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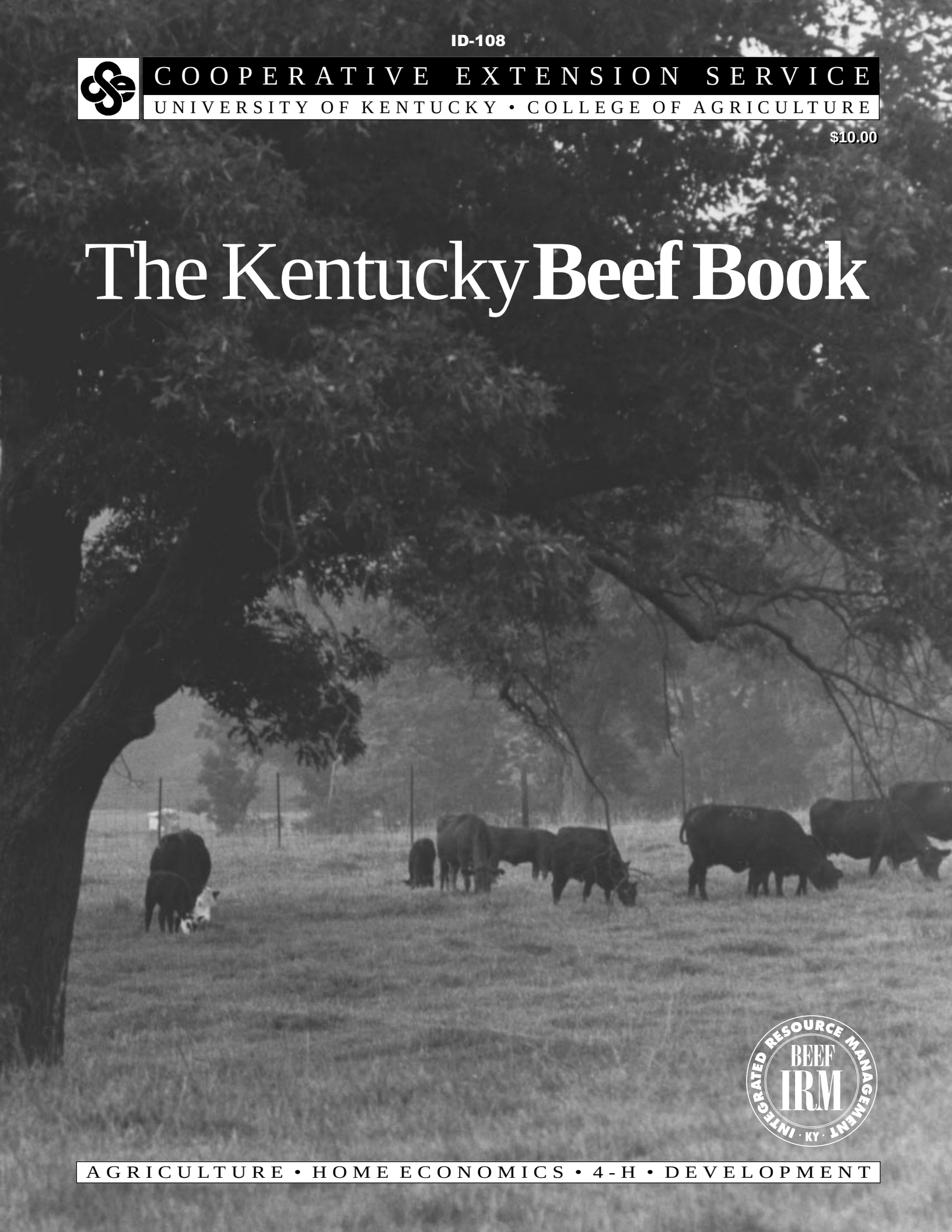
The Kentucky **Beef Book**



BEEF IRM
INTEGRATED RESOURCE MANAGEMENT · KY ·

ID-108

The Kentucky **Beef Book**

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Beef Book Survey

In order that we may add your name to the IRM mailing list and better serve the beef producers of Kentucky, please complete this form and return it to your county extension office or mail it to the address shown here.

Name _____

Address _____

City _____ State _____ Zip _____

County _____

Number of cattle in each type of operation:

Cow-Calf Operation	*number*
❑ Commercial	_____
❑ Purebred	_____
(breed?	_____)
Postweaning Program	*number*
❑ Backgrounding	_____
❑ Finishing for slaughter	_____

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Section 1.

The Kentucky Beef Industry

Doug Shepherd, Roy Burris, Jimmy Henning, Paul Joerger, and Darrh Bullock

Throughout the history of the United States, the American cattle industry has played an important role in the country's growth and economic well-being. As the largest segment of the American agricultural economy, the cattle industry comprises approximately 1.23 million businesses with cattle, including beef and dairy cattle. An estimated 1.064 million farmers and ranchers raise beef cattle in the United States.

Cattle and calves are produced in more states and regions of the country than any other commodity. Beef cattle can be found in all 50 states, and 34 states have at least 10,000 cattle farms and ranches. The dominant beef production region in the United States runs across a band of states from Montana to Texas and throughout the Southeast. Texas, Missouri, Oklahoma, Nebraska, South Dakota, Montana, Kansas, Kentucky, Tennessee, and Florida account for 58.4 percent of the nation's beef cow population.

The cattle business, almost four times larger than any other sector of animal agriculture, accounts for nearly 25 percent of all cash receipts from agricultural marketings, amounting to some $40 billion annually. U.S. cattle producers are also the world's most efficient and productive: with less than 10 percent of the world's beef animals, they produced 24.9 percent of the world's beef supply in 1994.

Our Beef Cattle History

Cattle have been a major part of Kentucky's agriculture for more than two centuries. In the early 1780s, settlers who poured across the Appalachian Mountains brought cattle with them. These early cattle, which were also used for milk and draft, were mostly "mongrels," predominately of Devon ("Rubies") or Spanish blood. As early as 1784, cattle also were being driven from the south branch of the Potomac to the glades of what is now Kentucky for summer pasture.

Many of the early cattle were kept near cabins and ate "switch cane," which grew wild among large trees. However, in 1792, Kentuckian Thomas Goff was on a trip to Virginia and saw his horse eating a strange grass (bluegrass) in the Powell Valley. He brought some seed back to Kentucky. Bluegrass, along with corn, later became the base of the cattle feeding program. Cattlemen wintered their 2-year-old steers on shocked corn, put them on bluegrass in the spring and summer, then fed them corn until February when the drive to the market began. Cattle were driven to markets in the East, generally at the speed of about seven miles a day.

In 1785, a family named Patton migrated to Kentucky (near Winchester) and brought a bull exported from England and some grade heifers. Later they brought into Kentucky a "full-blooded" (possibly Shorthorn) bull and cow…Mars and Venus. Through several years of selective breeding, they developed the "Patton Stock," which became the foundation of some early Kentucky breeding stock.

Shorthorn cattle were first imported into Virginia in 1783, and purebred Shorthorn cattle soon appeared in Kentucky. Their popularity increased rapidly, and Kentucky breeders established the Shorthorn herd book and record association—the first in the United States.

Famous statesman and politician Henry Clay is credited with bringing the first Herefords to Kentucky in 1817. However, their popularity did not increase like the Shorthorns. That same year, Lewis Sanders, of Bourbon County, imported four pairs of Shorthorns, one pair of Longhorns, and one pair of Herefords. These Shorthorn cattle, which had numerous descendants, became known as the "seventeens" in reference to the year 1817.

By 1837, the Shorthorns were immensely popular. Many producers feared they would become inbred and fail to pass on desirable traits. They were crossed with other breeds, especially Longhorns from the South. Longhorns were later discriminated against by packers, causing a good deal of panic among Kentucky producers who had crossed their cattle with Longhorns.

About 1888, the Shorthorn business collapsed to a great degree and Herefords swept to popularity, not necessarily because of superior hardiness but because "Shorthorn breeders had been selling pedigrees instead of individuals."

As early as 1840, Kentuckians were aware of the state's potential to produce forage. Cattlemen in the Barrens (between the Green and Cumberland rivers) stated, "grass can be the only basis for our cattle industry. We can never be a stock raising country to any extent until we change our system of farming. We must grass our lands and plow less."

By the 1850s, a system of marketing that centered around "court day" had evolved in Kentucky. Each county court usually held session one day a month at the county seat. Kentuckians came to town to conduct legal business, buy supplies, and sell their products, including cattle. Cattle were moved into town, along with other equipment, to be traded-on or auctioned off. One of the best known court days occurred in Paris, where as much as $250,000 worth of cattle, horses, and mules changed hands in a single day.

Cattle numbers steadily increased in Kentucky's Bluegrass area. Bourbon, Clark, Madison, Fayette, and Shelby counties each had 10,000 to 12,000 head of cattle during the 1840s and 1850s.

The first comprehensive cattle inventory was taken in Kentucky in 1920 (see Table 1-1). At that time, there were only 65,000 beef cows in the state, but there were 161,000 steers over 1 year old and 197,000 other calves (not kept for milk). The 1942 inventory recorded the first big increase in beef cows (105,000 head), while steers over 1 year old had decreased since 1920.

Table 1-1. Kentucky Cattle Inventory for Selected Years (000 head)

Year	Beef cows	Milk cows	Steers[1]
1920	65	455	161
1930	45	498	98
1940	80	555	140
1950	187	661	149
1960	515	561	197
1970[2]	1055	379	230
1980	1106	244	221
1990	1040	210	180

[1] Refers to steers over 1 year of age or, in later years, steers over 500 lbs.

[2] Beef cow numbers actually peaked in 1975 at 1,429,000

It is likely no coincidence that the buildup of beef cow numbers in the 1940s occurred along with the introduction of Kentucky 31 tall fescue. This new grass grew anywhere, prevented erosion, and could be used to support the growing cow herd.

As Kentucky moved into a grassland system of cattle production, emphasis changed from the grazing and feeding of mature steers to a cow-calf system of production. Corn Belt cattle feeders turned to the South as a major supplier of feeder cattle. Kentucky, Tennessee, and Virginia provided the largest numbers of these calves.

During the 1950s, the production of feeder calves increased as farmers realized beef cow herds made efficient use of available pasture land. However, many nondescript cows scattered across the state were not yielding quality feeder calves. Dr. W.P. Garrigus of the University of Kentucky introduced the Kentucky Cow-Calf Plan, which suggested the use of these cows to produce baby beef. This widely adopted program emphasized the use of quality beef bulls and led to the upgrading of beef cattle from many "family milk cows."

Kentucky beef cow numbers doubled in the '50s and again in the '60s. On January 1, 1970, the beef cow population numbered more than 1 million head. This increase in beef cow numbers was perhaps the most dynamic development in Kentucky agriculture during that period.

The physical appearance of beef cattle also has changed over time. Early British cattle, which were used mainly for draft and milk, were large-framed, late maturing, and not "finished" until they were 3 or 4 years old. Producers attempted to reduce size and hasten maturity and ability to fatten earlier. This trend intensified from the mid '30s to the mid '50s as smaller, earlier maturing, and earlier fattening cattle were selectively bred. By the late 1950s, this practice had been taken to extreme, and breeding stock were excessively small and fat.

In the mid 1960s, the beef cattle industry began to move toward cattle that could be grown to desirable slaughter weights without becoming too fat. The feedlot performance of Charolais crossbred steers in the 1960s created an awareness of the lean growth potential of the European breeds of cattle. In the late '60s, breeders began selecting within their breeds for larger framed, growthier, and leaner cattle. The use of other European breeds also increased at that time.

This intense selection for large-framed, lean cattle was also taken to extreme and caused concern because of carcass size, carcass grade, maintenance cost, and efficiency of resource utilization. Presently, selection emphasis is toward lean cattle of moderate frame with easy fleshing ability.

Kentucky survived the "market crash" in 1974, and, in recent years, Kentucky has shown the largest increase in beef cow numbers in the United States while other states generally have declined.

Kentucky presently has the 13th largest cattle herd in the United States at 2.65 million head as of January 1, 1996. Kentucky's beef cow herd is the eighth largest in the United States (the largest east of the Mississippi River) with 1.165 million beef cows.

According to recent data, beef cattle are produced on 45,000 (50.6 percent) of Kentucky's 89,000 farms. The economic impact of the production from these operations is significant. Sales of cattle and calves generated $648 million in cash receipts to Kentucky's farmers during 1994, accounting for 20.1 percent of total farm cash receipts, second only to tobacco.

Our Resources

Kentucky is ideally suited for cattle production. The main feed for cattle is a renewable resource Kentucky has in abundance—**forages**. The majority of the state's terrain favors cattle production over row crops. Kentucky farms cover 14 million acres, with approximately half of that occupied by forage grasses and legumes. Our natural resources and climate permit the growth of most cool-season and warm-season species. Water is readily available in all areas of the state, and we have a relatively long growing season.

A major percentage (83 percent) of the feed units for beef cattle comes from forages, and livestock and livestock products account for 51 percent of Kentucky's agricultural cash receipts. Cash hay also accounts for 24 percent of the total crop value in the state. In addition, forages play a major role in soil conservation, seed production, and aesthetics.

Figure 1-1

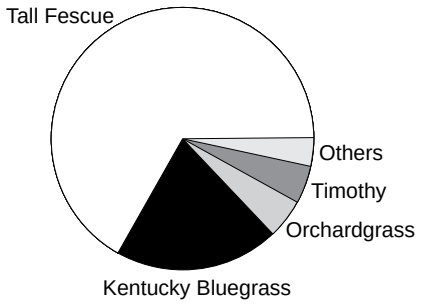
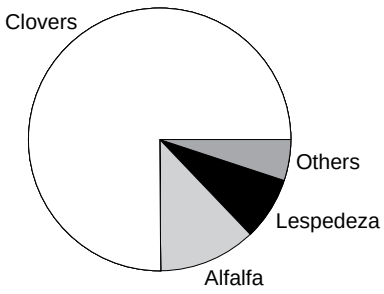


Figure 1-2



Kentucky's forage base consists of cool-season grasses and legumes. Four grasses compose the vast majority of our forage land, with Kentucky 31 tall fescue occupying the largest number of acres (Figure 1-1). Red, ladino, and white clovers (Figure 1-2) are by far the dominant legumes found in Kentucky's hay and pasture fields.

A Plan for the Future

There is still room for growth and improvement in the Kentucky beef industry. Information compiled during the development of the Ag Project 2000 Master Plan for Kentucky Agricultural Economic Development indicated that beef cattle production has the greatest potential for growth within Kentucky's agricultural economy and could be the leading sector of future cash receipts for Kentucky's farmers. Two actions most likely to cause this growth to be realized are increasing cattle numbers and adding value to the calves produced. It was felt that one of the best ways to fulfill Kentucky's beef industry potential is to increase beef cattle numbers while increasing profitability through integrated resource management (IRM). As a result, the UK College of Agriculture Administration formed the Kentucky Beef IRM Coordinating Committee in early 1995.

Kentucky's Beef IRM Effort

The integrated resource management concept was first introduced in Kentucky in 1981. Since that time, several impact application demonstrations have been conducted, primarily by members of the beef Extension group. However, it has been apparent that in order to have maximum impact, an IRM educational effort must be a true integration of disciplines and also must be conducted on a statewide basis.

In 1995, a small group of Extension personnel—composed of specialists from agronomy, animal science, and agricultural economics along with a county Extension agent for agriculture—was charged with the responsibility of developing an integrated resource management educational program for the beef industry in Kentucky. This committee has devised an action plan for implementing this new type of Extension educational activity. This plan includes defining the audience and developing a mission statement complete with emphasis areas and implementation strategies.

Kentucky Beef IRM Mission Statement

The Kentucky Cooperative Extension Service (KCES) Beef Integrated Resource Management (IRM) program will change the Kentucky beef industry in a measurable, positive way by providing a dynamic educational program that benefits the maximum number of beef producers with small, medium, and large herds. This program will use an integrated approach to provide the beef industry of Kentucky (beef producers, allied industry, KCES agents) with interdisciplinary, unbiased, research-based training and resource materials to enhance an individual's ability to make decisions.

Mission emphasis is on sustainability through:

- information integration
- environmental soundness
- goal development by producers
- profitability
- consumer-acceptable products
- quality of life in rural Kentucky

Strategies to fulfill mission:

I. In-service education for Extension personnel—better training according to their needs.
II. Educational opportunities for beef producers—to be offered to various size producers with differing levels of expertise to improve their knowledge.
III. Integration and evaluation of existing beef Extension programs—from an integrated resource management standpoint.

Kentucky beef producers generally have two important reasons for raising beef cattle on their farms: (1) available land or roughage resources and (2) beef cattle require less labor than other livestock enterprises (making the cow-calf enterprise complementary to off-farm employment). Enjoyment in raising cattle may also be an important reason. The typical Kentucky beef herd has about 25 cows (86 percent of all herds have less than 50 cows) and one bull, uses land not suitable for row crops, may be characterized as a "loosely managed operation," and may have no defined calving season. Practices known to improve beef productivity and efficiency have not been widely adopted by Kentucky farmers.

As discussed earlier, two components of Kentucky's beef industry most likely will have the greatest impact on the industry meeting its potential: increasing numbers and adding value to current production. Kentucky's fescue-based forage base can support a large number of cattle. As a renewable resource, forage can only be utilized by ruminant animals like cattle to bring an economic return to the state. However, this resource requires better and more efficient mangement to support potential beef numbers. If managed properly, Kentucky's forage can produce feeder cattle more economically than that of other states, giving Kentucky producers an advantage. The latest management techniques and practices to accomplish this task are discussed at length in this reference book.

Adding value to Kentucky beef calves can be accomplished in several ways. Increasing weaning weights, producing uniform calves of similar weights, improving marketing methods and information, and producing consumer-acceptable calves can all add value to Kentucky's calves before they leave the farm. Each of these topics is discussed in detail in later sections of this book.

In an effort to provide Kentucky beef cattle producers the best information available on profitable and efficient beef cattle production, this beef manual was developed as part of the IRM effort. This reference book was written by specialists in beef nutrition, beef cattle breeding, beef reproduction, forages, veterinary science, and production economics. The goal is to help Kentucky's beef producers realize greater profits from their beef enterprise regardless of the size of the operation and/or the expertise of the producer.

Literature Cited:

"Cattle and Beef Handbook," March 1995, Fourth Printing, National Cattlemen's Association, Englewood, Colorado

"Prospectus for Kentucky's Beef Cattle Industry," Kentucky Cattlemen's Association Long Range Planning Taskforce

"Kentucky Agricultural Facts," March 1996, Kentucky Agricultural Statistics Service, Leland E. Brown, Kentucky Agricultural Statistican

"Kentucky Cattle Facts," December 1995, Kentucky Agricultural Statistics Service, David D. Williamson, Kentucky Agricultural Statistican

"1994-1995 Kentucky Agricultural Statistics," Kentucky Agricultural Statistics Service, David D. Williamson, State Agricultural Statistician, and William Brannen, Deputy State Statistician

"Ag. Project 2000, A Comprehensive Master Plan for Kentucky Agricultural Economic Development"

"BEEF, Blueprint for Progress—An educational plan for changing Kentucky's beef industry," Beef Integrated Resource Management (IRM) Coordinating Committee, Kentucky Cooperative Extension Service, University of Kentucky

Cattle Kingdom in the Ohio Valley 1783-1860. Paul C. Henlein, 1959, University of Kentucky Press

Drovers, Dealers and Dreamers...150 years at Bourbon Stockyards. Carl Kramer, Bourbon Stockyard Co.

Section 2.

Forages for Beef Cattle

Jimmy C. Henning and Garry D. Lacefield

Introduction

Kentucky's forage base is composed of cool-season grasses and legumes. Four grasses occupy the vast majority of our forage land, with Kentucky 31 tall fescue occupying the largest number of acres (Figure 2-1). Clovers (red, ladino, white) (Figure 2-2) are, by far, the dominant legumes found in Kentucky hay/pasture fields.

Both cool-season grasses and warm-season grasses grow well in Kentucky. Cool-season grasses produce most of their forage before mid June with additional growth in the fall. Warm-season grasses are extremely productive during the summer months only. Warm-season grasses include annuals, such as sudangrass, sorghum-sudans, and pearl millets, and perennials, such as big bluestem and bermudagrass. The seasonal growth of many common Kentucky forages is found in Figure 2-3.

Present Forage Status

Since Kentucky's forage base is characterized by cool-season growth patterns, shortages of both quality and quantity occur during the hot, dry summer months. Tall fescue dominates our forage base, and more than 90 percent of our tall fescue pastures contain an endophytic fungus that lowers animal performance. Most of our pastures are too large for efficient management/utilization. Numbers and locations of water sources on farms limit the subdivision of existing pastures and limit utilization of grazable acres.

Less than 10 percent of the forage land is soil tested. Of the forage land that is tested, 40 percent is below pH 6.0, 45 percent is low in phosphorus, and 35 percent is low in potassium. Therefore, legume establishment and growth would improve by soil testing and subsequent fertilizer and lime applications.

Legumes are present at a high enough level to significantly improve overall animal production on less than one-third of the acreage needed. The hay supply for winter feeding comes primarily from excess cool-season forage grasses in spring and is usually harvested too late for highest quality and animal performance.

The bulk of hay for beef cattle is stored in large round bales outside with minimum protection from weathering losses. Dry matter savings of 20 percent or more can be achieved by improved storage of round bales.

Surveys of farmer practices indicate improved varieties are not utilized to the extent needed for optimum forage production and quality and profitability. Large document-

Figure 2-1

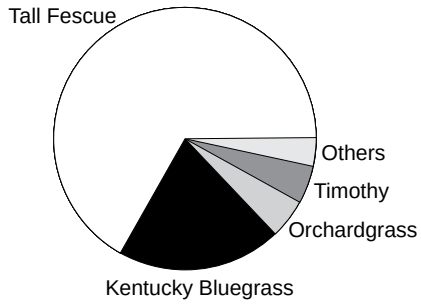


Figure 2-2

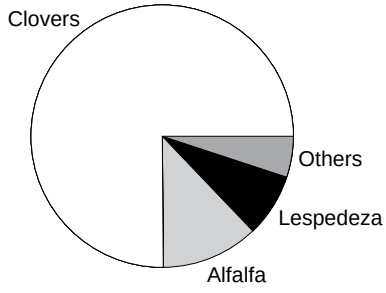
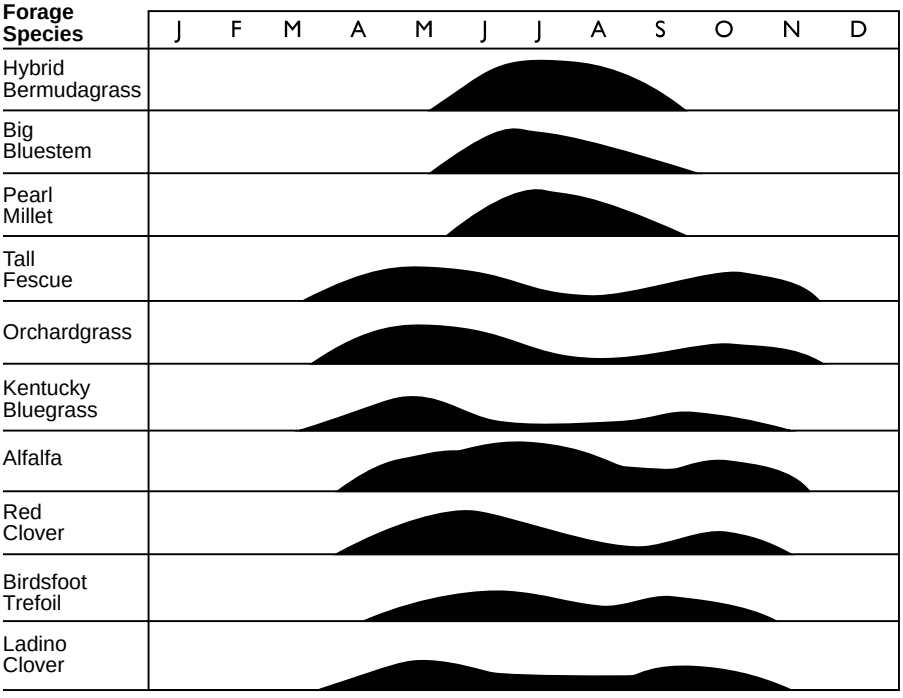


Figure 2-3. Normal forage availability by months.



able differences in yield and persistence exist between uncertified or common forage seed and that of newer improved and certified varieties.

Developing a Forage Plan

Develop a simple, realistic forage plan with attainable goals for the forage resource on the farm. Part of this plan should address the soil type and fertility levels across the farm. Another part should address the types of forages growing on each field and the usage of each field (hay or other stored feed, pasture, or both). Also consider the storage and feeding methods for the stored forage. A good way to start a forage plan is to list each pasture or hay field and the acreage, present forage base, future plans, soil testing information (including date last tested), fertilizer applications, and other characteristics of the field.

Measure the forage production potential of the farm against the needs of the livestock to be carried. Quantity, quality, and seasonal needs of the cattle must be considered. For example, a fall-calving herd requires higher quantity and quality feed during periods of little or no forage growth than a spring-calving herd (Figure 2-4). In the spring, however, that same fall-calving herd will have weaned calves that can be used to convert the surplus of spring forage growth into cheap gains.

A simple pasture-balancing computer program, called KYBEEF, is available at no cost to Kentucky producers through county Extension offices. This program is a simple DOS-based program for IBM compatible computers and does not require Windows to run. KYBEEF allows you to enter the inventory of animals to be carried on the farm, the forages present on the farm, plus the overall productivity of fields and then determines times of forage surplus and deficit. It also allows buying and selling prices for livestock to be entered and generates a simple cash flow data sheet for the farm.

Identify Limiting Factors in Forage Production

A key move in integrated resource management of beef cattle is to assess areas of a farm before taking action. In this case, assess the whole forage program to find the most limiting factor(s). Put another way, find the part or parts of the forage program that would respond most to improvement. Certain practices, such as rotating grazing systems (fencing and water), renovating grass pastures with legumes, using better varieties, stockpiling tall fescue to extend the grazing season, increasing hay quality, and protecting roll bales of hay from excessive weathering, often produce the most benefits for the additional input needed.

Selecting a Species

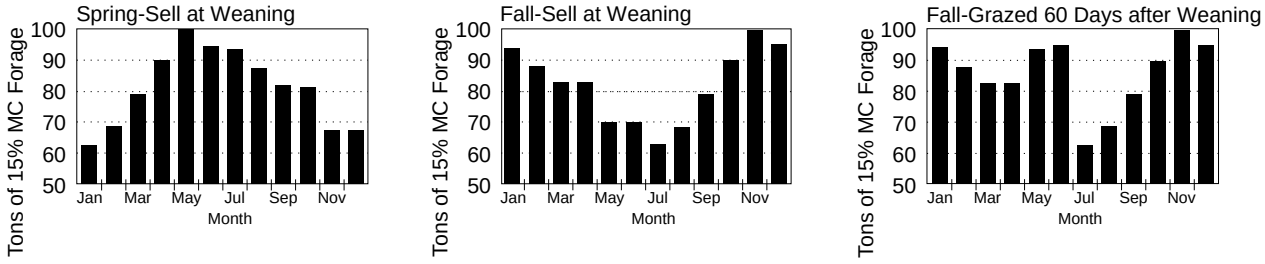
Many questions must be answered to properly select the forage or forages that make up the optimal system for the beef enterprise. The producer must define the role of forage in the enterprise, forage production goal, method of use and "utilizer," level of management available, soil/land limitations, and time limitations.

Define the role forage will play in the beef enterprise. Will it be the primary base grass in a pasture system or a supplemental forage interseeded into existing forage? Will the forage be permanent (a perennial) or a temporary (an annual) addition to the system? What will be the primary season of use? A species selected for winter grazing is of little value during the heat of August. Likewise, a productive summer forage has a short (but productive) growing season compared to a species like tall fescue.

Define the forage production goal for the species. Ultimately, a forage system must provide enough dry matter to carry a given set of animals for the year and meet livestock production goals, such as high conception rates, high weaning weights, and/or high stocker gains. Forages must therefore produce enough dry matter yield per acre to meet these needs. Also, that yield should come at a time when it can be used efficiently. The most efficient method of forage utilization is grazing. It is estimated that nutrients supplied by grazing cost approximately half of those supplied by stored feeds, such as hay and silage. Therefore, production during the time of animal need is highly desirable. Finally, the yield should be of the quality (protein and energy) necessary to allow good animal performance. Forage quality values of a number of Kentucky forages are known and vary by species and stage of maturity.

Forage grasses adapted to Kentucky are often grouped into categories called "cool-season" or "warm-season" grasses based on their optimum season of growth (Table 2-1). Tall fescue, orchardgrass, bluegrass, timothy, red clover, alfalfa, and white clover are cool-season forages, while

Figure 2-4. Animal forage needs—three calving systems.



sudangrass, bermudagrass, pearl millet, big bluestem, and Caucasian bluestem are warm-season species.

Even though species like alfalfa and red clover are known to be more productive during mid summer than fescue or bluegrass, these are still cool-season species whose growth slows greatly during hot summer months.

Define how the forage is to be used. A significant constraint to forage selection is the intended method of utilization. Systems that allow for a rotation of pastures and periods of rest/recovery from grazing offer many more forage selection options. On the other hand, systems that involve continuous grazing or suffer excessive traffic during dormant or wet seasons have fewer options. In extreme cases (such as winter feeding pastures), there may not even be a good, permanent solution. Often, you must answer the question, "Am I willing to rotate pastures?," early in the forage selection process. Not being realistic in this area can lead to unrealized expectations, disappointment, and often significant financial losses. For example, alfalfa is a species that must be rotationally grazed for maximum stand persistence and maximum economic animal performance. As good as it is, alfalfa will not persist or give proper animal performance when grazed continuously.

Define the "utilizer." In the grazing system, the animal is the marketed product. Therefore, all decisions about forage selection must be made with this "end user" in mind. Will the forage support the cow herd or growing stockers? Will it be used for pasture during early lactation and breeding (a time of maximum need for quality and quantity plus freedom from anti-quality factors, such as the fescue endophyte)? Will it be for the growth of replacement heifers or for backgrounded feeder calves? Growing animals and lactating animals require high quality (protein and energy) to meet production goals. In addition, these animals are sensitive to the effects of the endophyte of tall fescue, especially during hot weather.

Some forages can be used by more than just beef cattle. For example, native warm-season grasses can be managed as excellent cover for wildlife such as quail and rabbit. During winter, the standing stubble of these crops is more conducive to wildlife cover than the short, dense canopy of grasses like tall fescue or orchardgrass.

Define the level of management available. Requirements for forage yield and persistence may include pasture subdivisions (to aid in good rotations), high soil fertility, weed control, rotational grazing, residual height management, fall rest for winter hardiness, and insect control. Without pasture subdivisions and the ability to rotate pastures, certain forages (like alfalfa, native grasses) will not persist. Meeting fertilizer needs of a crop is necessary for production and persistence. Likewise, more intensive pest management is required for some crops, such as alfalfa. Controlling the alfalfa weevil and potato leafhopper does not always require the use of insecticides. However, the economic thresholds of treating each pest and other nonchemical controls must be understood and incorporated into the grazing plan.

Table 2-1. Forage Species for Kentucky Classified According to Growth Characteristics

	Annual	Perennial
Cool-season species	small grains brassicas	tall fescue orchardgrass bluegrass smooth bromegrass
Legumes	annual lespedeza soybeans vetch	alfalfa red clover white clover birdsfoot trefoil
Warm-season species	sudangrass sorghum-sudan hybrids forage sorghums corn silage pearl millet foxtail millet German millet	bermudagrass old world bluestems switchgrass big bluestem Indiangrass eastern gama grass

The level of management available determines what can be achieved from a forage system. In particular, the ability to maximize forage growth rates by using a good, fast rotation (three to five days of grazing followed by 30 to 40 days of rest) allows the maximum production of high quality forage per acre; consequently, animal output should be equally high. Also, soil nutrients must be managed to supply the mineral needs of the plant.

Define the soil resource. What are the soil limitations of the fields in the grazing system? Is the soil fertility and pH known on pasture fields? Surveys of Kentucky's pasture fields indicate that most are low in phosphorus and need lime to raise the pH. Low soil phosphorus and acidity are severe limitations to legume production. While some legumes, such as annual lespedeza and birdsfoot trefoil, are tolerant of acid soils and lower fertility, most are not productive or persistent under these conditions.

Other significant soil limitations include rooting depth, drainage, and topography. Shallow soils are droughty and stress forage plants during hot, dry weather. Poorly drained soils stress the root systems of forage crops and can be unsuitable for species like alfalfa and many native warm-season grasses. Because of its inaccessibility to planting equipment, severely rolling topography can prohibit the use of annual crops such as sudangrass or millet for forage systems. Even applying fertilizer and lime on these fields is a challenge in some cases.

Soil fertility is an addressable limitation in forage systems, and forage systems recycle a large portion of nutrients that plants take up during the growing system. However, seldom can all fields be "brought up to soil test" at one time. The important point is to know what and where the fertility limitations are and to have a plan for best using these fields in the beef-forage system.

Define the time constraints. Making changes in a forage system takes time. Making big changes in a forage system can take a lot of time. Some forages, by nature, can have an immediate effect, but the effect is often short-lived.

Sudangrass, pearl millet, German millet, wheat, and rye can have immediate effects, but these are annuals. Perennials like tall fescue, orchardgrass, big bluestem, and switchgrass have longer periods of usefulness. Forage system design must allow time for perennials to become established. This is particularly true in the case of species like birdsfoot trefoil and warm-season grasses such as the natives (big bluestem, Indiangrass, switchgrass), caucasian bluestem. In the case of native warm-season grasses, expect a 24-month period of establishment during which limited grazing or harvesting can occur. If impacts are needed immediately, these forages are not good options, at least in the short run. However, when time for adequate establishment is available, using these forages to supply summer grazing for an extended number of years can balance out the one to two years of limited use.

High quality pasture and well-milking cows provide good nutrition for feeder calf production.

Summarizing Forage Characteristics in Kentucky

Forage crops differ in their abilities to withstand stresses and their agronomic characteristics. A summary of many agronomic characteristics of several forage crops that can be grown in Kentucky is shown in Tables 2-2 and 2-3. Also, estimates of forage quality of several forage crops are found in Table 2-4. Forage quality can deviate significantly from these values; always take a forage analysis to know the nutrient value of forages. Use these values to help decide whether a given forage will meet the needs of the intended animal.

Establish for Stand

Establishment of a good stand is a first and very important step in a successful forage program. One to two tons of forage crop production usually covers the costs of stand establishment. Do everything possible to ensure success, because a stand failure can nearly double these costs. In addition, severe soil erosion can result from lack of cover. The following procedures are vital to establishing and maintaining good forage stands.

Match plants to soils. Almost every farm contains wide variation in soil capabilities. Soils differ in their capacities to supply nutrients, and they vary in slope, internal drainage, and other factors that affect both production and persistence of a given forage crop. In addition, different grasses and legumes and grass-legume combinations vary widely in their abilities to persist and produce on different soils. It is important to match the plant species or mixture of species to the various soils for greatest returns and proper soil and water conservation.

The best use of level-to-gently-sloping, deep, well-drained land is to plant the highest producing crops, such as corn silage or alfalfa or a mixture of alfalfa-orchardgrass or alfalfa-timothy. Maintain steeper land in sod-forming

Table 2-2. Characteristics of Perennial Cool-season Grasses in Kentucky

	Tolerance to:							
Grass	Heat/ drought	Flooding	Frequent cutting	Frequent grazing	Winter hardiness	Seedling vigor	Sod-forming capacity	Adaptation to Kentucky
Tall fescue—infected	E[1]	G	E	E	E	G	G	E
Tall fescue—non-infected	F	G	G	F	E	F	G	G
Orchardgrass	G	P	G	F	E	G	F	E
Bluegrass	P	F	G	E	E	P	E	E
Timothy	F	P	P	P	E	G	P	E
Matua prairie grass	F	--	P	P	G	G	F	F-G
Smooth brome	F	F	P	P	E	G	G	P-F
Reed canarygrass	G	E	G	G	E	F	E	G
Perennial ryegrass	P	P	E	E	F	E	P	F

[1] *E=Excellent, G=Good, F=Fair, P=Poor. Values presented are estimates. Conditions and actual performance vary widely across Kentucky. Bluegrass, for example, is very well adapted to central and eastern Kentucky but not well adapted to southern and western areas.*

Table 2-3. Characteristics of Perennial Legumes in Kentucky

Legume	Tolerance to: Heat/ drought	Wet	Winter hardiness	Haying	Grazing	Acidity	Seedling vigor	Bloat risk
Alfalfa	E[1]	P	E	E	F	P	G	Yes
B. trefoil	G	G	G	G	F	G	P	No
Crown-vetch	G	P	F	P	F	G	P	No
Sweet clover	E	P	E	P	F	P	G	Yes
Red clover	F	F	F	E	G	F	E	Yes
White clover	P	F	P	P	E	F	F	Yes
Alsike clover	F	G	P	P	F	G	G	Yes

[1] *E=Excellent, G=Good, F=Fair, P=Poor.*

grasses, such as tall fescue or bluegrass, to minimize soil erosion. Use alfalfa with a cool-season grass where soils are at least 2 feet deep and well drained. On soils that are less than 2 feet deep or poorly drained, use clover-grass mixtures or pure grass stands. Legumes may be established in grass-dominant sods through renovation. For more information on pasture renovation, see Cooperative Extension publication AGR-26, "Renovating Hay and Pasture Fields."

Match plants to the intended use. Plan for maximum quality and versatility in the forage program. Select plants that produce high quality feed, and plan to use each field for hay, silage, and/or pasture as weather and feed needs dictate. Legumes generally produce higher quality feed than grasses, resulting in higher animal performance. Use legumes as much as possible. Taller-growing legumes, such as alfalfa and red clover, are more versatile than a legume like white clover, which is used primarily for grazing. Grasses such as orchardgrass, timothy, and tall fescue are better adapted than bluegrass for hay and silage. Timothy-alfalfa mixtures give the benefits of a mixed alfalfa-grass stand in the first cutting while producing almost pure alfalfa in later cuttings (very little timothy growth occurs after the first cutting). The grass helps control weeds by filling in between alfalfa crowns and aids in getting the first hay harvest cured. With timothy-grass mixtures especially, subsequent harvests during the season are almost pure alfalfa. Owners of horses or dairy cattle often prefer later cuttings because of their high forage quality and freedom from mold and weeds.

Table 2-4. Forage Quality Values for Selected Forages

Crop	CP, %	ADF, %	NDF, %	TDN, %	RFV
Alfalfa					
Bud	22-26	28-32	38-47	64-67	127-164
E. bloom	18-22	32-36	42-50	61-64	113-142
Mid bloom	14-18	36-40	46-55	58-61	98-123
Corn Silage					
High grain	7-9	23-30	48-58	66-71	105-138
Low grain	7-9	30-39	58-67	59-66	81-105
Cool-season Grass					
Veg/boot	12-16	30-36	50-56	61-66	101-122
Boot/head	8-12	36-42	56-62	56-61	84-101
Warm-season Perennial Bunchgrass					
<Boot	10-14	35-40	55-60	58-62	90-104
Mature/head	6-10	40-50	60-75	50-58	62-90
Warm-season Annual Grass					
	10-14	35-40	55-60	58-62	90-104
Red clover					
E. flower	14-16	28-32	38-42	64-67	142-164
L. flower	12-14	32-38	42-50	59-64	110-142
Ann. lespedeza	12-16	35-40	45-55	58-62	98-127

Select high quality seed of an adapted variety. High quality seed is an essential step toward establishment and longevity of a forage stand. Such seed should have high percentages of germination and purity, low percentages of weed seed, and freedom from noxious weed seed. Certified seed meets or exceeds minimum standards for purity, germination, and quality and has a blue tag attached to the bag. The best assurance of the genetic purity of the variety selected is to plant certified seed, if available.

In addition, the certified seed should be from an "improved" variety adapted to your farm. Improved means the variety has been selected for improved yield, quality, persistence, disease resistance, or other positive traits. If you are uncertain about a variety's adaptation and performance, refer to UK forage variety test reports from your local county Extension office. It is never a good practice to plant large acreages to varieties of unknown performance or adaptation. Poor quality seed and/or unadapted varieties are never a bargain.

A 1993 comparison of the performance of certified, improved varieties of red clover to that of common medium red clover found that the better seed yielded an average of 1,000 pounds more dry matter per acre in the year of seeding, 2,000 pounds more in the second year, and 3,000 pounds more in the last year. The differences between the *best* certified red clover and the *worst* common red clover were twice these amounts, or nearly 12,000 pounds more yield per acre.

Supply proper fertility. Just as man and animals must have food to survive, plants need proper nutrition to survive and produce well. The soil is a reservoir of many nutrients needed by plants, but soils vary widely in their nutrient status and ability to supply essential minerals to plants. A deficiency of one element can limit forage plant growth and encourage weed encroachment. The most sensible approach to providing balanced fertility is to first test the soil to determine nutrient levels and then keep good records of fertilizer and lime applied to each field. A soil test is the most economical investment in your overall soil fertility program.

In Kentucky, the nutrients most limiting to growth are normally lime, nitrogen (N), phosphorus (P), and potassium (K). Boron (B) is also recommended for use where alfalfa is to be grown or where red clover is to be harvested for seed.

Prior to establishing a new stand, apply lime, phosphorus, and potassium as the soil test indicates they are needed. Where the cropping history of a field indicates nitrogen is needed at seeding, it is usually recommended at the rate of 30 pounds per acre on grass-legume mixtures and 50 pounds per acre for straight grasses. Annual applications of fertilizer subsequently should be made according to soil tests and/or nutrient removal from hay, haylage, or grazing.

Prepare an adequate seedbed. Till the soil to incorporate lime and fertilizers, destroy weeds and other vegetation, and prepare a level, firm seedbed. Reduce ridges and depressions to a minimum to make harvest machinery operation easier. Don't forget, this stand may be in the field for several years, so it is worth a little extra effort to get the soil surface smooth.

Seeding without tillage (no-till) requires control of existing vegetation by methods other than plowing or disking to prepare the site for planting. Control may come from very close grazing, mowing, or herbicides.

Inoculate legume seed, or use pre-inoculated seed. When properly nodulated, legumes such as alfalfa and clovers have a unique ability to convert large quantities of nitrogen from the air to a form plants use to make protein and other compounds necessary for growth. To ensure proper nodulation, inoculate all legume seed with the proper bacteria just prior to seeding or use pre-inoculated seed. Check the seed tags for the expiration date of the inoculum. Inoculate legume seed even if it has been grown in the field previously. To ensure that inoculum is stuck to each seed, use an appropriate commercial adhesive or sugar solution. Satisfactory results are obtained when a small amount of sugar solution is first added to seed and thoroughly mixed to get all seed moist, not wet. Then add the inoculum and mix again. If done properly, the peat in the inoculum mix absorbs excess moisture so seed flows well through the seeder.

Use proven seeding methods. Seeding can be done using aircraft, cyclone-type seeders, band seeders, cultipacker seeders, and drills with forage-box attachments. Each method can be successful if seeds are properly distributed, placed uniformly just below the soil surface (¼ inch to ½ inch), and firmed to give good seed-soil contact. Remember though, if the seeds are placed too deeply, they might not emerge. If they are placed at unequal depths, the stand will be uneven due to different emergence times. Also, remember that both the seed and the inoculum on legume seed must survive the seeding method. Seed germination and inoculum effectiveness can be lowered when mixed with fertilizer. Some cover over the seed aids inoculum survival and provides better seed-soil contact.

Seed at the right time with the correct amount of seed. Many cool-season grasses and legumes can be successfully seeded in either spring or late summer. Alfalfa, red clover, and white clovers are usually most successfully seeded in spring; however, late summer seedings can be successful if soil moisture is adequate. Many farmers prefer late summer and early fall seedings of such crops as alfalfa, fescue, bluegrass, timothy, orchardgrass, ryegrass, and small grains for forages because they can prepare seedbeds during favorable weather conditions and spread the year's work more evenly. In addition, there are often fewer weed problems than with spring seedings.

Lack of adequate moisture for germination and emergence is perhaps the major problem with late summer seedings. Cultipacking to get good seed-soil contact is highly desirable. Legume seed might be germinated by a small shower of rain but then perish if an extended dry period follows. One technique for avoiding problems caused by dry conditions is to have everything ready to seed but wait for at least an inch of rain before seeding. Seed as soon after the rain as soil conditions permit. This usually ensures that enough soil moisture is present not only to germinate the seed but to get the young, developing roots into moist soil. If rain doesn't come early enough to get plants established, you may plant the seed the following spring. For information on seeding rates and dates, see Cooperative Extension publication AGR-18, "Grain and Forage Crop Guide for Kentucky."

Control or manage competition from other plants. Most forage crops have small seeds and, therefore, much less seedling vigor than crops like corn. Competition from existing vegetation or encroaching weeds is the single biggest cause of seeding failures in Kentucky. Control competitive plants by mowing, grazing, or applying labeled herbicides. Mowing or grazing should remove the weed competition without removing extreme amounts of the newly seeded forage crop.

Allow forages to become established. Perennial forage crops need to develop an extensive root system; allow them to become fully established before heavily utilizing them. Allow new grass seedings to be cut for hay first before grazing. Allow spring seedings of legumes to show some bloom before the first harvest. There is no substitute for allowing pastures, especially, to become fully established before grazing. It might seem that there is not time to do this right, but stand failures demand more time to do it *over*.

Selecting Improved Forage Varieties

A forage variety should be high yielding, persistent, adapted to Kentucky, nutritious, palatable, and free from known antiquality components. In addition, it should be tolerant of the anticipated method of utilization and level of management.

Yield should always be a primary determinant in variety selection. Yield is more than an estimate of productivity; it is an indirect measure of the persistence and disease resistance of a variety. For example, alfalfa varieties that perform well at the Bowling Green site of the Kentucky Forage Variety Trials—a site infected with both phytophthora and aphanomyces—have proven they can tolerate these soil diseases and yield well and persist at the same time.

Tolerance of varieties to grazing is not well defined, and little information the subject exists. It is difficult to standardize what type of "grazing pressure" should be applied to varieties in a trial. Should it be abusive and heavy to evaluate persistence, or should it be "optimal" to evaluate animal performance? Research is ongoing at the University of Kentucky to evaluate varieties of alfalfa, red clover, tall fescue, orchardgrass, and other species under abusive, continuous grazing to answer questions about persistence. Initial observations of all crops indicate that most varieties can tolerate overgrazing for one season.

Several varieties of alfalfa are currently being marketed as grazing types. The first of these was AlfaGraze, a product of the forage breeding program at the University of Georgia. Several others, such as Pasture Plus, Pro-Grazer, Haygrazer, Spredor 3, and Graze King, have been subsequently released and marketed. Many more are expected.

Independent data on the true grazing tolerance of these varieties is either scarce or not available. However, mature stands of AlfaGraze in Kentucky have been grazed moderately (a mixture of long rotation and continuous grazing) for more than five years. These stands have shown a "normal" decline in plant density as would be seen in any alfalfa field. However, compared to Apollo, AlfaGraze had denser and more vigorous stands at the end of five seasons of use (Table 2-5). The breeding procedure used to develop AlfaGraze has been followed by breeders across the United States to develop similar varieties that will tolerate grazing better than traditional hay-type varieties.

Table 2-5. The Effect of Moderate Grazing Pressure on Stand Density and Vigor[1] of Two Alfalfa Varieties after Five Seasons of Use[2] on a Lincoln County, Kentucky, Beef Cattle Pasture

Variety	Plants per square foot	Percent ground cover
AlfaGraze[3]	1.9	23.5
Apollo	0.6	5.5

[1] *Seeded March, 1990. Interseeded with orchardgrass two years after seeding.*

[2] *Data are averages of 10 random locations within the field, taken 9/30/94.*

[3] The variety effect is highly significant (P = 0.01).

Variety yield data is collected annually in Kentucky on alfalfa, red clover, tall fescue, orchardgrass, and timothy. The data is regularly published as Progress Reports of the Agricultural Experiment Station of the College of Agriculture at the University of Kentucky. These reports are available at local county Extension offices.

Some varieties have been selected for improved animal performance or for higher forage quality. In particular, alfalfa has been selected to emphasize the "multifoliate" trait (so that each leaf has more than the normal three leaflets). In addition, Johnstone tall fescue was selected for higher forage digestibility. Studies on the effect of the multifoliate trait or selection for quality on the annual forage quality of alfalfa in Kentucky have shown a tendency for "high quality" varieties to have slightly higher protein (0.5 to 1 percentage unit) and higher relative feed values (4 to 5 units). However, this difference could not consistently be found in any one of the "high quality" varieties. Therefore, selecting alfalfa varieties based on the traditional parameters of yield, persistence, and disease resistance is not improved by selecting for quality. Certainly selecting a variety for quality would not be worth sacrificing much yield.

Resistance to known pests is desirable in all varieties. The disease and insect resistance of alfalfa varieties is well documented, while that of tall fescue and other species is not. Often the best indicators of pest resistance are high yield and good persistence in forage variety trials.

The Value of Improved Forage Varieties

A significant amount of forage seed is purchased annually in Kentucky. Approximately 1 million pounds of alfalfa seed are required for the 50,000 acres of alfalfa reseeded each year. If 10 percent of the fescue acreage is overseeded with red clover at the rate of 10 pounds per acre, more than 5.5 million pounds of red clover seed move across agribusiness counters in the state. Grass seed sales are somewhat harder to estimate but are significant for new hay fields or as cover crops behind tobacco or wheat. In addition, orchardgrass is usually included in mixes with new alfalfa seedings. Conservatively speaking, more than 600,000 acres of land in Kentucky are seeded or overseeded annually with some type of forage. Therefore, improving productivity of these acres by choosing an improved variety has a large impact on the potential farm income from forage livestock systems. These improved varieties should represent an increase in yield, persistence, and disease/pest resistances.

Benefits from Using Certified, Improved Forage Varieties

Farmers should plant seed that is both certified and of an improved variety. Both aspects are important. Certified seed has a blue tag from a noncommercial agency indicating that certain basic seed production standards have been met. In addition, the blue tag is an independent assessment that minimum standards for germination, purity, freedom from weed and other crop seed, and other factors have been

met. However, being certified does not always indicate that the variety itself is good. In other words, certified junk is still junk.

Select varieties that are "improved." This means the genetics of the seed represent something superior to what has been grown in the past. Claims of superior performance should be supported by independent university tests, such as the yield trials conducted as part of the University of Kentucky Forage Variety Testing Program.

Seed quality standards of companies marketing newer certified varieties of forage crops often exceed those required for certification. For example, the minimum requirement for germination of certified red clover seed is 85 percent. However, companies may specify that total germination be 90 percent, depending on their standards. Certified seed is free of other crop seed, inert material, and weed seed.

Certified seed is your assurance that the performance on your farm will match the name on the bag. Common or uncertified seed is an unknown product whose performance cannot be predicted. UK tests of common red clover seeds indicate that they do not yield or persist like certified, improved varieties.

There is quite a bit of confusion about whether buying uncertified Kenland means you are buying an improved variety. Much red clover seed is marketed each year as uncertified Kenland. The perception is that buying a "name" variety means buying an improved variety. However, seed producers can market any medium red clover seed they produce as Kenland. Seed can be sold under the names of any variety developed by public institutions or even companies as long as that variety was not plant variety protected (PVP).

UK research has shown that the performances of uncertified lots of Kenland vary greatly and in general are much poorer than those of certified varieties (Table 2-6). Sigafus and Taylor found that out of 10 uncertified lots of Kenland seed from a variety of sources, only two had any measurable yield in the third year after seeding into wheat compared to 3.4 tons per acre for Kenstar. Six of the uncertified lots produced less than half the yield of Kenstar in the second (primary) year of red clover growth.

Generally, all newer varieties released by universities or companies protect the name of the variety by a process known as plant variety protection. You will seldom find uncertified Renegade, Redland III, Cinnamon, or other privately owned and marketed red clovers because seed of these varieties cannot be marketed without permission of the companies that own them. However, with older varieties, like Kentucky 31 tall fescue and Kenland red clover, seed can be sold under the name without certification. The best way to be sure you will get the performance to match the name is to look for the blue certified seed tag.

Produce for Yield

The objective of the "establishment" phase of forage management is to get a good, thick stand of the species or

Table 2-6. Yields in 1978-79 of Certified Kenstar, Uncertified Kenland, and Several Lots of Common Red Clover (Sown at Lexington, March 25, 1977)[1]

				1979 Yields[2]				
Seed origin	Lot number	Identification	1978	May 29	July 3	August 13	Total	2 -yr. total
				tons dry weight per acre				
Ky.	59-L38-1554	Kenstar	4.00 a	2.06 a	0.98 a	0.36 a	3.40 a	7.40
Ore.	FSA-4778	Kenland	3.67 ab	1.76 b	0.76 b	0.16 b	2.71 b	5.46
Ky.	0-1384	Variety unknown	3.25 bc	1.72 b	0.77 c	0.15 b	2.53 bc	5.78
Ill.	0.340	Red clover	2.95 cd	1.42 d	0.44 e	0.10 c	1.96 e	4.91
Mo.	0-964	Variety unknown	2.91 cd					2.91
Ore.	0-402	Kenland	2.65 de	1.67 c	0.65 d	0.13 c	2.45 d	5.10
Ore.	0-473	Kenland (Aff.)	2.26 ef					2.26
Ore.	0-104	Kenland	2.17 ef					2.17
Ida.	0-533	Red clover	2.17 ef					2.17
Ohio	0-125	Variety unknown	2.06 e-g					2.08
Ore.	0-243	Kenland	1.93 fg					1.93
Mich.	0-229	Medium red	1.90 fg					1.90
Ore.	FSAM-4772	Kenland	1.68 f-h					1.68
Ore.	0-787	Kenland	1.51 gh					1.51
Ore.	0-282	Kenland	1.12 hi					1.12
Ore.	0-371	Kenland	0.67 ij					0.67
Minn.	0-111	Red clover	0-58 ij					0.58
Ore.	0-370	Medium red	0-51 j					0.51
Ore.	0-115	Red clover	0-41 j					0.41
Ore.	0-730	Kenland	0.24 j					0.24

[1] Seeded in wheat. Harvested in 1977 but no yields recorded. Yield after wheat in 1977 would have averaged less than 1 T/A.

[2] Where no yield is indicated, essentially no yield was produced. At best there were only one or two plants per plot. Results indicate that in the seed lots labeled Kenland, some were not Kenland. These lots of seed are typical of uncertified red clover seed sold in Kentucky.

Source: Kentucky Forage Variety Trials - 1979. R.E. Sigafus and N.L. Taylor. UK Ag. Exp. Stat. Progress Report 246.

mixture seeded. Good stands of forage crops have the potential for high yields, adequate nutritive quality, and acceptable stand persistence. Each of these components (yield, quality, and persistence) is critical to an effective, economical forage program. It can be argued, however, that yield is most critical.

Yield is important because it represents how many bales of hay, loads of silage, or days of grazing come from a particular field. Higher yield from the same or similar inputs ultimately means more profit.

Many factors affect forage yield. Weather, soils, fertility, species and mixtures, varieties, weeds, insects, diseases, age of plants, when harvested, harvesting method, and efficiency are some of the important factors. We, as managers, can control to some extent all of these factors except the weather. Our challenge is to control to the extent possible those factors that have the greatest impact on yield consistent with acceptable quality and persistence.

Forage species vary in their abilities to produce dry matter yield. The highest yielding forages in Kentucky include the summer annual grasses, corn silage, and alfalfa. However, timothy, tall fescue, orchardgrass, and red clover are also highly productive. Lesser yielding species include bluegrass and annual lespedeza.

Many varieties are available for most species commonly grown in Kentucky. Most of these varieties are tested in locations across Kentucky. Careful consideration in selecting varieties of either grass or legumes can pay big dividends in your overall forage production program. For the latest University of Kentucky Variety Reports, check your county Extension office or contact your State Forage Extension Specialist.

Soils and soil fertility vary greatly across Kentucky and even within most farms. Soils vary in depth, texture, structure, drainage, organic matter, water holding capacity, and fertility. Although we can modify fertility, the remaining soil characteristics cannot be changed much and major changes can require considerable time and expense.

Soil characteristics determine the species or mixtures we can grow most efficiently over the longest period of time.

Soil fertility and fertilizer needs are best determined by soil testing. A soil test is the most important and economical investment in an overall forage fertility program. Kentucky data indicates that only 10 percent of pasture land has had a soil test. Of land that is soil tested, 40 percent is below pH 6.0, 45 percent is low in phosphorus, and 35 percent is low in potassium.

Nitrogen is the most limiting nutrient in forage production. On many Kentucky livestock farms, most of the nitrogen can be supplied through legumes. In several situations, however, application of nitrogen fertilizer could and should be considered. Applying nitrogen to warm-season annual and perennial grasses can produce high yields. Using nitrogen on cool-season grasses can extend the growing season for earlier and later grazing. Adding nitrogen when tall fescue begins to green up in early spring usually results in pasture available for grazing seven to 12 days earlier than non-fertilized grass. Adding nitrogen to tall fescue or Kentucky bluegrass in mid August (stockpiling) and accumulating fall-grown pasture for late fall/early winter grazing can extend the grazing season and reduce the amount of stored feed required.

Forage crops harvested as hay remove large amounts of nutrients (Table 2-7). In addition to lime, P, and K, nitrogen and minor elements are also removed. To ensure optimum yields, add fertilizer elements. Consult AGR-1 for recommendations on lime, phosphorus, and potassium to be applied to grass, grass-legume, or legume based hay fields.

Approximately 85 percent of all nutrients consumed by grazing animals are returned to pasture. The fertilizer elements in feces and urine can be valuable in a grazing program. Unfortunately, in continuous grazing programs, most of the manure and urine is concentrated around water and shade. You can distribute nutrients more evenly with more controlled grazing programs and timely use of chain harrows.

Weeds, insects, and disease can reduce yield of forage grasses and legumes. Weeds compete with hay/pasture plants for water and nutrients. In addition, certain weeds and other weeds at certain times of the year can be toxic to animals.

Insects and diseases often damage or destroy leaf tissue. Leaves are the highest quality part of the plant. As leaves are damaged or destroyed, yield and quality is reduced.

Monitor weeds and insects, and control them any time a threshold level of infestation occurs. Select the most efficient, economical control measure available. Diseases are best controlled when selecting varieties. Choose an adapted, certified variety with as much resistance to problem disease as available.

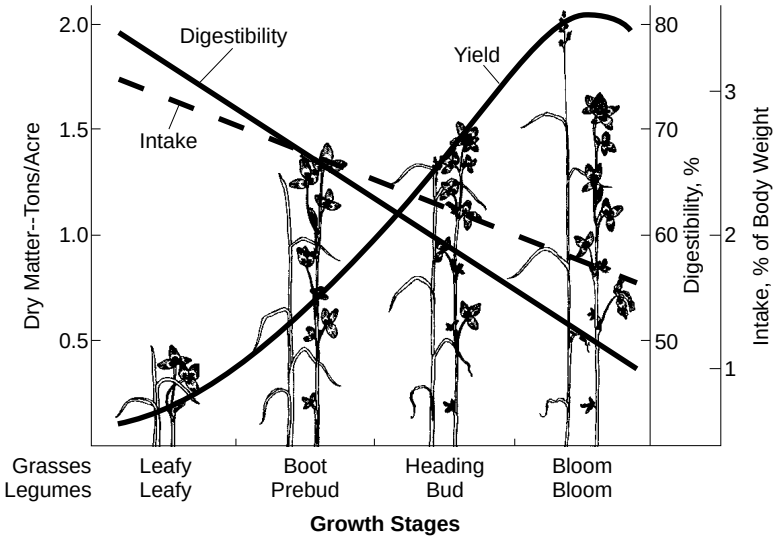
Cutting management affects yield, quality, and persistence either directly or indirectly. As any perennial forage plant advances from the young (leafy) stage to the mature bud-flower-seed (reproductive) stage, several things happen (Figure 2-5). Most characteristics associated with quality, such as digestibility and intake, decline as yield increases. The challenge is to harvest at a stage that results in good yield, adequate quality, and acceptable stand persistence. This stage for legumes and first-cutting grasses is usually when they are changing from the vegetative stage to the reproductive stage.

Table 2-7. Nutrients Removed by Hay Crops

Crop	Yield/acre (in tons)	Approximate lbs/acre removed		
		N	P_2O_5	K_2O
Alfalfa	5	255	68	245
Red clover-orchardgrass	4	136	47	204
Tall fescue, orchardgrass, timothy	3	87	29	144

Source: K.L. Wells and W.O. Thom. 1994. Estimated nutrient and uptake by Kentucky's Crops. Soil Science News and Views Vol. 15, No. 4.

Figure 2-5



Harvest for Quality: Importance of Hay Quality

The ultimate test of hay quality is animal performance. Quality can be considered satisfactory when animals consuming the hay give the desired performance. Three factors that influence animal performance are: (1) consumption—hay must be palatable if it is to be consumed in adequate quantities; (2) digestibility and nutrient content—once the hay is eaten, it must be digested to be converted to animal products; and (3) toxic factors—high quality hay must be free of components which are harmful to animals consuming it.

Factors Affecting Hay Quality

Stage of maturity when harvested is the most important factor affecting hay quality and the one in which greatest progress can be made. As legumes and grasses advance from the vegetative stage to the reproductive (seed) stage, they become higher in fiber and lignin content and lower in protein content, digestibility, and acceptability to livestock. The optimum stages of maturity to harvest for high quality and long stand life of many hay crops are listed in Table 2-8. Making the first hay cut early permits aftermath growth to begin at a time when temperature and soil moisture are favorable for plant growth and generally increases total yield per acre. The effects of stage of harvest on fescue hay quality and animal performance are shown in Table 2-9. Similar effects have been noted with alfalfa (Table 2-10). In both cases, early cut hay resulted in high quality feed and superior animal performance.

Curing and handling conditions can greatly affect hay quality. Poor weather and handling conditions lower hay quality. Rain can cause leaf loss and can leach nutrients from plants during curing. Sunlight can lower hay quality through bleaching and lower Vitamin A content. Raking and/or tedding dry, brittle hay can cause excessive leaf loss (Table 2-11).

Hay plants with an 80 percent moisture content must lose approximately 6,000 pounds of water to produce a ton of hay at 20 percent moisture. Crushing stems (conditioning) at time of mowing causes stems to dry at nearly the same rate as leaves. Conditioning usually decreases the

Table 2-8. Recommended Stages to Harvest Various Forage Crops

Plant species	Time of harvest
1. Alfalfa	Late bud to first flower for first cutting, first flower to 1/10 bloom for second and later cuttings.
2. Bluegrass, orchardgrass, tall fescue or timothy	Boot[1] to early head stage for first cut, aftermath cuts at 4- to 6-week intervals.
3. Red clover or crimson clover	First flower to 1/10 bloom.
4. Oats, barley, or wheat	Boot to early head stage.
5. Rye and triticale	Boot stage or before.
6. Soybeans	Mid to full bloom and before bottom leaves begin to fall.
7. Annual lespedeza	Early bloom and before bottom leaves begin to fall.
8. Ladino clover or white clover	Cut at correct stage for companion plant.
9. Sudangrass, sorghum hybrids, pearl millet, and johnsongrass	40-inch height or early boot stage, whichever comes first.
10. Bermudagrass	Cut when height is 15 to 18 inches.
11. Caucasian bluestem	Boot to early head stage.
12. Big bluestem, Indiangrass, and switchgrass	Early head stage.

[1] Boot is stage of growth of a grass just prior to seedhead emergence. This stage can be identified by the presence of an enlarged or swollen area near the top of the main stem.

Table 2-9. Effect of Stage of Harvest of Fescue Hay on Quality and Animal Gain[1]

Stage of harvest	Dry matter intake lb/day	Percent digestibility	Percent protein	lb. of hay fed per lb. gain	lb. of hay per acre 1st cutting	lb. of gain per day
Late boot to head, cut May 3	13.0	68	13.8	10.1	1334	1.39
Early bloom stage, May 14	11.7	66	10.2	13.5	1838	.97
Early milk stage—seed forming, May 25	8.6	56	7.6	22.5	2823	.42

[1] Holstein heifers were used, average weight: 500 pounds.
Source: Personal Communication, Monty Montgomery, University of Tennessee.

Table 2-10. The Effect of Alfalfa Hay Quality on Performance of Beef Steers[1]

	Good	Fair	Poor
Crude protein	18.7	15.9	13.7
Crude fiber	29.4	35.4	46.7
Animal performance			
Hay consumed, lb/day	17.1	16.5	13.8
Gain, lb/day	1.85	1.49	-0.06

[1] 550 lb. beef steers.
Source: A. S. Mohammed et al., 1967. Tennessee Farm and Home Science Progress Report 61. Pp. 10-13. University of Tennessee Agricultural Experiment Station, Knoxville.

Table 2-11. The Effect of Handling Conditions on Alfalfa Hay Losses

		Losses			
	Raked and baled correctly	Raked too dry	Baled too dry	Raked and baled too dry	Total
	lb/A	lb/A	lb/A	lb/A	Percent
Dry hay	2900	700	100	1000	34
Crude protein	660	210	60	290	44
T.D.N.	1710	480	90	690	40

Source: Alfalfa Hay Quality. D. Ball, T. Johnson, G. Lacefield, and H. White. Special Publication. Certified Alfalfa Seed Council. Davis, CA.

drying time of large-stemmed plants by approximately one day and can result in leaf and nutrient savings. Raking and/or tedding while hay is moist (about 40 percent moisture) and baling before hay is too dry (below 15 percent moisture) helps reduce leaf losses (Table 2-11).

Hay preservatives allow hay to be safely baled at greater than 20 percent moisture (small bales) and 18 percent moisture (large packages) when the preservatives are properly applied at baling. Effective hay preservatives prevent excessive heating and mold growth when applied uniformly and at the correct rate on moist hay.

The most proven forms of hay preservatives currently marketed in Kentucky are the propionic acid types. Early propionic acid products were either propionic acid or a mixture of propionic acid and acetic acids. Though effective, these products were not well accepted or widely adopted for many reasons, including their tendency to remove paint from balers, their offensive and penetrating odor, and the irritation of exposed skin that came in contact with the material.

Today the primary forms of propionic acid hay preservatives on the market are "buffered" products that are less volative, less harmful to paint, and less offensive to nasal passages and exposed skin. When applied uniformly and at the proper rates for the moisture of the hay (Table 2-12), the buffered materials are effective in reducing hay heating and molding in storage. In a UK study, alfalfa hay treated with a buffered propionic acid heated less and and was less dusty than both untreated wet hay and hay treated with a hay inoculant. In contrast, the inoculant product did not decrease heating or dustiness compared to the moist control.

Hay handled in a rough manner before it gets to the animal can lose an excessive amount of leaves. For the average bale (14 inches x 18 inches x 30 inches), about 29 percent of its total volume is contained in a l-inch depth all around the bale. For large round bales, the outer 4 inches contain roughly 25 percent to 30 percent of its total volume. This means a large portion of the bale is exposed and care in handling and storage should be practiced to minimize loss.

Adequate amounts of lime, nitrogen, phosphate, potash, and minor elements are needed to produce high yields of hay per acre and to maintain stands of desirable plants for a long period of time. Use a soil test as a guide in determining the amount of fertilizer and lime needed for economical hay production.

High yields of hay remove large amounts of nutrients (Table 2-7). Since properly inoculated legume plants are capable of fixing atmospheric nitrogen, mixtures containing more than 25 percent legumes usually do not give economical responses to nitrogen fertilization. With pure grass stands, nitrogen must be added for high levels of production.

Legumes are normally higher in quality than grasses, but within each group there can be a wide range of quality. When both grasses and legumes are harvested at the proper stage of plant growth, legumes are usually higher in total digestibility, rate of digestion, protein, and many minerals and vitamins. A mixture consisting of an adapted grass and legume is usually of high quality when properly managed. In addition, grasses can improve the drying rates of mixed stands compared to pure legume stands. Perennials, such as alfalfa, orchardgrass, timothy, fescue, and bermudagrass,

Table 2-12. The Effect of Hay Preservative Type on Post-storage Moisture Concentrations, Storage Losses, and Visual Characteristics of Alfalfa Hay

Treatment	Initial moisture (%)	Final moisture (%)	Peak temperature (degrees F)	Dry matter intake % of body weight[1]	Dust[2] rating
Wet control	21.6	13.0 b[3]	88	2.11 a	4.72 a
Buffered propionic acid	21.0	14.8 a	80	2.20 b	3.32 b
Inoculant	22.0	12.1 c	90	2.11 a	4.79 a
Dry control	12.2	12.4 c	75	2.32 c	1.96 c

[1] Dry matter intake = 110/neutral detergent fiber.

[2] Dust ratings are on a 1 to 10 scale, with 1 being dust-free and 10 being extremely dusty.

[3] Values within a column followed by different letters are statistically different.

are usually more economical for hay crops than annuals, although annuals such as sorghum-sudangrass hybrids, pearl millets, small grain, lespedeza and ryegrass can be used effectively.

Plant certified seed of adapted, improved varieties tested and proven under local conditions. For example, stands seeded with common medium red clover are visibly shorter and thinner than those from certified, improved varieties even in the seeding year. Over three years, improved varieties of red clover averaged 2.89 tons more dry matter yield per acre than common medium red clover. The maximum difference in total yield over three growing seasons between the best improved and worst common clover seed lot was 4.93 tons of dry matter per acre.The largest differences came in the third growing season when stands from common clover seed lots were essentially nonproductive.

Weeds generally lower hay quality by adding material lower in palatability and digestibility. Some may be harmful or toxic. Certified seed is free from most weed seed, which is especially important in perennial hay crops.

Seed at recommended rates and dates for the desired forage crop (see AGR-18 for specific dates and rates for most Kentucky forage crops). Perform fall seedings early enough for establishment before cold weather stops or slows growth. Make late winter and early spring seedings early enough to provide a vigorous stand to survive summer drought and weed competition.

Evaluating Hay Quality

Forage testing is the most practical way to determine the nutrient content of hay. If hay is stored so that a representative sample can be taken and analysis is done by a reputable laboratory, forage nutritional results can be used to assess quality and to determine the amount and type of supplementation needed for the desired level of animal production. Using an instrument to obtain a core sample of hay is one of the most reliable methods of getting a representative sample for nutritional analysis. Matching hay to different classes of livestock based on nutriental content of the forage and the requirements of the animal can lead to a more efficient forage-livestock program.

A visual estimate can be helpful in determining forage quality but is not as reliable as forage testing. Hay that is early cut, green, leafy, soft, and free of foreign material and has a pleasant odor is high quality. However, color and visual appearance are not always good indicators of hay nutritive quality.

Important Terms on a Forage Analysis Report

Several terms are common to most forage analysis reports. Understanding the basic meanings of these terms is necessary to evaluating the quality of hay.

Crude protein (CP) is the amount of nitrogen in the forage multiplied by 6.25 percent. Total nitrogen in forages is used to estimate the amount of actual protein present. Since the ratio of protein to percent nitrogen in forages is fairly constant at 6.25 to 1, the protein content of forages is estimated by measuring total N and multiplying by 6.25.

Acid detergent fiber (ADF) is the fraction of the forage most highly correlated to digestibility. All energy estimates on forage reports are calculated from ADF. Forages with lower ADF are higher in digestibility or energy and are more valuable to beef cows. ADF values rise with advancing maturity. Kentucky forages have ADF values ranging from 30 to 45 and higher. Energy estimates calculated from ADF include total digestible nutrients (TDN) and net energy (NE). ADF is also used to help calculate relative feed value (RFV).

Neutral detergent fiber (NDF) is the total fiber present in the forage. NDF values also go up with advancing maturity. NDF is highly correlated to intake of the forage by beef cattle. As NDF goes up, potential intake by beef cattle goes down, making low NDF values desirable. The NDF values of Kentucky forages range from 40 to 65 and above. NDF is used to estimate intake and to calculate RFV.

Relative feed value (RFV) is an index that allows forages to be compared based on their digestibility and intake as calculated from ADF and NDF. This index was adjusted so that full bloom alfalfa would have an RFV of 100. Good legume or grass-legume hays should have RFVs above 110, while good grass hays should have RFVs of 90 to 100. (See ID-101, “Interpreting Forage Quality Reports” for more information.)

Coping with the Tall Fescue Endophyte

Tall fescue (*Festuca arundinacea* Schreb.) is presently grown on approximately 5.5 million acres in Kentucky. It is a versatile perennial used for livestock feed, various turf purposes, and erosion control. Commonly referred to as simply "fescue," this widely adapted, persistent grass is easy to establish and tolerant of a wide range of management regimes and produces good forage yields. Laboratory nutritive analyses of fescue compare favorably to those of many other cool-season grasses. However, most older fields of fescue in Kentucky are infected with a fungus (*Acremonium coenophialum*) that results in unthrifty cattle conditions, especially during hot weather. This condition is referred to by the terms "summer syndrome," "summer slump," "fescue toxicosis," and "fescue toxicity." In studies, animals consuming endophyte-infected fescue have shown the following responses in comparison to animals grazing non-infected fescue: (1) lower feed intake, (2) lower weight gains, (3) lower milk production, (4) higher respiration rates, (5) higher body temperatures, (6) rough hair coats, (7) more time spent in water, (8) more time spent in shade, (9) less time spent grazing, (10) excessive salivation, (11) reduced blood serum prolactin levels, and (12) reduced reproductive performance. Some or all of these responses have been observed in numerous studies in dairy cattle, beef cattle, and sheep consuming endophyte-infected pasture, green chop, hay, and/or seed.

In Kentucky, more than half the plants were infected in 83 percent of the fields sampled and more than half the fields had 80 percent or higher infection levels.

The fungus spends its entire life inside the fescue plant and is spread only by seed. The presence of the fungus does not change the appearance of the plant, and its presence can only be detected by a laboratory analysis. Because it is spread only by seed, a field established with non-infected seed can be expected to remain free of the endophyte unless infected seed is introduced through hay or manure.

Dealing with Existing Endophyte-infected Stands

Producers with established fescue fields need to carefully assess their situations. Existing fescue stands should be tested on a field-by-field basis. County agricultural agents can provide information regarding cost, sampling methods, and laboratory addresses.

Once the level of endophyte in existing fescue pastures is known, a producer can select the best option for dealing with the problem. The best way to handle one field may not be best for another. Four general approaches are available:

Minimize the effects of the endophyte on animals with management practices. Grazing and/or clipping management that keeps plants young and vegetative results in better animal performance. Likewise, if fescue is cut for hay in the boot stage, better animal performance is obtained from late-cut hay. Other practices, such as chain harrowing, fertilizing, pest control, creep grazing, and rotational grazing, result in improved overall pasture quality and animal performance.

Avoid the endophyte by using other forage species. Using infected fescue in spring and fall with other grasses or grass-legume mixtures for summer grazing avoids the endophyte during the summer when fescue forage quality is low. Since animal performance is adversely affected by feeding infected fescue hay, feeding of hay of another species can also be helpful.

Dilute the endophyte or its products through the use of other feeds in the diet. Growing legumes with infected fescue is an attractive option. Many studies have shown increased pasture production, higher liveweight gains, and improved pregnancy rates when pastures are renovated to include legumes. This has been the number one strategy used by Kentucky producers.

Kill infected stands and replant. Low-endophyte or endophyte-free seed is available. Several varieties of endophyte-free fescue have been released, and others are expected.

The cost of converting from high- to low-endophyte fescue varies. Where fescue is used in rotation with other crops, the only difference in cost is the small price difference between low- and high-endophyte seed. Where the sod is killed with a herbicide and the seed drilled into the killed sod, the cost may be $30 to $50 per acre. Where existing fescue is destroyed by tillage and immediately replanted, the cost may be $100 or more per acre.

Prevent fescue seedhead formation by heavy grazing, clipping, or chemical application. Do not allow any infected fescue field which is to be replanted to produce seed during the re-establishment year. This is for the purpose of preventing seed production which could lead to the establishment of volunteer infected plants.

Methods of Replacing Endophyte-infected Stands

Rotating with other crops, followed by seeding endophyte-free fescue, is an excellent approach to replacing endophyte-infected stands. Options range from no-till corn or a summer annual grass to longer term rotations involving a perennial such as alfalfa or two or three annual crops. With any rotation option, careful consideration must be given to herbicide residues, erosion hazards (leave all waterways—it's better to have a highly infected sod waterway than a non-infected gully), and complete destruction of the old fescue.

Plowing can help destroy the old sod. Endophyte-free tall fescue may be replanted into the prepared seedbed. However, it is often difficult to completely destroy an old fescue sod by tillage alone.

Chemical kill of infected stands followed by no-tillage planting might be the only option remaining if crop rotation or plowing are not viable options. This technique can be used to go directly from infected fescue to non-infected fescue, or other forage crops can be used in a rotation. It is critical that chemicals be used effectively, killing all the existing infected fescue. Furthermore, in some cases there

may be common bermudagrass or other species which must also be killed, requiring the use of more than one herbicide or a higher herbicide rate. Effective sod kill requires attending to label instructions and striving for optimum environmental and plant conditions that permit greatest chemical effectiveness. Consult state recommendations on chemical, rates, and time of application.

Best results from no-till tests have been found with late summer or early autumn seedings of fescue. Although chemical kill has been satisfactory in spring, summer drought and competition from warm-season annual weeds tend to reduce stands of spring-seeded fescue.

Using no-till plantings of annual forages after killing infected fescue is a particularly effective approach. For example, infected fescue can be chemically killed in the spring and a summer annual grass can be drilled into the killed sod, followed by no-till planting of non-infected fescue in the fall. Similarly, fescue can be killed in the fall followed by sod planting of winter annuals and, if desired, sod planting of a summer annual grass the next spring. In this case, non-infected fescue would be planted one year after the infected fescue was killed. Use of annuals in this manner "smothers" fescue plants that escaped the chemical treatment and reduces the likelihood of insects in the old fescue sod damaging seedling fescue plants.

Improved Grazing Systems

There are many significant benefits for cattlemen who increase their efficiency through improved grazing systems. Most of Kentucky's pastures are too large to be efficiently utilized. Forage is often overgrazed and undergrazed in the same field in the same year, even several times a year because the stocking rate is not changed or pastures are not rotated.

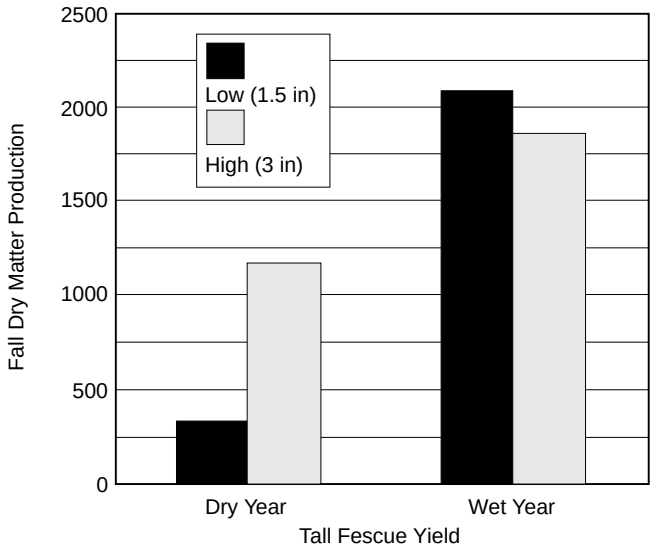
Overstocked pastures lead to weak, slow growing plants that do not produce to their genetic potential. Forage that gets overmature due to lax grazing pressure lowers animal production. Some overmature forage dies before it is consumed, which is forage yield grown but never consumed. Finally, the cost of supplying a cow's daily protein and energy needs by grazing is about one-third to one-half that of stored feed.

Improved grazing systems offer exciting possibilities for making beef cattle operations more efficient. First it is very important to understand how grasses and legumes grow and how these plants respond to defoliation by grazing.

The growing point of grasses is at or near the soil surface, while that of legumes is elevated above the ground (white clover is an exception). When grasses are grazed, only the leaf area is removed and the growing point stays intact. After being grazed, grasses have more residual leaf area with which to support new growth rather than relying mostly on stored carbohydrates.

With upright legumes, such as red clover and alfalfa, grazing removes the growing tip. New shoots must come either from crown buds or from the lower portions of shoots. The energy for this new growth comes almost totally from carbohydrates stored in the crown. These carbohydrates need to be replenished during a "rest" period following grazing.

Figure 2-6



Overgrazing of grasses takes away the residual green leaf area needed to support new growth (Figure 2-6). Therefore grasses also use some stored carbohydrates for regrowth, and rest periods can be important for grasses too.

Frequent defoliations hurt legumes more than grasses because legumes rely more on stored carbohydrates for regrowth and because grazing removes their growing point and a greater proportion of their leaf area. In most cases, grazing management should favor the legumes present.

How to Know When to Rotate

As a rule of thumb, individual fields should be grazed for two to seven days followed by approximately four weeks of regrowth. Fields should be sized or stocked so that the desired amount of forage can be removed in two to seven days. Shorter times on each paddock or subdivision result in less wastage, less spot grazing, and greater season-long utilization rates. Longer grazing periods allow animals to graze regrowth of forages, leading to uneven forage growth and reduced yield and persistence of forages in the overgrazed areas.

The following guidelines also aid in deciding when cattle should be moved to the next field:

Look at the cattle to see if they are acting hungry. Are they grazing at their usual times, or are they just standing at the gate?

Look at the present paddock. Keep enough forage before the cattle so that intake is not limiting. Evaluate the quality of the remaining forage and decide if it will support the level of production desired.

Look at their next paddock. If the next paddocks are getting too tall or too mature, consider moving animals before they have completely finished with their present paddock. This happens frequently during the spring or times

of rapid growth. Some paddocks may need to be taken out of the rotation and harvested for hay rather than letting them get overmature.

Look at their last paddock. Observe how fast it is growing back after grazing. Slow growth may be an indication that growth rates are slowing down and that paddocks should be given more rest between grazing. Often this may mean adding more pasture to the system or selling off the heavy end of a group of calves or just feeding some hay until growth catches up.

Look at the sky. Take into consideration what the weather is supposed to do. If heavy rains are expected, move to sacrifice paddocks of grass so legumes are not trampled out of stand.

Grazing Mathematics: Defining Paddock Number, Size, and Total Acres Needed for a Grazing System

Several questions arise in the development of a grazing system, such as how many paddocks to have in a given pasture system, total number of acres required, stocking rate and density, and acres required per paddock. These can be estimated rather easily given the following formulas (Table 2-13).

Logically, managers often start by trying to figure how many divisions or paddocks are required for their improved grazing system. The number of paddocks per grazing system should fluctuate within a season. System designers recommend that, initially, no internal fences be permanent since adjustments will need to be made as managers better understand their given pasture systems. However, rotating a grazing group among six to eight paddocks most often results in the proper lengths for the grazing and rest period of a paddock. The actual number of paddocks required is determined by adding one (1) to the ratio of the rest period to grazing period. For a rest period of 28 days and a grazing period of four days, the number of paddocks required would be 1 plus 7 (28 divided by 4), or 8.

Next, it is helpful to know how many acres are required to carry the grazing group or herd for the desired number of days per paddock. While the formula for this calculation looks rather intimidating, it can be thought of as simply estimating the forage needed by the herd for a given number of days divided by the grazable forage per acre. The daily forage intake per animal varies by animal size and stage of production and is most often expressed as a percent of body weight. Dry cows may only need about 2 percent of their body weight each day, while stocker steers may need 3 percent or more.

Benefits of Rotational Grazing and Improved Grazing Systems

Developing an improved grazing system usually involves subdividing pastures and adding sources of or improving access to water. Improvements in fence chargers, fencing materials, and temporary water systems have allowed farmers to improve their grazing systems easily and inexpensively. An improved grazing system significantly improves the efficiency and profitability of Kentucky beef cattle enterprises.

Forage utilization is increased by improved grazing systems. Kentucky cattlemen only utilize an estimated 40 percent to 50 percent of the available pasture under continuous grazing. Wastage comes in the forms of trampling, overgrazing, and defecation. Some available pasture just dies and decomposes before it can be consumed. Utilization efficiency goes up as the grazing time per pasture is reduced. Ideally, pasture should be allocated in blocks that provide five days or less of available forage for the grazing group. Longer grazing periods allow animals to graze regrowth leading to uneven utilization and slower regrowth in the overgrazed areas. Research has shown that season-long utilization rates can exceed 80 percent when grazing periods are between one and two days. Rotating every three to four days can yield 75 percent pasture utilization.

Forage yield per acre is increased by improved grazing systems. It would be quite incorrect to get the impression that simply stringing some electric fence will change the genetic potential of a forage to grow and produce pasture. However, traditional continuous grazing systems do not allow forages in most Kentucky pastures to reach their genetic potential. Using an improved grazing system to make animals remove pasture to an optimum target height followed by an adequate rest period allows pasture crops to maintain maximum growth rates over the grazing season (Figures 2-6 and 2-7). Overgrazing and lack of rest periods result in slow forage growth and can prematurely take some species out of stand.

Good rotational grazing schemes produce higher quality forage for livestock to consume. Rotational grazing does not magically make a forage better than it is. However, because rotational grazing has as its goal to keep all forages actively growing, green, and leafy, animals are presented with a higher quality pasture throughout the season. In addition, the graze and rest pattern of good rotational grazing can greatly favor and encourage the growth of legumes. It is common for those who rotational graze to see a significant increase in the amount of clover in their pastures.

Improved grazing systems give the producer the ability to manage forages, especially legumes, so that they can replenish their root reserves between grazings or defoliations. Therefore, improved grazing systems are a key tool in dealing with the tall fescue endophyte because they get, keep, and produce high quality legumes, such as white clover, red clover, and alfalfa, in grass pastures.

Implementing improved grazing systems opens new opportunities for using different forage species. Moving to a good rotational grazing scheme can allow alfalfa to be part of a well managed pasture system. Since alfalfa is Kentucky's highest yielding, highest quality forage legume, this addition could significantly benefit beef producers. A good rotational grazing system allows utilization of native warm-season grasses, such as switchgrass, big bluestem, and Indiangrass. These grasses require rotational grazing in order to persist.

Extending the Grazing Season

Nutrients in the form of pasture usually cost one-third to one-half as much as nutrients in stored feed. Extending the grazing season can provide quality pasture later in the season and reduce the amount of stored feed required.

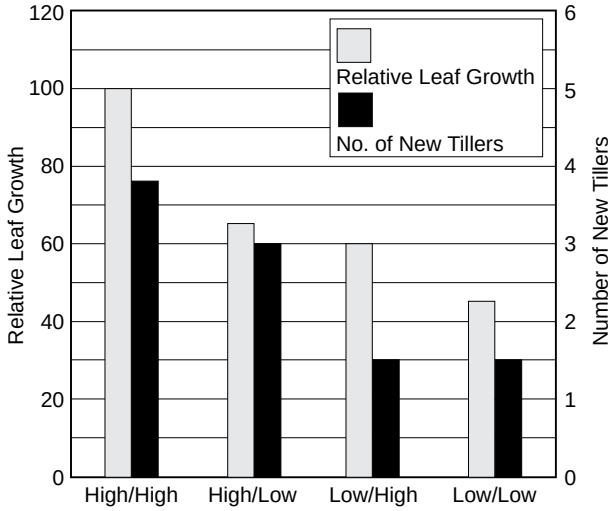
Crop residue can be a source of feed, especially for dry, pregnant beef cows. Use of cornfields for grazing has been found to lower winter feed cost from $20 to $30 per cow. Before grazing crop residues are utilized, be sure no pesticide with a grazing or utilization restriction on the label was used on the crop. Avoid grazing weedy cornfields just after the first hard frost because of potential toxicity from the prussic acid in johnsongrass that may be present.

Winter annuals, such as wheat and rye, can be used for late winter and early spring supplemental pasture. Fall production is greatest with rye but can be highly variable because soil moisture is often limiting during late summer. Rye is the most likely to support significant fall grazing

Table 2-13. Grazing Mathematics

$\text{Number of paddocks} = \frac{\text{days of rest}}{\text{days of grazing}} + 1$ *Example* $\text{Number of paddocks} = \frac{28 \text{ days rest}}{4 \text{ days grazing}} + 1$ **= 8 paddocks**	**Days of rest** values range from 10 or less for grasses during periods of rapid growth to 30 for legumes and even more for periods of very slow growth. **Days of grazing** varies from 1 to 7 and up. Shorter times on a paddock yield greater season-long utilization, less waste, less selectivity, and less regrowth grazing.
Acres required per paddock = $\frac{\text{(weight) x (\%DMI) x (number) x (days per paddock)}}{\text{(DM per acre) x (\% Utilization)}}$ *Example* Acres per paddock = $\frac{\text{(500 lb.) x (3\% DMI) x (100 head) x (4 days)}}{\text{(2000 lb/a) x (60\%)}}$ **= 5 acres**	**Weight** is weight per head, in pounds **% DMI** is the percent dry matter intake, ranging from 2% to 4% **Number** is the number of head to be grazed **Days per paddock** is the amount of time that animals are to be allowed to graze in a given paddock. Values can range from 1 to 7 and up. To keep animals from grazing regrowth, keep days per paddock 7 or less. **DM per acre** is an estimate of total forage dry matter available per acre as the animals enter a paddock **% Utilization** is the portion of the available forage per acre that animals will consume during a grazing period. Improved grazing systems can utilize 60% for grasses and 75% for legumes.
Total acres required per grazing cycle = (number of paddocks) x (acres required per paddock) In this example: 8 paddocks X 5 A per paddock = 40 acres	**Number of paddocks** is determined by the length of the rest and grazing periods. **Acres required per paddock** is determined by amount of forage needed each day by the grazing herd divided by the grazable forage dry matter per acre. The number of acres needed per grazing cycle varies with the growth rate of the forage. As the growth rate slows, the number of acres required to supply 3% DMI and maintain 4 days on and 28 days off a paddock increases.
$\text{Stocking rate} = \frac{\text{no. of animals to be grazed}}{\text{total acres grazed}}$ *In this example:* $\frac{100 \text{ head}}{40 \text{ acres}} = 2.5 \text{ head per acre}$	**Stocking rate** and stocking density are often confused. Stocking rate applies to an entire grazing period (in this example 32 days) or can be thought of as a season-long or whole-farm statistic.
Stocking density = $\frac{\text{no. of animals grazing on a paddock}}{\text{paddock size}}$ *In this example:* $\frac{100 \text{ head}}{5 \text{ acres}} = 20 \text{ head per acre}$	**Stocking density** is the stocking rate at a given point in time. In this example, 100 steers are grazing in a 5-acre paddock, which is a stocking density of 20 head per acre. Stocking density can be expressed as the number of pounds of grazing animals per acre at a given point in time (in this case, 10,000 pounds per acre).

Figure 2-7



and then only when planted on good, deep soil with some available moisture. Rye is also the earliest small grain to begin growth in the spring. Therefore, cereal rye is used most often to extend the grazing season.

Interseeding small grains of any kind into overgrazed (and often moisture-stressed) cool-season pasture during late summer is not a reliable way to produce fall pasture. The failure to produce much fall growth is most often caused by limited soil moisture for germination and growth of the small grain.

Applying nitrogen in the late winter/early spring can speed up the initial growth of grass pastures and get cattle onto pastures seven to 10 days earlier in the spring. In addition, a few acres of cereal rye can provide excellent early spring pasture in most years.

Stockpiling is a powerful and effective way for many cattlemen to take advantage of the late summer/fall growing conditions to obtain high quality pasture for fall and early winter grazing. Questions relative to stockpiling that need to be answered include: Which grass species is best for stockpiling? When should stockpiling begin? When, what kind, and how much fertilizer should be applied? When should the stockpiled material be used? What classes of cattle should be given access to stockpiled pastures? What grazing system should be used for most efficient use?

The best grass for stockpiling is a cool-season grass that retains its green color and forage quality later into winter. In addition, the grass should be somewhat resistant to low temperatures and have the capabilities of forming a good sod. Kentucky has two adapted grasses with these characteristics: tall fescue and Kentucky bluegrass. Tall fescue produces more fall and winter growth than bluegrass (Table 2-14).

Late July/early August is the time to begin stockpiling for fall and winter use. Remove cattle in late July or early August, apply necessary fertilizer, and allow the grass to accumulate growth until November or December.

During the stockpiling period, August 1 to November 1, other available forages, such as sorghum-sudan hybrids, sudangrass, bermudagrass, grass-lespedeza, and grass-clover, should be utilized. After frost, alfalfa-grass and clover-grass growth should be grazed first before moving to grass fields.

Fertilize with the phosphorus, potassium, and lime deemed necessary by a soil test. Nitrogen should be topdressed at the rate of 40 to 60 pounds of actual N per acre on bluegrass and 40 to 100 on tall fescue. Kentucky researchers have shown that bluegrass fertilized with 45 pounds of nitrogen per acre had a yield increase of 20 pounds of dry matter for each pound of nitrogen applied when nitrogen was applied August 15 and yields were taken December 1. In the same study, tall fescue showed an even greater nitrogen use efficiency with 24.4 pounds of dry matter for each pound of nitrogen applied. Additional studies have shown the greatest response for early application of nitrogen (Table 2-15). Nitrogen applications before August 1 may encourage the growth of summer grasses, such as crabgrass, and subsequently reduce the production of bluegrass and tall fescue. Source of nitrogen influences efficiency (Table 2-16). These studies show that urea was approximately 85 percent as effective as ammonium nitrate on an equivalent nitrogen basis.

These studies have shown that with wise use and timing of fertilizer, high production can be obtained during fall and early winter. However, what is the quality of tall fescue in fall? The crude protein and digestibility of tall fescue is better during fall/early winter than any other time of the year. This increased quality in fall has been shown in many studies that agree with the data in Table 2-17 from the University of Kentucky.

Utilize grass legume fields quickly after frost before the plants deteriorate. After these fields are grazed, the stockpiled grass field or fields should be grazed. Light stocking causes a lot of waste as a result of trampling. To make most efficient use of the high quality feed in stockpiled fields, install a temporary electric fence across the field dividing it so the area to be grazed first has a source of water and minerals. Once the animals have grazed this area off, move the fence back, opening up a new strip. Repeat this system until the entire field is grazed.

The high quality stockpiled grass is an excellent choice for fall-calving cows. The stockpiled forage can be used

Table 2-14. Yield and Crude Protein Content of Kentucky Bluegrass and Tall Fescue Produced from August 15 to December 1 under Different Levels of N Fertilization at Lexington (Average of 3 Years)

Nitrogen applied lbs/A	Bluegrass		Fescue	
	Yield lbs/acre	% Protein	Yield lbs/acre	% Protein
0	700	12.8	1700	11.1
45	1600	15.5	2800	11.8
90	2100	19.1	3900	14.8

Source: T.H. Taylor and W.C. Templeton Jr. 1976. Agron. Jr. Vol. 68, Mar-Apr.

Table 2-15. Effect of Time of Nitrogen Application on Production Efficiency of Ky 31 Tall Fescue

Date N applied	Nitrogen efficiency lb DM/lb N added
August 1	27.2
August 15	25.8
September 1	19.2
October 1	10.8

Source: Murdock, Lloyd W. 1982. Agronomy Notes. Volume 15, No. 2. April, 1982.

Table 2-16. Pounds of Tall Fescue 10 Weeks after N Application

Application date	None	Nitrate	Urea	U/N
Early August	786	1683	1406	84
Mid August	741	1438	1287	89
September	372	1076	852	79

University of Kentucky

after calving and during the breeding season when the cows' nutritional needs are greatest.

Spring-calving cows may benefit most from grazing stockpiled grasses if they are in thin body condition in the fall. They can regain condition while grazing and be in better shape going into the winter. Spring-calvers in mid gestation that are in good body condition might not need as high quality feed and could use lower quality feed. Over-conditioning cows in late gestation can increase birth weights of their calves.

Growing, weaned cattle also can be grazed on stockpiled fescue. Backgrounders can lower the feed costs of their operations by utilizing stockpiled grasses.

Liveweight gains of both weaned stock and mature cows are good on stockpiled tall fescue. These gains are a response to the high crude protein and digestibility of the fall growth of tall fescue. In particular, the sugar content rises to very high levels in response to lower temperatures and shortening day length. This nutritional change does not take place overnight due to the first frost but is spread over time.

Gains of calves grazing fall accumulated tall fescue are affected by several factors, including the endophyte status of the fescue and the length of the grazing period. The presence of the fescue endophyte decreases gain (Table 2-18) even with the cooler temperatures of fall. Calves grazing endophyte-infected, fall accumulated fescue gained 1.49 pounds daily in a Kentucky trial and 1.85 pounds in an Oklahoma trial. Calves on the endophyte-free tall fescue gained 2.17 in the Kentucky trial and 2.47 in the Oklahoma trial. While performance of cattle in the Oklahoma trial was greater than that of those in the Kentucky trial, the magnitude of difference was almost identical (0.68 pounds for Kentucky, 0.62 pounds for Oklahoma). A third treatment, the addition of clover, was included in the Oklahoma trial. Clover increased gain by 0.17 pounds over infected tall fescue but was 0.45 pounds less than non-infected tall fescue.

The extent of deterioration of the fall accumulated tall fescue also affects gain. In studies where calves were grazed from early November to mid December, gains were 2 to 2.13 pounds per day (Table 2-19). However, extending the period of grazing to early January in other trials produced gains of 1.27 to 1.47 pounds per day. Gains can be kept high if grazing ceases before grass quality declines. If cattle are forced to clean up lower quality grass by continuing to January, gains decrease.

The grazing season for the cow herd is extended by grazing stockpiled fescue, decreasing the need for stored feed. Studies also have shown that grazing stockpiled tall fescue can reduce labor requirements to 25 percent of that for conventional hay feeding of the beef herd. In a summary of using stockpiled tall fescue for dry, mature Angus beef cows for fall and winter pasture, UK researchers found tall fescue produced 66 days of grazing and allowed the cows to gain 1.24 pounds per day while keeping the hay fed to an average of 564 pounds per cow during the same period (Table 2-20).

Summary

Forages supply most of the nutrition for beef cattle in Kentucky. The ability to produce pasture and hay inexpensively and efficiently is Kentucky's competitive advantage in beef cattle. Developing a forage program that is inte-

Table 2-17. Seasonal Percentage Changes in Chemical Composition and Digestibility of Tall Fescue

	Spring	Summer	Fall
Sugars	9.5	8.5	19
Protein	22	18	19
D.D.M.[1]	69	66	74

[1] *Digestibility Dry Matter.*

Source: Buckner, R.C. 1975. University of Kentucky Coop. Ext. AGR-44

Table 2-18. The Effect of the Endophyte on Calf ADG When Grazing Fall Accumulated Tall Fescue

ADG, lbs Endophyte level	Kentucky, 1986	Oklahoma, 1986
E+	1.49	1.85
E-	2.17	2.47
E+ and clover	——	2.02

Table 2-19. Gain of Calves Grazing Fall Accumulated Tall Fescue

Trial	Grazing days	ADG, lbs
KY, 1982	59	1.27
KY, 1985	57	1.15
KY, 1986	56	2.00
OK, 1986	42	2.13
KY, 1990	63	0.97
ILL, 1992	56	1.76

grated into the overall beef cattle enterprise involves setting goals and determining the areas that will respond most to inputs. Most good forage programs have a plan that may include matching forage production closely to animal needs, maximizing the length of the grazing season, managing the effects of the tall fescue endophyte, producing quality hay that is protected from excess weathering losses, seeding certified seed of improved varieties, and using improved grazing systems. Any of these areas is a good place to begin the assessment of a beef-forage enterprise.

Table 2-20. Performance of Dry, Pregnant Cows[1] Grazing Stockpiled Tall Fescue (4-year Average)[2]

Grazing dates	11/6 to 2/10
ADG	1.24 pounds
Stocking rate	1.33 cows per acre
Gain per cow	119 pounds
Hay fed per cow (11/6 to 2/10)	564

[1] Mature Angus cows bred to calve in March.
Source: Neil Bradley, et al., 1984 Beef Cattle Research Report, UK College of Agriculture Progress Report 282, pages 11-12.

Section 3.

Facilities for Beef Production

Larry Turner, Roy Burris, and Sam McNeill[1]

Some facilities are necessary in your beef operation to allow you to practice certain recommended management procedures, such as handling your cattle, rotational grazing, and controlling mud. Facilities on your farm should be adequate to do the job and as economical as possible. They should last a long time and lead to better care of your farm and animals. Always plan carefully before you start any type of construction.

Planning and Construction of Fences

Before you build new fences, replace existing fences, or consider more cross fencing, you must first plan.

Your first consideration is having a well built, permanent boundary fence. This is important so that:

- you have a fixed property line between you and your neighbor or between you and the highway
- you can confine your cattle to your own farm. Liability for losses due to cattle-auto accidents or crop damage to surrounding farms can justify a well built fence
- your neighbor's cattle are fenced off from your property, which can protect your crops and your breeding program

When planning your pasture layout and fences, obtain copies of aerial photographs from your county NRCS office and sketch plans on them. Lay out the fences to follow contours of the topography providing as large and uniform fields as possible for major pasture divisions. Once you have laid out the fence lines, locate necessary lanes and gates.

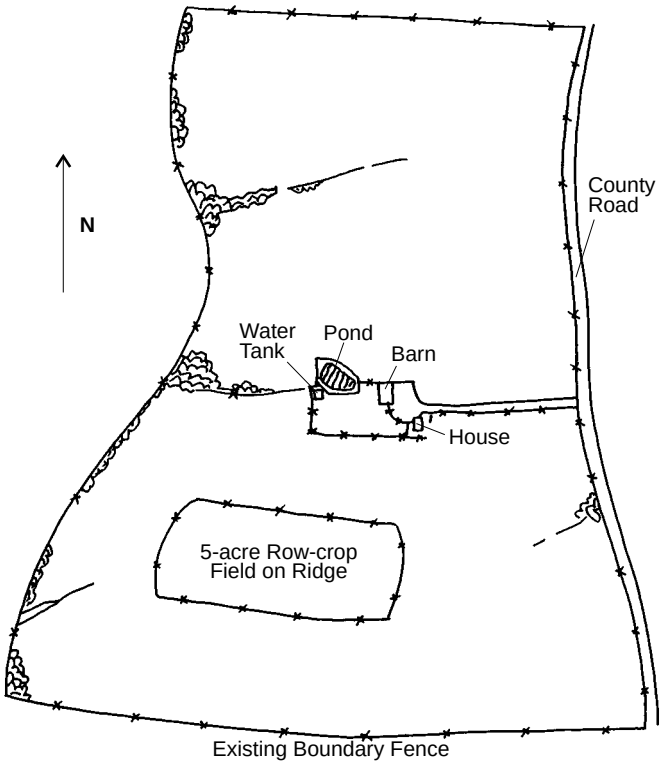
Keep in mind the **shape of pastures**. Square pastures are the most efficient because they allow animals to obtain forage with minimum trampling damage and use the least amount of fence material for a given land area. They also can be subdivided with less trouble. A pie-shaped arrangement is sometimes used to give animals access to a central water source. In these cases, cattle tend to overgraze and trample the area closest to the water and graze less in the back of the pasture. A lane to water provides an alternative to the pie design and reduces the trampled area. Figures 3-1, 3-2, and 3-3 show how fences might be arranged on a farmstead (these diagrams are from Kentucky Cooperative Extension Service publication ID-74, "Planning Fencing Systems for Intensive Grazing Management").

Gate placement is important for animal movement. Locate the gate in the corner of the paddock so that when the first cows move out, the others, especially calves, follow rather than going along the inside of the fence (see Figure 3-4). Never locate a gate in the middle of a fence line with no way to "funnel" the cattle toward it.

Fence Types

Fence types vary from physical barrier fences, such as woven wire, barbed wire, high tensile, and board fences, to psychological barriers, such as electric high or low tensile wire or portable polywire or polytape type fences. All of these types are used in Kentucky, and each has its advantages. Factors for selecting fence type include affordability, maintenance, durability, and effectiveness on the livestock to be contained.

Figure 3-1. Farm with two pastures. Further subdivision will permit better grazing management.



[1]*Much of the fencing material contained in this section is adapted from Buschermohle et al., University of Tennessee Extension publication EP-10-95.*

Figure 3-2. Subdivision to four paddocks using permanent (x-x-) and temporary (-) fence.

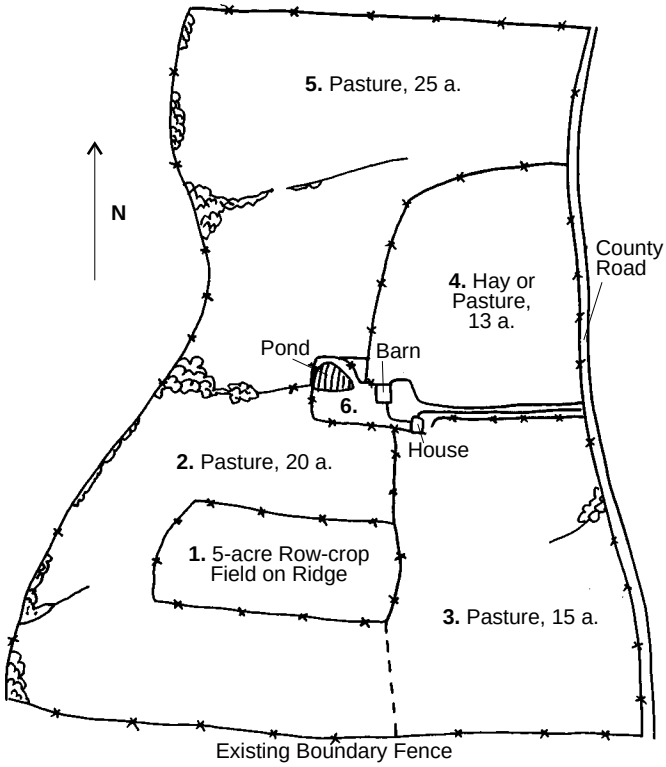


Figure 3-3. Subdivision to eight paddocks using portable fence.

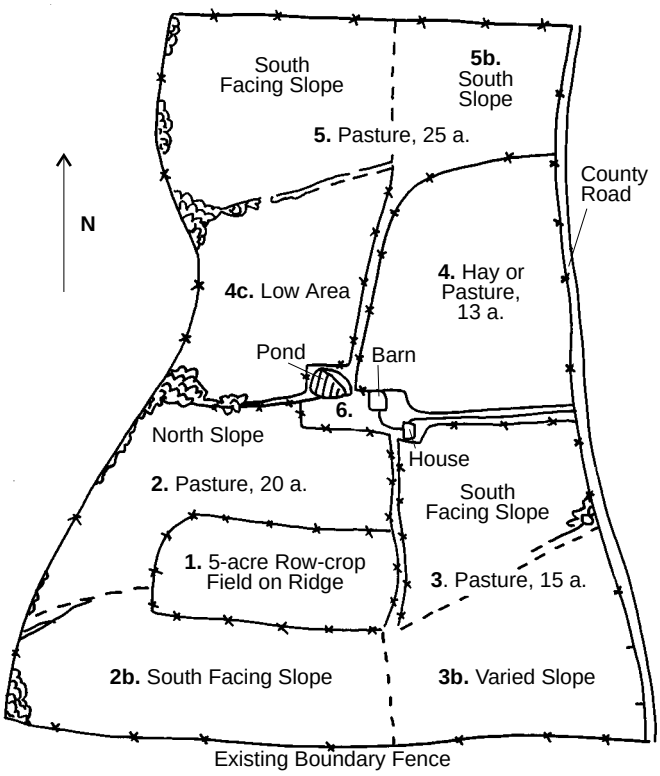
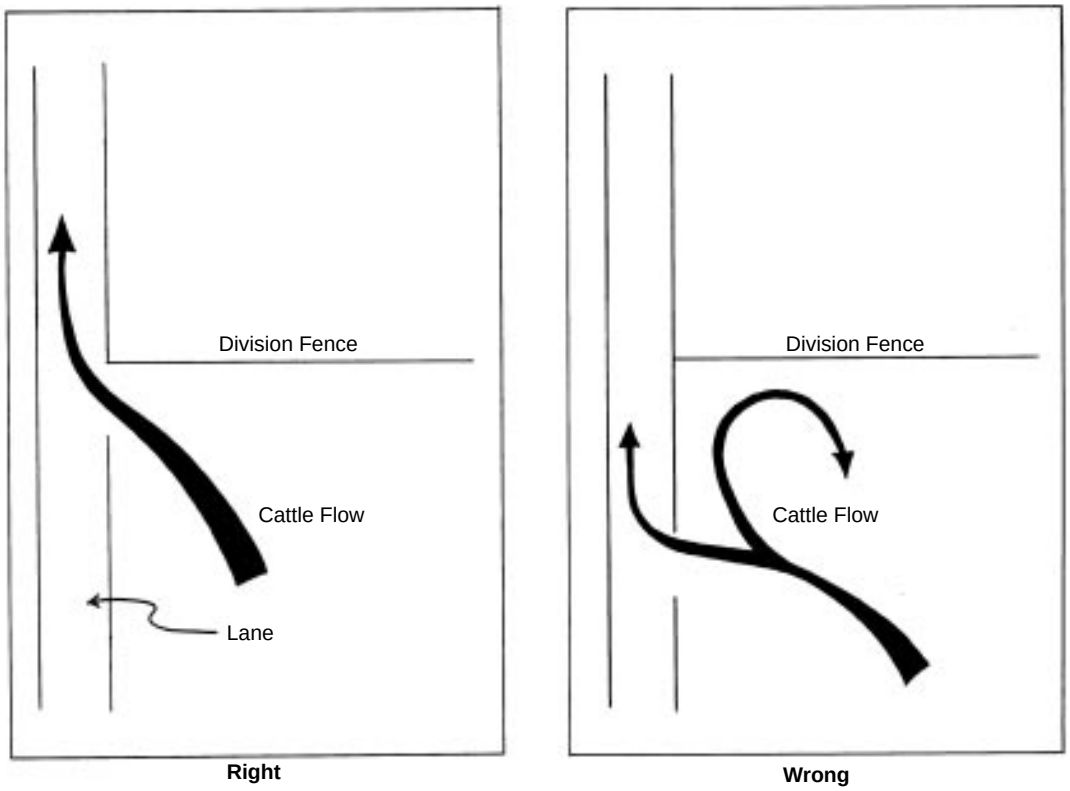


Figure 3-4. Gate placement is important to good animal movement.



Woven wire fences are generally used for boundaries, lanes, and lots. A woven wire fence consists of a number of horizontal wires held apart by vertical wires called stays. The distance between horizontal line wires may vary from as close as 1½ inches at the bottom for small animals to as wide as 9 inches at the top for large animals. In general, the spacing between wires gets wider as the fence gets taller.

Woven wire fencing is available in many combinations of wire sizes and spacings and varies in numbers of horizontal line wires and fence heights. The height of most woven wire fencing materials ranges from 26 to 48 inches. Select fence height based on the animals' sizes and jumping abilities. Stay wires should be spaced 6 inches apart for small animals and 12 inches for large animals.

The standard design number is listed on the tag to describe the wire. For instance, a design number 1047-12-11 indicates the wire has 10 horizontal wires and is 47 inches high, stays are spaced 12 inches apart, and stay and filler wires (wires between the top and bottom line wires) are 11 gauge wire. The top and bottom wires are generally two sizes larger. Standard woven wire fence heights are shown in Table 3-1; weights are in Table 3-2.

Barbed wire fences are made of two or more strands of smooth, galvanized-coated steel wire twisted together with two or four barbs spaced every 4 to 5 inches. Standard barbed wire fences usually have three to five strands of barbed wire stretched between posts spaced 15 to 25 feet apart. Barbed wire is sold in 80-rod rolls (80 rods = 1,320 feet = ¼ mile).

Board fences are attractive, strong, and safe for animals. They are typically used as border fences around the farm or home or for crowding areas in cattle working facilities. Board fences consist of 1- to 2-inch thick, 4- to 6-inch wide boards nailed to wooden posts spaced 8 to 10 feet apart. For additional strength, stagger the joints on the posts. For example, using four 16-foot boards and posts spaced 8 feet apart, the top and third boards should continuously span a given post (with the post at the center of the boards) while the joints of the second and bottom boards should butt together on that same post. Do the reverse on the next post.

The prices of lumber, nails, paint, and other materials, along with the labor required, makes the cost of these fences considerably higher than most permanent wire fences. Upkeep is also high, especially if untreated lumber is used.

High tensile fences are an increasingly popular type of fence. First used in New Zealand and Australia, they offer several advantages over conventional fencing:

- easier to construct
- longer lasting
- less expensive to build than most conventional fences
- require less maintenance

High tensile fences are constructed mostly with 12½ or 14 gauge Class III wires which have tensile strengths from 170,000 to 200,000 or more pounds per square inch (psi) and breaking strengths of approximately 1,800 pounds. This fence can withstand more than 1,100 pounds of livestock pressure without losing its elasticity, yet it is flexible enough to bend, wrap, tie in knots, or clamp with crimping sleeves. Wires are held in tension along wood, fiberglass, insulated metal posts, or a combination of posts and battens or droppers. Tension in the wire is maintained by permanent in-line strainers. Adequate tension for 12½ gauge high tensile wire is 200 pounds, indicated by a tension indicator spring.

High tensile wire fences can be used with electricity to improve animal-holding capability and predator control. It is important to use treated wood posts and set them properly in the ground with adequate braces to withstand the pressure caused by the tightly stretched wire.

Cable fences are used primarily for confinement areas, such as holding pens, feed lots, and corrals. These fences usually consist of 3/8-inch smooth steel wire cables stretched between anchor posts. The cables are normally made out of seven wires twisted together. Heavy-duty springs are placed at one end of each cable to absorb the shock on the wires caused by animals pressing against them. Cables are usually passed through holes in wooden or steel posts.

Table 3-1. Common Woven Wire Fence Heights

Design #	Horizontal wires	Height (in.)
635	6	35
726	7	26
832	8	32
845	8	34
939	9	39
949	9	49
1047	10	47
1156	11	56

Table 3-2. Woven Wire Fence Weights

Weight	Gauge of top and bottom wires	Gauge of intermediate line wires
Light	11	14 ½
Medium	10	12 ½
Heavy	9	11
Extra heavy	9	9

Any number of cables can be used; however, a six-cable fence is often used for large animals. The spacing between cables depends on the type of animals to be confined.

Electric fences are widely and successfully used in Kentucky. If constructed properly and energized with a controller designed to match the application, they can be an effective, safe, and inexpensive means of providing temporary and permanent fencing.

Electric fencing does not need to be strong because it seldom comes under pressure, but it must be well designed and constructed to absorb the impact of animals. Adequate power for the length of fencing and type of animals to be confined is also essential. Electric fencing has a low installation cost, is inexpensive to operate, can be used to extend the life of old permanent fences, can be used for deer and predator control, and can be built for temporary or permanent use.

Various types of inexpensive, easily erected temporary electric fences are available. Probably the most popular are the polywire strands or ribbons—fine wires woven together with polyethylene fibers.

Temporary electric fences can be used to subdivide pastures into smaller units which make grazing management easier.

Polyethylene and steel braided wire (polywire) comes in various colors. Black is the most difficult for animals and people to see. Brighter colors, such as orange or white, are also available. Polytape, particularly the extra-wide type, is easier to see than polywire and works better for horses and in other cases where visibility is especially important. Some newer polywires and tapes incorporate more wires so that the resistance to current is lower, allowing longer runs of wire. A practical maximum for the lower wire density polywires is about 1,200 feet. It is important to keep weeds and grass cut away from the fence, especially when using low impedance controllers. Polywires with stainless steel wires are more durable, but electric conductivity is lower. Aluminum conducts electricity better but tends to break more easily.

Aluminum, stainless steel, and high tensile wire also can be used. One advantage to using these type of wires is they conduct electrical charges for longer distances than the small-diameter wires of polywire and polytapes. However, they are harder for the animals to see. To effectively train animals to stay within an electric fence, the animals need to see the wire as they feel the shock. Tying pieces of white cloth or brightly-colored plastic ribbon helps make these wires more visible.

An electric fence controller energizes the wire, and the moist earth completes the electrical circuit. Corners and end posts in temporary electric fences require minimal bracing. Line posts can be small and spaced far apart since the fence generally will be used for a short period of time.

Fencing Systems for Controlled Grazing

Table 3-3 provides a comparison of fence types to assist in making a selection that best fits your needs and budget. In Kentucky, the most economical fence type for controlled grazing fencing systems is often a combination of permanent electric smooth high tensile wire fence and temporary portable polywire (available on reels). An advantage of the reel is that it allows rapid set-up and take-down of fence for temporary arrangements or for strip grazing. Portable fiberglass fence posts are often used with the portable braided wire, using one strand of wire for large animals and two strands for calves. Since it is electrified, high tensile wire for the permanent fence often can be installed using low-tension techniques. The following provides an overview of several types of fences and their appropriate place in a system.

For controlled grazing systems, the type of wire suggested for permanent boundary fence installations is New Zealand-type high tensile wire. This is 12½ gauge high tensile smooth wire which is heavily galvanized (Class III). Also, smaller diameter high tensile wires are now being used, particularly on interior division or paddock fences. These include 14½ gauge and 16 gauge thicknesses. The use of such wire has implications in energizer selection (since smaller wires have a greater resistance to current flow) and in allowable length of fencing to be energized.

For interior and temporary fences, a more flexible, low-tension wire is more popular. Small diameter high tensile wire can be used, but many producers prefer a slightly

Table 3-3. Comparison of Common Fences

Permanent types	Height (in) spacing (in)	Comparative cost materials and labor	Approx. life (humid climate)	Maintenance
Barbed wire				
2-point, 4" spacing	1 post per 16'			
3 strands, 12½ gage		132	33	high
4 strands, 12½ gage		143	33	high
5 strands, 12½ gage		154	33	high
3 strands, 14 gage		121	18	high
4-point, 5" spacing				
3 strands, 12½ gage		132	33	high
4 strands, 12½ gage		143	33	high
5 strands, 12½ gage		154	33	high
Woven wire	**Height (in) Stay spacing (in)**			
Light weight				
Top and bottom wire 11 gage	26 6	154	19	high
Filler wire 14½ gage	32 6	165	19	high
Medium weight				
Top and bottom wire 10 gage	26 6	176	30	medium
Filler wire 12½ gage	32 6	187	30	medium
	39 6	198	30	medium
	47 6	220	30	medium
Heavy weight				
Top and bottom wire 9 gage	26 6	209	40	low
Filler wire 11 gage	32 6	231	40	low
	39 6	253	40	low
	47 6	275	40	low
High tensile: 12½ gage				
3 strands		44	30	medium
4 strands		55	30	medium
5 strands		66	30	medium
8 strands		110	30	medium
Temporary				
12½ gage, 2 strands		20-35	30	medium
12½ gage, 1 strand		15-25	30	medium
Polywire		10-15	7-10	medium
Aluminum wire				
9 gage		30-40	30	medium
13 gage		25-35	30	medium

Cost index figures are to show relative cost, not actual cost. For example, fence with an index of 100 costs about twice as much per foot as fence with an index of 50. Fence life based on combination of post and wire life expectancy. Costs of electric controller not included.

Source: Adapted from Buschermohle et al., University of Tennessee Extension Pub. EP-10-95.

softer grade of wire that is somewhat easier to work with when moving and handling the fence. An excellent alternative for very temporary installations is braided wire containing very fine gauge steel wires braided with polyethylene strands into a wire, ribbon, or tape. These wires work well for installations of up to 1,200 feet. Because of the lower cross sectional area of the steel, energizer requirements differ from those of smooth high tensile wire. Some newer braided wires have more steel (thus less resistance), so they can be used in longer runs.

Wire spacing depends on the type of livestock being fenced. Table 3-4 presents suggested wire spacings for permanent or temporary electric fences.

Table 3-4. Suggested Wire Spacings for Permanent or Temporary Electric Fences

Cattle type	Distance from ground (for wire number) # 1	# 2	# 3	# 4	# 5
Cows	30"				
Cows and calves	17"	38"			
Hard to hold cattle	17"	27"	38"		
Boundary fence	5"	10"	17"	27"	38"

Fence posts are available in many different types in Kentucky (Table 3-5). Always try to find the best post to meet the demands of the situation. For example, it is best to use good, treated posts for permanent boundary fences, while light fiberglass or steel posts are more suitable for temporary fences in a controlled grazing cell.

Table 3-5. Fence Post Characteristics

Post type	Bending strength	Expected life (yrs)	Initial cost	Fire resistance	Maintenance
Steel-T, concrete	fair	25-30	medium	good	low
Steel rod 3/8" dia.	poor	15-20	low	good	medium
Heavy-duty fiberglass-T	fair (flexible)	25-30	high	poor	low
Light-duty fiberglass-T	poor (flexible)	15-20	low	poor	medium
Pressure treated wood	good	30-35	medium	poor	very low
Untreated wood	good	7-15	low	poor	high

Often the least expensive option is to cut your own posts or purchase untreated wooden posts. They are highly variable in size, shape, and durability (Table 3-6). Osage orange posts have a life span of 25 to 35 years; black locust or red cedar posts last 15 to 25 years. Other woods, such as oak, pine, and poplar, rot in just a few years unless they are pressure treated.

Table 3-6. Life Expectancy of Wood Posts

Kind	Untreated	Treated (pressure)	Treated (soak)
Osage o.	25-35 yrs	—	—
R. cedar	15-25 yrs	20-25 yrs	20-25 yrs
B. locust	15-25 yrs	—	—
W. oak	5-10 yrs	20-30 yrs	15-30 yrs
Hickory	2-6 yrs	15-20 yrs	10-15 yrs
R. oak	2-6 yrs	20-30 yrs	20-30 yrs
Y. poplar	2-6 yrs	20-25 yrs	15-25 yrs
S. gum	3-6 yrs	20-30 yrs	20-30 yrs
S. pine	3-7 yrs	25-30 yrs	15-20 yrs

Wood posts come in a variety of sizes and lengths. The larger the top diameter, the stronger the post. Corners are the backbone of a fence. Whether you plan to install a woven wire, barbed wire, or high tensile wire fence, choose good corner posts. Corner and gate posts should have a diameter of at least 8 inches. Brace posts should be 5 inches or more in diameter. Line posts can be as small as 2½ inches, but larger diameter posts make the fence stronger and more durable.

Steel posts have several advantages. They weigh less, can be driven into the ground rather easily, won't rot, and are fireproof. They also help ground the fence against lightning when the soil is wet. They are more likely to be bent or forced out of line by livestock. A widely used method is to use wooden line posts every 50 to 75 feet to help keep steel posts from bending and improve the strength of the fence. Table 3-7 provides guidelines on post spacing for fences.

Table 3-7. Recommended Post Spacings[1]

Fence	Spacing (feet)
Woven wire	14-16
Barbed wire	12-14
Electric[2]	20-75
High tensile[2]	16-60
Board	8
Corrals	6

[1] Driven posts are 1.7 times as strong as tamped posts.

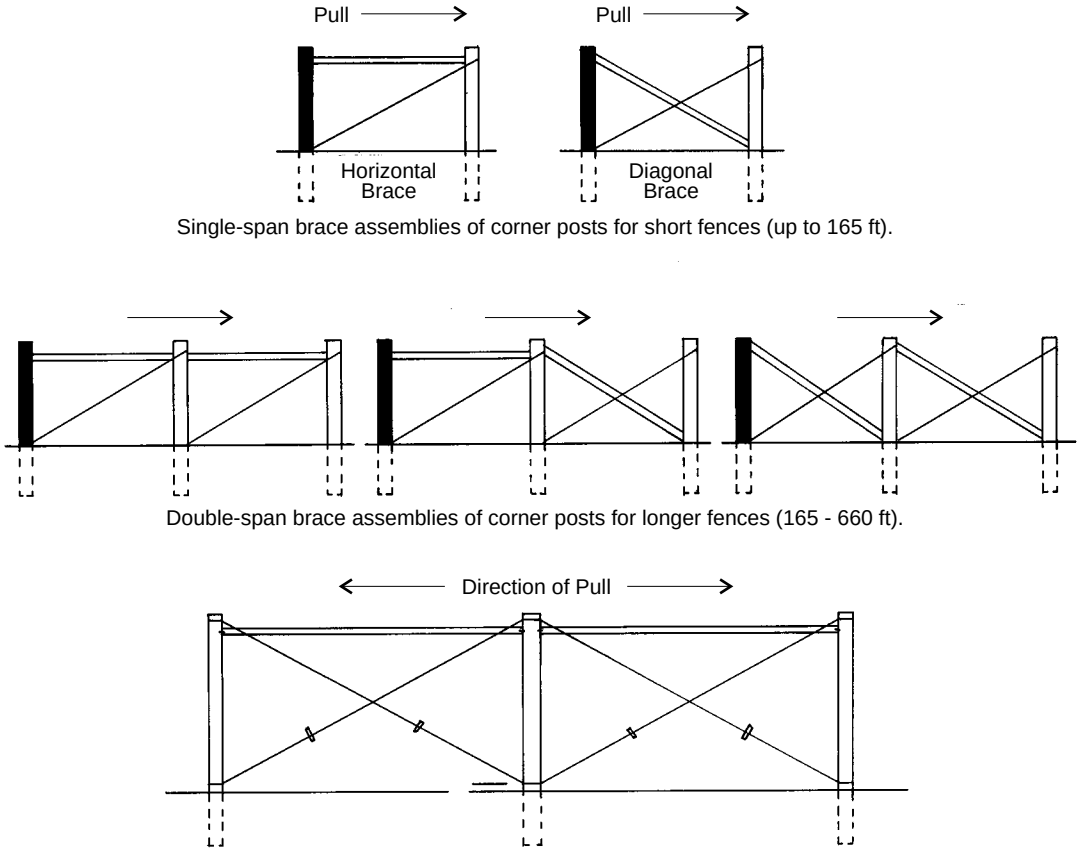
[2] Depending upon terrain, use of battens.

Fence construction includes setting posts, constructing braces, driving staples, and making splices. Corner and end-post assemblies are the foundation of the fence. The most common system is the horizontal brace or diagonal brace (Figure 3-5). Single span assemblies may be used for fence lengths up to 10 rods (165 feet). Use double span assemblies for 10 to 40 rods (165 to 660 feet). For more than 40 rods, use double span construction plus braced line posts.

Suspension fences (shown in Figure 3-6) are long spans of barbed wire over level to rolling terrain. Moderately tensioned wire that moves freely between staples and posts is essential. Place line posts every 100 feet on level terrain and closer on rolling terrain. Put stays every 15 to 20 feet between posts.

Staple length, diameter, and type of post all affect the holding power. For treated posts, use 1¾-inch, 9 gauge galvanized staples with slash-cut points. Drive staples slightly off vertical so they straddle the wood grain and wires may move freely (Figure 3-7). String wire on the cattle side of the posts (unless appearance is important) and on the outside of curves.

Figure 3-5. Corner and end-post assemblies for permanent wire fence.



Single-span brace assemblies of corner posts for short fences (up to 165 ft).

Double-span brace assemblies of corner posts for longer fences (165 - 660 ft).

Pull posts for the middle of long fences (over 660 ft).

Figure 3-6. Suspension fence.

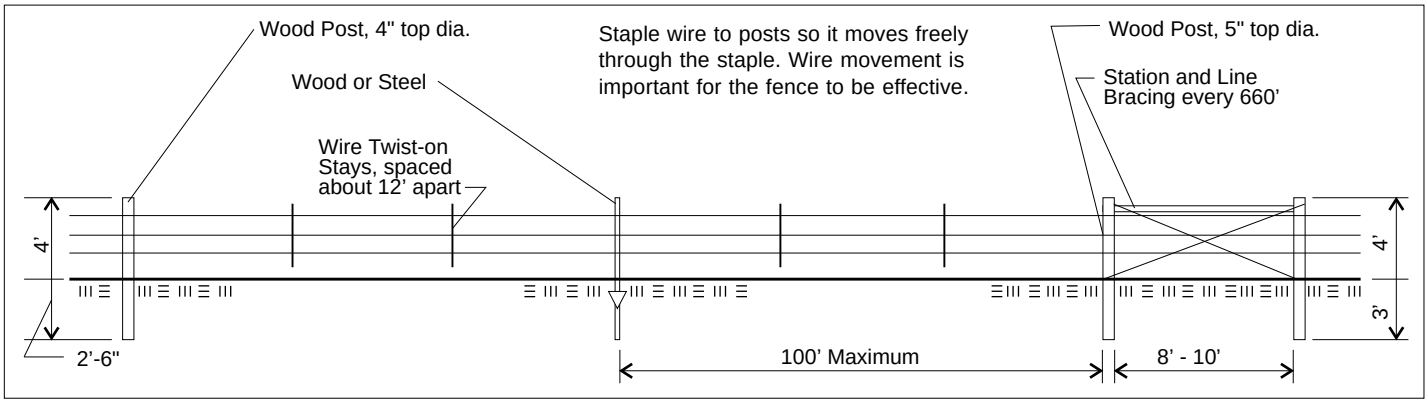
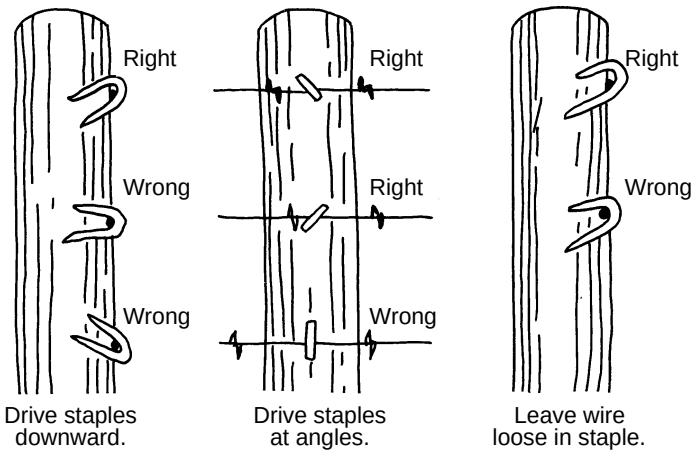


Figure 3-7. Illustration of proper stapling for fence construction.



Handling Facilities

More than anything else, the absence of cattle handling facilities contributes to the failure of producers to perform these proven money-making practices: pregnancy testing, implanting, controlling parasites, castrating, dehorning, and vaccinating. These procedures are essential to realizing profits in beef herds. Although most of the practices are relatively simple, they cannot easily be done without some type of restraining equipment. Facilities need not be elaborate or expensive but should be functional and economical and provide safe working conditions to the animals and workers.

The **location** of the facilities is critical. An all-weather road is needed so cattle can be moved at any time by truck or trailer. Corrals should be located for maximum ease in gathering the herd. Fences should form natural funnels into the corral. Because much cattle work is done during inclement weather when farmers can't do field work, some type of protection encourages more use of the system. Many farmers locate their handling facility inside an existing barn.

Components of a cattle handling facility include the holding pen, crowding pen, working chute, squeeze chute or headgate, loading chute, and scales. It is not necessary to use all of these parts in every system. Use only those that are needed and affordable. Table 3-8 gives the suggested dimensions for sizing facilities.

Design **holding pens** to hold the maximum number of cattle to be worked at one time. For example, a producer with 30 cows needs a minimum of two pens to sort cows and calves. One pen would hold 30 cows and 30 calves and would be 1,020 square feet in size (20 square feet per cow and 14 square feet per calf [see Table 3-8]). A second holding pen measuring 600 square feet would hold cows after they are sorted *away* from the calves. Other pens could be added for more flexibility.

Cost often prohibits the use of solid fencing in the cattle sorting area. A wire fence is sufficient if a single row of planks at eye-level add enough substance so that cattle see the fence and do not try to run through it. Five-foot-high fences are usually sufficient for British breeds of cattle, but a minimum of 5½ feet is recommended for Brahman-cross and exotics.

The **crowding pen** is the confining area that "funnels" cattle into the single-file working chute. A circular crowding pen with solid sides is effective because the only visible escape route is through the working chute. If the crowding area cannot be made circular, it should be funnel shaped; it should have one straight side and contain a crowding gate.

The purpose of the **working chute** is to align cattle into single file for treatment. It starts from the crowding pen and leads to the headgate. Cattle often balk or back up when they see the squeeze chute. The best working chutes are curved or have at least a 15-degree bend in them. Sloping the sides of the chute reduces the ability of an animal to

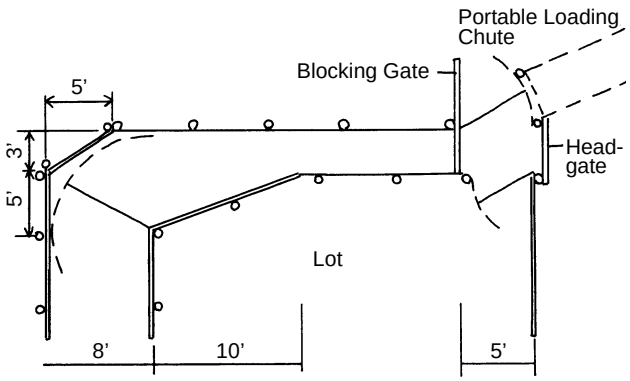
A properly designed cattle handling facility makes many management procedures easier on both man and animal.

Table 3-8. Corral and Working Facilities Dimensions for Cow-Calf Operations

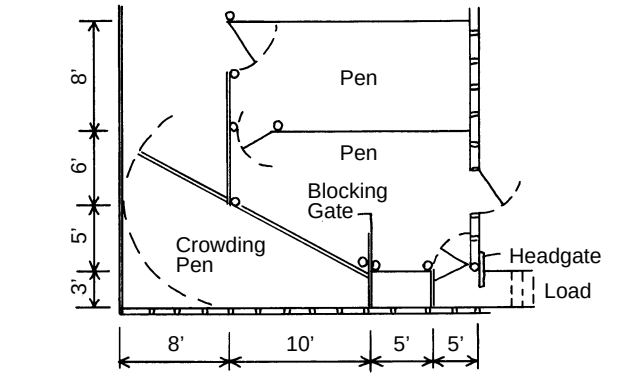
Holding area sq ft/head	
Cows	20
Calves	14
Crowding pen sq ft/head	
Cows	12
Calves	6
Working chute with vertical sides	
Width	28-30 in.
Length (minimum)	20 ft
Working chute with sloping sides	
Width at bottom inside clear	18-20 in.
Width at 4' height inside clear	30-33 in.
Length (minimum)	20 ft.
Working chute fence	
Recommended minimum height	50 in.
Depth of posts in ground (minimum)	30 in.
Corral fence	
Recommended height	60-66 in.
Depth of posts in ground (minimum)	36 in.
Loading chute	
Width	26-30 in.
Length (minimum)	12 ft
Rise, in./ft	3½
Ramp height for:	
Stock trailer	15 in.
Pickup truck	28 in.
Stock truck	40 in.
Tractor-trailer	48 in.
Double-deck trailer	100 in.

Source: Midwest Plan Service, 1987. Beef Housing & Equipment Handbook MWP S-6. Iowa State University, Ames, Iowa 50011.

Figure 3-8. Facilities for small herds need not be complex. These two are for tame cattle in small herds.



a. In lot corner.



b. In barn corner.

turn around. Common faults are making the chute too wide, which permits calves to turn around, and inadequate construction, which causes the sides of the chute to spread when subjected to intense pressure. Use the recommended width suggested in Table 3-8.

Located at the end of the working chute, the **headgate** and/or **squeeze chute** should hold the animal securely while it is being treated. A simple headgate can be constructed from heavy lumber or pipe. Many brands of commercial headgates are also available.

Some producers consider a **loading chute** an essential part of their cattle handling systems. Others, with fewer cattle, may use "goose-neck" trailers for hauling and do not need a loading ramp. Either way, you must be able to load cattle quickly before the first cattle entering can come back out.

Scales can be a valuable addition to handling facilities. They can help you obtain weaning weights and cow weights. Portable scales can be positioned in front of the headgate. In many cases, you can borrow scales from lending institutions, supply firms, or the Cooperative Extension Service.

One handling facility layout will not fit all cow-calf operations. Determine the components you need, and design your layout to fit your particular type of operation, herd size, existing facilities, and materials available. Your objective is to have a facility that allows you to sort, restrain, process, and ship cattle as efficiently, safely, and economically as possible.

Adequate handling facilities need not be elaborate or expensive. Existing fencelines and buildings may be used in planning a facility. Figures 3-8, 3-9, and 3-10 show handling facilities of varying degrees of complexity, from simple facilities located in a barn corner or lot corner to a circular facility for 25 to 75 head. Other plans are available from the Cooperative Extension Service.

Feed Bunks and Feeding Facilities

Feeding facilities should be designed so that they are convenient to the animals and encourage feed intake. The size of feed bunk needed depends on the size of the cattle, whether they are all fed at one time, and whether they eat on both sides of the bunk. When selecting a feed bunk, consider drainage, manure buildup, and materials needed.

Enough space should be provided so that animals are not crowded, thereby reducing stress around the bunk or feeding area and improving intake. Table 3-9 gives feeding space requirements for various ages of cattle and feeding schemes. Proper opening spaces and throat heights for feed bunks are

Table 3-9. Feeder Space Requirements for Cattle Feeding Facilities

	Space requirement, inches/animal				
Feeding program	**Calves (400-800 lb)**	**Finishing (800-1,200 lb)**	**Bred heifers (800 lb)**	**Cows (1,000 lb)**	**Bulls (1,500 lb)**
Once-a-day	18-22	22-26	22-26	24-30	26-30
Twice-a-day	9-11	11-13	11-13	12-15	12-15
Self-fed grain	3-4	4-6	4-6	5-6	5-6
Self-fed roughage	9-10	10-11	11-12	12-13	13-14

Source: Midwest Plan Service, Beef Housing and Equipment Handbook, MWPS-6.

Figure 3-9. USDA corral plan 5796. A two-pen corral with a simple working area arrangement.

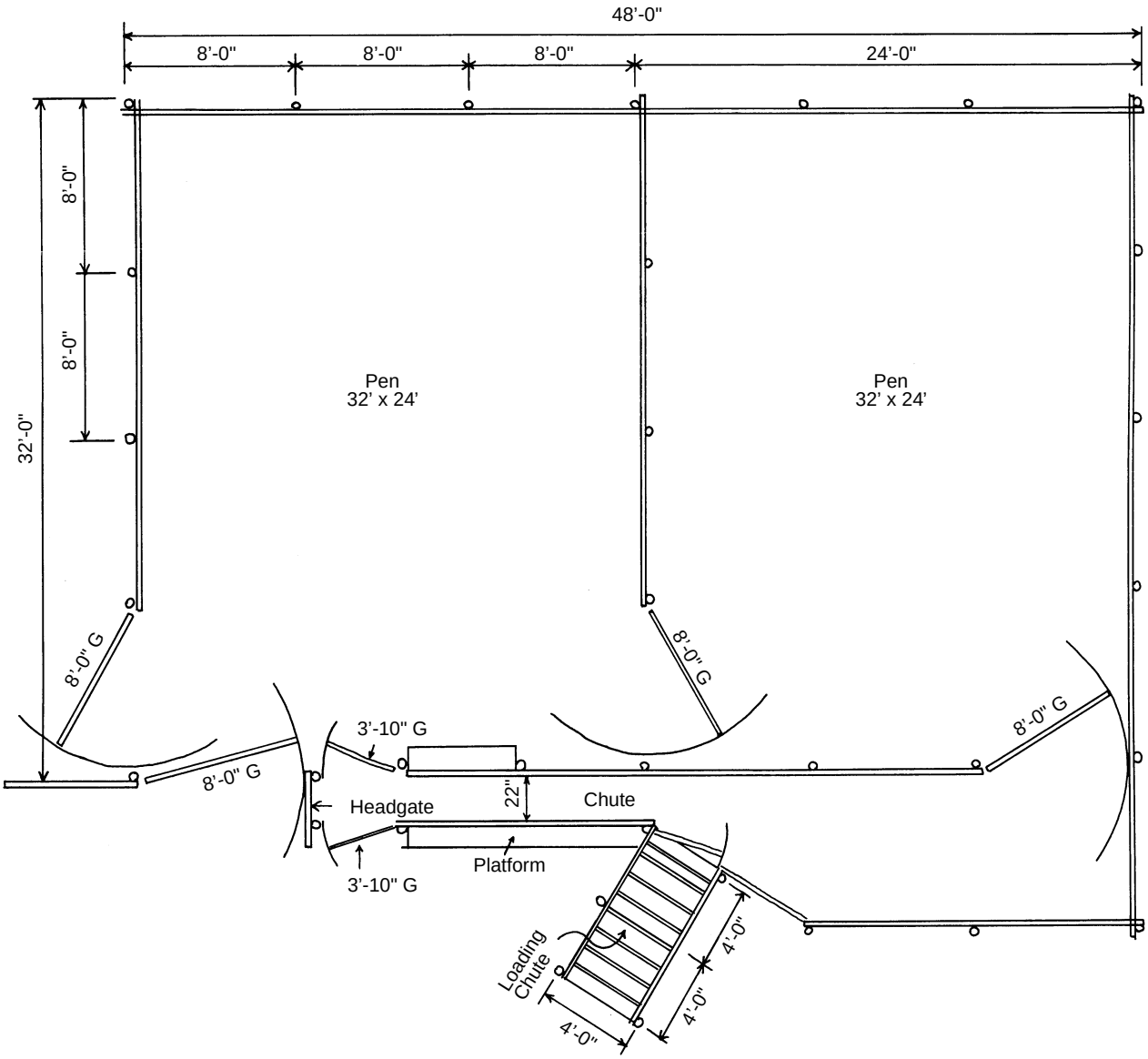
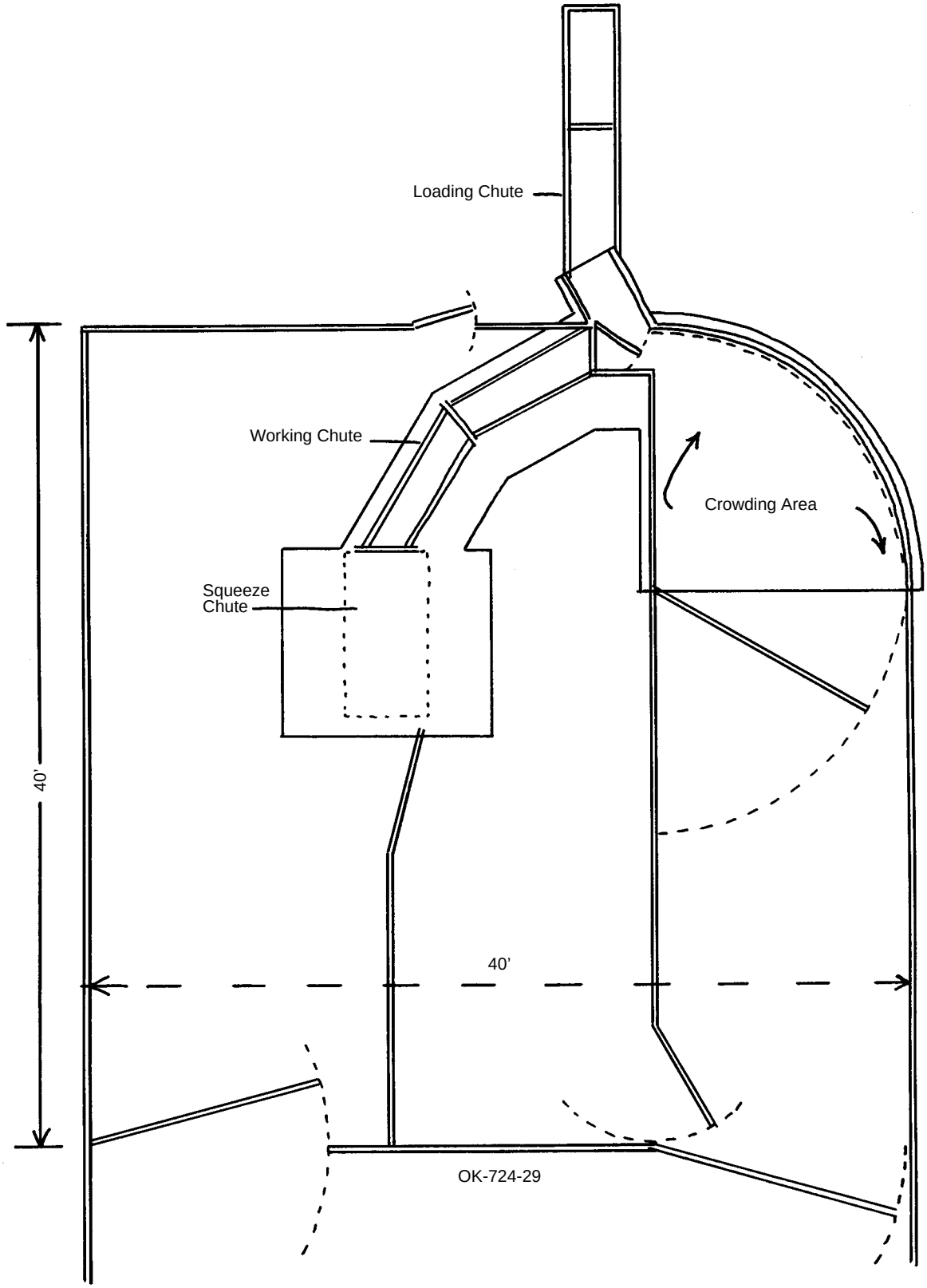


Figure 3-10. USDA corral plan 6230 has a circular crowding pen and working chute for 25-75 head and a good layout for loading and sorting.



important to relieving stress and providing adequate access for cattle of varying sizes. Figure 3-11 illustrates a bunk design that has proven to be good for many producers. Table 3-10 indicates suggested throat heights and neck rail heights for feed bunks for various sized cattle. This design is most appropriate for covered bunks and bunks inside buildings. The feed area allows for ease of cleaning, and the height of the bunk allows the cattle to eat in a more natural grazing position. In facilities where cattle have access to both sides of a bunk, use a partition on both sides of the feed. Other design options, including elevated bunks or mangers, are available in MWPS-6, "Beef Housing and Equipment Handbook," and through the UK Plan Service.

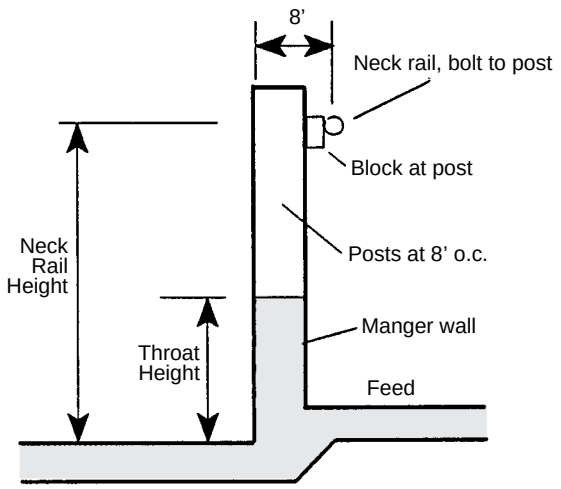
Many Kentucky cattlemen successfully feed cattle in bunks without any roof or covering. For summertime feeding, however, feeding under roof is strongly encouraged for high producing animals. This reduces heat stress and encourages animals to use the bunk. For winter conditions, some type of windbreak is advised if the bunk is on a ridge top or open to northwest winds. Ideally, a feed bunk offering cattle access on both sides should be oriented north-south, so the surfaces on both sides of the bunk have an opportunity to dry out from exposure to the sun. For bunks located outside or in locations where manure is not scraped frequently, a step (4 to 6 inches high and 12 to 16 inches wide) may be desired to improve access and minimize the problem of cows defecating in the bunk. For bunks with feed retaining walls on both sides, increase the depth and/or width for bulky feeds, such as silage. Table 3-11 provides guidelines for bunk widths and apron construction.

Table 3-10. Throat and Neck Rail Heights for Feed Bunks

Age (mo)	Weight (lbs)	Throat height (in.)	Neck rail height (in.)
6-8	360-490	14	28
9-12	490-650	15.5	30
13-15	650-780	17	34
16-24	780-1,200	19	41
Cows	1,200-1,500	21	48

Source: Bickert, 1990, NRAES-38.

Figure 3-11. Modified post and railing feeding barrier design (from Bickert, 1990; NRAES-38).



Pad Construction

To help avoid problems associated with mud, concrete pads or all-weather surfaces can be used where cattle are fed or confined. Concrete is probably the most desirable surface for durability and maintenance. However, an all-weather surface can be built of filter fabric, rock, and a fine surface cover for less than a third of the cost of concrete. Producers frequently use crushed rock in feeding acres in an unsuccessful attempt to minimize mud. With filter fabric, the rock stays in place and less rock is required initially.

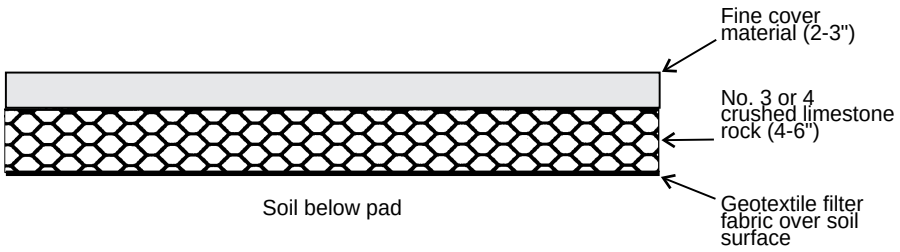
All-weather pad construction. Filter fabrics are basically of two types—a "geotextile" fabric material or a plastic-derivative, cross-hatched grid material. Both are used in the highway industry to support rock bases for roadbeds and to distribute the loads of vehicle traffic. Figure 3-12 illustrates the recommended construction details for animal-use pads. Such surfaces cost less than $0.50 per square foot compared to an installed cost of $1.50 per square foot for concrete.

Table 3-11. Suggested Bunk Widths and Apron Construction Characteristics

	Dimensions
Bunk width	
a. Both sides feeding	
calves	36"
heifers	48-60"
cows	48-60"
b. One side feeding	18" bottom width
Bunk apron	
width	10-12'
slope	¾"-1"/ft

Source: Midwest Plan Service, Beef Housing and Equipment Handbook, MWPS-6.

Figure 3-12. Recommended construction details for animal use geotextile and rock pads.



Filter fabrics are porous, so water and moisture pass through the material while the rock is held in place. Even with mud and manure buildup on the surface, the animals have solid footing and do not sink in mud. Number 4 crushed limestone rock is suggested for the base material, which is placed above the filter fabric. A 2- to 3-inch cover of sifted lime or dense grade material allows for easier scraping of the surface and less loss of rock through the box spreader. More information and a list of suppliers of filter fabric materials are available from your county Extension office. Ask for AEU-68, “Reducing Mud Using Highway Filter-type Materials.”

Section 4.

Managing Reproduction

David Patterson and Roy Burris

Reproductive efficiency is the single most important factor affecting your net returns as a cow-calf producer. You should have several goals in managing the reproduction of your beef herd:

- to obtain a live, healthy calf from every replacement heifer by the time she is two years of age
- to obtain an additional calf from each cow every year she remains in the herd
- to concentrate the calf crop into a short period of time

You also might want to use genetically superior herd sires through artificial insemination (AI).

To accomplish these goals, pay special attention to proper nutrition of the brood cow, disease prevention, minimizing calf death loss, using fertile bulls, culling nonbreeding cows, and breeding heifers 21 days earlier than the mature cow herd.

Choosing the Calving Season

Choose the time of year for calving that is best for your operation. Most Kentucky producers choose spring calving because it fits with their pasture programs. However, fall calving is most favorable weather-wise.

Spring calving

Spring calving (*March-April*)—cows can be wintered with less harvested and poorer quality feed because they are "dry" during the winter. Rebreeding is aided by good pastures in May and June. However, endophyte-infected fescue can be a problem during the later part of the breeding season (July) of spring-calving cows. Lush pastures can cause cows to produce more milk than young calves can consume. Spring calves generally are born during the wettest season, when it is frequently cold.

Fall calving

Fall calving (*September-October*)—cows are usually in good condition, and the weather is favorable. Fall calves offer some flexibility in marketing: they can be sold at weaning or grazed for a period of time. The market for fall-born calves is usually better than for spring-born calves. More stored feed of higher quality is required for the fall-calving herd because cows are in lactation and must rebreed during the winter. Stockpiled/accumulated fescue can be used effectively during the breeding season. Endophyte-infected fescue is less of a problem in the breeding season of fall-calving cows than that of spring-calving cows.

Winter calving

Winter calving (*January-February*)—occurs during the coldest part of the year, which means you must pay more attention during the calving period. The calves have heavier weaning weights for fall marketing than spring-born calves. The cows require ample amounts of feed in February and March if they are to rebreed on time. Calf disorders, such as scours and pneumonia, may be a problem.

Rationale for Controlled Breeding and Calving Seasons

Whichever calving season (spring or fall) is chosen, the following reasons illustrate why a controlled, seasonal calving schedule is desirable.

1. The culling of cows and selection of replacements is based on production records; however, accurate comparisons in the production of cows within a herd cannot be made unless a certain degree of uniformity exists among their calves. Decisions to keep or cull cows should reflect relative performance of calves within the herd. Acceptable performance implies not only weaning weight but also that a cow produce a calf every 12 months.
2. Shortened calving seasons provide a better opportunity to offer improved management and observation of the cow herd, which should result in fewer neonatal or postnatal calf losses (a major sources of reproductive failure among any herd of cows). This is vital because percent calf crop is the major profit-determining factor in a cow-calf operation.
3. Shortened calving periods facilitate improvements in herd health and management. Uniformity in timing of vaccinations and routine management practices result in decreased labor requirements and enhanced efficiency. Pregnancy testing and culling of open cows, which can reduce feed expense and improve herd efficiency, cannot be accomplished with year-round calving.
4. Brood cow nutrition can be improved by grouping cows according to stage of gestation and feeding each group accordingly. When cows are strung out in their expected calving dates, it is difficult to provide cows adequate nutrition in a cost-effective manner.
5. Calf crops that are uniform in age and size can be marketed to better advantage and thereby exceed returns over calves that lack uniformity in either age or weight. Calves born in the first 21 days of the calving season can weigh 30 pounds more at weaning than those born during the second 21-day period. Calves born 42 days into the calv-

ing season have been found to weigh as much as 70 pounds less than those born in the first 21 days and 42 pounds less than calves born in the second 21 days.

Hence, shortening the calving season results in:

- heavier, more uniform calves at weaning
- better use of available labor
- better opportunity to select for fertility in the cow herd
- greater income potential

A breakeven in a cow-calf operation is derived by the following formula:

$$\frac{\text{annual cow cost}}{\text{(average weaning weight) x (\% calf crop)}} = \text{breakeven price}$$

The denominator that drives this equation is directly influenced by reproductive success or failure in any given herd. Average weaning weight is affected by calving distribution (i.e., early-born calves weigh more at weaning than late-born calves). Economic analyses of herds in other parts of the United States show that high-profit cattlemen average 70 percent of their calves born during the first 21 days of the calving period. Calves grouped this close to one another in terms of birth date logically are more uniform at weaning than calves born during the second or even third 21-day period in the same calving year.

Percent calf crop is directly influenced by the number of cows that become pregnant and the number of pregnant cows that go on to wean calves:

$$\text{\% calf crop} = \frac{\text{number of calves weaned}}{\text{number of cows exposed for breeding}}$$

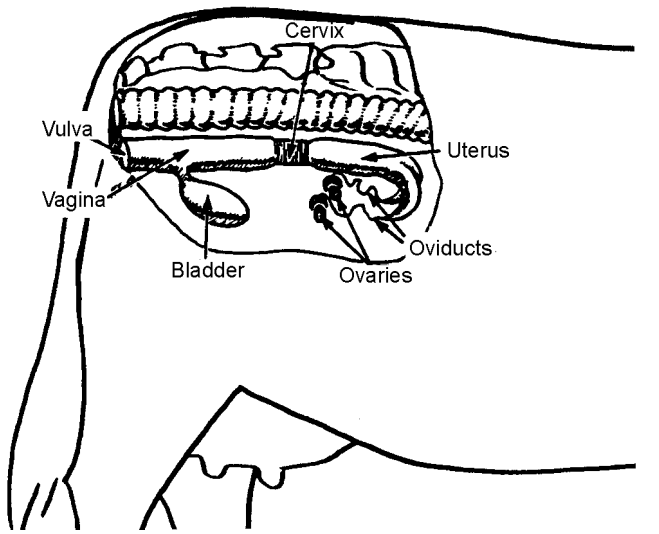
Reproduction in the Cow

The cow's reproductive tract is located in the pelvic and abdominal cavities and consists of a pair of ovaries, oviducts (also called fallopian tubes), a uterus, a cervix, a vagina, and a vulva (see Figure 4-1).

Ovaries—produce the female sex cells (eggs or ova) plus estrogen and progesterone. Each egg is produced in a blister-like structure on the ovary called a follicle. There are cells in the follicles that produce estrogen. High levels of estrogen make the cow "come into heat" (estrus) and stand to be ridden by other cows or bulls. After the egg is released from the follicle, the follicle changes to a corpus luteum, or "yellow body." The corpus luteum produces progesterone ("pregnancy" hormone), which is vital if conception occurs and pregnancy is to be maintained.

Oviducts—a pair of tubes that extend from near the ovaries to the uterine horns. Immediately after ovulation, the egg is caught by the "funnel-like" portion of the oviduct and transported through the oviduct to meet the sperm of the male.

Figure 4-1. A diagrammatic view of the cow's reproductive system.



Uterus—in a cow this has a body and two horns. The body is located near the cervix. Semen is deposited here during artificial insemination. The sperm cells from the male move from the body of the uterus to the oviducts by way of the uterine horns. The uterine horns house the developing fetus during pregnancy.

Cervix—connects the vagina to the uterus. It forms a "gateway" between the uterus and the vagina. The cervix is tightly closed or sealed during pregnancy but is relatively open and very moist during estrus.

Vagina—the "birth canal" during calving and the site where semen is deposited if the cow is serviced by a bull. There is a "blind pouch" in the vagina that has little significance except that it frequently presents a problem for inexperienced artificial insemination technicians because the tip of the insemination rod may be placed in it during insemination.

Vulva—the external opening or entrance to the cow's reproductive tract. It becomes swollen and moist during estrus. The vulva also becomes very swollen and relaxed as calving (parturition) approaches.

Estrus, ovulation, and pregnancy are controlled by hormones. Estrus and ovulation occur as a cycle. Estrus is the time when the cow will accept a bull, and it generally lasts about 14 to 18 hours. Ovulation generally occurs about 30 hours after the beginning of heat. If pregnancy does not occur, the cycle repeats itself in about 21 days (see Table 4-1).

The fertilized egg begins a series of cell divisions as it migrates down the oviducts. It attaches to the wall of one of the uterine horns where it is nourished during pregnancy. The gestation period (pregnancy) lasts about 283 days. Management at calving time is discussed later in this section.

Table 4-1. The Heat Cycle of the Cow

	Average	Range
Duration of heat (hr)	14-18	12-30
Ovulation (hours after beginning of heat)	30	18-48
Length of heat cycle (days)	21	17-24

Pregnancy Testing

Pregnancy diagnosis is a management tool used to identify nonpregnant females and to aid in grouping pregnant females according to anticipated calving dates.

Pregnancy testing offers the following advantages:

- Pregnancy diagnosis provides early warning of breeding problems, such as infertility in males and problem breeders in females.
- Management decisions can be made regarding rebreeding or sale of nonpregnant females.
- Separation and grouping of females based on pregnancy status improves feed utilization and enhances management efficiency.
- Improved utilization of facilities is possible.
- It is possible to guarantee pregnancy in females available for sale.

A thorough understanding of the female reproductive system is essential in order to accurately perform a pregnancy examination.

Pregnancy diagnosis in cattle is generally performed by rectal palpation; however, real-time ultrasound is beginning to be used routinely in some instances to diagnose pregnancy and determine fetal sex. Table 4-2 provides a summary of fetal development and identifying characteristics based on fetal age.

Practice and experience are the keys to accurate palpation. In many instances, the producer should not be the one to palpate but should supervise the operation and critically observe cows as they are processed through the chute. This provides an ideal time to begin making decisions regarding which cows to keep and which to cull.

Replacement heifers should be fed so that they will reach two-thirds of their mature weight (target weight) by the start of their first breeding season.

Selection and Management of Replacement Heifers

Replacement heifers are reinforcements for the herd; they either replace cows that have been culled or increase herd size. Consider replacement heifers investments in the future; have them calve early. Once replacement heifers take their places in the cow herd, they should be able to stay there for a long time.

A successful program for developing replacements starts before weaning and continues until they have rebred after having their first calf. Pay attention to three problem areas: low pregnancy rate of yearling heifers, high losses at first calving, and low percentage of heifers rebreeding for a second calf.

Selection. It is difficult to determine which selection criteria are the most important for all producers. However, since reproduction has more to do with profitability than any other trait, it should be emphasized. Heifers should appear to possess a high degree of fertility, good frame size, and structural soundness. The fertile heifer looks feminine

Table 4-2. Characteristics of the Bovine Fetus During Pregnancy

Day of gestation	Approximate size	Inches	Characteristics
30 (1 month)	1/100 oz	½	some fluid in embryonic vesicle (marble size)
45 days	1/8 oz	1	gravid horn enlarged
60 (2 months)	1/4 oz	2	fetus size of a mouse, uterine horn banana size (2 in. diameter)
90 (3 months)	8 oz	6	fetus size of small rat, uterine horns 3 inches in diameter and dropping into abdominal cavity
120 (4 months)	2 lbs	12	fetus size of small cat, uterine horns 5 inches in diameter, placentomas are palpable
150 (5 months)	5 lbs	18	fetus size of a cat, might be too deep in abdominal cavity to palpate, uterine horns 7 inches in diameter, placentomas 2-2.5 inches
180 (6 months)	11 lbs	24	fetus size of small dog
210 (7 months)	23 lbs	30	fetus is easily palpated from this point till term
240 (8 months)	47 lbs	36	fetus is easily palpated from this point till term
283 (term): size depends on genetic and environmental factors			

and has a normally developed udder. In purebred cattle, maintain standards established by the breed associations (as long as they are not simply fads). Adequate growth to allow breeding and reproduction on schedule is absolutely essential.

Selection is a continuous process during a heifer's development. They should be evaluated and kept or culled at the following stages:

- at weaning
- at one year of age
- after the breeding season
- after weaning of first calf

Select more replacement heifers than you need to allow for culling at each stage.

At weaning, evaluate heifers for weight, height, structural soundness, and other traits important in young herd replacements. Rank heifers on the basis of actual weaning weight and adjusted weaning weight. Eliminate heifers that are not structurally sound for any reason. Then save the heaviest calves that are not overly fat and have acceptable frame size. Save about 50 percent more heifers than you need as herd replacements.

Evaluate heifers again between the time at which they turn 1 year old and the start of the breeding season. A few heifers might be eliminated at this time due to unthriftiness or structural problems.

A critical time for selection is about two months after the heifers have been exposed to a bull for a short period of time (45 to 60 days). Heifers should be pregnancy checked; all that are not bred should be culled. If more heifers than needed are bred, keep those that were bred early and sell those that were late as bred heifers.

A final evaluation of heifers occurs at the weaning of their first calves. Cull those that wean a poor calf or do not rebreed after their first calf. A heifer's status at this time is a good indication of whether she will be the type of cow suited to your management and environmental conditions.

Table 4-3. Breed Crosses Grouped in Biological Type on the Basis of Four Major Criteria[1]

Breed group	Growth rate & mature size	Lean:fat ratio	Age at puberty	Milk production
Jersey	X	X	X	XXXXX
Hereford-Angus	XX	XX	XXX	XX
Red Poll	XX	XX	XX	XXX
Devon	XX	XX	XXX	XX
South Devon	XXX	XXX	XX	XXX
Tarentaise	XXX	XXX	XX	XXX
Pinzgauer	XXX	XXX	XX	XXX
Brangus	XXX	XX	XXXX	XX
Santa Gertrudis	XXX	XX	XXXX	XX
Sahiwal	XX	XXX	XXXXX	XXX
Brahman	XXXX	XXX	XXXXX	XXX
Brown Swiss	XXXX	XXXX	XX	XXXX
Gelbvieh	XXXX	XXXX	XX	XXXX
Holstein	XXXX	XXX	XX	XXXXXX
Simmental	XXXXX	XXXX	XXX	XXXX
Maine-Anjou	XXXXX	XXXX	XXX	XXX
Limousin	XXX	XXXXX	XXXX	X
Charolais	XXXXX	XXXXX	XXXX	X
Chianina	XXXXX	XXXXX	XXXX	X

[1] *X lowest, XXXXXX highest.*
Cundiff, 1986

Heifer Development

Because decisions about selection and management of replacement beef heifers can affect the future productivity of an entire cow herd, programs to develop breeding heifers have focused on the physiological processes that influence puberty. The timing of puberty is critical to whether a heifer remains in the herd and whether lifetime productivity is optimized.

Diversity among breeds

Table 4-3 groups breed crosses by their biological types and four other criteria. The table summarizes data from the Meat Animal Research Center for 19 F_1 crosses grouped into seven biological types based on relative differences (X lowest, XXXXXX highest) in growth rate and mature size, lean-to-fat ratio, age at puberty, and milk production. This data shows that faster-gaining breed groups of larger mature size reach puberty at later ages than do slower-gaining breed groups of smaller mature size. Breeds that have a history of selection for milk production (e.g., Gelbvieh, Brown Swiss, and Simmental) tend to weigh less at puberty than do those with the same genetic potential for growth and mature size that are not selected for milk production (e.g., Charolais, Limousin, and Chianina).

Heifers sired by breeds with a large mature size tend to be older and heavier at puberty than heifers sired by breeds with a smaller mature size. The relationship between mature size and age at puberty can be offset by associations with milk production (i.e., heavier milking breeds or lines within a breed reach puberty at younger ages and lighter weights). When these interpretations are expanded to mature cows, it is evident that the additional nutrient requirements of cows of large size and higher milk production potential must be met or the intervals from calving to first estrus increase and conception rates decline.

Matching the development program with genotype

We know that most components of fertility that influence first calving and subsequent reproductive performance are not highly heritable. This suggests that management practices are most likely to influence the majority of factors related to reproductive performance. How we manage replacement heifer calves from the time they are weaned from their dams to the beginning of the first breeding period is critical for their subsequent performance.

Studies indicate that puberty can be expected to occur at a genetically predetermined size among individual ani-

Table 4-4. Body Weight & Height of Breeding Females of Different Frame Sizes[1]

Frame score	205 day		426 day		Maturity	
	Height	Weight	Height	Weight	Height	Weight
1	35	356	41	580	44	880
2	37	375	43	618	46	953
3	39	396	45	653	48	1,027
4	41	418	47	693	50	1,100
5	43	438	49	728	52	1,172
6	45	458	51	766	54	1,247
7	47	480	53	803	56	1,320
8	49	499	55	838	58	1,393
9	51	521	57	880	60	1,467

[1] Hip height (in.) based on Beef Improvement Federation standards. Weights (lbs) are expected averages for flesh condition (body condition score 5; Fox et al., 1988).

Table 4-5. Optimum Growth Rate for Breeding Herd Replacement Females[1]

	Frame size				
	1	3	5	7	9
Optimum weight at first estrus, lbs	580	653	728	803	880
Mature weight, lbs	880	1,027	1,172	1,320	1,467

[1] Optimum weight or target weights at which reproductive cycles are initiated are reinitiated as soon as possible without excess fat deposition that will inhibit milk production and reproduction (Fox et al., 1988).

mals, and only when heifers reach target weights can high pregnancy rates be obtained. In other words, heifers with the genetic potential to reach a heavier mature weight must attain a heavier prebreeding weight before their first breeding season. Using the standard set by the Beef Improvement Federation for nine frame-size classifications for U.S. breeding cattle (Table 4-4), producers can estimate body composition and energy requirements per pound of gain at various weights during the feeding period.

Optimum growth rates for replacement females of various body types are also available. These growth rates (listed in Table 4-5) represent optimums for heifers that vary in mature size; they were established to maximize female lifetime productivity. The target weight principle calls for feeding heifers to a prebreeding target weight that represents 65 percent of the heifer's projected mature weight.

Reproductive tract score (RTS)

Heifers must reach puberty by 15 months of age if they are to conceive and calve by 24 months, but as many as 35 percent of all beef heifers fail to reach puberty by this time. First-service conception rates for heifers bred on their first heat are lower than those of heifers bred on a second or subsequent heat. Therefore, heifers should reach puberty one to three months before the average age at which they are to be bred. Earlier age at puberty in relation to breeding ensures that a high percentage of heifers are cycling and that the effects of lowered potential fertility at the first estrus are minimized.

Because age at puberty in beef heifers is difficult and labor intensive to measure directly, a method for evaluating the reproductive tract of yearling heifers has been developed. The reproductive tract scoring (RTS) system was designed to estimate pubertal status via rectal palpation of the uterine horns and ovaries. Scores are subjective estimates of sexual maturity, based on ovarian follicular development and palpable size of the reproductive tract. Each heifer is assigned a score of 1 (immature) through 5 (cycling), as described in Table 4-6.

RTS values have been shown to be predictive of reproductive performance of yearling heifers, especially for pregnancy rates to synchronized breeding and pregnancy rates at the end of the breeding season. Heifers with more mature reproductive tracts had higher pregnancy rates and delivered calves earlier. Preliminary data indicates that tract scores can be used to evaluate the status of heifer development and to time synchronization programs and the start of the breeding season. Scoring can be done as part of a yearling heifer evaluation and health program in conjunction with collection of *yearling weights, condition scores, pelvic measurements,* and *general processing*.

An RTS of 1 is assigned to heifers with infantile reproductive tracts, indicated by small, toneless uterine horns and small ovaries lacking significant structures. Heifers scored as 1 are likely the furthest from cycling at the time of the examination. Heifers given an RTS of 2 are thought

Table 4-6. Description of Reproductive Tract Score[1]

Reproductive tract score	Uterine horns	Ovaries—Approximate Size Length (mm)	Height (mm)	Width (mm)	Ovarian structures
1	Immature < 20 mm diameter, no tone	15	10	8	No palpable follicles
2	20-25 mm diameter, no tone	18	12	10	8 mm follicles
3	25-30 mm diameter, slight tone	22	15	10	8-10 mm follicles
4	30 mm diameter, good tone	30	16	12	>10 mm follicles, Corpus luteum possible
5	> 30 mm diameter, good tone, erect	>32	20	15	> 10 mm follicles, Corpus luteum present

[1] Reproductive tract score was determined approximately 1 month prebreeding by rectal palpation. Anderson, et al., 1991.

Table 4-7. Using Pelvic Area to Estimate Deliverable Calf Birth Weight for Yearling Heifers Before Breeding

Heifer wt., lb	Pelvic area sq. cm.	Pelvic area/ birth wt. ratio factor	Estimated calf birth wt., lb
600	140	2.1	67
	160	2.1	76
	180	2.1	86

to be closer to cycling than those scoring 1, due primarily to the presence of small follicles and slightly larger uterine horns and ovaries. Heifers assigned an RTS of 3 are thought to be on the verge of cycling, based on slight uterine tone in addition to the presence of follicles. Heifers assigned a score of 4 are presumably cycling, as indicated by good uterine tone, uterine size, and follicular growth. However, heifers with tract scores of 4 lack an easily distinguished corpus luteum due to the stage of estrous cycle. Heifers with tract scores of 5 are similar to those scoring 4 except for the presence of a palpable corpus luteum.

Pelvic measurements should be taken before the breeding season so the results can be incorporated into the heifer management program (see Table 4-7). Pelvic measurement can be taken by a veterinarian or skilled technician. Heifers with small pelvic areas could have problems at calving and can be culled.

Commercial producers should choose a sire (or sire breed) known to produce small calves at birth. You can expect trouble if you mate large-framed, heavily muscled bulls with smaller, medium-framed yearling heifers. Certain bulls in every breed sire small calves at birth. Breed associations and bull studs give expected progeny differences (EPDs) for birth weight and calving ease. Use this information. Also, well-grown heifers with greater pelvic area tend to have less calving difficulty.

Breed yearling replacement heifers about 21 days earlier than the breeding season for the mature cow herd because young cows take more time to return to heat after calving than mature cows. The first calf heifer must provide milk for her calf, get ready to start a new pregnancy, and still continue her own growth. Earlier breeding gives them a better opportunity to rebreed and have an early calf the next year.

At least two weeks prior to calving, move heifers to an accessible area. An ideal situation would be a small pasture near a corral, complete with a place to pull calves and a small pen for getting heifers to "pair up" with their calves after they are born. Check heifers at least three times a day during the calving season.

Keep heifers separated from the older cows, and feed them better after calving. Heifers nursing their first calves often have low conception rates or are slow to rebreed. Inadequate nutrition is often at fault. Rations should contain ample energy. Many producers turn heifers on to spring grass after they calve. Most immature grasses are of high quality. However, cattle must consume large quantities of grass, due to its high moisture content, to meet their nutritional needs. Supplementation with high energy feeds, such as grain, is justified when grass is short or sparse.

When managing replacement heifers, emphasize high fertility, early pregnancy, and ease of calving. These are more important than trying to get calves with heavy weaning weights from first-calf heifers.

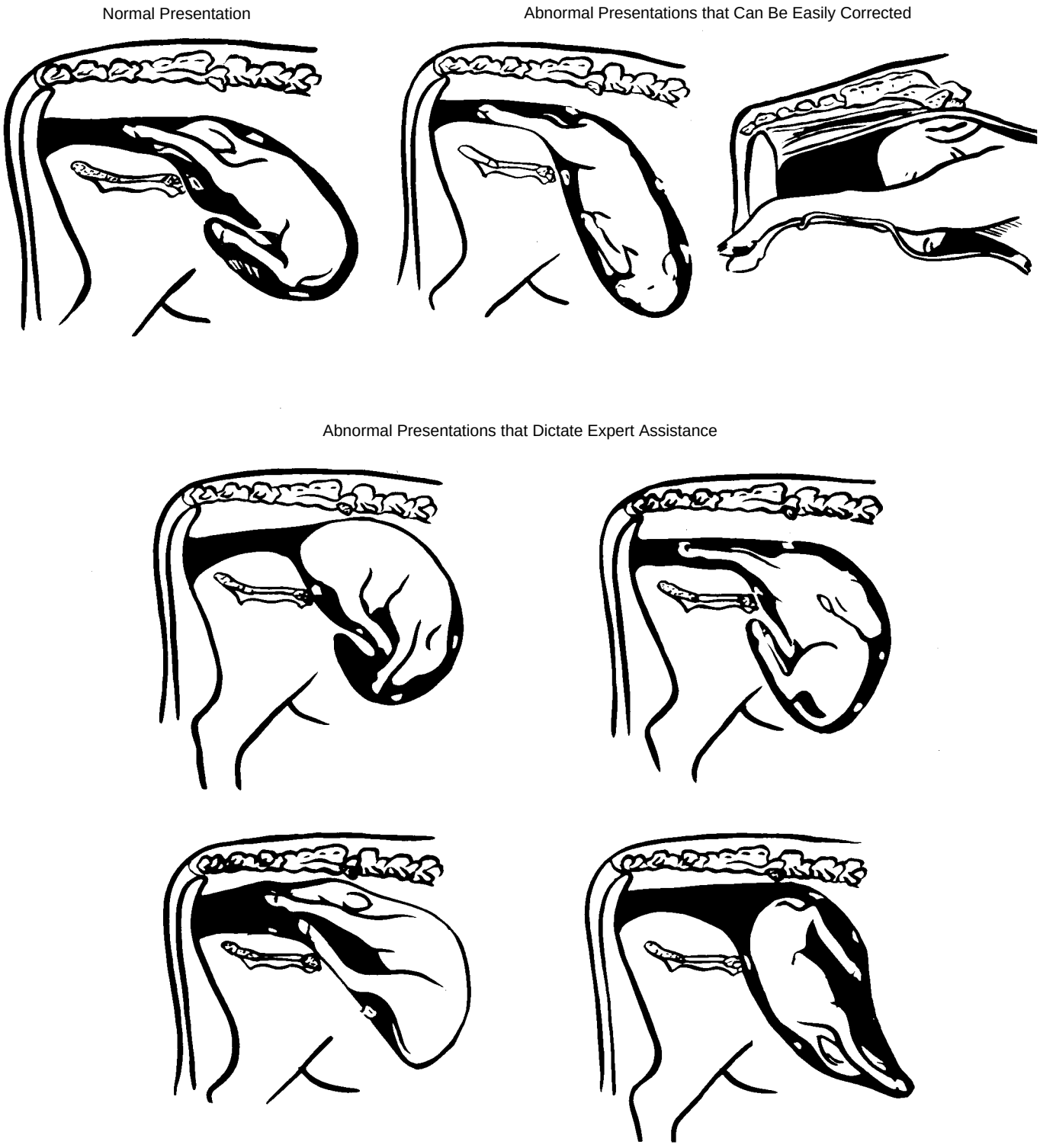
Management During Calving

Death of calves at or near calving time represents a major economic loss for beef producers. A newborn calf represents the chance to recover the annual cost of maintaining the beef cow and obtain a profit. Death rates in excess of 5 percent unfortunately are not uncommon at calving time. You generally can prevent these losses by providing keen management to the beef herd during the calving season. It is important to have a short calving period so you can provide frequent observation and assistance if needed.

Here are some specific things you can do:

- **Separate first-calf heifers from mature cows.** Calving difficulty can run as high as 30 percent to 40 percent for 2-year-old heifers; whereas, 3 percent might be normal for mature cows. It is especially important to closely observe first-calf heifers. Place them in a small, accessible pasture near a corral where assistance can be given if needed.
- **Provide a clean area for calving.** The calving area should be a well-sodded pasture or clean, dry maternity pen instead of a wet, muddy lot. Calving pastures should be large enough to permit adequate exercise and offer protection against prevailing winds.
- **Be familiar with the signs of calving.** The earliest sign that may be noticed is enlargement of the udder; however, this can occur several weeks before calving. Several days before calving, the ligaments around the tailhead and in the pelvic area relax. The vulva becomes swollen and may begin to sag with strings of mucus appearing. Within a few hours of calving, most cows become nervous and uneasy. Cows generally wander away from the rest of the herd as contractions increase.
- **Check cows frequently.** Close observation is needed so that assistance can be given to cows with calving difficulty. Observing cows three or four times daily and providing assistance as needed results in more live calves. However, cows should be disturbed as little as possible during labor.
- **Know when cows need assistance.** Intervention is justified when two or three hours have passed without progress or if delivery has not occurred within 90 minutes after the water sac appears. In a normal delivery, the calf's forelegs and head, surrounded by membranes, are forced through the birth canal and appear from the vulva. Train yourself to recognize an abnormal delivery

Figure 4-2. Normal and some abnormal presentations of the calf at parturition.



Source: Hardin, R. 1986. Factors Affecting Calving Difficulty. Athens, GA: University of Georgia Cooperative Extension Service. Bulletin 943.

and know when professional help is needed. Using a disposable glove, determine the position of the calf by feeling the various parts of the calf.

When the calf is in a normal position, the bottom of the feet are face downward and the head can be felt between the front legs. Some abnormalities—such as one or both forelegs back or head turned back—can be corrected by pushing the calf back and putting the extremities into the correct position. Figure 4-2 illustrates some normal and abnormal presentations of the calf at parturition.

The cow needs help when:
- presentation is backward
- only the calf's head or tail is visible
- the front feet protrude past the knees but the calf's nose cannot be located
- the head and one foot are visible
- more than two feet are visible

- **Be sure the calf is breathing normally.** After the calf is delivered, some stimulation may be required to start its breathing. You can rub it briskly, slap it on the ribs, or tickle its nostrils with a straw. Remove mucus from the mouth and throat. Lifting the calf up by the hind legs helps drain fluids from the respiratory system.
- **Be sure the calf consumes colostrum.** Every calf should ideally consume colostrum (first-milk) within 15 to 30 minutes after birth. A newborn calf depends on colostrum as a source of antibodies to protect it from diseases. The sooner a calf receives colostrum, the better its protection will be. Saving and freezing colostrum or using a commercial colostrum supplement helps save calves that do not nurse within one to two hours after birth. Give colostrum through an esophageal feeder to calves that were assisted during calving.
- **Increase feed after calving.** Increase the cow's energy intake to about 16 pounds of total digestible nutrients (TDN) per day as soon as the calf appears to be taking all of the milk (10 to 14 days after calving). The extra energy helps the cow produce enough milk for her calf and rebreed on schedule.

Improving Reproductive Rates of Second Calf Heifers with Nutritional Management

A shortened breeding, hence calving, season results in uniform calf crops. Use shortened breeding seasons with replacement heifers to ensure that these young cows calve early and over a short period of time. As mentioned earlier, heifers that attain puberty at an early age and subsequently calve early during the first calving period realize more improvements in lifetime production efficiency than contemporaries that calve late that first year.

Replacement heifers, while still growing themselves, assume the added burden of postpartum recovery and lactation. Postpartum anestrus is often extended in first calving cows for this reason. As a result, it is imperative that first calf heifers be given the opportunity to calve prior to the mature cow herd to ensure adequate recovery time going into their second breeding season.

Postpartum interval

Postpartum interval is the period of time from calving to resumption of cyclicity after calving. The length of the postpartum interval varies depending on the body condition of the heifer, the degree of calving difficulty she experienced at parturition, and the added stress of suckling. The effects of suckling and nutritional status seldom act independently but instead interact to yield varying degrees of suckling and nutritionally induced anestrus.

Long intervals from calving to first estrus are a major factor contributing to low reproductive efficiency. After embryo mortality and postnatal losses are considered, failure of 15 percent to 20 percent of the nation's cow herd to wean a calf annually is due primarily to cows that fail to rebreed within 85 days after calving. Furthermore, cows that conceive late in the breeding season produce substantially smaller calves at weaning. Cows that calve late the first time initiate a pattern that eventually prohibits rebreeding in a subsequent year.

To maintain a 365-day calving interval, a heifer must conceive by 80 to 85 days following calving (gestation = 283 days). Extended postpartum intervals are a frequent cause of late calving and can affect the number of heifers that subsequently conceive during the second breeding season. Inadequate dietary energy and/or protein during nutritionally demanding times drastically influences the length of the postpartum interval and subsequent conception rates. It is generally assumed that *precalving weight change determines if a cow will ovulate, while postcalving weight change determines when a cow will ovulate.*

Contrary to the opinions of many producers, feeding a balanced diet of protein and energy during the last trimester of pregnancy does not increase the incidence or severity of calving problems. Numerous studies show that adequate prepartum protein and energy decreases the likelihood of dystocia, enhances immune function of the newborn calf, and increases weaning percentage and subsequent conception rate of the cow.

Artificial Insemination

Successful AI breeding programs depend on adequate facilities, good herd health programs, sound nutritional management, and experienced, well-trained technicians responsible for detecting estrus and insemination. Most problems and failures in AI programs are associated with poor nutritional development in replacement heifers, inadequate body condition of cows after calving, failure to identify cows in heat, and failure to breed cows at the proper time.

Heat detection—accurate heat detection and record keeping are perhaps the most time consuming and least interesting jobs associated with the AI program. However, in many respects, they are the most important to the overall success rate. Heat detection requires skilled observation, patience, and a general familiarity with the reproductive processes of cattle. Inadequate heat detection can affect herd profitability in the following ways:
- Undetected heats result in longer calving intervals and decreased weaning weights of calves.
- Breeding cows that are not ready to be inseminated results in decreased conception rates and wasted time and semen. (See Figure 4-3 for the best times for breeding to occur.)

- Inseminating already pregnant cows that were mistakenly identified as being in heat can result in abortion.

Standing to be mounted is the sign of heat that is most accurate in selecting cows for insemination. Because pregnant cows will on occasion exhibit heat, it is important to keep thorough records and use a skilled technician.

The efficiency of heat detection may depend on the proportion of animals in heat at the same time. This is usually not a problem in larger herds but may present problems in smaller herds. Synchronization of estrus becomes a valuable alternative in these situations.

Other physical and behavioral signs that may signal that a cow is either coming into heat or actually is in estrus include mounting of other cows, swelling of the vulva, strands of mucus discharged from the vulva, chin resting, and sniffing and licking of the vulva of other cows.

Cows that are isolated or with cows that are not sexually active may exhibit signs of estrus that include hyperactivity and movement, bellowing, tail raising and switching, and frequent urination. Extremes in weather, including periods of extreme cold or heat, can disrupt or diminish estrual behavior and make accurate heat detection difficult.

Heat detection can be assisted through the use of sterilized ("Gomer") bulls or hormone treated steers or cows, which readily mount cows in standing heat. Chin-ball markers, which mark the back of cows in heat, can be used on these animals. Also available are patches that can be placed on the rump and turn from white to red when an animal stands to be ridden by another cow or bull. Cows should be checked at least twice daily during the AI breeding period.

Semen storage—frozen semen is stored in ampules (glass vials) or plastic straws maintained in liquid nitrogen (-320°F). The plastic or French straw is most commonly used. Semen should be transferred from one container to another carefully and swiftly; the transfer should be completed within 10 seconds. Semen tanks should be routinely checked to determine if the level of liquid nitrogen is sufficient to ensure proper storage of semen.

Semen thawing—frozen semen should be thawed in a warm water bath at 95°F for a minimum of 15 seconds. Extreme water temperature can kill the sperm. It is important to annually check the accuracy of the thermometer used to determine water temperature.

Insemination procedure—use semen within 15 minutes of being thawed. Once the semen is thawed, the straw should be removed from the thaw bath and thoroughly dried with a paper towel. In loading the gun, the straw should be cut depending on the type of French gun used. The cut should be made at a right angle to the straw or diagonally. The model of French gun determines the type of sheath used. Thawed semen should be protected against temperature shock, preferably by wrapping the front end of the gun with a paper towel.

Semen deposition—once the external genitalia have been wiped clean, the inseminating rod may be inserted into the reproductive tract. It is important to remember that the cervix should be worked over the rod and not vice versa. To ensure proper placement of semen in the body of the uterus, the tip of the technician's index finger should run over the front edge of the cervix to enable the technician to feel the tip of the gun as it protrudes into the uterus. This is illustrated in Figure 4-4. Placement too far into the uterus may result in damage to the uterine lining, as illustrated in Figure 4-5. Research has clearly shown that the body of the uterus is the preferred site of semen deposition. How-

Figure 4-3. Best times for breeding relative to the start of estrus.

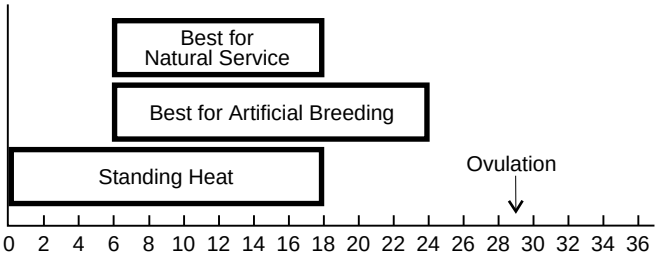


Figure 4-4. The proper site of semen deposition in the cow.

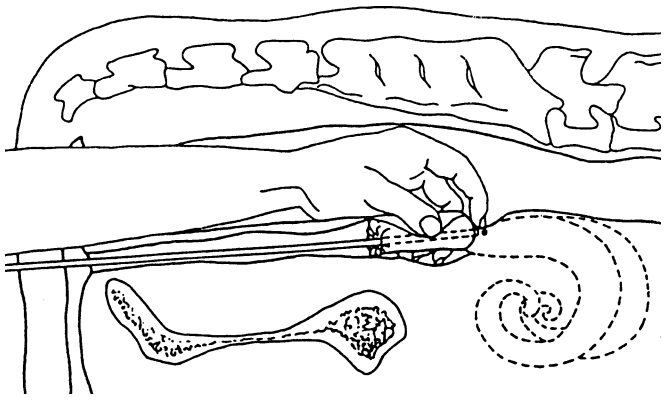
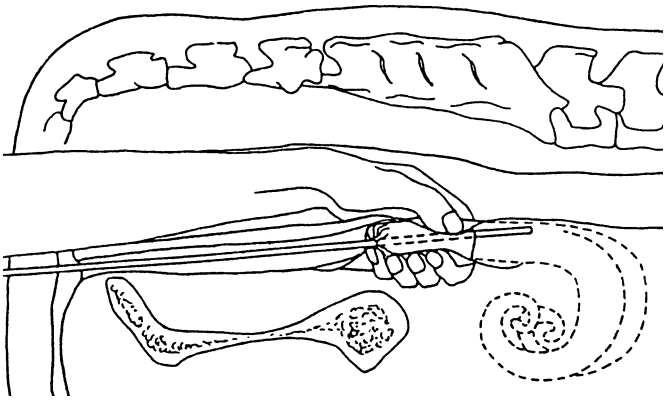


Figure 4-5. This figure illustrates incorrect placement of semen. Notice that the tip of the gun is too far into the body of the uterus and not immediately through to the cervix and just into the body of the uterus.



Source: Cliff Marshall, Select Sires, "Some A.I. 'Tricks of the Trade' Can Help You Settle More Cows."

Table 4-8. Comparison of Heat Synchronization in AI Breeding Programs

Program	Injections (number)	Times cattle handled	Heat detection (days)	AI breeding (days)	Relative drug cost	Uses semen on cycling females only
Prostaglandin One injection	1	2	11	11	minimal	yes
Prostaglandin Two injections[1] & detection	2	3	16	16	moderate	yes
Prostaglandin Two injections (all cows) with heat detection	2	3	5	5	high	yes
Syncro-mate B® with heat detection	1 + 1[2]	3	4	4	high	yes
Syncro-mate B® without heat detection (breed by appointment)[3]	1 + 1[2]	3	0	1	high	no
MGA® + prostaglandin	1	2	4	4	minimal	yes

[1] Only reinject cows which fail to respond to first injection but heat detect and breed after both injections.
[2] Implant.
[3] Breed 48-52 hours after removal of the implant.

ever, semen may be deposited in the cervix on second and later services. This is to prevent disrupting pregnancy if a pregnant cow is accidentally re-inseminated.

Estrus Synchronization

You might not be using artificial insemination because heat detection and breeding require so much time and labor. Heat synchronization allows you to use AI and reduce heat detection and insemination time.

Synchronization alters estrous cycles so that all cycling cows come into heat at a predetermined period of time, usually the beginning of the breeding season. Cows that breed and calve earlier wean older, heavier calves and have more time to rest and recycle between calving and next breeding. With synchronization, you can have two chances to settle a cow or heifer in a 21- to 25-day period.

With a shorter calving season, you can get a more uniform calf crop and more uniform management. You can schedule breeding/calving so that it fits around other work.

Table 4-8 compares several available methods of heat synchronization. Today's methods involve three systems: prostaglandins, Syncro-Mate B®, and MGA®.

Prostaglandins include products being marketed as Lutalyse®, Estrumate®, and Bovilene®. These products are given as injections and cause the cow to begin a new estrous cycle. They exert their effect during days 5 through 17 of the estrous cycle and have no effect during the first four days of the cycle. Therefore, cattle that are five days or less into their estrous cycle do not respond to the injection and a second injection is needed for complete synchronization. Breeding systems where prostaglandin is used are shown in Figure 4-6.

Syncro-Mate B is a treatment that consists of an ear implant and an injection. This treatment requires that cattle be handled first to administer the injection and insert the implant and nine days later to remove the implant. Syncro-Mate B is different from the prostaglandin treatment because it can induce estrus in heifers or cows that are not cycling. Cows may be inseminated after detection of heat or by appointment 48 to 52 hours after removal of the implant. Calf removal for 48 hours can be used to increase conception rates of nursing cows. These treatments are shown in Figure 4-7.

MGA is the most recently developed heat synchronization method. It has been used to suppress heat in feedlot heifers when included in the feed. Short feeding periods with MGA combined with prostaglandin at the end of treatment might be an alternative to more expensive or labor-intensive methods of synchronizing breeding females. MGA is easy to use and can induce estrus in non-cycling females.

MGA is fed in a grain mix at the rate of 0.5 mg/head daily for a 14-day period. Cattle will show heat within 48 hours after MGA is removed from the feed but should not be bred on that heat. Prostaglandin should be administered 17 days after MGA withdrawal, with insemination based on heat detection (Figure 4-8).

Reproductive Biotechnologies

Reproductive biotechnologies include estrus synchronization, artificial insemination, superovulation, embryo recovery and transfer, cryopreservation of sperm and embryos, sexing semen, in vitro fertilization, bisection and cloning of embryos by nuclear transplantation, biopsy of embryos for sex determination and other genetic analyses, and transgenic technology.

Figure 4-6. Various breeding systems using prostaglandin (PGF).

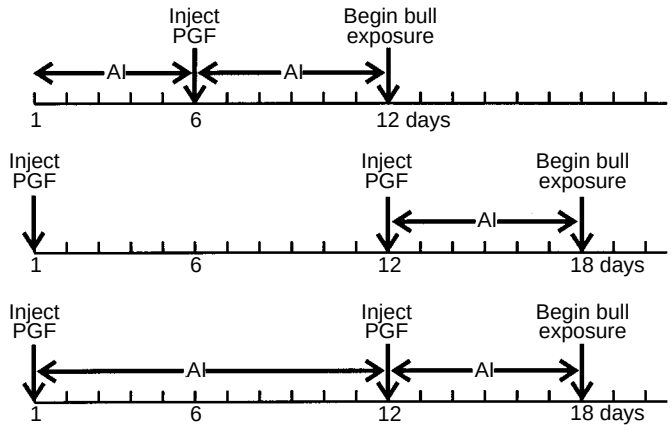


Figure 4-7. Breeding systems using Synchro-Mate B®.

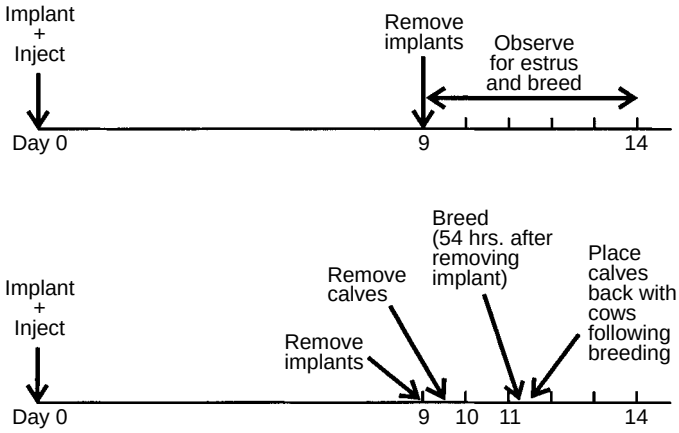
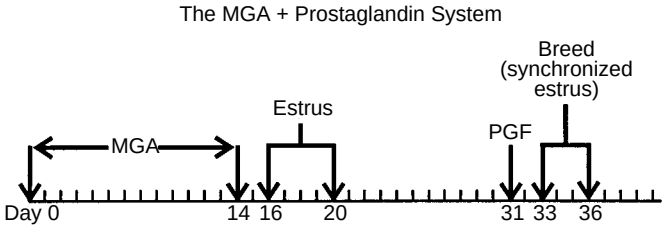


Figure 4-8. Breeding system where melengestrol acetate (MGA®) is fed for 14 days followed by an injection of prostaglandin (PGF).



This list can be expanded to include even more procedures; however, it is generally assumed that, at least at this point, selective breeding programs are perhaps more profitable for the majority of beef cattle operations than the biotechnologies listed. Estrus synchronization and artificial insemination are the most important and widely applicable technologies currently available and, at present, offer the best opportunity to affordably impact a beef production system.

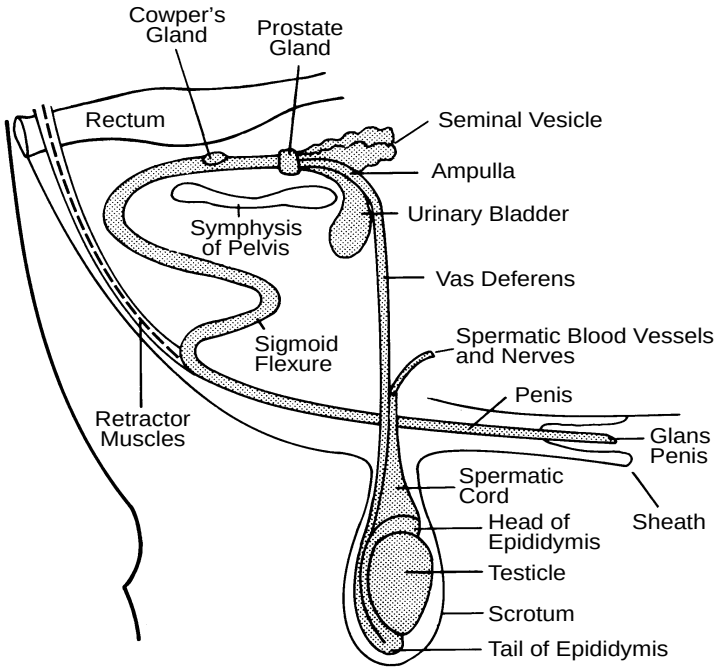
Reproduction in the Bull

Figure 4-9 shows the reproductive tract of the bull. The bull's organs of reproduction include two testicles, which are held in the scrotum. Male sex cells (called sperm) are formed in the testicles. Upon ejaculation, sperm are transported from the testicle through a tube called the vas deferens. The vas deferens empties into the urethra which serves to excrete both semen and urine. The penis serves as a passageway for semen and urine, and it is the organ of copulation. Semen, the fluid ejaculated from the male, contains sperm cells in fluid from the accessory sex glands (testicles). The sperm cells carry genetic information from the male and fertilize the female egg.

Breeding Soundness and Bull Fertility

Fertility of the herd bull is essential to a successful cow-calf operation. In many respects, it is more of a concern than that of the cow since the bull(s) contributes half of the genetic potential of the entire calf crop in comparison to a cow that is expected to wean only one calf per year. Subfertile bulls create low calf crop percentages and can be responsible for poor herd weaning weights. This is evidenced by the fact that for every heat cycle a female fails to conceive, there is a corresponding decrease in calf weaning weight from 25 to 45 pounds. It doesn't take long to realize that poor fertility or infertility of a bull can be extremely expensive to the cow-calf producer.

Figure 4-9. Diagram of the reproductive system of the bull.



Source: Turman and Rich. 1977. Reproductive Tract Anatomy and Physiology of the Bull. Great Plains Beef Cattle Handbook GPE-8450. Cooperative Extension Service, Great Plains States.

Beef bulls should be evaluated for breeding soundness 30 to 60 days before the breeding season is scheduled to begin. A breeding soundness exam helps eliminate losses due to infertility and provides time to replace questionable or unsatisfactory bulls. A breeding soundness evaluation should include:

- a physical examination
- examination of the reproductive tract
- a semen evaluation

Physical examination—a thorough physical examination should be conducted to ensure that bulls are capable of locating cows in heat and physically capable of mating. The physical should include an appraisal of body condition. Thin bulls lack stamina necessary to breed and settle cows during a short or restricted breeding season, whereas overly fat bulls lack vigor and fail to realize their breeding potential. Feet and legs should be carefully inspected to identify faults that can impair the bull's ability to travel and mount. Structural problems, including sickle hocks, post legs, and sore feet, can impair breeding performance. Eyes should be clear and free of disease or injury. Bulls should also be evaluated for disease or sickness that might impair breeding performance.

Examination of the reproductive tract—a complete examination of the reproductive tract for disease and abnormalities should be made. This includes rectal palpation of the bull's internal reproductive organs. The external examination includes palpation of the spermatic cord, testes, scrotum, and epididymis. The penis and sheath should also be examined. Scrotal circumference may be obtained at this time. Recommended scrotal circumferences are shown in Table 4-9. Young bulls with above average scrotal circumferences should produce more sperm cells. University research shows that 63,000,000 more sperm cells are produced for each additional centimeter of scrotal circumference. Bulls with larger scrotal circumferences should produce heifers which reach puberty at an earlier age.

Scrotal circumference can be measured by slipping a flexible centimeter tape over the bottom of the scrotum. The tape should be pulled snugly over the widest point of the scrotum with the testicles fully descended. Commercial measuring devices are available. However, a sewing tape can be used in an emergency. Measurements are generally given in centimeters (1 inch = 2.54 centimeters).

Table 4-9. Scrotal Circumference by Age[1]

Age	Very good	Good	Fair
12-14 mos.	> 34 cm	30-34	< 30
15-20 mos.	> 36 cm	31-36	< 31
21-30 mos.	> 38 cm	32-38	< 32
over 31 mos.	> 39 cm	34-39	< 34

[1] > = greater than; < = less than

Source: Spitzer, et al. Breeding Soundness Evaluation on Beef Bulls. Southern Region Beef Management Handbook. ASC-121 Lexington, KY: University of Kentucky Cooperative Extension Service.

Development of Young Bulls

Try to develop your young bulls so that they have a good rate of growth, and try to ensure early development of their reproductive capacity without excessive fattening. Most bulls are sold at about one year of age and still have a lot of growth and development ahead of them. This is particularly true of today's bulls, which are frequently selected for extra growth.

Most bull sales are held in March and April to allow some time before the start of the breeding season for spring calving. Most of the bulls have been on a fairly high concentrate diet for more than 100 days as a result of being on a performance-testing program or just because bull buyers prefer bulls in fleshy condition. Whether the yearling bull is fed on the farm or at a test station, most are fed to gain 2.5 to 4.0 pounds per day. After coming off test, they should continue to gain about 2 pounds per day.

Very fleshy young bulls require some conditioning prior to the breeding season. They will have to maintain a high level of physical activity when they are breeding several cows. You can give them plenty of exercise by locating feed and water away from each other in a small pasture. Bulls should be "let down" gradually by decreasing the amount of grain and increasing the amount of roughage in the diet. To keep gain at about 2 pounds per day, feed about 8 to 12 pounds of grain per day in addition to spring pasture, or provide free-choice high quality roughage with 1 to 1.5 pounds of grain supplementation per 100 pounds of body weight daily.

At the start of the breeding season, bulls should be in good physical condition, fertile, and able to cover considerable distance to keep up with the cows. Overconditioned bulls lose weight rapidly and may not be as fertile as well-conditioned bulls.

If yearling bulls are purchased without a breeding soundness exam, they should be given one before the start of the breeding season. They should be observed closely during the breeding season to see if they are detecting heat and getting the cows bred. If they become too thin, it may be necessary to rest and/or hand feed them.

It is not uncommon for yearling bulls to lose as much as 100 to 300 pounds during their first breeding season. They should gain this weight back and continue to grow so that they weigh about 75 percent of their mature weight by the time they are 2 years old. This requires more than summer grass pasture; however, too much grain too fast can cause founder.

Section 5.

Planning the Breeding Program

Darrh Bullock

The quality of cattle produced by the beef industry is determined by the cattle's genetic make-up and the environment to which they are subjected. Genetic make-up is under total control of breeders, both purebred and commercial, and this responsibility should not be taken lightly. According to a report from the National Cattlemen's Association (*Beef Business Bulletin*, June, 1983), about one-fourth of the calves born in the United States each year are of such poor genetic value that they do not produce profits for any of their owners—producer, feeder, or packer.

The selection of bulls and heifers used in the herd and the breeding system used dictate the genetic quality of the calf crop. The purebred producer uses selection for genetic management, while the commercial producer uses both selection and mating systems, especially crossbreeding.

Selection refers to the breeder's decision to use some animals as parents and to cull others. For selection to be most effective, breeders must be able to identify superior animals. This is done by placing emphasis on economically important traits that are heritable (see the "Genetic Principles" segment of this section). "National Cattle Evaluations," which furnish information (expected progeny differences) on traits of various bulls, are available from most breed associations and are useful in making selection decisions. By using artificial insemination (AI), the average producer can select a bull of proven breeding value from the "national" herd rather than using one of lesser quality.

Because most sires are purchased from them, purebred breeders exert a great influence on the direction of the beef industry. Commercial producers are insisting that the purebred seedstock producer keep records and make these records available. It is important that both purebred and commercial producers understand and use the principles and tools of genetic improvement.

Genetic Principles

To fully understand breeding management, it is important to know some basic genetic principles. Knowing the role genetics plays in each economically important trait of beef cattle can assist in making wise selection decisions. It is necessary to know which traits can be altered through breeding management (selection and/or crossbreeding) and which traits should be altered by other management techniques.

Each trait of economic importance in beef cattle is controlled by two factors: the environment in which the animal lives and the animal's genetic make-up. The environment consists of not only the weather but how the cattle are managed. Creep feed, forage quality and quantity, and health programs are examples of environmental effects. Environmental effects on economically important traits are controlled through management techniques discussed in the other sections of this manual.

The two types of genetic effects on the economically important traits of beef cattle are additive and non-additive. When a bull and cow are mated, each contributes 50 percent of its genetics to their calf. If that calf is then allowed to reproduce, it passes 50 percent of its genetics to each of its calves; however, each calf gets a different sample of genes from its parents (that is why brothers and sisters are different). The sample of genetics that offspring receive from their parents and ultimately pass on to their progeny is referred to as the additive genetic effects. These are the genetic effects passed on from generation to generation; therefore, they are the basis of selection.

Heritability, the percentage of each trait controlled by the additive genetic effects, is an important factor when making selection decisions. Highly heritable traits respond more rapidly to selection, while lowly heritable traits respond more rapidly to management practices (environment) and heterosis (crossbreeding). Table 5-1 illustrates the relative heritability and heterosis of several economically important traits.

Non-additive genetic effects refer to how the genetics from the two parents combine and how they interact with the environment. The best example of non-additive genetic effects are the benefits realized from crossbreeding. These benefits are known as heterosis. Heterosis is defined as the increase in productivity in crossbred offspring over the average of breeds that are crossed. Heterosis is highest for lowly heritable traits (such as reproduction) and lowest for highly heritable traits (such as carcass traits). Crossbreeding might result in relatively small amounts of heterosis for each trait, but these effects tend to accumulate to produce large increases (about 25 percent) in overall productivity. In some instances a portion of this advantage is passed on to future generations, but, to maximize the benefits, a new breed must be introduced each generation.

Table 5-1. The Relative Heritability and Heterosis Effects of Several Economically Important Traits in Beef

Trait	Heritability	Heterosis
Birth weight	moderate-high	moderate
Weaning weight	moderate	moderate
Yearling weight	moderate	moderate
Milking ability	moderate	moderate
Carcass traits	high	low
Reproduction	low	high
Longevity	low	high

Another genetic effect that is important when making selection decisions is genetic correlations. A genetic correlation occurs when you select for one trait and another trait is affected. The effect of one trait on the other can be either complementary or disadvantageous. Here is an example of a complementary genetic correlation: as selections are made for increased weaning weight, yearling weight is also increased. A disadvantageous correlation would be: as selections are made for increased weaning weight, birth weight also increases. Genetic correlations work the same regardless of which trait is being selected for. In other words, as selections are made to decrease birth weights, weaning and yearling weights are usually decreased, too. The implications of genetic correlations for many traits for which expected progeny differences are calculated are discussed below (also, see Table 5-4).

Understanding Performance Information

Performance testing is a helpful tool that takes some guesswork out of the selection of breeding animals. When purchasing a herd bull or selecting replacement heifers, place emphasis on the genetics that animal will pass on to its offspring, not necessarily on how that animal performed. The easiest, and an often used, method of performance evaluation is simply comparing animals' actual measurements. Unfortunately, this is a poor method of performance evaluation, and other methods that do a much better job of determining more genetically suitable cattle are often available. Besides actual measurements, two other types of performance information are available to producers—contemporary group ratios and expected progeny differences (EPDs).

Raw or even adjusted figures on most economically important traits are not very valuable in bull selection. For example, if you are considering a bull and all you know is that he had a weaning weight of 600 pounds, you don't have much to go on. He could have been raised by a heifer on drought-stricken pasture and have superior preweaning growth genetics, or he could have been raised by a mature cow on lush pasture with plenty of creep feed and actually have poor genetics for pre-weaning gain. Environmental conditions play a large part in a calf's actual measurements but have no effect on their future offspring. Selecting cattle based on actual measurements should be the last alternative, and information on environmental conditions should not be ignored.

Using contemporary group ratios is a good way to evaluate cattle raised under the same environmental conditions. A contemporary group ratio is calculated by dividing a calf's actual measurement (adjusted for age of dam, age of calf, etc.) by the average adjusted measurement of the group of same sex calves with which it was raised and multiplying by 100. This means an average calf in the group would have a contemporary group ratio of 100, calves with larger than average measurements would have values greater than 100, and calves with smaller measurements would have values less than 100. A weaning weight contemporary group ratio of 113 indicates the calf is 13 percent heavier than the average of the group with which it was raised. However, a contemporary group ratio of 113 on one farm may be entirely different than a contemporary group ratio of 113 on another. Therefore, contemporary group ratios should not be used to compare cattle from different locations or cattle raised under different conditions on the same farm. Contemporary group ratios are the best alternative when EPDs are unavailable but should only be used in those circumstances.

The best way to determine breeding values for economically important traits is by using expected progeny differences. The EPDs of two animals of the same breed indicate the expected differences in the average performance of the offspring of those animals. For example, if bull A has a weaning weight EPD of +20 pounds and bull B has a weaning weight EPD of +5 pounds and they are mated to a large number of comparable cows, under similar environmental conditions, a 15-pound difference between the average weaning weights of their calves would be expected (20 pounds - 5 pounds = 15 pounds). In other words, calves sired by bull A would weigh 15 pounds more at weaning, on average, than calves sired by bull B due to genetics for increased growth to weaning. It is likely some calves sired by bull B would weigh more than some calves sired by bull A, but, on average, calves sired by bull A would have a weight advantage. Expected progeny differences can be either positive or negative for the measurement in question. They are easily used to make comparisons among cattle but can only be used to compare animals of the same breed.

Traits available for comparison vary from breed to breed. They usually include some of the following: birth weight, weaning weight, milking ability (expressed as pounds of weaned calf), and yearling weight. Other traits for which EPDs are offered on some breeds are: yearling hip height, mature hip height, mature weight, carcass traits (hot carcass weight, fat thickness, ribeye area, and marbling score), scrotal circumference, stayability (measure of longevity), calving ease, and possibly others. The following are descriptions and implications of selection of some commonly used EPDs:

Birth weight EPD—differences in this EPD reflect differences in the average birth weight of the two animals' offspring. This is an extremely important EPD, particularly when selecting a bull to breed to replacement heifers. Birth weight is the largest contributor to calving difficulty and should be controlled. As cows mature, their ability to have larger calves without complication increases and restrictions on birth weight EPDs can be relaxed to some degree.

Implications: Birth weight is genetically correlated to growth in cattle. When birth weights are decreased, you can expect a decrease in weaning and yearling weights. Therefore, it is not advisable to simply buy the bull with the lowest birth weight EPD (this is particularly true when breeding cows that are not first calf heifers). Instead, within the desired breed, determine a birth weight EPD you are comfortable with and do not buy a bull above this level. If

a calving ease EPD is available, it is likely a better indicator of potential calving difficulty and should be used instead of the birth weight EPD.

Weaning weight direct EPD—measures the genetic contribution of the parent to weaning weight with no consideration to milk. In other words, differences in weaning weight direct EPDs indicate the average genetic potential differences of the calves to grow to 205 days, assuming milking ability of the dams is the same.

Implications: Weaning weight direct is genetically correlated with birth weight and milking ability. As weaning weight direct goes up, birth weight usually goes up and milking ability usually goes down. However, yearling weight is usually increased.

Weaning weight (maternal or milk) EPD—the terminology for this trait is different among the breeds but refers to the expected milking ability of a parent's daughters in pounds of weaned calf. A bull with a 10-pound advantage in weaning weight milk EPD should produce daughters that raise calves that average 10 pounds heavier due to the increased milking ability of those daughters. Bulls with higher weaning weight milk EPDs sire daughters with an advantage in milking ability.

Implications: Milking ability is genetically correlated with growth traits. As milking ability goes up, the genetic potential for growth often goes down. Avoid extremes in this trait, particularly in breeds known for superior milking ability. It is easy to produce too much milk for the environment the cattle are in. If this happens, cows lose condition which results in increased feeding or loss of reproductive performance, either of which decreases the economic potential for the herd.

Weaning weight (combined or total maternal) EPD—this EPD is simply half the weaning weight direct EPD plus the weaning weight milk EPD. This measures the daughter's ability to raise a calf to weaning (205 days), regardless of whether the growth comes from genetics for growth or milk.

Implications: Most producers know whether they need to increase the milking ability or the growth potential of their herd and should focus on the point of need.

Yearling weight—measures genetic differences in weight at 365 days. This EPD becomes more important than the weaning weight EPD when the marketing endpoint is at yearling age or beyond.

Implications: Yearling weight is unfavorably correlated with birth weight and milking ability. Yearling weight is also highly correlated with mature weight. The mature size of your cow herd will increase and milking ability will likely decrease if you select for increased yearling weight and retain replacement heifers.

Calving ease EPD—Different breed associations measure calving ease differently. The difference in two same-breed animals' calving ease EPDs indicates the average percentage difference in calving difficulty in the cows or heifers bred. In all breeds, larger numbers indicate greater calving ease.

Implications: The best EPD to use in trying to reduce calving difficulty. It is not recommended to use this EPD in conjunction with birth weight EPDs or actual measurements because those factors have already been taken into consideration when calculating this EPD.

Calving ease maternal EPD—measures the calving ease ability of an animal's daughters. Larger values indicate a greater likelihood that an animal's daughters will have less calving difficulty.

Implications: High calving ease maternal EPDs on a bull **does not** indicate that it is an easy calving (heifer acceptable) bull; it means his daughters should be easy calvers. To determine an easy calving bull, use either the calving ease or birth weight EPD, not calving ease maternal.

Fat thickness EPD—a carcass trait EPD that indicates leanness. Lower values indicate less external fat cover, which reflects a more desirable yield grade.

Implications: Use extreme caution if you use this EPD when replacement heifers will be retained. A reduction in fat thickness, while beneficial to carcass value, can cause a reduction in fleshing ability and a loss of reproductive performance in replacement heifers.

Ribeye area EPD—the best easily measured indicator of muscling. Ribeye area is a factor in calculating yield grades with larger ribeyes contributing to a more desirable grade.

Implications: Extremes should be avoided in this trait. Even though larger ribeyes produce more desirable (lower) yield grades, today's consumer is concerned with portion size and extremely heavily muscled carcasses are difficult to market.

Marbling score EPD—this trait has the largest role in determining the quality grade of carcasses. Larger values indicate more marbling (flecks of fat within the lean of the ribeye), which results in higher quality grades (USDA Prime and Choice; see Section 9—The End Product). Each whole number difference reflects one marbling score difference. Therefore, an advantage of .5 marbling score EPD indicates progeny by that bull should grade 50 degrees better on average.

Implications: When marketing calves "on the rail," this trait can be important since quality grade is a large factor in carcass pricing. If a producer is not receiving a premium for high quality carcasses, this trait should not be over emphasized.

Mature weight and height EPDs—indicator of mature size of an animal's daughters. Mature weight is adjusted to a condition score 6 basis. In other words, differences in this EPD reflect the mature (5 to 11 years) weight differences of daughters with a condition score of 6. The mature height EPD reflects the differences in inches of the animal's daughters at maturity.

Implications: Larger cows are typically less efficient in producing pounds of calf per acre than smaller more moderate cows. This EPD allows producers to have direct control over the mature size of his cow herd. If these EPDs are not available, the best alternative is to select for modera-

tion in yearling weight EPD because mature size and yearling weight are closely correlated.

Scrotal circumference EPD—differences in scrotal circumference are reflected in the average scrotal circumference of an animal's bull calf crop.

Implications: Purebred breeders can use this EPD to increase scrotal circumferences of bulls they plan to market since scrotal circumference is an indicator of sperm production (volume). However, probably the most important use of scrotal circumference EPDs is indirect. Animals with higher scrotal circumference EPDs tend to have daughters that reach puberty at an early age. This can be an important advantage, particularly for breeds that have a problem with late maturing heifers. Therefore, this EPD should not be ignored by commercial producers.

An **accuracy value** (ACC) is given for each EPD calculated and is a measure of the reliability of that EPD. EPDs are never perfect, and, as more information is obtained on an animal, the EPD value may change, either up or down. Accuracy values indicate the likely maximum amount an EPD may change with new information, and they indicate how much confidence can be placed on whether the EPD is the true genetic value for that trait. EPDs, regardless of their accuracy values, are the best available estimate of an animal's genetic merit.

Accuracy values range from .00 to 1.00 and can be classified into three basic categories: low (.00 - .50), moderate (.51 - .70), and high (.71 - 1.00). As accuracy increases, the amount of possible change in an EPD related to added information becomes smaller. These ranges of possible change are both trait- and breed-specific. For a correct range of possible changes in EPDs, obtain a sire summary for the breed in which you are interested.

Unless artificial insemination is an option, accuracy values are usually of little concern to commercial producers. Young bulls (which always have low accuracy) are usually purchased and any offspring produced are crossbred or non-registerable calves. Therefore, the bull's accuracy will likely remain low. Low accuracy bulls are a fact of life for most commercial producers, but their EPDs are still the best available indicator of their progeny's potential performance.

Certain management practices help eliminate problems associated with low accuracy bulls. Since the bull's EPD might not be completely accurate, a young bull should be mated with a limited number of females. If there is a problem with his EPDs, it won't have a major effect on the herd.

Expected progeny differences are useful to both purebred and commercial producers. Beef breeders can use records to mate the "best to the best," or, perhaps more important, cattle producers can use this information to select the right bull to use on a particular cow or set of cows based on their weaknesses or strengths. For example, a commercial producer selecting a bull to breed to first calf heifers can use either birth weight or calving ease EPDs to choose a bull that will minimize calving problems.

Production Records for the Commercial Beef Operation

Keeping production records is essential in evaluating the performance of the cow herd and making selection decisions. With proper record keeping, you can make evaluations on the reproductive, productive, and financial status of the cow herd. Then you can implement management and selection practices to make improvements where necessary. The following items deal with production and reproduction records.

Getting started—the first step in keeping production records is to identify each cow in the herd. Any combination of identification that is readable from a short distance and permanent is acceptable. Three methods that work well are:

1. Put identical ear tags in each ear of the cow. If one is lost, replace it as soon as possible.
2. Put an ear tag in one ear and the corresponding tattoo in the other.
3. Cross-reference ear tag with the cow's brucellosis or calfhood vaccination tag.

With these methods, when a cow inevitably loses a tag, she still can be identified. It is essential to have the cow herd consistently identified to ensure each cow gets proper credit during the lifetime of her production.

The second step is to determine the age of the cows in the herd. If unknown, mouth the cows or estimate as close as you can (see Section 6—Health and Management Techniques). Weaning weights are adjusted based on the ages of the cows; therefore, the more accurate your estimates are the more accurate the adjusted weights will be.

Third, record the breed of the cows. If unknown, estimate the breed based on appearance. If she appears to be predominantly of one breed, list her as a cross of that breed (e.g., Angus cross, Charolais cross, etc.). If breed composition cannot be determined, list the cow as a Crossbred. This record is not essential but can provide information on how particular breeds perform in your environment.

Breeding season—take a breeding inventory. List all cows and heifers exposed through either natural service or artificial insemination. Record all AI information, including identification and breed of the bull(s), tag number of the cow, and date of insemination. For natural service, record bull identification and breed, identification of the cows exposed to that bull, and the dates when the bulls were turned out and removed. This information is extremely important in determining the reproductive performance of the herd. Calving and weaning percentages are based on the number of females exposed to the bull.

Pregnancy test—pregnancy information assists in identifying which females did not conceive so that culling options are available sooner. Also, this information helps determine when pregnancy problems are occurring. If a large number of females pregnant at the pregnancy test do not calve, losses during pregnancy due to disease or malnutrition likely are occurring and can be corrected.

Calving—observing calving can provide useful information to help avoid calving losses. Information obtained at calving is essential to good record keeping and incudes:

1. Calving date (required). The exact date may not be known if cattle are not checked daily, but estimates within three days are acceptable.
2. Proper identification of calf and matching with female. If calf identification is not done at birth, it must be done prior to weaning. If done at some time other than birth, an easy way to match calves with cows is to separate all the calves from the cows for a few hours and then turn them back together. Generally they will nurse immediately and easily can be matched in this manner.
3. Calving ease score (very useful). The scoring system is: 1 - unassisted, 2 - easy pull, 3 - hard or mechanical pull, 4 - cesarian section, 5 - abnormal presentation. If unobserved but no problems apparent, score a 1.
4. Birth weight (useful). If unknown, BIF recommends using 70 pounds, which is the value used by most computer programs.

Weaning—production records are of little value without weaning weights. If you do not own a scales, many county organizations have them available. Check with your county Extension agent for more details. The following information can be collected at weaning.

1. Individual weaning weight and date (essential).
2. Weight and condition score of the cow (very useful).
3. Sex of the calf (essential). If the calf is castrated prior to weaning, record as a steer; if castrated at weaning, record as a bull.
4. Management code (essential). This is a code associated with the CHAPS (Cow Herd Appraisal Program) computer program.
5. Contemporary code (essential). All calves raised under the same conditions receive the same contemporary group code. If a group of calves (or their dams) gets preferential treatment, it should get a different contemporary code. Producers that have spring and fall calving herds should use different contemporary group codes for each herd.
6. Frame score (hip height) and calf grade are optional entries.

Yearling—if calves are to be kept through a year of age, whether to market at that time or be retained as replacements, additional records can be beneficial. The following information is needed:

1. Individual yearling weight and date (essential).
2. Sex of calf (essential).
3. Contemporary code (essential). Same as with weaning weights.

Other data—many producers might find other information useful. If so, this information should be recorded. Production goals of each operation are different, and records should reflect those goals.

Using the information—performance records are only beneficial if they are incorporated into management making decisions. Records must be recorded accurately, analyzed, and interpreted. From the interpretation, informed decisions on selection and management practices can be made. These decisions become more economically sound if financial information is available and can be incorporated.

The information in this section corresponds with the Cow Herd Appraisal Performance Software (CHAPS), a computerized records keeping system supported by the UK Cooperative Extension Service.

Bull Selection

Bull selection is one of the most important decisions you will make as a cow-calf producer. The bull (or bulls) is generally thought of as “half of the herd” because he contributes half of the **genetic make-up** to each calf crop. However, in herds where replacement heifers are retained, approximately 87.5 percent of the genetic make-up of each calf comes from the last three bulls used. Therefore, the importance of selecting bulls genetically suited to your operation cannot be over emphasized.

The first decision to make when selecting a bull is which breed or breed type to use. Producers always have strong feelings about the merits of their favorite breeds of cattle. However, no one breed excels in all traits. It is important to know the relative strengths and weaknesses of various breeds so you can plan mating systems in which breeds complement each other.

Knowledge of some general characteristics of breed types is helpful in planning. British breeds (those that originated in the British Isles, such as Angus and Hereford) generally excel in fertility, good disposition, and finishing at medium weights. Continental breeds (European breeds, such as Simmental and Charolais) are larger, have faster growth rates, and have leaner carcasses unless fed to heavier weights. American breeds (primarily of Brahman origin) have better heat tolerance and longevity.

Select a breed or combination of breeds to use in your beef program based on the following:

- goals of your operation
- marketability in your area
- cost and availability of good seedstock
- climate
- how breeds in a crossbreeding program complement each other
- personal preference

Table 5-2 groups breeds according to size and type (beef, dairy, dual purpose, and Zebu influence). Table 5-3 indicates the level of production of some breed crosses, based on growth rate and mature size, lean-to-fat ratio, age at puberty, and milk production.

A sire breed in a crossbreeding program might have the following characteristics: rapid growth rate, moderate to thick muscling, and adequate calving ease. A dam breed

might have these characteristics: high fertility, good milking ability, and small to medium mature size. Since no breed possesses all of these characteristics, some compromises must be made when selecting breeds for a crossbreeding program.

Once you have chosen a breed, it is time to select a bull within that breed. Use four basic criteria when selecting a bull: physical soundness, reproductive soundness, performance information, and visual appraisal.

Physical soundness—structural soundness is important if bulls are to travel distances to keep up with cows and be able to mount them (especially if they are expected to breed a large number of cows in a short time). Beware of the following problems: rear legs that are too straight (post legs), rear legs too close at the hocks with too much angle (cow hocked), corns and abnormal hoof growth (evidence of founder). Structural soundness should be emphasized to the point of the animal being functional. A minor flaw that will not affect a bull's performance should not be grounds for overlooking the bull.

Reproductive soundness—reproductive efficiency is best measured at this stage by a **breeding soundness evaluation** (BSE) (for a complete discussion, see Section 4—Managing Reproduction). A bull should have passed his BSE or the seller should be willing to guarantee that he will before you proceed with the selection process.

Performance information—evaluate performance records to take the guesswork out of selection. Evaluate the strengths and weaknesses of your cow herd; then select a bull that will complement your herd. In the case of purebred herds using artificial insemination, mating may be planned on an individual cow basis. If you are a commercial producer, your goals might be to increase weaning weight, minimize calving difficulty, increase or maintain milking ability, etc. Expected progeny differences allow you to make genetic progress when necessary or maintain current production when appropriate for your environment. When EPDs are not available, use one of the alternatives discussed in the "Understanding Performance Information" segment of this section (with the understand-

Table 5-2. Grouping of Some Cattle Breeds by Functional Type

Smaller beef			
Angus	Beefalo	Belted Galloway	Devon
Dexter	Galloway	Hereford	Murray Grey
Polled Hereford	Red Angus	Shorthorn	Scotch Highland
Sussex	Longhorn	White Park	
Smaller dual purpose			
Amerifax	Normande	Milking Shorthorn	Pinzguaer
Red Poll	Salers	Tarentaise	Welsh Black
Gelbvieh			
Smaller dairy			
Ayrshire	Guernsey	Jersey	
Zebu			
Brahman	Gyr	Indu-Brazil	Nellore
Zebu	Sahiwal		
Zebu crosses			
Barzona	Beefmaster	Braford	Brangus
Simbrah	Santa Gertrudis	Senepol	Red Brangus
Pinzbrah	Gelbray	Charbray	Bralers
Brahmousin	Brahmaine	Brahmanstein	
Larger beef			
Charolais	Chianina	Blonde D'Aquitaine	Limousin
Marchigiana			
Larger dual purpose			
Beef Friesian	Char-Swiss	Maine Anjou	Simmental
Larger dairy			
Brown Swiss	Holstein		

Table 5-3. Some Breed Crosses Grouped Into Production Types

Breed group[1]	Growth rate and mature size	Lean-to-fat ratio	Age at puberty	Milk production
Jersey-X	+[2]	+	+	+++++
Hereford-Angus-X	++	++	+++	++
Red Poll-X	++	++	++	+++
South Devon-X	+++	+++	++	+++
Tarentaise-X	+++	+++	++	+++
Pinzguaer-X	+++	+++	++	+++
Sahiwal-X	++	+++	+++++	+++
Brahman-X	++++	+++	+++++	+++
Brown Swiss-X	++++	++++	++	++++
Gelbvieh-X	++++	++++	++	++++
Simmental-X	+++++	++++	+++	++++
Maine Anjou-X	+++++	++++	+++	+++
Limousin-X	+++	+++++	++++	+
Charolais-X	+++++	+++++	++++	+
Chianina-X	+++++	+++++	++++	+

[1] X = Hereford-Angus on dam side, sire breed is listed first.

[2] + = low, +++++ = high

Source: Crossbreeding Beef Cattle for Western Range Environments. 1988. University of Nevada-Reno and USDA. TB-88-1.

Performance Pedigree of an Angus Bull from the University of Kentucky Beef Herd

PERFORMANCE REGISTRATION CERTIFICATE

AMERICAN ANGUS ASSOCIATION

Certifies That

REGISTRY NUMBER 12016806

NAME OF ANIMAL: U K TRAVELER 237C

SEX: BULL

TATTOO — LEFT EAR: 237C | RIGHT EAR: 237C

DATE CALVED: 3/21/93

BREEDER: UNIVERSITY OF KENTUCKY LEXINGTON KY

MEMBER CODE: 303275

FIRST OWNER: UNIVERSITY OF KENTUCKY LEXINGTON KY

MEMBER CODE: 303275

EXPECTED PROGENY DIFFERENCES	BIRTH WEIGHT EPD	BIRTH WEIGHT ACC	WEANING WEIGHT EPD DIRECT	WEANING WEIGHT ACC	MILK EPD	WEANING WEIGHT MATERNAL ACC	WEANING WEIGHT MATERNAL DAUGHTERS	COMB. VALUE	YEARLING WEIGHT EPD	YEARLING WEIGHT ACC
I	+1.1	.35	I +31	.33	I +15	.24		+30	I +46	.07

AS OF 12/93

SIRE

R R TRAVELER 5204

DAM

U K BLACKCAP 005

	SIRE EPD	SIRE ACC
BIRTH	-2.1	.93
WEANING	+24	.92
MILK	+20	.75
YEARLING	+47	.87

	DAM EPD	DAM ACC
BIRTH	+3.4	.28
WEANING	+29	.25
MILK	+9	.19
YEARLING	+44	.22

BAND 234 OF IDEAL 3163 # 8505294

Q A S TRAVELER 23-4 # 9250717

Q A S BLACKBIRD EVE 601 1 7885153

10705768

SHOSHONE VANTAGE JB23 9250940

ERISKAY OF ROLLIN ROCK 3302 10392537

ERISKAY OF ROLLIN ROCK 7003 9000259

RITO 8221 OF IDEAL 087 36 # 9233329

U K RITO 236 10238302

U K BLACKCAP 770 # 8993686

11506044

U K SKYWALKER 617 10803038

U K BLACKCAP 839 11085072

U K BLACKCAP 439 #10659820

PATHFINDER

PEDIGREE RELATIONSHIP	PRODUCTION: CALVING EASE HERDS PROG.	CALVING EASE IND. OR AVE.	BIRTH WEIGHT HERDS PROG.	BIRTH WEIGHT CONT RATIO	WEANING HERDS PROG.	WEANING CONT RATIO	YEARLING HERDS PROG.	YEARLING CONT RATIO	MATERNAL: CALVING EASE HERDS DAUS.	CALVING EASE PROG. AVE.	WEANING HERDS DAUS.	WEANING PROG. RATIO	CARCASS EPD: CARCASS WEIGHT ACC.	MARBLING ACC.	RIBEYE AREA ACC.
INDIVIDUAL		3		65 101		65 115									
PROGENY															
SIRE PROGENY	259 1255	1.1	325 2191	95	338 2253	51 100	157 898	26 101	53 119	119 1.3	54 125	192 103	+11 .47	+.13 .46	+.16 .47
PAT. G. SIRE PROGENY	1132 10647	1.2	1381 18107	98	1472 19078	69 100	968 12655	41 101	7103704 3680	1.1	836 4635	12041 102	+6 .95	+.04 .94	+.16 .95
DAM PROGENY	1 1	4.0	1 1	101	1 1	65 115									
MAT. G. SIRE PROGENY	3 11	1.3	6 91	97	6 91	41 102	6 75	16 102	2 15	15 1.5	3 18	58 102			

NAME AND LOCATION OF RECORDED OWNER — MEMBER CODE — DATE OF SALE

SERVICE DATE — SERVICE BULL NAME — BULL NO. — TRF. NO.

TRANSFER

I (we) hereby authorize transfer of Registration on the records of the Association to:

NAME _____ MEMBER CODE _____

ADDRESS _____ TOWN _____ ST. ___ ZIP CODE _____

DATE OF SALE _____ 19 ___ SIGNATURE OF TRANSFEROR X _____

Genetic Defect or Genetic Factor Codes:

S-Syndactyly
H-Double Muscling
D-Dwarfism
M-Osteopetrosis
HI-Heterochromia Irides
HG-Horn Gene
R-Red
X-Multiple Defects, Check List for Kind.
F-Tested For Defect Printed without producing abnormal calves.
GDF-Produced 35 or more calves from Daus. without a Genetic Defect

All Animals that have been reported and verified prior to the issue date on this certificate as carriers of recessive genetic defects or genetic factors are coded with the above codes. Animals with an "F" code have been progeny tested and are very unlikely to carry the genetic defect(s) or genetic factor(s) for which they are tested. These codes represent a reporting of information on file when this certificate was issued and does not indicate that any animal, coded or not, is free of genetic defects or genetic factors.

If above animal is a female, serviced prior to Date of Sale, Date of Service or exposed period as follows:

Service date, if known _____ NATURAL ☐ ARTIFICIAL ☐ CHECK ONE

SERVICE BULL NO. _____ MEMBER CODE _____

Pasture exposure: From _____ to: _____

SERVICE BULL NO. _____ MEMBER CODE _____

If above animal is female and sold with A.I. Breeding Privilege to seller's bull, certify by checking box, ☐ Sold with A.I. Breeding Privilege.

I certify that the above service conforms with the ownership provision of Section VIII of the Rules governing artificial insemination, if applicable, as follows:

☐ immediate relative ☐ full time employee ☐ _____

SIGNATURE OF OWNER OF RECORD OF SERVICE BULL IF NOT SELLER OF FEMALE _____

AMERICAN ANGUS ASSOCIATION CHARTERED SEAL 1883

The animal described in this Certificate was entered in the American Angus Herd Book in accordance with application certified by First Owner to conform to the By Laws and Rules of Registration of this Association. Certificate and Entry are made subject to the right of correction and cancellation.

REG. NO. 12016806

DATE ISSUED 12/21/93 U63872

AMERICAN ANGUS ASSOCIATION
3201 FREDERICK BOULEVARD
ST. JOSEPH, MISSOURI 64506

Richard L. Spader

EXECUTIVE VICE-PRESIDENT

ing that this information is not as reliable as EPDs). Any bull that doesn't appear "on paper" to be of potential benefit to your cow herd should be eliminated from further consideration, regardless of price. Fads in the cattle industry are usually short-lived and "bargain" bulls are usually economic disasters in the long run.

It is also of extreme importance to understand how each economically important trait responds to selection based on performance information (EPDs). Table 5-4 summarizes these correlations.

Table 5-5 gives information on three bulls with different performance data. Assuming all bulls are structurally and reproductively sound and visually acceptable, which bulls would you select? If your only priority is to maximize growth, select bull C. If your priority is calving ease (use on heifers) and improving milk, select bull B. If your priority is improving growth and improving milk while maintaining relative calving ease, select bull A. Bull selection is an individual decision based on the producer's needs. The best bull for one producer may not be the best bull for another.

Visual appraisal—many traits of importance, including body capacity, thickness, etc., are not measured by EPDs. Also, visual inspection is necessary to determine the structural soundness of a bull. Even with all the advanced technologies, visual appraisal is a necessary step of bull selection. Since cattle are foragers and usually deliver a 70- to 100-pound calf, adequate body capacity is needed for the animals to consume enough nutrients for maintenance and growth. Body capacity is determined by the length and depth of body and spring of rib. The bull should be well muscled, which is plainly evident in a large, bulging forearm and thickness in the round. Terms such as long, smooth, and flat are frequently used to describe muscling. These are misleading. Since all muscles attach to the skeleton at the same places, length of the muscle depends strictly on frame size. Flat muscles aren't likely either since muscle fibers are round and muscles are formed by bundles of fibers. "Smooth muscling" may mean the animal is covered with an outside layer of fat. Don't be misled by meaningless terms when someone is trying to sell you a bull. However, location of muscling can be important. It is best if the bull has most of his muscling along the topline and in the round. Since the most expensive cuts are towards the rear, heavy fronted feeder calves are not desired. If performance information is not available for frame size (or hip height), evaluate this trait visually.

Crossbreeding is an effective way to increase the size and quality of feeder calves.

If you are purchasing a bull in a sale, decide which bulls you like and how much you are willing to pay before the bidding starts. Don't sit back and see how they are going to sell while the best bulls are selling. Don't do the entire selection process in the time it takes an auctioneer to sell a bull. Study the performance information ahead of time and arrive at the sale site early enough to allow adequate time to evaluate the bulls.

Sire selection continues after you purchase the bull. **Observe the bull closely** during the first few weeks of the breeding season to see if he is willing and able to mate with the cows. Bulls with a high libido (sex drive) and high fertility sire the early calves. Also, observe cows for return to heat after mating to see if the bull is settling them. Your

Table 5-4. Selection Based on EPDs

	Birth weight	Weaning weight	Yearling weight	Milking ability	Calving ease	Mature size
BW EPD	+	+	+	0	-	+
WW EPD	+	+	+	-	-	+
YW EPD	+	+	+	-	-	+
Milk EPD	0	-*	-*	+	0	0

+ = as EPD goes up, this trait also tends to increase
- = as EPD goes up, this trait tends to decrease
0 = no relationship
** Increased milk EPDs result in decreased growth rate for the first generation. Due to added milk production, offspring of first-generation females have increased WW and YW.*

Table 5-5. Example of Performance Information on Various Bulls

	Calv. ease		Birth weight		Wn. wt.		Yrl. wt.		Maternal milk	
SIRE	EPD	ACC.	EPD	ACC.	EPD	ACC.	EPD	ACC.	EPD	ACC.
A	97	.70	+1.6	.70	+20	.85	+25	.80	+22	.75
B	105	.70	-2.5	.75	- 2	.90	+ 7	.85	+25	.80
C	87	.70	+12.0	.72	+40	.80	+62	.75	- 5	.70

final step is to annually **evaluate each bull's progeny.** If the bull's calves are acceptable and the bull continues to pass a BSE, retain him. If the bull's calves are unacceptable, the bull fails his BSE (a second chance may be in order first), or a breed change is necessary to maintain heterosis, replace him.

Heifer Selection

Heifer selection is also important for commercial producers, but heifer selection is an easy task if proper sire selection is practiced. When replacement heifers are to be retained, bull selection cannot be over emphasized. Selection should include maternal ability, mature size moderation (particularly frame size), and calving ease maternal, if available. From the resulting heifers, selection should be based on physical structure, body capacity, and likelihood of reaching puberty by the next breeding season (older heifers are more likely to be ready to breed). If purchasing replacement heifers, knowledge of their sire or the reputation of the breeder is desirable.

Cow Culling

Cow culling plays a small role in the genetics of your herd and should be based solely on economic considerations. The following are likely reasons to cull cows: open, consistently poor calves (young cattle—2- and 3-year-olds—should not be expected to perform at the level of older cows), structural defects, disease. Unusual situations in the market can alter normal culling procedures, but favorite cows that do not perform should not be kept.

Crossbreeding for the Commercial Producer

Crossbreeding is the mating of cattle of different breeds or breed composition. It can be an effective method of improving beef production. The two primary reasons to use crossbreeding are (1) breeds have characteristics which complement each other and (2) heterosis (hybrid vigor). When crosses are made, one breed's strength can complement the other's weaknesses. Since no one breed is superior in all traits, a planned crossbreeding program can significantly increase herd productivity.

Selection can be based on heritable traits, such as growth, while crossbreeding enhances traits such as reproduction. Figure 5-1 shows the relative importance of both selection and crossbreeding in an improvement program. Superior purebreds are the backbone of a crossbreeding program. Do not be fooled into thinking that if you use crossbreeding, you no longer need to buy good bulls. This is not the case!

The benefits of crossbreeding can be impressive because its effects are cumulative. Any one trait might seem to be of minor importance, but when increases in calving rate, liveability, and growth rate are added together, the results are substantially increased over straightbred cattle. In well-planned crossbreeding programs, there is an increase of approximately 25 percent in cow lifetime productivity. Crossbreeding is one of the few things in the cattle business that costs nothing but has great returns.

Crossbreeding Systems

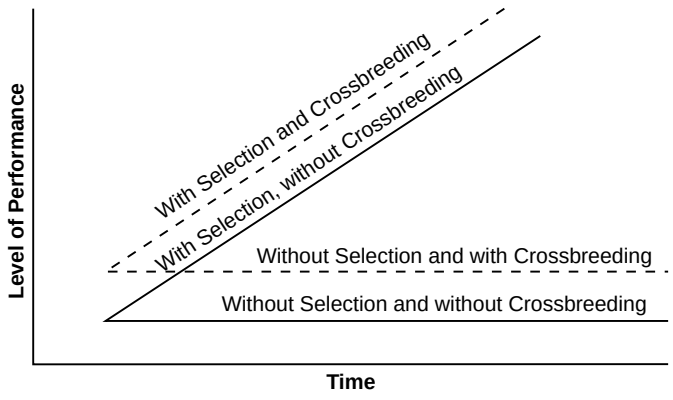
Crossbreeding systems must be planned for each operation depending on herd size, potential market, level of management, and facilities. A long-term plan is necessary to gain maximum benefits from crossbreeding. The advantages and disadvantages of various crossbreeding systems are listed below.

Two-breed terminal cross—uses straightbred cows and a bull of another breed. It is a terminal cross if stopped at this point. An example would be Angus cows bred to Charolais bulls. In this system, replacements must be bought from another source, or part of the herd (perhaps heifers and young cows) would have to be bred to Angus bulls to generate replacement heifers. This is not a desirable system because it does not realize any heterosis in the cow since she is a straightbred.

Three-breed terminal cross—uses a two-breed cross (F_1) cow and a bull of a third breed. It produces maximum hybrid vigor in the cow and calf. This is an excellent system because hybrid vigor is realized for both growth rate and maternal ability. Replacement females for this system must be purchased or raised from another source. This is a good system for any size herd if high quality replacement females are available.

Two-breed rotation or crisscross—a simple crossbreeding system involving two breeds and two breeding pastures. A two-breed rotation is started by breeding cows of breed A to bulls of breed B. In each succeeding generation, replacement heifers are bred to bulls of the breed that is the opposite of their sire (see Figure 5-2). Two breeds of bulls are required after the first two years of matings. The two breeds chosen should be comparable in birth weight,

Figure 5-1. Role of selection and crossbreeding in determining level of performance.



mature size, and milk production. This minimizes calving difficulty in first calf heifers and simplifies management.

Three-breed rotation—follows the same pattern as the two-breed rotation, but a third breed is added (see Figure 5-3). The three-breed rotation maintains a higher level of hybrid vigor than the two-breed system. Mating plans can be confusing, but individual cows are not moved from one breeding group to another. Three distinct groups of cows are eventually created, and they are mated to the sire to which they are least related. This scheme continues for the life of the cow.

Rotational-terminal sire combination—involves the use of rotational mating of maternal breeds (breeds A and B) in a portion of the herd to provide replacement females for the entire herd (see Figure 5-4). The older crossbred cows are then mated to the terminal sire breed (breed C). All of the terminal cross offspring are marketed.

This system maintains a high level of production but also requires a high level of management. It almost does away with heifer selection since nearly all heifer calves produced by the rotational mating must be kept to maintain herd numbers.

Heifers out of heifers—this is a specific example of a **rotational-terminal sire combination**. There is no foundation to the argument that you should not keep a heifer out of a heifer. In contrast, this system is one of the best available to maximize efficiency. In herds that have more than one bull or where AI is a possibility, this is a productive crossbreeding system. Breed all heifers and enough younger females to total about two and a half times the number of replacement females you plan to keep the next year to an easy calving, good maternal bull. For example, if 10 replacement females are desired the following year, breed 25 heifers and young females to the bull. Select all replacement heifers out of this group of calves. Breed the rest of the herd (older cows) to a growthy, heavy-muscled terminal bull, and market all of the calves (refer to **three-breed terminal cross**). This system allows the producer to get easy calving in his first calf heifers and good maternal characteristics in his replacement heifers and to maximize growth and muscling in the majority of his feeder calves. The only drawback is the nonconforming steers out of the heifers and young cows, but the benefits are worth it.

Figure 5-2. Two-breed rotational system (criss-cross).

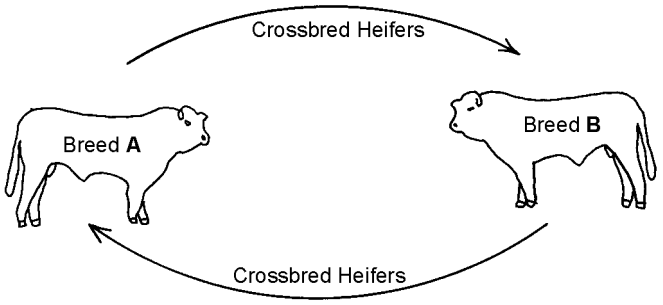


Figure 5-3. Three-breed rotational system.

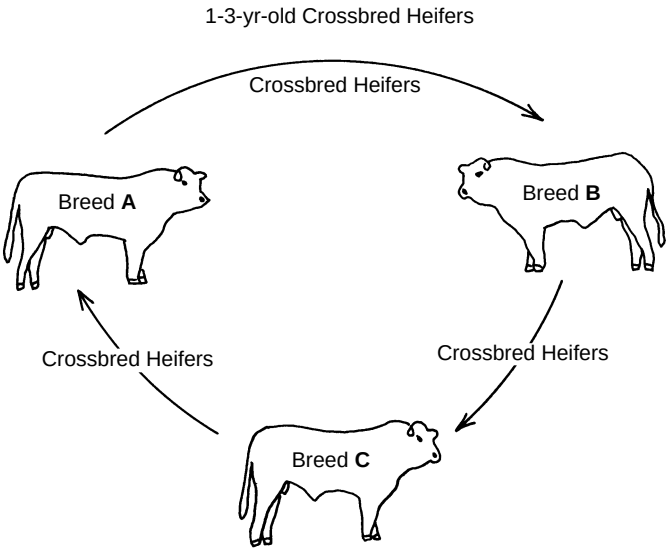
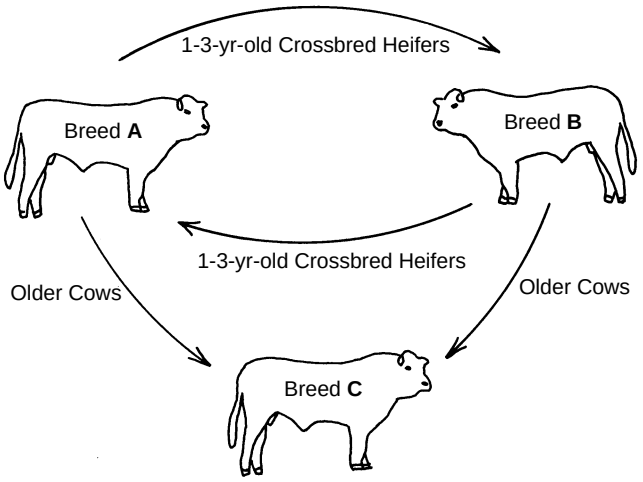


Figure 5-2. Rotational-terminal sire program.



Modified Crossbreeding

In many herds, the facilities and level of management required to use intricate crossbreeding systems are not available. However, with some modification, you can use some of the basic crossbreeding principles. Here's how to simplify the traditional systems:

Purchase crossbred females. This is the simplest and fastest method of obtaining maximum hybrid vigor. Purchased two-breed cross females can be bred to a terminal sire of a different breed; this maximizes both individual and maternal hybrid vigor. The producer needs an available supply of high quality, disease-free females.

Use multi-year bull-breed rotation. This involves using one bull for a series of years then rotating to a different breed of bull. If a balance between good feeder calves and good replacement heifers is desired, switching between breed types is also desired. In other words, use a British breed bull for several years, then switch to a Continental breed. Try to save a larger number of replacement heifers in years that a maternal type bull is used. Only one breeding pasture is required, and replacement heifers are generated within the herd. This system sacrifices some hybrid vigor when compared to a two-breed rotation, but it is simple enough to be practical for more producers.

Section 6.

Health and Management Techniques

Roy Burris and Patricia Scharko

Several management techniques, including identifying, implanting, vaccinating, castrating, and dehorning, should be done in as timely and humane a manner as possible. As discussed in Section 3, adequate handling facilities are required to properly restrain the animals for treatment.

Before moving or processing animals, it is useful to have some knowledge of animal behavior. Animals generally respond to the way they are handled. They remember bad experiences. If you handle cattle gently, they will be less excitable when you handle them in the future.

Cattle have a flight zone—the area around them which they do not like for people to enter. The size of the flight zone depends on how wild an animal is. This area can be very large in range cattle; however, it might be only 5 to 20 feet in cattle accustomed to people. Extremely tame cattle can be difficult to drive because they have no flight zone. These cattle are best moved by leading them with a feed bucket.

When a person penetrates the animal's flight zone, it moves away. You can use this behavior to your advantage when moving cattle. Approach an animal slowly; when you enter its flight zone, it will move away from you. If you move too rapidly or try to get too close, the animal will turn back or break and run away. The best place to be is on the edge of the flight zone. This causes the animal to move away slowly. Cattle stop moving when they get a comfortable distance away. Don't crowd them or make sudden moves until you have them through the gate and in the corral. Cattle have a strong herding instinct and do not like to be isolated. Occasionally, a Brahman-type or exotic breed animal becomes excited if it is left alone in the crowding area of the working facility after others have entered the single-file working chute.

When processing cattle, work carefully. If you try to set a record for speed, you might end up unduly stressing or injuring your cattle. Cattle can be worked rapidly enough when they are handled skillfully and gently and when the handling facility is constructed so that cattle flow through it easily. Remember that animal health products, such as vaccines and implants, must be administered properly to be effective. Therefore, emphasize proper technique, rather than speed.

A healthy, disease-free herd is a goal of all beef producers. Your cow-calf herd health program will be most successful when you and your veterinarian customize it to your herd's needs. Local veterinarians are knowledgeable about diseases in your area and should be able to make cost-effective recommendations. Plan a program that *prevents* diseases and disorders; don't depend on your veterinarian just to treat problems.

Requirements for a successful herd health program include:

- controlled breeding season
- adequate handling facilities
- adequate nutrition
- working relationship between producer and veterinarian
- willingness to follow a program once it is established
- management level that reduces stress in cattle

Contagious Diseases

Several contagious diseases can be problems in Kentucky beef herds. If you understand these diseases, you might be able to prevent them in your herd.

Anaplasmosis is caused by a microscopic parasite that destroys red blood cells. Horseflies, mosquitoes, and ticks are the principal blood-sucking insects that spread anaplasmosis. Since the infection is easily transmitted by the transfer of infected blood, outbreaks can be caused by mass operations, such as bleeding, dehorning, castrating, ear-tagging, and vaccinating. Disinfect equipment to minimize spread of the disease.

Signs of anaplasmosis include anemia, pale mucous membranes, dehydration, and constipation. Death can occur in older cattle. Most cases occur in late summer or early fall and occur in older cattle.

Oxytetracycline is the drug of choice for treating anaplasmosis. Treatment to clear the carrier state requires injections of 5 mg of oxytetracycline per pound body weight daily for 10 days or feeding 5 mg chlortetracycline per pound body weight daily for 60 days. One method of prevention is a low-level feeding of chlortetracycline at 0.5 mg per pound bodyweight daily during the insect vector season.

A vaccine is available for controlling anaplasmosis. Discuss a vaccination program with your veterinarian since special precautions may be necessary. The vaccine protects cattle against an acute attack of anaplasmosis, but it does not clear up the carrier state.

Blackleg and **malignant edema** are similar and are part of the Clostridium complex. They are caused by Clostridial organisms that live in the ground and enter calves through wounds, ingestion, and navel cords. The bacteria are not spread directly from animal to animal, but from the soil. These organisms produce toxins in the animal's body that are rapidly fatal. Blackleg usually occurs in cattle 6 months to 2 years of age; malignant edema can occur at an older age.

The vaccine is inexpensive, effective, and economical. All calves should be vaccinated at about 4 months of age.

A booster in four to six weeks is always recommended. Calves that receive the vaccine at less than 2 months of age should be revaccinated.

Bovine Virus Diarrhea (BVD) affects cattle by causing abortions, diarrhea, weak calves at birth, and death. BVD is frequently diagnosed in Kentucky herds. BVD can create persistently infected cattle, animals that do not appear sick and shed BVD sporadically in the herd. Bulls can introduce BVD into a closed herd of cattle. Treatment for cattle with BVD is generally not effective. The vaccines available are killed or modified-live virus products. Do not use the modified-live vaccine in pregnant animals. The killed vaccines require a booster two to four weeks after the first vaccination. Annual revaccination with a single dose is then recommended. Use these vaccines only after discussing them with a veterinarian.

Brucellosis (Bang's disease) affects cattle primarily by reproductive losses, such as abortions. An important point is that brucellosis can cause disease in humans called "undulant fever." Cows with brucellosis shed large numbers of infectious organisms at calving. Calves receiving milk from infected cows shed live organisms in the feces.

There is no cure for brucellosis in cattle. Efforts are directed at control and prevention. Test and slaughter of infected animals is the only choice available for control. Prevention is best accomplished by calfhood vaccination of heifer calves. It is permissible to vaccinate calves between 4 to 10 months of age, preferably between 4 and 7 months. Heifer calves must be vaccinated by an accredited veterinarian. Upon vaccinating a calf, the veterinarian will place an official tattoo in the right ear and record the vaccination with the state veterinarian. It is recommended that you work with your veterinarian to have your herd certified brucellosis free.

Footrot is an infectious disease characterized by sudden lameness and inflammation of the subcutaneous tissues of the interdigital space. It is caused by interdigital trauma and infection with the bacteria *Fusobacterium necrophorum* and *Bacteriodes melaninogenicus.* Treatment consists of systemic antibiotics (penicillin, oxytetracycline, Naxcel, etc.) and local treatment of the interdigital area (copper sulfate, zinc sulfate, etc.). Prevention includes adequate nutrition and immunization with *B. nodosus.* The vaccine appears to reduce the severity of interdigital dermatitis.

Haemophilus somnus causes an infectious disease of the central nervous system. It is also associated with bovine respiratory disease, especially in feedlot cattle. Additionally, it is recognized by veterinarians in Kentucky as an infection that can affect reproduction. Vaccines are available; they require two doses initially and an annual booster.

Infectious Bovine Rhinotracheitis (IBR) can cause respiratory infections, abortion in cows exposed during pregnancy, and eye inflammation similar to pinkeye. All forms of IBR can be prevented by vaccination with products for intranasal or intramuscular use. Modified live virus vaccines, in combination with BVD and PI_3 for intramuscular injection, are most effective but can cause abortion in pregnant animals. Calves should be vaccinated 30 days before weaning. Replacement heifers should be vaccinated at least 30 days before breeding.

Johne's Disease (pronounced yo-knees) is a contagious bacterial infection of the intestinal tract of ruminants caused by the bacterium *Mycobacterium paratuberculosis.* The bacteria can survive for more than a year in contaminated soil or water because they are resistant to heat, cold, and drying. Individual animals become infected at a very early age by exposure to fecal material or colostrum/milk from infected cattle. Young cattle are more susceptible to infection than adults. The incubation for disease is usually two to eight years. Infected cattle develop diarrhea and rapidly lose weight. They continue to eat but appear unthrifty; they do not have a fever. The disease typically enters a herd when infected but healthy cattle are purchased. Several years later, the producer begins to see signs of Johne's in the herd.

There is no effective treatment for Johne's. Cattle become subclinical shedders of the bacteria before they show clinical signs. Cattle can be tested for *M. paratuberculosis.* The feces can be cultured, but it can take as long as 16 weeks to get results. Fecal culture is the most definitive test. Blood tests can be done quickly. There are few false positives, but a negative test does not guarantee the animal is negative. Some animals with infection are never positive to the test.

Leptospirosis (Lepto) is a bacterial disease that produces abortions, stillbirths, weak calves, and death in nursing calves. *L. hardjo* and *pomona* are the two strains of primary concern for cattle. The infection occurs in the kidneys, and the urine infects other animals, including humans. Prevention of leptospirosis is a good reason to keep cattle out of ponds. Lepto is also spread by natural breeding. All cattle older than 4 months of age should be vaccinated for all available strains of Lepto. Annual revaccination is highly recommended. Some areas are forced to vaccinate every three to four months to maintain adequate herd immunity.

Listeriosis (circling disease, silage disease) is caused by the bacterium *Listeria monocytogenes* which has worldwide distribution but is most frequent in temperate climates. Animals show neurologic disease with head pressing, drooped ear, and/or compulsive circling. The recovery rate is best if treatment is administered early in the course of the disease. Prolonged treatment with antibiotics of oxytetracycline or penicillin is recommended. Prevention includes discarding moldy feed, especially silage, and preventing access to contaminated areas. Rule out other diseases that can cause similar signs, especially rabies.

Parainfluenza type 3 (PI_3) primarily causes respiratory problems in cattle. It is considered to be a secondary factor in a lot of shipping fever outbreaks. Vaccines are available in combination with IBR, and sometimes BVD, for use in immunization programs.

Pinkeye in cattle is characterized by inflammation and watering of the eye, painful sensitivity to light, and varying degrees of corneal damage. Research in Kentucky indicates a severe decrease in weaning weight of calves with

pinkeye. This decreased performance, coupled with a decrease in selling price of affected calves, can mean severe losses for Kentucky beef producers.

The common cause of pinkeye is the bacterium *Moraxella bovis*. The bacteria are generally spread by face flies but may not produce the disease until irritation of the eye occurs. During the summer months, tall grass with seedheads, dust, and pollen can cause trauma to the eye, thereby increasing the risk of penetration by *M. bovis*. Viral infections, such as that caused by IBR, are also thought to sometimes trigger an outbreak of pinkeye.

Be alert for early signs of pinkeye. Usually the first indication of the disease is watering of the eye. A short time later, the face on the affected side might be wet. The animal might try to stay in the shade, stand with the affected side away from sunlight, blink repeatedly, or keep the eye closed. As the disease progresses, the redness of the eye intensifies and a whitish-opaque spot might appear in the center of the eye. If the eye is untreated, the white area enlarges and may rupture and ulcerate.

Treat pinkeye as early as possible. Early cases might respond to a variety of antibacterial preparations placed in the mucous membranes surrounding the eyes. It is important to place the topical medication in the eye; repeated applications are necessary. If the eye is seriously damaged, cattle are frequently treated with a subconjunctival (under the eyelid) injection of antibiotic and corticosteroid. Affected eyes should be protected from irritants and flies. You can cement a patch over the eye to provide shade and avoid flies. Leave the patch on for one to two weeks.

Intramuscular injections of a long-acting oxytetracycline antibiotic are also effective in treating pinkeye cases. This intramuscular injection should stop cattle from shedding *M. bovis*. If the pinkeye is caused by other agents (e.g., the virus IBR), more cases could be expected to occur.

A Kentucky study also indicated a significant reduction in incidence of pinkeye when an antibiotic was included in the salt-mineral mixture.

Don't look for a single, easy solution to control pinkeye. Instead, follow these suggestions to reduce costly outbreaks of the disease:

- Develop a program to control face flies.
- Reduce eye irritation by keeping pastures clipped. Keep cattle out of dusty lots, and provide plenty of shade.
- Consult with your veterinarian to develop a treatment or control plan; consider vaccinating for pinkeye. All cattle herds should be routinely vaccinated for IBR.
- Observe herds regularly for early detection and **treat problems as they arise.**
- Treating the cow herd with antibiotics may be needed in an outbreak of pinkeye to clear up the *M. bovis* infection and eliminate the carrier state. This is an expensive option.

Salmonella is a disease that causes diarrhea in calves and/or adults. It can lead to multiple deaths in a herd. ***Salmonellae*** are invasive bacteria that can penetrate intestinal, oral, ocular, or nasal mucous membranes. Cattle are primarily infected with *salmonellae* by three methods:

- Transmission by wildlife. Rodents and birds can bring in *salmonellae* from outside sources or act to maintain the infection by infecting cattle feed.
- Being fed contaminated animal protein by-products (40 percent are reported to be contaminated in the United States). The bacteria can rapidly multiply in high moisture feeds after contamination by birds, rodents, or equipment.
- Transmission by cattle and other livestock. Asymptomatic and sick cattle can shed large numbers of the bacteria in the feces. Carrier cattle are especially important with *S. dublin* since they shed numerous bacteria into the environment while appearing healthy.

There appears to be an association between intensive management practices, such as crowded conditions and high protein diets, with an increased incidence of Salmonella. Stress factors play an integral part in the disease. Stresses include transportation of animals, inadequate nutrition, bad weather, overcrowding, parturition, and concurrent disease. Salmonella frequently affects calves already diseased with rota virus, corona virus, or cryptosporidia. If the challenge dose of Salmonella is large enough, salmonellosis may occur as a primary disease in healthy cattle. The risk may be greatest when the infection occurs in a herd that is under environmental or nutritional stress and is close to calving.

Salmonellae survive for months in moist areas out of direct sunlight and in lagoons and drainage areas. Composting can decrease on-farm Salmonella. Survival of *salmonellae* in composted cattle manure was less than seven days. Freezing feces at -4° F kills 85 percent of Salmonella in two days and more than 95 percent by one month. In cold manure, Salmonella can survive longer than 200 days.

The primary Salmonella isolated in Kentucky is *Salmonella typhimurium*. *Salmonella typhimurium* infection does not usually produce chronic carriers. Cattle typically eliminate *S. typhimurium* within three months after infection. *Salmonella* spp. can persist in the environment.

Existing killed vaccines have limited efficacy against salmonellosis. The calf protection from passive colostral antibodies lasts only three weeks. Vaccines could be used to decrease clinical illness only in the early phases of a control program. Vaccination of cattle 3 months of age or older with two doses of killed Salmonella bacterins is likely to be useful for preventing salmonellosis. J5 *E. coli* bacterin can be protective in calves vaccinated at 3 and 10 days of age. Hyperimmune serum can be given to neonate calves in immediate danger during an outbreak.

Adverse reactions to Salmonella vaccines can result in death. Adverse reactions commonly occur on the first dose, are more likely to occur if given during hot weather, and can occur if given with other gram negative bacterial vaccines. Therefore, Salmonella vaccines should be given in cool weather (mornings are much better than evenings) and not given with other *E. coli* bacterins or *Brucella abortus* vaccine. Epinephrine should be used in case of anaphylactic reactions.

Calf scours/diarrhea is a clinical sign, *NOT* a disease.

Noninfectious causes:
- inadequate nutrition or overabundant nutrition
- inclement weather

Infectious causes: *Age affected*
- E. coli < 10 days
- Clostridium perfringens > 2 to 3 weeks
- Salmonella > 3 weeks
- Rota virus - 1 day to 3 weeks
- Corona virus - 7 days to 3 weeks
- BVD > 7 months
- Cryptosporidia - 7 days to 5 weeks
- Coccidia > 3 to 4 weeks
- Combination of all of the above

Treatment:
1. ID and isolate.
2. Electrolytes—use esophageal tube feeder if weak calf. Feed electrolytes full dose for one day. Make sure that electrolyte will not affect the milk clot in the abomasum (not sodium bicarbonate).
3. Use Pepto-bismol or other binders; can mix with electrolytes.
4. Use antibiotics if *E. coli* diarrhea.

Prevention:
1. Decrease numbers of organisms in environment with pasture management. Reduce stress: avoid crowding, provide adequate shelter.
2. Provide adequate amount of colostrum at birth.
3. Vaccinate dam at end of gestation to protect calf through colostrum, *or*
4. Vaccinate calf at birth BEFORE ingestion of colostrum.

Vibriosis (Vibrio or Campylobacter) is a sexually transmitted disease that causes early abortions and infertility in the cow. Treatment is difficult. Prevention is accomplished by vaccinating cattle 30 to 60 days before the start of breeding. Bulls should also be vaccinated. Take precautions to prevent adding infected breeding stock to the herd and thus introducing the disease.

Your veterinarian should develop a **vaccination program** to prevent contagious diseases for your particular herd. The time of year you work your cattle and the number of times you work them will influence the program for your herd. Table 6-1 is an example of a "Cattle Working Schedule" in which cattle are corralled four times a year.

Forage-related Disorders

Bloat is caused by an abnormal collection of gas in the rumen. Bloat results when an animal cannot "belch up" gases produced in the process of rumen fermentation. Pasture bloat usually occurs in cattle grazing lush legumes, such as alfalfa, ladino, or red clover. The danger of pasture (frothy) bloat is greatest when pasture plants are young, lush, and high in soluble protein. Frothy bloat results from the production of a stable foam that does not allow gas bubbles to form free gas and be "belched" off. The disorder is due to the foaming properties of soluble leaf proteins, which are more prevalent in legumes.

A cow's inability to expel the gas allows pressure to build up in the rumen. As the pressure increases, the rumen becomes distended on the cow's upper left side between the last rib and the point of the hip. As the bloat becomes more severe, breathing becomes difficult. After the cow is no longer able to stand, death follows within a few minutes.

In these severe cases, a ¾-inch to 1-inch rubber hose can be passed through the throat into the rumen to provide relief. However, since pasture bloat is frothy, this may not be sufficient. If it is not, a defoaming agent (vegetable oil or detergent) may be added through the tube. As a last resort, relief can be obtained by making a hole in the rumen large enough to release the foam. An incision is made at a point halfway between the last rib and the hook bone on the left side. The incision must be sutured, and antibiotics must be administered.

The best plan is to **prevent** bloat. Bloat preventing products, such as Bloatguard® and Bloat Blox®, are effective if consumed with regularity and in adequate amounts. These other management practices also can help prevent bloat:
- Fill cattle with hay or grass pasture before turning on to alfalfa or clover pasture. Don't turn hungry cattle on lush, immature alfalfa or clover.
- Once cattle are turned onto pasture, don't remove them at the first signs of bloat. Mild subacute bloat occurs frequently on alfalfa pasture, unless a bloat preventative is fed.
- Provide a grass-legume mixture for pasture.
- Feed grain or a grain-roughage mixture to reduce pasture intake.

Fear of bloat should not keep you from using high quality legumes, such as alfalfa and clover, in your pasture program.

Fescue toxicosis and summer syndrome are terms widely used to denote poor performance of animals grazing tall fescue during the summer. This poor performance is due to the presence of high levels of a fungus in the fescue—the endophytic fungus *Acremonium coenophialum*—sometimes referred to simply as the endophyte.

Cattle consuming fescue infected with high levels of the fescue endophyte show some or all of the following symptoms:
- lower feed intake
- lower weight gains
- lower milk production
- decreased pregnancy rates
- rough hair coat
- more time spent in the shade and higher body temperature

Hot, humid weather worsens the effects. In Kentucky research, pregnancy rates in beef cows grazing low-endophyte and high-endophyte fescue averaged about 90 percent and 65 percent, respectively, over four years. Weaning weight of calves was decreased by about 50 pounds.

Table 6-1. Cattle Working Schedule

Time	Calves	Cows
Birth (March, April)	Identify Record birth date, dam Castrate, implant male feeder calves	
Prebreeding (May)	Vaccinate—IBR-PI_3 (killed or modified-live) Clostridial diseases (4-way) Dehorn, if needed	Vaccinate—Lepto (5-way), IBR-BVD (klled), *Hemophilus somnus,* Vibriosis Deworm Sort into breeding groups
Midsummer[1] (July)	Deworm[2] Reimplant steers Calfhood vaccinate heifer calves for brucellosis	Deworm[2]
Preweaning—3-4 wk (September)	Vaccinate—IBR-PI_3, Clostridial diseases, BVD, *H. somnus*, BRSV	Pregnancy exam
Weaning (October)	Vaccination booster Treat for internal/external parasites	Sell open and cull cows

[1] Avoid working cattle during periods of extreme heat—early morning is best.

[2] Use a dewormer that is effective against inhibited Ostertagia larvae.

Note: The Kentucky Cooperative Extension Service publication ID-14, "Management Calendar for Spring-Calving Cows," contains additional management recommendations.

At least three areas should be considered to avoid or minimize the effect of the endophyte in animal production:

1. **Manage to minimize the effect.** Clipping seedheads eliminates a concentrated source of the endophyte and helps keep the plants vegetative. Hay harvested at the proper stage of maturity also gives better animal performance than late-cut hay.
2. **Dilute out the endophyte.** The most practical way is to add legumes, such as clovers, to the fescue pasture. Even small amounts of legumes can increase animal gains.
3. **Replace infected stands with low-endophyte varieties.** Several low-endophyte or endophyte-free varieties are now available. When you consider new varieties, pay attention to adaptability, forage production, animal performance, persistence, and pest resistance. These new varieties require good grazing management to persist in a stand.

Grass tetany is a disorder caused by an abnormally low amount of magnesium in the animal's blood. Beef cattle producers in Kentucky have generally been successful in reducing the incidence of tetany. However, the potential still exists in most herds for this disorder to be a problem.

Grass tetany occurs most often in cows grazing lush spring forages—especially small grains and cool-season perennials, such as fescue. It is most common in spring calving cows, especially if they are high producers in their third to fifth lactation. Several factors contribute to the increased incidence of tetany at this time. The magnesium requirement of cows doubles from late gestation to early lactation (from 9 grams to 21 to 22 grams). When this rapid change in magnesium needed by the cow is coupled with lowered magnesium in the plant, along with certain components that lower the availability of magnesium (such as high applications of nitrogen and potassium fertilizers), tetany can develop. Weather can also have an effect; the greatest threat is when temperatures are between 40°F and 60°F. Temperatures in excess of 60°F for a week markedly decrease the incidence of tetany. When all of these factors are combined, the risk can be high.

Cattle affected with grass tetany might isolate themselves from the herd and stagger. As the disease progresses, they may exhibit extreme nervousness, rapid breathing, and muscle trembling. They might become aggressive and charge anyone in the pasture. In the most severe stage, the animal collapses to the ground with muscular spasms. Treatment must be given rapidly as death can occur within an hour after the onset of convulsions.

For the cow down with tetany, treatment is the only option. Treatment consists of an intravenous injection of solutions containing magnesium, calcium, and glucose. **This must be done correctly.** If the IV solution is administered too rapidly, death can result. Consult a veterinarian familiar with the herd and its management about treatment procedures and whether you should keep emergency medication and equipment on hand. To prevent relapse, recovered animals should be removed from the pasture and fed a hay/concentrate mixture supplemented with magnesium oxide for at least a week.

As a producer, you should be concerned with preventing tetany. About 2 ounces of magnesium oxide (22 grams of magnesium) is recommended to meet the magnesium needs of lactating beef cows. Since legumes are higher in magnesium than grasses, feeding cows legume hay during the early spring may supply some magnesium. Cows grazing spring grass pasture should have magnesium in the mineral mixture; in "high risk" situations, it may be supplied in a supplement.

Many commercial mixtures are available in various forms to prevent tetany. Before you make a purchase, determine if the product will give adequate magnesium intake. This depends on the magnesium content and the expected consumption of the product. Both should be listed on the tag. If it appears that magnesium intake will not be adequate, a product with more magnesium or greater intake should be used.

In "high risk" situations where tetany is a frequent problem, it might be necessary to force feed the daily magnesium needs. Magnesium oxide can be included in a grain

or protein supplement. Supplements for "high risk" situations are shown in Table 6-2.

Nitrate toxicity can affect cattle that consume forages containing excessive amounts of nitrate. It also might occur if animals (especially those hungry for salt) have access to nitrate fertilizer. Under normal conditions, low levels of nitrate consumed by cattle are converted to ammonia and then to protein. However, high levels of nitrate interfere with the ability of red blood cells to carry oxygen. Thus, the animal dies from nitrate poisoning, but the death is caused by lack of oxygen.

Forage crops most likely to collect nitrates are warm-season annual grasses, such as sorghum, sorghum-sudan hybrids, sudangrass, corn, and johnsongrass. Avoid grazing these warm-season grasses, especially those heavily fertilized with high amounts of nitrogen, when growth ceases due to drought or cold damage. Suspect forage should be tested for nitrate level. Consult your county Extension agent for agriculture or veterinarian for information concerning sampling and how to send samples to a diagnostic lab.

The chart below should help you interpret laboratory results. Results are generally reported on a percentage or parts per million (ppm) of **nitrate** on a dry matter basis. Be sure results are reported as nitrate levels.

Cattle being fed or grazed on suspect forages should be watched closely for these signs:

- labored breathing
- frothing at the mouth
- diarrhea
- frequent voiding of colorless urine
- staggering
- convulsions
- brown color of the membranes

Table 6-2. Suggested Supplements for Preventing Grass Tetany

	"High-risk"	
Ingredient	**Free choice supplement**	**Hand-fed supplement**
Grain	39	66
Soybean meal	19	17
Dicalcium phosphate	10	10
Magnesium oxide	7	7
Salt, plain	25	- -
Vitamin A premix	*	*
	100 lb	100 lb
Expected intake/day	2 lb	2-3 lb

** Vitamin A should be added to any of the mixtures to provide approximately 30,000 IU daily to each cow.*

Remove animals showing symptoms from the feed or pasture, and feed them a high concentrate diet. A solution of methylene blue can be given intravenously to help restore the oxygen-carrying ability of the red blood cells.

Do not bale forage that tests high in nitrate. The nitrate content of cured forage is stable. Corn fodder or sorghum-type plants have about the same nitrate content when fed as they did when baled. Properly fermented silage loses about half of its nitrate content. Do not enter the silo during the ensiling process; gases that are given off are toxic. Ground limestone added to the silage as it enters the silo, at the rate of 20 pounds per ton, can cause more nitrate to be lost.

Hay that tests high in nitrate can be diluted with low-nitrate feeds. Feed a ration high in carbohydrates (such as grain). This especially applies to feed that is marginal in its nitrate content.

Nitrate Levels in Forages (dry matter basis)

Percent (%) nitrate	PPM nitrate	Comments
0 to 0.25	0 to 2,500	Safe
0.25 to 0.50	2,500 to 5,000	Caution. Generally safe when fed with a balanced ration. For pregnant animals limit to one-half of total dry ration. Make certain water is low in nitrates. Prolonged feeding may result in a Vitamin A deficiency. Do not feed with liquid feed or other nonprotein (NPN) supplements. Be cautious with pregnant and young animals.
0.50 to 1.50	5,000 to 15,000	Danger. Limit to one-fourth of ration. Should be well fortified with energy, minerals, and vitamin A. May experience decreased milk production in 4 to 5 days, possible occurrence of reproductive problems.
Over 1.50	Over 15,000	Toxic. Do not feed free choice. Feed containing such high levels can only be used if ground and mixed with other feed. Limit to 15% of total ration.

Source: D.M. Ball, C.S. Hoveland, and G.D. Lacefield. Southern Forages. 1991. Atlanta, GA: Potash and Phosphate Institute.

These are management guidelines for feed and forages that contain high levels of nitrates:

- Leave drought-damaged forage in the field as long as practical before harvest since nitrate diminishes as plants mature.
- Cut suspect forage higher than usual to avoid the higher nitrate-containing portion of the plant. Don't force cattle to eat the lower portion of the stalk during grazing.
- Avoid use of drought-stricken forage until three to five days after a rain.
- Regulate the intake of nitrate-containing feeds so that small amounts are fed initially and increases are gradual.
- Run an analysis on suspect feed to determine nitrate level.

Prussic acid poisoning occurs in animals that have consumed plants containing cyanide-yielding compounds. The prussic acid (hydrocyanic acid) poisoning potential is affected by species and variety of plants, along with weather and soil fertility. Plants of the sorghum family and leaves of wild cherry trees have the potential to produce prussic acid poisoning. Some sudangrasses are low in prussic acid, and pearl millet is free of toxic amounts of prussic acid.

The first sign of trouble might be a dead animal. Symptoms from small amounts of prussic acid can be labored breathing, frothing at the mouth, and staggering.

You can lower the risk of prussic acid poisoning by following these management practices:

- Don't graze sorghum or sorghum-cross plants until they are at least 15 inches tall.
- Don't graze wilted plants.
- Don't graze these plants during or shortly after drought periods when growth is retarded.
- Don't graze for two weeks after a non-killing frost.
- Don't graze until about 48 hours after a killing frost (until plant material is dry).
- Don't graze at night when a frost is forecast.
- Don't allow cattle access to wild cherry leaves.
- Do check pastures after storms for fallen wild cherry trees or limbs.

Parasites

Internal parasites are present in most beef herds in Kentucky. The condition is often subclinical and results in hidden losses. Reduced gain and feed efficiency occur in what appear to be healthy cattle. Cattle infected with a heavy load of internal parasites may show many of the following symptoms:

- anemia
- rough hair coat
- "bottle jaw"
- progressive weight loss
- persistent diarrhea
- unthriftiness

This is how the cycle works: mature female worms that live in the gut of animals produce a large number of eggs which pass out of the animal in the manure. The moisture and warmth of the manure pad helps the eggs hatch and develop into larvae. When they reach the infective stage, the larvae of most species crawl onto the forage where they are ingested by cattle. Once inside the animal, they grow to maturity and the cycle begins again.

The medium brown stomach worm (*Ostertagia ostertagia*) is different in that the larvae enter digestive glands in the stomach lining and can become inhibited (hibernate) for as long as four months. This period of inactivity generally occurs in the summer and winter. The hibernation is a method of survival for the worms because the eggs are not deposited on hot, dry summer pastures or frozen ground where they would die quickly. However, when favorable weather resumes for development of worms on pasture, the larvae become active in the stomach lining. They develop into adult worms and break out of the glands, damaging them as they leave. They can emerge gradually or suddenly, causing much damage to the stomach lining.

Several products help control internal worms in cattle. They are in the forms of injectables, pour-ons, drenches, pastes, boluses, blocks, crumbles, and feed additives. Select the appropriate product based on your management practices and your veterinarian's recommendations. Dewormers used during the hot summer and cold winter should be effective against inhibited *Ostertagia ostertagia* larvae. Albendazole (Valbazen®), doramectin (Dectomax®), ivermectin (Ivomec®), oxfendazole (Synanthic®), or a double dose (10 mg/kg) of fenbendazole (Safe-Guard®, Panacur®) removes the adult and inhibited *Ostertagia*.

Cattle are typically dewormed in the fall at weaning time, spring at pasture turn out, or both. If you deworm in the spring, keep the animals in a confined pasture for 24 to 48 hours after treatment and before turning out onto the spring/summer pasture. This time allows the anthelmintics (dewormers) to kill the worms and discard them onto a "contaminated" pasture. The cattle can then be turned out onto "clean" pastures.

Strategic deworming programs should be designed to work with the natural rise and fall of infective larval populations on pastures at various times of the year. The most important part of strategic deworming is **timing**. Timing for deworming is dependent on the weather, grass growth, and management. Strategic deworming coordinates grazing pastures with several strategic dewormings in the spring/summer. The timing between dewormings depends on the type of anthelmintic used.

Chemical control of internal parasites should be accompanied by other measures, such as not overstocking pastures, pasture rotation, feed bunk management and sanitation, and an adequate level of nutrition. Pastures on which cattle have been concentrated can be harrowed with a chain-link harrow to expose eggs and larvae to the effects of drying and heat or cold.

External parasites, such as flies, lice, and cattle grubs, cause losses to beef producers from lowered weight gains, reduced milk production, and diseases transmitted by parasites. Animals that are severely infested with parasites are more susceptible to disease.

Lice occur primarily during the winter months when cattle have longer coats and less oily skin. Two types of lice infest cattle in Kentucky: biting lice and sucking lice. *Biting lice* (little red lice) do not suck blood but use their chewing mouthparts to feed on dead skin, hair, and skin secretions. These lice are very active and cause irritation to animals by their movement and feeding. Biting lice are usually found around the tailhead and the top of the shoulder. *Sucking lice* have piercing mouthparts which they use to feed on blood. Sucking lice are bluish or slate-gray in color. They are often found in colonies, which look like patches of dirt or manure against light colored hair.

Symptoms of lice infestation are licking the hair to soothe the irritation, rubbing, and scratching. Severely infested cattle often rub off patches of hair. The rubbing can cause damage to fences or injury to the cattle.

Lice can be controlled easily in the winter by using pour-on or spot-on insecticides, either those used for cattle grub control or those designed specifically for lice control. Keep lice in check by using backrubbers or dustbags throughout the year. Some forms of dewormers (ivermectin, doramectin) kill sucking lice and grubs.

When treating for lice, treat all animals in the herd to prevent reinfestation from untreated cattle. To rid the herd of lice completely, you will need a second insecticide treatment 14 to 21 days after the first (to kill lice that have hatched from unkilled eggs).

Flies are pests of beef cattle and cause most problems during the warmer months. Most flies have either sponging or piercing-sucking mouthparts. Face flies have sponging mouthparts; hornflies, stable flies, and horseflies have piercing-sucking mouthparts.

Face flies usually feed on mucus secreted from the eyes of cattle. They spread the bacteria *Moraxella bovis*, which causes pinkeye in cattle.

Hornflies are blood-sucking pests that stay on cattle continuously, leaving only when disturbed or when they move to fresh manure to deposit their eggs. They are usually found on the shoulders and backs of cattle. Since hornflies stay on the cattle, they are easy to control.

Horseflies are severe blood-sucking pests of cattle that cause problems usually during late summer. Horseflies greatly irritate cattle by feeding on them, and they can spread anaplasmosis. The control of horseflies is difficult since they spend little time on the cattle.

You can control face flies and hornflies by using insecticide sprays, backrubbing devices, dust bags, insecticide-impregnated ear tags, and feed-through insecticides. Insecticide-impregnated ear tags have been used effectively for several years. Tags give the best fly control when you use two tags per animal, apply them in late May or early June when the fly population builds up, and put tags on all animals in the herd.

Flies can become resistant to chemicals used in insecticide ear tags when they have been used for long periods. In these cases, alternate the types of insecticide and/or methods of control to eliminate insecticide-resistant populations of flies.

An intraveneous injection can be made by placing a finger or thumb over the jugular vein, causing it to "bulge." The needle is then inserted with a quick, sharp thrust.

Cattle grubs are the immature or larval form of heel flies. Producers are likely to be aware of these parasites at two stages of their life cycle: first, when heel flies try to deposit their eggs on cattle, causing them to run with their tails up (this is sometimes called "gadding") and, second, when grubs appear in the cattle's backs after nine months or so in the animals' bodies.

Control of these insects is important because of losses due to disturbed or "gadding" cattle, reduced vigor of cattle while larvae are migrating through the body, and damage to loin muscle and hide when slaughtered. Control can be accomplished while the larvae are small and in the "wandering" stage in the body. In Kentucky, this is from mid July until the end of October. Systemic insecticides are applied as pour-ons, spot-ons, and sprays. The injectable dewormers ivermectin and doramectin also kill cattle grubs.

Administering Drugs to Cattle

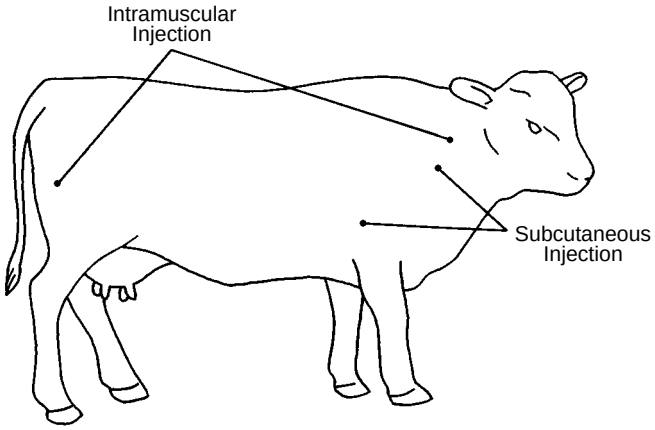
Drugs used by producers and veterinarians are generally classified broadly as *pharmaceuticals* (used for treatment) or *biologicals* (used for prevention). Both are necessary for a herd health program.

Types of pharmaceuticals used for treatment include antibiotics, coccidiostats, and steroids. An example of a biological used for prevention is a vaccine, which stimulates immunity against specific diseases. [Note: Vaccines should be refrigerated and are sensitive to light. Do not reconstitute them until they are to be used. Observe the expiration dates printed on the labels.]

No matter which method you use to administer drugs, always use proper animal restraint to do a good job. Since most drugs are relatively expensive, take your time and do the job right. If your technique is sloppy, your biggest loss will be caused by a lack of response to the drug.

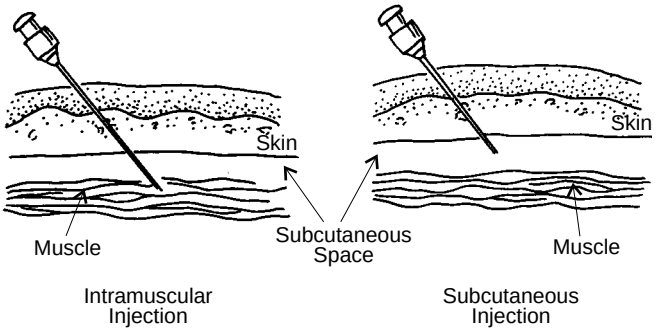
Injections are probably the most common method of administering drugs. Drugs that are injected act rapidly, are used efficiently, and may act longer than those given

Figure 6-1. Injection sites.



Source: John Johns and Lee Meyer. Backgrounding Beef Cattle. ID-62. Lexington, KY: University of Kentucky Cooperative Extension Service.

Figure 6-2. Illustration of intramuscular or subcutaneous injections.



Source: John Johns and Lee Meyer. Backgrounding Beef Cattle. ID-62. Lexington, KY: University of Kentucky Cooperative Extension Service.

orally or applied topically. *For the best results, take care to properly prepare the injection site, equipment, and product.*

There are three types of hypodermic syringes: plastic disposable, glass reusable, and metal pistol-grip reusable. Be sure to keep extras in case of breakage or malfunction. Convenient sizes to have available are 5, 10, and 20 cc. Larger sizes (about 50 cc) can be used in administering large doses or for multiple doses (like pistol-grip syringes). When loading the syringe, pull back the plunger and fill with an amount of air equal to the drug to be put in the syringe. Then inject the air into the bottle and withdraw the drug.

Needles also come in many lengths and sizes; remember, the diameter becomes smaller as the gauge number gets larger (for example, 14 gauge is larger in diameter than 22 gauge). Consider both length and gauge when you prepare to give various types of injections. Generally, 16 and 18 gauge needles are required for most injections. Smaller diameter needles may not allow thick liquids to flow easily and may bend. Larger diameter needles make a large hole and might let the product flow back out.

The most commonly used types of injections are subcutaneous (SC), intramuscular (IM), intravenous (IV), subconjunctival, and intranasal.

Subcutaneous injections are made just under the skin but not into the muscle tissue. The side of the neck is a good area to make injections in cattle. Behind the point of the elbow where the skin is loose can also be used. To properly administer the injection, lift the skin with your free hand and insert the needle into the raised fold of skin. Needles of 16 to 18 gauge and ½ to 1 inch are usually used. A ½-inch needle is needed when the skin is not lifted with the free hand during injection. Do not give more than 10 cc at a single injection site. Separate injection sites by at least 5 inches.

Intramuscular injections are made directly into muscle tissue, generally with a 1- to 1 ½-inch needle. Absorption of the drug is more rapid here than under the skin because of the good blood supply to muscle tissue. After the injection site is chosen, distract the animal by slapping the injection site firmly. Immediately insert the needle with a quick thrust. Do not inject more than 10 cc at an injection site. Too much drug in one area can cause muscle damage. Do not make injections in the rump (see Figure 6-3 for proper injection sites).

Intravenous injections are useful when a large volume must be given, when the drug must not be deposited outside the vein, or when it might be irritating to tissues. These are made directly into a blood vessel, usually the jugular vein. An injection site can be found on the side of the animal's neck by placing the thumb or forefinger of your free hand firmly onto the area where the jugular vein is located. The vein should bulge between your thumb and the animal's head so that it can be seen and felt. The needle must be sharp and inserted with a quick thrust to hit the vein. Don't stick the needle in until you can see the vein.

Because some knowledge of anatomy and experience is needed, intravenous injections should be performed only by an experienced person following recommendations and instructions by a veterinarian.

Subconjunctival injections involve injection of a drug into the eyelid. This type of injection might be needed for treating pinkeye. Invert the top eyelid of the infected eye and make an injection under the pink lining of the eyelid.

Intranasal refers to inside the nostril; drugs administered intranasally (such as IBR vaccine) are "squirted" inside the nostril. Only a small amount of the product needs to come in contact with the mucous membranes to cause the animal to develop immunity.

Precautions

When using injectable drugs:

- **Never** exceed the recommended volume per injection site. This could cause:
  - tissue damage
  - soreness
  - extended withdrawal times
  - altered absorption
  - increased possibility of "leakage" of the product
- **Never** use a needle on an animal and then insert it back into the bottle. Leave a clean needle in the bottle for withdrawing the drug.
- **Always** take your time, handle drugs properly, and make injections correctly.

Administering drugs orally

Another way to administer drugs is orally. In this case, the product is fed or given directly through the mouth. Feeding of drugs requires that all animals eat an adequate amount. Therefore, the product must be palatable, and adequate feeding space must be allowed so that all animals eat the proper amount in the required time. Balling guns are used to give boluses, capsules, and tablets. Drenching can also be used to give liquid to cattle.

Identification of Cattle

Animal identification is important in beef cattle herds for effective record-keeping, performance testing, and artificial insemination, as well as routine observations. The three most common methods of identification are ear-tagging, tattooing, and branding.

Regardless of the method you use, you must decide on a numbering scheme if your records are to be meaningful. Each animal should have a unique number. Herd size determines how many digits are necessary, but each digit should have some meaning.

In a four-character number, you could use this common scheme: the first number or letter denotes the year of birth; the second character identifies the sire or breed crossed; and the last two numbers are the order of birth. Or, a letter can be used to denote the year of birth using the international year/letter designation (see Table 6-3).

For example, the tattoo "7 2 14," read from the left, could be:

7 = 1997 birth year
2 = sire No. 2
14 = 14th calf born in 1997

Or, the calf could be tattooed G214 and have the same meaning.

Ear-tagging is probably the most common method of identification. It is not permanent, because tags are frequently lost. Ear tags are best used in combination with a permanent form of identification, such as a tattoo or brand. You can purchase pre-numbered tags. If you number your own, be sure to use ink that will bond to the tag and allow adequate time for it to dry.

A properly applied breeze-brand on dark-colored cattle makes an effective method of identification.

Step-by-step procedure for ear-tagging

1. Select the tag and numbering system to be used.
2. Number plastic ear tags with a marking fluid or ink that bonds to the ear tag. Number tags no later than the **day before** they are to be used.
3. Insert the ear tag into the appropriate applicator. When two-part tags are used, be sure they line up correctly and that you are using the correct pin for the type of tag.
4. Select the tagging site on the ear. Place one-piece plastic tags between the cartilage ribs, approximately one-half the distance from the base to the tip of the ear. You may place two-piece tags between the cartilage ribs or below the ribs. Place metal tags into the top of the ear near the ear's base.
5. Insert the ear tag. Apply the two-part tag with the plier-type applicator by squeezing the handles until the ear tag snaps together. Metal types are applied in the same manner. The knife-like applicators (for one-piece tags) are forced through the ear using extreme care. Be sure the knife is turned so that the tag hangs straight down or at an angle away from the base of the ear.
6. Treat the wound with an antiseptic to prevent infection.

Tattooing is a permanent means of identification, but it cannot be read from a distance. Most purebred organizations require that animals be tattooed in one or both ears

Table 6-3. International Year/Letter Designations

Year	Letter	Year	Letter
1997	G	2004	P
1998	H	2005	R
1999	J	2006	S
2000	K	2007	T
2001	L	2008	U
2002	M	2009	W
2003	N	2010	X

This system skips the letters I, O, Q, and V.

before registration. The tattooing instrument consists of a pliers-type device with numbers and/or letters. These numbers or letters are made of needle-like projections that pierce into the ear when the handles of the tattoo instrument are squeezed together. An indelible ink is then rubbed into the small punctures. After healing, the tattoo is permanent.

Step-by-step procedure for tattooing

1. Restrain the animal.
2. Locate the area of the ear you wish to tattoo. Two ribs of cartilage divide the ear into top, middle, and lower thirds. Place the tattoo in the top of the ear just above the cartilage rib. It is generally best not to tattoo between the two cartilage ribs as this area is frequently used for ear tags. Also, the area between the two ribs on the right ears of heifers is reserved for brucellosis vaccination tattoos.
3. Clean the inside of the ear where the tattoo is to be placed with a cloth soaked in alcohol.
4. Position the tattooing instrument so that the numbers are in the proper position. Squeeze the handles together completely and quickly.
5. Rub tattoo ink into all needle marks. You can apply the ink with a roll-on applicator or rub it in with your thumb or an old toothbrush.

Hot-branding is used for two basic reasons: to establish ownership of an animal and to identify an individual animal. Like many states, Kentucky registers ownership brands through the Department of Agriculture. The use of a registered ownership brand helps discourage cattle rustling and serves as the cattleman's trademark. It has the disadvantage of lowering the value of the hide and is considered by some as inhumane.

Brands used for individual animal identification usually consist of three or four numbers. Hot-branding permits quick identification of an animal from a distance. The most common locations of brands are the hip, rib, thigh, and shoulder. Brands can be applied easily to these locations when animals are restrained in a squeeze chute, and the brand is easy to see from a distance. Each character is generally 3 or 4 inches high. Numbers that are 3 inches are generally used on young cattle; 4-inch numbers are used on mature cattle.

Step-by-step procedure for hot-branding

1. Restrain the animal. Place the animal in a squeeze chute with a head gate. Apply tension to the squeeze mechanism to prevent the animal from moving.
2. Heat the irons. Electric irons may be used; these require a 110-volt outlet. Electric irons heat in about 90 seconds and maintain a constant heat. A set of electric irons consists of three irons with three numbers on each iron; thus, three outlets are required to keep all irons hot.

   Regular irons (iron or steel) may be heated with a propane gas burner or a wood fire. The gas burner is usually built inside a drum to help contain the heat and is hooked to a propane tank for a constant fuel source.
3. Check temperature of irons. A properly heated iron looks ash-gray in daylight but glows when held in a dark place, such as the bottom of a five-gallon bucket. A black iron is too cold. It might be hot enough to burn the hair but will not form a permanent brand. A red hot iron is too hot and should be allowed to cool until the ash-gray color appears.
4. Apply the iron. Firmly press the branding iron against the hide and rock the handle gently to vary the pressure and obtain uniform application of the entire character.

   The iron should be applied to the hide just long enough to burn the hair and outer layer of skin. This generally requires about five seconds, depending on the age, hair cover, and iron temperature. New brands should be the color of saddle leather (light tan).

   Repeat this step until the animal is branded with all the desired characters.

Tips for better brands

- Do not brand wet animals. An iron applied to wet hair loses temperature rapidly and tends to scald rather than burn the hide; this results in a scar that is slow healing and hard to read.
- Do not permit the iron to slip or slide during application or a blotch will result.
- Clip hair over the brands in fall or winter before the calving season begins.

Freeze-branding of cattle with super-chilled irons (copper or copper alloy) is considered more humane than hot-branding. When applied properly, the cold brand destroys the color-producing cells in the hide and the hair grows out white. The visibility of these brands is much better on black or dark colored cattle, and not as good on white or light colored cattle.

Step-by-step procedure for freeze-branding

1. Prepare the branders. They should be made of copper or copper alloy.
2. Cool the irons in a refrigerant. One method of doing this is to place the branders in liquid nitrogen (-320°F). Place 3 to 4 inches of liquid nitrogen in a Styrofoam cooler or insulated bucket before the irons are added. It takes about 5 quarts of liquid nitrogen for 20 head of cattle.

   The second method of cooling branders involves placing them in a mixture of 99 percent isopropyl alcohol and dry ice. The recipe for 20 head of cattle is 1 gallon of 99 percent isopropyl alcohol plus 20 pounds of dry ice placed in a Styrofoam cooler. The ratio of alcohol to dry ice is not critical, but one pound of dry ice per animal branded is a good rule of thumb.

   Both methods require more refrigerant to cool the branders initially than to rechill between animals. Add refrigerant (liquid nitrogen or alcohol and dry ice) as needed to ensure the branders are covered by refrigerant.

3. Fill a quart squeeze bottle with 99 percent isopropyl alcohol.
4. Restrain the animal in a squeeze chute.
5. The irons are ready for use when the refrigerant stops boiling. Initially, this takes about 20 minutes and depends on how many branders you are trying to cool at one time. When the boiling stops, the brander has reached the temperature of the surrounding refrigerant.
6. Clip the area to be branded as closely as possible. This can best be done by using a No. 40 surgical clipper to remove the hair and "underfur," which acts as insulation and increases the time required for proper branding. If necessary, a stiff-bristled grooming brush can be used after clipping to remove dirt, hair, and dandruff.
7. Liberally apply 99 percent isopropyl alcohol from the squeeze bottle over the branding site. Soak the area but don't waste alcohol. It need not be rubbed in.
8. Put on a pair of leather gloves, take the brander out of the refrigerant, and check the character to be used to be sure it is the right one.
9. Check the clock to ensure the proper brand application time.
10. Apply the brander to the clipped, alcohol-soaked area, and apply pressure to the brander by leaning on it.

    When either liquid nitrogen or alcohol-dry ice are used as refrigerants, the minimum time of application is 30 seconds. When liquid nitrogen is used in the winter, hold the iron on black calves for 45 seconds and on red calves for 60 seconds. When dry ice and alcohol are used during the winter, hold the brander in place for at least 60 seconds.

    The calf usually jumps and squirms for the first 10 seconds after the brander is applied to the hide. The reason for this is that the extreme cold activates the nerve endings. After about 10 seconds, the nerve endings are frozen and inactivated and the animal usually stops moving. You should be ready for this and keep the brander in the same position the entire time to ensure a good, clear freeze brand.

Implants for Beef Calves

Growth-stimulating implants offer the commercial producer a fast, easy-to-use method of increasing weight gain of calves. They have been proven effective through research as well as in the beef industry.

Implants are placed underneath the skin on the back of the ear. They appear to exert a positive effect by increasing growth hormone and insulin, resulting in increased formation of muscle tissue and decreased fat. Growth hormone is naturally produced by the pituitary gland and is an important regulator of growth. Implants generally increase the rate of gain by 4 percent to 8 percent.

As a general recommendation, male calves should be implanted when they are castrated. Do not implant bull calves that you intend to save for breeding. Research has shown that suckling male calves implanted at castration weighed as much at weaning as non-implanted bull calves of the same age. While bull calves weigh more at weaning than non-implanted steers of the same age, they generally bring a lower price per pound when sold as feeders.

Growth-stimulating implants offer the commercial cow-calf producer a fast, easy-to-use method of increasing weaning weight of calves.

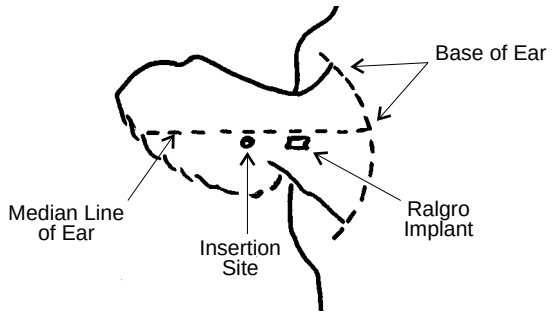
Compudose® is cleared for use in suckling steers. The implant is a 1.18-inch long, 3/16-inch thick silicone rubber cylinder that contains 24 mg of crystalline estradiol 17ß. This provides for a controlled release of the product for 200 days. Individual implants are contained in a 20-dose hard plastic cylinder designed for use in the Compudose implant gun. Each implant is coated with oxytetracycline powder to minimize ear infections and consequent loss of the implant.

The active ingredient in **Ralgro®** is zeranol, derived from a mold commonly found in corn. Although it functions through the hormonal system, it is not a hormone itself. Ralgro is approved for suckling calves (from birth) of either sex that are not intended for use as breeding animals. One dose of Ralgro consists of 36 mg zeranol regardless of size or sex of calf. It is available in 24-dose cartridges made for the Ralgro implant gun. **Magnum** contains 72 mg of zeranol and is for use in feedlot steers.

Revalor®-G is for weaned pasture cattle. Each implant contains 40 mg trenbolone acetate (TBA) and 8 mg estradiol and provides for improved average daily gain.

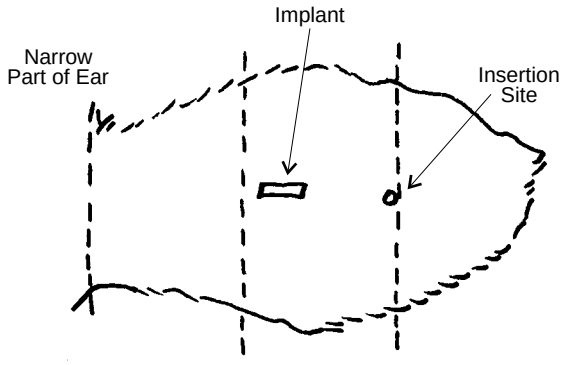
Synovex®-C is cleared for steer or heifer calves ranging from 45 days old to 400 pounds. It can also be used on heifers intended for later breeding, if used during this period. An individual dose of Synovex-C® consists of four cylindrical pellets contained in a clear plastic implant cylinder. **Synovex-S** is for steers weighing more than 400 pounds. Each implant contains 200 mg progesterone and 20 mg estradiol in eight cylindrical pellets. **Synovex-H** is for heifers weighing more than 400 pounds. Each implant contains 200 mg testosterone and 20 mg estradiol in eight cylindrical pellets. Each implant cylinder contains 10 doses and is made for use in a Synovex implanter. There are two types of Synovex implanters, one of which has a retractable needle to improve implant retention and absorption.

Figure 6-3. Site of insertion for Ralgro® implant.



Source: Burris et al., 1990. Growth Stimulating Implants for Beef Cattle. ASC-25. Lexington, KY: University of Kentucky Cooperative Extension Service.

Figure 6-4. Site of insertion for other implants.



Source: Burris et al., 1990. Growth Stimulating Implants for Beef Cattle. ASC-25. Lexington, KY: University of Kentucky Cooperative Extension Service.

Calf-oid, Implus H, and **Implus S** have the same ingredients and labeled uses as Synovex-C, Synovex-H, and Synovex-S, respectively.

Research has shown that calves respond to reimplanting. With the exception of Compudose, calves should be implanted every 90 to 100 days. UK data indicates that 97 percent of the gain stimulation from Ralgro occurred in the first 84 days. Your best approach is to implant calves at or near birth when the males are castrated and reimplant midway through the suckling phase, unless Compudose is used.

Step-by-step procedure for administering implants

1. Properly restrain the animal.
2. Determine which ear you want to implant and adjust the implant instrument so the needle can be positioned next to and parallel to the ear, with the slant side of the needle facing outward. Implant all calves in the same ear to minimize confusion.
3. Select the proper implant site on the back of the ear (Figures 6-1 and 6-2). Put the implant between the skin and cartilage on the back of the ear.
4. Clean the needle and implant site with cotton dipped in alcohol to reduce contamination of the needle wound.
5. Grasp the ear with one hand while the other hand positions the instrument parallel to and nearly flush with the ear. Put the point of the needle against the ear with the beveled part facing you.
6. Use the tip of the needle to prick the skin, lift slightly, and completely insert the needle under the skin.
7. Pull the instrument and needle back to create a space for the implant, unless using an implanter with a retractable needle.
8. Depress the plunger of the implant gun and withdraw the needle.
9. Feel the ear for the implant under the skin to see that it is inserted properly.

Precautions

- When the ear is grasped and the needle inserted, the animal may throw its head. This can be prevented by using a nose lead, halter, or a headgate equipped with a head and nose bar.
- Avoid piercing or cutting ear veins with the needle.
- Do not allow the needle to gouge or pierce through the cartilage. If you feel resistance as you insert the needle, it is quite probable that the cartilage has been gouged, and pellets may be covered with scar tissue and "walled off," resulting in poor drug absorption and decreased gain.
- Never sacrifice a careful implantation technique for speed.

The products named in this section should be available through animal health and farm supply stores or your veterinarian.

Castration of Bull Calves

Castration is the removal or destruction of the testicles of a bull by surgical or nonsurgical methods. The castrated male calf is then referred to as a steer. Steers are preferred in the marketplace and bring more per pound than bull calves because they have a better disposition and their meat is preferred over that from bulls. Implanted steer calves weigh as much at weaning as bull calves.

Bull calves should be castrated as soon after birth as possible. You can castrate calves at birth when they are ear-tagged and implanted. In some herds, it is not practical to castrate that early because herd sire prospects will not be selected until weaning. However, older and heavier bulls generally bleed more and suffer more setback.

There are several methods of castration. All of the surgical methods accomplish successful removal of the testicles, but not all of them permit the scrotum to drain properly while healing.

Knife castration is the most common method used. Two variations are generally used: cutting off the lower third of the scrotum or slitting the scrotum down the side. A sharp and sterile pocket knife works fine for making the incision.

However, specially designed castration knives are available.

After the incision is made, squeeze the testicles one at a time through the incision. Pull on the testicle and, with the thumb and index finger of the other hand, separate the testicle and cord from surrounding connective tissue. Sever the spermatic cord as high as possible by scraping with the knife blade, or use an emasculator which crushes as it cuts (this prevents hemorrhage in older calves). Apply an effective antiseptic, and a fly repellent if needed.

The **bloodless emasculator** (Burdizzo®) is the preferred method of nonsurgical castration. It can be used at any time of year without concern for an open wound. "Clamped" bull calves may become staggy (have some of the physical characteristics of a bull) if the procedure isn't done properly.

Clamping is best done with the calf standing and a tail-hold applied (grasp the tail near the base and bend it sharply upward and over the back toward the calf's head). Be sure the emasculatome closes properly. Each cord should be crushed separately. Position one cord against the outside of the scrotum. Clamp approximately 2 inches above the testicle. The emasculatome should be left in place for about a minute. The crushing of the cord should make the testicle atrophy and become nonfunctional.

It is a good practice to clamp each cord twice. Repeat the procedure on the other cord, making sure to leave the middle (septum) unclamped for adequate circulation to the scrotum. If you clamp all the way across (including the septum), the scrotum can slough off and expose the testicles.

The **elastrator** method should only be used on calves less than 1 month old. In this method, a special rubber band is placed around the scrotum at its neck. You apply the rubber band with a forceps-like instrument. Expand the rubber ring and press both testicles through the band. Release the rubber band and remove the elastrator. The testicles and scrotum will fall off in about two weeks. Elastrators can be used only before the testicles become too large to pass through the band.

The elastrator method has some serious disadvantages: tetanus can be a problem when the bottom of the scrotum atrophies and sloughs off; also, the rubber band sometimes breaks and voids the operation. Complete removal of the scrotum is also objectionable to some producers.

Dehorning Calves

Buyers of feeder calves prefer calves without horns. Dehorning reduces the possibility of injury and bruising of animals. Hornless cattle require less space at the feed bunk and in transit. Horned animals are more difficult to catch in a headgate and more likely to injure the handler during processing.

It is best to dehorn animals as early as possible to minimize stress, preferably at less than 2 months of age. As calves get older, the process causes more trauma, more bleeding, and an increased chance of infection. When calves have matured enough to have a "horn" sinus, cutting the horn out leaves an open hole into the sinuses of the head. Do it early when little or no cutting is required!

It is also best **not** to dehorn cattle by a method requiring cutting during either the fly season or extremely cold weather. Maggots can be a problem during hot weather, and the exposed sinuses can lead to respiratory problems during extremely cold weather.

Calves can be dehorned genetically with the use of polled animals in the breeding herd. If calves are born with horns, however, dehorn them as early and humanely as possible, using one of the following methods.

A **caustic paste** or **stick** can be used on very young calves (up to 2 or 3 weeks of age), where only a button can be felt. Clip the hair around the base of the horn. Then clip off the end of the horn button with a sharp pocket knife so the dehorning chemical can penetrate the horn. Apply a ring of petroleum jelly around the base of the horn button to protect the skin. Apply the caustic stick or paste according to label directions. Rub the caustic stick on the horn until blood appears. Keep the calf away from its dam until the treated area has hardened and dried.

Spoon, tube, or knife dehorning works on horn buttons or small horns just emerging. These tools separate the horn from the adjoining tissue with very little bleeding. Clean the area around the horn with a disinfectant. The cut should be made around the base of the horn to include about ⅛ inch of skin and should be about ¼ to ½ inch deep. After removing the horn, apply an antiseptic, and insect repellent if needed.

An **electric dehorner** is an excellent tool for removing horns from calves of any age when the horn is still small. Most electric dehorners have cupped ends of different sizes which are placed over the horn. Select the "cup" that fits best over the base of the horn and hold it on long enough to destroy the ring of growth cells around the base of the horn. The skin will look copper or bronze colored when completed. The horn or button can then be knocked off with the hot iron or it will drop off in a few weeks.

Barnes-type dehorners may be necessary if dehorning is delayed until weaning. The instrument should fit over the horn plus a ring of skin and hair. The dehorners are available in calf and yearling sizes. The older the calf, the greater the potential for complications with this method.

Close the handles to fit the blades around the base of the horn; then spread the handles and twist while applying considerable pressure. Control bleeding by using forceps to pull exposed arteries. Pick up the artery (bleeder) with the forceps, twist and pull the artery until it breaks and retracts into surrounding tissue. A hot iron (electric dehorner) may be used to cauterize small blood vessels. Treat the wound with an antiseptic spray, and fly repellent if needed. Do not use blood-clotting powders if there are openings into the sinus cavity. Place a thin layer of cotton over the exposed cavity to keep out foreign particles, like dust.

Estimating Age of Cattle by Their Teeth

If you don't know how old a cow is, it is sometimes helpful to estimate its age. Decisions on purchasing or culling commercial cattle are best when based on age. For example, if you were to purchase a group of "4- or 5-year-old" cows, it would be an expensive lesson to learn they were actually 10 or older. The appearance of the teeth gives an indication of how old cattle are.

Only the front "cutting" teeth (incisors) are important in calculating age. Of course, the cow has no upper incisors. The eight incisors on the lower jaw appear at different times and exhibit varying degrees of wear depending on age.

By the time a calf is about a month old, it has eight temporary incisors. These temporary teeth are shed and replaced by permanent teeth, in pairs. The first pair is the two central incisors in front. The second pair is the two teeth on either side of them, and so on for the third and fourth pairs.

At 19 to 20 months of age, the first permanent incisor tooth appears. By 24 months, the center incisors are fully erupted and in line. The following pattern of growth and wear appears after 2 years of age.

2 years—the central permanent incisors (pinchers) attain full development.

2½ years—the second set of incisors (one on each side of the pinchers) is cut. They are fully developed by age 3.

3½ years—the third set of incisors is cut. They are fully developed and begin to wear at age 4.

4½ years—the fourth set (corner teeth) is replaced. By age 5, they are fully developed.

Age determination past 4 ½ years is less accurate and is mainly related to wear on the surface of the eight incisor teeth. The center pair begins to show wear at 5, the second pair at 6, the third pair at 7, and the corners at 8 years. The teeth begin to take on a "pegged" appearance at age 7; that is, the gum begins to recede from the base of the teeth. By the 10th year, the corner teeth show noticeable wear. By the 12th year, the row of teeth appears to be in a nearly straight line, as opposed to the normal arch, and shows progressive wearing to stubs. The animal may then become "smooth-mouthed," when the teeth are worn to the gums, or "broken-mouthed," when some teeth are lost.

The central permanent incisors (pinchers) attain full development in a 2-year old heifer.

The second set of incisors (one on each side of the pinchers) are fully developed by age 3. Note the "baby" teeth on the outside of the four permanent teeth. This pair of teeth will be replaced at 3½ years and fully developed by age 4.

This cow is 7 years old. She has four pairs of permanent teeth. The center pair begins to wear at 5, the second pair at 6, and the third pair at 7. The corner teeth will begin to wear at age 8.

Section 7.

Feeding the Cow Herd

Roy Burris and John Johns

Feed is the biggest single cost of maintaining the beef herd. You must meet the nutrient needs of the beef cow if you want to obtain a high percent calf crop with heavy weaning weights in a short period of time. However, you must meet these nutrient needs in a cost-effective manner to achieve profitability in your operation.

Cattle belong to a group of animals known as ruminants; that is, they possess a four-compartment stomach, the major part of which is the rumen. The rumen is a large fermentation vat with a population of microorganisms (bacteria and protozoa) that allows digestion of large amounts of roughage. The cow uses the end products of this microbial fermentation. To work properly, the digestive system of the cow needs a balance of essential nutrients. Since ruminants have the unique ability to digest large amounts of roughage, base the feeding program for your cow herd on forages adapted to your area.

Essential Nutrients

Nutrients are essential for animal maintenance, growth, reproduction, milk production, and fattening. Nutrients fall into the following classes: energy, protein, minerals, vitamins, and water.

Energy is the major nutrient requirement for beef cattle. It is commonly expressed as TDN (total digestible nutrients), NE (net energy), or ME (metabolizable energy). Both carbohydrates and fats are in the energy group. Think of energy as the fuel a cow uses for grazing, producing milk, maintaining temperature, growing, reproducing, digesting, and voiding body wastes. Most of this fuel comes from forages and roughage products. With proper amounts of protein and minerals, the rumen can obtain energy from some feeds that are useless to nonruminants.

TDN is the measure of energy commonly used for grazing beef cattle. TDN values are readily available for most forages. Net energy is most widely used for drylot growing and finishing of cattle. NE is a more precise measurement because it is divided into maintenance and gain; also, it might be used more in the future.

Protein is made up of many amino acids, which are used in the body as "building blocks" for muscle and other body tissue. These amino acids contain nitrogen, along with other elements. Because cattle have rumen microorganisms, they can use either natural protein or nonprotein nitrogen (NPN) compounds (such as urea and biuret) in their diets to meet their protein requirements. The microorganisms break down much of the dietary protein and synthesize into microbial protein, which is digested by the cow.

Lightweight, growing cattle, such as young calves, cannot adequately use NPN and can benefit from natural protein sources (such as soybean meal). NPN is generally cheaper than natural protein supplements and is best used to reduce feed costs for older cattle on higher energy diets. Low quality roughages do not contain enough energy to permit rumen microorganisms to use NPN. Use supplements high in natural protein with low quality roughages, even for older cattle.

Protein is generally expressed as **crude protein** on feed tags and in feed analyses. Crude protein is calculated as nitrogen (N) x 6.25 to make it "equivalent" to true protein. However, not all nitrogen can be converted to true protein. Protein needs are more precisely expressed as **metabolizable protein**. The use of metabolizable protein recognizes that rations must meet the nitrogen needs of the rumen microbes for optimal fermentation as well as the protein needs of the animal. Metabolizable protein can be further divided into **degradable** (DIP—degradable intake protein) and **undegradable** (UIP—undegradable intake protein) in the rumen.

Minerals are an essential part of the beef cow's nutritional needs. The normal diet in Kentucky provides most of them. However, a good mineral supplement should be available to cows at all times.

Phosphorus is the mineral most likely to be deficient for cattle in Kentucky. The need for phosphorus increases during lactation (milk production) and growth. Generally, forages are low in phosphorus and grains are high in phosphorus. Phosphorus is stored in the bones and has several functions in the body. Phosphorus deficiencies can cause poor growth, reduced appetite, poor digestibility of feedstuff, and poor reproduction.

Lack of calcium is generally not a problem. Most forages, especially legumes, are high in calcium, and mineral supplements generally contain considerable amounts of calcium. Keep the calcium-phosphorus ratio in the total diet from becoming too wide. A ratio of about 2-to-1 is ideal; the ratio should not be wider than about 5-to-1. Low calcium is most often found in cattle fed high grain diets with little roughage.

Cattle might need supplemental magnesium under certain conditions. Grass tetany (low blood magnesium) can be a severe problem for lactating brood cows grazing cool-season pasture, such as fescue, during early spring. Prevent grass tetany by supplying adequate levels of magnesium (about 20 to 22 grams) in the mineral mix.

Salt (sodium and chlorine) is deficient in the forage diet and generally makes up a large part of the mineral supplement. Trace minerals (microminerals), such as selenium, copper, zinc, cobalt, iron, iodine, and manganese, also should be in the mineral mix.

Chelated minerals also are available in many commercial mixes. Chelation can alter the availability of minerals. If the bioavailability of a mineral is increased, lower dietary concentrations can be used. Compare the costs of chelated mineral sources to inorganic mineral sources; it might be more cost effective to simply increase the amount of inorganic minerals used. (Some chelates may affect performance in other ways. Research in this area is continuing.)

Many good commercial mineral supplements are available. The mineral supplement needed varies depending on the time of year, the cow's stage of production, other ingredients in the diet, and, perhaps, breed and the geographic area of the state (some regions might be marginal or deficient in certain microminerals). Table 7-1 illustrates the nutrient specifications of mineral supplements fed for the past few years to the UK-Princeton beef herd.

Table 7-1. Example of Mineral Supplements Fed to the UK-Princeton Beef Cow Herd

	Month of the year		
Level	**Sept-Jan[1]**	**Feb-April[2]**	**May-Aug[1]**
Salt, %	25-28	15	25-31
Mg, % (from MgO)	2	15	2
Ca, %	12	12	12
P, %	6	5	6
K, %	1	1	1
Cu (no CuO), ppm	800	800	800
Zn, ppm	2,000	2,000	2,000
Se, ppm	53	26	48
I, ppm	48	48	48
Co, ppm	10	10	10
Vit A, IU/lb	200,000	150,000	200,000
Vit E, U/lb	400	300	400
CTC, mg/lb	--	--	800[b]

[1] Distiller's dried grains (40 lb/ton), wet molasses (20 lb/ton), and mineral oil (20 lb/ton).

[2] Distiller's dried grains (100 lb/ton), wet molasses (20 lb/ton), and mineral oil (20 lb/ton).

Vitamins belong to two groups: fat-soluble (A, D, E, and K) and water-soluble (B vitamins and vitamin C). Bacteria in the rumen and intestines make the necessary water-soluble vitamins and vitamin K. Vitamin D is synthesized in the skin when animals are exposed to sunlight. Vitamin E is found in most feeds. This leaves vitamin A.

Vitamin A can be synthesized in the body from carotene, which is found in plants. Vitamin A deficiency is rare when good quality roughages are fed to beef cattle. Vitamin A deficiencies can occur when the ration consists of weathered or low quality hay and concentrates low in carotene content, such as old corn, small grains, or grain sorghums. Cattle that are fed or that graze highly nitrated forages can have a vitamin A deficiency due to poor use of carotene.

You can add supplemental vitamin A to the ration or mineral supplement as a dry, stabilized vitamin A premix, or give it as an injection. An injection of 1 million IUs prevents deficiency symptoms for two to four months in cattle. The most common method is to provide a mineral/vitamin supplement with approximately 150,000 to 200,000 IUs of vitamin A per pound.

Water is an essential nutrient for animal life; although, because of its abundance, it is often overlooked. Clean water is most important for young, growing calves. Stagnant, dirty water can retard performance and be a breeding ground for disease. Cattle generally drink about a half gallon of water per pound of dry matter intake, but this varies considerably with temperature. Water requirements increase as the temperature rises and as dry matter intake increases (Table 7-2).

Classification of Feeds

Feedstuffs are generally divided into two broad categories: roughages/forages and concentrates. Roughages/forages are usually high in fiber and somewhat low in energy. Concentrates, on the other hand, are low in fiber and high in energy. Both broad categories are sometimes further divided into energy and protein feeds. These feedstuffs may require mineral and vitamin supplementation or feed additives. Figure 7-1 shows various feeds classified according to their use.

Various feedstuffs are available for use in beef cattle diets. Brief descriptions of several ingredients you can use to supplement forage-based diets follows. Table 7-3 shows

Table 7-2. Total Daily Water Intake (gallons) as Affected by Temperature and Feed Intake[1]

Temperature:	**40°F**	**50°F**	**60°F**	**70°F**	**80°F**	**90°F**
Gallons of water/lb dry matter:	**0.37**	**0.40**	**0.46**	**0.54**	**0.62**	**0.88**
500-lb calf (12 lb d.m.)	4.4	4.8	5.5	6.5	7.4	10.6
750-lb preg. heifer (16.6 lb d.m.)	6.1	6.6	7.6	9.0	10.3	14.6
1,100-lb dry preg. cow (20 lb d.m.)	7.4	8.0	9.2	10.8	12.4	17.6
1,100-lb lactating cow (22 lb d.m.)	8.1	8.8	10.1	11.9	13.6	19.4

[1]Adapted from Winchester and Morris, 1956. Water intake rates of cattle. Journal of Animal Science 15:722.

Table 7-3. Nutrient Concentration and Bulk Density of Selected Feed Ingredients

		Concentration in dry matter									
	Dry matter	TDN	NEm	NEg	Starch-sugars	Fat	Crude protein	Bypass protein	Ca	P	Bulk density
Feed	%	%	mcal/lb	mcal/lb	%	%	%	%CP	%	%	lb/ft³
Grains											
Corn	88	87	0.96	0.64	75	4.2	10	65	0.02	0.30	48
Oats	89	76	0.81	0.52	47	4.6	13	21	0.09	0.40	25
Rye	89	81	0.88	0.58		1.7	12	20	0.07	0.39	45
Wheat	89	88	0.98	0.65	69	2.0	12		0.06	0.40	48
High energy feeds											
Hominy	90	92	1.03	0.70	52	5.3	11	44	0.04	0.45	28
Molasses, heavy	78	78	0.79	0.50	60	0.0	9	0	1.10	0.10	78
Rice bran	91	66	0.68	0.38	27	15.8	14	34	0.08	1.68	20
Soybean hulls, grd	91	77	0.82	0.53	14	2.5	14	30	0.63	0.22	20
Wheat middlings	89	82	0.89	0.59	35	4.6	18	24	0.14	1.04	20
Medium protein feeds											
Brewer's grains	92	84	0.92	0.61	14	7.4	30	56	0.30	0.60	15
Broiler litter	78	53	0.52	0.16		2.0	25		2.10	1.80	35
Cottonseed, whole	90	94	1.06	0.72	8	18.0	23	39	0.16	0.62	25
Corn gluten feed	90	82	0.89	0.59	30	3.3	24	25	0.20	0.85	30
Distiller's grains	92	87	0.96	0.64	12	9.0	27	47	0.30	0.75	15
High protein feeds											
Blood meal	91	66	0.66	0.37		1.3	92	82	0.29	0.23	38
Corn gluten meal	91	89	0.99	0.67	19	2.4	67	60	0.05	0.51	42
Cottonseed meal	91	76	0.81	0.52	12	2.0	47	41	0.21	1.18	42
Feather meal	92	69	0.71	0.43	7	5.0	88	72	0.40	0.60	15
Fish meal	90	72	0.75	0.47	2	8.0	66	63	6.40	3.60	40
Meat and bone meal	93	71	0.74	0.46		10.4	55	53	9.95	5.00	37
Soybean meal	91	87	0.96	0.64	10	1.2	55	30	0.28	0.70	42
Soybeans, whole	88	93	1.04	0.71	10	18.5	40	30	0.27	0.64	48

Source: Kunkle, W.E., R.L. Stewart, and W.F. Brown. 1995. Using byproduct feeds in supplementation programs. 44th Annual Fla. Beef Cattle Short Course Proc. p. 89.

nutrient concentration and feed density of several types of feeds.

Corn is the most widely fed grain. It is used as an energy source and is low in crude protein, fair in phosphorus, and low in calcium. Corn is fed in different forms—shelled corn, whole ear corn, and high moisture corn (20 percent to 34 percent moisture)—and may be processed to different degrees.

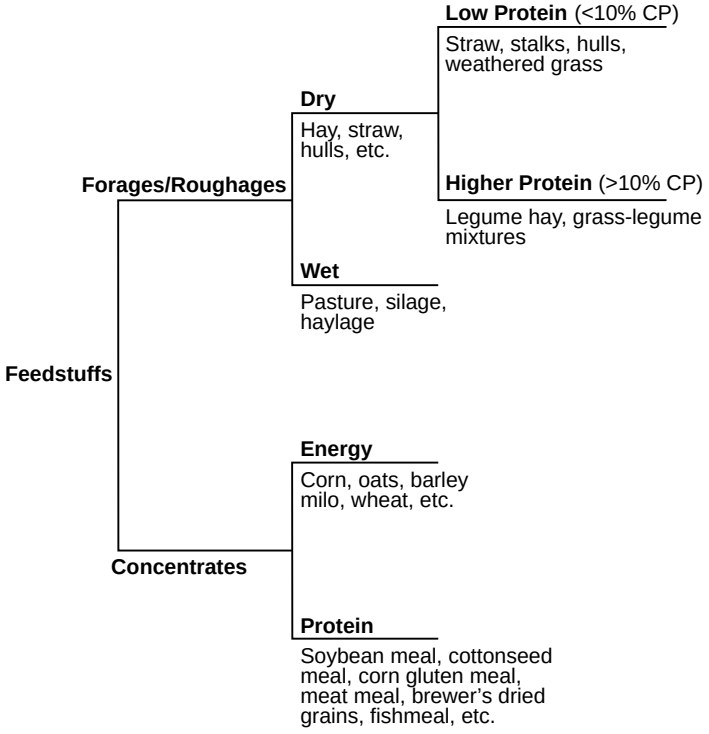
Wheat is about 105 percent the feeding value of corn when it makes up no more than 50 percent of the beef ration. It is a good feed but can pack in the stomach, especially when it is finely ground.

Sorghum grain (milo) is about 85 percent to 90 percent the value of corn for beef cattle. It is lower in energy than corn and more variable in its protein content. Sorghum grain must be processed for maximum digestibility. Milo is generally grown as a crop when it is too late to plant corn or in areas that are susceptible to drought.

Oats are about 85 percent the feeding value of corn because of their high fiber level. Oats are very palatable and excellent for starting young calves on feed. You can use oats as a creep feed for calves in a 50-50 mixture with corn.

Rye is the least palatable of all the grains and should not make up more than one-third of the ration. It tends to

Figure 7-1. Classification of feed for beef cattle.



cause digestive disturbances if ground too finely. Rye also can be contaminated with ergot.

Corn-and-cob meal consists of whole ears of corn (cob and grain), ground to varying degrees of fineness. The mixture is usually about one-fourth cobs and three-fourths corn grain. It is a good feed for growing calves because of its increased fiber content.

Many commercial protein supplements are available, and most contain some of the following ingredients (which also may be fed as the sole protein supplement).

Soybean meal (SBM) is the most popular of all the natural protein supplements for cattle. It is the most widely used of all the oilseed meals and is the standard to which other protein supplements are compared. The amino acid composition of soybean meal makes it an excellent supplement with corn, which is deficient in lysine. This amino acid composition is beneficial to young, growing calves.

Cottonseed meal is not as readily available in Kentucky as SBM and is lower in its protein content. It is a satisfactory protein supplement for beef cattle.

Urea and biuret are not proteins but are nitrogen supplements that can be converted to protein by rumen microorganisms. The diet should contain a source of readily fermentable energy (carbon skeletons) to be combined with ammonia (nitrogen) by the rumen microbes to form protein. Generally, NPN should not make up more than 1 percent of the total diet or 3 percent of the concentrate mix.

Liquid urea-containing supplements are popular with some producers because they can be self-fed from "lick tanks." This makes supplements from "lick tanks" convenient for producers, but they are generally expensive in terms of nutrients provided and performance obtained. Some liquid supplements contain molasses as a palatable carrier for the urea. While molasses would seem to provide a source of readily fermentable energy for bacteria to use for protein synthesis, it might reduce forage intake and/or digestion, which would offset its energy value. Some liquid supplements now contain byproduct ingredients that contain natural protein, such as corn steep liquor, brewer's solubles, or fish solubles.

Dried distiller's grains with solubles are a byproduct of the production of ethyl alcohol. Solubles left over from the fermentation are added to the grains before they are dried. Corn, the predominant grain, is used with varying amounts of other grain. Dried distiller's grains with solubles, if dried properly, are a good source of bypass (undegraded in the rumen) protein.

Wet distiller's grains are a byproduct of alcohol for "gasohol" production and contain about 65 percent to 75 percent moisture. The moisture content limits their use to areas near the place of production.

Corn gluten feed is a byproduct obtained when high fructose corn syrup is made. It contains about 25 percent crude protein. **Corn gluten meal** is higher in protein—about 65 percent.

You can feed **whole soybeans** to beef cattle as a protein supplement. Do not feed them at high levels, however, because of their fat content. Limit them in the diet to replacing the usual protein supplement of calves (usually 2 to 3 pounds), and don't feed in diets with urea.

Soyhulls, the seed coats of soybeans, are removed during oil extraction. The hulls are high in fiber, which is highly digestible by ruminants. They also have a lower starch level, resulting in a lower rate of fermentation and reducing the chance of acidosis. They are very palatable, making them a good feed for newly weaned calves and for supplementing bulls because of the reduced chance of founder.

Broiler litter is readily available in areas where broilers are produced. Broiler litter contains poultry excreta, bedding, and feed waste. Much of the crude protein in broiler litter is in the form of nonprotein nitrogen, which is utilized better when combined with moderate to high energy feeds. Deep-stack litter, and allow it to go through a heat to destroy pathogens and weed seeds and to eliminate some ammonia, which improves palatability. Broiler litter is usually mixed with grain in a 50-50 mix and fed to stocker cattle as a supplement to forages. It can be fed to beef cows at levels up to 80 percent litter. Broiler litter has a high concentration of minerals, notably calcium and potassium. Feeding high levels to pregnant cows near calving can cause milk fever.

Nutritional Requirements

When you build a nutrition program for your cow herd, keep three issues in mind: fulfilling the nutrient requirements of the cow, responding to "stress points" that can cause nutrient deficiencies, and making maximum use of forage supplies while filling gaps with supplemental feed.

Nutrient requirements of the cow vary according to the cow's size, whether the cow is lactating or dry, the level of milk production, and the stage of production. Figure 7-2 divides the beef cow's productive year into periods of differing nutritional requirements according to her stage of production.

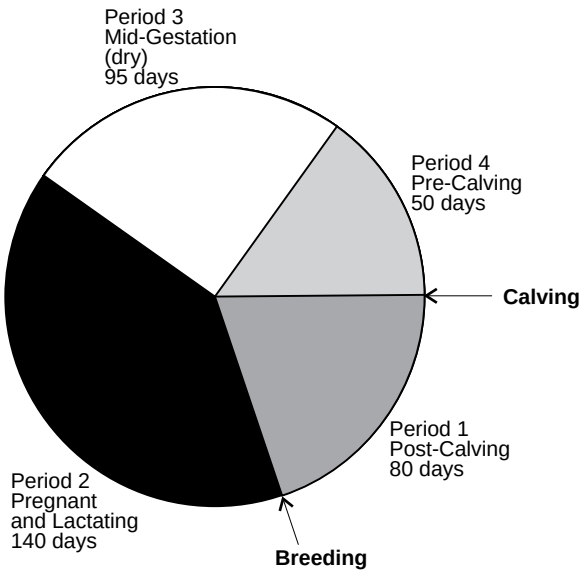
Table 7-4 shows the nutritional requirements of an 1,100-pound beef cow for each of the production periods. Period 1 (the time between calving and rebreeding) is the time of greatest nutrient need. Nutritional "stress" is likely to occur around this time. Probably the greatest stress point occurs when first calf heifers are being prepared to rebreed

Table 7-4. Daily Nutrient Requirement for 1,100-lb Beef Cow with Average Milk Production (15 lb/day)[1]

	Period			
Nutrient	**1**	**2**	**3**	**4**
TDN, lb	13.3	11.5	9.5	11.2
NE, Mcal/day	13.5	12.2	9.2	10.3
Protein, lb	2.3	1.9	1.4	1.6
Calcium, g	33	27	17	25
Phosphorus, g	25	22	17	20
Vitamin A, IU	39,000	36,000	25,000	27,000

[1] *Adapted from Nutrient Requirements of Beef Cattle. Revised edition, 1984. Washington, DC: National Academy Press.*

Figure 7-2. Beef cow year by productive periods (calf weaned at 220 days of age).



after their first calf. The critical period for the cow herd is from 50 days before to 80 days after calving. Another problem period is when you are trying to get yearling heifers to gain adequate amounts so they can breed soon enough to calve at 24 months of age.

Table 7-5 gives examples of rations for various classes of cattle. You can use these rations as a guide to planning the feeding program for your beef herd or when a forage analysis is not available.

Winter Feeding the Cow Herd

The cost of winter feeding the cow herd makes up 40 percent to 50 percent of the total variable costs of producing a weaned calf. Because winter nutrition is vital to calf health and cow reproduction, you must supply adequate nutrition while avoiding feed waste.

As shown earlier, cattle in different developmental stages have different nutrient needs. You can meet these needs by separating the herd into groups with similar nutrient needs. You also make the most efficient use of feed resources this way.

The following brief discussions of the production groups will help you understand their needs. Not all groups are present in all herds, and your facilities may limit the amount of grouping you can do. If you can only do limited grouping, separate the animals having the greatest differences in nutrient needs and feed accordingly.

The **mature, dry, pregnant cow** in medium flesh has the lowest nutrient needs: she can use lower quality feed than other groups in the herd. Treat this as an opportunity to cut feed costs by using such feeds as crop residue, mature standing grass, or mature hay. Recognize that body condition score or the amount of flesh the cow is carrying must be adequate if you use lower quality feeds. However, lower quality feeds are not suitable even for the mature, dry, pregnant cow if she is thin initially.

Nutrient needs begin to increase in the last third of pregnancy and increase dramatically after calving when the cow is nursing a calf. Thus, you should move cows dropping calves to a separate pasture and increase the quantity and/or quality of feed. This ensures the best feed to those cattle needing it most and prevents overfeeding cows calving later in the season.

Feed **first and second calf heifers** differently than the mature lactating cow. Unlike the mature cow, their nutrient

Table 7-5. Sample Rations for Various Classes of Beef Cattle

Weaned Heifer Calves (500 lb—1½ lb ADG)
1. High quality pasture + 5 lb corn
2. 5-10 lb grass-legume hay + 5 lb corn
3. 5-10 lb grass hay + 5 lb corn + ¼ lb protein supplement
4. 35 lb corn silage + 1 lb protein supplement
5. 30 lb corn silage + 5 lb alfalfa hay

Bred Yearling Heifers (850 lb—1 to 1½ lb ADG)
1. High quality pasture
2. 20 lb good grass hay
3. 45 lb corn silage + 1 lb protein supplement
4. 25 lb corn silage + 10 lb hay + ½ lb protein supplement

Dry, Pregnant Cows
1. Low to medium quality pasture
2. 20 lb grass hay
3. 20 lb stalks or straw + 8 lb good hay
4. 20 lb stalks or straw + 2½ lb corn + 1 lb protein supplement

Dry, Pregnant Cows (last 2 months before calving)
1. Medium to high quality pasture
2. 22 lb of good hay
3. 25-30 lb corn silage + 10 lb legume hay
4. 25-30 lb corn silage + 10 lb grass hay + ½ lb protein supplement

Lactating Cows (average milk)
1. High quality pasture
2. 25 lb hay
3. 65 lb corn silage + 1 lb protein supplement
4. 55 lb corn silage + 5 lb alfalfa hay

Lactating Cows (heavy milk)
1. High quality pasture + grain if needed for condition
2. 30 lb grass-legume hay + grain if needed for condition
3. 60 lb corn silage + 2½ lb protein supplement
4. 50 lb corn silage + 10 lb alfalfa hay

Young Herd Bulls (yearlings or 2 yr old)
1. High quality pasture + 12 lb corn
2. 20 lb grass-legume hay + 12 lb corn
3. 80 lb corn silage + 2 lb protein supplement

Mature Herd Bulls
1. High quality pasture + grain, if needed for condition
2. 30 lb hay + grain, if needed for condition
3. 70 lb corn silage + 1½ lb protein supplement

Notes: Actual amounts vary depending on quality of forage used. A forage analysis should be obtained so that rations can be balanced more accurately.
Mineral and vitamin supplementation should be included.

needs are increased by the need to continue growing. *Provide young cows nursing calves the highest quality feed.*

Replacement heifers, both bred and open, comprise another group in the herd. Heifers going into their first winter are at the lowest level of social order in the herd and would certainly be "bossed" by older cows. In addition, their nutrient requirements for growth demand a much higher quality feed than that needed by the mature cow.

The bred heifer entering her second winter must be fed sufficiently to grow and develop the fetus. A higher quality feed than so-called "dry cow hay" is necessary. Do not to get her too fat or calving difficulties can occur. If forage quality is high and enough feeding space is available so that competition does not occur, you do not have to feed bred heifers separately from mature, dry, pregnant cows.

Stored forage, such as large round bales, is relied upon for wintering beef herds in Kentucky.

The **bull** is often the forgotten animal in winter feeding, but he should not be. If the bull is mature and in adequate condition, nutrient needs are not high. Feed so that the bull maintains body condition. Fattening the mature bull is a waste of feed and money.

Young bulls are still growing and must be fed accordingly. A high quality forage, and possibly some concentrate, is necessary for these animals. If possible, maintain younger bulls in separate lots from mature bulls for feeding and safety reasons.

Evaluating Nutritional Status with Body Condition Scores

Adequate nutrition from about 50 days before to 80 days after calving is critical to the cow's ability to rebreed and maintain a 365-day calving interval. If the cow gets inadequate nutrition or is in poor body condition at calving and breeding, she will take longer to come into heat and may require more services per conception.

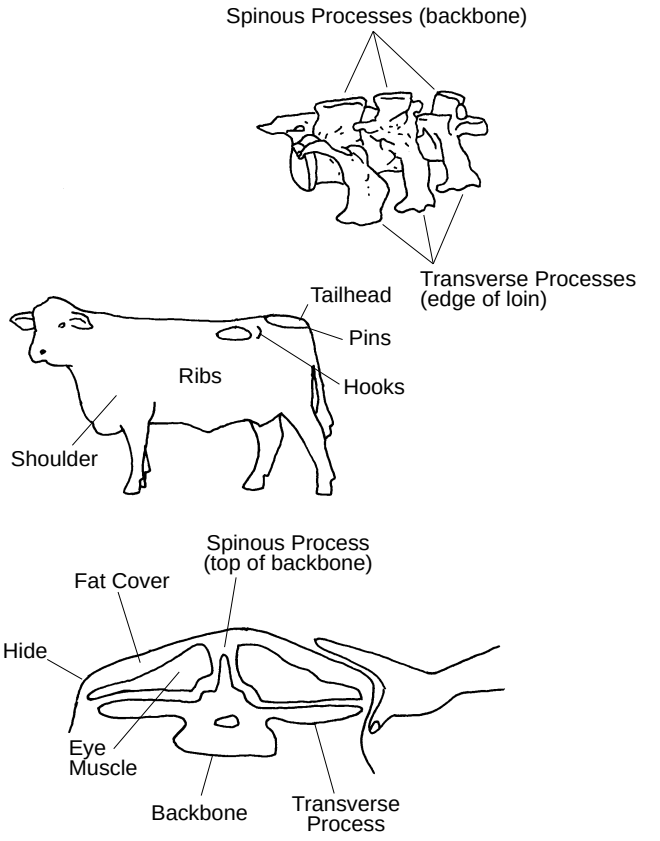
It is not economical to maintain cows that are too thin to rebreed properly or those that are too fat. Cows need appropriate fat reserves for the increase in production during calving and rebreeding to help ensure satisfactory breeding performance.

Body Condition Scoring (BCS) allows you to judge the adequacy of your feeding program based on the condition of your cows. This evaluation can help you plan supplemental feeding programs to maintain adequate productivity.

Body Condition Scores are numbers used to evaluate body energy reserves of the cow. Most reports suggest a scale from 1 to 9, with 1 being extremely thin and 9 being extremely fat. You should at least be able to recognize the differences in thin (3), marginal (4), and optimum (5, 6, 7) condition in order to plan the feeding program. Table 7-6 provides a description of condition scores.

How do you determine body condition? Figure 7-3 shows the areas of the body that are best for scoring body condition.

Figure 7-3. Anatomical areas which are useful in scoring body condition.



Research and field observations indicate the importance of adequate body condition for cows from calving through rebreeding. Table 7-7, which shows the results of five Texas trials involving more than 1,700 cows, illustrates the effect of body condition at calving on subsequent reproductive performance. In all instances, cows scoring less than 5 at calving time had the lowest pregnancy rates, indicating that their condition at calving time is undesirable. Scores of less than 5 at calving impede reproduction. The body condition score should be at least 5 or possibly 6. Anything higher than 6 may not be helpful.

The best way to use condition scoring is to sort cows according to condition at 90 to 100 days before calving. Grouping cows according to body condition and nutrient needs can optimize reproductive performance. The goal should be to have a BCS of 5 or 6 for the herd. Table 7-8 gives guidelines for maintaining the 5 or 6 optimum condition in a 1,000-pound cow.

Winter Weather

You also must consider the special problems of cold winter weather. Cold increases the rate at which feed passes through the digestive tract. Less time in the digestive tract means less digestion of nutrients. In other words, a high fiber, lower digestible feed provides even fewer nutrients in cold winter weather.

Cold weather also increases the cattle's nutrient requirements, especially for energy. As wind chill drops below the low critical temperature for the animal, the amount of energy required for maintenance increases. Thus, prolonged cold periods decrease the digestion of nutrients from feed and increase the animal's energy requirements. Producers can cope with long periods of cold by increasing the quality of the forage being fed or by substituting concentrates for a portion of the forage.

Certain nutrients, such as water, require specific attention in winter. If water intake is limited by freezing or cold

Table 7-6. Description of Body Condition Scores (BCS)

Thin condition

1. **Emaciated**—Emaciated with no detectable fat over backbone, hips, or ribs. All ribs and bone structures easily visible.
2. Still emaciated but tailhead and ribs are less prominent. Backbone still sharp but some tissue on it.
3. Ribs still identifiable but not as sharp to the touch. Backbone still highly visible.

Borderline condition

4. **Borderline**—Individual ribs no longer obvious. Foreribs not noticeable. However, 12th and 13th ribs may still be noticeable particularly in cattle with big spring of rib. The backbone is still prominent but feels rounded rather than sharp.

Optimum condition

5. **Moderate**—Good overall appearance. The 12th and 13th ribs are not visible unless the animal has been shrunk. Fat cover over the ribs feels spongy. Area on each side of the tailhead filled but not mounded. The transverse processes (see Figure 7-3) are not noticeable to the eye. Spaces between the processes can only be felt with firm pressure.
6. **High moderate**—A high amount of fat present over the ribs and around the tailhead. Noticeable sponginess over the foreribs and on each side of the tailhead. Firm pressure now required to feel the spinous processes.
7. **Good**—Cow appears fleshy and carries some fat. Spongy fat cover over the ribs and around the tailhead. Some "patchiness" evident around the tailhead.

Fat condition

8. **Fat**—Fleshy and overconditioned. Bone structure disappearing from sight. Animal taking on a smooth, blocky appearance. Large fat deposits over ribs, around tailhead, below vulva. Patchy fat.
9. **Extremely fat**—Wasty, patchy, and blocky. Tailhead and hips buried in fat. Bone structure no longer visible. Animal's movement may be impaired.

Table 7-7. Effect of Body Condition Score at Calving on Reproductive Performance

	Body condition at calving		
	4 or less	5	6 or more
Trial 1			
Percent in heat within 80 days after calving	62	88	98
Trial 2			
Percent pregnant after 60 days	69	80	- - -
Trial 3			
Percent pregnant after 60 days	24	60	87
Trial 4			
Percent pregnant after 180 days	12	50	90
Trial 5			
Percent pregnant after 60 days	70	90	92

Adapted from Herd and Sprott, 1986. Body Condition, Nutrition, and Reproduction of Beef Cows. Texas Agricultural Extension Service. B-1526.

Table 7-8. Body Condition Score 90 to 100 Days Prior to Calving

Score	Desired score at calving	Recommendation
3	5	Needs to gain 200 to 300 lb
4	5	Needs to gain 150 to 200 lb
5	5-6	Needs to gain weight of fetus (100 lb)
6	5-6	Needs to gain weight of fetus (100 lb)
7	5-7	No weight gain needed
8	5-7	Can probably lose 50 to 150 lb

Adapted from Beverly, 1985. Reproduction in beef cattle as related to nutrition and body condition. Proceedings, Kentucky Beef Cattle Roundup, pages 1-12. Lexington: University of Kentucky.

weather, feed intake, especially of hay, decreases. Producers must keep water sources open in the winter and, if possible, above 40°F for maximum feed intake.

We earlier described vitamin A as critical. This is especially true in winter. Cows consuming high fiber, low quality hay and coming out of a hard winter will have used most of the vitamin A in their bodies. Supplement the vitamin in the winter by either feeding or injecting.

The greatest out-of-pocket expense for winter feeding is generally protein supplementation. Test your forage for protein content before you add a protein supplement. If a supplement is needed, don't purchase on price alone. Instead, purchase a supplement that is useful; that is, one high in natural protein. High NPN supplements have limited usefulness for cows being wintered on low quality hays.

Before winter, give yourself time to make decisions by estimating whether an adequate quantity of feed is available to meet animal needs. Table 7-5 shows sample rations for various classes of beef cattle. Multiply the appropriate ration by 120 (approximate number of days in winter) and the number of cattle you have to estimate the amount of winter feed you will need.

If forage supply is inadequate for the entire feeding period, you can substitute concentrates for forages. One pound of corn contains the same amount of energy (TDN) as 1.5 pounds of good hay or 2 pounds of medium quality hay. When hay is in short supply, grains might be a cheaper source of nutrients. Use ground corn as a carrier for magnesium or vitamin A when needed.

Feed costs represent the greatest single expense in calf production. Managing to keep feed costs low and production levels high will improve your profitability.

Creep Feeding Beef Calves

Creep feeding is the practice of supplying supplemental feed to the nursing calf without the cow being able to get to the feed. After a calf is 90 to 120 days of age, cow's milk only supplies about 50 percent of the nutrients it needs for maximum growth. The other nutrients have to come from somewhere else if the calf is to realize its genetic potential for growth. High quality pasture is the best source of nutrients; if this is unavailable or inadequate, you can use creep feeding.

Creep feeding the nursing calf increases its rate of gain and weaning weight. Expect increases in gain of .10 to .25 pounds/day. You must determine if the increased rate of gain will be profitable. To do this, consider the conversion rate, or the pounds of creep feed needed to produce a pound of gain. Conversion rates may range from 3-to-1 to 18-to-1. For high energy creep feeds, use a 10-to-1 conversion rate as a rule of thumb. Table7-9 gives the cost of additional gain at various conversion rates and feed costs.

You have to base your decision on your own operation, but you will generally find that creep feeding is profitable under the following circumstances: long periods of dry weather or drought, poor milking cows, large numbers of first calf heifers or very old cows in the herd, late calvers (such as midsummer), fall-born calves, only low quality pasture available, and periods of low feed costs and high calf prices.

Table 7-9. Cost ($/cwt) of Extra Gain from Creep Feeding

Feed/pound extra gain	Feed cost ($/cwt)				
	5	6	7	8	9
6	30	36	42	48	54
8	40	48	56	64	72
10	50	60	70	80	90
12	60	72	84	96	108

Creep feeding may not be beneficial under these situations: good milking cows; abundant, high-quality pasture; high feed costs and low calf prices; weaned calves kept to yearling weights; and heifers kept as replacement females. Creep feeding can be detrimental to replacement females. Fat can be deposited in the mammary gland, permanently reducing the heifer's ability to produce milk. Creep feeding also can "mask" the presence of poor milking dams and may make performance records difficult to analyze.

Creep rations do not have to be complex, but they should be economical and palatable. No matter how good a ration might be, if calves don't eat it, they won't gain more. You can use wet molasses or distiller's dried grains to enhance consumption. For example, a creep ration that is 12 percent crude protein could be 67.5 percent shelled corn, 22.5 percent oats, 5 percent soybean meal, and 5 percent distiller's dried grains. If consumption is not adequate, substitute wet molasses for 3 percent to 5 percent of the corn. If possible, process the grains by coarse grinding or cracking. When only grain is being used as the creep ration, it is useful to roll the grain. You may substitute other grains or grain products for the corn and oats. High quality commercial creep feeds are available, and you might find that purchasing these is your best choice.

Starting calves on creep rations is sometimes difficult. One of the best starting methods is to feed their mothers small amounts of ground feed for a few days prior to beginning creep feeding. The calf learns to eat with its mother and can soon be switched to the creep.

Limit-fed, high protein creep rations have drawn attention recently. These types of creep rations may be useful with large framed, rapidly growing calves that have greater than normal protein needs. The benefit can be increased gain without excessive fattening due to excessive energy intake. Monitor daily creep intake to be sure it does not exceed 1.5 pounds. Conversion rates should be no greater than 5 pounds of high protein creep to 1 pound of calf gain for this to be profitable.

Creep grazing is basically the same as creep feeding. The calf has access to higher quality forage, while the cow does not. Control access with creep gates constructed so that calves can pass through but cows cannot (from 15 to 18 inches wide and 36 to 40 inches high), or raise an electric fence that permits calves to walk under it but restricts cows.

Feed Additives for Beef Cows

Feed additives are either nutritive or non-nutritive compounds that improve performance and/or feed efficiency or act as a disease preventative when consumed in feed. If you properly use feed additives, you can greatly improve the profitability of your beef cattle operation.

You have the responsibility to use feed additives properly. This means:

- using the feed additive for its intended purpose
- following the feeding guidelines and any warning statement on the label
- storing feed properly
- observing any withdrawal time when necessary

Most feed additives fall into one of six broad categories: rumen fermentation modifiers, antibiotics, hormone or hormone-like products, anthelmintics, buffers, and coccidiostats. Other products that are approved for use in feed but do not fit the broad categories will be discussed as general additives. Additives in each category that apply to the beef cow are discussed below.

Rumen fermentation modifiers (which include the ionophores) alter microbial fermentation in the rumen, thereby allowing cattle to obtain more energy from the feed consumed. Products currently available are Rumensin® (monensin), Bovatec® (lasalocid), GAINPRO™ (bambermycin), and Cattlyst® (laidlomycin). These products are most commonly used for increased weight gain and improved feed efficiency for cattle fed in confinement or increased rate of weight gain for pasture cattle. Rumensin is also approved for increased feed efficiency in mature reproducing beef cows. All products have various label claims and are available in different forms of feed. Instructions for use of rumen fermentation modifiers are found on feed tags of commercial feeds that contain them.

Antibiotics are generally added to the feed of growing and finishing cattle, but most may also be used with the beef cow when necessary. They are normally used at continuous low levels for an improvement in rate of gain and feed efficiency. Antibiotics may be used at higher levels for prevention and treatment of diseases such as the bovine respiratory complex, anaplasmosis, and pinkeye.

Use care when feeding antibiotics. Recommended levels give the desired results; too much can interfere with rumen function and actually decrease performance.

Many **anthelmintics**, or dewormers, are available in feed forms. Dewormers are generally administered directly to the animal, but, when handling is a problem, feeding can be an acceptable method. Products may be mixed into meal feed, or they are commercially available as cubes or pellets. Some products are also available in block form and as loose minerals. Check with a local feed or animal health dealer to find products available in your area.

Other products are approved as feed additives for specific purposes. These include products to prevent bloat when cattle are grazing lush legume pastures and fly control products that act as growth regulators or as a larvacide (also available in feed forms).

Remember, feed additives are controlled by the Food and Drug Administration, and you have the responsibility to use these products properly. For more information and a listing of common products, refer to Kentucky Cooperative Extension Service publication ASC-123, "Feed Additives for Beef Cattle."

Feeding Management During Drought

The effect that drought and the ensuing pasture shortage have on the beef herd largely depends on when the drought occurs. For example, if drought conditions occur in late spring and early summer (June and July), production is decreased in both the current year and the subsequent one. Producers must deal with decreased weaning weights and understand that the rebreeding of the spring-calving cow herd is in jeopardy. Managing the cows for adequate rebreeding is a primary concern. If the same conditions were to occur in late summer, the cows should already be pregnant and the calves closer to weaning age.

These are options to consider when deciding what to do in a drought situation: early-weaning calves, feeding the cow herd, creep feeding calves, "stretching" the forage supply, marketing a portion of the herd, or implementing various combinations of these options.

Early weaning has been successfully used on calves as young as 35 days of age to encourage cows to cycle and rebreed earlier during periods of drought or when body condition is poor. It is a fairly common practice for first calf heifers, which are more likely to have poor rebreeding performance. Weaning calves at 3 to 5 months of age is also a viable alternative when forages are scarce and milk production is low, but this is too late to assist early cycling. Consider early weaning when cows milk poorly, calf growth is below normal, and cows are likely to experience poor reproductive performance.

Before you wean calves early, make plans to handle the calves based on their age and the available feed supply. In some situations, you might need to sell early-weaned calves. However, this is not usually a good option since calves are lightweight and the market is depressed during a widespread drought. The long-term considerations might be more important than the present economic situation (that is, high feed prices). Early weaning eliminates the nutrient needs for milk production, thus freeing up more energy for maintenance and reproduction. Removing the suckling calf also causes hormonal changes in the cow that stimulate estrus (heat).

The first two weeks are the most critical time in the early weaning period. Calves must overcome the stress of weaning and learn to eat/drink **quickly**. The first ration should be very palatable and high in protein and energy, since intake at first is small. Place calves in a small pen with shelter available. The feed bunk and water source should be accessible and easily recognizable to small calves.

Place feed bunks perpendicular to fences, and allow water troughs to overflow to attract calves. Vaccinate all calves for blackleg and malignant edema.

Several commercial starter/conditioning feeds are available, or you can have feed mixed locally. The diet should be high in natural protein (13 percent to 15 percent) and energy (70 percent to 75 percent TDN), with adequate minerals and vitamins. It should also contain an antibiotic or coccidiostat.

Some problems to look for during drylot rearing of calves are respiratory problems, especially seven to 14 days after weaning; sorting of the feed, which can lead to founder; coccidiosis; and scouring. If calves become fleshy or scour, increase the roughage content of the ration or cut back on the amount fed. Remember that early-weaned calves are started on a diet high in energy and protein and should be gradually changed to a grower-type ration as their intake increases.

Early weaning permits high conception rates and rapid rebreeding. Although it is not recommended as a standard practice, it can be useful in times of drought when purchased feed may be more efficiently fed directly to the calf than to the lactating cow.

Kentucky research shows that weights at normal weaning time were 508 pounds for early-weaned and fed calves compared to 463 pounds for calves reared on dams that were fed. If supplemental feed for the cow herd had not been available during drought, early weaning or selling the calves would have been the only choices.

Feeding the cows is an option if early weaning is too drastic, requires too much management, or isn't needed because an economical source of feed is available. The amount of feed needed varies with cow size, stage of production, and amount of feed being supplied from pastures. As an example, the nutrient needs of an 1,100-pound cow during the first three to four months of lactation could be met with 20 to 25 pounds of good quality hay (minimum 55 percent TDN; 10 percent protein) with mineral/vitamin supplementation. Heavy-milking cows require another 3 to 5 pounds of grain. If cows are getting some portion of this from pasture, feeding can be reduced.

If the cow herd is still in the breeding season, it is desirable to supplement with good hay instead of "saving it for winter." Protein supplementation can help increase digestion and intake of roughage, but energy is the greatest need. Therefore, some grain or better quality hay might be needed for high-producing cows. Vitamin A should be supplied in the mineral/vitamin supplement since it is likely to be lacking in "dried" forage (pasture or hay).

When pastures are short and the corn crop has little grain due to drought, producers frequently decide to green chop the damaged corn and feed it directly. *This can be extremely dangerous*. Drought-stricken corn fed as green chop, whether grazed or baled, carries a high risk of nitrate toxicity. Nitrate level in forage can be checked, but it changes constantly. The safest use of drought-stricken corn is to ensile it and wait six to eight weeks before feeding it. Although this does not help your immediate feed shortage, it will cause the corn stalk to lose 40 percent to 60 percent of its nitrate content and provide a safe feed for later use.

Sorghum and sorghum-cross plants used for temporary summer pasture are also potentially dangerous during drought due to their prussic acid contents. These plants should not be grazed during or shortly after drought periods when they are stunted or wilted.

Creep feeding (see earlier discussion in this section) may have extra merit during drought. When pastures are adequate and of good quality and cows are supplying plenty of milk to the calf, benefits may not be great relative to the added cost. However, when pastures are poor during a drought, the increase in gain should be greater.

Balancing Rations

Feed costs are the major component of the total cost of producing a feeder calf. Feeding cattle a balanced ration prevents wasting feed dollars and allows the most efficient level of production.

Before you begin ration balancing, you'll need some basic information, including definitions of terms:

Ration is the amount of feed an animal receives in a 24-hour period.

Balanced ration is a ration that supplies the proper amounts and proportions of nutrients needed for an animal's growth, maintenance, lactation, or gestation. Table 7-11 shows the amounts of nutrients required for beef cattle.

Nutrient composition refers to the amounts of specific nutrients contained in the feed. It is expressed as a percentage of the dry matter and may also be looked up in a feed composition table (see Table 7-12). These tables contain only average values; your feed will be represented only if it is average. For accurate information, you'll need a nutrient analysis on stored forages; this can easily be done for a reasonable cost.

Dry matter is the portion of feed left after all water has been removed. It contains the nutrients. Levels of dry matter intake for animals are shown in the requirement tables. These amounts are not all an animal will consume, but they represent an amount that can be consumed under normal circumstances. Different feeds contain different levels of dry matter; therefore, it is desirable to balance the ration on a dry matter basis and then convert the various feeds back to an as-fed basis.

Table 7-10. Nutrient Composition of Various Feedstuffs, Dry Matter Basis*

Feed	% Dry matter	% TDN	% Protein	% Ca	% P
Fescue hay	92	48	9.5	.3	.26
Shelled corn	88	90	10.1	.02	.35
Soybean meal	89	84	49.9	.33	.71

Table 7-11. Nutrient Requirements of Beef Cattle

Body wt.,lb	Daily gain, lb	Dry matter intake, lb	Crude protein lb/day	Crude protein % of D.M.	TDN lb/day	TDN % of D.M.	Ca,%	P,%
Steer calves (medium-frame)								
400	1.5	10.8	1.24	11.5	6.8	63.0	.47	.25
400	2.0	11.0	1.41	12.7	7.5	67.5	.56	.26
400	2.5	11.0	1.56	14.2	8.1	73.5	.68	.30
500	1.5	12.8	1.33	10.5	8.1	63.0	.40	.22
500	2.0	13.1	1.49	11.4	8.9	67.5	.47	.24
500	2.5	13.0	1.63	12.5	9.6	73.5	.56	.27
600	1.5	14.7	1.42	9.8	9.3	63.0	.35	.21
600	2.0	15.0	1.57	10.5	10.2	67.5	.40	.22
600	2.5	14.0	1.69	11.4	11.0	73.5	.46	.24
Heifer calves								
400	1.5	10.2	1.17	11.4	7.0	68.5	.45	.24
500	1.5	12.1	1.25	10.3	8.3	68.5	.38	.22
600	1.5	13.8	1.32	9.5	9.4	68.5	.32	.21
Pregnant yearling heifers—last third of pregnancy								
750	1.4	16.6	1.5	8.9	10.0	59.9	.32	.21
850	0.9	17.6	1.4	8.2	9.6	54.5	.26	.20
950	0.9	19.0	1.5	8.0	10.3	54.1	.27	.20
Dry pregnant mature cows—middle third of pregnancy								
1,000	- - -	18.1	1.3	7.0	8.8	48.8	.18	.18
1,100	- - -	19.5	1.4	7.0	9.5	48.8	.19	.19
1,200	- - -	20.8	1.4	6.9	10.1	48.8	.19	.19
Dry pregnant mature cows—last third of pregnancy								
1,000	0.9	19.6	1.6	7.9	10.5	53.6	.26	.21
1,100	0.9	21.0	1.6	7.8	11.2	53.2	.26	.21
1,200	0.9	22.3	1.7	7.8	11.8	52.9	.26	.21
Two-year-old heifers nursing calves—first 3-4 months postpartum—10 lb milk/day								
800	0.5	17.6	1.9	10.8	11.2	63.8	.34	.24
900	0.5	19.2	2.0	10.4	12.0	62.7	.32	.23
1,000	0.5	20.8	2.1	10.0	12.9	61.9	.31	.23
Cows nursing calves—first 3-4 months postpartum—average milking (10 lb/day)								
1,000	- - -	20.2	2.0	9.6	11.5	56.6	.28	.22
1,100	- - -	21.6	2.0	9.4	12.1	56.0	.27	.22
1,200	- - -	23.0	2.1	9.3	12.8	55.5	.27	.22
Cows nursing calves—first 3-4 months postpartum—superior milking (20 lb/day)								
1,000	- - -	20.6	2.5	12.3	13.8	67.0	.39	.27
1,100	- - -	22.3	2.6	11.9	14.5	65.2	.83	.27
1,200	- - -	23.8	2.7	11.5	15.2	63.7	.36	.26
Bulls—maintenance and slow rate of growth (regain condition)								
1,400	2.0	27.7	2.2	8.0	17.8	64.0	.25	.20
1,600	1.0	29.7	2.2	7.3	16.6	55.8	.22	.19
1,800	0.5	30.9	2.2	7.0	16.1	52.0	.20	.20

Note: Vitamin A for:
(1) pregnant heifers and cows—1,270 IU per lb dry feed
(2) lactating cows and breeding bulls—1,770 IU per lb dry feed
Source: Reprinted with permission from "Nutrition Requirements of Beef Cattle," 6th revised edition, c. 1984 by the National Academy of Sciences. Published by National Academy Press, Washington, D.C.

A systematic approach helps in ration balancing. First, determine the nutrient requirements of the animal. This means you have to know the animal's type, size, and production level. Then look up the requirements in Table 7-11. Next, determine the feeds available for use. List their composition on a dry matter basis from a composition table (such as Table 7-12) or a chemical analysis. Now you are ready to determine the amounts of the feeds necessary to balance the ration.

Table 7-12. Composition of Commonly-used Feeds (dry matter basis)

Feedstuff	% Dry matter	% TDN	% CP	% Ca	% P
Alfalfa hay, midbloom	90	58	17.0	1.41	.24
Alfalfa hay, late bloom	90	52	14.0	1.43	.25
Barley grain	88	84	13.5	.05	.38
Bluegrass hay	89	56	13.0	.33	.16
Crimson clover hay	87	57	18.4	1.40	.22
Ladino clover hay	90	60	22.0	1.35	.31
Red clover hay	89	55	16.0	1.53	.25
Corn, yellow	88	90	10.1	.02	.35
Corn, yellow, high-moisture	72	93	10.7	.02	.32
Corn stover	85	50	6.6	.57	.10
Ground ear corn	87	83	9.0	.07	.27
Corn silage (few ears)	29	62	8.4	.34	.19
Corn silage (well-earred)	33	70	8.1	.23	.22
Corn, distiller's grain (dehy.)	94	86	23.0	.11	.43
Fescue hay, early veg.	91	61	12.4	.51	.36
Fescue hay, early bloom	92	48	9.5	.30	.26
Lespedeza hay, midbloom	93	50	14.5	1.20	.25
Molasses (syrup)	78	79	8.5	.17	.03
Oats	89	77	13.3	.07	.38
Orchardgrass hay, early bloom	89	65	15.0	.27	.34
Orchardgrass hay, late bloom	91	54	8.4	.26	.30
Sorghum stover	88	54	5.2	.52	.13
Sorghum grain (milo), 8%-10% CP	87	84	10.1	.04	.34
Sorghum silage	30	60	7.5	.35	.21
Sorghum sudangrass hay	91	56	8.0	.55	.30
Sorghum johnsongrass hay	89	53	9.5	.84	.28
Soybean meal (44%)	89	84	49.9	.33	.71
Timothy hay, midbloom	89	57	9.1	.48	.22
Urea (45% nitrogen)	99	0	287.0	0	0
Wheat	89	88	16.0	.04	.42
Wheat hay	88	58	8.5	.15	.20
Wheat silage, full bloom	25	59	8.1	.15	.20
Wheat straw	89	41	3.6	.18	.05
Mineral Sources					
Dicalcium phosphate	97	- - -	- - -	22.0	19.3
Ground limestone	100	- - -	- - -	39.4	- - -
Steamed bone meal	97	8.4	15	31.5	14.2
Sodium tripolyphosphate	96	- - -	- - -	- - -	25.0

Source: Reprinted with permission from "Nutrition Requirements of Beef Cattle," 6th revised edition, c. 1984 by the National Academy of Sciences. Published by National Academy Press, Washington, D.C.

Using the Pearson Square

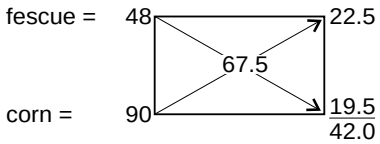
A relatively simple technique of ration balancing involves using the "Pearson Square." This square is used to determine the proportions of two feed materials needed to create a feed of the desired nutrient level. It can only be used for two feed materials; however, one or both of those can be mixtures.

The following example will help explain the Pearson Square method. In this example, a ration will be balanced for a 500-pound steer calf having a desired gain of 2.0 pounds per day. The daily requirements (from Table 7-11) are:

13.1 lb dry matter intake
11.4% crude protein
67.5% TDN

The feeds available in this example and their compositions are shown in Table 7-10. Values for their compositions came from Table 7-12.

The animal requires a 67.5 percent TDN ration. Place 67.5 in the center of a square. Place the TDN values of fescue (48 percent) and corn (90 percent) on the left side of the square and subtract diagonally, smallest from largest. Now, add the two numbers on the right side of the square.



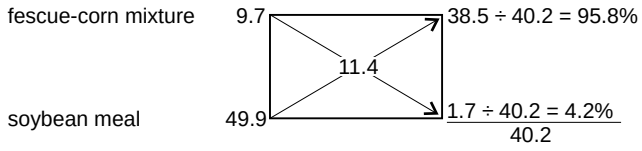
The numbers on the right side show that 22.5 parts of fescue and 19.5 parts of corn would give a 67.5 percent TDN mixture. This would be a total of 42 parts. Divide these two numbers (22.5 and 19.5) by the total (42) to determine the preliminary percentages of fescue and corn in the ration.

fescue 22.5 ÷ 42 = .54 (54%)
corn 19.5 ÷ 42 = .46 (46%)

The next step is to determine the percentage of crude protein in this fescue-corn mixture. Multiply the percentage of each ingredient in the mix by its crude protein content. Fescue is 54 percent of the mix and contains 9.5 percent crude protein. Corn is 46 percent of the mix and contains 10.1 percent crude protein.

fescue .54 × 9.5 = 5.1%
corn .46 × 10.1 = 4.6%
9.7%

The crude protein content of the mix is 9.7 percent. The animal requires 11.4 percent. Therefore, the crude protein content needs to be increased by adding a protein supplement. Use the square method again to balance the fescue-corn mix with soybean meal (SBM) to obtain an 11.4 percent crude protein mixture (see below). Place 11.4 in the center of the square and 9.7 and 49.9 on the left side, and subtract as before. Add the two figures on the right side of the square (38.5 and 1.7) to determine the total parts of the ration (40.2). Divide each of the numbers by the total to determine the percentages of fescue-corn (95.8 percent) and soybean meal (4.2 percent).



Next, determine the pounds of dry matter each ingredient contributes to the total. Multiply pounds of dry matter required daily by the animal (13.1) by the value obtained for soybean meal (.04).

Dry matter intake, lb x value for SBM = SBM dry matter, lb
(13.1 × .042 = 0.55)

Subtract this amount (0.55) from the dry matter intake (13.1) to determine how much dry matter will come from the fescue-corn mixture.

(13.1 - 0.55 = 12.55)

There should be 12.55 pounds of fescue-corn on a dry matter basis.

To determine the amounts of dry matter each of fescue and corn, multiply 12.55 by the relative amounts of fescue and corn obtained in the first square (.54 fescue and .46 corn).

12.55 × .54 = 6.77 lb dry matter from fescue
12.55 - 6.77 = 5.78 lb dry matter from corn

Next, convert each ingredient from dry matter to an as-fed basis so you know how much to actually feed. To do this, divide the pounds of dry matter from each ingredient by the amount of dry matter in each pound of feed (obtained from Table 7-10).

Fescue 6.77 ÷ .92 = 7.36 pounds as fed
Corn 5.78 ÷ .88 = 6.57 pounds as fed
SBM 0.55 ÷ .89 = 0.62 pounds as fed

Minerals are generally supplied by free-choice supplementation with commercial mineral supplements or "homemade" mixes. Calculate mineral levels by multiplying the dry matter pounds of each feed by that feed's calcium and phosphorus contents and adding the results. Compare the results to the animal's needs.

Supplementing Cows Receiving Free-choice Hay

Again, you must determine the nutrient requirement of the animal. In this example, use an 1,100-pound cow nursing a calf, in the first three to four months postpartum, with average milking ability (from Table 7-11):

Dry matter intake, lb	Crude protein, lb	TDN, lb
21.6	2.0	12.1

If fescue hay is being fed and corn and soybean meal are available, list their compositions next (from Table 7-12):

	Dry Matter	TDN	Protein
Fescue hay (early bloom)	92%	48%	9.5%
Corn	88%	90%	10.1%
Soybean meal	89%	84%	49.9%

Since you are interested in using as much hay as possible, begin by assuming the cow will consume her dry matter requirement (21.6 pounds) from fescue hay. This will be 23.5 pounds of actual hay (21.6 pounds of dry matter divided by .92).

Next, calculate nutrients supplied by 21.6 pounds of hay (dry matter basis):

TDN = 21.6 x .48 = 10.4 lb
Protein = 21.6 x .095 = 2.1 lb

Now, see how 21.6 pounds of hay on a dry matter basis (23.5 pounds as-fed) matches up to the animal's requirements:

	Protein	TDN
Required	2.0	12.1
Furnished	2.1	10.4
	(OK)	minus 1.7 lb TDN

An addition of corn grain for extra energy is needed. If 21.6 pounds of dry matter from fescue is all the cow can consume, corn must be substituted for fescue. One pound of fescue dry matter contains .48 pounds of TDN, while one pound of corn contains .90 pounds of TDN. The net effect of replacing one pound of fescue with one pound of corn is a gain of .42 pounds of TDN (.90 - .48 = .42).

Since a deficiency of 1.7 pounds of TDN exists, divide this by .42 to get the pounds of dry matter to substitute.

$$1.7 \div .42 = 4.0$$

Now, the ration is 17.6 pounds (21.6 - 4.0) of fescue and 4 pounds of corn on a dry basis. Divide each by its dry matter content to convert to an as-fed basis.

$$17.6 \div .92 = 19.1 \text{ lb of fescue}$$
$$4.0 \div .88 = 4.5 \text{ lb of corn}$$

Animals will gain more efficiently with a balanced ration. Using the guidelines should enable you to balance rations for your cow-calf operation. The Kentucky Cooperative Extension Service can help you obtain forage analyses and ration balancing.

Section 8.

Retaining Ownership

John Johns, Patty Scharko, and Lee Meyer

Retaining ownership of calves, as it is used here, simply means continuing to maintain ownership of the animals beyond weaning. Calves may be maintained on the site of production or in custom production facilities. Retained ownership can cover one or any combination of the following periods: conditioning, backgrounding, yearling, feedlot finishing. Producers retain ownership for many reasons, which include improving the health of feeder cattle, increasing the pounds of beef sold without increasing the number of cows owned, capturing compensatory and/or efficient gains, taking greater advantage of superior genetics, taking advantage of favorable market conditions, and marketing quality farm-produced feeds. The primary focus of this chapter is the backgrounding/stockering phase of retained ownership.

The decision about whether or not to retain calves to yearling weights with winter backgrounding or summer pasture programs depends on many factors. You eventually will want to prepare a budget, but you must first think about the type of program that will best fit with your resources and goals. Decide whether you want to make major investments (such as in facilities) or build a program on resources you already have. Will you consider purchasing calves to go with your own? Will you reduce the size of your cow herd and put more resources into your yearling program? Start with these ideas. Then, as with any decision, list advantages and disadvantages and prepare a budget for each option before making your final decision.

Making Major Investments for the Long Run

Many producers have the resources on their farms to retain calves without substantial investment in facilities or equipment. This gives them the flexibility to retain calves when market and feed conditions are favorable. If you need or want to make a major investment for backgrounding, decide if the long-run payoff from backgrounding justifies the added investment. You also should evaluate alternatives. For example, you might consider adding a confinement facility. This would improve feed efficiency and gains, if managed properly, but also would add an expense that must be paid for over many years. A more cost-efficient strategy might be to construct some low-cost feeding pads.

Remember that once an investment is made, it becomes a "fixed cost." Fixed costs are not included in the short-term "partial budget" but still must be paid for. If you make a substantial facility investment, there might be cases in which you will be encouraged to background cattle just to make the payments. For example, suppose you prepared a budget with your facility in which you projected a $25 per head return over short-term costs—feed, interest, labor, etc. (in this budget, you should consider only your additional costs, which do not count the building). Even though the facility cost might be $35 per head, giving you a loss overall, you should background the cattle. If you were to keep your building empty, you would lose $35 per head, whereas if you were to background your calves, you would lose only $10 per head.

Look at equipment in the same way. Farm management specialists at the University of Kentucky have found that in many situations hay can be purchased below the cost of production, when the costs of harvesting equipment and labor are included. In other words, it is sometimes cheaper to buy hay than to invest in the equipment necessary to produce it yourself. Of course, home production can give you more control over quality and cash flow.

The bottom line about long-term investments for retained ownership programs is: be careful! Many Kentucky producers have demonstrated that simple, low-investment retained ownership programs can be cost effective and provide maximum flexibility.

Designing a Retained Ownership Program

Retained ownership can work with grazing cattle on large pastures, intensive and rotational grazing, feeding harvested feeds on pasture, and feeding in confinement. Each system has pros and cons, but usually the most important considerations are: Where am I now?, What resources do I have?, and What is the market telling me?

Do you have calves ready for weaning in spring or fall? When can you wean in the fall—as early as August? What are your cow herd's winter feed needs? These may be key considerations. Fall-born calves can be weaned and put on pasture in the spring. Spring-born calves can be weaned and pre-conditioned in the fall on pasture with some supplement. Fall stockpiled forages are a good fall/early winter feed. These alternatives can be combined if you wish to retain ownership beyond the end of the tax year: calves can be weaned in the fall, grazed, then moved to a program using harvested feeds.

Markets can be critical for the profitability of backgrounding. (More detailed information on marketing is provided in Section 10—Marketing Beef Cattle.) Retained ownership is a "margin" business. Money can be made regardless of the overall cattle market situation because profits depend on price margins (differences between the purchase and sale prices). The following table shows historical buy/sell price margins.

Buy/Sell Price Margins (drop in dollars per cwt)—1990-1994 Averages

Grazing:

450-lb. steer
Buy in April, sell 750 lb. in October .....$24 per cwt

Winter Backgrounding:

450-lb. steer
Buy in October, sell 650 lb. in March .....$8 per cwt
450-lb. steer
Buy in October, sell 750 lb. in May .....$14 per cwt
450-lb. heifer
Buy in October, sell 650 lb. in March .....$5 per cwt
450-lb. heifer
Buy in October, sell 750 lb. in May .....$10 per cwt

As most cattle producers know, the sale price (per hundredweight) is typically much lower than the purchase price. The profit in retained ownership comes from inexpensive weight gains. However, large negative margins, which at times exceed a negative $20 per cwt, can almost doom a backgrounding program.

However, margins reflect the overall market situation. When cattle prices are low and feed costs are high (as in 1995-96 and 1983), margins are very narrow. This situation favors retained ownership, especially if feed costs per pound of gain can be reduced through the use of forages instead of grain.

Should I Retain this Year's Calf Crop?

After you have designed your general retained ownership program, you must budget for your current situation. Many budget formats are useful. The most important factor is to include all of your short-term costs. Most of these are cash costs, but some are not. The cost of the retained calf is not a cash cost but needs to be included at the potential sale value. Since hay is typically home-grown, it is not a cash cost but needs to be included at whatever its market value is. (In economics this is called the "opportunity cost" concept and means you should use the potential market value of your non-purchased inputs.)

A budget form, which can help you make your short-term decision, is provided (Figure 8-1). The form provides space for two alternative programs, so you can make comparisons. First you specify the technical parts of your program; then the form guides you in putting costs on the program. Finally, it provides assistance with the calculations needed to make decisions and evaluate performance.

It is important to recognize that this is a partial budgeting process. It includes only the short-term costs appropriate for making the annual decision. The "returns over listed expenses" line is not profit because it does not include your fixed costs. Some of these costs, such as your labor and management and depreciation of equipment (i.e., feeders, buildings), should be charged against the cattle enterprise. Other items may be general farm costs. The decision rule is: as long as income from the enterprise is greater than the short-term (marginal) costs, you will be better off by retaining ownership.

Finally, realize that the budgeting process is a projection. If you were to know perfectly how the cattle would perform, what all of the costs would be, and what the calves would sell for, the projections would be exact. However, all of these factors are uncertain. Therefore, good managers change key elements of their budgets to test different situations. If the average daily gain is ¼ pound less than expected, will the program still cover its costs? If the market price is $3 per cwt less than projected, will the program still fit your objectives?

Facilities

Regardless of where calves are maintained, adequate facilities are necessary for proper management. You will need centrally located corrals that allow access from any point in the production facility and facilities that allow working calves with the least amount of stress. Requirements and designs are provided in Section 3—Facilities for Beef Production.

Weaning/receiving lots deserve special considerations. Even calves going to pasture should be kept in small lots or pastures for a short period. This makes it easier to check for sickness and treat those in need. These small lots also make it easier to provide stress rations and teach calves how to eat. Calves under stress do not eat normally, so they need more nutrient-dense rations to obtain adequate nutrition. Placing bunks at right angles to the fence line in the small lots ensures that calves come into contact with the rations as they walk the fence line. These bunks should be low enough that all calves can reach the feed. The maximum height should be no more than 18 inches. Feeding space is also important if all calves are to have access to the feed. Provide 18 to 22 inches of bunk space per calf.

A good working facility greatly assists in the assessment and treatment of unhealthy cattle. Construct alleyways to bring the sick individual safely into the chute, preferably with the assistance of only one person. A chute should have sides that can be opened to examine the individual. Ill animals can go down and be trapped in the chute, so it is important to have one side that completely opens to get the down animal out. Have a thermometer readily available to check all sick animals. A livestock digital thermometer with a probe is recommended if you treat many animals at the facility. A digital thermometer is costly, but it can pay for itself by being easier to use and less apt to break than a mercury thermometer. Keep the thermometer near the chute at all times to encourage monitoring animals' temperatures.

In the hospital area, keep written or computer records to monitor the progress of sick animals and to follow treatment plans. Place a table near the chute to hold records, drugs, and syringes. This provides easy access and keeps your materials clean. You will also need a sink or water faucet for clean up of equipment and personnel.

Management at Weaning/ Receiving

Management at weaning/receiving is vital for the success of your retained ownership program. Research has shown that sick calves have lower performance than calves which remain healthy.

Vaccination

Acute respiratory disease, or "shipping fever," is a common disease of weaned calves. The stresses of weaning, along with environmental stresses that coincide with the time of weaning, leave the calf susceptible to disease. The colostral immunity has disappeared by the time a calf is weaned at 6 to 8 months of age. Vaccination is intended to increase the calf's immunity to the major bacteria and viruses that cause pneumonia and other diseases.

The goal of vaccination is to prevent or control disease in a herd. Not all animals may be protected. Rather, the idea is to decrease the number of susceptible animals in case a particular bacteria or virus (for example, BVD) enters the herd in a newly acquired animal. Vaccination is an insurance policy. You have to evaluate the cost effectiveness of vaccination versus the possible economic loss associated with a herd outbreak.

Vaccines are either killed, modified live, or attenuated. Table 8-1 shows the advantages and disadvantages of the types of vaccines. Timing is important in vaccination. Stress reduces a calf's ability to respond to a vaccine. Weaning is one of the most stressful times in a calf's life. Castration and dehorning are the next most stressful procedures. A calf's immune response to a vaccine is greater if the calf is vaccinated at least three weeks before weaning rather than at weaning. Therefore, preweaning vaccination is highly recommended. Vaccination can also be done at weaning. However, this adds to the stress already encountered when the calf is removed from the dam. If boosters are required, you can give the vaccine at weaning or 14 or more days after weaning. Vaccination upon arrival at the feedlot is not reliable because there is not sufficient time for the immunity to develop before the animal is exposed to the infectious agents in the feedlot.

Figure 8-1. Cattle backgrounding budget form.

		My Farm Programs	
Average Daily Gain			
Purchase Weight:			
Sales Weight:			
Days in Program:			
Feed Uses		**Amounts Used** (lbs., bushels, etc.)	
Examples:	corn		
	hay		
	pasture		
	cond. ration		
	protein supplement		
Prices		**Cost for Weight Gained** ($ spent per head) **Program #1**	**Program #2**
feeder calf	1		
corn	2		
hay	3		
pasture	4		
protein	5		
conditioning ration	6		
misc./day	7		
misc./head	8		
interest (calf)	9		
death loss (%)	10		
Performance			
11 Feed cost—total	(2+3+4+5+6)*		
12 Feed cost per day	(2+3+4+5+6)/# of days		
13 Feed cost/lb. gain	(11/gain)		
14 Non-feed costs	(7+8+9+10)		
15 Non-calf costs	(11+14)		
16 Cash costs (feed, misc.)	(depends on situation)		
17 Total budgeted cost (per head)	(1+11+14)		
18 Cost per pound of gain	(15/gain)		
19 Sale price _____ $/cwt.			
20 Gross returns	((19 x weight)/100)		
21 Returns over listed expenses:	(20 - 17)		
22 Breakeven price:	(17/weight)		

** Formulas refer to line numbers.*

The following factors affect a calf's immune response:

- Stress—the duration of time in the chute, the number of stresses (vaccination, weaning, dehorning, castration, etc.) at the time of the event, and the number of times through the chute. The first time through the chute has the biggest impact on a calf.
- Weather—hot weather can be especially stressful to an animal.
- Birth—vaccinate no sooner than five days after birth. Vaccinate during the least stressful time for the calf.

Proper handling and administration are almost more important than the vaccine used. If the vaccine is not stored properly as per label directions, it will not provide the expected immunity. Most vaccines should be kept refrigerated. Reconstitute vaccines immediately before using. Use clean syringes and needles to prevent infection at the in-

jection sites, which could decrease the animal's response to the vaccine. Do not use alcohol to clean out syringes immediately before use in vaccination. Administer vaccines only to healthy animals. Do not combine vaccines that are not intended to be mixed.

If a vaccine can be given subcutaneously (under the skin), this is the preferred site. Clostridial vaccines cause a large amount of muscle damage if given intramuscularly. Most Clostridial vaccines can be given subcutaneously. The neck muscle should be used for any intramuscular injections.

Table 8-1. Types of Vaccines Available

Vaccine	Advantages	Disadvantages
Killed/attenuated	• safe in pregnant animals • unable to cause disease • stable in storage	• poor immunity with one dose; usually need a booster in 2-4 weeks • need larger amount to provide immunity • hypersensitivities or local reactions
Live/modified live	• inexpensive • good immunity • fewer doses necessary	• possibility of abortion • limited shelf life • reconstitution usually necessary • possible reversion of virus to virulent state

The vaccines your herd will need depend on the occurrence of various diseases in the herd and in the area. Table 8-2 shows vaccines available to protect against several bacteria and viruses. Categorize your vaccination plan by those which must be used, those that might be necessary, and those that may be used. Vaccination for blackleg might need to be given at 2 to 3 months of age, then boostered at weaning. An example immunization program could include the following: IBR, BVD, Hemophilus, and Clostridia 7-way.

Parasite Control

Parasite control is a necessary part of management at weaning/receiving. Several products to help control internal worms in cattle are available. They are in the forms of injectables, pour-ons, drenches, pastes, boluses, blocks, crumbles, or feed additives. Select an appropriate product based on your management practices and your veterinarian's recommendations. Dewormers used during the hot summer and cold winter should be effective against inhibited *Ostertagia ostertagia* larvae. Albendazole (Valbazen), doramectin (Dectomax), ivermectin (Ivomec), oxfendazole (Synanthic) or double dose (10 mg/kg) of fenbendazole (Safe-Guard, Panacur) removes the adult and inhibited *Ostertagia*.

Calves are typically dewormed in the fall at weaning time, in the spring at pasture turn-out, or at both times. If you deworm in the spring, keep the animals in a confined pasture for 24 to 48 hours after treatment before turning them out onto the spring/summer pasture. This allows time for the worms to be killed and discarded onto a "contaminated" pasture. Then turn the cattle out onto "clean" pastures.

Table 8-2. Available Vaccines

Diseases	Use[1]	Comments
Bacterial		
Clostridia: blackleg	R	*Clostridium chauvoei, C. septicum, C. sordelli*
Malignant edema	R	*Clostridium septicum*
Enterotoxemia	S	*Clostridium perfringens* Types C & D; "overeating disease"
Tetanus	S	*Clostridium tetani*
Leptospirosis	R	protection of cattle from infections due to Leptospirosis
Hemophilus	S/R	protection of calves from the multiple clinical forms of Hemophilus
Pasteurella	C	protection of calves against Pasteurella pneumonia
E. coli	C	for calves against diarrhea due to *E. coli* through the colostrum or at birth
Fusobacterium	C	protection against acute footrot in cattle
Salmonella	C	protection from diseases caused by *Salmonella typhimurium* or *S. dublin*
Moraxella	C	protection against pinkeye
Anaplasmosis	C	subclinical problem in many cattle
Brucellosis	C	for replacement heifers
Viral		
IBR/PI_3	R	infectious bovine rhinotracheitis Parainfluenza 3
BVD	R	Bovine Virus Diarrhea
BRSV	S	Bovine Respiratory Syncytial Virus
Papilloma	C	aids in the control of warts
Rabies	C	protection of animal from rabies

[1] *R=highly recommend; S=suggested; C=consult with veterinarian*

Strategic deworming programs should be designed to combat the natural rise of infective larval populations on pastures at various times of the year. Timing is the most important part of strategic deworming. Timing for deworming is dependent on the weather, grass growth, and management, and might not necessarily be at your convenience. Strategic deworming coordinates grazing pastures with several dewormings in the spring/summer. Timing between dewormings depends on the anthelmintic (dewormer) used.

Combine chemical control of internal parasites with other measures, such as not overstocking pastures, pasture rotation, feed bunk management and sanitation, and an adequate level of nutrition.

External parasites, such as flies, lice, and cattle grubs, can have an economic impact on cattle. You can apply systemic insecticides as injections, pour-ons, spot-ons, sprays, and powders. An insecticide is usually administered when vaccinating calves in the fall to remove grubs and reduce lice infection.

Surgeries

Whether you background your own calves or buy bull calves or calves with horns, surgery is necessary. There is usually an economic incentive to castrate and dehorn bulls.

Castration has a negative impact on the animal's performance immediately after the surgery. Again, timing is important. It has a minimal effect in a young nursing calf. The impact and serious complications increase with the age of the animal. Castrations and/or dehorning should be done as early as possible in the calf's life or at least two to three weeks before weaning. There are numerous surgical and bloodless techniques for castration (Burdizzo, elastrator band, EZE band). When castrating with bands, protect the animal against tetanus. Caustic paste can be used on the horn buds of a newborn, a hot iron can be used on calves up to 3 months of age, and a gouger (Barnes) can be used on horns up to 4 inches long. Section 6—Health and Management Techniques has more information on castration and dehorning.

Identifying Sick Animals and Working with Your Veterinarian

Immediately after weaning, place calves in an area where you can easily check on them and "pull" and assess sick calves. Walk among the cattle to see if any do not want to move or appear abnormal. Always take the temperature of a pulled animal. Rectal temperatures can be an early indicator of illness. Consider treatment for animals with temperatures over 104° F. Factor in the ambient temperature when evaluating an animal's body temperature. Animals' rectal temperatures are increased on hot days.

A physical examination on the sick animal should be performed. The following areas should be examined: the animal's eyes, its rumen for bloat, its tail for diarrhea, its head if recently dehorned, and its back end if recently castrated. Pneumonia is often diagnosed by observation and elevated temperature.

Your veterinarian is aware of diseases in the area. A good working relationship with your veterinarian is important in avoiding disasters. To develop this relationship, set up a time for the veterinarian to come and "walk through" your facilities and animals. Discuss vaccination and anthelmintic programs. Set treatment protocols for standard diseases (pneumonia, bloat, foot rot, etc.). Establish a record system for all of the animals (this is especially important for treated animals). Your veterinarian can periodically assess with you the success of treatment protocols.

Nutritional Management

Adequate feeding programs are essential for calves to develop maximum immunity. Stressed calves have reduced feed intake (Table 8-3). In fact, feed intake may not reach normal levels for as long as 14 days after the end of the stress. Thus the starting ration must be highly palatable, easily accessible, and nutrient dense. Use intake stimulants, such as dried distiller's grains, wet molasses, artificial flavors, and cottonseed hulls. You may add antibiotics, antibiotic-sulfa combinations, coccidiostats, or growth-promoting ionophores to the starting ration when desirable. Sample stress rations are shown in Tables 8-4 and 8-5. Remember, cattle that quickly consume feed are less likely to have health problems.

After the adjustment period, design your feeding and management programs to promote rapid and efficient gains. To ensure this, you must understand factors that affect the nutrient requirements of growing cattle. Sex, frame size, flesh condition, and environment are major factors affecting the amounts of nutrients cattle need to grow. The effects of sex and frame size are shown in Table 8-6. The table shows values for steers and heifers at the same weight and rate of gain. Heifers require more energy and less protein than equal weight steers for the same rate of gain because the composition of gain is different in heifers than in steers. Regardless of calf sex, large-frame calves need more protein and less energy than medium-frame cattle for equal gain. Again, the reason is different composition of gain. Fleshy calves require higher energy levels for equal gains than thinner calves. Increased maintenance needs are the reason. Environmental factors can greatly increase nutrient needs. Increasing or decreasing the temperature from the thermoneutral zone, for example, increases the maintenance needs of cattle. Mud creates major problems. Not

Table 8-3. Dry Matter Intake of Stressed Feeder Cattle

Time after arrival at feed yard	Dry matter intake, % of body weight
1 to 7 days	.5 to 1.5
8 to 14 days	1.5 to 2.5
15 to 28 days	2.5 to 3.5

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only does it increase maintenance needs, but it also decreases feed intake. Estimates of decreases in feed intake range from 15 percent for 12 inches or less of mud to 30 percent when mud depths are 12 to 24 inches.

The major management factor affecting performance of cattle is dry matter intake. Animal, environmental, and feed factors all influence dry matter intake. Small changes in dry matter intake make large changes in gain of cattle (Table 8-7). Regardless of what causes intake to decrease, performance suffers when cattle do not eat to their capacity. A decrease of only 1 pound of dry matter reduces gain by .25 pounds daily. When cattle decrease feed intake, all of the nutrients lost come from gain: maintenance needs must still be met, so gain is the only place from which nutrients can come. If intake decreases enough, even maintenance needs cannot be met and cattle lose weight.

The critical factor affecting dry matter intake of calves through the backgrounding period is the quality of the forage used in rations. The single most important factor in determining forage quality is forage maturity at harvest (Table 8-8). Even with a quality legume such as alfalfa, fiber content increases and digestibility decreases with advancing maturity at harvest. Delaying harvest until mid-bloom gives only small changes in crude protein content and hay intake. Gain drops dramatically. This illustrates that small changes in intake and digestibility lead to large changes in performance. Simply harvesting forage at a less mature stage allows less supplementation in rations and fosters better performing cattle.

Table 8-4. Stress Rations Based on Ear Corn, Pounds per Ton

Ingredient	Ration 1	Ration 2	Ration 3
Ground ear corn	1,223	1,156	1,189
Soybean meal	282	278	210
Distiller's dried grains	94	93	70
Mixed hay	266	- - -	- - -
Wet molasses	100	100	100
Alfalfa hay	- - -	- - -	416
Cottonseed hulls	- - -	143	- - -
Dehydrated alfalfa pellets, 17%	- - -	200	- - -
Trace mineral salt	10	10	10
Potassium chloride	10	10	- - -
Calcium carbonate	15	10	5
Vitamin A (IU per ton)	4 million	4 million	4 million
B-vitamin premix	+	+	+
Composition, % of the ration			
Crude protein	13.7	14	14,1
TDN	68	67	67.5
Calcium	.45	.40	.42
Phosphorus	.29	.28	.26
Potassium	1.2	1.25	1.1

Table 8-5. Stress Rations Based on Shelled Corn, Pounds per Ton

Ingredient	Ration 1	Ration 2	Ration 3
Ground shelled corn	900	902	1,000
Soybean meal	247	280	100
Distiller's dried grains	83	93	40
Mixed hay	650	- - -	- - -
Wet molasses	100	100	100
Alfalfa hay	- - -	- - -	725
Cottonseed hulls	- - -	395	- - -
Dehydrated alfalfa pellets, 17%	- - -	200	- - -
Trace mineral salt	10	10	10
Potassium chloride	- - -	10	- - -
Calcium carbonate	10	10	- - -
Sodium tripolyphosphate	- - -	- - -	25
Vitamin A (IU per ton)	4 million	4 million	4 million
B-vitamin premix	+	+	+
Composition, % of the ration			
Crude protein	14	14	14
TDN	67	66	68
Calcium	.44	.45	.9
Phosphorus	.3	.29	.57
Potassium	1	1.2	1.25

Table 8-6. Frame and Sex of Growing Cattle (440 lbs, ADG = 2.2 lbs) and Nutrient Needs

	Steers		Heifers	
Frame	Ne_gMcal/day	CP, grams/day	Ne_gMcal/day	CP, grams/day
Medium	2.96	682	3.65	583
Large	2.62	718	3.23	668

Table 8-7. Effect of Feed Intake on Gain of Growing Cattle

500-pound Steer, ADG = 2 Pounds			
Pounds of dry matter intake daily	13.1	12.1	11.1
ADG, pounds	2.0	1.75	1.49

Table 8-8. Maturity of Alfalfa at Harvest and Steer Intake and Gain

Harvest stage	Bud	Mid-bloom	Full-bloom
Crude protein, %	18.7	15.9	13.7
TDN, %	56.6	56.6	44.9
Average daily intake, lbs	17.1	16.5	11.6
ADG, lbs	1.85	1.49	-.06

Table 8-9. Implants and Gain of Stocker Steers and Heifers, 58-trial Summary

Control ADG, lbs	Implant ADG, lbs	Percent increase
1.36	1.56	14.7

Table 8-10. Reimplanting and ADG of Growing Cattle, 10-trial Summary

Treatment	Control	Implant	Reimplant
ADG, lbs	2.49	2.91	3.02
% Increase	—	16.8	21.2

Various products used

Table 8-11. Effect of Ionophores[1] on ADG of Growing Cattle

Ration	Control ADG, lbs	Ionophore ADG, lbs	% Increase
High silage	1.92	2.03	+ 5.91
High hay	1.35	1.54	+ 14.1

[1] Rumensin

Gain and Feed Efficiency Enhancers

The use of growth-stimulating implants in retained ownership programs is one of the most cost-effective management tools available to the producer. A summary of the effect of implants on gain of growing cattle is shown in Table 8-9. For each 100 days of growth, implanted calves weigh 20 pounds more than non-implanted calves, as illustrated by this data.

Gain stimulation from implants generally does not last through an entire retained ownership period, unless it is of short duration. Normally, calves must be reimplanted. Some producers contend that gain stimulation from reimplanting is less than the increase from the initial implant. This is not the case, as seen in Table 8-10. In this summary of data, reimplanting not only maintained the initial increase but resulted in a slight increase in gain over the initial implant. You should expect to see similar stimulation of gain each time calves are implanted properly.

Ionophores (Rumensin, Bovatec, or Cattlyst) should be used in any retained ownership program. These products work through the microbes in the rumen to allow cattle to receive more energy from any ration. On high forage rations, as in a backgrounding retained ownership program, increases in ADG and feed efficiency occur. On high energy rations, as in a finishing retained ownership situation, the primary effect is an improvement in feed efficiency. The data in Table 8-11 illustrates the effect of ionophores on high forage rations. Rumensin is used as the example, but other products would yield similar results. When more energy is available, ADG increases in growing cattle. Ionophores can be provided through minerals, protein supplements, or premixes added to the grain portion of the ration.

Implants express their effect through the hormonal system of the animal, while ionophores work through the digestive system. When the compounds are used together, the effects should be additive. The data in Table 8-12 shows the effects of ionophores and implants used singularly and together. The combination of these two gain-stimulating products was almost additive in its effect. Good management requires using these two product types together.

When ionophores cannot be used, antibiotics are useful alternatives. Low level use of antibiotics also stimulates gain in growing cattle. In addition, antibiotics may be useful in controlling pinkeye, which greatly reduces performance. Many antibiotics have clearance to be fed to cattle. One new product, Bambermycin (GainPro), recently was cleared. The effect of GainPro on gain of grazing cattle is shown in Table 8-13. Cattle fed 20 mg of GainPro gained .23 pounds per day more than control cattle.

A non-implanted hormonal gain stimulant, Melengestrol acetate (MGA), is available. The product works only on intact females but is a very effective gain stimulant, as shown in Table 8-14. Heifers fed .5 mg of MGA gained .24 pounds per day more than the control heifers. Consider heifers that have been fed MGA for long periods of time to be feeder heifers only. Long-term MGA has detrimental effects on reproduction. Feed MGA in combination with ionophores as the effect on gain is mediated through different systems of the body.

Table 8-12. Implants and Ionophores on Gain of Growing Cattle

Treatments	Control	Ionophore	Implant	Combination
ADG, lbs	2.25	2.51	2.56	2.80
Increased ADG, lbs		.26	.31	.55
% Increase		11.5	13.7	24.4

Four-trial summary with various products used

Table 8-13. Effect of GainPro on ADG of Grazing Cattle

Dose, mg/hd/day	0	5	10	20
ADG, lbs	1.52	1.56	1.69	1.75

Data from GainPro Resource Manual

Table 8-14. Effect of MGA on ADG of Growing Heifers

Treatment	Control	MGA
ADG, lbs	2.14	2.38

Data from MGA Resource Manual

Table 8-15. Fall Accumulated Fescue and Calf Gain

Trial	Grazing days	ADG, lbs
KY, 1982	59	1.27
KY, 1985	57	1.15
KY, 1986	56	2.00
OK, 1986	42	2.13
KY, 1990	63	.97

Table 8-16. Fall Accumulated Endophyte-infected Fescue and Calf ADG

Endophyte presence	KY, 1986	OK, 1986
E +	1.49	1.85
E -	2.17	2.47
E + with clover	—	2.02

Parasites can rob animals of nutrients needed for growth, so anthelmintics may be thought of as gain stimulants as well. Several effective products are available. Use products that are effective against all stages of the parasite life cycle. Producers most often ask when and how many times dewormers should be used. The concept of strategic, or multiple, deworming is becoming popular. With this concept, calves are dewormed when they are turned to grass and after 30 and 60 days on grass. This concept seeks to reduce not only the parasite burden in the calf but on the pasture as well. Research has shown significant increases in gain of strategically dewormed calves compared to single-dose-treated animals. Cattle do not have to be handled to administer the second and third doses. Products are available that can be given in feed or mineral.

Feeding Systems

Feeding programs for retaining ownership from weaning to yearling ages usually involve high forage rations. For spring-born calves weaned in the fall, you can use accumulated fescue for 45 to 60 days of high quality grazing. A five-trial summary of data is shown in Table 8-15. Gains ranged from .97 pounds to 2.13 pounds daily. Gains tend to decrease the farther into winter grazing continued. This is logical. As more freezes occur, more cells in the plant rupture and high quality nutrient content is lost. Depending on the winter, gains will remain high through mid to late December and decrease thereafter.

Endophyte-infected fescue has a detrimental effect on gain, even when the weather cools in the fall (Table 8-16). Although the rate of gain was greater for calves in the Oklahoma test compared to those in the Kentucky test, the difference between E+ and E- fescue calves was almost identical. The presence of the endophyte reduced ADG by two-thirds of a pound daily. The presence of clover with the accumulated fescue partially alleviated the gain reduction.

A summary of several years of backgrounding demonstration and research projects utilizing different rations is shown in Table 8-17. Gain increases as higher energy rations, such as corn silage, are fed. Also, small amounts of high quality alfalfa hay can be an effective protein supplement for corn silage as shown in the last column.

Gain on spring and summer grazing programs is dependent on many factors, such as maturity and legume content of pasture, grazing system used, and animal management practices. A summary of performance in 14 Kentucky trials is shown in Table 8-18. These figures represent season-long continuous grazing. Certainly gains are better early in the season and improve with some rotation. Including legumes with the fescue would have increased performance. Use these figures or values similar to them for planning. The surest way to lose money is to assume the cattle will gain more weight than is possible.

Pasture gain can be increased by supplementation of energy. Feed supplements so that they complement forage intake, rather than compete with forage intake. The data in Table 8-19 shows that the efficiency of conversion of supplement to extra gain ranges from about 8 to 10 pounds of supplement to 1 pound of additional gain. When supplement prices are high and cattle prices are low, this is not a good management practice. As prices decrease for energy

Table 8-17. Performance Summary of Backgrounding with Various Rations

	Corn silage and protein	Alfalfa and shell corn	Alfalfa	Orchardgrass and red clover	Corn silage and alfalfa
Int. wt. lbs	493	520	496	451	506
Final wt. lbs	735	688	652	658	688
ADG, lbs	2.16	1.60	1.42	1.49	1.85
Average daily feed intake, pounds per head					
Corn silage	41				36
Protein	1.45				
Alfalfa		14	16.5		3.5
Shell corn		4			
OG and red clover				15.5	

supplements and/or cattle prices increase, supplementation on pasture may be advantageous.

Supplements containing a highly digestible source of fiber may be used on pasture to better advantage than corn. The data in Table 8-20 shows that feeding soyhulls stimulated greater gain and feed efficiency than feeding shelled corn.

Retained ownership of cattle does not always prove profitable. However, it is a management option you should consider each year for profit potential.

Table 8-18. A Summary of Steer Grazing Performance on Various Pasture Types

Pasture type	ADG, lbs	Number of trials
Fescue	1.1	9
Endophyte-free fescue	1.8	2
Bluegrass-clover mixture	1.4	3

University of Kentucky Beef Day Reports, 1977 through 1986

Table 8-19. Energy Supplementation and Stocker Gain on Summer Pasture

Lbs of supplement	0	1	2	3
ADG, lbs	1.37	1.49	1.61	1.71

Elanco Stocker Cattle Notebook

Table 8-20. Supplement Type and ADG of Stockers on Pasture

Supplement	Control	3 Pounds of corn	3 Pounds of soyhulls
ADG, lbs	.68	1.04	1.19
Difference	- - -	.36	.51
Efficiency of extra gain, lbs	- - -	8.3	5.9

Nebraska, 1985

Section 9.

The End Product

Darrh Bullock and Benjy Mikel

A variety of end or salable products exists for cattle producers: seedstock—bulls and/or replacement heifers; cow/calf—weanlings and/or yearlings; backgrounders—yearlings; and feedlot—fed cattle. Today cattle producers realize, however, that the ultimate end products of the beef cattle industry are the steaks, roasts, and hamburgers consumed every day. Each segment of the industry is responsible for doing its part to ensure a safe, healthy, and enjoyable eating experience. If there is a breakdown at any segment, the entire industry suffers. Therefore, under the umbrella of economic soundness, every effort should be made to provide the most desirable product to the eating public.

Cuts of Meat

The four major primal cuts on a beef carcass are round, loin, rib, and chuck. These cuts comprise approximately 75 percent of the weight of a carcass but about 90 percent of the carcass value. (Table 9-1 illustrates the breakdown by weight and value of the primal cuts.) The remaining 25 percent of the weight and 10 percent of the value comes from the brisket, foreshank, plate, flank, and kidney knob.

Steaks and roasts come from the primal cuts of meat (Figure 9-1). Each primal cut has its own characteristics in terms of tenderness, fat content, preferred cooking methods, and price (Table 9-2). The loin and rib are considered the most desirable in terms of tenderness and are suitable for any type of cooking method (grilling, pan frying, dry roasting, etc.); however, these cuts are generally the most expensive on a per pound basis. The round is intermediate in terms of tenderness, desirability, and affordability. Cuts from the round are usually the most desirable from a leanness standpoint, but greater caution must be taken in cooking methods. Many cuts from the round must be moist cooked or mechanically tenderized to be considered acceptable (sirloin tip—slow, low dry heat roast; top, bottom, and eye of round—cubed steaks, moist cook roast, etc.). The most economical cuts of beef generally come from the chuck. Cuts from the chuck often have excess seam fat (large amounts of fat between the groups of muscle) and are tougher, especially if not prepared correctly. Cuts from the chuck require moist cooking (pot roast, stews, etc.).

A leading cause of bad eating experiences with beef is improper preparation. When a consumer buys a low budget cut of meat (eye of round) and prepares it as a high quality cut (grilled), the result is usually an unacceptable eating experience. Consumer education in beef preparation is necessary if our industry is to gain greater acceptability and win back market share.

Beef Carcass Grading

The quality and cutability of beef is an important issue for today's cattle producers. Over the past 20 years, beef has consistently lost market share to poultry. While Americans are eating more total meat (beef, pork, and poultry), they are consuming less beef than in years past. With consumer concerns over the lack of consistency in beef tenderness and excess fat, beef producers are interested in making the changes necessary to provide a more acceptable product. To make changes, it is important to understand the USDA grading system and how management and breeding practices affect those grades.

USDA Quality Grades

The beef quality grades, from most desirable to least desirable, are USDA: Prime, Choice, Select, Standard, Commercial, Utility, Cutter, and Canner. The USDA quality grade is an indicator of the palatability or eating quality of beef. Meat from carcasses with superior quality grades (USDA Prime and Choice) are expected to be the most

Table 9-1. Percentage of Total Carcass Weight and Value of Each of the Major Primal Cuts

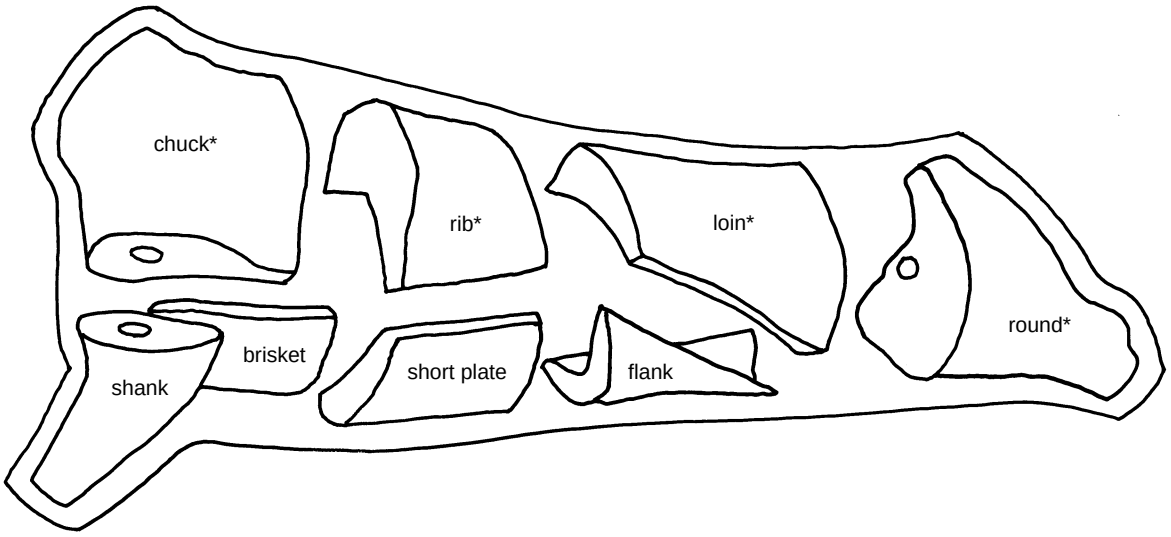
Primal cut	Percent by weight	Percent by value
Round	23	29
Loin	17	29
Rib	9	11
Chuck	26	21

Adapted from Live Animal Carcass Evaluation and Selection Manual. Third Edition. Boggs and Merkel.

Table 9-2. Ranking of the Primal Cuts for Tenderness, Leanness, and Price

Primal cut	Tenderness	Leanness	Price
Round	3	1	2
Loin	1 (tie)	2	4
Rib	1 (tie)	3	3
Chuck	4	4	1

Figure 9-1. The wholesale cuts and their locations on a beef carcass (*the four major primal cuts).



tender, juicy, and flavorful. USDA quality grades are determined by two factors: maturity of the carcass and amount of marbling (intermingling or dispersion of fat within the lean) in the ribeye.

Maturity

Maturity in beef is based on the physiological appearance of the carcass: amount of cartilage remaining in the vertebrae, flatness and color of the ribs, color and texture of the muscle. The maturity range is from A to E with A being the youngest, most desirable carcasses. Maturity is further subdivided into degrees ranging from 0 to 100 in increments of 10, which is necessary for determining the final quality grade. For a carcass to receive an acceptable quality grade, it must have no greater than a B maturity, which relates to a 42-month or younger steer or heifer. Carcasses of C maturity or older receive grades of Commercial, Utility, Cutter, or Canner, based on the amount of marbling they possess, and are typically used in processed meat products (hamburger, hot dogs, etc.). Younger carcasses (A and B) are eligible for quality grades of Prime, Choice, Select, and Standard, which are usually cut into steaks and roast. However, recently it has been shown that a high percentage of Standard and even low Select carcasses have unacceptable eating quality, without processing, and many of these carcasses are now used in processed foods. Also, the USDA is currently considering making only A maturity carcasses (30 months or less) eligible for the young carcass quality grades (USDA Standard or higher).

Marbling

Marbling scores are determined by the amount and distribution of the flecks of fat within the lean of the ribeye. The marbling scores, from lowest to highest, are: practically devoid, traces, slight, small, modest, moderate, slightly abundant, moderately abundant, and abundant. Marbling is considered to be an indicator of palatability, with higher scores indicating greater eating quality. Therefore, higher marbling scores result in higher quality grades (USDA Prime and Choice) than lower marbling scores (USDA Select and Standard) (Figure 9-2). Marbling scores are further subdivided into degrees ranging from 0 to 100, which is necessary for determining the final quality grade.

Determining the Final Quality Grade

Once the maturity and marbling scores have been determined, a USDA quality grade is assigned, with younger, higher marbled carcasses receiving the superior grades. USDA quality grades can be further subdivided into high (+), average (0), and low (-), based on the degree of maturity and the marbling score (Table 9-3 illustrates this within A maturity). Other factors that influence the final quality grade of a carcass are the color and texture of the muscle. If a carcass is determined to be a “dark cutter” (dark, often coarse ribeye muscle), it may be reduced one full quality grade (i.e., from USDA Choice to Select). This condition is usually associated with extreme excitability or stress prior to slaughter.

USDA Yield Grades

Beef yield grades refer to the cutability of the carcass and range from 1 to 5. These grades are based on the yield of boneless, closely trimmed retail cuts from the round, loin, rib, and chuck. Yield grade 1 indicates the highest yielding carcasses, and yield grade 5 indicates the lowest

Table 9-3. USDA Quality Grade with Corresponding Marbling Score, Assuming A Maturity

USDA quality grade	Necessary marbling score
Prime+	Abundant 0-100
Primeo	Moderately abundant 0-100
Prime-	Slightly abundant 0-100
Choice+	Moderate 0-100
Choiceo	Modest 0-100
Choice-	Small 0-100
Select+	Slight 51-100
Select-	Slight 0-50
Standard+	Traces 34-100
Standardo	Practically devoid 67-100—traces 0-33
Standard-	Practically devoid 0-66

Table 9-4. Corresponding Percent Closely Trimmed Retail Cut from the Chuck, Loin, Rib, and Round for Several Yield Grades

Yield grade	% Retail cut[1]	Yield grade	% Retail cut[1]
1.0	54.6	3.5	48.9
1.5	53.5	4.0	47.7
2.0	52.3	4.5	46.6
2.5	51.2	5.0	45.4
3.0	50.0	5.5	44.3

[1]*Calculated from the formula:*
% Retail cuts = 51.34 - (.0093 X hot carcass weight)
- (5.78 X adjusted fat thickness, 12th rib)
+ (.74 X ribeye area)
- (.462 X percent kidney, pelvic, and heart fat)

(Table 9-4). Official USDA yield grades are calculated to the nearest tenth (i.e., yield grade 2.7); however, only the whole number is placed on the carcass (i.e., yield grades 2.0 to 2.9 are assigned yield grade 2—the decimal is not rounded, but dropped).

The components used to calculate the USDA yield grade are: hot carcass weight; fat thickness over the ribeye at the 12th rib; ribeye area at the 12th rib; and percentage kidney, pelvic, and heart fat. The equation to calculate yield grade is as follows:

Yield grade = 2.5 + (.0038 x hot carcass weight)
+ (2.5 x adjusted fat thickness*, 12th rib)
- (.32 x ribeye area)
+ (.2 x percent kidney, pelvic, and heart fat)

**The fat thickness may be adjusted up or down from the actual measurement if the carcass appears to have more or less total fat than a typical carcass with that actual measurement. This actually allows an extremely lean carcass to have a negative adjusted fat thickness value.*

Yield grades of 1 to 3 are usually considered acceptable; grades of 4 and 5 are considered to be too fat and unacceptable. Even when yield-grade-4 and -5 carcasses are closely trimmed, there are large amounts of seam fat, which results in plate waste after cooking.

Factors that Affect USDA Grades

It is a long process from the seedstock producer to the cow-calf commercial cattleman to the backgrounder/finisher to the slaughter plant, and each of these steps can have an effect on the final yield and quality grade of the carcass. At some points the influence is genetic (seedstock producer); some, management (backgrounder/finisher and packer); and others, both (cow-calf producer). Some mistakes made in genetics can be compensated for through proper management, but mistakes in management usually result in inferior carcasses.

Breeding

The breed of the animal can have an influence on carcass characteristics, and different breeds or breed types should be managed differently. Smaller breed types usually require less time on feed to reach an acceptable quality grade (refer to Tables 5-2, 5-3 in Section 5—Planning the Breeding Program). If they are fed beyond that point, the result is an unacceptable carcass from a cutability (yield grade) standpoint. On the other hand, large breed types, particularly extremely lean breeds, require a much longer period of time on feed to reach an acceptable quality grade, which may result in the carcass having an unacceptable hot carcass weight (greater than 850 pounds). Another breed consideration is the influence of Zebu breeding in the cattle. A high percentage of Brahman breeding in fed cattle results in tougher, less desirable carcasses. These cattle often have acceptable yield and quality grades, but feeders and packers often discount prices for high percentage Brahman cattle because of the potential tenderness problem. However, with the proper mix of Brahman breeding and good management, the result is a lean acceptable carcass.

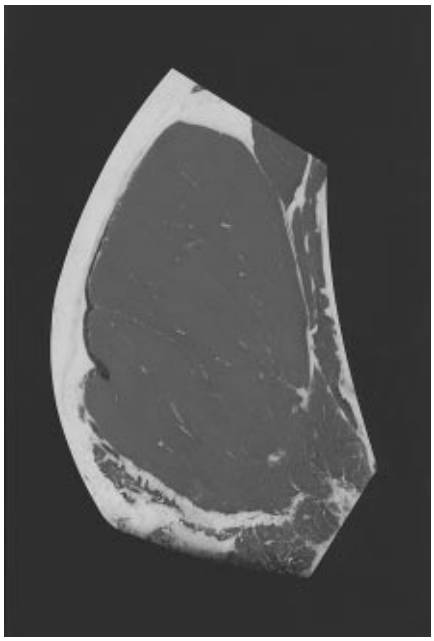
Some breeds offer expected progeny differences for carcass traits, allowing seedstock and commercial producers to select cattle with superior genetics for carcass characteristics within that breed. Other breeders progeny-test herd bulls by slaughtering their offspring and collecting carcass information. This information also can assist in making selection decisions for improved carcass performance.

Management

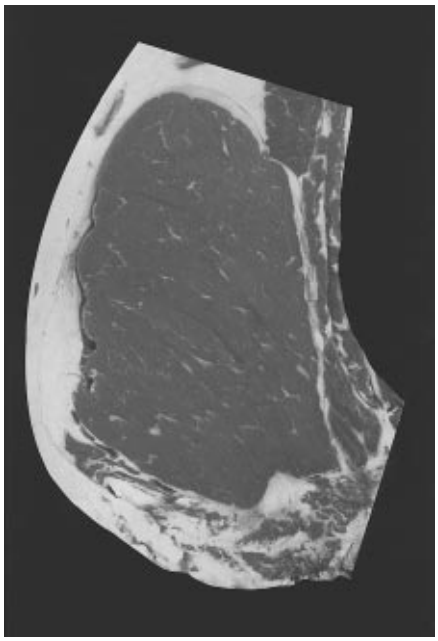
Management practices that influence carcass grades and acceptability start with the cow-calf producer. Proper injection sites are critical to the overall acceptability of the carcass. Blemishes resulting from injections can result in damage to the high price cuts of meat; therefore, be certain to avoid the round, loin, rib, and chuck (see Figures 6-1, 6-2 in Section 6—Health and Management Techniques for proper injection sites). If an injection site blemish is detected in one of these cuts, it often results in the condemnation of that cut and possibly the entire carcass. It is never to soon to practice proper injection site techniques, because even the first injection a calf receives can result in a blemish in the carcass.

Backgrounding cattle can have an influence on carcass grades, particularly quality grade. It has been determined

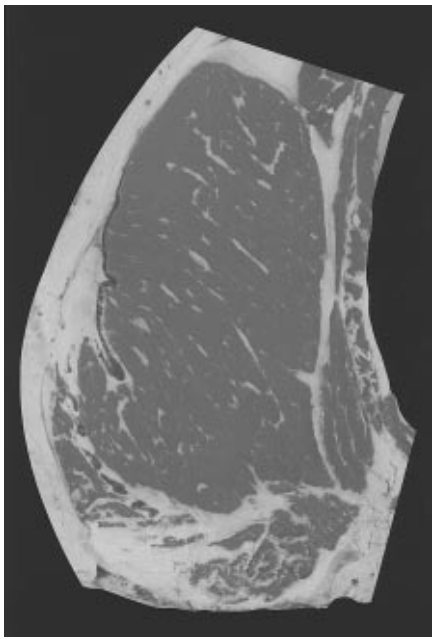
Figure 9-2. Examples of minimum marbling necessary for a carcass with A maturity to grade USDA Select, USDA Choice, and USDA Prime.



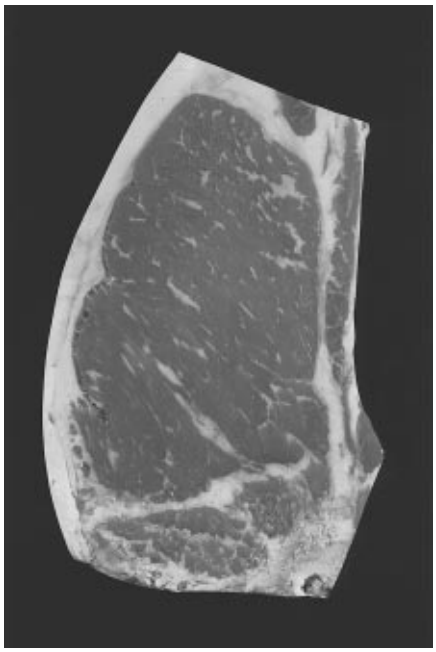
Slight (Sl^o)



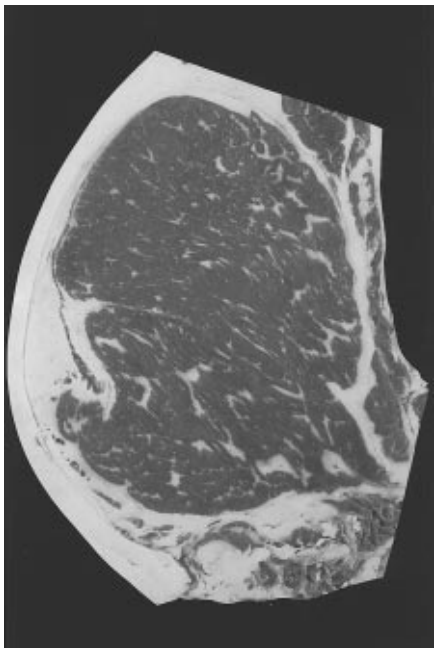
Small (Sm^o)



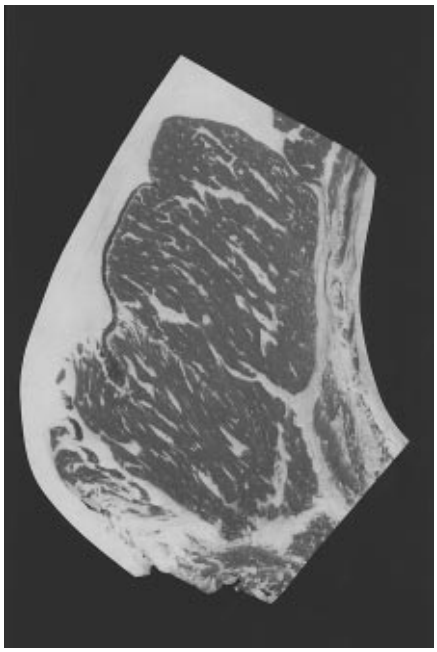
Modest (Mt^o)



Moderate (Md^o)



Slightly Abundant (SlA^o)



Moderately Abundant (MdA^o)

that calves entering the feed yard as yearlings have a higher percentage of choice, or better, carcasses than those entering the feed yard as weanlings. Also, calves not grown properly during the backgrounding phase can result in unacceptably heavy carcasses.

To produce cattle with acceptable carcasses, management considerations when the cattle enter the feedlot are critical. Most cattle fed in the United States are brought to the feed yard and sorted into pens based on their anticipated slaughter dates. Therefore, cattle expected to reach the proper slaughter endpoint are penned together. When it is determined that the pen, on average, is ready for slaughter, the entire pen is slaughtered. This is called an "all in, all out" system. If the feed yard management does a poor job of sorting cattle into their respective pens, a large number of unacceptable carcasses can result. On average, the pen might be slaughtered at the appropriate time, but there might be a large number of underfed cattle offset by a large number that are overfed. Therefore, sorting the cattle going into the feed yard is an important management practice. Many feed yards now depend on sophisticated machinery (including ultrasound) to determine expected

slaughter dates and sort the cattle accordingly. Most large feedlots do a good job of determining when the average of the pen is ready to slaughter, but, if mistakes are made, the entire pen could be either underfed or overfed, resulting in a large number of unacceptable carcasses.

Handling of the cattle in the feed yard, during transport to the slaughter plant, and while at the slaughter plant is important. Use extreme caution to avoid bruising the cattle, since bruises are condemned and must be removed from the carcass. Also, over stressed, excited cattle can result in "dark cutters," lowering the final quality grade.

Dressing Percent

Many producers and packers are interested in the dressing percent of their cattle. This makes sense, because most cattle are bought on a liveweight basis, but the packer has the carcass to sell. Therefore, the higher the dressing percent, the more pounds there are to sell. Factors that affect dressing percent are condition (fatter carcasses have higher dressing percents), amount of fill (more fill means lower dressing percent), and pregnancy status (pregnant heifers have low dressing percents). Dressing percent is calculated as hot carcass weight divided by the liveweight of the animal prior to slaughter times 100. Typical dressing percents for beef cattle are from 60 percent to 65 percent.

Using Carcass Information

Pricing of beef carcasses is based on USDA yield and quality grades, with higher quality, higher cutability carcasses commanding the highest prices. Currently, most of the economic benefit of producing high quality, high yielding carcasses is realized by the packers. However, there is some trickle down economics to producers, and producing better beef will result in increased market share, resulting in more demand, resulting in high prices all the way back to commercial and seedstock producers. In reality, under our current marketing system, most commercial cattlemen get little economic benefit from producing cattle that have superior carcass characteristics. Therefore, greater emphasis probably should be placed on reproduction, survivability, and growth since those are traits for which commercial producers are paid. However, if a producer is retaining ownership and being paid by the packer based on how his or her cattle perform on a carcass basis or is selling to a buyer that rewards for carcass performance, appropriate emphasis should be placed on carcass trait selection.

Section 10.

Marketing Beef Cattle

Lee Meyer

In marketing your beef cattle enterprise, you must make numerous decisions, including what types of cattle to produce, how many cows to maintain, when to calve, when and where to sell, what to feed, and whether to background. None of these decisions or the many others you will make should be based solely on market information. Make each decision using market price information, historical patterns, and analyses, along with on-farm production information.

The most profitable cattle operations produce cattle that meet the needs of the market while controlling production expenses. Feeder cattle prices vary widely, causing extreme differences in outcome between good and poor marketing decisions. In late August, 1996, Kentucky feeder cattle prices at auctions ranged from $32 per cwt to $66 per cwt for 400- to 500-pound steers. Reasons for these price differences include location, health, breed, frame and muscling (grade), lot size, and shrink (percentage of weight lost during marketing). Farmers who study these market factors and make careful decisions can consistently earn higher incomes.

The market factors described so far have focused on the short term and local market, but producers are influenced even more by the national beef market. Feeder cattle prices declined by more than 40 percent from early 1994 until late 1995. The collective actions of producers are a key factor affecting the national market. The beef consumption level is determined by producers—however much beef is produced will be consumed. But, if too much beef is put on the market, prices will drop as they did in the mid 1990s.

Contrary to producer perceptions, prices adjust at all levels of the system. Prices for live animals fluctuate the most, while prices at retail tend to move slowly. In the 1990s, the average retail price for beef varied from $2.93 (1993) to $2.81 (1990), while feeder cattle price varied from $101 per cwt (1991) to $72 (1995). These prices move together, but it generally takes several months for retail price changes to catch up with live animal price changes.

Why is it important for the feeder cattle producer to understand how the national beef market works? The national market sends signals about consumer preferences and long-run prices. For example, as described later in this section, cattle types (genetic crosses) that fit market needs consistently earn premiums. A Kansas study found premiums of $1.70 to $3.60 per cwt in 1993 for preferred types of cattle, completely separate from lot size, health, etc.

Changing consumer demands is the second key factor affecting beef prices. Figure 10-1 shows changes in per person consumption of the major meats. The stress on leanness, along with competition from poultry, has been the chief culprit in demand declines. If demand were as strong now as it was in the mid 1970s, the retail price of beef would be more than $1.50 per pound higher (more than 50 percent higher) than in 1996 and Kentucky feeder cattle prices would be about $40 per cwt higher.

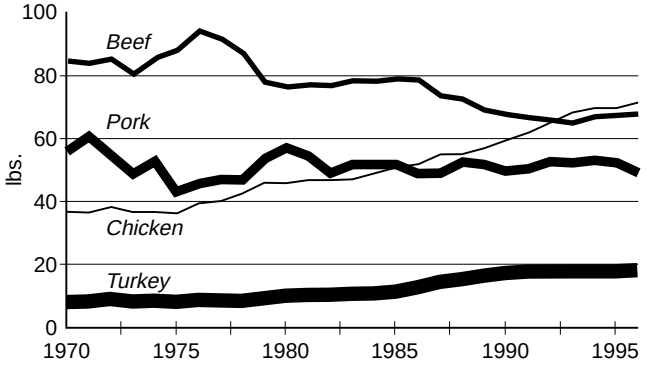
Some analysts believe some of the lost demand can be won back, but it will take a concerted effort by the whole beef industry. Decisions made by cow managers are critical to this effort. They must make breeding decisions that allow the rest of the industry to efficiently produce the beef consumers want. These breeding decisions should be directed by market signals.

Understanding the Beef Market

Feedlots are the primary source of beef consumed in the United States. However, non-fed cattle (cull cows, steers, and heifers directly off pasture) and imports are also significant, especially for processing and ground beef uses. Exports are becoming increasingly important to the U.S. beef industry. During 1995, the United States became a net exporter (exports exceeded imports) of beef for the first time. Since the United States imports relatively low quality beef and exports higher quality beef, the value of exports greatly exceeds the value of imports. Japan is the primary destination for U.S. beef exports. Some Kentucky producers are investigating strategic alliances with feeders and a packer to deliver beef to the Japanese market.

Beef prices are determined by supplies of beef, competition from other meats, changes in consumer attitudes, and changing institutions. Consumer preferences toward poultry and leaner foods has hurt beef demand since the early 1980s. Increasing supplies of all meats, leading to record

Figure 10-1. U.S. meat consumption—per capita, retail weight.



USDA Data, UK Ag. Econ. Dept. 12/96

high levels available to consumers, have reduced beef demand and prices. Increasing exports have been a key positive factor in beef demand, adding an estimated $3 to $5 per cwt to carcass beef price. For a while, beef prices stayed high even though supply was also high. This made some people believe supply would not influence prices. They were proven wrong. Supplies continued to increase, and prices started a crash in the spring of 1995, leading to a 20 percent decline in slaughter cattle prices and more than 40 percent drop in feeder prices.

Planning Around the Cattle Cycle

When calf production is profitable, managers tend to expand cow numbers. Eventually, the herd size increases and so does the amount of beef available to consumers. The result is lower prices and eventual losses for the cow-calf enterprise. The opposite occurs during periods of low calf prices. Managers typically reduce cow numbers, which eventually lowers beef production and leads to price increases. This pattern is known as the "cattle cycle." These cycles typically last eight to 12 years. During 1996, the United States entered the liquidation phase of the current cattle cycle, which is expected to continue for at least two years before supplies are low enough for prices to start increasing. Figure 10-2 shows the U.S. cattle inventory cycles of the past 45 years.

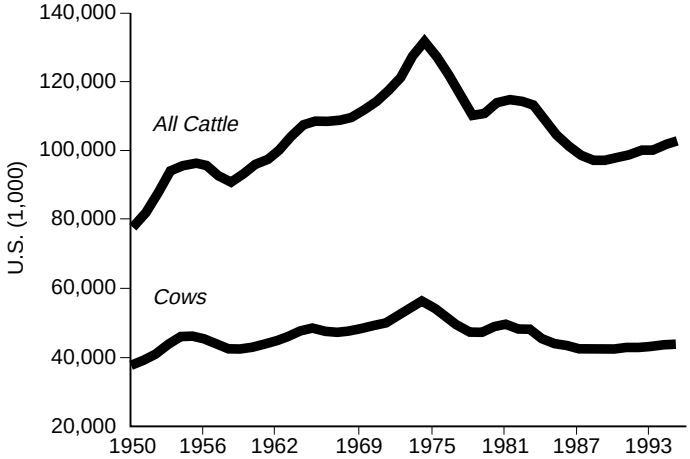
Increasing productivity of the cow herd has been a complicating factor. Since the early 1970s, the U.S. cattle industry has increased its production of beef per cow by 30 percent. Put another way, the amount of beef produced in 1970 could be produced today with 30 percent fewer brood cows. The bottom line is that today not as many cows are needed to produce the nation's beef supply.

Research shows that when cow slaughter is less than 13 percent of the January cow inventory, the size of the cattle herd increases. When cow slaughter exceeds 15 percent, the size of the herd declines. Cow slaughter during 1996 is around the 16 percent level, an indication that liquidation is in progress. This will increase beef supplies during 1997 but will lead to smaller beef supplies and stronger prices for 1998 if this cycle follows past patterns.

Feeder Calf Price Determination

At the national level, feeder cattle prices are determined by their value to cattle feeders and availability of feeders. Feedlot managers predict future slaughter cattle prices and estimate feed and other finishing expenses to determine how much they can afford to bid for feeders. If they are optimistic about slaughter cattle prices, they raise their bids. If feed costs rise, as they did during the 1995-96 crop year, they lower their bids. When large supplies of feeder cattle are available, feedlots can buy feeder steers and heifers at prices lower than their maximum bid prices.

Figure 10-2. U.S. cattle inventory cycles.



UK Ag. Econ. Dept.

Tremendous variety among feeder cattle means the cattle perform very differently in the feedlot. Some gain extremely efficiently. Feedlot managers might be willing to pay higher prices for these calves. Other calves do not do as well in the packing plant. These cattle may have a low yield of salable cuts, too much fat, or meat that grades low. For any of these reasons, feedlot managers might lower their bids for feeders.

This variation in quality leads to widely varied feeder cattle prices. On any given day at Kentucky markets, prices for calves in a given weight range can vary by $20 per cwt. Health, breed, frame size, and condition are important factors in determining prices.

Many price factors change over time. A Kansas State University study found that 1993 market prices declined about $5 per cwt for each 100 pounds of weight for steers weighing 300 to 600 pounds. In other words, the price for a 550-pound steer was about $5 per cwt less than for a 450-pound animal. For heavier animals (over 600 pounds), this discount was about twice as much as in 1987. By 1996, however, the situation had changed again due to much higher feed costs. The discount for heavier animals dropped to less than $1 per cwt per 100 pounds.

Breed/type differences also are important price factors. The same Kansas study found a difference of more than $11 per cwt due to breed/genetics. Exotic cross calves earned a $3.60 per cwt premium over Hereford "base" calves, with yearling steers getting a $1.90 per cwt premium. Feeder steers that were more than one-quarter Brahman received substantial discounts—more than $8 per cwt for calves and more than $3 for yearlings. These price differences change over time. Producers who make long-term breeding decisions based on past information might not have what the market wants. It is critical to consider past prices, but also to watch for trends. The current emphasis is on cattle that can efficiently produce Choice carcasses. Quality Continental/English cross cattle, especially "black-hided" ones, have been earning premiums.

Several other factors determine feeder cattle prices. Some are logical and result from the practicalities of the business. For example, a large lot (typically 40 to 50 head or more) receives higher prices because it transports and finishes the cattle more efficiently. Distance to the buyer is another important consideration. Competition in a given market is also critical and is difficult to measure. Even the reputation of cattle from a particular area can affect feeder cattle prices.

Marketing Alternatives

Many marketing alternatives are available to Kentucky cattle producers. Each alternative has advantages and disadvantages. Producers who select their marketing alternatives carefully can significantly increase their gross incomes.

Stockyards

There are more than 30 stockyard auction sales in Kentucky. A majority of Kentucky's feeder calves is sold through these outlets. Price levels at these markets are affected by the markets' competitiveness. Those with higher volumes attract more buyers and have higher prices. Because most of Kentucky's calves are sold in small groups even though buyers need large groups of similar cattle, stockyards serve an important role by providing places to co-mingle cattle. Buyers can buy various small groups, sort them, and leave the sale with truckloads of "like" animals. Stockyards also provide places where all types of cattle can be sold, unlike outlets that do not handle "off-market" calves or cull cows, for example.

Another advantage of the stockyard is that prices are determined in public auction bidding. This can be an advantage when there is enough buying pressure to ensure competitive prices. However, there are not always enough buyers, especially for certain classes of cattle. At some markets, only one or two buyers actively buy cull cows.

Public auction bidding is a good source of market information. The Kentucky Department of Agriculture (KDA) Livestock and Agricultural Services and USDA Agriculture Market Services have reporters at major markets who provide daily reports. These reports can be helpful for producers in selecting markets, watching market trends, and observing price differentials between classes of animals. You can receive a weekly report by mail by contacting the KDA at (502) 564-4896. You also can access daily market information for Kentucky and other markets and commodities through the University of Kentucky's World Wide Web site: **<http://www.ca.uky.edu/agcollege/agweather/Aginfo.html>**.

Even stockyards with strong competition might not be the best outlets for some situations. The cost of marketing through stockyards—in terms of fees, but also in terms of trucking and handling costs, cattle weight loss, and shrink—can be high. Using alternative market outlets might keep costs down, and the savings can be shared between buyer and seller. General purpose stockyard sales might not be well-suited for specific types of cattle, especially breeding stock. However, special sales to attract these buyers can work well.

To make the most of the stockyard sale, deliver good, healthy calves. Talk to the market manager to determine the best time to sell. To get the highest prices, have fresh calves for sale. This might mean delivering immediately before selling. In some cases, the cattle will be at the stockyard for some time. Make sure they have a good supply of clean water and palatable feed. Also, work with the sale manager about promoting your calves. If you plan to bring a group of good quality calves to market, tell the manager. He or she might be able to attract more buyers and generate better bids.

Direct Sales

A common marketing method when larger lots are to be sold is direct sales. Most direct sales are to order buyers and dealers, who buy directly off the farm. Without effective bidding, it is often difficult to determine the market value for direct sales, and buyers who trade on a daily basis usually have an advantage. Some managers market their cattle through direct sales to other farmers and/or to feedlots. These arrangements can reduce marketing costs but create problems with price determination. Both sides must agree on a price, plus adjustments for shrink, weights much different from the average, and quality differences. Sometimes a public market is used as a base. In addition, there is a greater financial risk of default with this choice.

Weighing conditions are a key technical aspect of direct sales. Feeder cattle typically lose 5 percent to 10 percent of their weight during marketing—this is called "shrink" or "drift." The weighing point location and conditions determine who takes this loss. For example, a "pencil shrink" (deduction in scale weight to account for actual loss) is a typical element of a direct sale. A buyer may agree to pay a specific price for a load of steers, "weighed on the truck, with a 3 percent pencil shrink." This means the truck would be weighed empty, travel to the farm, be loaded with the steers, and return to the scales for a loaded weight. The pay weight would be the weight of the cattle, less the 3 percent pencil shrink. The specification of weighing conditions is determined along with price in negotiations with the buyer.

Video-satellite Sales

An increasing number of cattle producers are using satellite-based sales agents to sell their calves. Most are larger operations, like producers which have backgrounded more than 100 calves. However, some smaller farms work with other farms to group their calves into attractive-sized lots and market them through electronic sales.

To sell through one of these agents, the seller consigns the cattle. The sales company then sends a representative to videotape the animals. A catalog of consigned groups of cattle is mailed to potential buyers. At a given time, a satel-

Example of Cattle Price Information from the Kentucky Livestock and Grain Market Report—1996

KENTUCKY CATTLE PRICES

BLUEGRASS STOCKYARDS: Bluegrass Stockyard* **BOURBON STOCKYARDS:** Bourbon Stockyards* **GREEN RIVER AREA:** Kentuckiana Livestock-Owensboro* **'PURCHASE AREA:** Mayfield ^,Livingston Co. *, Kentuckiana -Marion* **PENNYRILE AREA:** Christian Co ^, Russellville ^, Ky-Tn Stkyd^ **MAMMOTH CAVE AREA:** Bowling Green^, Glasgow ^ **'LAKE CUMBERLAND AREA:** Russell Springs *, Lake Cumberland*, Taylor Co.^ **BLUEGRASS AREA:** Mt. Sterling *, Paris* **NORTH EAST AREA:** Flemingsburg ^, Maysville*, **FORT HARROD AREA:** Lancaster *, Danville *

(*indicates weigh-out market, ^indicates weigh-in market) nq = no quote

	Bluegrass Stockyard 10/14,15,&16	Bourbon Stockyard 10/14&15	Green River Area 10/16	Purchase Area 10/14,15,&16	Pennyrile Area 10/10,15&16	Mammoth Cave Area 10/11&12	Lake Cumberland 10/12&16	Bluegrass Area 10/16&17	North East Area 10/14&15	Fort Harrod Area 10/11&14	High	Low	Median
Receipts:	6,748	5223					3745	3950	2368	3534			
Feeder Steers:													
Med & Lrg Frame #1													
300-399 lbs.	54.00 - 65.00	5				) - 61.75	50.00 - 64.00	53.00 - 62.00	51.25 - 59.00	56.00 - 64.50	65.00	49.00	57.63
400-499 lbs.	53.00 - 63.25	5				) - 60.50	50.00 - 62.25	51.50 - 60.00	50.00 - 59.00	56.00 - 66.00	66.00	44.50	56.10
500-599 lbs.	53.00 - 64.25	5				) - 58.75	50.00 - 56.00	53.00 - 59.75	50.00 - 57.00	54.00 - 63.00	64.25	40.50	55.21
600-699 lbs.	52.00 - 60.50	5				) - 57.00	47.00 - 56.00	53.25 - 58.50	50.00 - 57.95	53.00 - 61.60	63.00	47.00	54.57
700-799 lbs.	51.00 - 60.90	5				) - 56.00	50.00 - 58.50	55.00 - 62.45	51.00 - 54.40	54.00 - 61.00	62.45	47.00	54.48
800-1000 lbs.	56.00 - 61.70	5				) - 57.10	51.50	55.25 - 63.05	51.00 - 54.40	51.50 - 60.20	63.05	47.00	55.36
Small Frame #1													
300-399 lbs.	40.00 - 50.00					) - 44.00	40.00 - 50.00	45.00 - 53.00	46.50 - 53.00	46.00 - 54.50	54.50	35.00	45.65
400-499 lbs.	35.00 - 46.00	4				) - 48.00	40.00 - 50.00	46.50 - 55.00	46.50 - 53.00	46.00 - 54.50	55.00	35.00	45.37
500-599 lbs.	38.00 - 43.00	4				) - 48.00	40.00 - 49.50	47.00 - 54.00	45.00 - 51.25	47.00 - 54.00	54.00	35.00	45.03
Feeder Heifers													
Med & Lrg Frame #1													
300-399 lbs.	43.00 - 50.50	4				5 - 47.50	40.00 - 50.00	40.00 - 49.50	41.25 - 51.00	42.00 - 48.00	53.50	40.00	45.50
400-499 lbs.	42.00 - 52.50	4				) - 48.00	40.00 - 49.50	45.00 - 54.00	45.00 - 47.50	42.50 - 53.00	57.50	40.00	47.48
500-599 lbs.	44.00 - 52.25	4				) - 50.00	40.00 - 51.00	45.00 - 54.50	42.50 - 48.75	44.00 - 52.50	55.50	38.00	47.35
600-699 lbs.	45.00 - 54.50	5				) - 49.50	40.00 - 50.00	45.00 - 53.50	43.25 - 49.25	45.00 - 54.00	57.75	40.00	48.61
Over 700 lbs.	47.00 - 54.50	4				) - 50.50	45.00 - 47.00	44.00 - 53.00	43.25 - 51.60	47.50 - 56.00	56.00	38.00	48.61
Small Frame #1													
300-399 lbs.	25.00 - 40.00	3				) - 34.00	28.50 - 42.00	30.00 - 43.00	33.00 - 40.00	34.50 - 44.00	46.00	25.00	35.80
400-499 lbs.	25.00 - 40.00					) - 38.00	28.50 - 46.00	36.00 - 45.00	33.00 - 41.50	34.50 - 44.00	46.00	25.00	36.50
500-599 lbs.	37.00 - 45.00					) - 38.00	32.00 - 40.00	35.00 - 43.00	33.00 - 43.00	35.00 - 41.00	45.00	29.00	36.64
Slaughter Cows													
Bkg Ut & Comm 3-5	27.50 - 33.00	3				) - 31.00	26.50 - 33.50	27.00 - 33.75	24.75 - 31.00	30.25 - 34.75	35.00	24.75	30.18
Hg Cut & Bon Ut 1-3	28.00 - 33.50	3				) - 31.00	27.50 - 35.50	30.00 - 36.00	29.00 - 34.25	30.25 - 35.25	36.00	25.00	30.88
Cutter 1-2	24.75 - 29.00	2				20.00 - 28.50	22.00 - 29.00	26.00 - 30.00	25.50 - 29.50	26.00 - 30.50	31.00	20.00	28.46
Slaughter Bulls													
Yield Grade #1	35.00 - 42.25	37.00 - 40.00	nq	37.50 - 38.25	nq	36.50 - 40.00	37.00 - 39.50	38.00 - 40.50	37.00 - 43.00	36.25 - 40.75	43.00	35.00	38.66
Yeild Grade #1-2	28.00 - 35.75	34.00 - 37.00	34.00 - 38.00	33.00 - 37.50	30.00 - 37.00	30.00 - 36.50	32.75 - 38.00	32.00 - 38.00	32.00 - 39.00	33.25 - 37.75	39.00	28.00	34.68
Slaughter Steers													
Choice 2-3	nq	67.75 - 68.60	nq	nq	nq	nq	nq	nq	nq	nq	68.60	67.75	68.18
Slaughter Heifers													
Choice 2-3	nq	nq	nq	nq	nq	nq	nq	nq	nq	nq	0.00	0.00	#DIV/0!
Stock Cows & Calves													
Med & Lrg. Frame #1	320.00 - 585.00	nq	355.00 - 455.00	300.00 - 355.00	320.00 - 500.00	330.00 - 460.00	340.00 - 540.00	320.00 - 410.00	*225.00 - 410.00	295.00 - 510.00	585.00	295.00	400.29
Stock Cows													
Med & Lrg Frame #1	245.00 - 420.00	nq	nq	250.00 - 300.00	355.00	nq	245.00 - 415.00	350.00 - 460.00	*275.00 - 330.00	280.00 - 410.00	460.00	245.00	338.33
Baby Calves	15.00 - 35.00	nq	40.00 - 70.00	15.00 - 100.00	15.00 - 45.00	5.00 - 70.00	5.00 - 43.50	20.00 - 32.50	*12.00 - 62.50	3.00 - 57.50	100.00	3.00	37.29

Med & Lrg Frame #1
300-399 lbs. 54.00 - 65.00
400-499 lbs. 53.00 - 63.25
500-599 lbs. 53.00 - 64.25
600-699 lbs. 52.00 - 60.50
700-799 lbs. 51.00 - 60.90
800-1000 lbs. 56.00 - 61.70

Small Frame #1
300-399 lbs. 40.00 - 50.00
400-499 lbs. 35.00 - 46.00
500-599 lbs. 38.00 - 43.00

Feeder Heifers

Compared to last week: Slaughter Steers steady to .50 higher. Slaughter Heifers untested. Slaughter Cows mostly steady to 1.00 lower.Slaughter Bulls mostly steady.Feeder Steers.and Feeder Heifers mostly steady to 1.00 lower. Some price strenght occurred on cattle over 700 lbs. on mid to late week sales.

*Maysville only

Boyle County Stockyards
October 14, 1996
Danville, Ky
Feeder steers:
54 head 867 lbs. 60.20
Feeder Heifers:
21 head 709 lbs. 52.10

Gateway Livestock
October 16, 1996
Mt. Sterling, Ky
Feeder Steers:
69 head 674 lbs. 57.90
56 head 731 lbs. 59.70
Small & Med Frame #1-2
98 head 455 lbs. 47.80
90 head 569 lbs. 50.70
Feeder Heifers:
Small & Med Frame #1
31 head 591 lbs. 44.00

Christian County Livestock
October 16, 1996
Hopkinsville, Ky
Feeder Heifers:
31 head 400 lbs. 46.50
25 head 454 lbs. 48.50
37 head 495 lbs. 49.00
24 head 647 lbs. 49.50

Livingston County Livestock
October 15, 1996
Ledbetter, Ky
Feeder Steers:
68 head 685 lbs. 60.50

lite broadcast provides visual information about the offerings and buyers call in their bids in an auction format. When a sale is consummated, buyer and seller negotiate final delivery conditions. Research, conducted by DeeVon Bailey (at Utah State University) and others, found that this method earned price premiums and reduced marketing costs in general, but not in every situation. This suggests that satellite sales are not for every producer, but that they can be an effective marketing method when chosen carefully.

Group Sales, Special Sales, and Strategic Alliances

A broad array of pilot marketing activities is emerging in Kentucky. Some, such as the sales of Certified Preconditioned for Health (CPH) calves in Western Kentucky, have been successful for several years. Replacement heifer sales and the Gold Tag program are other merchandising efforts meeting the needs of selected producers. All of the cattle in these sales have been selected to meet a market need. They attract buyers who have a particular interest in the selected type of cattle and provide good markets and rewards for those producers.

Several strategic alliance efforts that would connect Kentucky farmers with feedlots and, in some cases, packers are being investigated. Strategic alliances are arrangements between buyers and sellers with a longer term agreement. The concept is that by working together, both sides benefit. Because these are new efforts, details are still being developed. For example, if some of the benefits do not come until six months after the feeder calves are sold, how is the producer paid?

Selecting the "Best" Market

The market selection decision must be made by matching the characteristics of the market with the needs of the farm. For example, farms with only a few head to sell should not try to sell directly.

Price, the key factor, may be difficult to know ahead of time, especially since market intelligence is limited for nonpublic market outlets. Most farmers make decisions by gaining experience and talking with neighbors. These are currently about the only ways to get information about di-

rect sales prices, although Extension and market personnel are working on this problem.

When it comes to comparing markets—for example, two stockyard auctions—consider several factors. Obviously, the overall price level is crucial. Compare price levels by watching market news reports over a long period of time for the specific class of cattle to be sold. You also can consider market fees; however, they rarely vary enough to be a decision factor. Usually, the most important factor is shrink.

The difference in the direct transportation cost of hauling between two markets that are, for example, 20 miles and 60 miles from home might not be large. If the cattle lose an extra 2 percent of their weight traveling to the farther market; however, that might add a transportation cost of $5 to $10 per head.

In some parts of Kentucky, cattle are still being weighed when they are received at the market (the in-weigh system). While the farmer gets paid for a greater amount of weight, lower prices at these markets tend to more than offset the weight gain. The in-weigh system also encourages farmers to fill or "load" their cattle before hauling. This puts extra stress on the calves, adding to transportation health problems. The result is lower valued cattle and damage to the reputation of cattle from those areas.

Connecting Marketing with Production Decisions

Market information is essential in guiding production decisions, which range from selection of genetic types to short-term selling decisions. Seasonal price indices can be helpful in timing of marketing and design of production systems. A seasonal price index shows how the average price in a given month compares to the annual price. Table 10-1 shows seasonal feeder cattle price indices for 1993 through 1995. The following example shows how to interpret the table. The price index for 400- to 500-pound steers for March is 1.03. This means prices for these steer calves averaged 3 percent over the average annual price. The .95 index for November indicates that calf prices averaged 5 percent under the average annual price. Although these indices are history, they are a good indicator of future trends. In general, calf prices show more extreme seasonality than yearling prices. Also, calf prices tend to peak in early spring, while yearling prices tend to peak in early summer.

The goal of the cattle enterprise is not to maximize price, but to earn the greatest profit. Selling in the fall might be the most profitable as long as costs are enough lower to compensate for the lower prices. Farmers frequently face difficult marketing decisions in late summer and early fall, as the prices of their calves decline but weights continue to increase. The decision can be made by using a short-term budget framework, such as this example of a fall sale decision:

> Suppose calves weigh 400 pounds in mid September with a market price value of $60 per cwt. The value per head would be $240. The typical change in price, based on the price index, is a drop of 4 percent from mid September to mid October. If the calves are gaining weight at a rate of one pound per day, the steers would weigh 430 pounds in mid October. The 4 percent price adjustment, along with a slight discount for the heavier weight, would give an expected price of $57 per cwt, or a value per head of $245 ($.57 x 430 pounds). The gain in value per head is only $5. If it costs more than $5 per head to keep the calves for the month, the calves should be sold in mid September.

Table 10-1. Seasonal Price Indices for Kentucky Feeder Steers ('93, '94, '95 avg.)

	300-400 lbs	400-500 lbs	500-600 lbs	600-700 lbs	700-800 lbs
Jan	1.01	1.00	0.99	1.01	1.03
Feb	1.04	1.04	1.01	1.00	1.01
Mar	1.08	1.08	1.06	1.03	1.02
Apr	1.04	1.04	1.05	1.01	0.98
May	1.00	1.01	1.02	0.99	0.96
Jun	0.99	1.01	1.01	1.01	0.99
Jul	0.98	0.98	1.00	1.01	1.02
Aug	0.99	0.99	1.01	1.02	1.03
Sep	0.96	0.97	0.98	1.00	1.01
Oct	0.95	0.95	0.95	0.96	0.98
Nov	0.97	0.96	0.96	0.98	0.99
Dec	0.98	0.97	0.96	0.98	0.99

Section 11.

Economics of Beef Production

Paul Joerger

Management

Successfully managing a farm is the goal of most producers. Management is an important component in determining the longevity of a farm business. Skillful managers continually search for resources to improve the quality of their management and convert data from various sources into information that enhances their knowledge base. Each day, new information is available, requiring managers to re-evaluate prior decisions or determine if the new information benefits their farm businesses. New technology, like new or improved feeds, beef production software, carcass quality EPDs, health products, or carcass quality data, provides information that must be interpreted by farm business managers.

What exactly is farm management? Farm management is the decision-making process aimed at meeting the goals of the farm business. Decisions center around the efficient allocation of limited resources (e.g., land, labor, and capital).

Management sometimes is better understood by looking at the functions a manager performs. The functions are planning, implementation, and control. The planning function involves defining issues and collecting data. After the data is analyzed and various options are identified, the manager selects the best alternative. The implementation function involves implementing the plan developed during the planning phase. It can entail purchasing inputs, applying health products, selecting bulls, marketing the cattle, and all of the other tasks involved in production, financing, and marketing. The control function involves record keeping and the analysis of information. Decisions to change are made as a direct result of analyzing gathered information. This information is also used to enhance the planning process when it begins again.

Identifying the goals of the business is one of the most important tasks a farm manager performs. These goals provide the basis for making management decisions and serve as a measuring stick to evaluate progress. A manager must be a good decision maker to fulfill the goals. The decision-making process is as follows:

- Identify the issue/opportunity/problem.
- Collect relevant information.
- Identify and rank potential solutions.
- Make the decision.
- Implement the decision.
- Monitor the decision to determine if goals are being met.

Effective managers are good decision makers. They spend time planning and executing business plans with precision. Record keeping is vital to the success of effective managers. These managers make adjustments to plans with information gained through record keeping.

Factors of Production

Four factors of production are involved in producing beef. These factors comprise the resource base that produces income. The four factors are land, labor, capital, and management. Availability of these resources is different for each farm business. In fact, all farms have limited amounts of land, labor, capital, and management. It is important to understand what is involved in each factor of production to properly manage a farm.

Land represents the most basic input for beef production. Forages and feed grains are produced on the land. Forages are either grazed or mechanically harvested, while most grains are harvested mechanically. The quantities of forage and feed grains harvested are dependent on many factors. The quality of the land producing forages and feed grains has a major impact on the quantity harvested. Since land plays a key role in forage and crop production, an inventory of the land can determine the potential production level of the farm. Some land characteristics include:

- land classification (I - VIII)
- soil types (Elk, Nolin, Lowell, etc.)
- productivity (yield per acre)
- land use classification (pasture, cropland, timber, etc.)
- property rights (easements, zoning, restrictions)
- commodity quotas, allotments, marketing contracts
- water quality, quantity, location, surface, subsurface

Identification of these characteristics helps the farm manager determine the best use of the land. To illustrate, the following example of land use could produce several thousands of pounds of beef: a 100-acre pasture described as class III, Faywood-Cynthiana soil type, 200 animal-unit-days of productivity per acre (fescue), no easements or zoning restrictions, tobacco quota of 0 pounds, one 2-acre spring fed pond. This land description clearly portrays the production potential. Beef cattle can convert forages into meat, which adds value to the land resource. The market value of land is determined by its productivity (beef production), location, highest and best use, and other factors. The value of pasture land is primarily determined by the profitability of the livestock enterprises grazing the pastures.

Labor is the second factor of production. Even though technology can displace labor for some farm tasks, most beef cow-calf operations require about nine hours of labor per cow per year. Substituting capital for labor is somewhat limited for cow-calf operations. Labor at calving time can't be reduced significantly or eliminated with technol-

ogy. Feeding the beef herd in the winter is another caretaking task that requires labor. There haven't been any recent technological advances to reduce the time spent winter feeding. Technology is more prevalent for backgrounding beef calves in confined areas. Automatic feeding systems are sometimes used with this type of beef enterprise. Feedlots use significant amounts of capital and technology to minimize the quantity of labor in finishing cattle.

Farm labor is either skilled or unskilled. Skilled labor employees are involved in making decisions, while unskilled laborers typically are given tasks to perform without the opportunity to provide much input. Family labor can be skilled or unskilled and is an important component on many Kentucky beef farms. Typically, this labor source is reliable, high quality, and skilled. Successful large beef operations have managers who hire, train, motivate, and satisfactorily compensate qualified employees. Managing labor as a valuable farm asset can reward the business with additional profits.

Capital, the third factor of production, includes items like breeding stock, machinery, and buildings. Capital also includes the quantity of credit available from lending institutions. This type of capital is used to purchase other capital items or pay operating expenses. Large amounts of capital are needed to produce, background, and finish beef calves (Table 11-1).

Management is the fourth factor of production. Management involves the people who make the decisions on the farm. The goal of management is to obtain the proper mix of land, labor, and capital to meet the goals set forth. Astute managers incorporate short- and long-run goals and planning into their management strategies.

Management fees can be either cash or noncash expenses. Management is a noncash expense for most sole proprietors producing beef. However, professional farm property management companies charge a fee of 7 percent to 10 percent of gross farm returns to manage farm property for owners. The management fee for experienced farm managers is larger than that for inexperienced managers due to their ability to create higher beef returns.

Financial Management

Financial management of the farm's resources is an integral component of managing the farm. Preparing enterprise budgets helps the farm manager determine the level of profitability of each beef enterprise. The profitability of each enterprise is then divided by the assets dedicated to that enterprise to determine the return on assets (ROA). The ROA measures the financial performance of assets and is one financial tool used to compare the performance of different enterprises. Let's examine the basic components of profitability, which are revenue and expenses.

Table 11-1. Capital Needed for a Cow-calf Enterprise

Land and improvements	
(2 acres per cow @ $1,000/acre)	$2,000
Breeding stock (cow, bull)	550
Equipment	100
Building(s)	50
Total investment per cow	$2,700

This example assumes the land is purchased for exclusive use of a cow-calf enterprise. Renting pasture instead of purchasing land for pasture can reduce the per cow investment to $700.

Revenue associated with beef enterprises is the value of livestock that is sold or could have been sold. Revenue sources are different for each type of beef enterprise. For example, a cow-calf enterprise could have revenue from heifer calves, steer calves, cows, and bulls. If the producer raises heifers as replacements, yearling heifers and 18-month-old heifers should be included as revenue sources. This amounts to six possible sources of revenue from six different products. What further complicates the total cow-calf enterprise revenue is that each revenue source (product) has a different value per pound. When the break-even price is calculated, it is meaningless because several products are involved.

Converting all sources of cow-calf revenue to hundredweights-of-steer equivalent (HSE) can assist in calculating a meaningful break-even, which is useful in marketing beef calves at a profitable level (Table 11-2).

The average pounds of beef sold per cow is 642, with an average revenue per head of $395.61. The average selling price is $69.19 per cwt. These three pieces of data are not meaningful because they are an average of beef cattle of different ages, genders, and classes. The hundredweights-of-steer equivalent method of determining break-even is calculated by dividing the average revenue per cow ($395.61) by the steer price ($80/cwt), which yields 4.945 of HSE. So, 4.945 HSE multiplied by $80 per cwt (steer price) produces $395.61 of revenue per cow. If, for example, the cost of production (COP) per beef cow per year is $375, this value ($375) is divided by 4.945 (HSE) to produce a break-even steer price of $75.83 per cwt. Since the steer calves sold for $80 per cwt, the net income per cow is $4.17 per cwt or $20.61 (4.17 X 4.945) per head.

Calculating revenue for backgrounding or feedlot beef enterprises is less complex because calves/feeders are sorted by gender. These market cattle (heifers or steers) are sorted and managed as separate products within the same enterprise. Examples of revenue for backgrounding (calves-to-feeders) and feedlot (feeders-to-fed) enterprises are found in Table 11-3.

The sale weight (after shrink adjustment) and price (after sales expenses) are the values for which the producer receives payment. Often times, the terms for these values are pay weight and pay price. It is common for packing plants that purchase fed cattle to apply a 4 percent pencil shrink factor to the cattle weight prior to shipping. Shrink is a reduction in weight loss due to loss of body fluids and tissue when both water and feed are withheld from the cattle. Therefore, pay weight is 4 percent less than the actual scale weight.

Table 11-2. Calculating a Breakeven Point for a 100-cow Herd

Sales	lbs/hd	$/unit	$ per herd	$ per cow
45 steers	550	$.80/lb.	$19,800	$198.00
25 heifers	525	$.75/lb.	$ 9,844	$ 98.44
13 cows	1,000	$.45/lb.	$ 5,850	$ 58.50
1 bull	2,000	$.60/lb.	$ 1,200	$ 12.00
2 yearling heifers	725	$.70/lb.	$ 1,015	$ 10.15
3 18-mo. heifers—open	950	$.65/lb.	$ 1,852	$ 18.52
inventory adjustment	0	$.00/lb.	$ 0	$ 0
Total—89 head	57,175 lbs.	-----	$39,561	-----
Average— -----	642 lbs.	$69.19/cwt	-----	$395.61
HSE breakeven	($375/4.945)	$75.83/cwt		

Some buyers of backgrounded calves also apply a pencil shrink factor to the scale weight if they are sold direct.

Examining **expenses** (costs and expenditures) associated with operating a farm business is another responsibility of the manager. Classifications of costs include variable, fixed, opportunity, short-run, long-run, cash, and noncash. Defining each of these costs is useful in understanding how to manage them to accomplish goals.

Variable costs change with the level of production and are associated with variable inputs. If production is incurred, these costs cannot be avoided. *Fixed costs* do not change with the level of production and are incurred even if production does not take place. These costs are associated with fixed inputs like breeding livestock, machinery/equipment, land, and buildings.

An *opportunity cost* is the value of a product not produced because an input was used for another purpose. Stated differently, it is the income that could have been received if the input(s) were directed to the most profitable alternative use. *Short-run costs* are costs associated with a time period where at least one production input is fixed. A time period where all production inputs are variable is considered *long-run*. As the planning horizon increases, the number of fixed inputs decreases. *Cash costs* are expenses that reduce the checking account balance. *Noncash expenses* include costs like depreciation, unpaid operator labor, and management. Normally, a check is not written for these expenses.

Understanding cost categories can help producers calculate the cost of producing beef and develop strategies to reduce production costs. Farm expenditures are outlays of cash associated with the farming business. Farm expenditures can include disbursements of cash for principal payments, purchasing capital assets, and most farm operating expenses. A cash farm expenditure is not necessarily a farm expense, and a farm expense is not always in the form of cash. Principal paid on an operating note and pickup depreciation are examples of this. Table 11-4 categorizes selected farm costs and expenditures.

Capital expenditures for producing beef represent a large portion of the cash required to operate a beef enterprise. Capital expenses can include items like fencing, land, working facilities and other buildings, breeding livestock, machinery, and equipment. If the capital investment per cow is high, the net returns per cow should be high to achieve an acceptable rate of return on assets. This rate can be improved by increasing the net returns per cow, reducing the capital investment per cow, or both.

Enterprise Budgets

An enterprise budget is an estimate of returns, expenses, and net returns for a specific enterprise. This budget is useful in comparing similar enterprises and can serve as a planning tool in preparing other financial budgets. The unit-cost of producing beef is calculated using an enterprise budget, and this facilitates developing strategies to market the cattle at a profitable level.

There are enterprise budgets for each type of beef enterprise. The types are cow-calf, backgrounding, and finishing. The cow-calf budget is more complex than the other two. Factors that complicate the cow-calf budget include multiple products, accounting for death loss of raised versus purchased cattle, accounting for raised versus purchased replacements, determining the value of farm-raised feeds, and the quantity of feed fed to different classes of cattle. Maintaining an accurate inventory of the cattle for different dates throughout the year is a challenging task, but it is useful in isolating beef production problems like death loss, slow rates of gain, low conception rates, etc.

Table 11-5 displays a cow-calf herd inventory, by event. This is prepared for a 100-cow herd as of January 1 of a calendar year. It is important to examine the enterprise budget assumptions before reviewing an enterprise budget.

The enterprise budget in Table 11-6 is prepared using three methods of computation: cash, financial, and economic. A **cash** enterprise budget includes expenses normally paid in cash. Consequently, several items are excluded using this method. These items are depreciation, unpaid labor, management, and interest on equity capital. If forages are raised

Table 11-3. Revenue for Backgrounding and Feedlot Enterprises

	hd	lbs/hd	$/lb	total	total (per head)
Backgrounding Steers *(calves-to-feeder)*	100	750	$.70	$52,500	$525.00
Feedlot Steers *(feeders-to-fed)*	100	1,200	$.65	$78,000	$780.00

Table 11-4. Farm Costs and Expenditures

Item	Variable cost	Fixed cost	Expenditure	Cash outlay	Noncash outlay
Interest-breeding herd note		X	X	X	
Property taxes	X	X	X		
Property insurance		X	X	X	
Accounting and tax preparation		X	X	X	
Pickup depreciation		X			X
Unpaid operator labor		X			X
Management		X			X
Purchase 20 bred heifers			X	X	
Principal payment—pickup			X	X	
Principal on operating note			X	X	
New fence			X	X	
Health supplies	X		X	X	
Marketing	X		X	X	
Interest—operating note	X		X	X	
Pasture lease (1 year)	X		X	X	
Machinery repairs	X		X	X	
Fuel	X		X	X	
Mineral and protein supplements	X		X	X	
Purchased hay	X		X	X	
Herbicides and fertilizer	X		X	X	
Pregnancy testing	X		X	X	
Estrus synchronization	X		X	X	

Table 11-5. Assumptions, Spring-calving Herd Inventory by Event

	Beginning inventory	Births	Transfers in	Purchases	Deaths	Sales	Transfers out	Ending inventory
Cows	85		15 (from BH)		1	14		85
Calves—steers (CS)	0	49			4*	45		0
Calves—heifers (CH)	0	49			4*	23	22	0
Open heifers (OH)	22		22 (from CH)			2	20	22
Bred heifers (BH)	15		20 (from OH)			5	15	15
Bulls	4			1		1		4
Total	126	98	57	1	9	90	57	126

** 3 deaths at birth and 1 death from birth to weaning*
Cow death loss—1%
Calf death loss at birth—5%
Calf death loss (birth to weaning)—2%
Breeding herd replacement rate—15%
No. of cows open at beginning of calving season—2
Open heifers sold in spring
Calves, cull cows, bulls, and bred heifers sold in fall

Other Enterprise Budget Assumptions
- *cattle inventory values did not change from January 1 to December 31*
- *hay was purchased*
- *pasture was leased at $20/acre with 2 acres per cow*
- *no debt on capital items like machinery, cattle, buildings*
- *management fee is 10 percent of returns*
- *net returns (cash) are returns to equity capital, unpaid labor, management, depreciation, risk*
- *net returns (financial) are returns to equity capital, unpaid labor, management, risk*
- *net returns (economic) are returns to risk*
- *breakeven is calculated on the basis of hundredweights-of-steer equivalent (HSE)*

on the farm, the cash costs of producing the forage are listed under feed costs. The **financial** method of preparing an enterprise budget includes all cash costs and depreciation. Farm-raised feeds are normally valued at the prevailing market price. This valuation is different from the cash method but similar to the economic method. Calculating the cost of production by the **economic** method includes all costs with the addition of equity interest, unpaid labor, and management. All factors of production receive a return under the economic cost of production method. Typically, the cost of producing beef is the highest using this method.

Table 11-6 presents the cost of production for each method. The cash method has the lowest cost of production with $318 per head or $70.95 cwt per HSE. Financial and economic costs of production are higher with $338 or $75.41 and $493.86 or $110.18, respectively. Net returns were $40.56 for the cash method as compared to $20.56 for the financial method. The economic method falls short of achieving a profit by $135.30. It is difficult for most enterprises in agriculture to realize a profit using the economic method. The goal of all producers, however, should be to pay all costs associated with the economic method.

Table 11-6. Commercial Cow-calf Budget, Spring-calving Herd

						Cost of production method					
						Cash		Financial		Economic	
			Amount	Unit	Price	Total	Per cow	Total	Per cow	Total	Per cow
Expected returns											
	No.	**Wt.**									
Steer calves	45	475	21,375	lb.	.80	$17,100	$171.00	$17,100	$171.00	$17,100	$171.00
Heifer calves	23	425	9,775	lb.	.75	7,331	73.31	7,331	73.31	7,331	73.31
Cull cows	14	1,000	14,000	lb.	.40	5,600	56.00	5,600	56.00	5,600	56.00
Bull(s)	1	1,800	1,800	lb.	.55	990	9.90	990	9.90	990	9.90
Yrlg. heifers	2	900	1,800	lb.	.70	1,260	12.60	1,260	12.60	1,260	12.60
18-mo. heifers	5	1,100	5,500	lb.	65	3,575	35.75	3,575	35.75	3,575	35.75
Inventory chg.	0										
Total returns			**$53,250**			**$35,856**	**$358.56**	**$35,856**	**$358.56**	**$35,856**	**$358.56**
Variable costs											
Feed											
Hay			1.75	ton	$40	$7,000	$70.00	$7,000	$70.00	$7,000	$70.00
Grain			5.0	bu.	3.00	1,500	15.00	1,500	15.00	1,500	15.00
Salt/mineral			75	lb.	.20	1,500	15.00	1,500	15.00	1,500	15.00
Pasture maint.			2.0	ac.	25.00	5,000	50.00	5,000	50.00	5,000	50.00
Vet and medicine			1	hd.	15.00	1,500	15.00	1,500	15.00	1,500	15.00
Livestock supplies			1	hd.	5.00	500	5.00	500	5.00	500	5.00
Breeding			1	hd.	20.00	2,000	20.00	2,000	20.00	2,000	20.00
Marketing			1	hd.	9.00	900	9.00	900	9.00	900	9.00
Repairs (mach./build./fence)			1	hd.	15.00	1,500	15.00	1,500	15.00	1,500	15.00
Machine hire			1	hd.	2.00	200	2.00	200	2.00	200	2.00
Fuel and lube			1	hd.	5.00	500	5.00	500	5.00	500	5.00
Hired labor			1	hd.	20.00	2,000	20.00	2,000	20.00	2,000	20.00
Interest—operating			1	hd.	10.00	1,000	10.00	1,000	10.00	1,000	10.00
Misc.			1	hd.	2.00	200	2.00	200	2.00	200	2.00
Total variable costs						$25,300	$253	$25,300	$253	$25,300	$253
Return over Variable Costs						$10,556	$105.56	$10,556	$105.56	$10,556	$105.56
Fixed costs											
General overhead						1,000	10.00	1,000	10.00	1,000	10.00
Property taxes/insurance						500	5.00	500	5.00	500	5.00
Interest						0	0	0	0	10,000	10.00
Depreciation						0	0	2,000	20.00	2,000	20.00
Hired labor						1,000	10.00	1,000	10.00	1,000	10.00
Unpaid operator/family labor						0	0	0	0	2,000	20.00
Leases (land, mach., bldg., etc)						4,000	40.00	4,000	40.00	4,000	40.00
Management						0	0	0	0	3,586	35.86
Other						0	0	0	0	0	0
Total fixed costs						$6,500	$65.00	$8,500	$85.00	$24,086	$240.86
Total Costs						$31,800	$318.00	$33,800	$338.00	$49,386	$493.86
Net returns						**$4,056**	**$40.56**	**$2,056**	**$20.56**	**$-13,530**	**$-135.30**
Breakeven (HSE)							$70.95		$75.41		$110.18

Paying variable costs in the short run is important. A beef enterprise should be terminated if it cannot pay the variable costs. The return over variable costs (ROVC) is $105.56 for the example on Table 11-6. This is an acceptable value to continue producing beef in the short run. If this value were negative, the beef enterprise should be liquidated. ROVC is the figure used to compare different cow-calf herds. ROVC is a powerful analytical tool in comparing herds with different lease arrangements.

In the long run, all costs become variable costs and must be paid to remain a viable business concern. In Table 11-6, the variable cash costs account for 80 percent of total costs and fixed costs represent 20 percent of total costs. This is typical for a herd that does not have debt on capital assets. As more fixed expenses are added (economic method), the variable costs represent only 51 percent of the total costs. These added fixed costs are not cash costs. Consequently, producers do not experience additional cash flow outlays. In the long run, all costs are variable. The level of resources committed to an enterprise can change in the long run, so expanding or contracting the size of the breeding herd is a normal business practice.

Section 12.

CES = BEEF Help Desk

Using Extension Programs to Improve Your Beef Operation

Doug Shepherd

SERVING ALL KENTUCKIANS…that's the motto of the UK College of Agriculture Cooperative Extension Service (CES). Some people know Extension from its popular 4-H/youth development programs; others know Extension as "agricultural experts" from its work with farmers, producers, and agribusiness; still others know it from publications on various subjects relating to agriculture, gardening, and home economics. Sometimes people come for only one program without discovering the wide range of Extension programs available for all Kentuckians.

County CES offices make up the University of Kentucky's statewide, off-campus information and education arm. County Extension agents are UK staff members who work closely with subject-matter specialists. Research-based information comes from the University of Kentucky, Kentucky State University, and other land-grant institutions to this network of agents and specialists who translate it into practical, useful information. Extension helps you put that knowledge to work on your farm, on your job, in your home, and in your community. This section provides a brief overview of the Kentucky Cooperative Extension Service as well as a list of publications, programs, demonstrations, computer software, and other services related to beef cattle available at your local Cooperative Extension Service office and/or through the UK College of Agriculture.

The Kentucky Cooperative Extension Service

Cooperative: Federal, state, and county governments, as well as local citizens through advisory groups, cooperate to plan, develop, and finance educational programs. The backbone of this community-based education network is Extension agents, volunteers, and faculty sharing the University's resources and expertise with clients.

Extension: CES "extends" the University and its resources to all Kentucky citizens, where they live and work. Through education programs, information is delivered one-on-one or to groups. The CES classroom is wherever someone seeking information is met: in an office or meeting room, at home, or in the field. Extension brings clientele information through direct mail, demonstrations, tours, workshops, video tapes, and computer programs. Other resources used to get the message to residents are newsletters, other publications, newspapers, radio, television, distance learning through satellite and compressed video, and the telephone. Extension reaches out to its clients and relays the research and information needs of communities back to the campus.

Service: Extension's last name may be service, but serving people is its first priority. CES educational programs help people lead better, fuller lives. Because county Extension professionals live and work in their communities, they know the local people and their needs. Programs in agriculture, home economics, youth development, and rural and economic development are tailored to best meet those needs.

Extension provides education, training, and technical assistance to individuals and businesses concerned with profitable agriculture. Educational programs include information on food and fiber production, farm business management, marketing and processing agricultural products, natural resource management, and home lawn and garden information.

In home economics, Extension's goal is to improve the quality of life for individuals and families, as well as to help Kentuckians meet new challenges in a changing environment. CES focuses on its clients' economic and social well-being through programs that help people extend their incomes, improve their health, and strengthen their personal and family relationships.

4-H/youth development programs help young people gain knowledge, develop life skills, and form attitudes that enable them to become self-directed and productive members of society. This goal is accomplished through the help of parents, volunteers, and professional staff who organize educational experiences. Young people take part through organized 4-H clubs, special interest and project groups, 4-H school enrichment programs, 4-H camp, and other special activities.

The Cooperative Extension Service helps communities resolve locally determined problems with objective information and educational assistance and by developing community leadership potential. CES also helps communities determine long-range programs of action on issues such as economic development, community services, land use, solid waste, and community resource management.

Extension agents are available in each of Kentucky's 120 counties. They are backed by specialists at the University of Kentucky in Lexington, Kentucky State University in Frankfort, and at other research and education facilities near Princeton and Quicksand.

A list of Kentucky CES offices is located in Table 12-1. CES programs are available to all Kentuckians regardless of race, color, age, sex, religion, disability, or national origin.

Extension delivers information, education, and solutions.

County Programs

County Extension agents for agriculture located in each Kentucky county, along with volunteer leaders, help identify issues and community needs and develop and carry out informal educational programs that contribute to the county's social and economic development. Extension agents for agriculture have access to a wide variety of information on all aspects of beef production and agriculture, all of which is research-based, up-to-date, and available in several forms. Agricultural agents can assist in total farm management planning, diagnose nutritional and/or disease disorders within beef herds, and provide management recommendations. Other services and materials generally available at all county Extension offices are soil and forage testing, ration balancing, weed and insect identification, private pesticide certification training, farm record books, and current marketing outlook. Each county program offers local beef producers educational opportunities via seminars, meetings, newsletters, workshops, demonstrations, video tapes, and numerous publications. All of this information and assistance is generally free for the asking!

Supporting Organizations for Beef Producers

Numerous statewide and national supporting organizations work closely with county Extension agents for agriculture, state Extension specialists, and other personnel at the University of Kentucky College of Agriculture to provide Kentucky's beef producers the best possible information and management recommendations on all facets of beef production. Some of these are listed below.

Kentucky Cattlemen's Association
733 Red Mile Road
Lexington, KY 40504
(606) 233-3722

Kentucky Forage & Grassland Council
N-222D Ag Science Bldg. North
University of Kentucky
Lexington, KY 40506-00914
(606) 257-3144

Kentucky Department of Agriculture
Livestock and Agricultural Services
500 Mero St., 7th Floor CPT
Frankfort, KY 40601
(502) 564-6676 Ext. 260

Kentucky Agricultural Statistics Service
P.O. Box 1120
Louisville, KY 40201-1120
(502) 582-5293

Beef Improvement Federation
Kansas State Northwest Research Extension Center
105 Experiment Farm Road
Colby, KS 67701

National Pedigree Livestock Council
272 Meetinghouse Lane
Brattleboro, VT 05301
(802) 257-9396

National Cattlemen's Association
P.O. Box 3469
Englewood, CO 80155
(303) 694-0305

CES Resources Available to Beef Producers

As discussed earlier, numerous resources are available for use by beef producers interested in integrated resource management. These resources are available in several forms, including publications, video tapes, computer software, ongoing Extension programs, newsletters, and access to the UK College of Agriculture Data Center via the Internet. For further information or to request any of these resources, contact your local county Cooperative Extension Service office.

• **Publications:** The UK Cooperative Extension Service has literally thousands of publications available on all aspects of beef and forage production, veterinary science, agricultural engineering, agricultural economics, and other areas. A complete list of these is provided in Table 12-2.

• **Video tapes:** Video tapes dealing with many aspects of profitable, efficient beef production are available free of charge through your county Extension office. They are listed in Table 12-3.

• **Computer software programs:** Each computer software program listed below can be accessed through your county Extension agent. Depending on the software requested, there might be a charge for individual copies.

C.H.A.P.S.—Cow Herd Appraisal Performance Software: Developed at North Dakota State University, C.H.A.P.S. is designed to record cow herd information and provide summaries on herd performance that can guide decision making to improve the productivity of the commercial beef cow herd.

KYBEEF 1.0: This user-friendly, menu-driven pasture/hay budgeting program is designed to help farm managers and advisors make decisions about forage production system options. The program first helps design a system scenario by prompting for decisions on cattle enterprises and herd size, as well as land and forage species decisions. The program then uses its stored information on livestock forage needs and forage productivity to calculate a monthly balance sheet of forage needs and availability.

QUICKEN® Farm Record Keeping Program: Ag economics Extension specialists have developed farm business expense categories that can be used with the commer-

cially available Quicken® "cash-based" record-keeping system computer program. This relatively inexpensive computer program does a large number of record-keeping tasks, such as information and data storage, sorting, mathematical manipulations, report formatting, and report printing.

BMIS—Kentucky Beef Management Information System: Using a questionnaire, this computer program uses baseline information collected by Extension agents and economic analysis software to answer questions from producers on their beef management techniques and procedures. This software integrates production and economics.

• **Statewide Extension Programs:**

Kentucky FACTS—Feedlot and Carcass Test Study: This program is an educational effort to help beef producers learn more about their calves after the feeder calf production phase. The program is sponsored by the UK Cooperative Extension Service, Southern Kentucky Agricultural Development District, and the Kentucky Cattlemen's Association. The three objectives of the FACTS program are: (1) to provide an opportunity for producers to determine if their breeding and management are producing cattle that fit current industry demand; (2) to improve the reputation of Kentucky cattle by establishing a database of health, feedlot performance, and carcass quality that could be used to educate both producers and buyers of Kentucky cattle; and (3) to provide an opportunity for producers to evaluate the genetics of various sires for carcass production and characteristics.

The minimum requirements to participate in the FACTS program are:

- Cattle must be born in the test year.
- Cattle must weigh a minimum of 500 pounds at delivery; no shrink will be given.
- Cattle must be vaccinated and boostered prior to delivery according to CPH guidelines and be tagged with a CPH tag.
- Cattle must be weaned a minimum of 30 days before delivery and must be eating from a bunk and drinking water from a trough.
- Cattle must be treated with grub and lice control and dewormed with a product effective against inhibited ostertagia.
- Cattle must be castrated, dehorned, and completely healed.
- Calves that participate in the program will be nominated and weaned during the month of October. Consignors will deliver calves to selected pickup points during mid to late November.
- Consignment fee of $35 per head due at nomination time. A consignment consists of a minimum of five steers.

Producers maintain ownership of the cattle throughout the FACTS test period and are responsible for all costs. Total costs are deducted from gross receipts at the end of the FACTS program. Producers receive individual calf information on type, health, feedlot performance, carcass quality, and economic analysis.

The FACTS program allows producers to obtain information on the feedlot performance and carcass traits of their feeder calves.

CPH—Certified Preconditioned for Health: CPH provides a minimum number and uniform set of procedures to be done to each calf in the program. The owner, the local veterinarian, and the county Extension agent for agriculture all serve as certifying agents of the cattle. A Certified Preconditioned for Health Kentucky feeder calf is: weaned 30 days; trained to eat from a bunk and drink from a trough; treated for lice and grubs; dewormed within 45 days of sale; vaccinated for clostridium CSNS; vaccinated and boostered for IBR, PI3, Hemophilus somnus, BVD, and BRSV; and identified with an official CPH ear tag. Heifers are sold guaranteed open and steers are guaranteed not to be bulls. For more information, contact your county Extension agent for agriculture.

Certified Replacement Heifer Program: Several of these special program sales are conducted across Kentucky each spring and fall. These sales offer a consistent, reliable source of breeding herd replacement females. Rigid standards have been implemented to assure that heifers consigned to these sales are reproductively sound with more than adequate frame and muscle. Pelvic measurements, approved birth weight EPDs, and reproductive tract scores, along with minimum weights for breed types form the basis of qualification. Sales offer added value to bred heifers via the use of estrus synchronization in conjunction with artificial insemination and natural service by sires with approved EPDs for birth weight. Heifers are sold in uniform lots of two to six head and have a minimum weight of 600 pounds for English breeds and 700 pounds for Continental and cross breeds. A set health program that is veterinarian-certified includes not only vaccinations but internal and external parasite treatments. Growth-promoting implants are not allowed; however, heifers do receive ionophores throughout the program. All of these programs are sponsored by the UK College of Agriculture Cooperative Extension Service, Kentucky Cattlemen's Association, Kentucky Department of Agriculture, local cattlemen's associations, and other local or national allied industry.

Total Quality Management (TQM) for Kentucky Beef Producers: This Extension program is designed to help cattle producers improve the quality of their operations to be profitable and meet system needs. The program was developed with assistance from the Kentucky Quality Assurance Partnership, a coalition of seven organizations with a common goal of improving the Kentucky beef industry. TQM for Kentucky Beef Producers is designed for five sessions, conducted with small to medium sized groups of producers. Each session includes videotaped and print materials that are used as resource materials. Local resource people, such as veterinarians and marketers, are also effectively used in this program. Upon completion of the course, participants receive a farm certification number from the Kentucky Cattlemen's Association.

Kentucky EPD bull sale programs: The UK College of Agriculture Cooperative Extension Service and the Kentucky Cattlemen's Association cosponsor two EPD bull sales. These sales have replaced the former Central Test Sale program, where bulls were brought to a central location, fed for maximum performance and offered for sale. Now all bulls are tested on the farm and are required to have expected progeny differences for birth weight, weaning weight (growth and milk), and yearling weight (see Section 5—Planning the Breeding Program). The reason for the change was to take the focus away from postweaning growth in performance tested bulls and direct that focus toward producers buying bulls that best fit their needs. The bulls offered for sale must meet minimum requirements for growth and maximum requirements for birth weight specific for their breed, based on their EPDs. Also, the bulls must meet minimum development guidelines and health requirements and pass a reproductive soundness test. Bulls that exceed in certain traits (heifer acceptable, growth, or milking ability) are noted in the sales catalog. The Western Kentucky EPD Bull Sale is for bulls over 15 months of age, and the Central Kentucky EPD Bull Sale is for bulls under 15 months of age.

Kentucky Beef IRM Calendar: A management calendar that can help beef producers organize their production year and have reminders for important management actions or production decisions. The calendar delivers integrated recommendations from state Extension specialists to producers in a monthly format. Each month a producer can quickly scan various forage, cattle, and general production recommendations or procedures listed for that period to see what activities should be done. Accompanying peel-off stickers can be placed on the calendar to denote major events that correspond to attached recommendations during the beef cattle year. Initially, all calendars are delivered to beef producers through a meeting setting, conducted by the local county Extension agent and any other resource personnel they choose.

Statewide field days: Field days covering various topics and management procedures of current interest to all facets of modern agriculture are conducted annually across Kentucky. Annual field days are conducted on alternate years at the University of Kentucky's Lexington Research Farm and Princeton Education and Research Center. Contact your local Extension office for upcoming field day dates and locations.

• **Newsletters:** Most Kentucky county Extension offices distribute agricultural newsletters covering several topics, including beef production, to local clientele. Some of these newsletters are aimed solely at beef producers. Contact your local county Cooperative Extension Service office to request any local beef or statewide agricultural newsletters. Listed below are some statewide newsletters of interest to Kentucky beef producers.

Kentucky Beef IRM Newsletter—covers current topics of interest to state beef producers and is presented in an integrated format. Distributed quarterly to all county Extension agents for agriculture and to those producers who have completed the Beef IRM Calendar training.

Herd Health Memo—monthly newsletter that can help producers, veterinarians, Extension agents, and allied industry keep informed about livestock health in food production. Topics discussed involve food-animal total quality management.

Forage News—monthly newsletter addressing upcoming events and production practices of interest to Kentucky forage producers. Also discussed are various forage research findings from across the nation.

Kentucky Pest News—weekly newsletter during the normal crop growing season; distributed less frequently during the winter months. This integrated newsletter provides state crop and livestock producers with the latest information from the University of Kentucky's entomology, plant pathology, and agronomy specialists. Current and potential pest problems on all crops, in gardens, on livestock, and in the home or lawn are discussed.

• **Access to UK College of Agriculture Data Center:** For those producers who have access to a computer, modem, and the Internet or Worldwide Web, a wealth of information is at your fingertips via the UK Ag Data Center on the UK College of Agriculture's home page. Not only can producers access all of the information available electronically from the College of Agriculture, but the College home page also has a "link" to the University of Kentucky's home page, where even more information can be accessed. Currently each county Extension office in Kentucky can be accessed from the UK Ag College home page. These local Extension office home pages provide directories of local Extension agent staff, office locations, phone numbers, upcoming events, local weather information, current ag markets, and other information regarding that particular county's Extension program. Producers needing specific information can also e-mail their local Extension agent with their request via this system. The location of the UK College of Agriculture home page is: <http://www.ca.uky>.

Literature Cited:

"Serving All Kentuckians," IP-17, 1995, University of Kentucky College of Agriculture Cooperative Extension Service.

Ringwall, Kris, 1989, "CHAPS Cow Herd Appraisal Performance Software." North Dakota State University, reviewed and approved for use in Kentucky by Carla Gale Nichols, University of Kentucky, Department of Animal Sciences, Extension Series #1.

"KYBEEF 1.0, A Pasture/Hay Budgeting Program for Beef Cattle, A User's Manual," AGR-159, 1993, J.C. Henning, G.D. Lacefield, M. Collins, C.T. Dougherty, and M. Rasnake, Agronomy Extension, University of Kentucky College of Agriculture.

"Elite Replacement Heifer Program," Bourbon County Extension office.

Table 12-1. University of Kentucky College of Agriculture County Extension Offices

County	Location	City	Telephone
Adair	409 Fairground St.	Columbia 42728-0347	(502) 384-2317
Allen	Courthouse	Scottsville 42164-0355	(502) 237-3146
Anderson	300 Lincoln St. Center	Lawrenceburg 40342-1235	(502) 839-7271
Ballard	110 Broadway	LaCenter 42056-0237	(502) 665-9118
Barren	415 Courthouse Square	Glasgow 42141-2812	(502) 651-3818
Bath	85 Miller Drive	Owingsville 40360-2212	(606) 674-6121
Bell	101 Courthouse Square	Pineville 40977-1635	(606) 337-2376
Boone	6028 Camp Ernst Road	Burlington 41005-9520	(606) 586-6101
Bourbon	603 Millersburg Road	Paris 40361-2044	(606) 987-1895
Boyd	P.O. Box 638	Catlettsburg 41129-0638	(606) 739-5184
Boyle	127 By-Pass North	Danville 40423-1487	(606) 236-4484
Bracken	Courthouse	Brooksville 41004-0066	(606) 735-2141
Breathitt	1155 Main St.	Jackson 41339-1191	(606) 666-8812
Breckinridge	Courthouse	Hardinsburg 40143-0459	(502) 756-2182
Bullitt	1470 Hwy. 44 East	Shepherdsville 40165-6127	(502) 543-2257
Butler	132 E. Logan St.	Morgantown 42261-0306	(502) 526-3767
Caldwell	100 E. Market St.	Princeton 42445-1600	(502) 365-2787
Calloway	607 Poplar St.	Murray 42071-2587	(502) 753-1452
Campbell	3500 Alexandria Pike	Highland Heights 41076-1705	(606) 572-2600
Carlisle	Jones Bldg., Hwys. 51 &123	Bardwell 42023-0518	(502) 628-5458
Carroll	Courthouse, 2nd Floor	Carrollton 41008-1060	(502) 732-7030
Carter	Veteran Square, Courthouse	Grayson 41143-0605	(606) 474-6686
Casey	Hwy. 127 South	Liberty 42539-9805	(606) 787-7384
Christian	509½ W. 9th St.	Hopkinsville 42240-2133	(502) 886-6328
Clark	34 S. Main St.	Winchester 40391-2600	(606) 744-4682
Clay	Courthouse	Manchester 40962-0421	(606) 598-2789
Clinton	Courthouse	Albany 42602-0207	(606) 387-5404
Crittenden	107 S. Main St., Ste. 101	Marion 42064-1500	(502) 965-5236
Cumberland	Courthouse	Burkesville 42717-0039	(502) 864-2681
Daviess	212 St. Ann St.	Owensboro 42303-4148	(502) 685-8480
Edmonson	227 Mammoth Cave Road	Brownsville 42210	(502) 597-3628
Elliott	Courthouse Annex	Sandy Hook 41171-0709	(606) 738-6440
Estill	148 Richmond Road	Irvine 40336-9316	(606) 723-4557
Fayette	1145 Red Mile Place	Lexington 40504-1172	(606) 257-5582
Fleming	Courthouse	Flemingsburg 41041-0192	(606) 845-4641
Floyd	670 South Lake Drive	Prestonburg 41653-1238	(606) 886-2668
Franklin	101 Lakeview Court	Frankfort 40601-8750	(502) 695-9035
Fulton	2006 South 7th St.	Hickman 42050-9107	(502) 236-2351
Gallatin	Courthouse Annex	Warsaw 41095-0805	(606) 567-5481
Garrard	Citizen's Bldg.	Lancaster 40444-1238	(606) 792-3026
Grant	224 S. Main St.	Williamstown 41097-1220	(606) 824-3355
Graves	251 Houseman St.	Mayfield 42066-1165	(502) 247-2334
Grayson	126 S. Clinton St.	Leitchfield 42754-1115	(502) 259-3492
Green	106 S. Public Square	Greensburg 42743-0371	(502) 932-5311
Greenup	226 W. Main St.	Greenup 41144-0646	(606) 473-9881
Hancock	Main-Cross	Hawesville 42348-0010	(502) 927-6618
Hardin	201 Peterson Drive	Elizabethtown 42701-9370	(502) 765-4121
Harlan	Courthouse	Harlan 40831-0329	(606) 573-4464
Harrison	Route 7, Parkland Heights	Cynthiana 41031-0153	(606) 234-5510
Hart	Courthouse	Munfordville 42765-0367	(502) 524-2451
Henderson	3341 Hwy. 351 East	Henderson 42420-9202	(502) 826-8387
Henry	Farm Bureau Building	New Castle 40050-0246	(502) 845-2811
Hickman	116 S. Jefferson	Clinton 42031-0198	(502) 653-2231
Hopkins	P.O. Box 450	Madisonville 42431-0450	(502) 821-3650
Jackson	Vee Gay Building	McKee 40447-0188	(606) 287-7693
Jefferson	8012 Vinecrest Ave.	Louisville 40222-4690	(502) 425-4482

continued

Table 12-1. University of Kentucky College of Agriculture County Extension Offices, continued.

County	Location	City	Telephone
Jessamine	205 South 1st St.	Nicholasville 40356-1527	(606) 885-4811
Johnson	Courthouse	Paintsville 41240-0806	(606) 789-8108
Kenton	10990 Marshall Road	Covington 41015-0097	(606) 356-3155
Knott	Masonic Lodge Bldg., Main St.	Hindman 41822-0462	(606) 785-5329
Knox	HC 84, Box 518	Barbourville 40906-8910	(606) 546-3447
LaRue	807 Old E'town Road	Hodgenville 42748-0210	(502) 358-3401
Laurel	200 County Extension Road	London 40741-9008	(606) 864-4167
Lawrence	Courthouse Square	Louisa 41230-0686	(606) 638-9495
Lee	Courthouse	Beattyville 41311-0546	(606) 464-2759
Leslie	Old Elam Bldg.	Hyden 41749-0788	(606) 672-2154
Letcher	135C W. Main St.	Whitesburg 41858-0784	(606) 633-2362
Lewis	Courthouse	Vanceburg 41179-0128	(606) 796-2732
Lincoln	P.O. Box 326	Stanford 40484-0326	(606) 365-2459
Livingston	Wilson Ave.	Smithland 42081-0189	(502) 928-2168
Logan	121 S. Spring St.	Russellville 42276-0660	(502) 726-6323
Lyon	231 West Main St.	Eddyville 42038-0036	(502) 388-2341
McCracken	2705 Olivet Church Road	Paducah 42001-9755	(502) 554-9520
McCreary	Old Whitley Middle School	Whitley City 42653-0278	(606) 376-2524
McLean	Farm Bureau Bldg., 670 Main St.	Calhoun 42327-0265	(502) 273-3690
Madison	Farm Bureau Bldg., Lexington Road	Richmond 40476-0270	(606) 623-4072
Magoffin	333 West Maple St.	Salyersville 41465	(606) 349-3216
Marion	135 E. Water St.	Lebanon 40033-1550	(502) 692-2421
Marshall	905 Joe Creason Drive	Benton 42025-1460	(502) 527-3285
Martin	P.O. Box 325	Inez 41224-0325	(606) 298-7742
Mason	800 U.S. 68	Maysville 41056-1141	(606) 564-6808
Meade	770 By Pass Road	Brandenburg 40108-1602	(502) 422-4958
Menifee	City Hall, Old Campus Road	Frenchburg 40322-0085	(606) 768-3866
Mercer	215 Morris Drive	Harrodsburg 40330-0324	(606) 734-4378
Metcalfe	422 East St.	Edmonton 42129-0055	(502) 432-3561
Monroe	1194 Columbia Ave.	Tompkinsville 42167-1246	(502) 487-5504
Montgomery	158 Civic Center	Mt. Sterling 40353-1400	(606) 498-8741
Morgan	Government and Community Ctr.	West Liberty 41472-0035	(606) 743-3292
Muhlenberg	318 N. Main St.	Greenville 42345-0199	(502) 338-3124
Nelson	317 S. Third St.	Bardstown, 40004-1032	(502) 348-9204
Nicholas	368 East Main St.	Carlisle 40311-1158	(606) 289-2312
Ohio	1337 Clay St.	Hartford 42347- 0066	(502) 298-7441
Oldham	2305 S. Hwy. 393	LaGrange 40031-9688	(502) 222-9453
Owen	114 W. Bryan St., Ste. 301	Owenton 40359-0037	(502) 484-5703
Owsley	218 Church St.	Booneville 41314-0186	(606) 593-5109
Pendleton	400 Main St.	Falmouth 41040-1227	(606) 654-3395
Perry	Courthouse	Hazard 41702-7070	(606) 436-2044
Pike	1110 Hambley Blvd.	Pikeville 41501-1342	(606) 432-2534
Powell	Courthouse	Stanton 40380-0038	(606) 663-6404
Pulaski	28 Parkway Drive	Somerset 42502-0720	(606) 679-6361
Robertson	Senior Citizens Bldg.	Mt. Olivet 41064-0283	(606) 724-5796
Rockcastle	Richmond St.	Mt. Vernon 40456-0900	(606) 256-2403
Rowan	Courthouse	Morehead 40351-0848	(606) 784-5457
Russell	2340-B S. Hwy. 127	Russell Springs 42642-4013	(502) 866-4477
Scott	1130 Cincinnati Pike	Georgetown 40324-0581	(502) 863-0984
Shelby	1201 Mt. Eden Road	Shelbyville 40066-8822	(502) 633-4593
Simpson	300 N. Main, Old Post Office	Franklin 42135-0446	(502) 586-4484
Spencer	Main St.	Taylorsville 40071-0368	(502) 477-2217
Taylor	1712 E. Broadway	Campbellsville 42718-9231	(502) 465-4511
Todd	Courthouse	Elkton 42220-0097	(502) 265-5659
Trigg	Farm Bureau Bldg.	Cadiz 42211-0271	(502) 522-3269
Trimble	Courthouse	Bedford 40006-0244	(502) 255-7188
Union	1938 U.S. Hwy. 60 W.	Morganfield 42437-6246	(502) 389-1400
Warren	1117 Cabell Drive	Bowling Green 42102-1018	(502) 842-1681
Washington	211 Progress Blvd.	Springfield 40069-1435	(606) 336-7741
Wayne	1820 N. Main, Ste. B	Monticello 42633-2048	(606) 348-8453
Webster	Courthouse	Dixon 42409-0097	(502) 639-9011
Whitley	428 Main St.	Williamsburg 40769-0270	(606) 549-1430
Wolfe	Courthouse	Campton 41301-0146	(606) 668-3712
Woodford	184 Beasley Road	Versailles 40383-9558	(606) 873-4601
UK Research and Education Center	P.O. Box 469	Princeton 42445-0469	(502) 365-7541

Table 12-2. University of Kentucky College of Agriculture Beef/Forage Publications

NOTE: Some of these publications may not be available from your local county Extension office or the UK Ag Distribution Center and/or may not be on the UK Ag College CD-ROM and/or may contain outdated material.

Animal Science

ASC-3 Learn the Modern Cowboy Lingo: Beef Production Glossary
ASC-4 Beef: Preweaning Evaluation of Growth Rate
ASC-5 Beef: Post Weaning Evaluation of Growth Rate
ASC-6 Artificial Insemination for the Beef Herd
ASC-7 Nonprotein Nitrogen in Beef Cattle Rations
ASC-8 Beef: Feeding and Management of the Beef Female
ASC-11 Beef Cattle Identification
ASC-12 Balancing Rations for Beef Cattle
ASC-16 Beef: Grass Tetany in Beef Cattle
ASC-17 Double Muscling in Beef Cattle
ASC-22 Conditioning Cattle for Growing and Finishing
ASC-25 Growth Stimulating Implants for Beef Cattle
ASC-30 Feeding, Managing, and Vaccinating Dairy and Orphan Beef Calves
ASC-31 Kentucky Forage Testing Program
ASC-36 Tips on Custom Processed Beef
ASC-42 Shrink and Its Importance to Cowmen and Cattle Feeders
ASC-44 Beef Cows as Community Assets
ASC-45 Developing Replacement Heifers
ASC-46 Coping with Calving Difficulties
ASC-47 Foot Rot in Beef Cattle
ASC-48 Beef Tuberculosis
ASC-49 Management of Commercial Cow-calf Beef Herd for High Calf Crop Percentage
ASC-50 Grazing Systems
ASC-51 Pinkeye
ASC-52 Management of the Beef Cow at Calving Time (Prior, During, and After)
ASC-54 Applied Genetics
ASC-55 Castration and Dehorning
ASC-56 Producing Slaughter Beef with Grain on Pasture
ASC-57 Forage Related Cattle Disorders
ASC-58 A Controlled, Seasonal Cattle Breeding Program
ASC-60 Reproductive Tract Anatomy and Physiology of the Cow
ASC-61 Determining Pregnancy in Cattle
ASC-68 Cattle Selecting Guidelines for Females
ASC-78 Grouping the Commercial Beef Herd for Winter Feeding
ASC-102 Anhydrous Ammonia—A Protein Boosting Additive for Corn Silage
ASC-108 Utilizing Performance Data in Judging Classes
ASC-109 Utilizing Performance Records in Commercial Beef Herds
ASC-110 Scoring Beef Cow Condition
ASC-121 Breeding Soundness Evaluation in Beef Bulls
ASC-122 CHAPS Cow Herd Appraisal Performance Software
ASC-123 Feed Additives for Beef Cattle
ASC-132 Using MGA to Shorten the Beef Breeding Season
ASC-141 Using EPDs Expected Progeny Differences
ASC-142 Pelvic Measurements and Calving Difficulty
ASC-144 Beef Heifer Development Breed Type, Weight, and Height
ASC-150 Keeping Production Records for the Beef Herd

Agronomy

AGR-1 Lime and Fertilizer Recommendations
AGR-5 When to Apply Lime and Fertilizer
AGR-16 Taking Soil Test Samples
AGR-17 Double Cropping Land for Silage Production
AGR-18 Grain and Forage Crop Guide for Kentucky
AGR-19 Liming Acid Soils
AGR-20 Nodding Thistle and Its Control in Grass Pastures
AGR-26 Renovating Hay and Pasture Fields
AGR-33 Growing Red Clover in Kentucky
AGR-40 Lime & Fertilizer Recommendations: Reclamation of Surface Mined Soils
AGR-43 Nitrogen in Kentucky Soils
AGR-44 The Season of the Year Affects Nutritional Value of Tall Fescue
AGR-45 The Effects of Weather on Hay Production
AGR-48 Bermuda Grass: A Summer Forage
AGR-57 Soil Testing: What It Is and What It Does
AGR-58 Orchardgrass
AGR-59 Tall Fescue
AGR-61 Hay Feeding Systems
AGR-62 Quality Hay Production
AGR-64 Establishing Forage Crops
AGR-69 Urea as a Source of Fertilizer Nitrogen for Kentucky Crops
AGR-76 Alfalfa the Queen of Forage Crops
AGR-79 Producing Corn for Grain and Silage
AGR-84 Timothy
AGR-85 Efficient Pasture Systems
AGR-86 Growing Lespedeza in Kentucky
AGR-88 Producing Summer Annual Grasses for Emergency Supplement Forage
AGR-90 Inoculation of Forage Legumes
AGR-91 Cropland Rotations for Kentucky
AGR-93 Growing White Clover in Kentucky
AGR-95 Revegetation Guide for Surface-Mined Land in Kentucky
AGR-96 Controlling Soil Erosion with Agronomic Practices
AGR-97 Surface Water Management Systems
AGR-103 Fertilization of Cool-Season Grasses
AGR-104 Fergus Birdsfoot Trefoil
AGR-107 Alfalfa Quality Means Profits
AGR-108 Tall Fescue in Kentucky
AGR-116 Fertilizing Forage Legumes
AGR-119 Alternatives for Fungus Infected Tall Fescue
AGR-126 Replacement of an Endophyte Infected Tall Fescue Stand
AGR-134 Kentucky Bluegrass as a Forage Crop
AGR-137 Alfalfa Hay Quality Makes a Difference
AGR-141 Kura Clover for Kentucky
AGR-142 Buffalo Clover
AGR-144 The Nature and Value of Residual Soil Fertility
AGR-145 Perennial Grasses
AGR-148 Weed Control Strategies for Alfalfa and Other Forage Legumes
AGR-149 The Tall Fescue Endophyte
AGR-151 Evaluating Fertilizer Recommendations
AGR-159 KyBeef 1.0—A Pasture/Hay Budgeting Program for Beef Cattle
AGR-160 Managing Small Grains for Livestock Forage
AGR-162 Stockpiling for Fall and Winter Pasture
AGR-165 The Agronomics of Manure Use for Crop Production

Veterinary Science

VET-2 Stomach Worm Disease of Cattle
VET-3 Infectious Bovine Rhinotracheitis
VET-4 Preconditioning Feeder Calves
VET-5 Anaplasmosis in Cattle
VET-7 Taxus (Yew) Poisoning
VET-15 Blackleg in Cattle
VET-16 Oak Acorn Poisoning
VET-18 Bovine Respiratory Disease

VET-22 Diarrhea of Newborn Calves
VET-26 Brucellosis of Cattle
VET-27 Chemical and Drug Residues in Livestock
VET-28 Preventing and Treating Disease in Exhibition Market Animals
VET-31 A Health Calendar for Spring-calving Beef Herds

Interdepartmental
ID-2 Some Plants of Kentucky Poisonous to Livestock
ID-5 A Beef Forage System
ID-9 Salvage Feeds for Beef Cattle
ID-13 Beef Corral Essentials
ID-14 Management Calendar for Spring-calving Cows
ID-18 The Importance of Forage Quality
ID-19 Farm Manure: Production, Value, and Use
ID-33 Renovating Grass Fields with a Renovation Seeder
ID-46 Hay Preservatives
ID-62 Backgrounding Beef Cattle
ID-74 Planning Fencing Systems for Intensive Grazing Management
ID-76 Creep Grazing for Beef Calves
ID-86 Using Drought Stressed Corn
ID-96 Beef Cattle Production on Surface-mined Land
ID-97 Grazing Alfalfa
ID-101 Interpreting Forage Quality Reports
ID-104 Managing Diseases of Alfalfa
ID-108 The Kentucky Beef Book

Ag Engineering
AEN-16 A Mineral Feeder for Cattle
AEN-44 Livestock Waste Management
AEN-48 Minimizing Odor from Confinement Facilities by Management Practice
AEN-49 Feasibility Manure Odor Control Using Commercial Products
AEN-50 Generation and Legal Regulations of Odors from Animal Manures
AEN-52 Safe Use of Animal Waste Management Systems

Ag Economics
AEC-5 Financial Planning: Calculating Debt Repayment Capacity
AEC-7 Interest Rate Terminology “Buzz” words
AEC-13 Debt Repayment, Borrowing Capital, and Financial Stability
AEC-14 Determination of Cash Rental Rates on Cropland
AEC-17 Working with Your Lender
AEC-80 Kentucky Farm Machinery Economic Cost Estimates for 1996
AEC-81 1996 Kentucky Custom Rates for Farm Machinery

Other
Options 3 Beef—Options for Kentucky Farmers
UK-IMC Total Cattle Management
PPA-28 Alfalfa Varieties: Relative Disease Resistance and Winter Hardiness
PPA-30 Sampling for the Tall Fescue Endophyte in Pasture or Hay Stands
ENT-11 Insect Control on Beef Cattle
ENT-39 Beef Cattle Pests
IP-45 Livestock Waste Storage
IP-46 Livestock Yards Management
IP-47 Silage Storage

Table 12-3. University of Kentucky College of Agriculture Cooperative Extension Service Video Tapes

Note: Not all of these videos may be readily available at your local county Extension office; however, your county Extension agent for agriculture can order a copy for you.

VAG-0134 Alfalfa in the South
VAG-0228 Taking a Soil Sample
VAG-0961 Plastic Wrapped Round Bale Silage: An Alternative Solution
VAG-0841 Grazing Alfalfa
VAG-0052 Maximum Alfalfa Yield Through Research
VAG-0238 Preventing Agricultural Groundwater Contamination in Kentucky
VAG-0067 The Western Alfalfa Seed Production Story

VAS-0177 A Report Card on Beef
VAS-0113 Beef Cattle Fitting and Grooming
VAS-0196 Beef Cattle Identification
VAS-0201 Beef Council Series
VAS-0129 Cattle Handling and Transport
VAS-0125 Cattle Restraint with Ropes
VAS-0293 Cattlemen Care about the Environment
VAS-0165 Grading Feeder Cattle
VAS-0130 Integrated Resource Management
VAS-0292 Preventative Health Care for Cattle
VAS-0025 The Production of Modern Beef
VAS-0023 The Story of Modern Beef
VAS-0430 Using MGA to Shorten the Beef Breeding Season
VAS-0569 Advanced Artificial Insemination
VAS-0714 Beef Cow Condition Scoring
VAS-0733 Starting Cattle—The Feedbunk Management Series
VAS-0734 Ration Management—The Feedbunk Management Series
VAS-0735 Bunk Management—The Feedbunk Management Series
VAS-1021 Improving Your Beef Herd Through Better Bull Selections
VVS-0104 Bull Breeding Soundness Evaluation
VVS-0024 Cattle Abnormalities
VVS-0094 Embryo Transfer
VVS-0298 Implanting Beef Cattle—An Update
VVS-0118 Pregnancy Diagnosis in Cattle
VVS-0292 Preventative Health Care for Cattle
VVS-0230 Proper Handling and Use of Vaccines and Injections
VEC-0882 Farm Record Keeping in Kentucky

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