-year lag between making breeding decisions and marketing finished steers and heifers, it is apparent that a producer must have a sound understanding of industry trends and directions.

Beef Carcass Alliances and Risk

Under grid pricing programs, performance risk lies with the cattle feeder/seller. That is, premiums and discounts are not assessed until the live cattle have been processed and carcasses evaluated. Sound risk management dictates that producers have some idea how their cattle are likely to perform, both in the feedlot and at the carcass level, before enrolling a significant portion of their production in an alliance. There are Extension programs across the country that can help producers send sample calves through feedlots and get information on feeding performance and carcass quality. While no sample is perfect, many producers have learned a lot about the cattle they produce through such programs. This could be the first step in determining whether you have the type of cattle to fit certain alliance programs and their pricing grids.

When comparing different pricing structures, remember that different grids use different base prices (for example, plant average prices versus USDA-reported regional prices) and different base grades (for example, one grid uses USDA Choice as a base and discounts cattle that grade USDA Select, while another grid uses Select as a base and awards premiums to cattle that grade Choice). Examine the pricing structures and make sure you are making accurate comparisons.

The same performance and financial risks faced by a producer considering traditional retained ownership programs also face a producer considering a BCA. Please consult "Retained Ownership Strategies for Cattlemen," RM1-3.0 in this series, for more information.

Many breed associations and commercial entities maintain listings of alliance program contact information on their web sites. One such site is *http://www.beefshorthornusa.com/logo/beef.html*. This is the official site of the Amercian Shorthorn Association.

Partial funding support has been provided by the Texas Wheat Producers Board, Texas Corn Producers Board, Texas Farm Bureau and the Houston Livestock Show and Rodeo.

Texas A&M AgriLife Extension Service

AgriLifeExtension.tamu.edu

More Extension publications can be found at *AgriLifeBookstore.org*

Produced by Texas A&M AgriLife Communications

Ag Decision Maker

File B1-72
March 2005
www.extension.iastate.edu/agdm

Retained Ownership Strategies for Cow Herds

Retaining ownership of calves beyond weaning is a value-added manufacturing process that provides cow owners opportunities for additional profit. It turns lower value calves and feedstuffs into higher value animals. The accelerating trend toward value-based marketing also provides an opportunity for cow owners to more fully capture their investment in genetics. It increases the size of the operation while adding diversification and improves marketing flexibility. Producers considering retained ownership must consider first year cash flow and income tax implications for their operation. Producers must also decide whether to feed their calves at home or in a commercial feedyard.

Obviously, prices for feeder cattle, fed cattle, and feedstuffs impact profit potential in beef production. While feed supplies and prices are impacted annually by weather, cattle supplies and prices tend to follow a cyclical pattern. Recognizing this pattern and what stage of it the industry is in can help fine tune the retained ownership decision. This paper examines factors to consider in the retained ownership decision and evaluates the returns and risks for selected strategies over the 1983 - 1999 calf crops.

Opportunities From Retained Ownership

Retained ownership provides opportunities to cow owners that selling the calves in the fall does not. One of the greatest, and commonly overlooked, opportunities is the direct information feedback to the genetic decision maker to improve the animal and product quickly. Cow owners may discuss the performance of their cattle with the cattle feeder and be able to adjust the breeding program. However, the signals are clearer if there is a direct economic link between cost of production, the price received at slaughter and the person controlling the genetic make-up of the cattle. These signals are becoming clearer with increasing use of grid marketing. Thus, in any retained ownership program information is essential.

Retained ownership provides cow owners the opportunity to capture the benefit of their superior genetics, nutritional practices, health program, and overall management system. It is also an opportunity for adding value to or marketing other resources such as labor, facilities, feedstuffs, management skills, capital, and others. While it provides the opportunity, it is up to the individual to be sure the full potential is realized. The points below are important points to consider when evaluating retained ownership in an operation.

Increased marketing flexibility

Retained ownership increases marketing flexibility as to when, what, and where the cattle are sold. Calves can be sold as feeder cattle of different weights up to approximately 900 pounds or sold as fed cattle. While it is difficult to attract a packer buyer to the farm for a small pen of cattle, the producer can increase market access and competitive bids by feeding the cattle in a commercial feedyard that is visited by several buyers.

Selling some at weaning, some as feeders, and some as fed cattle spreads marketings and price risks over time. It is also easier to hedge fed cattle than feeder cattle. Packers offer cash forward contracts on fed cattle, but they are less common on feeder cattle. While feeder cattle futures and options do exist, the live cattle futures and option market is typically easier to use because it has higher liquidity and orders are filled quickly.

Feeding at home or in a commercial feedyard

Regardless of whether the calves are fed at home or in a commercial feed yard, retained ownership adds an enterprise to the farm or ranch increasing gross

John D. Lawrence
extension livestock specialist
(515) 294-6290, jdlaw@iastate.edu
Adapted from ISU Extension publication M-1276.

revenue and making it more diversified. The cow owner must decide whether to feed the calves at home or in a feedyard. When examining this question the producer must first determine what resources (skills, labor, facilities, feedstuffs) he or she has and how they can best be utilized.

Feeding the calves at home adds value to farm resources such as the calf and access feedstuffs. It is also a way to sell resources that may otherwise be difficult to market, i.e., labor, forages, facilities, and equipment. While feeding the cattle at home may not produce as efficient gains as those of a commercial feedyard, net farm income may increase by marketing available resources through a retained ownership program.

Feeding cattle in a commercial feedyard allows the cow owner to hire specialists and state-of-the-art facilities and equipment. Many feedyards have consulting nutritionists, marketing and risk management specialists, and other professionals whose sole objective is profitable cattle feeding. For cow owners using information to improve their herd, some feedyards have scales under their working chute and can record individual weights when the cattle are worked and can work with the packer and the National Cattlemens Association to gather individual carcass information. Feeding cattle in a feedyard may provide greater access to lower feed costs such as alternative feedstuffs or simply a wider corn basis.

By pooling calves from multiple farms, efficient sized pens of steers and heifers can be fed in a cost effective manner. Most Midwest cow herds are small and find it difficult to have a pen of heifers and a pen of steers. It is also difficult for smaller feeders to justify the type of equipment and facilities needed to efficiently feed cattle and to develop the expertise that a professional has when dealing with a limited number of cattle. Commercial feedyards can combine cattle from different owners in the same pen and can equally divide the feed bill according to the animal's size and average daily gain using the net energy system.

Some custom feedlots offer shared risk programs for the cow owner. Variations include (1) sharing ownership of the calf and the feeding cost, (2) the feedlot provides the feed and yardage and the cow owner supplies the calf and the revenues are split according to the percentage of inputs provided.

Many lots now offer financing for feed and may finance a percentage of the value of the calves to the owner at placement to ease cash flow problems.

Cash flow and tax implications

Cash flow requirements may be complicated for the first year that a producer retains ownership. In addition to not having the income from selling calves in the fall, the producer must buy feed increasing the cash outflow. If the producer typically sold calves and sold corn that he is now feeding, the cash flow can be a particular problem. Because the cattle are not sold and feed may be purchased, debts may remain unpaid for a few additional months. While the cattle are collateral for the loan, the producer's financial risk may increase. Lenders must be aware of the producer's plans and see the benefit of the retained ownership strategy. Financing packages offered by feedyards that free up part of the value of the calf and finance the feed can greatly ease cash flow binds.

Feeding calves one year and not the next will complicate income tax management. This is only a problem for a cow owner on cash accounting that switches from a retained ownership program to selling both calves and fed cattle where they fall in the same tax year. In a diversified farming operation in which cattle sales are only a part of total income, selling two calf crops in one year may not cause a problem because sale of grain may be shifted. However, if cattle sales are a major part of total revenue, tax considerations are significant. Pre- or post-paid feed bills may provide some relief for an uneven income stream. It is really only a problem if producers end a retained ownership program and sell their calves at weaning.

Additional advantages to retained ownership
In addition to the market access, resources utilization, and specialization advantages discussed above, retained ownership can capture additional efficiencies if properly planned. Because the cattle are under single ownership over their lifetime, management practices that favored either the buyer or seller but not both can be utilized. For example, creep feeding is known to reduce stress at weaning and help get calves started on feed sooner, but sellers are typically discounted for having fleshy calves that were not rewarded by the buyer. A cow owner can creep feed and reap the benefit of giving a quicker start to healthier calves in the feedlot. There is less stress on the calf because it is moved directly from the farm to the feedlot and bypasses the auction market. The calf has less stress and shrinks less that has to be made up in the feedlot. The cow owner can also benefit from a sound health program without the costly duplication of vaccination if he communicates with the feedyard on processing protocol.

Alternative retained ownership strategies

Alternative retained ownership strategies were compared for 19 calf crops, 1983 - 2001, that would be sold as fed cattle in 1984 - 2002 and the results are shown in the table. Iowa State University Extension Beef Cow Business Records for each year were used as estimates of the cost of producing a weaned calf and as the estimated weaning weight assuming a November 1 weaning date. The ISU Extension Feedlot Enterprise Records for each year were used as estimates of variation in feedlot feed efficiency and average daily gain. The enterprise records serve as a proxy for the weather related risk that affects feedlot performance and more accurately captures the production risk a producer would have faced during the time period. Selling prices for calves and fed cattle were the weekly average price reported in the USDA Livestock Meat and Wool. It assumed that two-thirds of the calves fed are steers and one-third are heifers. The remaining heifers are kept for breeding animals. A $4.00/cwt price slide is assumed for cattle weighing other than the midpoint of the quoted price range. Other input prices (corn, hay, supplement, and interest) were monthly average prices reported for the placement month (ISU Estimated Livestock Returns). Yardage and health cost were adjusted over the 17 years to reflect inflation. The cattle were assumed to be trucked 100 miles in and out and the cost per mile per cwt was held constant over the period.

Selling at weaning: Selling calves at weaning serves as the bench mark strategy. Calves are weaned and sold on November 1. This strategy produced a lower average and maximum return than did the feedlot strategies, but it had a higher minimum return and less variation in returns.

Background for 60 days: The calves were weaned November 1 and backgrounded for approximately 60 days. Average daily gain was targeted at 1.75 pounds but was adjusted each year to reflect the performance conditions experienced in feedlots. This strategy had the lowest average return, but less downside risk than the feedlot strategies.

Retain backgrounded cattle to slaughter: The backgrounded calves in the earlier strategy were put in the feedlot January 1 and fed until August 20. The cattle were assumed to grade 75 percent Choice, 25 percent Select, and were priced accordingly. Average returns were higher than the previous two strategies, less than another feeding strategy, and had the greatest downside risk.

Early wean calves into feedlot: Calves are weaned September 1, placed directly into the feedlot, and sold April 15 grading 60 percent Choice. This strategy was the most profitable one evaluated due to the improved feedlot performance and because the cattle were sold before seasonal price declines.

Place directly in feedlot at weaning: Calves were weaned November 1, placed directly in the feedlot, and were sold grading 70 percent Choice July 1. Returns averaged better than the backgrounding strategies or sell at weaning and were less risky than the combination strategy above.

Profit share arrangements: The three feedlot strategies outlined above were used to illustrate a profit sharing agreement between the cow owner and the feedyard. In this example the cow owner and the feedyard divide the revenue from selling the finished animal based on the percent of inputs provided by each party valued at placement time. These examples assume that the cow owner provides the calf, interest, trucking to the lot, and half of the vet bill. The feedyard provides the feed, interest, yardage, trucking to the packer, and half of the vet bill. For example, if the feedyard's share is 45 percent of the cost to finish the calf it will receive 45 percent of gross revenue at market time.

The average return to the cow owner was improved under all three strategies but downside risk increased compared to selling at weaning. The most profitable strategy when retaining full ownership, weaning early, produced a considerably lower return to the cow owner under the profit share agreement. In this strategy the feedyard adds more value to the calf than does the cow owner. The feedyard returns were relatively stable and, with the exception of the early wean strategy, were less than the cow owner return.

Summary

Cow herds selling at weaning earned positive returns on their 2000-2001 calf crops, but lost money on the six calf crops 1994-1999. The 1995 calf crop losses were the largest in the series. Cowherds that retained ownership into the feedlot suffered losses in only three years. The early wean strategy was most profitable among the strategies examined, and typically had smaller losses than other strategies in any given year. In some years, 1983-85 and 1995-97, cow herds lost money under all strategies. Unprofitable years trigger a liquidation of the breeding herd to reduce beef supplies. They are also inevitable and should be planned for.

Retained ownership alternatives examined added value to the cow owner's resources in most years. It paid market rates for the calf, feed, capital, labor, and facilities and produced a profit. Compared to selling at weaning, retaining ownership until slaughter increased average profits. In individual years the return was over three times higher. Selling calves at weaning did reduce losses in unprofitable years of the cattle cycle, 1983-85, 1995, and 1997. However, retained ownership was more profitable in the other years. These results suggest that no one strategy is most profitable every year. Successful cow owners will be those who can adjust their program to changes in market conditions to achieve the greatest returns to their resources.

Cow owner retains ownership of the calf

Calf crop year	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	10 Yr Summary Avg	10 Yr Summary Min	10 Yr Summary Max	19 Yr Summary Avg	19 Yr Summary Min	19 Yr Summary Max
Wean & sell Nov 1	57	33	-8	-149	-121	-62	-56	-34	21	41	-28	-149	57	-3	149	155
Background & sell Jan. 1	64	10	33	-183	-168	-98	-37	-1	21	81	-28	-183	81	-6	-183	163
Backgrd & finish Aug 20	139	-39	0	-98	-9	-110	48	56	85	49	12	-110	139	35	-209	246
Wean Sep 1,finish Apr 15	178	84	45	-170	-27	-94	27	96	144	74	36	-170	178	51	-175	263
Wean Nov 1, finish July 1	137	-85	16	-164	-67	-145	16	54	68	22	-15	-164	137	14	-181	193

Cow owner and feedyard share inputs and returns

Calf crop year	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	10 Yr Summary Avg	10 Yr Summary Min	10 Yr Summary Max	19 Yr Summary Avg	19 Yr Summary Min	19 Yr Summary Max
Cow owner	138	-9	38	-124	-62	-86	42	68	97	92	19	-124	138	38	-162	256
Feedyard	35	-1	-5	49	76	3	32	18	21	-10	22	-10	76	29	-10	76
Wean Sep 1, finish Apr 15																
Cow owner	108	45	1	-170	-101	-103	-31	23	72	54	-10	-170	108	6	-184	226
Feedyard	70	39	44	0	74	8	58	74	72	20	46	0	74	45	0	74
Wean Nov 1, finish July 1																
Cow owner	130	-24	31	-137	-75	-88	7	48	81	58	3	-137	130	26	-145	208
Feedyard	36	-36	12	-7	28	-32	30	31	15	-9	7	-36	36	16	-36	71

TEXAS A&M AGRILIFE EXTENSION

EAG-018
7/15

Key Performance Indicator Targets for Beef Cow-calf Operations

Stan Bevers and David Anderson
Professors & Extension Economists
The Texas A&M University System

The national beef herd is currently expanding from historically low levels. This expansion and the possibility of lower prices provide an excellent opportunity for you to review financial performance measurements that are critical to your operation. These measurements are known as Key Performance Indicators (KPIs) and are based on production and financial data. You can use these KPIs to evaluate different factors that are crucial to the success of your cow-calf operation. They can help any rancher evaluate whether the operation is fulfilling his or her goals. In a sense, they are a report card that can be used to identify weaknesses in a given operation. Below are thirteen KPIs that every rancher should consider as they start the process of restocking their ranch.

It is important that you calculate KPIs correctly and base them on good data. Be honest with yourself. In some instances, ranchers find that their financial recordkeeping isn't as good as it should be. The most accurate KPIs are calculated from financial accrual-adjusted records. Remember that no single KPI assures success. As with a ranch's resources, the ranch manager must balance the use of these indicators. To focus on one KPI, at the expense of another, will not improve the overall performance of the ranch. As an example, increasing the pounds weaned per exposed female does no good if the nutritional base expense indicator is too high. KPIs have to be in balance for overall performance to be excellent. Finally, most ranches are involved in multiple enterprises. The KPI's discussed below are strictly for the cow-calf segment of a ranch.

Target levels for the various KPIs have been identified through analysis of herd data from several sources including hundreds of herds in the Beef Cow-calf SPA and the authors research and experience working with individual ranch owners and managers.

1 Pounds Weaned per Exposed Female – Greater than 460 pounds per Exposed Female

The primary objective for owning breeding beef females is to wean calves. While every rancher has this goal, how they accomplish it over time varies. However, the number of calves weaned and how heavy those calves are serve as an indicator of ranch productivity. From a production standpoint, the pounds of weaned calf per exposed female remains the most important production KPI. To calculate this KPI, divide the total pounds of weaned calves by the total number of exposed breeding females that were intended to be bred. This KPI is a function of

weaning percentage and weaning weights. A high weaning percentage begins with a high pregnancy rate followed by a high calving percentage. While weaning weights are certainly a function of genetics and management, weather and days of age are the most important determinants. To solve low pounds weaned per exposed female, a rancher should look first at reproduction rates, not at increasing weaning weights.

2 Revenue per Breeding Female – Greater than $950 per Breeding Female

For a ranch to record net income, it must sell products and generate revenue. In its simplest form, this KPI is a product of pounds weaned being sold for a competitive price. However, revenue per breeding female also includes other items. First, this KPI would include the gains or losses associated with the sales of culled breeding stock. Second, it should include the annual value change (accrual adjustment) of the weaned calves that are kept in the herd as replacement heifers or replacement bulls. Ideally, this value would be the accumulated expenses of the calves; however, many ranchers may choose to use market value. The target figure of $950 per breeding female is based on accumulated expenses, not market value. If you use the market value approach, the KPI should be higher than $950.

3 Nutrition Base Expense as a Percent of Total Expenses – Between 30.0 and 45.0 Percent

Because reproduction is the the most important factor in ranch productivity, proper herd nutrition is imperative. Yet, no two ranches have exactly the same resources to grow, purchase, and maintain the nutritional base required by the breeding herd. Thus, we need to identify three types of nutritional expense: 1) expenditures for purchasing forage, protein supplement, salt, and minerals; 2) expenses for producing raised feed, such as hay production; 3) costs to maintain and improve grazing for the herd. Those familiar with the Beef Cow-calf SPA analysis will recognize these as the Raised/Purchased Feed Expense and the Grazing Expense. To calculate this KPI, start with the total expense of the ranch including owner labor and depreciation. Then, identify the nutritional costs. Most successful ranchers keep nutritional expenses at 30 to 45 percent of total expenses.

4 Labor and Management Expense as a Percent of Total Revenue – Less than 15 Percent

Labor and management expense can be the most variable cost across beef herds. To calculate this KPI, determine what the total labor and management expense is. If the ranch uses only hired labor and management, this figure is relatively easy to determine. If an owner operates the ranch, he must establish a figure for his labor for this KPI to be comparable. In either case, items such as payroll taxes and employee benefits need to be included. Labor and management costs are higher than most people realize due to the benefits that hired managers receive. To interpret this KPI, the ranch owner should target spending less than $0.15 for labor and management per one dollar of revenue generated.

5 Operating Expense as a Percentage of Total Revenue – Less than 75 Percent

Controlling expenses can be one of the most important exercises for ranch owners and managers. Managers should target operating expenses at less than 75 percent of total revenue. Operating expenses include all expenses except interest and depreciation. If operating expenses are less than 75 percent the ranch's total revenue, the ranch can use the remaining 25 percent to 1) pay interest, 2) hold in escrow to cover depreciation expense, or 3) retain as net income. Clearly, a ranch will suffer a net loss if operating expenses plus interest expense and depreciation is greater than total revenue.

6 Net Income Ratio – Greater than 5 Percent

This ratio corresponds with the fifth KPI. Net Income is calculated as total revenue minus total expenses. This KPI represents that portion of total revenue that is retained as net income. Put another way, a ranch can do four things with total revenue, 1) pay operating expenses, 2) pay interest expenses, 3) place in escrow to account for depreciation expenses, or 4) retain as net income. This KPI records each of the four as a percent of total revenue. This target is to retain greater than 5 percent of the total ranch revenue as net income, while the remaining 95 percent can be used to pay for operating, interest, or depreciation costs.

7 Cost per Cwt. of Weaned Calf – Less than $170.00 per Cwt.

For a ranch manager, the best number to know is what it takes to produce a pound of weaned calf, or in this case, 100 pounds of weaned calves. This KPI incorporates the productivity of the ranch and the total expenses it took to create that productivity. Every ranch has a different set of resources that it uses to create calves. This KPI illustrates how efficiently that manager is using those resources. When calculated correctly, you can compare this figure to other ranchers across the country regardless of the resources that the manager is using.

Industry-wide, this bottom line KPI is where ranchers compete with one another. Further, it is known that the cattle industry is cyclical and calf prices move between high (resulting in financial profits) and low (generating financial losses). This cyclical movement of prices relative to each ranch's cost of production is what encourages specific ranchers, and the cow-calf industry in general, to expand or contract. Given current fundamentals, a cost of less than $170 per cwt. is a target ranchers should shoot for.

8 Current Ratio – Greater than 2.0

Most ranchers have only one significant payday per year. That makes it imperative to have enough liquid assets to combat unforeseen events such as prolonged dry periods. The current ratio KPI reflects a ranch's ability to pay short-term liabilities, but also provides an estimate of its ability to quickly mitigate the impact of short-term unknown events. This indicator is calculated by dividing the ranch's current assets by the liabilities that have to be paid within the year. Current assets can be cash, savings, or any other asset that can be quickly turned into cash. Ranchers should strive to maintain a current ratio greater than 2.0.

9 Total Investment (Market Basis) per Breeding Female – Between $7,500 and $12,500

On most ranches, owned land is the major asset on the balance sheet. Currently, external factors have driven land prices higher. In today's real estate market, ranchers are finding it hard for breeding cows to pay for any land purchase. Furthermore, potential ranch heirs look at the large investment, labor required, and low rate of return, and have to wonder whether it would be better to invest elsewhere. The ranch manager's job is to generate the greatest return on the lowest investment possible. This KPI target range, $7,500 to $12,500, takes into account that some land has already been purchased (or inherited) or that some portion of land the ranch uses is leased. To calculate this KPI, divide the total asset investment from the balance sheet by the beginning fiscal year inventory of breeding females.

10 Debt per Breeding Female – Less than $500 per Breeding Female

Given the low rate of return on assets, most ranches cannot pay for much debt. To illustrate, a target Rate of Return on Assets KPI (Target KPI #13) is greater than 1.5 percent. With interest rates greater than 4.0 percent, it is impractical to purchase assets that will only return 1.5 percent when that interest is costing the ranch 4.0 percent. This example does not take into account cases where the asset improves the ranch efficiency enough to overcome the interest cost. This KPI can vary with some herds able to handle more

debt than others. To calculate this KPI, divide the total debt of the ranch from the balance sheet by the beginning fiscal year inventory of breeding females. In general, successful ranch managers keep the debt per breeding female under $500 each.

11 Equity to Asset Ratio (Market Basis) – Greater than 50 Percent

The equity to asset ratio is the percentage of a ranch the owner owns. To calculate this KPI, divide the net equity by the total assets. Both figures come from a ranch's balance sheet. The opposite image of this KPI is the debt to asset ratio that shows the percentage of the ranch owned by others, such as a lender. Few lenders will want to finance a ranch if they already own more than 50 percent of it. This being the case, you should strive to own more than half of the assets. The type of ranch assets you own will influence whether you can get financing. For example, if your share is made up of land you own, a lender may find it easier to lend money against an equity to asset ratio of less than half.

12 Asset Turnover Ratio (Cost Basis) – Greater than 15 Percent

Because ranching is such a highly capitalized business, it is vital that the manager generate the greatest possible net income from those assets. The asset turnover ratio illustrates how much those assets are generating (turning). To achieve a KPI target of 15 percent, every dollar of asset making up a particular ranch must generate $0.15. This figure may seem quite low, but it demonstrates the nature of the ranching business. To calculate this KPI, divide the net income by the value of assets from the balance sheet.

13 Rate of Return on Assets (Market Basis) – Greater than 1.5 Percent

Managers depend on the rate of return on assets to evaluate their performance. The manager's charge is to use the ranch's assets to generate positive net income. In this way, ranch managers are like fund managers on Wall Street. The difference, however, is the expected ROA. While the long-term return from Wall Street may be greater than 6.0 percent, the long-term return from breeding beef cows is closer to 0.5 percent. When calculated correctly, the ROA can be compared to any other asset management business including your savings account at the local bank. To calculate this KPI, start with the net income and add to it the interest expenses for the year. Then, divide this figure by the average value of the assets from the balance sheet. In this case, we use the market value basis as opposed to the cost basis of the assets. Successful ranches have an ROA greater than 1.5% over time.

The thirteen KPI's presented here are not the only measures that a ranch should consider. However, these KPI's provide an excellent starting point for evaluating the financial targets a ranching operation should strive for. Remember, each ranch is unique and possibly involved in multiple enterprises that contribute to the financial well-being of the operation. These variations may alter how certain KPIs are viewed.

Texas A&M AgriLife Extension Service

AgriLifeExtension.tamu.edu

More Extension publications can be found at *AgriLifeBookstore.org*

The Texas A&M University System, U.S. Department of Agriculture, and the County Commissioners Courts of Texas Cooperating.

New

TEXAS A&M AGRILIFE EXTENSION

E-410
9-99

Livestock Seasonal Price Variation

Ernest E. Davis, James D. Sartwelle, III and James Mintert*

Nature dictates many of the production and supply patterns in the livestock industry. For example, a majority of the annual calf, lamb and kid crops are born in late winter and spring. By the time animals are weaned vegetation and forages are readily available. This also is the time when the animals' nutritional requirements are at a peak. Nature has a method of keeping this pattern fairly consistent unless interrupted intentionally by man. During the hot summer months, the fertility rates of both females and males decline as flesh condition declines with decreasing forage. For these reasons, supplies of feeder animals are usually largest during the fall and lowest during the spring. This production and supply pattern usually causes spring livestock prices to be higher than fall livestock prices.

Seasonal consumer demand patterns (such as a higher demand for beef in the spring) have caused livestock producers to alter production patterns to take advantage of market opportunities. Severe winter weather can disrupt marketings and cause prices to increase because of reduced weight gains. For these two reasons, fed cattle prices usually peak in March or April. Feedlots attempt to have supplies of fed cattle to meet this demand. Feeder cattle (700 to 800 pounds) are contracted or purchased in the late summer or fall to ensure that there are feeder cattle supplies to meet this market. At the same time, feedlot buyers must compete with stocker operations buying cattle to stock winter small grain pastures. During the 1970s and 1980s, this increased the demand for stocker-feeder cattle in the summer. Summer prices for these cattle are bid up from spring lows. Therefore, we now have two periods of the year when prices for 700- to 800-pound feeder cattle rise above the annual average prices—one peak in the winter and another in the summer.

Seasonal price movements can be measured over a period of years. Monthly prices can be indexed to show, proportionally, how much they are above or below the annual price average. With changing consumption patterns or transition periods of increasing or decreasing supplies, seasonal price patterns may change either permanently or temporarily.

The seasonal price indexes in this publication were calculated over a 10-year period (1989 through 1998) for Amarillo direct fed steers (1,100 to 1,300 pounds), Texas feeder steers (700 to 800 pounds), Texas feeder steers (500 to 600 pounds), San Angelo Cutter cows 1's and 2's, and San Angelo feeder lambs (55 to 90 pounds).

Two kinds of information have been extracted from this price data: 1) the monthly price variations relative to the annual average price or the monthly seasonal price indexes, and 2) the price variability within a month during the years included in the analysis. It is important when analyzing the variability of monthly average prices that the price data be "statistically normally distributed" before one can have confidence about the variability. For a data set to have a statistically normal distribution means that the frequency of the data, in this case monthly price data, centers around the average and is symmetrical on both sides (higher and lower than the average price), forming a mound shape (or bell curve) with the highest point being at the average. If the price data are statis-

*Professor and Extension Economist and Extension Program Specialist–Risk Management, The Texas A&M University System; and Extension Agricultural Economist, Kansas State University.

tically normally distributed, then the variability factor can be used with some degree of confidence (68 percent of the time) to develop price expectations. Specifically, the variation factor above and below the monthly price index specifies a range where price may be expected to fall 68 percent of the time.

Figures 1 through 6 plot the average annual price and monthly price index, with the variability range indicated by points above and below the index values. The monthly price index numbers and the monthly variability factors are listed at the bottom of each figure.

For example, in Figure 1 for January, the monthly price index of 102.58 means the average January price is 102.58 percent of the annual average price. The variability factor of 6.24 means that, statistically, the monthly index can vary 6.24 percentage points higher or lower than the monthly index. The price in a particular year may be as high as 108.82 percent (102.58 + 6.24) or as low as 96.34 percent (102.44 - 6.24) of the annual average. The smaller the variability factor (the closer the high and low points are to the monthly price index), the more reliable is the monthly price index.

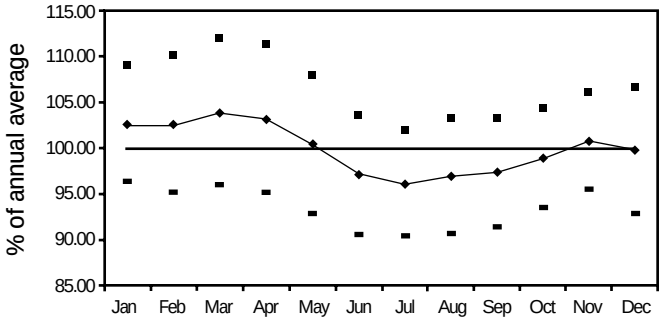
Monthly price indexes can be used as an indication of possible price trends for a period of time. The variability factor, **in cases where the price series is statistically normally distributed**, can be used to estimate the possibility of prices varying within the estimated range. Many of the livestock price indexes shown here have relatively large variability factors, which limits their value in projecting specific price trends. Also, only the price series for Amarillo direct fed steers and San Angelo feeder lambs, 55 to 90 pounds, are normally distributed. For the other price series, only seasonal price trends will be useful when planning marketings.

Seasonal price indexes also can be used to forecast prices for the months ahead based on the past relationship, again subject to normal distribution of the price data set. To forecast a future month, divide the current month's average price by the index of that current month, then multiply that number by the index of the future month for which the price forecast is being determined. For example, if June Amarillo direct fed cattle prices averaged $64 per hundredweight (cwt.), the forecast for October would be $64 divided by 97.12, multiplied by 99.04 = $65.27 per cwt. Adjusting for the variability suggests that there is a 68 percent probability that the October monthly average price would fall between $70.67 cwt. and $59.87 cwt.

Seasonal Price Index for Amarillo Direct Fed Steers

The price series used for Amarillo direct fed steers was normally distributed, so this information can be used to predict price from current to future months and determine ranges of expected prices. The 10-year seasonal price pattern for fed steers in more normal years (i.e., no droughts or unusually large feedgrain price fluctuations) has been reasonably stable. As depicted in Figure 1, the highest prices for fed steers are expected to occur in March or April, and the lowest from June through September. This pattern is logical when you consider that the largest number of calves are usually weaned and marketed in the fall.

Figure 1. Seasonal price index, 1989-98, for Amarillo direct fed steers (1100 to 1300 pounds).



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Price Index	102.58	102.56	103.92	103.17	100.39	97.12	96.21	96.99	97.37	99.04	100.85	99.81
Variability	6.24	7.41	7.93	8.08	7.49	6.48	5.73	6.26	5.93	5.40	5.33	6.94

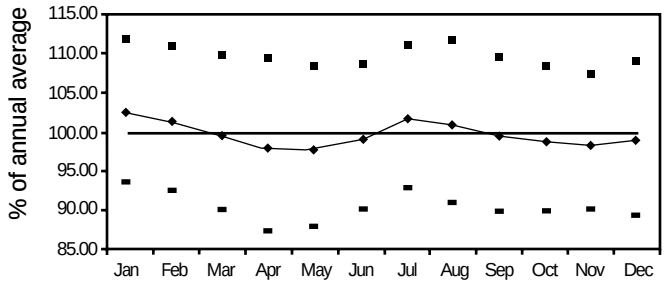
Seasonal Price Index for Texas Feeder Steers, 700 to 800 Pounds

The price series used for 700- to 800-pound Texas feeder steers was not normally distributed, so this information cannot be used to predict price from current to future months or to determine a range within which prices might be expected to fall. Note the high variability in the data. The variability ranges from a November low of $8.64 per cwt. to an April high of $11.02 per cwt. (Fig. 2). The seasonal price patterns are usually consistent across 10-year time periods, with highest prices in January, declining prices from then through May, increasing prices in June, July and August and declining prices in the fall.

This pattern seems logical when you consider that these cattle are in "storage" on improved winter pastures in January, begin moving to market in February, and are marketed in the largest numbers from March through May. In late spring and summer feedlots normally experience their largest marketings of the year and

their demand increases for replacement cattle to put on feed, to refill the feedyards. By fall most feedlots are full and feeder cattle prices decline. Usually there are also many calves from the year's calf crop on the market during the fall.

Figure 2. Seasonal price index, 1989-98, for Texas feeder steers (700 to 800 pounds).



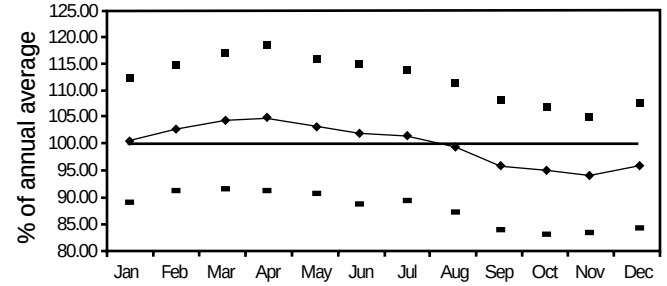
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Price Index	102.66	101.60	99.83	98.30	98.02	99.34	102.60	101.36	99.69	99.08	98.77	99.29
Variability	9.05	9.21	9.85	11.02	10.22	9.22	9.15	10.38	9.87	9.29	8.64	9.79

Seasonal Price Index for Texas Feeder Steers, 500 to 600 Pounds

The price series used for 500- to 600-pound Texas feeder steers was not normally distributed. Once again there was large variability in the data. The lowest monthly variability was November at $10.65 per cwt. and the highest was April with a $13.50 per cwt. price range (Fig. 3). The seasonality patterns, however, are generally consistent over 10 years, with the highest prices occurring in March, April and May and the lowest prices occurring September through December.

This pattern also seems logical because about 76 percent of the annual calf crop is born in the first 6 months of the year. There are short supplies of 500- to 600-pound calves during that period, but larger supplies after August when fall weaning and marketing begin.

Figure 3. Seasonal price index, 1989-98, for Texas feeder steers (500 to 600 pounds).



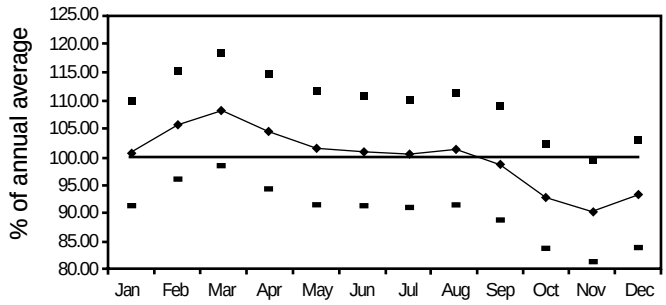
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Price Index	100.54	102.79	104.35	104.82	103.23	102.03	101.59	99.49	96.09	94.93	94.14	96.01
Variability	11.56	11.57	12.80	13.50	12.55	13.17	12.24	12.21	12.17	11.85	10.65	11.65

Seasonal Price Index for San Angelo Cutter Cows, 1-2

The price series used for the San Angelo Cutter Cows, 1-2, was not normally distributed. The monthly price variability was relatively high, but was about the same for each month. For example, November had the lowest monthly price variability of $9.04 per cwt., and April had the highest at $10.16 per cwt. (Fig. 4). The seasonalities of cutter cows are consistent with other studies on slaughter cows, with the higher prices February through April and the lower prices October through December.

Again, this seasonal pattern seems logical. Most calves are born form February through April. Ranges and pastures begin growing, with forage production heading towards seasonal peaks. Both conditions mean that not many cull cows will find their way to market. In the fall, however, with declining pasture conditions, fall weaning and marketing of calves, and pregnancy testing of cows, open cows are often sent to market.

Figure 4. Seasonal price index, 1989-98, for San Angelo cutter cows, 1-2.



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Price Index	100.69	105.71	108.32	104.58	101.74	100.98	100.57	101.43	98.91	93.03	90.47	93.56
Variability	9.08	9.38	10.10	10.16	10.08	9.68	9.48	9.89	9.95	9.20	9.04	9.41

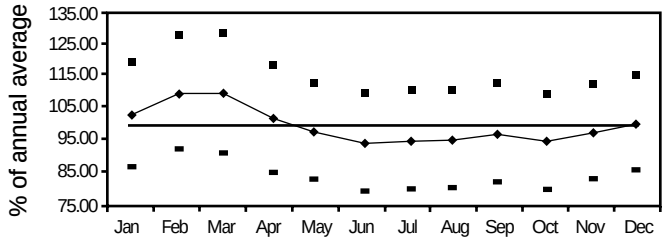
Seasonal Price Index for San Angelo Feeder Lambs

The price series used for San Angelo feeder lambs was normally distributed so this information can be used to predict price from current to future months and a price range into which prices might be expected to fall. The variability within the monthly price data, however, is so wide that the price projections would be of little help. For example, assume San Angelo feeder lamb prices averaged $82 per cwt. during April. To get a price forecast for October, $82 would be divided by 101.76 (April price index), then multiplied by 95.03 (October price index). The result is $76.58 per cwt. Adjusting for the October variability suggests that there is a 68 percent

probability that the October San Angelo feeder lamb average price would fall between $91.78 and $61.38 per cwt. That wide range does not provide much help in planning market returns.

The data still show definite seasonal patterns of higher prices from January through April and lower prices for the remainder of the year. This is in line with spring lambing and Easter demand for lamb.

Figure 5. Seasonal price index, 1989-98, for San Angelo feeder lambs.



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Price Index	103.09	109.96	109.76	101.76	97.95	94.44	95.41	95.61	97.63	95.03	98.27	101.09
Variability	16.32	17.93	18.82	16.70	14.89	15.25	15.47	15.31	15.30	15.20	14.59	14.76

Partial funding support has been provided by the Texas Wheat Producers Board, Texas Corn Producers Board, and the Texas Farm Bureau.

Texas A&M AgriLife Extension Service

AgriLifeExtension.tamu.edu

More Extension publications can be found at *AgriLifeBookstore.org*

Educational programs of the Texas A&M AgriLife Extension Service are open to all people without regard to race, color, sex, disability, religion, age, or national origin.

The Texas A&M University System, U.S. Department of Agriculture, and the County Commissioners Courts of Texas Cooperating.

Produced by Texas A&M AgriLife Communications

TEXAS A&M AGRILIFE EXTENSION

L-5263
RM2-4.0
5-99

Livestock Basis

James Mintert, Ernest E. Davis, Kevin Dhuyvetter and Stan Bevers*

Basis is the difference between the local cash market and a futures contract price (Basis = Cash Price – Futures Price). Knowledge of historical basis patterns can be useful when estimating expected sale or purchase prices at the conclusion of a futures or options hedge, when evaluating a current cash market quote, and when forecasting cash prices. This publication explains how livestock basis is computed, outlines an approach to developing a history of local basis levels, and discusses how historical basis data can be used to forecast basis.

A futures contract price represents today's opinion of a commodity's value at a specific time in the future. Moreover, the futures price quote is for a specific grade of the commodity at a particular location. On the other hand, a commodity's local cash price represents the price at which buyers and sellers are willing to trade the commodity on a particular date at a given location. Cash prices vary by geographic location, actual grade or quality of the commodity, and, like futures prices, by date.

The difference between a commodity's futures contract and cash prices, for a particular grade at a specific location, is known as the basis. Basis is sometimes referred to as the price of a cash commodity at a particular location, relative to a specific futures contract, because it provides a measure of the local supply and demand conditions vs. the aggregate supply and demand situation depicted by the futures contract's price.

Defining Basis

Mathematically, the formula for computing basis can be stated as:

Basis = Cash Price – Futures Price (1)

The formula indicates that, if basis is negative, the futures price is greater than the cash price. Conversely, a positive basis indicates the futures price is less than the cash price.

Basis is usually computed using the nearby (closest to expiration) futures contract. For example, in October the nearby corn futures contract is the December futures contract and the December contract is generally used to compute basis for corn to be delivered in the fall. Similarly, in January the nearby live cattle futures contract is the February contract since it is the contract closest to expiration.

Livestock basis is always computed using the nearby (closest to expiration) futures contract since, generally, it is not possible to store livestock into the expiration period of a subsequent futures contract. However, grain basis can be computed using a deferred futures contract price. A deferred futures contract is any futures contract farther away from expiration than the nearby futures contract. For example, in the fall you could choose to compute corn basis using the July corn futures contract, which is a deferred contract since the December contract is the nearby

*Extension Agricultural Economist, Kansas State University Agricultural Experiment Station and Cooperative Extension Service; Professor and Extension Economist, The Texas A&M University System; Extension Agricultural Economist, Kansas State University Agricultural Experiment Station and Cooperative Extension Service; Assistant Professor and Extension Economist, The Texas A&M University System.

contract in the fall. It makes sense to do this with grains because they are a storable commodity, unlike livestock. Computing grain basis using a deferred futures contract makes it possible to evaluate expected changes in the basis over a long period of time. This can be helpful when evaluating storage profitability.

Basis is much easier to predict than either the cash or futures price. This is because most of the factors that influence a commodity's price affect both cash and futures prices simultaneously. Usually there is a one-to-one relationship (approximately) between cash and futures prices. This means that cash and futures prices tend to move together. That is, if live cattle futures prices go up by $1.00 per hundredweight (cwt.), cash prices also tend to go up by $1.00 per cwt. There are times, particularly in the grains, when something other than a one-to-one relationship between cash and futures prices can be expected. The ability to anticipate these situations can create a profit opportunity.

Using Basis Information

The mathematical formula used to compute basis is a powerful tool. If we rearrange equation (1) and solve for the cash price we discover the following relationship:

Cash Price = Basis + Futures Price (2)

Hedgers can use basis for the time frame when they expect to deliver (or accept delivery of) the cash commodity to estimate their expected price if they place a hedge at today's futures price level. This works because a hedger effectively locks in the futures price when the futures contract is sold, in the case of a short hedger, or when the futures contract is purchased, in the case of a long hedger. Effectively, this means that the difference between a hedger's actual price, at the conclusion of the hedge, and the expected price, at the outset of a hedge, will be attributable to the difference between the actual and expected basis.

Suppose, for example, it is currently April and you will have fed cattle ready for market in September. The October Live Cattle contract is currently trading at $71 per cwt. But what does that mean to you when feeding and selling finished steers in Hereford, Texas? To more accurately estimate what your actual selling price might be, you would need a basis estimate for 1) fed steers, 2) at Hereford, Texas, and 3) during September. Suppose, historically, such a basis had averaged – $2.00 per cwt., then your estimated selling price would be $69 per cwt. If pricing through the futures market with an October Live Cattle contract, this would be the best estimate of your September fed cattle selling price in Hereford, Texas. This is the first and foremost use of estimate basis.

Knowledge of historical basis levels also can be useful when judging the acceptability of a local cash market price. As equation (2) indicates, a commodity's cash price can be separated into its futures price and basis components. The basis component can be compared with historical basis levels for that particular time of year and a judgement made regarding the acceptability of the cash price. If the basis differs substantially from historical levels, some additional research to determine why the difference exists and whether it is likely to persist is warranted.

Finally, you can forecast the cash price by replacing basis with expected basis. In this case the formula becomes:

Expected Cash Price = *Expected* Basis + Futures Price (3)

This means you can use a basis forecast, in conjunction with the futures price, as a cash price forecasting tool. The technique is straightforward. Simply add today's futures price (choosing the futures contract that will be the nearby contract during the forecast period) and a forecast of the basis during the forecast period to obtain a cash price forecast. To clarify, assume that you need a western Kansas fed steer cash price forecast for mid-November. Take today's December live cattle futures price and add a forecast of the mid-November western Kansas slaughter steer basis to the futures price. The result will be an expected mid-November cash price, based upon today's futures market price and your basis forecast. This futures-based price forecast can then be compared to forecasts from alternative sources such as university Extension economists, the U.S. Department of Agriculture and market advisory firms.

Constructing Historical Basis Tables

Basis tends to follow the same pattern year after year. As a result, historical basis data can be used to forecast basis. The first step to forecasting basis is to generate a historical basis table to compare basis across years. Setting up basis tables on a weekly basis is the preferred approach because it provides enough detail to be useful for forecasting without requiring that you spend an inordinate amount of time collecting prices.

Both feeder cattle and lean hog basis can be computed one day per week for most markets. Feeder cattle auction markets typically trade just one day per week. As a result, cash prices are

only available one day per week. When performing the feeder cattle basis computations, it is important to use the futures and cash price from the same date. Lean hog basis data for major markets also can be recorded just one day per week because most hog markets trade every day. To avoid holidays, recording the closing cash and futures prices on Wednesday is often a good choice.

Unfortunately, computing and recording slaughter cattle basis one day per week is not satisfactory. Many cash slaughter cattle markets, such as western Kansas slaughter cattle, don't trade every day. As a result, picking a single day per week (for example, every Wednesday) to compute basis will yield a surprisingly large number of weeks with no basis to report, simply because the cash trade occurred on days other than the one chosen. To avoid this problem, you can average both cash and nearby futures prices for the week and use them to calculate weekly average basis. Whether you choose the weekly average technique or one day per week approach, it's important that you use the same technique from week to week and year to year to ensure consistency.

Calculating the weekly average basis for slaughter cattle requires that a rule be established regarding when to change the futures contract used to compute basis. One rule that works well for livestock basis is to continue using the futures contract closest to expiration to compute the weekly average futures price, as long as it continues to trade the entire week. If the nearby contract expires during the middle of the week, switch all of your calculations for that week to the next closest to expiration contract. To clarify, examine how this rule would have been employed with the October 1997 and December 1997 live cattle futures contracts. October live cattle futures expired on Wednesday, October 22. Consequently, the last week to compute live cattle basis using the October contract was the week ending Friday, October 17. Basis for the week ending October 24 was computed using the December live cattle futures contract, because by the end of that week, it was the new nearby futures contract.

Remember, anything that affects cash prices will affect basis. For example, since feeder steer and heifer basis is computed using the same futures contract, feeder steers and heifers will generally have a much different basis because heifer prices typically trade at a substantial discount to steer prices. Similarly, different feeder cattle weight classes will also have substantially different basis levels and patterns because light weight cattle prices generally trade at a premium to heavy weight cattle prices and follow a different seasonal pattern. As a result, it's important to have data available for the appropriate sex and weight since it can have a big impact on basis.

Other factors that influence cash prices also can have a big impact on basis. Prices for Choice and Select slaughter cattle vary, and as a result, these two quality grades have a different basis pattern. Similarly, there is a wide variety of physical characteristics that influence cash sale prices for feeder cattle, all of which can affect the basis for a particular pen of steers or heifers. Lean hog prices vary depending on the carcass weight and the percentage of the carcass that is lean meat, which means both these characteristics will affect lean hog basis.

Forecasting Basis

Since basis tends to follow the same pattern year after year, historical basis data can be used to help forecast future basis levels. The basis tables described previously can be a great help when forecasting livestock basis. The simplest technique, and one of the most reliable, is to use the historical average basis level for the week you are interested in as a forecast. Recent research indicates that, generally, 3-year averages are preferred when forecasting feeder cattle or slaughter cattle basis (Dhuyvetter and Parcell). Comparable research regarding the appropriate historical average to use when forecasting lean hog basis is not available, but it's likely that a 3- to 5-year average will perform well.

Forecasting Example

Table 1 provides historical weekly feeder steer basis data for steers weighing 700 to 800 pounds that were sold at the Winter Livestock Auction in Dodge City, Kansas. If you are interested in forecasting basis for 700- to 800-pound steers to be marketed in southwest Kansas the week of October 15, 1998, it's reasonable to expect basis to be near the 3-year average of negative $0.27 per cwt. However, remember that the actual basis could be above or below that level.

Updated Basis Information Available on the World Wide Web (WWW)

Although it's best to maintain your own historical basis data for markets that you customarily use, current livestock basis data for several major markets is available from Kansas State University on the WWW. Point your web browser to the following address

www.agecon.Ksu.edu/livestock

to obtain historical livestock basis information

for feeder cattle (Dodge City, Kansas), slaughter cattle (western Kansas direct, 1100- to 1300-pound steers) and lean hogs (Western Cornbelt Lean). Weekly historical basis charts are available for each futures contract and the nearby basis chart is updated each week. In addition, the Texas Agricultural Extension Service has historical feeder cattle and calf basis available for many Texas auction markets, as well as for the Texas Panhandle slaughter cattle trade.

Table 1. Dodge City, Kansas 700- to 800-pound feeder steer basis, Chicago Mercantile Exchange October feeder cattle futures.

1997 Dates	1995	1996	1997	3-Year Average
		$/cwt.		
10/1	1.23	-0.12	-1.88	-0.26
10/8	1.29	-0.82	2.27	0.91
10/15	-0.01	-0.34	-0.47	-0.27
10/22	1.29	-0.14	-1.10	0.02
10/29	N/A	1.98	-3.24	N/A

References

Dhuyvetter, K.C. and J. L. Parcells. "Understanding and Forecasting Cattle Basis." Paper presented at the Kansas State University Cattle Profitability Conference, Manhattan, Kansas, August 14-15, 1997.

Kastens, T. L., R. Jones and T. C. Schroeder. "Futures-Based Price Forecasts for Agricultural Producers and Businesses." *Journal of Agricultural and Resource Economics*, Forthcoming, 1998.

Partial funding support has been provided by the Texas Wheat Producers Board, Texas Corn Producers Board, and the Texas Farm Bureau.

Texas A&M AgriLife Extension Service

AgriLifeExtension.tamu.edu

More Extension publications can be found at *AgriLifeBookstore.org*

Produced by Texas A&M AgriLife Communications

TEXAS A&M AGRILIFE EXTENSION

E-557
RM1-11.0
03-09

Risk Management

Grid Pricing of Fed Cattle

Robert Hogan, Jr., David Anderson and Ted Schroeder*

Grid prices, or value-based marketing, refers to pricing cattle on an individual animal basis. Prices differ according to the underlying value of the beef and by-products produced from each animal. Schroeder et al. have reported that pricing fed cattle on averages is detrimental to the industry because it does not send appropriate price signals to cattle feeders, stockers and, ultimately, cow-calf producers. However, incentives to sell cattle on averages and problems associated with identifying beef quality have inhibited the development of value-based pricing. Both cattle feeders and packers have been reluctant to change from a live animal pricing system to a carcass pricing system.

Opportunities to profit from better matching fed cattle prices to value have encouraged packers, alliances and producers to use carcass-based pricing. Now, there are several value-based fed cattle pricing systems, including formula pricing, price grids and alliances. Is there one "best" pricing method? How are live weight, dressed weight and grid or formula prices related? The purpose of this publication is to help producers decide which form of fed cattle pricing may be most profitable for them.

Is Carcass Merit Pricing For You?

Should you market your cattle on a carcass merit basis? If so, does it matter which pricing system you use or which packer or alliance you sell to? The answer to both questions is, ***"It depends."*** The most critical factors that influence the profitability of these decisions include: 1) the quality and dressing percent of the cattle you produce; 2) the Choice-Select market price spread; 3) production and feeding cost differences associated with targeting your cattle to a particular price grid or packer; and most important 4) your knowledge about the price/quality distribution of your cattle and your (or the feeder's) ability to sort your cattle to meet the criteria for a particular grid or formula. The following analyses focus on the price/cattle quality relationship, without considering production costs. This is not to imply that production costs associated with attaining a particular quality-related price incentive are not important. They are critical to profitability. However, production costs differ with producers and cattle types and are not explicitly evaluated here.

Cattle Pricing Methods

Fed cattle usually are priced in one of three ways: 1) live; 2) dressed weight or *"in the beef;"* or 3) carcass grade and yield or grid pricing.

Live Cattle Pricing

When fed cattle are priced on a live basis, price is generally negotiated between the packer and the feedlot based upon the expected

AgriLIFE EXTENSION
Texas A&M System

*Assistant Professor and Extension Economist–Management, and Professor and Extension Economist–Livestock and Food Marketing, The Texas A&M System; and Professor and Extension Economist, Kansas State University.

value of the cattle when processed (a 4 percent pencil shrink on the cattle from the feedlot to the packing plant is usually included). To establish a buy order, the packer starts with a base Choice carcass price and then adds or subtracts expected quality and yield grade premiums and discounts associated with quality traits the pen of cattle are expected to exhibit when processed. The adjusted carcass price is converted to a live animal price by multiplying it by the expected dressing percentage. This live price is adjusted with by-product and hide values and further adjusted for slaughter costs, transportation costs, and the packer's profit margin[1] to establish an estimated live animal bid price. If packers can purchase a large number of cattle from one location at one time, they may increase their bid price to reflect reduced transactions and procurement costs.

Pricing cattle on a live basis is appealing to some cattle feeders who want to maintain complete flexibility in cattle pricing until the transaction price is established. Live pricing may also be preferred if the producer does not know the characteristics of the cattle or expects the dressing percentage, quality grade or yield grade to be below average. However, because meat quality and carcass dressing percentage are difficult to predict accurately on live animals, premiums and discounts paid on a live basis generally do not reflect the true value of the final product. In other words, high-quality cattle are often undervalued and low-quality cattle often overvalued. This gives producers no incentive to invest in better genetics and produce a better product.

Dressed Weight Pricing

When cattle are marketed on a dressed-weight basis, the cattle seller assumes the risk of dressing percentage. Price is based upon the actual hot carcass weight. The dressed price offered is similar to the live price bid in that the buyer starts with a base Choice carcass price and adjusts it for expected quality and yield grade, weight premiums and discounts, by-products, slaughter costs (seller generally pays transportation on dressed cattle sales), and the packer's profit.

In principle, the dressed-weight price will be comparable to a live price adjusted for dressing percentage for the same pen of cattle. In practice, the dressed price (after transportation costs) may be higher or lower because there are no errors in estimating dressing percentage. Over time, across a large number of pens, the average dressed price should be greater than the average dressing percentage-adjusted live price, other things being equal.

Grid Pricing

Pricing cattle on a grade and yield or grid basis is essentially the same as pricing on a dressed-weight basis, except that in addition to dressing percentage, the seller assumes the risk of the quality and yield grade of each animal in the pen. Many beef packers offer cattle producers the opportunity to price cattle on a carcass grid basis. Most packer grids list a base price for a Choice, yield grade 3, 550- to 900-pound steer carcass. For example, a typical price premium and discount schedule offered by beef packers is shown in Table 1.

Table 1. Example grid, as presented by a packer ($/dressed cwt).

Choice YG3 550- to 900-lb	Base price
Prime-Choice Premium	6.00
CAB-Choice Premium	1.00
Choice-Select Discount	-9.00
Choice-Standard Discount	-18.00
Yield Grade I	2.00
Yield Grade II	1.00
Yield Grade IV	-15.00
Yield Grade V	-20.00
Light Carcasses (<550 lb)	-19.00
Heavy Carcasses (>900 lb)	-19.00
Dark Cutters	-25.00
Bullocks/Stags	-25.00

[1] It's important to note that the packer is not guaranteed a profit. The cattle market is a competitive market where packers still have to bid to get the cattle. That bidding sometimes is easier or harder. Packers do lose money, at times, when market conditions dictate that they pay more for the cattle than was profitable.

The assorted premiums and discounts are then simply copied into the grid as shown in Table 2.

Table 2. Example of grid premiums and discounts.

Quality grades	Yield grade 1	2	3	4	5
			($/cwt carcass)		
Prime			6.00		
CAB			1.00		
Choice	2.00	1.00	**Base**	-15.00	-20.00
Select			-9.00		
Standard			-18.00		
CARCASS WEIGHTS			OTHER		
550-900 lb		Base (105.00)	Dark Cutter, etc. Bullock/Stags		-25.00 -25.00
Less than 550 lb			-19.00		
More than 900 lb			-19.00		

The rest of the grid is now filled in typically by just adding premiums and discounts. For example, to get the premium for Prime-Yield Grade 1, add the $6.00 Prime premium and the $2.00 Yield Grade 1 premium to get $8.00. As another example, to compute the discount for Select-Yield Grade 5, add the $9.00 Select discount and the $20.00 Yield Grade 5 discount to get $-29.00. The entire grid is shown in Table 3.

Table 3. Example grid premiums and discounts.

Quality grades	Yield grade 1	2	3	4	5
			($/cwt carcass)		
Prime	8.00	7.00	6.00	-9.00	-14.00
CAB	3.00	2.00	1.00	N.A.	N.A.
Choice	2.00	1.00	**Base**	-15.00	-20.00
Select	-7.00	-8.00	-9.00	-24.00	-29.00
Standard	-16.00	-17.00	-18.00	-33.00	-38.00
CARCASS WEIGHTS			OTHER		
550-900 lb		Base (105.00)	Dark Cutter, etc. Bullock/Stags		-25.00 -25.00
Less than 550 lb		-19.00			
More than 900 lb		-19.00			

The price received for each carcass is the base price plus the particular premiums and discounts. For example, if the Choice, yield grade 3, 550- to 900-pound carcass price is $105.00/cwt, a Select, yield grade 4, 700-pound carcass would receive a price of $81/cwt ($105.00/cwt - $24.00/cwt, the Select-yield grade 4 discount).

The USDA reports a weekly survey summarizing selected beef packer grid premium and discount schedules. This report is on the internet at *http://www.ams.usda.gov/mnreports/lm_ct155.txt* (National Weekly Direct Slaughter Cattle – Premiums and Discounts). The LM CT155 report is useful for understanding average grid price premiums and discounts being offered by packers, and for raising awareness of the range of discounts and premiums.

Table 3 illustrates how quickly net price can decrease with yield grades 4 and 5 and with quality grades below Choice (Select and Standard). In this example, the discount from Choice to Select is a relatively severe $9/cwt. The discounts between Choice and Select quality grades typically range from $1.00/cwt to $12.00/cwt, depending on the supplies of Choice versus Select carcasses, the demand for each, and seasonal purchasing patterns and habits. (The weekly Choice-Select spread has been as large as $23.08 and as small as $0.68 over the past 5 years.) There are usually large discounts for Standard grade carcasses, dark cutter carcasses, and carcasses lighter than 550 pounds or heavier than 900 to 950 pounds. Some grids also offer premiums and discounts for hide quality.

For many packers' grids, price premiums and discounts are additive. That is, the base price is adjusted in an additive manner for the associated characteristics of the carcass (as in our example above). For some packers, not all premiums and discounts in their price grid are additive. For example, some packers quote the same price for all Standard grade cattle regardless of yield grade. The USDA grid summary report assumes additive discounts and premiums. In addition, this report is not volume-weighted and includes only packer-stated grids, not actual purchases. As a result, the report does not represent market average grid prices. This is important to understand when interpreting the USDA price report and comparing it with any particular packers' grids you may be considering.

Summary of Pricing Methods

Table 4 summarizes and compares issues associated with typical fed cattle pricing arrangements. Differences in the various methods are important because they use different kinds of information and cause prices to differ even for the same pen of cattle. The key is that as a producer moves from live cattle pricing to dressed-weight to grid pricing, it is increasingly important to understand the type of cattle being marketed and the pricing system being used, and to assess probable net price received.

Over time, average cattle or cattle with little background information may sell better with live pricing. A somewhat better class of cattle may sell better with dressed pricing. First rate classes of cattle whose characteristics are known by the producer may sell better by pricing on the grid.

Table 4. Assessing ways to sell fed cattle.

	Cattle pricing method		
Producer pricing attribute	**Live**	**Dressed**	**Grid**
Pricing level	pen level	pen level	animal level
Paid for quality	No	No	Yes
Paid for yield	No	No	Yes
Paid for dressing %	No	Yes	Yes
Who pays trucking?	Buyer	Seller	Seller

Formulas: Importance of Base Price

When fed cattle are priced on formula, an important consideration, in addition to the premium/discount structure, is the base price. In interviews with packers and cattle feeders, Schroeder et al. discovered several different types of base prices being used. One was the average price of cattle purchased by the plant where the cattle were to be slaughtered. The average price of cattle was usually for the week prior to, or the week of, slaughter. Other base prices were specific market reports such as highest reported price for a specific market for the week prior to, or week of, slaughter. One base price was tied to live cattle futures prices. Some base prices were negotiated. Some base prices were on a carcass weight basis, whereas others were on a live weight basis based upon yields of the cattle slaughtered.

Many packers have established base prices using plant average quality grades and dressing percentages of cattle slaughtered during the week. Before agreeing to deliver cattle to a particular packer on formula or grid, the producer should understand in detail how the base price is calculated and obtain some base price quotes over time from several packers. The producer does not want any surprises at this point.

Importance of Grid Premium/Discounts

When selling cattle on price grids, in addition to considering base prices, cattle producers should carefully evaluate the price premium/discount structures of various packers' grids and determine which grid is most advantageous to them. Different grids may offer significantly different prices for the same quality of cattle. In addition, packers value traits differently. For example, one packer might not discount select cattle and another packer might not discount Yield Grade 4 as much as another packer.

Pens of cattle that are fairly uniform generally bring similar prices with different packer grids. However, pens with even small percentages of higher or lower grade carcasses, heavier or lighter animals, or more than the average number of "out" cattle (dark cutters, stags, bullocks, etc.) have much more variable prices. For this reason, it is important for cattle producers to know their cattle, sort their cattle carefully for uniformity, and target them for specific packers.

Grid Price Determinants over Time

In addition to variability in prices across grids, it is important that producers understand determinants of price differences over time. Small changes in dressing percentage alter the relative advantages of selling on either a live or dressed basis. For example, with a $65/cwt live steer price and a $102.50/cwt dressed carcass price, cattle dressing higher than 63.4 percent will receive a higher price per head if sold dressed than if sold live, and cattle with a lower dressing percentage will receive a higher price on a live basis. With

these prices, a 1200-pound live steer will gain $6/head in value for each 0.5 percent increase in dressing percentage.

Over time, one of the most important determinants of price grid premiums and discounts is the Choice-Select carcass price spread. The greater the Choice-Select spread, the greater the price discount for lower quality cattle. The Choice-Select price spread varies over time as the cattle supply and demand for specific quality grades change.

There is a seasonal pattern to the Choice-Select spread. It typically is the widest in May-June and narrowest in February and again in August. The Choice-Select spread widens and narrows based on seasonal patterns in relative supplies of Choice and Select cattle. Seasonal demand patterns for different cuts and qualities also affect the spread.

Yield grade premiums and discounts have remained relatively stable over time for all packer grids. Therefore, this pricing factor is expected to remain more predictable than the Choice-Select price spread.

References

Schroeder, T.C., C.E. Ward, J. Mintert and D.S. Peel. "Beef Industry Price Discovery: A Look Ahead." Research Institute on Livestock Pricing, Research Bulletin 1-98, March 1998.

Partial funding support has been provided by the Texas Corn Producers, Texas Farm Bureau, and Cotton Inc.–Texas State Support Committee.

Texas A&M AgriLife Extension Service

AgriLifeExtension.tamu.edu

More Extension publications can be found at *AgriLifeBookstore.org*

Produced by Texas A&M AgriLife Communications

TEXAS A&M AGRILIFE EXTENSION

L-5063
8-98

Using a Slide in Beef Cattle Marketing

Rick Machen and Ronald Gill*

Selling cattle well in advance of their delivery date, or forward contracting, is a marketing option available to beef producers. Such a transaction requires the seller to estimate the weight of the cattle prior to delivery. Weights estimated at the time of sale and those recorded upon delivery often differ. Therefore, to ensure fair market value upon delivery, an adjustment of the sale price is often necessary.

The "slide" is a predetermined adjustment in the sale price of cattle and is included in the contract (forward contracting) or in the description of the cattle (video or Internet marketing) being offered for sale. It is based on the difference between the weight estimated prior to consignment or contracting and the actual pay weight. Pay weight is the actual live weight of the cattle upon delivery minus a "pencil" shrink. This pencil shrink is negotiable and normally ranges from 2 to 4 percent.

Three slides are used: up, down or both ways. The seller decides the magnitude and direction. Liveweight and the magnitude of the slide are inversely related; as liveweights increase, the slide will usually decrease. Calves (less than 600 pounds) often are sold with a two-way slide. Sliding cattle both ways is particularly useful when environmental conditions such as rainfall and forage availability can drastically affect weaning weights. The two-way slide protects the buyer if the cattle deliver heavier than expected, and ensures the seller will receive a fair market price if the cattle are lighter than expected. The weight of yearling cattle is more predictable; therefore, yearlings are usually offered with an up slide only.

*Extension Livestock Specialists, The Texas A&M University System.

Up Slide

An up slide is exercised when the weight of the cattle upon delivery is heavier than expected. Selling with an up slide locks in a maximum price (dollars per hundredweight or $/cwt) that will be paid for the cattle.

Example A

In a mid-July sale, 600-pound calves consigned for November delivery sell for $80/cwt. The slide is $5/cwt. Calves will be weighed at the ranch with a 2 percent shrink. Upon delivery in November, the cattle average 630 pounds per head.

slide = $5/cwt
slide weight = 600 lbs.
shrink = 2%
sale price = $80/cwt
delivered weight = 630 lbs.

The slide will be exercised because the cattle were heavier than expected at delivery.

shrink = 630 lbs. x 2% = 12.6 or 13 lbs.
pay weight = 630 lbs. – 13 lbs. = 617 lbs.
weight subject to slide = 617 – 600 = 17 lbs.

17 lbs. = 0.17 cwt
0.17 cwt x $5/cwt = $0.85/cwt
$80/cwt – $0.85/cwt = $79.15/cwt

The extra 17 pounds (expressed as cwt) is multiplied by the slide, yielding $0.85/cwt. The $0.85/cwt is then subtracted from the sale price of $80/cwt to yield the actual price of $79.15 per hundredweight. The actual price paid for the cattle under this agreement is $488.36 per head.

6.17 cwt (617 lbs.) x $79.15/cwt = $488.36

Down Slide

A down slide is exercised when the delivered weight of the cattle is less than expected at the time of sale (contract). Selling with a down slide locks in the minimum price ($/cwt) to be paid for the cattle.

Example B

In a mid-June sale, 500-pound calves consigned for October delivery sell at $90/cwt. The slide is $10/cwt. Calves will be weighed at the ranch with a 3 percent shrink. Upon delivery in October, the cattle average 480 pounds per head.

slide = $10/cwt
slide weight = 500 lbs.
shrink = 3 %
sale price = $90/cwt
delivered weight = 480 lbs.

The down slide will be exercised because the cattle weighed less than expected upon delivery.

pay weight = 480 lbs. – 3% = 466 lbs.
500 lbs. – 466 lbs. = 34 lbs.

This 34-pound (.34 cwt) difference is multiplied by the slide ($10/cwt) to get $3.40/cwt, which is added to the sale price of $90/cwt to obtain the actual price of $93.40 per hundredweight.

34 lbs. = 0.34 cwt
0.34 cwt x $10/cwt = $3.40/cwt
$90/cwt + $3.40/cwt = $93.40/cwt
$93.40/cwt x 4.66 cwt (466 lbs.) = $435.24

Therefore, the actual price received for the cattle is $435.24 per head.

A worksheet for evaluating the use of a down slide (line A is greater than line E) follows.

	Contract (Expected) Values	
A.	*Expected* weight	_____lbs.
B.	Price	_____$/cwt
C.	Pencil shrink	_____%
D.	Slide	_____$/cwt
	Expected value [(A/100) – C] x B	_____$/hd
	Actual Values	
E.	Scale weight (avg.)	_____lbs.
F.	Pay weight (E/100) – C	_____cwt
G.	Weight subject to slide (A/100) – F	_____cwt
H.	Slide adjustment G x D	_____$/cwt
J.	Adjusted sale price B + H	_____$/cwt
K.	Price received F x J	_____$/head

To evaluate an up slide (line A is less than line E), calculations in lines G and J change as shown.

G.	Weight subject to slide F – (A/100)	_____cwt
J.	Adjusted sale price B – H	_____$/cwt

Texas A&M AgriLife Extension Service

AgriLifeExtension.tamu.edu

More Extension publications can be found at *AgriLifeBookstore.org*

Produced by Texas A&M AgriLife Communications

TEXAS A&M AGRILIFE EXTENSION

E-496
RM2-1.0
01-09

Risk Management

Introduction To Futures Markets

James Mintert and Mark Welch*

Futures trading has a long history, both in the U.S. and around the world. Futures trading on a formal futures exchange in the U.S. originated with the formation of the Chicago Board of Trade (CBOT) in the middle of the 19th Century. Grain dealers in Illinois were having trouble financing their grain inventories. The risk of grain prices falling after harvest made lenders reluctant to extend grain dealers credit to purchase grain for subsequent sale in Chicago. To reduce their risk exposure, grain dealers began selling "To Arrive" contracts, which specified the future date (usually the month) a specified quantity of grain would be delivered to a particular location at a price identified in the contract. Fixing the price in advance of delivery reduced the grain dealer's risk and made it easier to obtain credit to finance grain purchases from farmers. The "To Arrive" contracts were a forerunner of the futures contracts traded today. Although dealers found it advantageous to trade what essentially were forward cash contracts in various commodities, they soon found these forward cash contract markets inadequate and formed futures exchanges.

The first U.S. futures exchange was the Chicago Board of Trade (CBOT), formed in 1848. Other U.S. exchanges also began in the last half of the 1800s. For example, the Kansas City Board of Trade (KCBT) traces its roots to January 1876 when a precursor to today's hard red wheat futures contract was first traded. Similarly, a forerunner of the Chicago Mercantile Exchange (CME) was formed in 1874 when the Chicago Product Exchange was organized to trade butter. In each case the exchanges were formed because commercial dealers in corn, wheat and butter needed a way to reduce some of their price risk, which hampered the day-to-day management of their businesses. Sellers wanted to rid themselves of the price risk associated with owning inventories of grain or butter and buyers wanted to establish prices for these products in advance of delivery. In recent years futures contracts have proliferated, particularly in the financial arena, as businesses become more aware of the price risks they face and seek ways to reduce them.

What Is A Futures Contract?

A futures contract is a binding agreement between a seller and a buyer to make (seller) and to take (buyer) delivery of the underlying commodity (or financial instrument) at a specified future date with agreed upon payment terms. Most futures contracts don't actually result in delivery of the underlying commodity. Instead, most traders find it advantageous to settle their futures market obligation by selling the contract (in the case of a contract that was purchased initially) or by buying it back (in the case of a contract that was sold initially). The trader then completes the actual cash transaction in his or her local cash market.

Futures contracts are standardized with respect to the delivery month; the commodity's quantity, quality, and delivery location; and the

RISK MANAGEMENT EDUCATION

*Professor and Extension Agricultural Economist, Kansas State University Agricultural Experiment Station and Cooperative Extension Service, and Assistant Professor and Extension Economist–Grain Marketing, The Texas A&M System.

payment terms. The fact that the terms of futures contracts are standardized is important because it enables traders to focus their attention on one variable, price. Standardization also makes it possible for traders anywhere in the world to trade in these markets and know exactly what they are trading. This is in sharp contrast to the cash forward contract market, in which changes in specifications from one contract to another might cause price changes from one transaction to another. One reason futures markets are considered a good source of commodity price information is because price changes are attributable to changes in the commodity's price level, not changes in contract terms.

Unlike the forward cash contract market, futures exchanges provide:

- Rules of conduct that traders must follow or risk expulsion
- An organized market place with established trading hours by which traders must abide
- Standardized trading through rigid contract specifications, which ensure that the commodity being traded in every contract is virtually identical
- A focal point for the collection and dissemination of information about the commodity's supply and demand, which helps ensure all traders have equal access to information
- A mechanism for settling disputes among traders without resorting to the costly and often slow U.S. court system
- Guaranteed settlement of contractual and financial obligations via the exchange clearinghouse

The Purpose of Futures Markets

Futures markets serve two primary purposes. The first is price discovery. Futures markets provide a central market place where buyers and sellers from all over the world can interact to determine prices. The second purpose is to transfer price risk. Futures give buyers and sellers of commodities the opportunity to establish prices for future delivery. This price risk transfer process is called hedging.

Changes in a Futures Contract's Value

A futures contract's value is simply the number of units (bushels, hundredweight, etc.) in each contract times the current price. Each contract specifies the volume of grain or livestock it covers. Both Chicago and Kansas City Board of Trade grain and oilseed futures contracts cover 5,000 bushels. The CME's live cattle futures contract covers 40,000 pounds (400 hundredweight) of live weight steers. The lean hogs futures contract covers 40,000 pounds (400 hundredweight) of carcass weight pork and the feeder cattle futures contract covers 50,000 pounds (500 hundredweight) of feeder steers. To determine both contract value and changes in contract value, examine the July KCBT wheat futures contract on a day when the settlement price is $6.00 per bushel. The total contract value would simply be 5,000 bushels times $6.00 or $30,000. If the July KCBT wheat futures price changes to $6.10 per bushel the next day, the new contract value is 5,000 bushels times $6.10 or $30,500. The change in contract value is $30,500 minus $30,000, or $500. Alternatively, you can compute the change in contract value by simply multiplying the price change per unit ($6.10-$6.00=$0.10/bushel) times the number of units in the contract ($0.10/bushel x 5,000 bushels= $500).

The effect of a change in contract value depends on whether you previously sold or purchased a futures contract. A decrease in contract value (a price decline) is a loss to anyone who previously purchased a futures contract, but a gain for a trader who previously sold a futures contract. Conversely, an increase in contract value (a price increase) is a gain to anyone who previously purchased a futures contract (i.e., is long), but is a loss for a trader who previously sold a futures contract (i.e., is short). One trader's loss is another trader's gain. For example, in the previous wheat futures example, a trader who purchased July KCBT wheat futures at $6.00/bushel saw the value of his futures market account increase by $500 when the price rose to $6.10; a trader who sold a futures contract at $6.00/bushel saw the value of his futures market

account decline by $500. The $500 gain earned by the futures contract buyer came from the futures contract seller's $500 loss via the exchange clearinghouse, as outlined in Figure 1.

Futures contract performance is guaranteed by the exchange through an institution known as the exchange clearinghouse, which tracks the value of each trader's position and ensures that sufficient funds are available to cover each trader's obligations. The exchange clearinghouse requires that traders (via the futures commission merchant or broker) deposit money before a trade to ensure contract performance. This deposit is usually referred to as the initial margin deposit. Each trader's margin money is maintained in a separate margin account, which is adjusted daily to reflect the gain or loss in contract value that occurred that day. This process is sometimes referred to as "Marking-to-Market," because the account is adjusted to reflect its current market value based on that day's closing or settlement price. Although the margin requirements are small relative to the total value of the contract (typically less than 5 percent of contract value), traders of futures contracts are relieved of the responsibility of worrying that the trader on the other side of the contract will default on his or her financial obligations by the mark-to-market margin system and by a series of checks and balances put in place by the exchange to ensure that sufficient funds are available to cover each account's risk exposure.

Figure 1. Marking-to-Market Buyer and Seller Accounts at Exchange Clearinghouse.

Buyer (Long)

Date	Action	Price
Day 1	Buy at	$6.00/bu
Day 2	No action (but price increases)	$6.10/bu
		$0.10/bu gain x 5,000 bu
		$500 gain from day 1

Seller (Short)

Date	Action	Price
Day 1	Sell at	$6.00/bu
Day 2	No action (but price increases)	$6.10/bu
		$0.10/bu loss x 5,000 bu
		$500 loss from day 1

Futures Trading Terminology

To trade futures contracts you must become familiar with the terminology used in the trade. Here are some terms and definitions.

Long	A buyer of a futures contract. Someone who buys a futures contract is often referred to as being long that particular contract.
Short	A seller of a futures contract. Someone who sells a futures contract is often referred to as being short that particular contract.
Bull	A person who expects a commodity's price to increase. If you are bullish about wheat prices you expect them to increase.
Bear	A person who expects a commodity's price to decline. If you are bearish about wheat prices you expect them to decline.
Market order	An order to buy or sell a futures contract at the best available price. A market order is executed by the broker immediately. "Sell one July KCBT wheat, at the market" is an example of a market order.
Limit order	An order to buy or sell a futures contract at a specific price, or at a price that is more favorable than the price specified. For example, "Buy one March KCBT wheat at $6.30 limit" means buy one March KCBT wheat contract at $6.30 or less. In this example, the order will not be executed at a price higher than $6.30.
Stop order	An order which becomes a market order if the market reaches a specified price. A stop order to buy a futures contract would be placed with the stop price set above the current futures price. Conversely, a stop order to sell a futures contract would be placed with the stop price set below the current futures price.

Using Futures Contracts in a Farm Marketing Program

There are a number of ways futures contracts can be used in a farm marketing program. Futures contracts can be useful when marketing grain or livestock because they can be a temporary substitute for an intended transaction in the cash market that will occur at a later date. This is a working definition of hedging. For example, if you plan on selling wheat for cash at harvest, but would like to lock in the futures price ahead of harvest, you could sell a KCBT July wheat futures contract as a temporary substitute for the cash grain you plan to sell in the future. When you actually make the cash grain sale at harvest, you will no longer need the "temporary substitute," which was your sale of the wheat futures contract. Thus, as soon as you sell the cash wheat you would exit your "temporary substitute contract" by buying a KCBT July wheat futures contract. Doing so means you no longer have an open position on the futures exchange. Your actual net sale price for the wheat would be the amount you received for the cash wheat at the elevator, plus any gain or minus any loss on the futures transaction.

Futures contract prices also can be used as a source of price forecasts. A futures contract price represents today's opinion of what a commodity's value will be when the futures contract expires. If a history of the difference between a commodity's futures contract and cash prices, for a particular grade and specific location of interest (known as the basis) is available, it can be used to estimate a futures market-based cash price forecast. For example, assume that on March 15 the KCBT July wheat futures contract is trading at $6.00 per bushel, and your local cash market price at harvest is generally $0.40 per bushel below the KCBT July wheat futures contract price (i.e., a basis of negative $0.40 per bushel). In this case, a futures-based local cash price forecast at harvest time would be $5.60/bushel. This forecast can be compared with price forecasts from other sources such as university Extension economists, market advisory services, and the U.S. Department of Agriculture when preparing budgets and making marketing decisions.

For more details on basis and how hedging works, see the following publications in this series: *Selling Hedge with Futures* (E-497) and *Buying Hedge with Futures* (E-498).

Partial funding support has been provided by the Texas Corn Producers, Texas Farm Bureau, and Cotton Inc.–Texas State Support Committee.

Texas A&M AgriLife Extension Service

AgriLifeExtension.tamu.edu

More Extension publications can be found at *AgriLifeBookstore.org*

Produced by Texas A&M AgriLife Communications

Commodity Options as Price Insurance for Cattlemen

R. Curt Lacy[1], Andrew P. Griffith[2] and John C. McKissick[3]
Adapted from "Managing For Today's Cattle Market and Beyond"

Introduction

Most cattlemen are familiar with insurance. Examples include insuring buildings against fire, equipment against accidents and lives against death or injury. Purchasing insurance trades the possibility of a large but uncertain loss for a small but certain cost: the insurance premium.

One of the greatest risks cattle producers face is price risk. Price changes can come in the form of declining cattle prices for sellers, increasing cattle prices for buyers or increasing feed prices for feed users.

Because of this risk, producers might want to "insure" feeder cattle, fed cattle or feed against unfavorable price movements, while still being able to take advantage of favorable price movements. Cattlemen have this opportunity by using the commodity options market[4].

What is the Commodity Options Market?

The commodity options market is a market in which producers may purchase the opportunity to sell or buy a commodity futures contract at a specified price. Purchasers in options markets have the "opportunity" or "right" but not the "obligation" to exercise their agreement. Therefore, the markets are appropriately named "options markets" since they deal in an option, not an obligation.

Just as a cattleman may purchase the right from an insurance firm to collect on a policy if a building burns, he can purchase the right to sell commodities at a specific price in case prices drop below the specified price. A separate options market also exists to allow the purchase of commodities at a specified price in case prices increase.

For instance, if a cattleman wanted to buy the right to sell feeder cattle for $175/cwt., the feeder cattle options market might provide the opportunity. By paying the market-determined premium, the cattleman could then collect on the option if prices fell below $175/cwt. when the cattle were actually sold. If prices are higher than $175/cwt., the cattle are sold for the higher price, and the cost of the premium is absorbed.

While this is a simplified version of the actual way in which producers might operate in the options market, the reality behind this concept is not much different. Just as with other types of insurance, by paying a premium, insurance can be purchased against price declines or increases. Collecting on the insurance would be an option if the price moves in an unfavorable direction.

The "Ins" and "Outs" of Options: Puts and Calls

There are two types of commodity options: a **put** option and a **call** option. The **put** option gives the holder (usually a commodity seller) the right -- but not the obligation -- to sell the underlying commodity contract to the option writer at a specified price on or before the commodity expiration date. The **call** option gives the holder (usually a commodity purchaser) the right -- but not the obligation -- to buy the underlying commodity contract from the option writer (seller) at a specified price on or before the option expiration date.

The put option and the call option are two different and distinct contracts. A call option is not the opposite of a put option. Distinguish between the two types of options by remembering that the holder of the put option can choose to "put-it-to-them"; that is, sell the product, while the holder of the call option can "call-upon-'em" to provide the product.

---

[1] *Associate Professor and Extension Economist-Livestock, University of Georgia*
[2] *Assistant Professor and Extension Economist-Livestock, University of Tennessee*
[3] *Professor Emeritus and Distinguished Marketing Professor, University of Georgia*
[4] *Cattle producers can purchase Livestock Risk Protection (LRP) through crop insurance agents. A good reference on LRP for feeder cattle producers is "Livestock Risk Protection Insurance (LRP): How It Works for Feeder Cattle," publication number W 312, available through the University of Tennessee at http://economics.ag.utk.edu/riskmgmt.html.*

Buyers and Sellers

In the option market, as in every other market, transactions require both buyers and sellers. The buyer of an option is referred to as an **option holder**. Holders of options may be either seekers of price insurance or speculators.

The seller of an option is sometimes referred to as an **option writer**. The seller may also be either a speculator or someone who desires partial price protection. The choice to buy (hold) or sell (write) an option depends primarily upon one's objectives.

Buyers and sellers of cattle options "meet" on the Chicago Mercantile Exchange. Rather than physically meeting, all transactions are carried out through brokerage firms that act as the buyer's and seller's representative at the exchange. For this service, the brokerage firm charges a commission. The exchange has no part in the transaction other than to insure its financial integrity. In effect, the exchange offers a place for option buyers and sellers to get together under organized rules of trade.

Strike Price

The "specified price" in the option is referred to as the **exercise price** or **strike price**. This is the price at which the underlying commodity contract can be bought or sold and is fixed for any given option, put or call. There could be several options with different strike prices traded during any period of time. If the price of the underlying commodity changes over time, then additional strike prices may be listed for trade.

Underlying Commodity

The "underlying commodity" for the commodity option is not the commodity itself but rather a futures contract for that commodity. For example, an October feeder cattle option is an option to obtain an October feeder cattle futures contract. In this sense, options are the right to buy or sell a futures contract and not the physical commodity.

A more extensive explanation of futures contracts is available in UGA Extension Bulletin 1404, "Using Futures Markets to Manage Price Risk in Feeder Cattle Operations."

Because options have futures contracts as their underlying commodity, each option contract represents the same quantity as the underlying futures contract. That is, most grain options represent 5,000 bushels, while the live cattle option represents 40,000 pounds of fed cattle. The feeder cattle option represents 50,000 pounds of feeder cattle. Options are traded for each of the futures contract months in each of these commodities. A table showing the option contract specifications for feeder cattle and live cattle is shown at the end of this bulletin (Table 1).

Expiration

Futures contracts have a definite predetermined maturity date during the delivery month. Likewise, options have a date at which they mature and expire. The specific date of expiration for the feeder cattle option contract is the same as its underlying futures contract – the last Thursday of each month, with the exception of November and any month when a holiday falls on the last Thursday or any of the four weekdays prior to that Thursday.

Because fed cattle futures contracts can be settled by physically delivering the cattle, the fed cattle option contract expires the first Friday of the futures contract month, prior to the futures contract expiration around the 20th of the month. For example, a $175/cwt. October fed cattle put option is an opportunity to sell one October live cattle futures contract at $175/cwt. The holder can execute this option on any business day until the first Friday in October.

Option Premiums

The option writer is willing to incur an obligation in return for some compensation. The compensation is called the **option premium**. Using the insurance analogy, a premium is paid on an insurance policy to gain the coverage it provides. Similarly, an option premium is paid to gain the rights granted in the option. The option premium is determined either by public outcry and acceptance in an exchange trading pit or electronically through a "virtual" trading pit. Like all commodity prices, option premiums can be expected to change not only daily but often by the minute.

While the interaction of supply and demand for options will ultimately determine the option premium, two major factors will interact to affect the level of premiums. The first factor is the difference between the strike price of the option and the futures price of the underlying commodity.

This differential in prices may give the option "**intrinsic**" or **exercise value**. For example, consider an October feeder cattle put option with a strike price of $175/cwt. and the underlying October feeder cattle futures with a current price of $172/cwt. The option could be

sold for at least $3/cwt. since anyone would be willing to purchase the right to sell at $175 when the market is currently $172. This $3 is said to be the intrinsic value. As long as the market price on the option's underlying futures contract is below the strike price on a put option, the option has intrinsic value. The converse of the price relationship is true for a call option. A call option has intrinsic value when the futures market price is above the strike price.

Any option that has intrinsic value is said to be "in-the-money." An "in-the-money" option has value to others because the futures market price is below the put or above the call strike price. An option is said to be "out-of-the-money" and has no intrinsic value if the current futures market price is above the put or below the call strike price. When the futures market price of the commodity and the strike price are equal, the option is said to be "at-the-money," and has no intrinsic value.

A second factor influencing the option premium is the length of time to expiration of the option. Assuming all else is held constant, option premiums usually decline in value as the time to expiration decreases. This phenomenon reflects the time value of an option. For example, in August the time premium on a $175 September feeder cattle option will be less than the premium on a $175 November option. The option with a longer time to expiration has a greater probability of moving "in-the-money" than the option with less time. Therefore, it is worth more on that factor alone. The longer the time period, the greater the chance that events will occur that could cause substantial movement in futures prices and change the value of the option. As a result, the option writer requires a greater premium to assume the risk of writing a longer-term option.

"Out-of-the-money" options have a value that reflects time value. "In-the-money" options possess both time value and intrinsic value. The total cost of a premium minus the intrinsic value yields the time value of an option (Time Value = Premium – Intrinsic Value).

Offsetting an Option

The method by which most holders of "in-the-money" options realize accrued profit is by resale of the option. This is referred to as "**offsetting**" an option position and completing a round turn (the buy and sell or the sell and buy of an option). Options can be offset anytime between their purchase and expiration date if the holder so desires. Most option buyers will offset their position rather than exercise the option to avoid losing any remaining time premium and (or) assuming a futures market position and its resultant decisions, margin deposits and commissions. In most situations, the option can be resold to another trader at a premium at least equivalent to the intrinsic value that results from an "in-the-money" price relationship.

Another method by which the holder of an option could realize accrued profits is by "**exercising**" the option. Options are only exercised at the direction of the owner or if there is intrinsic value at expiration. The opportunity to exercise the option means the option buyer can always get the intrinsic value of the option premium even if there is little or no trading in the option being held. It also provides for a means of continuing price protection after the option expires.

If the decision is made to exercise, the following procedures are followed. For a put, the holder is assigned a short (sell) position in the futures market equal to the strike price. At the same time, the option writer is obligated to take a long (buy) futures position at the same price. Both positions are then adjusted to reflect the current settlement price. It is rational to exercise a put option only when the futures market price is below the strike price, so the holder's futures position will show a profit. The futures position of the writer will show an equivalent loss. At this point the option contract has been fulfilled and both parties are free to trade their futures contracts as they see fit.

Evaluating and Using Options Markets

Now that the mechanics of options trading have been explored, it is time to consider two critical questions: 1) What do varying strike prices mean in terms of price insurance? and 2) How does a producer actually obtain this insurance?

There are three steps to consider in evaluating option prices.

1. Select the appropriate option contract month. To do this, select the option whose underlying futures will expire closest to, but not before, the time the physical commodity will be sold or purchased.

For example, if a group of feeder calves were to be sold in early October, the October option would be appropriate.

2. Select the appropriate type of option. To insure products for sale at a later time against price declines, the producer would be interested in buying a put (the right to sell). If the producer's motive is to insure future commodity purchases against cost increases (for instance, corn needed to feed cattle), then purchasing a call would be an appropriate strategy.

   To continue the example: If the cattleman wishes to insure the feeders he will be selling in early October, then he will be interested in purchasing an October put option.

3. Calculate the minimum cash selling price being offered by the put option selected. For a call option, the maximum purchase price would need to be calculated. These calculations can be accomplished in five steps:

   1. Select a strike price within the option month. For instance, a $175/cwt. October feeder cattle put.
   2. Subtract the premium from the strike price for a put or add the premium for a call. For example, if a $175 October put costs $2.75/cwt., the result is $175 - $2.75 = $172.25/cwt.
   3. Subtract (for a put) or add (for a call) the "opportunity cost" of paying the premium for the period it will be outstanding. For example, if the option premium of $2.75/cwt. is paid in June and the option is expected to be liquidated by an offsetting resale in early October, an interest cost for the three-month period needs to be added. If borrowed funds are used and the interest rate is 9 percent, then the interest (opportunity) cost would be .75 percent per month, or 2.25 percent for three months. The interest cost associated with a $2.75/cwt. put option premium would be $0.06/cwt. This leaves a net price of $172.25 - $0.06 = $172.19/cwt.
   4. Subtract (for a put) or add (for a call) the commission fee for both buying and offsetting the option. Assume the brokerage firm charges $75 per round turn for handling each option contract. The commission fee would be $0.15/cwt. ($75 for 50,000 lbs., $75/500 cwt.). The net price is now $172.19 - $0.15 = $172.04/cwt.

   5. One final adjustment must be made to these prices. The option strike price must be localized to reflect the difference between prices in the local markets where the cattle will be sold or grains purchased, and the futures market price. This difference is called **basis** (Basis = Local Cash Price – Futures Price). The basis differs for cattle at different weights, sex, location and time of year across the country. See UGA Extension Bulletin 1406, "Understanding and Using Cattle Basis in Managing Price Risk" for some of the factors that affect cattle basis. Many state Extension offices have historical basis estimates for cattle and inputs that may be helpful in determining the appropriate basis.

Basis estimation is a critical component in estimating the expected net purchase or sale price. Interested readers should also consult UGA Extension Bulletin 1406, "Understanding and Using Cattle Basis in Managing Price Risk" to help them better understand the various factors that can affect basis.

By adjusting the option price for basis, a minimum selling price can be obtained for a put or a maximum purchase price obtained for a call. For the example, if in early October, 600 lb. feeder steers normally bring $10/cwt. less than the feeder cattle futures market, then the likely minimum local cash price becomes $172.04-$10 = $162.04/cwt. In the end, the only thing that will change this price is the fluctuation in the basis.

More or less price insurance can be purchased by buying options with different strike prices. To determine the minimum selling price suggested by each strike price, repeat steps one through five for the various strike prices and their associated premiums.

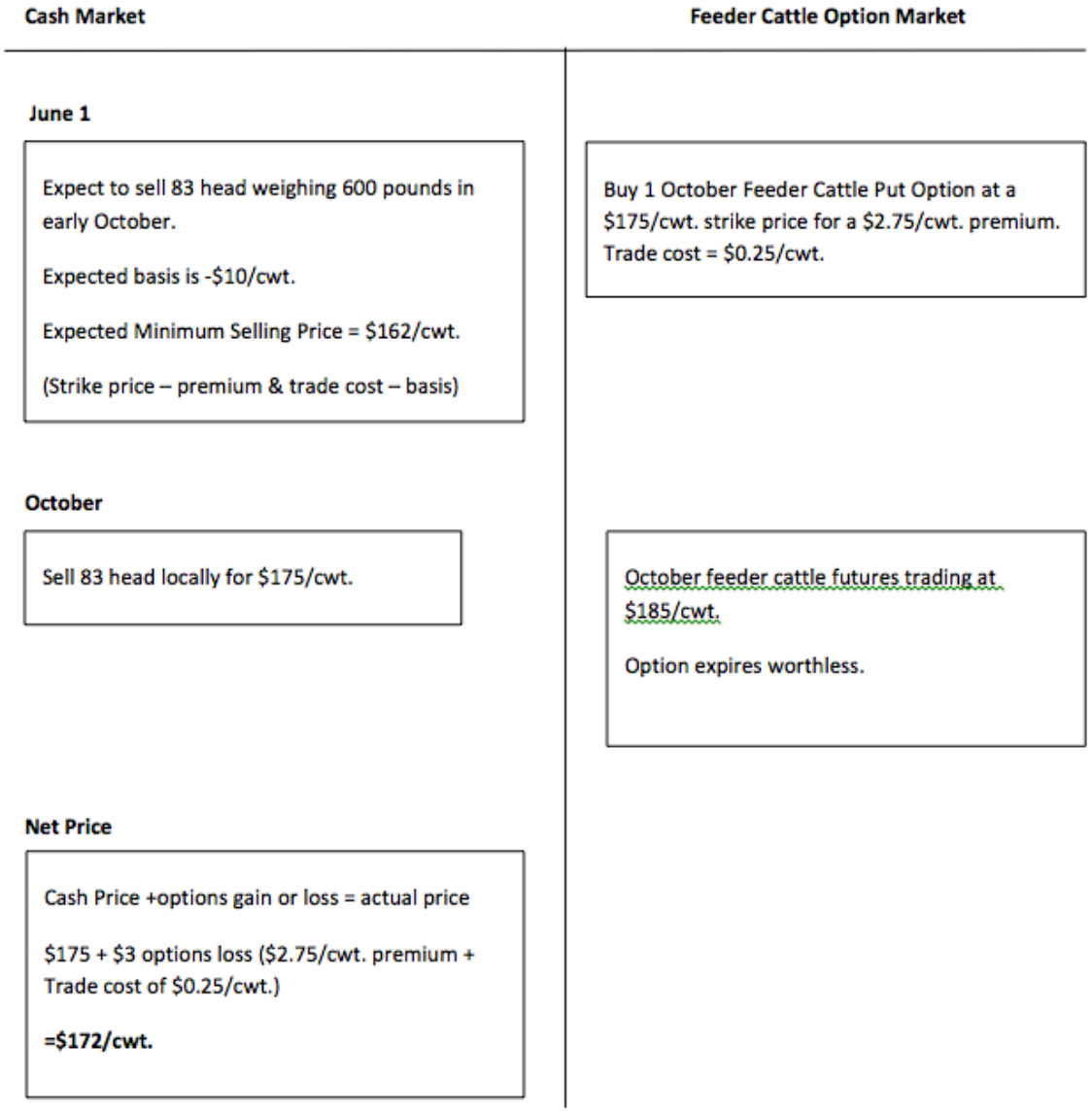
Options Arithmetic: Two Examples

Once the relevant options prices have been evaluated, the next question is, how would the producer go about obtaining a certain level of price insurance? Two examples, one using a put to establish a price floor (an expected minimum selling price) and one using a call to establish a price ceiling (an expected maximum purchase price), will help illustrate the total process.

Put Option Example

In the following put option example (Figures 1 and 2), we discuss a cattleman who will be selling a load of feeder cattle in early October. In our example, he checks the options quotes in June and finds he could purchase an October feeder cattle put option to sell at $175/cwt. at a premium of $2.75/cwt. To further localize this strike price, he subtracts $10/cwt. basis since he normally sells 600 lb. steer calves for a somewhat lower local cash price in October than the October futures price. Commission ($75 per contract) and interest on the premium cost will be about $0.25/cwt., so the $175 put would provide an expected minimum selling price of $175 - $10 - $2.75 - $0.25, or $162/cwt. By comparing this with his other pricing alternatives and his production cost, he decides that purchasing this put would be an appropriate strategy for the 83 steers he plans to sell in October. He advises his broker that he wants to purchase one "$175 October feeder cattle put at $2.75." He then forwards a check for $1,450 (500 cwt. X $2.75/cwt. plus $75 brokerage fee) to his broker.

Figure 1. Put Option Example. Feeder cattle pricing example where the option expires as worthless.

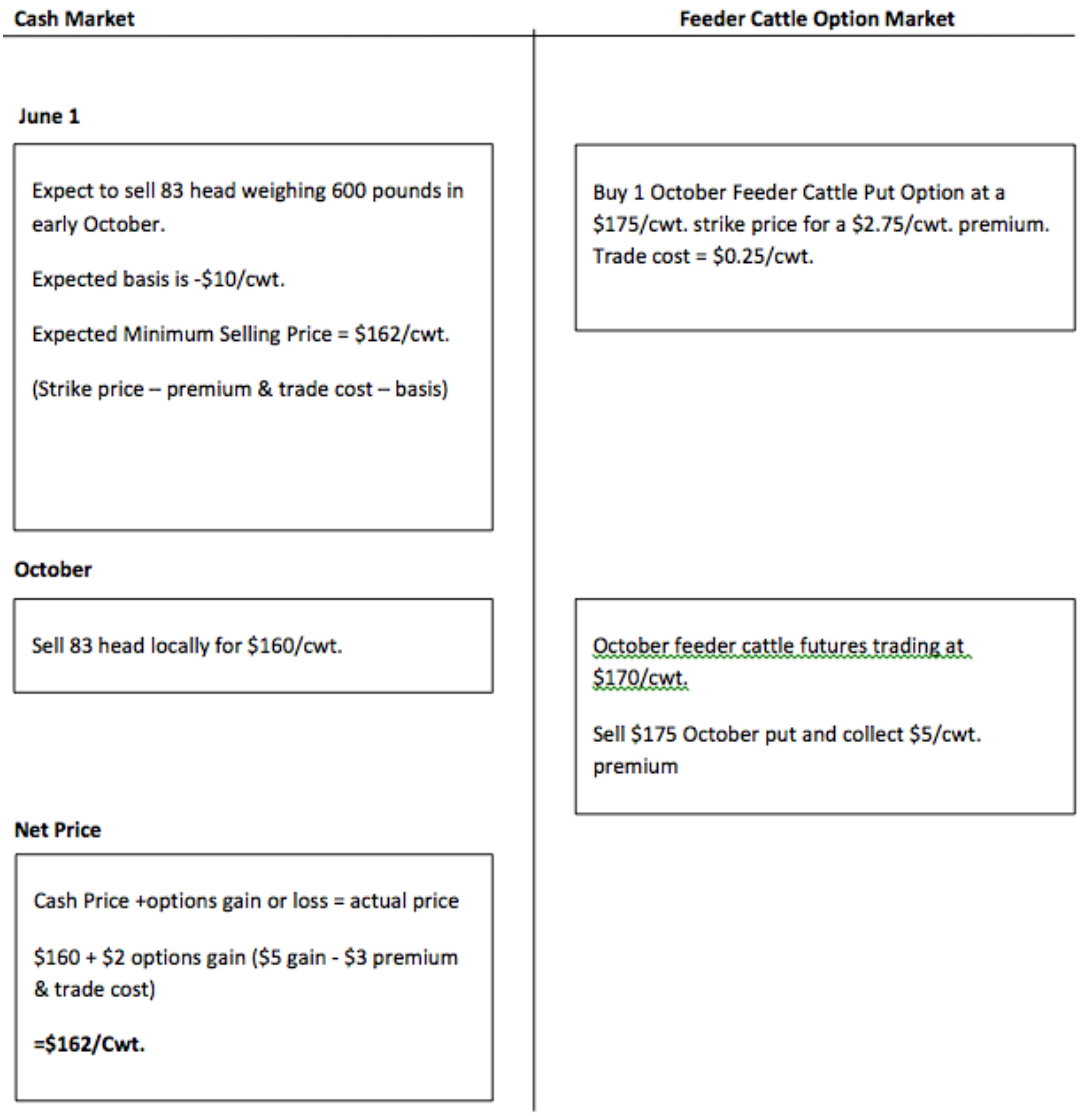


As October approaches, one of three things will happen: prices will stay relatively unchanged, rise above the option strike price (thus making the option worthless) or fall below the strike price (thus making the producer's option valuable). Remember that for a put option, if the current futures price is above the strike price, the option is said to be "out-of-the-money." If futures are below the strike price, it is "in-the-money."

First, assume the futures market prices in early October are $185/cwt. -- well above the put option strike price of $175/cwt. This makes the producer's option "out-of-the-money." Since no one is willing to pay for an option to sell at $175/cwt. when they could sell currently for $185/cwt., the option expires as worthless (Figure 1). In this case, the cattleman sells the load of feeders and does not use the option. The net price would be the cash price received less the net premium cost originally paid. Assuming the basis did not change (-$10/cwt.) and the cattle brought $175/cwt., the actual net received would be $172/cwt. ($185 - $10 basis - $2.75 premium - $0.25 commission and interest).

In this case, the insurance policy was not needed. Had this been known in advance, the cattleman could have saved the premium. However, just as fire or other disasters can't be predicted, price movements can't be predicted with accuracy either. For this reason, the cattleman was willing to substitute the known loss (premium) for the possibility of a larger unknown loss.

Figure 2. Put Option Example. Feeder Cattle Pricing Example where market declines and option is sold.



What happens if the cattleman does need to collect on his option position? The mechanics of this instance are shown in Figure 2. Assume the futures market price at the first of October is $170/cwt. In this case, the option to sell does have value, because others are willing to purchase the right to sell at $175 when they are currently only able to sell at $170/cwt. Remember, this means the option is "in-the-money." One way to collect on an options policy (offset) is very much like collecting on insurance. Since the value of the loss is $5/cwt., the cattleman should be able to sell the option back for at least this amount. He calls his broker and tells him to sell the October put at $5 or better. The sale of a previously bought put cancels the option, and the broker sends a check for $5 per cwt. X 500 cwt. or $2,500. Since he paid a premium of $2.75/cwt. plus the $0.25/cwt. option trading cost, he really netted $2/cwt. on the option trade. The producer sells his calves for $160/cwt. on the cash market and adds the $2/cwt. gained on the option market to get the net price of $162/cwt. Thus, the option was successful in assuring the minimum price when he bought it in June.

In this case, the producer collected on his option (policy). Just as with insurance, he collects to the extent of his loss. In options terminology, we are talking about the strike price (the face amount of the policy) less the current futures price of feeder cattle.

A second way in which the "insurance" could have been recovered would be to exercise the option, converting it into a sell (short) position in the futures market. If the futures position were then immediately closed out with a purchased October futures (long), the $5/cwt. difference would be realized ($175 - $170 current futures) with only an additional commission for the futures purchase. Since fed cattle options expire before the underlying futures, this may be the route to completing the options "insurance" if the cattle were not sold until after the option had expired. With feeder cattle, however, this is not a problem, because the futures and options expire together.

Figure 3 summarizes the resulting net price from purchasing an October put for $2.75/cwt. with $0.25/cwt. trading cost under several futures market prices in October and a realized -$10/cwt. basis. It also makes clear why put option purchases are sometimes referred to as "floor pricing."

In reality, the producer will only be able to estimate what his basis will be when he sells the cattle. If the actual basis is better (stronger) than anticipated, then the

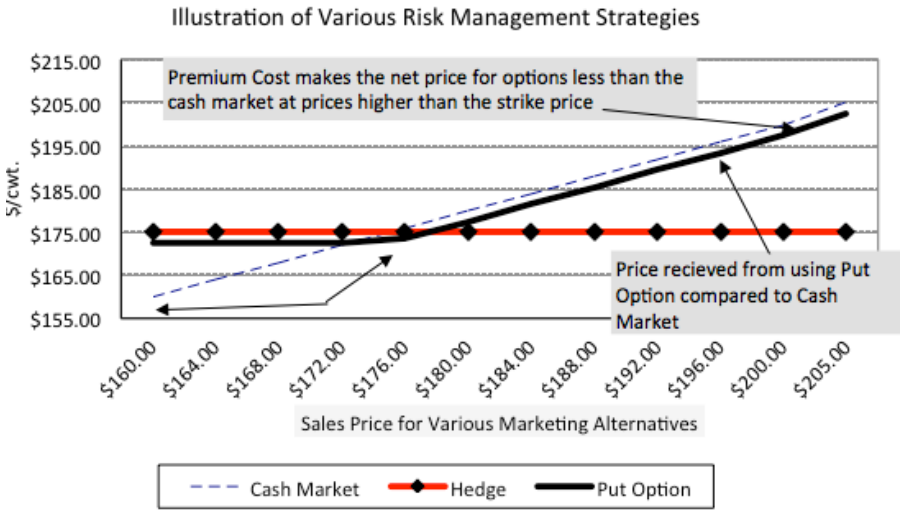


Figure 3.

realized net price from the options will be higher. If the actual basis is worse (weaker) than anticipated, then the realized net price from the options will be lower. In either case, the actual net price will vary by the difference in forecast and actual basis.

Buying More or Less Insurance

Figure 4 shows the net futures floor prices achieved at various strike prices. ***Basis would still need to be subtracted to arrive at an estimated cash price.***

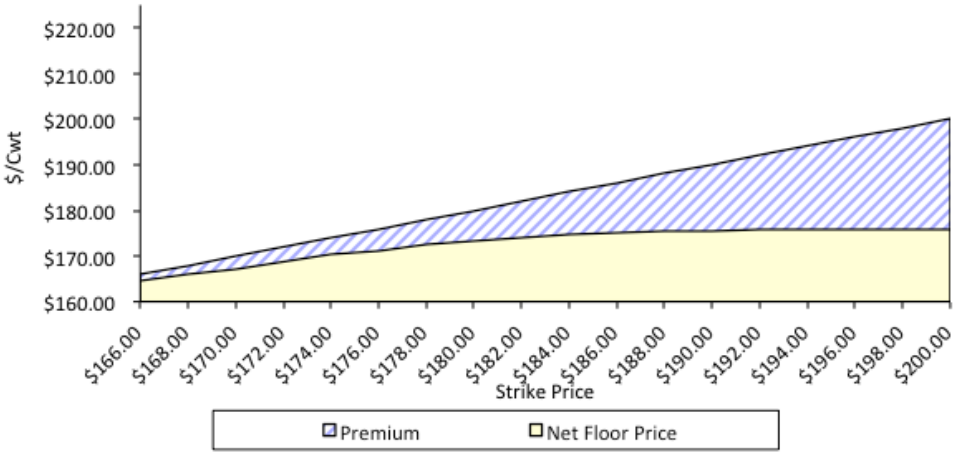


Figure 4. Net futures prices for put option at various strike levels. Nov FC contract. Prices quoted in June.

The crosshatched area indicates the amount of the premium paid. For instance, a $180 put could have been purchased for $6.70/cwt. This would have provided a higher floor price but at an unreasonable expense. Alternatively, a $170 put could be purchased for $3/cwt., providing a net futures price of $169. Finally, a $166 put would have cost only $1.30/cwt. but provided a futures floor of only $164.70/cwt. Again, readers are reminded that these prices are calculated before any basis adjustment. So, if the basis is -$10/cwt., as has been used throughout this publication, then net cash prices will range from $164.70 to $175.90/cwt.

This graphic illustrates the impacts of strike prices and premiums on net futures prices. Selecting the "right" strike price involves knowing not only what level of protection is afforded, but also how much the protection costs.

Call Option Example

As mentioned previously, call options can be used to establish an expected maximum purchase price. Call options may be useful for stocker operators or feedlots to set a maximum purchase price of incoming cattle. Likewise, livestock producers can use corn or soybean meal options to set a maximum purchase price for feed ingredients. Similar to a put option establishing a price floor, call options establish a price ceiling.

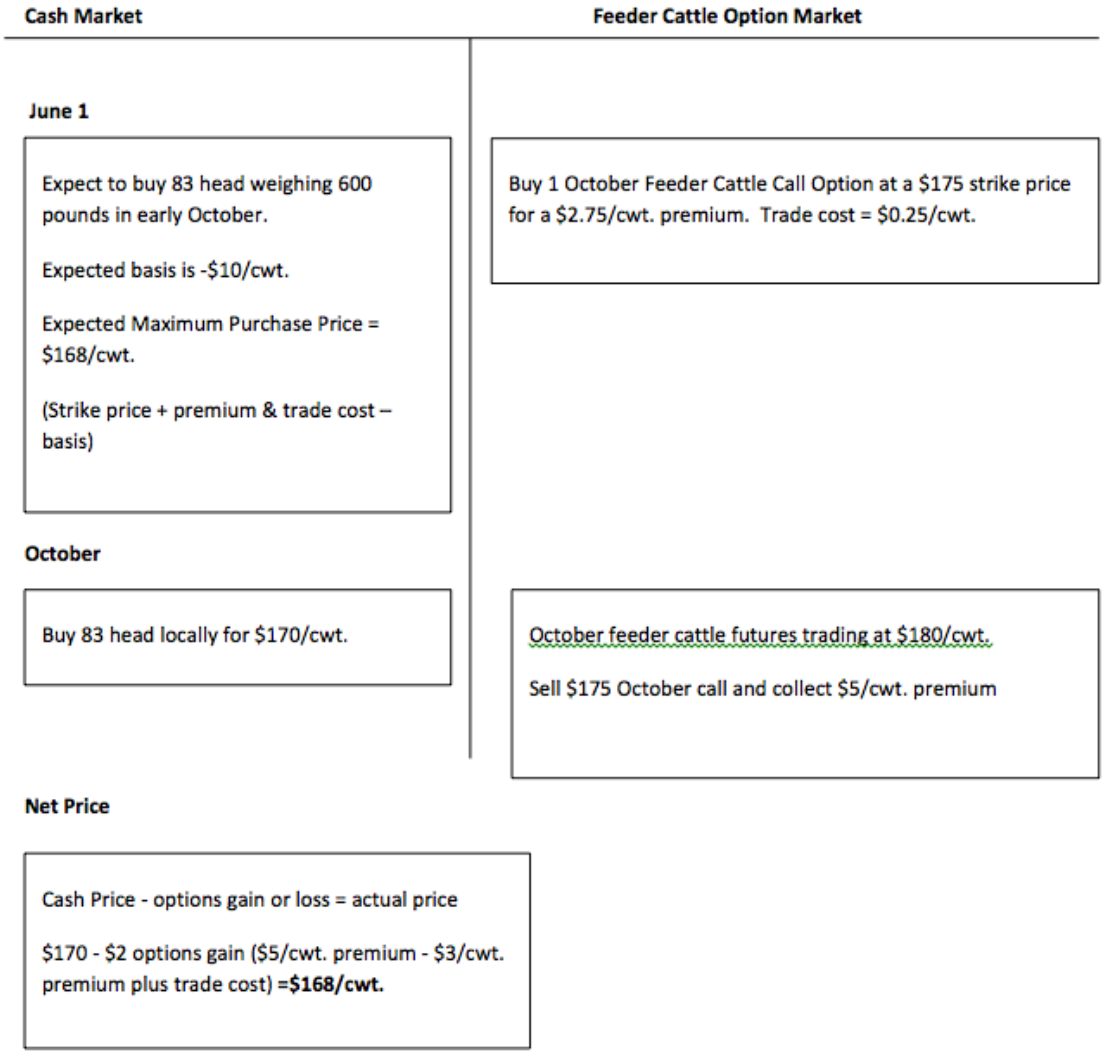
Call options give the holder the right but not the obligation to **BUY** a futures contract at a given price. The same terms (strike price, premium, etc.) apply for call options as they do with put options except the objective is to set a maximum purchase price for feeder cattle, live cattle or feed ingredients as opposed to a minimum price. As a result, premiums and other transaction costs are **added** to the strike price in calculating the net price paid, where with put options they were subtracted. In either instance, the result is the same. The holder experiences a small but known loss in exchange for mitigating the risk of upward price movements in the market.

To illustrate a call option, consider the feeder cattle example presented for the put option (Figure 5) except that a feeder cattle buyer wants to set a maximum purchase price of $168/cwt.

In this instance, prices increased enough to make the call option "in-the-money." As result, the owner offset the option for the intrinsic value and reduced his net purchase price to $168/cwt.

If the futures market had gone down to, say, $165/cwt., the cattleman would have purchased the cattle for $155/cwt. ($165 - $10 basis) and let his call expire as worthless. Because his total purchase price (premium + commission + interest) was $3/cwt., his net purchase price would have been $158/cwt.

Figure 5. Call Option Example. Feeder Cattle Price Increase Example.



Summary

Purchasing options for price insurance is a way cattlemen can use the futures markets as a pricing alternative. This alternative should be carefully compared to all other pricing alternatives in light of the producer's objectives and risk-bearing ability. Options purchased for price insurance provide a "hybrid" market with characteristics of both doing nothing (cash market pricing) and hedging or forward-contracting. That is, the producer who purchases an option for price insurance has some of the same price protection offered through a hedge or forward contract. On the other hand, options are not as protective against unfavorable price movements as hedging or forward contracting or as attractive as the open cash market if prices become more favorable. In fact, option purchases will always be, at best, second to either of the other two pricing alternatives when evaluated after the fact. However, cattlemen do not have the luxury of making pricing decision after the fact. Because of this, many cattlemen may find a place in their pricing plans for the kind of "hybrid vigor" offered through the option market.

Table 1. Comparison of Options Specifications

Item	Feeder Cattle	Live Cattle
Underlying Contract Size	**50,000 pounds**	**40,000 pounds**
Delivery	Cash settled	Physically delivered
Months traded	Jan, Mar, Apr, May, Aug, Sep, Oct and Nov	Feb, Apr, Jun, Aug, Oct, Dec
Last day of trading[1]	Last Thursday of the contract month with exceptions for November and other months when a holiday falls on the last Thursday or any of the four weekdays prior to that Thursday, 12:00 p.m. See CME Rule 102A01.I.	First Friday of the contract month, 1:00 p.m. See CME Rule 101A01.I.

[1] Source CME website – accessed May 27, 2014
http://www.cmegroup.com/trading/agricultural/livestock/feeder-cattle_contractSpecs_options.html
http://www.cmegroup.com/trading/agricultural/livestock/live-cattle_contractSpecs_options.html

Bulletin 1405 **June 2014**

Hidden Costs in the Feedlot

It's hard to make a profit feeding cattle especially when there are some hidden costs at the feedlot.

The high cost of feed and feeder cattle is making it hard to make a profit feeding cattle. While buying and selling cattle will be an important part of finding a profit, there are some hidden costs at the feedlot. Consider these three features of feeding cattle:

- Shrink
- Feed Waste
- Animal Health

Shrink

One of the costs that is often forgotten is the cost of shrink for incoming cattle. The weight that is used as the payweight for feeder cattle often will include a “pencil shrink” to account for some of the weight loss before the cattle reach the feedlot. However, that is not the only cost associated with shrink. Before being loaded and shipped, the shrink on cattle increases during any time of fasting. Consider the results from an unpublished study from Kansas State University.

These data indicate the standing time before cattle are loaded will significantly affect the total level of shrink, and the “pencil shrink” may or may not account for these losses. The next period of shrink will be transit. These losses are usually well-documented and considered in pricing feeder cattle, but the level of shrink may be surprising to some. The same Kansas State study evaluated shrink for 914-lb steers under differing periods of transit.

Fasting Time (hrs)	Shrink (% BW per hour)
Kansas State University, unpublished.	
0-2	1.25
2-5	0.61
5-7	0.66
7-9	0.74

Table 1. Shrink for 825-lb feeder cattle in drylot prior to shipment

Transit time (hrs)	Shrink (% BW per hour)
Kansas State University, unpublished.	
0-5	0.92
5-10	0.38
10-15	0.11

Table 2. Shrink for 914-lb steers for differing periods of transit

These data indicate that for even short hauls common in the Mid-Atlantic region, cattle can shrink up to 4% fairly easily. The issue is also compounded because the shrink from standing prior to transit and the transit period can be at least partially additive.

Why is shrink important?

The reasonable way to describe the performance of cattle in the feedlot is average daily gain or feed efficiency on a pay-to-pay basis. The recovery of shrink in the feedlot is a cost with no return from feed use in regaining lost weight. Self and Gay (1999) conducted a study to determine how long it takes to regain shrink after arrival at the feedlot. The results are shown in Table 3. Using these data it can be shown reduction in the weight recovery period by 33% is worth nearly $1000 for a load of feeder cattle at current feed prices, and the value can be even more for stressed and comingled calves that may originate from a sale barn.

Feed Waste

Feed waste comes in many forms at the feedlot:

- Bunk space and design
- Feed storage
- Bunk management
- Proper mixing and ration balance

Bunk space

In most cases a linear foot of bunk space per animal in the pen should be sufficient when feeding most rations twice daily. The space may need to be doubled when feeding only once daily. The throat height for most feeding facilities should be about 18 inches, the back of the feeder up to 24 in high, and the depth of the feeder no more than 12 inches. A step in front of the bunk 6-8 in high and 12 in wide will keep the bunk cleaner.

Source	Season	Transit time (mi)	Shrink(%)	Recovery time (days)
Self and Gay (1999)				
Farm	Spring	714	7.9	6.3
Farm	Summer	608	8.3	11.7
Farm	Fall	540	6.4	11.7
Farm	Average	591	7.3	10.4
Sales Barn	Spring	696	9.1	7.0
Sales Barn	Summer	624	8.9	9.0
Sales Barn	Fall	878	9.2	13.5
Sales Barn	Average	761	9.1	10.9

Table 3. Recovery of Weight Shrink in Feeder Cattle

Feed storage

The term “feed shrink” describes the loss of feed between storage at the farm and what gets through the steer. This loss has often been measured at 4% or more. In addition to losses at the feed bunk, a significant part of feed shrink is from storage losses. Storage facilities will vary from farm to farm, but improvement of storage management including rodents, birds, mixing and feeding equipment, and spoilage reduction can soon account for considerable savings in feed cost.

Bunk management

Observations in feedlots around the region indicate the typical bunk management is to keep bunks full of feed until just prior to refilling. However, there are a number of studies that have shown this is a very inefficient way to manage bunks. This result is from two reasons. First, increased intake of feed does not result in a linear increase in weight gain. Weight gain may actually go down as feed intake increases beyond an optimum amount. In most cases the studies have shown feed intake at 90-95% of ad libitum (voluntary) intake will result in similar weight gain while improving feed efficiency (Table 4.)

	Experiment 1 Ad lib	Experiment 1 Restricted	Experiment 2 Ad lib	Experiment 2 Restricted
Preston and Bartle, 1992.				
Average daily gain	3.39	3.37	2.97	3.08
Dry Matter intake	20.7	20.6	18.3	18.3

Table 4. Restriction of feed intake to 95% of ad libitum level

Secondly, inconsistent intake of feed can create digestive issues that will reduce feed intake and gain. Cattle develop eating behavior that may not be the most effective way for them to eat. Some cattle will eat large amounts of feed for a short period of time and others will eat smaller meals throughout the day. When feed is available throughout the day, some cattle resort to sorting ration ingredients early in the day (usually the most energy-dense portion of the ration), and then eat more roughage later in the day. For high-energy finishing rations this can cause inconsistent intake across the entire pen of cattle.

The “slick bunk” system must be carefully managed to be sure the cattle are getting enough feed to reach performance potential without having excess feed available. There is no single time period the bunk should be slick that will be useful for all situations. Rations, weather, cattle weight, and other factors can cause variations in the amount of feed to offer. Horton (1990) suggested that at the time of feeding, 25% of the cattle should be lined up ready to eat, 50% should be standing and working their way to the bunk and 25% should be getting up and stretching as a method of evaluating the need for feed in the bunk.

The timing of feed delivery also contributes to feed efficiency. The results in Table 5 show how variation in the timing of feed delivery can affect animal performance.

Proper mixing and ration balance

For the totally-mixed ration, the feed ingredients must be mixed thoroughly. It is usually recommended that the mixer run for 5-10 minutes after all the ingredients are added. This helps keep intake consistent and sorting to a minimum. If there continues to be excessive sorting of feed ingredients, processing by cracking or coarse grinding may be necessary to make a more consistent mix. Grains should never be ground fine in a feedlot mixture. Proper balancing of feedlot rations will insure the feed being presented will allow performance goals to be achieved. For example, a corn/corn silage ration calculated to be.60 Mcal/lb NEg using soybean meal only as the protein source will reduce expected gain by 3% and feed efficiency by 3% compared to a ration properly balanced for protein. Inaccurate moisture content of feed such as corn silage will also reduce performance. For example corn silage included in a ration at 27% dry matter that is actually 22% dry matter will reduce daily gain by 4% and feed efficiency by 1% with a subsequent increase on cost of gain from the ratio

	Consistent	±10%
Galyean et al, 1992.		
Initial wt.	829	835
Final wt	1100	1089
ADG	3.23a	3.02b
DMI	17.2	17.2
F/G	5.33a	5.70b

Table 5. Variation in feed offer and animal performance

Animal Health

The cost of treatment, morbidity, and mortality from sick cattle in the feedlot represents a significant loss. There are other losses in performance and income from sick cattle even if they get well. Consider the results in Table 6.

	Sick	Healthy
Texas Ranch to Rail, 1998.		
# Head	218	1080
Death Loss	5.5%	0.7%
Wt.gain/day	2.65	3.08
Medicine Cost	$26.78	0
Quality Grade: Choice	37%	54%
Quality Grade: Select	53%	43%
Quality Grade: Standard	10%	3%

Table 6. The Affects of Animal Health On Carcass Grade

The cost of lower performance, feed efficiency, days on feed, and quality grade are additive effects of sick cattle in the feedlot. At current carcass prices, that steer that slips down to Select from Choice because he was sick, even if he got well, incurs a cost of over $100.

Beef Column, Dr. John Comerford, Penn State Beef Extension Specialist, September, 2012

---

extension.psu.edu

Penn State College of Agricultural Sciences research and extension programs are funded in part by Pennsylvania counties, the Commonwealth of Pennsylvania, and the U.S. Department of Agriculture.