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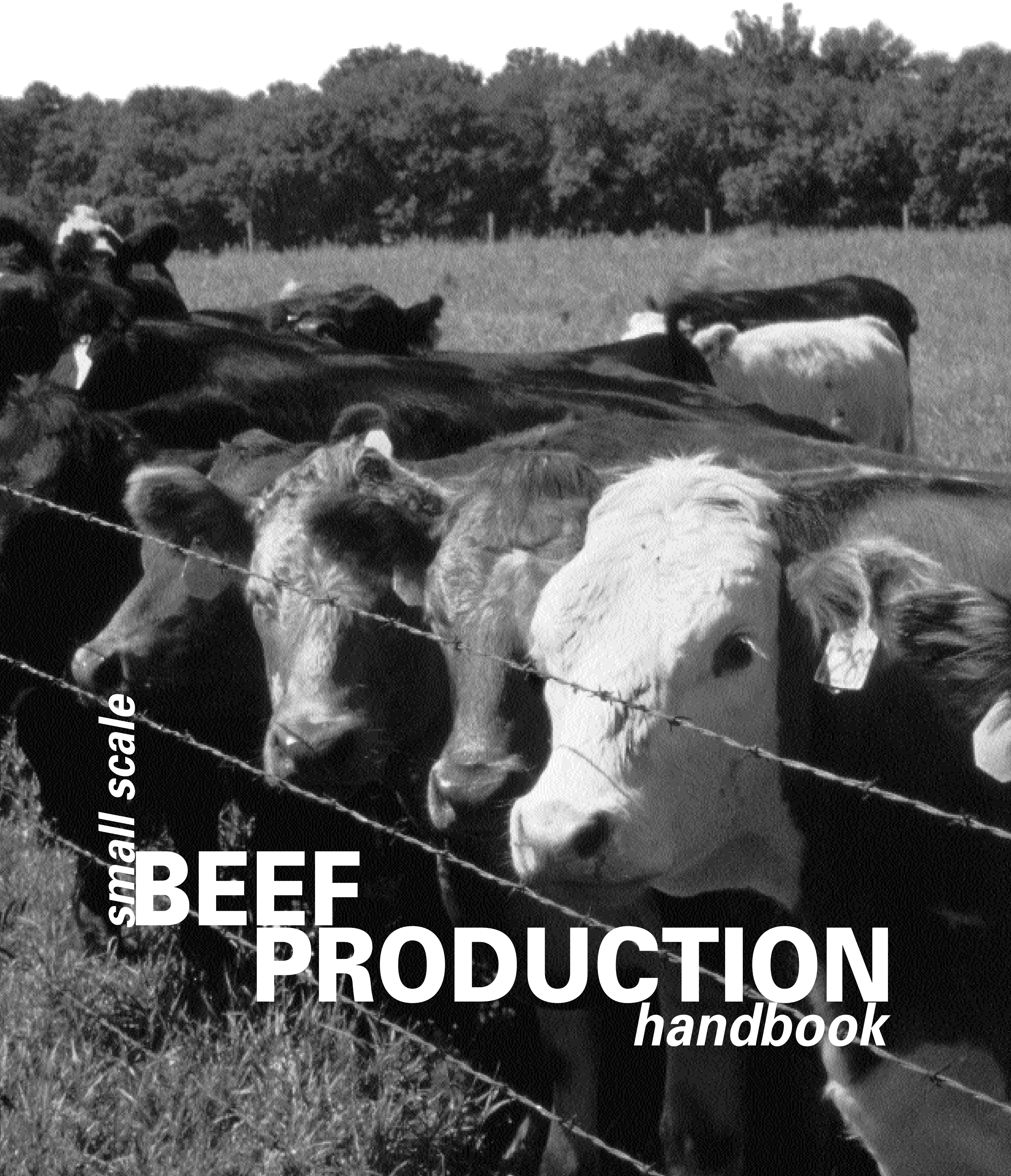

small scale BEEF PRODUCTION handbook

UNIVERSITY OF ILLINOIS
EXTENSION
College of Agricultural, Consumer and Environmental Sciences

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introduction

While most beef cattle produced in the Midwest come from herds of more than 50 animals, over half the beef operations in the region are small herds of 25 head or less. Many of these smaller beef enterprises are supplemental to a full-time grain farm, or are owned and managed by people who are employed full-time off the farm. These owners may have limited experience with beef production.

Small beef enterprises encompass many different types of operations: cow-calf units, small farmer-feeders, family 4-H or FFA projects, or fattening a single calf for home consumption. This publication is aimed primarily at these operators of small beef enterprises. It is designed to provide general information about a variety of topics in the field of beef production. If you would like more in-depth information about a specific topic, contact the University of Illinois Extension office nearest you. The U of I Extension also cooperates in producing the *National Beef Handbook*, a three-ring binder of over 150 factsheets dealing with specific beef-production concerns. You may purchase the complete handbook through the nearest University of Illinois Extension office.

importance to the midwest

Beef cattle have historically been an important part of the economy of the Midwest. In the 1800s, eastern meat packers set up meat packing plants in Chicago to slaughter the beef that was produced in the western United States and shipped to Chicago by rail. As time progressed and Midwest grain farms became more productive, western feeder cattle were shipped to Corn Belt states for fattening, then sent to market at the Chicago Union Stockyards. This pattern continued until the 1960s, when large commercial feedlots and beef packing plants moved to the plains. Irrigated crop land and more efficient transportation systems allowed cattle feeding and slaughtering to take place in smaller, localized facilities.

The total number of beef cattle in the Midwest has remained stable in recent years, yet great potential exists for increased cattle production. More efficient use of crop residues, as well as better pasture and forage use, would support at least 20 percent more cattle. Smaller beef operations may be poised to make more efficient use of their pastures and other forages. By using the information presented in this book, paying attention to detail, using available resources, and improving efficiency, you may find it possible to compete with the economies of scale enjoyed by large beef-production units.

nutrition

Of the factors that influence the growth and reproductive performance of beef cows, proper nutrition is probably the most critical. Because feed costs represent over half the total cost in a cow–calf production system, it is very important to keep feed costs low while meeting your animals' nutritional needs. Vital nutrients in beef cattle diets include water, energy, protein, calcium, phosphorus, potassium, sodium, trace minerals, and vitamins. This chapter presents easy methods for calculating your animals' needs based on their condition, age, and reproductive status.

The photos show a thin cow, a cow in average condition, and a fat cow. These examples will help you evaluate your cows' current body condition as you calculate their nutritional needs.

Photographs of body condition scored cows are courtesy and copyrighted by the University of Florida, Institute of Food and Agricultural Sciences (UF/IFAS).

types of diets

Depending on your circumstances, you may choose from a number of feeding approaches for your herd. The traditional approach is to allow the cattle unlimited access to pasture or hay harvested from the pasture. But if the forage is not sufficiently high in protein and other nutrients, the cows may be malnourished even though they have all they can eat. Poor quality forage has a high proportion of fiber to protein and takes longer for cows to digest. Consequently, cows can eat only about one and a half times their body weight per day of low-quality forage (see Table 1.1). If the forage is of high quality, cows can digest about three and a half times their body weight daily, but this would actually be more nutrition than cows need. Unlimited access to feed is sometimes referred to as *ad lib*, short for the Latin *ad libitim*.

It may be necessary to supplement a low- to medium-quality forage diet with high-quality hay, or with soybean meal, grain, or gluten. With supplementation, cows can actually digest more low-quality forage—up to two percent of their body weight, as shown in Table 1.1. This approach is only feasible if the nutritional needs can be met with a supplement of no more than 0.5 percent of the cow's body weight (**BW**). If the forage is of such poor quality that more supplementation is required, you should consider a different diet altogether. When using supplements, you need to know the approximate weight of your cows so you can calculate how much supplement to provide. You also

table 1.1 forage digestion limitations

Description of forage	% BW the animal can digest
Poor forage (straw, mature hay)	1.5
Poor forage supplemented with protein	2.0
Good forage (grass/legume hay)	2.5
Excellent forage (pre-bud legume hay)	3.5

can adjust the relative proportions of corn, a high energy supplement, and soybean meal, a high protein supplement.

Yet a third approach is to feed cows a high-energy diet of grain and meal, "supplemented" with a daily roughage allotment (hay or silage) of *at least* half of one percent of the cow's body weight. To keep costs under control using the high-energy approach, you will need to carefully track your cows' needs, based on their body weight and reproductive status. You also may need to monitor your cows' feeding, to keep "boss" cows from eating more than their fair share.

High-energy diets are referred to as *limit-fed*, since the more expensive components are not offered to the cows in unlimited quantities, but in amounts that match their nutritional needs.

water

Water is often the forgotten nutrient. It is important to have an adequate supply of fresh, clean water available for cattle. To be sure your water is not contaminated with chemical run-off or biological organisms, you should have it tested by one of the commercial services that are widely available.

energy and protein

The primary nutrients of concern for beef cattle are **energy** (referred to as "total digestible nutrition," or **TDN**) and **protein** (also called "crude protein," or **CP**). Tables 1.2 through 1.5 present energy and protein requirements based on National Research Council Recommendations. The nutrient requirements vary due to weather, environment (muddy lots), age of cattle (young and old cattle require more energy), cow size, cow milking ability, stage of production, and body condition (fat cows require less energy and thin cows require more energy). More detailed requirements are available in *Nutrient Requirements of Beef Cattle* from National Academy Press, 2101 Constitution Avenue NW, Washington, DC 20418.

table 1.2 nutrient requirements, heifers*

	Desired gain per day (lbs)					
	1.5		2.0		2.5	
Current weight	TDN	CP	TDN	CP	TDN	CP
400	7.0	1.23	7.7	1.38	1.51	8.3
500	8.3	1.32	9.1	1.46	1.57	9.9
600	10.4	1.54	10.4	1.54	1.63	11.2
700	10.6	1.49	11.7	1.61	1.68	12.6
800	11.7	1.57	12.9	1.64	1.74	13.9
900	12.8	1.64	14.1	1.74	1.78	15.3
1,000	13.9	1.71	15.3	1.80	1.83	16.6
1,100	14.9	1.78	16.4	1.86	1.88	17.8

*Steers will gain approximately 10% more than heifers on a similar diet.
In extremely cold weather, increase amounts 20 to 30%.
For muddy conditions, increase amounts 10 to 50%.

table 1.3 nutrient requirements, nursing cows

	Heifers		Cows	
Weight in lbs	TDN	CP	TDN	CP
850	11.6	1.9	—	—
900	12.0	2.0	13.1	2.4
950	12.5	2.0		
1,000	12.9	2.1	13.8	2.5
1,100	—	—	14.5	2.6
1,200	—	—	15.2	2.7
1,300	—	—	15.9	2.8
1,400	—	—	16.5	2.9

Superior milk, increase amounts 10 to 40%.
For thin cows to be bred within 60 days, increase amounts 20 to 30%.
In extremely cold weather, increase amounts 20 to 30%.
For muddy conditions, increase amounts 10 to 50%.

table 1.4 nutrient requirements, dry pregnant mature cows by stage of pregnancy

	Middle third		Last third	
Weight in lbs	TDN	CP	TDN	CP
900	8.2	1.2	9.8	1.5
1,000	8.8	1.2	10.5	1.6
1,100	9.5	1.2	11.2	1.6
1,200	10.1	1.4	11.8	1.7
1,300	10.8	1.4	12.5	1.8
1,400	11.4	1.4	13.1	1.9

In extremely cold weather, increase amounts 20 to 30%.
For muddy conditions, increase amounts 10 to 50%.

table 1.5 nutrient requirements, bulls

Weight in lbs	TDN	CP
1,400	15.0	2.0
1,500	15.8	2.0
1,600	12.8	2.0
*1,600	16.6	2.2
1,800	14.0	2.0

*This row represents thin bulls 60 days before breeding, that need to gain 1 lb per day.
In extremely cold weather, increase amounts 20 to 30%.
For muddy conditions, increase amounts 10 to 50%.

Table 1.6 presents the compostion of common feeds, including their dry matter (**DM**) factor, energy and protein provided, and the presence (+, ++) or absence (–) of the macro minerals calcium, phosphorus, and potassium. Actual values vary widely—it is advisable to pay for a nutrient analysis of your forage. If you buy commercial feed mixes, you can use the content analysis provided by the manufacturer.

All values are expressed on a dry-matter basis to permit comparison of feeds that vary in moisture content. As you will see in the examples later in this chapter, all calculations are done on a dry-measure basis and then converted to an "as-fed" basis.

table 1.6 composition of common feedstuffs

Feed	DM	TDN	CP	Nutrients Ca	P	K
Alfalfa (early bloom)	88	53.0	18.6	++	–	++
Alfalfa (late bloom)	88	50.0	12.9	++	–	++
Brome (vegetative)	88	56.0	14.6	++	–	++
Brome (late bloom)	88	53.0	6.0	++	–	++
Corn (cracked)	87	91.0	8.6	–	+	
Corn Silage	35	69.0	8.0	–	–	+
Clover (red; fresh)	25	64.0	15.6	++	–	++
Clover (red-hay)	88	55.0	15.5	++	–	++
Fescue (vegetative)	88	61.0	12.4	++	–	++
Fescue (late bloom)	88	46.0	7.4	++	–	++
Oats (rolled)	88	77.0	13.3	–	+	
Oat hay (early bloom)	88	64.3	9.2	++	–	++
Orchardgrass (vegatative)	88	72.0	18.4	++	–	++
Orchardgrass (late bloom)	88	54.0	8.4	++	–	++
Sorghum silage	35	58.0	7.5	+	–	++
Soybean meal	90	90.0	44.0	+	+	++
Sudex silage	35	55.0	10.8	+	–	++
Wheat (cracked)	90	92.0	13.5	–	+	
Wheat silage	35	61.9	11.9	++	–	++

DM = dry matter %, TDN = total digestible nutrients (energy), CP = crude protein.
Ca = calcium, P = phosphorus, K = potassium; presence (+,++) or absence (–) indicated.

determining nutrient cost

To find the least expensive source of nutrients, multiply the cost per pound by the nutrient content expressed as a decimal. The following example compares hay and soybean meal that each have 85 percent moisture content (the "dry matter percentage"). The hay costs $70 per ton and has 15 percent crude protein (CP). The soybean meal (**SBM**) costs $186 per ton and has 46 percent crude protein. To compare the relative costs of these two nutrients, calculate as follows.

cost per lb, x DM percentage, x percent protein
= cost per lb of crude protein

hay (70/2000) (.85) (.15) = 27.5 cents/lb CP

SBM (186/2000) (.85) (.46) = 23.7 cents/lb CP

So although the soybean meal appears much more expensive per ton, when you work out the figures you see that the protein it delivers actually costs less per pound than the hay. If you were considering alfalfa hay at 20 percent crude protein instead of 15 percent, then:

hay (70/2000) (.85) (.2) = 20.5 cents/lb CP

The alfalfa hay would be cheaper than soybean meal. However, there can be considerable waste with hay. Table 1.7 shows typical hay waste percentages.

table 1.7 hay waste

Feeding method	% wasted
Limit fed, with corn – small bales or ground hay	0
Limit fed – bunk, small bales or ground hay	10
Ad libitum ("unlimited") – bunk, small bales or ground hay	10
Ad libitum – big bales	30
Ad libitum – big bales (outside)	40

Table 1.8 shows the typical composition of some common feeds and their prices. Using the values from this table and from Tables 1.3, 1.4, and 1.7, diets were calculated for a 1,200-pound dry cow (last third of gestation) and for a 1,200-pound lactating cow in average condition with average milk production. Tables 1.9 and 1.10 show the calculated amounts and costs of various diets for this scenario. (For a step-by-step explanation of how to calculate sample diets, keep reading!)

Note that Table 1.9 shows there is a large variation in cost per day for the diets—they range from 59 cents to $2.14 per day. If the cows were fed for 120 days, the high-cost diet for the dry cow would be $186 *more* (*per cow)* than the low-cost diet. That difference could certainly "make or break" your profit situation!

table 1.8 typical feedstuff values

	TDN, %	CP, %	DM, %	Cost, $
Corn	91	8.3	88	2.10/bu
Corn gluten feed	87	20.0	40	42/ton
Alfalfa hay	60	19.5	85	85/ton
Mixed hay	54	12	85	60/ton
Poor hay (mature fescue)	46	7.4	85	30/ton
Soybean meal	90	44	90	162/ton

table 1.9 calculated diets for a dry cow (1,200 lbs)

	lbs (as-fed)	Cost/d, $
Limit corn, hay	8.2, 7	.62
Limit gluten	29	.59
Alfalfa* (ad lib, big bale)	50.4	2.14
Alfalfa (limit, bunk)	22	.94
Mixed hay* (ad lib, big bale)	47.4	1.42
Mixed hay (limit, bunk)	24.4	.73
Poor hay, mixed hay	29.4, 10.1	.74
Poor hay, alfalfa hay	29.4, 6.9	.73

*exceeds requirements

table 1.10 calculated diets for a lactating cow (1,200 lbs)

	lbs (as-fed)	Cost/d, $
Limit corn, hay, SBM	13, 7, 1.4	.90
Limit gluten	39.4	.90
Alfalfa (limit, bunk)	33.1	1.40
Alfalfa* (ad lib, big bale)	50.4	2.14
Mixed hay (ad lib, big bale)	47.4	1.42
Corn silage, SBM	59.2, 2.8	.96

*exceeds requirements

diet formulation samples

By using the values in the preceding tables, you can balance diets for any type, age, and condition of cattle. Three step-by-step examples of diet planning follow, all involving a 1,100-lb lactating cow in average condition with average milk. Some of the steps presented could be done in different order, but an effort has been made to present a logical series of calculations for each problem.

Step 1: Find daily TDN and CP needs; calculate intake and energy.
Step 2: Check that the computed TDN values do not exceed supplementation recommendations.
Step 3: Check roughage ratio.
Step 4: Calculate protein need.
Step 5: Convert to an as-fed basis.
Step 6: Consider hay waste, if appropriate.
Step 7: Calculate the cost of the feed.

example 1: balance diet based on mature fescue

Balance a diet of low-quality fescue and figure its cost per day.

Step 1: Find daily TDN and CP needs; calculate intake and energy.
Look up the daily requirements of TDN and CP for a lactating cow in average condition with average milk. When you consult Table 1.3, you will find that a 1,100-lb cow of this description has a daily TDN requirement of 14.5 and CP requirement of 2.6.

In this example, the diet is based on mature fescue, presented ad lib. How much will the cow eat, and will that amount supply the necessary nutrients? Table 1.1 shows that a cow can eat 1.5 percent of its body weight in mature fescue. If you do the calculation,

1100 x 0.015 = 16.5 lbs

you see that the cow will eat 16.5 pounds of mature fescue. Will that amount of mature fescue meet the cow's energy needs? To figure the amount of energy delivered by a given amount of food, multiple the intake amount by the food's percent TDN. Table 1.8 states that the mature fescue in this scenario has a TDN percentage of 46.

lbs intake x % TDN = lbs TDN
16.5 x .46 = 7.6

The calculation shows that 16.5 pounds of mature fescue will only deliver 7.6 pounds of energy. You saw in Table 1.3 that this cow needs 14.5 pounds TDN, so you'll need to supplement the forage diet. Before you can figure how much supplement will be needed, you need to adjust the forage amount, since the cow will actually be able to digest more forage when there is a protein supplement in the diet. Table 1.1 shows that a cow can digest 2 percent of its body weight (BW) in poor-quality forage with protein supplementation. Repeat the previous calculations to see how much mature fescue the cow will eat at the 2 percent BW level.

2 percent BW 1100 x .02 = 22 lbs
TDN value 22 x .46 = 10.12

The cow will be able to digest 10.12 pounds of mature fescue if there is a protein supplement. For the supplement, use corn, which has a TDN of 0.91. Here's how you decide how much corn to give:

cow's TDN = TDN of 22 lbs fescue (already calculated) + (corn TDN times "x" lbs corn)
14.5 = 10.12 + .91x
14.5 -10.12 = .91x
4.38 = .91x
438 = 91x
438 / 91 = x
4.8 = x

According to this calculation, you would need 4.8 pounds of corn as a supplement to 22 pounds of mature fescue.

Step 2: Check that the computed TDN values do not exceed supplementation recommendations.

You need to check to see that the amount of supplement you calculated is not more grain than a cow should get as a supplement to forage. Recall that grain supplements should not exceed 0.5 percent of the cow's body weight. One percent of 1,100 is 11 pounds, and half of that is 5.5 pounds; this amount of corn does not exceed that guideline.

Step 3: Check roughage ratio.

The roughage ratio check applies to high-protein diets rather than forage-based diets, so you can skip that step for this example.

Step 4: Calculate protein (CP) needs.

Table 1.3 shows that a cow of this description needs 2.6 pounds crude protein daily. How well does the fescue-and-corn diet meet that need? Multiply each amount of feed by the percentage of CP it provides (shown in Table 1.8). The protein needs of a 1,100-pound lactating cow (2.6 pounds CP) should equal the fescue amount (22 pounds) times its CP percentage (0.074), plus corn amount (4.8 pounds) times its CP percentage (0.10).

$$
\begin{aligned}
\text{CP need} &= \text{CP hay} + \text{CP corn} \\
2.6 &= 22\ (0.074) + 4.8\ (0.10) \\
2.6 &= 1.6 + .48 \\
2.6 &= 2.08
\end{aligned}
$$

At 2.08 pounds crude protein, the forage and corn do *not* meet the cow's protein needs. Try supplementing with soybean meal (SBM). If "x" represents the amount of SBM to be used, the amount of corn is now 4.8 minus "x." Use these amounts in the calculation with the correct CP values for the different feeds. The fescue amount (22 pounds) times its CP percentage (0.074), plus the corn amount (4.8 - x pounds) times its CP percentage (0.10), plus the SBM amount (x) times its CP percentage (0.44), should equal 2.6 pounds CP.

$$
\begin{aligned}
2.6 &= 22\ (.074) + (4.8 - x)\ (.10) + x\ (.44) \\
2.6 &= 1.6 + .48 - .10x + .44x \\
2.6 &= 2.08 + .34x \\
0.52 &= .34x \\
1.5 &= x
\end{aligned}
$$

The amount of soybean meal needed to balance the equation is 1.5 pounds. Subtract 1.5 pounds from the amount of corn that was originally planned, and you have 3.3 pounds of corn. Therefore a 1,100-lb. cow on low-quality forage needs a daily diet of:

22 lbs fescue
3.3 lbs corn
1.5 lbs. SBM

However, these amounts have been based on a dry matter basis. To figure how much to actually feed, you must convert to an as-fed basis.

Step 5: Convert to an as-fed basis.

Convert to an as-fed basis by dividing the amount required to meet nutritional needs by the DM percentage shown in Table 1.5.

	lbs divided by DM percent	=	as-fed
fescue	22 divided by .85	=	25.9 lbs as-fed
corn	3.3 divided by .90	=	3.66 lbs as-fed
SBM	1.5 divided by .90	=	1.7 lbs as-fed

These calculations mean that to achieve the necessary nutrient level, you would actually need to feed 25.9 pounds of fescue, for example, at 85 percent moisture. But there's another wrinkle—cows waste hay, and the amount of waste depends on how the hay is presented to them.

Step 6: Consider hay waste, if appropriate.

Table 1.7 shows typical hay waste amounts. Suppose you'll feed the hay in large bales stored outside. Table 1.7 shows that this method has a 40 percent waste factor (quite a lot of waste). To estimate the amount of hay to offer, divide the as-fed amount by 60 percent.

as-fed amount divided by percent eaten	=	lbs hay to feed
25.9 divided by (1.0 - 0.4)	=	43.2 lbs hay

Step 7: Calculate the cost of the feed.

The final step is to calculate the cost of the diet. To do this, multiply the pounds of each feed by the cost per pound for each, then add them together.

fescue	43.2 x (30/2000)	=	.65
corn	3.7 x (2.10/56)	=	.14
SBM	1.7 x (181/2000)	=	.15
Total cost per day			$.94

This diet would cost 94 cents per day. These calculations do not consider the cost of delivery, or labor for mixing and presenting the supplements.

example 2: limit-feeding

Balance a limit-fed diet involving the same feeds and cow as Example 1 and figure the cost per day. The steps from Example 1 should work here, too.

Step 1: Find daily TDN and CP rneeds; calculate intake and energy.
Step 2: Check that the computed TDN values do not exceed supplementation recommendations.
Step 3: Check roughage ratio.
Step 4: Calculate protein need.
Step 5: Convert to an as-fed basis.
Step 6: Consider hay waste, if appropriate.
Step 7: Calculate the cost of the feed.

You already know the values for Steps 1 and 2 from Example 1, so the detailed explanations will be skipped.

Step 3: Check roughage ratio.

In this limit-fed situation, you can assume that only the minimum roughage will be fed. That figure, calculated earlier, was 5.5 pounds (0.5 percent of the animal's weight). As you calculate the energy part of the diet, you will multiply the fescue TDN (0.46) by the amount to be fed, 5.5 pounds. Then you'll use "x" as the amount of corn to feed. Balancing the equation, you'll find the value of x.

$$\begin{aligned} \text{TDN need} &= \text{TDN hay} + \text{TDN corn} \\ 14.5 &= .46\,(5.5) + .91\,(x) \\ 14.5 &= 2.5 + .91x \\ 13.2 &= x \end{aligned}$$

At this point in your diet balancing task, you've found that 13.2 pounds of corn with 5.5 pounds of mature fescue will give the cow sufficient energy.

Step 4: Calculate protein need.

In the earlier example you saw that corn and mature fescue alone did not supply the necessary protein. In this example, you'll be feeding more corn, but if you were to do the CP calculations for these amounts of hay and corn, you'd see that, once again, corn and low-quality hay alone, even in different proportions, do not meet the cow's protein needs. You'll need to supplement with soybean meal. As before, represent the unknown quantity of SMB by "x," and remember to subtract x from the corn figure as you calculate corn's protein contribution to the diet.

$$\begin{aligned} \text{CP need} &= \text{CP hay} + \text{CP corn} + \text{CP SBM} \\ 2.6 &= .074\,(5.5) + .10\,(13.2 - x) + .44\,(x) \\ 2.6 &= .407 + 1.32 - .10x + .44x \\ .873 &= .34x \\ 2.56 &= \text{lb SBM} \end{aligned}$$

You'll need 2.56 pounds of soybean meal. Subtract that from the original corn amount to get the new amount of corn to include. That comes to 10.64 pounds of corn.

Step 5: Convert to an as-fed basis.

Next you need to convert these DM amounts to an as-fed basis.

lbs divided by DM percent		=	as-fed
fescue	5.5 divided by .85	=	6.5
corn	10.64 divided by .8	=	12.09
SBM	2.56 divided by .90	=	2.8

So you need to feed 6.5 pounds fescue, 12 pounds corn, and 2.8 pounds SBM daily. But what about hay waste?

Step 6: Consider hay waste.

According to Table 1.7, there is no hay waste when hay is limit-fed with corn, so you can ignore this concern.

Step 7: Calculate the cost of the feed.

Finally, figure the cost of this daily feed mixture.

lbs as-fed x cost/lb		=	cost/lb of feed
fescue	6.5 (30/2000)	=	.097
corn	1.8 x (2.10/56)	=	.442
SBM	2.8 (181/2000)	=	.253
Total daily feed cost		=	$0.79

This limit-fed diet would cost 79 cents daily. As with the earlier example, these calculations did not consider the cost of labor for mixing and presenting the feed, or delivery or transport costs for the supplement.

example 3: high-quality hay

Balance a diet of high-quality hay and determine the cost per day for the same 1,100-lb cow which still needs 14.5 lbs energy and 2.6 protein. Alfalfa hay will be presented ad lib in bunks and supplemented with corn and soybean meal only if needed. Consult Table 1.8 for the TDN and CP values to use, and use the same steps as in the previous examples.

Step 1: Find daily TDN and CP needs; calculate intake and energy.
Step 2: Check that the computed TDN values do not exceed supplementation recommendations.
Step 3: Check roughage ratio.
Step 4: Calculate protein need.
Step 5: Convert to an as-fed basis.
Step 6: Consider hay waste, if appropriate.
Step 7: Calculate the cost of the feed.

Step 1: Find daily TDN and CP needs; calculate intake and energy.
As you calculate the forage intake using Table 1.1, you'll need to use intermediate values, because the high-quality hay in this example falls between the "good quality" and "excellent" forages shown in that table. Therefore, assume an intake level of 3.0 percent body weight.

Intake 1100 x .03 = 33 lbs

When you calculate the energy supplied by the hay, you won't even need to complete the calculation before you find that no corn is needed; the energy supplied by 33 pounds of good-quality hay is more than enough to meet the cow's needs. Table 1.8 shows the TDN value of alfalfa as 60 percent.

TDN need = TDN hay + any necessary supplementation
14.5 = .60 (33) + x
14.5 = 19.8 + x

No corn is needed because the TDN of the hay, 19.8, is greater than the cow's requirement, 14.5. Go on to the next step.

Step 2: Check that the computed TDN values do not exceed supplementation recommendations.
This diet does not involve energy supplements, so skip this step.

Step 3: Check roughage ratio.
A hay-based diet does not need the roughage ratio check, so you can skip this step.

Step 4: Calculate protein need.
It's possible no soybean meal will be needed, either. Calculate the amount of protein supplied in 33 pounds of good hay. Table 1.8 shows the CP value for alfalfa hay to be 19.5 percent.

CP need = CP hay + any necessary supplementation
2.6 = .195 (33) + x
2.6 = 6.43 + x

Again, you don't need to complete the calculation because the protein in 33 pounds of good hay (6.43 pounds CP) well exceeds the cow's requirement of 2.6 pounds.

Step 5: Convert to an as-fed basis.

lbs divided by DM percent = as-fed
alfalfa 33 divided by 0.85 = 38.82

You would need about 39 pounds of good-quality hay per day.

Step 6: Consider hay waste.

Consult Table 1.7 to see if there is any waste with good hay (small square bales), ad lib in bunks. According to that table, the waste is 10 percent.

as-fed amount divided by percent eaten	=	lbs hay to feed
38.8 divided by (1.0 - .10)	=	43 lbs

Step 7: Calculate the cost of the feed.

Finally, figure the cost of this daily feed.

	lbs as-fed x cost /lb	=	cost for feed
alfalfa	43 (85/2000)	=	1.82

This fed diet would cost $1.82 daily. There would be some labor costs for putting the hay into feed bunks, but the labor and transport costs associated with energy and protein supplements are not involved.

mineral and vitamin supplements

Diets must be evaluated for other requirements besides energy, protein, and roughage. This section discusses minerals, vitamins, and preventive antiobiotics.

minerals

Maintenance and growth require minerals for various enzyme systems and chemical reactions, as well as for bone and teeth formation. The amounts of minerals needed depend on the stage of growth and reproduction status of the animal, and the local soil conditions (which affect the nutrient content of locally grown feed). For beef cows in the upper midwest, the minerals typically requiring some supplementation (in addition to salt) are calcium (Ca) and phosphorus (P). Potassium (K) is the other "macro mineral" needed by beef cows, but it is provided in the diet and does not need to be supplemented.

Other minerals, needed in much smaller amounts, are called "trace" minerals. The trace minerals selenium and iodine are deficient in many midwestern soils and may need to be added to the diet. Selenium deficiency can lead to lowered fertility, white muscle disease, retained placenta, stillbirths, and weak calves that are susceptible to diarrhea and pneumonia. Generally, trace mineral supplementation is cheap and good insurance for preventing problems. Supplementing the cattle diet with a mineral mix that includes all the trace minerals is probably best. Recent research suggests that copper sulfate is more usable than copper oxide, so look for supplements with the sulfate form of copper. Also, magnesium oxide is recommended in spring feeds to prevent grass tetany.

vitamins and preventive antibiotics

Vitamin E interacts with selenium in the deficiencies mentioned, so it is advisable to have at least 400 IU (international units) per pound of vitamin E in a mineral mix. Vitamin A may be deficient in some feeds and should also be supplemented, with at least 80,000 IU per pound in a mineral mix. Vitamin-mineral mixtures should not be stored for extended periods because vitamins can break down when mixed with minerals. Table 1.11 shows a mineral mix with minimum recommended levels. Note that the suggested values for the trace minerals selenium and iodine, and vitamins E and A, are the same regardless of the feed. Phosphorus and calcium are the only items that vary.

Table 1.11 minimal levels in salt mineral mix (4 oz per day consumption)

Feed	Phosphorus	Calcium	Selenium	Iodine	Vitamin E	Vitamin A
High-quality forage	6%	10%	0.003%	0.01%	400 IU	80,000 IU
Low-quality forage	10%	12%	0.003%	0.01%	400 IU	80,000 IU
Corn silage	6%	20%	0.003%	0.01%	400 IU	80,000 IU
High grain	0%	25%	0.003%	0.01%	400 IU	80,000 IU

Antibiotics are recommended in summer feeds to prevent anaplasmosis and pink eye. There are many excellent commercial mineral mixes available both in a salt mix and alone. Either form is acceptable, but be sure that salt is available to supply the cows with sodium. The mineral mixture should be matched to the type of cattle and type of diet you are feeding. Be sure the animals are consuming the recommended amount of the mixture.

forage production

As ruminant animals, cattle have evolved through the centuries to make use of large amounts of forages in their diet. Animals with simple stomachs (pigs, chickens, dogs, humans, etc.) can use very little of the fiber found in forages. Animals with rumens can digest fiber because it ferments in the rumen. This feature of ruminants also allows cattle to harvest land that is not suitable for mechanical cultivation and harvest. Perhaps beef producers should consider themselves *forage* producers that choose to harvest their production using beef cattle.

If you want to remain competitive with producers of other classes of livestock, you'll find it useful to know as much as possible about producing your own forage. Proper forage production requires the same kind of management as producing a good crop of corn or any other row crop. You must select the proper forage species and varieties to complement the cowherd management scheme you're using. Forages also present unique fertilization, pest control, and harvesting needs that you must consider in order to optimize their production and, therefore, that of the beef cattle they support.

In the midwest, producers must deal with the fact that forage production is cyclical through the year. Annual forage crops are killed with the first frosts of fall, and perennial forages are dormant from late fall until early spring. Forages must therefore be saved to supply a feed source during the dormancy period.

Nutritional needs of a cowherd are also cyclical (Chapter 6). A judicious manager will plan a forage production system that provides large quantities of high-quality forage when the nutritional needs of the cowherd are highest. To plan a forage production system that complements the nutritional needs of the cowherd, you must understand the life cycles of the forages. Grasses and legumes both provide quality diets for beef cattle. Following is a short discussion of the various classes of forages and some of the more important species of each class.

timothy grass, often the standard to which other grasses are compared (see p. 19)

cool-season grasses

Cool-season grasses are the most common forage grasses for beef cattle east of the Great Plains. These grass species prefer the cool, moist climate that is generally found in the eastern portion of the United States. Cool-season grasses generally are not drought tolerant. While each species varies in its growth pattern, these grasses are most productive during the early spring through early summer period, drop in productivity during the hot summer months, and then pick up again as the cool weather of late summer and fall arrives. Some species will continue to grow during the winter months, as long as the temperature remains above 40°F.

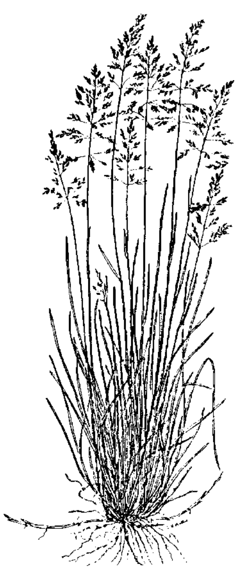
tall fescue

tall fescue

Tall fescue is the most widely adapted cool-season grass. This perennial grass has been a favorite of producers because it is highly palatable to cattle during the fall and spring, can withstand trampling, is easy to establish, and will tolerate a wide range of soil and climatic conditions. Tall fescue is not without its faults however, as it becomes very unpalatable during the hot summer months, leading to decreased forage intake and reduced animal performance.

The source of the palatability problem occurs when tall fescue is infected with an endophyte (fungus) that lives in the cells of the fescue plants. The endophyte does not affect the appearance of the grass, so a laboratory analysis is necessary to detect its presence. Transmission is only by seed; there is no way to remove the infection from a stand of fescue except by killing the infected plants and planting endophyte-free seed.

Tall fescue is a deep-rooted bunch-type grass that produces a dense sod when continually grazed or mowed. It is very aggressive and will readily fill in thin spots. It tolerates both wet and dry conditions. Fescue thrives under cool conditions and does not become completely dormant even when temperatures dip to 34°F. Active growth occurs when temperatures reach about 39°F.



kentucky bluegrass

kentucky bluegrass

Kentucky bluegrass is the oldest native, cool-season grass that is grown in the United States. It is known as one of the highest quality cool-season grasses, but its dry matter yield is generally lower than most other cool-season grasses. Kentucky bluegrass is the chief component of many pastures because it is a long-lived perennial grass that forms a dense sod. Kentucky bluegrass does not tolerate drought conditions. It is characterized by a rather shallow root system and therefore requires more frequent precipitation for maximum growth than the other cool-season grasses. It grows during the cool spring and fall, but will go completely dormant during the hot, dry summer period. Kentucky bluegrass does not tolerate shade very well and should be kept grazed or clipped to 6 to 8 inches to eliminate self-shading. It grows best when temperatures are between 60 and 90°F, with very little growth occurring below 40°F or above 90°F.

orchardgrass

Orchardgrass is an early maturing cool-season grass that produces high-quality early spring growth. This deep-rooted, bunch-type grass does not produce the dense sod associated with Kentucky bluegrass or smooth bromegrass. However, orchardgrass tolerates shade and is fairly drought resistant. Although all cool-season grass yields decrease with high summer temperatures, orchardgrass yields do not decrease as rapidly as most other grasses. Orchardgrass also has good fall growth, although not as much as tall fescue. Regrowth after mowing or grazing is rapid and is all leaves. Because of the open sod produced by orchardgrass, legumes can be grown in a mixture without suffering undue competition.

orchardgrass

smooth bromegrass

A perennial, sod-forming grass, smooth bromegrass is adapted to a wide range of soil types. It is deep-rooted, yet a high percentage of the root system is in the top few inches of the soil profile. When compared to other cool-season grasses, smooth bromegrass is considered to be of very good quality. It is very winter-hardy and will survive colder winter conditions than most other cool-season grasses. Pure stands of smooth bromegrass can become sod-bound, lowering its productivity. Smooth bromegrass is not as responsive to nitrogen fertilization, nor are its seedlings as vigorous as most of the other cool-season grasses.

smooth bromegrass

timothy

Timothy is a short-lived, perennial, bunch-type grass. Because of its high quality, it is often the standard to which other grasses are compared. It will not tolerate drought conditions because it has a very shallow root system. It therefore performs best in areas with frequent precipitation and high humidity. Timothy produces more dry matter the further north it is grown. When harvested frequently, timothy regrows more slowy than other cool-season grasses.

reed canarygrass

Reed canarygrass is the cool-season perennial grass best suited for poorly drained soils, especially those too wet for other crops. It has a very deep root system, making it more drought tolerant than the shallower rooted species. Reed canarygrass is a sod-forming grass that spreads by short rhizomes, forming a dense sod. Reed canarygrass is very productive during early spring and produces nearly two-thirds of its total production before early summer.

Cattle find reed canarygrass less palatable than the other cool-season grasses. Reed canarygrass is also the most difficult to establish of the cool-season grasses discussed here, and it produces less forage during the summer and fall period.

reed canarygrass

warm-season grasses

Warm-season grasses are characterized by their requirement for warm temperatures. They usually are more drought resistant than the cool-season grasses and can tolerate high temperatures. As might be expected, these grasses emerge from dormancy much later in the growing season, are productive during the hot summer months, and decline in productivity once the cooler autumn weather arrives. Warm season grasses such as bermudagrass and dallisgrass are found in the southern part of the United States. Big bluestem and the grama grasses are found in the Great Plains and western portion of the country.

bermudagrass

bermudagrass

Bermudagrass is a popular, cultivated warm-season perennial grass that is grown from the Gulf Coast as far north as Kansas, Missouri, and Kentucky. It reproduces by seeds, rhizomes, and stolons. It is very competitive and might be considered a weed when found in cultivated row crops. It is very responsive to nitrogen fertilization, and with intensive management can continue to respond to rates of nitrogen as high as 800 lbs/acre. Bermudagrass must be harvested often to remain in a young, tender, nutritious state. In general, bermudagrass is not competitive with other grass species in the northern two-thirds of Illinois.

native prairie grasses

A number of native prairie grasses have enjoyed renewed interest during the past few years as “new” pasture grasses. In reality, these grasses were developed over centuries of grazing by roaming herds of buffalo. Some of the major species include both big and little bluestem, the grama grasses, buffalograss, and switchgrass. A major deterrent to the use of these grasses is the problem with their establishment. The seed is fluffy and hard to handle, usually low in germination rate, and the seedlings are not very competitive when compared to many of the cultivated grasses. It may take more than a year after seeding for native prairie grasses to be ready for grazing or haying.

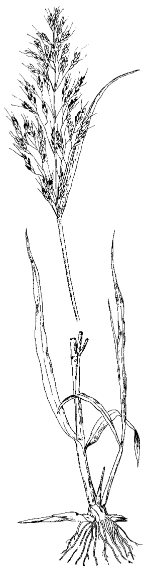
summer annual grasses

In a given year, you may face a shortage of forage for either grazing or storing for winter feed, possibly due to severe winter kill or to a long period of dry weather. In cases like this, you may need a forage crop that will germinate rapidly and grow a harvestable crop as quickly as possible. A number of summer annual grasses, such as the shorghums and pearlmillet, can be seeded to help alleviate a shortage of forage. Such “emergency” forages are generally expensive to raise and are therefore not usually relied on from year to year.

sorghums

Within the sorghum family a couple of species are regularly used as summer annual grasses. Both sudangrass and the sorghum-sudangrass hybrids grow in the same areas as corn. For acceptable germination, be sure soil temperatures are above 60°F before planting sorghums. Sorghums are adapted to drought conditions, once established, and can even go dormant, then resume growth with the return of sufficient rainfall. With favorable conditions, sudangrass can be harvested approximately 45 days after seeding. Additional harvests can be taken about every 30 days until a killing frost. Quality of the forage drops rapidly as the plant matures, so always harvest before the seedheads emerge. When sorghums are harvested as hay, the succulent stems require longer drying times than other hay crops, and crimping of the stems at cutting is almost mandatory. With adequate nitrogen fertilization, the sorghums can produce large amounts of dry matter in a relatively short period.

CAUTION. A word of warning if the sorghums are to be grazed. Prussic acid poisoning can be a problem to grazing livestock. Prussic acid concentrations are particularly high when the plants are small, so don't graze sorghums until the forage is at least 24 inches tall. Sudangrasses usually have less prussic acid than sorghum-sudan hybrids.



johnsongrass/sorghum

pearlmillet

Pearlmillet is another summer annual grass that is commonly used. It, like the sorghums, can withstand drought conditions and should be planted after the soil has exceeded 60°F. Pearlmillet will produce a leafier crop than the sorghums and is especially suited to grazing. Unlike the sorghums, pearlmillet does not produce prussic acid and can therefore be grazed at shorter heights. Grazing can begin when the plants are as short as 10 to 12 inches and should be grazed to a 3- to 4-inch stubble before the grazing animals are rotated to another pasture. Even though pearlmillet might not be as productive as sudangrass, many producers prefer pearlmillet because it is leafier and they do not have to worry about the prussic acid problem.

pearlmillet

legumes

The other class of plants that serve as forages is the legumes. Legumes can take nitrogen from the air and convert it for their own use with the help of symbiotic bacteria. If enough of these bacteria are present on legume roots, no nitrogen fertilizer is needed. Although this is a tremendous economical advantage when legumes are compared with grasses, the disadvantage is that legumes are not as long-lived as grasses in either pure stands or mixes. Compared with grasses at the same developmental stage, legumes are generally higher in crude protein and lower in crude fiber. This makes legumes important when higher quality diets are required by grazing animals.

alfalfa

alfalfa

Alfalfa is capable of producing more crude protein per acre than any other crop cultivated in the United States. Even soybeans, a crop raised for its protein content as well as its oil, will only produce about half the crude protein as a comparable crop of alfalfa. Because of alfalfa's high yield potential and fast regrowth, it is usually the "yardstick" for all other forage legumes.

Alfalfa tolerates both heat and drought, primarily due to its deep, extensive taproot. The root has been known to penetrate to depths of 20 feet and more under favorable soil conditions. Alfalfa is best adapted to well-drained, highly fertile soils and has little tolerance for poorly drained sites or soil pH levels below 6.5. Although alfalfa is a perennial plant, the life of an alfalfa stand is limited by plant disease, winterkill, and grazing.

Grass-alfalfa mixtures make excellent pastures that work especially well in rotational grazing systems. Alfalfa needs to be harvested and then allowed to rest before the next harvest. Any grazing system that harvests the alfalfa in just a few days (less than a week) and then allows a regrowth period of 28 to 30 days will prolong the life of the stand for up to 6 years.

red clover

red clover

Red clover tolerates shade better than many legumes and the seedlings are highly competitive. These traits make red clover a good addition to grass-legume mixtures. While it is a shorter-lived perennial forage than alfalfa, red clover tolerates lower soil fertility and poorer drainage. The taproot of red clover has more lateral branching than alfalfa, which reduces frost heaving. However, the clover taproot does not extend as deep into the soil and red clover is therefore not as drought tolerant as alfalfa.

Compared with alfalfa, red clover is less affected by insect pests such as potato leafhopper and alfalfa weevil, but can be more susceptible to many plant diseases. Red clover is easy to establish, and overseeding in the early spring will usually produce an adequate stand with favorable conditions. The red clover plants will remain in the pasture for two years.

ladino clover

Ladino clover

Ladino clover is a high-quality forage that retains its quality longer (as the forage matures) than many other legumes. Its shallow, fibrous root system is both an advantage and a disadvantage. This root system allows the plant to thrive under very moist conditions where other species would fail, but does not give it the drought tolerance of most legumes. Ladino's growth habit makes it very tolerant to close grazing as well as early-season grazing. It is an excellent legume to use in pasture mixtures where animals are continuously grazed.

lespedeza

Both annual and perennial species of lespedeza are used as forage legumes. Lespedezas are generally grown as warm-season annuals on soils that are low in fertility. Some species can tolerate soil pH levels as low as 5.0, and will grow where many other legumes will not grow. Lespedeza is easy to establish and will reseed itself, so the annual species act almost like perennials. Lespedeza is fairly resistant to drought as well as most plant diseases and insects. On the negative side, forage yields are generally lower than with other legumes. Lespedeza also contains tannin, which reduces its palatability to cattle.

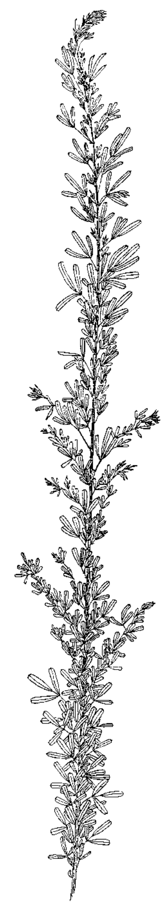
lespedeza

crop residues

Residues remaining in the field after row crops are harvested can be grazed or stored for later use. The two primary crop residues used this way are corn stalks and milo (grain sorghum) stubble. Soybean residue is also generally available, but is much lower in quality than either corn or milo residue. Grazing corn and milo residues is limited to late fall and early winter, after the grain has been harvested and before the stalks have lost significant nutrients due to weathering. It is interesting to note that cattle will select a higher quality diet if allowed to graze residues than if the resuidues are mechanically harvested and offered as feed.

Cows grazing corn rubble eat stalks, leaves, husks, cobs, and ears left in the field by harvesting equipment. With milo, grazing animals consume the remaining leaves and new plant growth.

Although crop residues provide a cheap source of forage for beef cows, protein and energy supplementation may be necessary unless cows are at a stage of production where nutrient requirements are low. It generally takes about one acre of crop residue per cow per month, for adequate nutrition



perennial lespedeza

harvesting systems

Before selecting which forage or forage mixture to use, you will need to decide whether your forage will be harvested mechanically, or by grazing. This section discusses various grazing and haying systems.

grazing systems

Grazing systems are of two basic types, continuous stocking or rotational stocking. A third grazing system consists of stockpiling desirable forage for use during the dormant season.

Continually stocked systems. With continuous stocking, animals graze the same pasture for the entire season. All parts of the pasture are always available for grazing. It is important that the forage species be compatible with continuous stocking. Alfalfa, because it needs regular rest periods, responds poorly to continuous stocking. Alfalfa would not remain in the pasture more than a couple of years under continuous grazing conditions. Other forage species, such as ladino clover and tall fescue, are more tolerant of continuous stocking and will persist longer. If the stocking rate is moderate to light, grazing patterns will be noticeable. Some species of forage will not be selected by the grazing animals and will become mature and unpalatable. Other species, preferred by the animals, will be repeatedly grazed and may disappear from the stand.

Continually stocked systems have the lowest fencing cost. All grazing systems require perimeter fences around the area to be grazed, but that is all the fencing that is required with continuous stocking. Labor costs are usually relatively low with this type of grazing, since cattle do not have to be moved to other paddocks as the growing season progresses.

Rotational stocking. Rotational stocking schemes involve splitting the pasture area into smaller paddocks that are grazed, rested, and regrazed. The size and number of paddocks determines how long each is grazed and allowed to rest before regrazing. With a basic rotational stocking scheme, four or five paddocks are produced from the existing pasture by either permanent or temporary fencing. Cattle are allowed to graze each paddock in a systematic order. Each paddock is grazed, then rested while another paddock is being grazed. In a high-intensity grazing set-up, a producer might have from 15 to 30 or more paddocks. Under this type of system, cattle would be allowed to graze each paddock from 1 to 3 days.

Any rotational system requires more labor, because the cows must be rotated to each paddock as needed. Another expense is the additional fencing.

Research generally shows that rotational stocking increases the production of beef per acre when compared to continuous stocking. This is not a result of increased weight gain by the grazing animals, but reflects the fact that more animals can be grazed on the same amount of land. Rotational stocking tends to reduce selective grazing, because animals concentrated in a small area are forced to graze more of the available forage.

Some forage plants—for example, alfalfa—tolerate rotational stocking much better than continuous stocking. In some rotational schemes, hay can be harvested from paddocks before they are grazed for the first time, or any time that excess forage is present. Harvesting is preferable to letting the forage mature and drop in quality.

Stockpiling. In another grazing system, a cool-season grass is stockpiled for grazing during the dormant season. For example, a cool-season grass is grazed during the spring and early summer months, (or harvested in early August for hay) then fertilized with 40 to 80 lbs of nitrogen and allowed to accumulate or stockpile from then until late fall or winter. Tall fescue is especially well-suited for this purpose because it is low in palatability during the hot summer months, but is high in sugars and its palatability increases during the cooler months of autumn. Fescue is also quite tolerant of the trampling that may occur during winter. Research has shown that stockpiled tall fescue will provide an adequate diet for winter feeding mature pregnant beef cows.

haying systems

Beef producers have customarily harvested forages as hay during the growing season and fed the hay to cattle during the winter. Over the years, a number of different methods have been developed to harvest and store hay prior to feeding. These methods include conventional and high-density square bales, large and small round bales and stacks. The most common methods used today are conventional square bales and large round bales. The square bales, weighing 50 to 90 lbs each, are generally stored under a roof and require more labor per ton to harvest and feed. The square bales generally involve less waste than round bales because there is less spoilage during storage and less wasted during feeding. If large bales are stored outside, more than 40 percent of the hay may be lost to spoilage during storage and wasting while eating.

You need to evaluate the labor and financial resources available before deciding which haying system best fits your needs. Many smaller operations find it more economical to either buy hay or have their hay custom-harvested. The high cost of hay harvesting equipment means that it must be used on substantial volume to justify its price. If enough interested producers exist in a given area, they may jointly purchase equipment that they then will share.

soil fertility

Like all other crops, forages remove nutrients from the soil as they grow. The primary nutrients used by forage crops are nitrogen, phosphorus, and potassium or potash. Other elements used in lesser amounts include boron, sulfur, iron, and zinc. To maintain high levels of production, you must replace these nutrients. Different amounts of these nutrients are removed depending somewhat on the forage species being grown, but even more on the harvesting method employed. If the forages are grazed, most of the nutrients are redistributed back on the pastured ground in the form of animal manure. If the forage is harvested as hay, the nutrients are removed from the field. Therefore, hay fields need more pounds of nutrients replaced than do pastures.

nitrogen

Nitrogen is the most important element used by growing forage crops. A dark green plant color is indicative of adequate nitrogen availability. Nitrogen is also the most mobile plant nutrient in the soil. It is water soluble and can leach down through the soil profile or it can volatilize into the atmosphere. In either case, it is no longer available for plant use. Nitrogen that leaches into groundwater causes other problems, such as high nitrate levels in drinking water.

Because of this mobility, applied nitrogen rates should never exceed what the plant will use in the very near future. As previously discussed, legumes can fixate nitrogen from the atmosphere, so supplemental nitrogen fertilizer is not necessary when legumes are being grown. Research has shown that as long as legumes make up at least 30 percent of a grass–legume mixture, supplementary applications of nitrogen fertilizer are unnecessary. At 30 percent of the stand or more, the legume can fixate all the nitrogen needed for the grass–legume mixture. So, not only do legumes increase the quality of the grass forages, they can also eliminate the need for nitrogen fertilizer applications.

In pure grass stands, supplemental nitrogen is necessary to improve the dry matter yield. For most cool-season grass species, total nitrogen application rates of up to 100 to 150 lbs per acre are recommended. More uniform forage production is obtained if you split the necessary nitrogen into two or more applications. Ideally, the first application is made in early spring when the cool-season grass is just beginning its spring growth. The second application is generally made immediately after the first harvest or the first grazing period. When you are stockpiling tall fescue for winter grazing, delay the second application until early August.

phosphorus

Phosphorus is especially important for establishing legume and grass seedlings because it is necessary for good root growth. The number of nodules on legume plants also increases with applications of phosphorus. A larger root system and more nodules give the potential for increased nitrogen fixation.

Phosphorus is removed with grazed or harvested forage. It does not readily leach from the soil. Test your soil for phosphorus, then fertilize according to the soil test results. Top-dress phosphorus (and potassium) whenever it is convenient. Applying phosphorus after the last harvest ensures that plants will have sufficient phosphorus going into the winter to maintain good root structure and spring vigor.

potassium

Both legumes and grasses are heavy users of potassium. Potassium helps the plant resist insect and disease damage, and functions in sugar transport within the plant. Since plants take up large amounts of potassium, it must be replenished or deficiencies will become apparent. When a forage is harvested as hay or silage, potassium removal is especially severe because the whole plant is being removed from the field. Like phosphorus, soil testing should be used to make sound decisions regarding potassium fertilization. To increase soil potassium levels, you can apply potassium any time, but half the application after the first and half after the last harvest of each year is recommended.

soil ph

The acidity level of the soil can be a serious limitation to forage productivity. Most forage crops prefer a neutral soil pH level. (A neutral pH has a score of 7.0. An acidic pH is less than 7.0, and an alkaline pH is greater than 7.0.) Smooth bromegrass and alfalfa, for example, are more sensitive to acidity than tall fescue or alsike clover. The availability of soil nutrients is also affected by the pH of the soil. Most nutrients are at or near their maximum availability when the pH is between 6.5 and 7.0. Potassium availability drops off rapidly at a pH below 6.0, while a pH above 7.0 decreases the availability of iron, manganese, boron, copper, and zinc. The pH of the soil can be accurately determined with a soil test. If the pH is below 6.0 to 6.5, limestone should be applied to bring the pH levels up to an optimum range. Contact your nearest Extension office for information on soil testing.

minor elements

A number of additional elements are also needed by forage crops, although in lesser amounts than the elements discussed thus far. In many instances the soil levels of these nutrients are OK, so supplemental fertilization is not necessary. The minor or trace elements requiring the most attention for forage production include sulfur, boron, manganese, magnesium, and molybdenum.

forage-related disorders

A number of disorders are common to ruminant animals grazing forages. While many of these disorders can be life-threatening to the foraging animal, all the disorders can be minimized or avoided completely by taking the proper precautions. The following discussions are designed to inform you of the these specific problems and some of the management options available. If you suspect a problem with any of these disorders, contact your veterinarian or nearest Extension livestock specialist for more detailed information.

bloat

Bloat is the excess accumulation of gas in the rumen and reticulum of ruminant animals. It can quickly lead to death by suffocation. Bloated animals are easily identified by severe distention and pressure of the left flank, uneasiness and obvious discomfort, and labored breathing. In pasture situations, bloat is most likely a problem when cattle are grazing lush, immature legumes. There appear to be some genetic factors involved, as some cattle tend to bloat more easily and more often than others. A number of strategies can be employed to minimize the chance of bloat. Birdsfoot trefoil, crownvetch, and the lespedezas do not cause bloat. Incidence of bloat is greatly reduced if 50 percent of the grazed forage mixture is grass. Cattle should be introduced to legume pastures when they are full. Be sure to turn them in only when the forage is dry, not wet from a rain or heavy dew. When grazing new pastures, check cattle on a regular basis for signs of bloat.

Proloxalene has proven to be a good bloat deterrent. For full effectiveness, cattle need to consume proloxalene before being introduced to legume pastures. One to two grams per 100 pounds of body weight per day is sufficient, for as long as they are on pasture. Proloxalene can be purchased in salt or mineral blocks, or as a feed additive.

fescue endophyte

Endophyte is a fungus that grows within the cells of tall fescue plants, primarily in the seeds and lower stems. Cattle that consume endophyte-infected tall fescue will respond with lowered feed intake, lower weight gains, high respiration rate, increased body temperature, increased water consumption, rough hair coat, and increased time spent standing in water or shade. Cows will show a reduced reproductive rate. In severe cases, a malady known as fescue foot results in lameness and can cause sloughing of the hooves, tail tips, or ear tips.

Fescue infected with endophyte shows no outward symptoms. In fact, plants infected with the endophyte fungus will show increased seedling vigor, increased resistance to environmental stresses, and increased resistance to disease and insects. The degree of infestation can be quite variable. To prevent production problems, you need to know the infestation level before planning a course of action.

Any management option that dilutes the amount of infested fescue in the diet will help offset deleterious effects. Good options include establishing legumes in infested pastures, and feeding endophyte-free hay to cattle on infected pastures. Always make sure that seedhead production is prevented, since the endophyte tends to concentrate there. Pastures that can't be grazed intensively enough to prevent seedhead emergence should be mowed.

ergot

Ergot is a fungal infection of the seedhead of cool-season grasses and cereals. Unlike the endophyte fungus, ergot is easily spotted: inspect the seedheads and look for the black ergot bodies that will replace some or all the seeds in a seedhead. Ergot bodies are generally 2 to 4 times larger than the seed would have been and are dark brown or black in color. When cattle eat ergot bodies, they produce alkaloids that can reduce blood flow to the extremities. This reduced blood flow can cause the sloughing of hooves, tail tips, and ear tips much like endophyte, and can even cause death in extreme cases. Only minute quantities of ergot are necessary to produce these symptoms. Ergot alkaloids will also reduce the reproductive performance of the animals and they never fully recover. Fortunately, ergot poisoning is easily prevented. Since ergot only infects the seedhead of grasses, simply prevent seedhead emergence by intensive early grazing or mowing. If no seedheads are produced, ergot will not be a problem.

prussic acid

Under the right conditions, prussic acid poisoning is a concern when cattle graze summer annuals. The prussic acid level in plants is affected by plant maturity, soil fertility, and climate. Prussic acid, in the body of ruminant animals, can metabolize into cyanide. Cyanide interferes with the tissues using oxygen and the tissue dies. In field cases of prussic acid poisoning, grazing animals die quickly with few symptoms. Nonruminant animals, such as pigs and horses, show little or no effects of prussic acid.

Cattle can consume small amounts of prussic acid and expel it through the urine and show no effects. When large amounts of prussic acid are consumed in a short time, it becomes lethal. When summer annual grasses are being used in a forage program, a few management techniques will help guard against prussic acid poisoning. Prussic acid is highest in fresh or new, growing tissue. Therefore, do not graze sudangrass until it is at least 18 inches tall; sorghum-sudan must be at least 24 inches tall. If these grasses are frosted, large amounts of prussic acid are released in the plant for a short time after frosting. Research indicates that frosted plants may be safely grazed only if the plant tissue has dried thoroughly and if the crop height was safe for grazing before the frost. New tiller growth is especially dangerous, so be careful if warm weather occurs after a frost, or if cattle have been grazing a summer annual pasture longer than seven days.

grass tetany

Grass tetany is the result of a magnesium deficiency in the blood of grazing animals. It will generally occur in the spring, but can also happen in the fall when the season has been preceded by a wet period and the grass makes a rapid, lush growth. Producers can help to prevent grass tetany problems by including a legume in the pasture mix, as legumes have higher magnesium concentrations than grasses. Feeding a mineral mix with increased levels of magnesium at least a month before and during grazing will also decrease the incidence of grass tetany.

nitrate poisoning

Drought conditions often result in poor pastures and reduced forage yields. It's natural that producers may wish to use barren or low-producing grain crops as replacement forage, but these forages may be toxic due to high nitrate levels. All plants contain some nitrate, but excessively high amounts are likely to occur in forages grown under stress conditions. Stress conditions include the following:

- Shading or low light intensity
- Detrimental weather like drought, frost, hail, or low temperatures
- Herbicide applications
- Plant diseases

The amount of nitrate in plant tissue also depends on a number of factors:

- ***Plant species*** - Certain plants, such as pigweed, lamb's quarter, oats, millet, sorghum, sudangrass, and corn are often high in nitrate, but other grasses and legumes also can have excessive levels under extreme conditions.
- ***State of growth*** - The nitrate level is usually higher in young plants and decreases as the plant matures.
- ***Plant parts*** - Various parts of the plant contain different levels of nitrate. The lower part of the plant contains more nitrate.
- ***Nitrogen fertilization*** - There is a direct relationship between the level of nitrogen fertilization and the nitrate content of the plants.
- ***Rain*** - In plants that survive drought, nitrates may be high for several days following a rain.

Nitrate poisoning can be rapidly fatal. When you suspect nitrate poisoning, call a veterinarian immediately to confirm the tentative diagnosis and to start treatment. Since death comes from oxygen insufficiency, handle affected cattle as little and quietly as possible to minimize their oxygen needs.

beef facilities

feeding facilities

Cattle may be fed in an open lot, a barn and lot, or a total confinement barn. The optimum feeding facilities depend greatly on the prevailing climate. Table 3.1 lists statistics about the size and number of beef handling facilities.

moderate climates

In moderate climates, cattle do well in open yards with limited or no shelter if there is sufficient space, good drainage, and moderate annual precipitation. Typically, feeding is done along a fence line. An earthen mound and good drainage help keep the animals out of the mud. Natural landscape features, a wind break, and/or a sunshade may be the only protection needed.

Most cattle feedlots are unpaved, except for a strip of concrete along the feedbunk and around the water tanks (Figure 3.1). If space is limited or drainage is questionable, the yard may be paved. However, facilities to handle runoff are essential, and manure must be scraped from paved feedlots more often than from unpaved lots.

less moderate and humid climates

In humid climates and regions where temperatures get quite low, shelter and a bedded resting area may increase animal comfort and feeding efficiencies

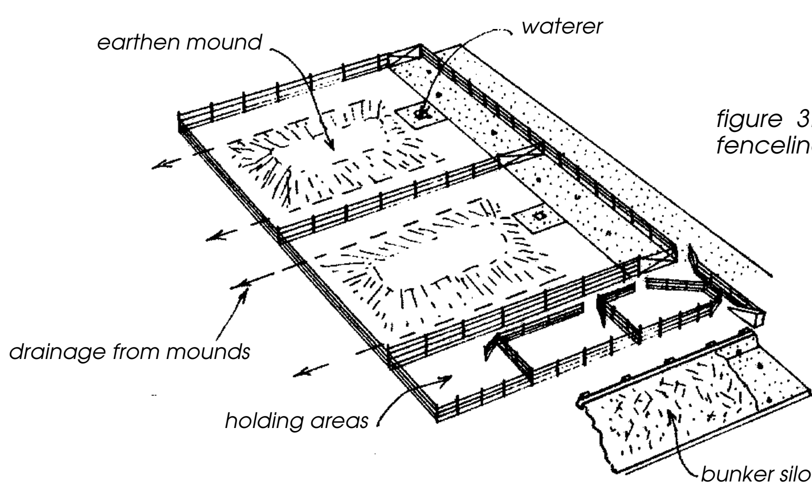


figure 3.1. open feedlot with fenceline feedbunks

sufficiently to offset the investment in buildings. Barns are usually built with one side open to the east or south, away from the prevailing winter wind. The yards may be partially or completely paved depending on drainage and space available. Usually feed bunks and waterers are located outside to reduce the bedding needed and the amount of manure accumulation in the barn.

cow/calf facilities

Cows bred to calve in the spring can be wintered outdoors. Confining cows to a pasture or lot near the farmstead just before calving makes it easier to observe and to help the cows if needed. In cold areas, a calving barn is desirable for winter calving and for sick cows or calves. Portable calf shelters give calves on pasture a dry place to rest (Figure 3.2).

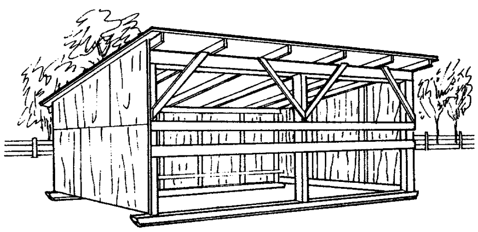


figure 3.2. portable calf shelter

An open-front barn with electrical heat lamps makes an excellent unit for winter calving or for helping cows with difficult deliveries (Figure 3.3). Using gates for pen dividers simplifes cow and calf handling and permits easy cleaning. A frost-proof hydrant can supply water. A heat lamp provides heat for the calf, if needed. A calf warming box with electric radiant heaters is good for weak calves on extremely cold nights. Closed barns are not good for calving because high humidities frequently contribute to calf sickness. Return cows and calves to an outdoor lot in two or three days.

Keep mature cows, first-calf heifers, bulls, and steer and heifer calves in separate feedlot areas if they are kept over winter.

All cattle operations require a corral with a holding pen, working chute, and headgate (Figure 3.4). Fencing is a major requirement for the pasture. Line fences should be tight with either 5-strand barbed wire or 6- to 8-strand high-tensile wire. Internal fences can be 3-strand or single-strand electrified.

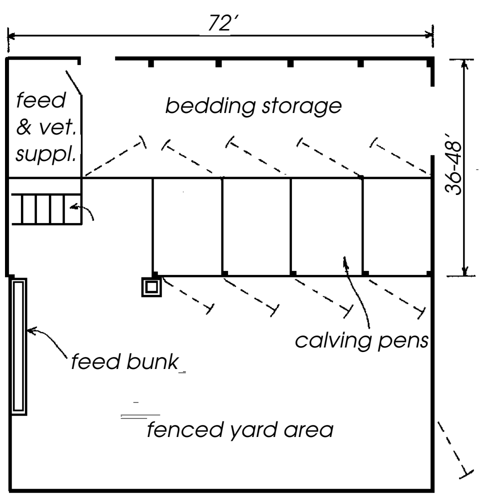


figure 3.3. calving facility for a cow-calf beef operation

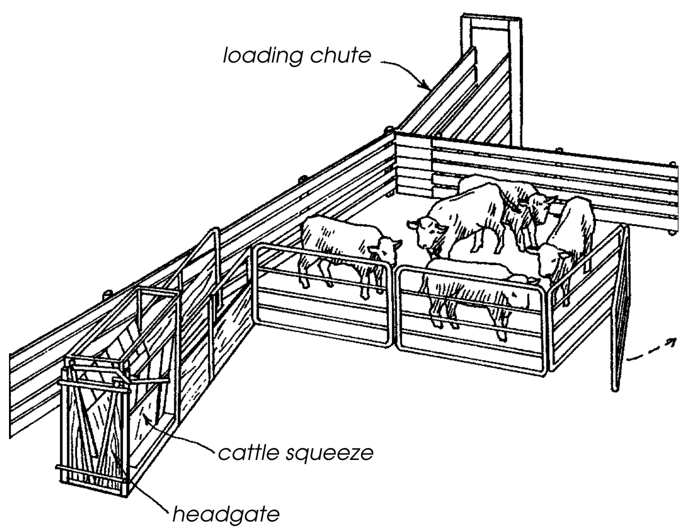


figure 3.4. simple corral layouts for beef operation

table 3.1 optimal physical setup

Feedlot and Buildings	
Hardsurfaced: 30 sq ft/animal.	
Unsurfaced except around waterers, bunks, and open-front buildings: 250 to 800 sq ft/animal	
(lower values for areas with 20" annual rainfall or less, higher values for areas with 36" rainfall or more).	
Calving pen - 100 sq ft	
Calving space - 1 pen/12 cows	
Feeder Length	
(All animals eat at once)	
Calves to 600 lb	18 to 22 inches
600 lb to market	22 to 26 inches
Mature cows	26 to 30 inches
Waterers	
One watering space minimum for up to 40 head	
Corrals	
Holding	14 to 20 sq ft/head
Crowding	6 to 12 sq ft/head
Mounds	
25 sq ft/head	
Mound slopes	5:1 (1 foot rise per 5 foot run)
Lot slope	4 to 6 feet per 100 ft
Daily Manure Production	
Feces and urine -	60 lb (1 cu ft)/head

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beef cattle breeding

Beef cattle production is a segmented industry composed of purebred breeders (seed-stock producers) commercial producers, cattle feeders, packers and retailers. All are trying to efficiently produce and merchandise a wholesome, nutritious product. Maximum improvement in beef production can occur when producers have a thorough knowledge of industry demands and production efficiencies. Lasting changes and improvements in beef come about with the genetic changes and breeding practices made by cattle breeders.

traits selection

Cow/calf producers design beef products by the breeding and selection decisions they make. The breeds you choose to use in your program determine the size, growth rate, milking ability, market finish weights, and reproductive efficiency of the cattle you raise. Cow/calf producers have traditionally made most of their profit by keeping cow maintenance cost low and reproductive efficiency high. While there will be increasing pressure to improve and develop the carcass characteristics in cattle, the production efficiencies will still be primarily determined by cow unit production cost and high reproductive performance. If beef producers are going to retain consumer demand, they must produce a market product that is efficient to raise and consistent in quality and nutritional value. Even though the United States contains a wide range of production scenarios, all producers must now become more efficient in producing a uniform, high-quality product.

Optimum performance requires a balance between reproductive performance, growth traits, and desired market specifications. It is not sensible to focus on optimizing one trait alone; there are too many trade-offs involved. For example, heavier weaning and yearly weights would seem desirable in terms of gross income. But the heaviest yearlings usually are heavy at birth also, and calves with higher-than-average birth weights are more likely to die due to birthing difficulties. Also, difficult births tend to reduce the rebreeding performance of the dams. On the other hand, calves that are lighter than average at birth are more likely to die of various stresses. So, to maximize calf survival, your goal as breeder would be to aim for intermediate birth weights, and to optimize the calves' growth through good management. But your goal would not necessarily be for *maximum* growth—heavier mature cows increase gross income when they are sold, but they also need more feed and have other additional costs. Table 4.1 lists market and production targets for beef producers.

reproductive traits

Maximum profit in a beef herd is associated with high reproductive performance. Chapter 6 of this publication identifies the goals and management guidelines for reproduction characteristics in the beef herd. Genetic improvement from selection is slow. You should focus on improving the environmental factors that affect reproduction, such as nutrition, disease control, and management. Your goal should be for every cow to wean a calf every 12 months.

For the best reproductive performance of your herd, you need to balance the nutritional limits of your operation against the nutritional needs of your herd. These needs are based on the size of your cows and their level of milk production. If resources become limited, larger cows are often the first not to breed. High-milk-producing cows also require more feed to maintain themselves and reproduce efficiently. Poor fertility rates are a red flag of caution that cow size and/or milk production rates in cows may be exceeding the nutritional limits of a given production environment.

growth traits

Growth traits are easily measured. Since producers are paid by the pound, growth traits have a clear impact on the beef enterprise's profitability.

birth weight

Birth weight is a useful indicator of calving difficulty. Selection of breeding animals for smaller birth weights appears to be an effective criterion for improving calving ease. But to balance birthing ease with optimal growth, you should ideally select for moderate birth weights with high growth potential.

weaning weights

Weaning weights are obtained to evaluate differences in mothering abilities of cows and to measure growth potential in calves. Weaning weights are generally adjusted to a common age (205 days) and then calves from similar management groups and of the same sex can be compared with each other to identify the faster growing calves, or calves from the heavier milking cows. Calves should be weighed when they are between 160 and 250 days old. The formula for estimated 205-day weight is:

$$\text{205 day weight} = \frac{\text{actual weaning weight} - \text{birth weight}}{\text{age in days at weaning}} \times 205 + \text{birth weight}$$

table 4.1 market and production specifications for beef cattle

Market Cattle	Optimum Range	Target
Live weight	1,000–1,250	1,150
Carcass weight	600–800	700
Quality grade	Select+, Choice+	Choice
Yield grade	1.5–3.5	2.5
Fat thickness (in.)	0.15–.4	0.3
Rib-eye area (sq in.)	11–16	13

Growth	Optimum Range	Target
Feedlot gain (lb.)	2.5–4.0	3.5
Feedlot feed efficiency		
(lb feed/lb grain)	6–8	6
Mature cow weight	900–1,300	1,200
Weaning weight (7 months)	425– 650	550
Yearling weight - bulls	1,000–1,400	1,200
heifers	650–900	750
Frame size	4–7	5

Reproduction	Optimum Range	Target
Age at puberty (months)	11–16	14
Scrotal circumference (CM)	30–40	34
Age at first calving (months)	23–25	24
Birth weight		
Calves from cows (lbs)	75–95	85
Calves from heifers (lbs)	60–80	70
Body condition score (BCS)	4–6	5
Post-partum interval (days)	45–90	60
Calving interval (days)	365–390	365
Calving season (days)	45–90	65
Calf crop weaned		
(% of cows exposed)	80–95	90
Cow longevity (years)	9–15	11

table 4.2 bull hip height and frame scope[a]

Age in months	Frame Score					
5	37.5	39.5	41.6	43.6	45.6	47.7
6	37.8	40.8	42.9	44.9	46.9	48.9
7	40.0	42.1	44.1	46.1	48.1	50.1
8	41.2	43.2	45.2	47.2	49.3	51.3
9	42.3	44.3	46.3	48.3	50.3	52.3
10	43.3	45.3	47.3	49.3	51.3	53.3
11	44.2	46.2	48.2	50.2	52.2	54.2
12	45.0	47.0	49.0	51.0	53.0	55.0
13	45.3	47.8	49.8	51.8	52.8	55.8
14	46.5	48.5	50.4	52.4	54.4	56.4

[a]BIF Guidelines for Uniform Beef Improvement Programs (1986)

yearling weight

Yearling weight is used to estimate growth potential in cattle. It also has a high genetic association with efficiency of gain. How an animal is fed between weaning and yearling measurements can greatly influence yearling weight. Bulls are often fed moderate- to high-concentrate rations to support a maximum growth rate and allow them to develop to their fullest genetic potential. It is generally more practical to develop replacement heifers on a lower feeding regime which keeps them growing, but not getting fat.

frame score

Frame score is a convenient way of describing the skeletal size of cattle. It also is a useful tool for estimating the maturity rate in cattle. Generally, larger framed cattle have increased growth rates and produce leaner, higher curability market cattle, but they also are large, high-maintenance cows and market cattle that have to be fed to heavy weights before they will grade "USDA Choice." The guidelines for frame scores in bull calves are shown in Table 4.2. Table 4.3 describes general frame score and cattle characteristics. Moderate-framed cattle (frame score 4 to 6) offer the most optimums for balancing production and market demands.

carcass traits

Carcass traits are also important in beef production. Refer to Table 4.1 to identify carcass goals. In the future there will be increasing pressure to breed cattle with more predictable and uniform carcass characteristics. Increased selection for lean, extremely heavily muscled cattle could be offset by lower fertility rates, calving difficulty, and lower milk production.

performance testing

Successful businesses use records to measure the productivity and efficiency of their operations. Performance testing in beef production makes it possible for you to measure differences among cattle so you can select superior animals to produce the next generation. Objective weights provide basic information for management decisions.

The differences in individual animals or groups of animals are due either to inherited traits or environmental causes. When animals are raised together under the same conditions, the genetically superior individuals can be readily identified. In each herd, there are individual cows and sires that produce heavier offspring at weaning than the average of the herd. More pounds of calf weaned results in improved chances for profit.

The University of Illinois Extension has a very detailed Beef Performance Testing Program available to producers. Contact your Extension Educator for Animal Systems for information on this program.

table 4.3 relationship of frame score to mature cow size and market weights of "choice" grade cattle[a]

Frame Score	Hip Height	Cow Wt	Steer Wt[a]
3	48	1,030	1,100
4	50	1,100	1,175
5	52	1,175	1,250
6	54	1,250	1,325
7	56	1,325	1,400

[a]NRC, 1996
[b]Assumes the steers were implanted with a Trembelone acetate implant which adds 75 lbs over estrogen implants (i.e., Ralgro, Synovex)

animal identity systems

First, you must commit to identifying each animal individually in your herd. Using ear tags or freeze brands, you should assign an individual identification number to each animal for that animal's lifetime. Choose your identification system carefully to cover a 12- to 15-year period and eliminate the possibility of duplicated numbers. Many producers want to include as much information on a tag as possible, but too many numbers make the tag hard to read. It is best to work with a 4-digit number and include year of birth (as a single number or letter) with an individual animal number. Do not number calves with their dam's number! Rather, give each animal an individual number at birth.

sire evaluation programs

Genetic evaluation programs designed by a majority of the purebred breed associations have resulted in a powerful tool for your breeding program, the *Expected Progeny Difference* (**EPD**). An EPD predicts how future progeny of a sire can be expected to perform for a particular trait, as compared to a fixed breed average. *Difference* is the key to understanding EPDs. If bull A has a weaning weight EPD of +30 pounds and bull B has a weaning weight EPD of +5 pounds, and each is bred to a representative sample of your cow herd, you would expect the progeny of bull A to average 25 pounds [+30 - (+5)] more than bull B's offspring at weaning under the same management system.

EPDs will not predict actual weights of future progeny. If you want 80-pound birth weight calves, the EPD cannot predict what the birth weight of offspring from a bull will be. EPDs do provide the best predictable differences among a group of bulls. A breeder selecting bulls with low birth weight EPDs has a much better chance for having low birth weight calves. The EPDs predict differences in progeny performances, not absolute values. But you will have less risk and more reliability in your purchases when you use EPDs.

EPD calculations include adjustments for trait heritabilities, environmental and management differences among herds, and the number of records available for evaluation. A purebred breeder's goal is to produce cattle with reliable and repeatable genetics. This encourages purebred producers to use proven bulls (mainly through artificial insemination) on a majority of the cows.

For yearling bull buyers (commercial producers), EPDs (even with lower accuracies) are still the best tool to use to compare bulls on their genetic merit. There is no such thing as a "good" or "bad" EPD. What is good for one program or environment may be less than ideal for another. EPDs are not a contest or a race. Single-trait selection has been proven to lead to negative changes in genetically correlated traits of economic importance. EPDs should guide selection and aid producers in genetically describing the cattle they will use in their breeding programs. Table 4.4 gives an example listing and trait definition for commonly used EPDs.

An EPD is a prediction of an individual's genetic transmitting ability. As with any prediction, there is a margin of error or possible change associated with an EPD, based on the amount of performance information available when the EPD was calculated. The accuracy figure is an estimate of the reliability of an EPD. The higher the accuracy, the less change is expected from an EPD.

Breed associations also include in their sire summaries tables of EPD distribution or percentile rank. These tables allow a producer to quickly evaluate where a bull ranks within a breed for a given trait (such as top 1 percent, 5 percent, 20 percent).

table 4.4 epd example with trait definitions[a]

Sire [1]	Birth wt[2]		Weaning wt[4]		Milk[5]		Maternal weaning wt[6]	Yearling wt[7]	
	EPD	Acc[3]	EPD	Acc	EPD	Acc	EPD	EPD	Acc
Bull A	+5.0	.95	+28.0	.90	+10.0	.70	+24.0	+46.0	.85
Bull B	+1.5	.70	+20.0	.60	+ 3.0	.15	+13.0	+34.0	.50

[a]BIF factsheet FS 3, 1992.

[1]Sires are listed according to their registered name. Other information such as registration number, birth date, sire, dam's sire, breeder and current owner are also presented.

[2]Birth weight is related to calving ease. Larger birth weight EPDs generally indicate more calving difficulty. Progeny of Bull A can be expected to weigh 3.5 lbs more than progeny of Bull B.

[3]Accuracy is an indication of the reliability of the EPD. Bull A's higher accuracy indicates more progeny records have been collected.

[4]Weaning weight EPD reflects preweaning growth. Progeny of Bull A can be expected to average 8.0 lbs more at weaning time than progeny of Bull B.

[5]Milk EPD reflects the milking ability of the sire's daughters expressed in pounds of calf weaned. The milking ability of daughters of Bull A should contribute 7 lbs more to the weaning weight of their calves (maternal milk) when compared to daughters of Bull B.

[6]Maternal weaning weight EPD predicts the difference in weaning weight of the sire's daughter's progeny due to the combination of growth genetics and milking ability. It is equal to one half of the weaning weight EPD plus the milk EPD. Calves from daughters of Bull A can be expected to average 11 lbs. heavier at weaning than calves from daughters of Bull B (4 lbs from growth and 7 lbs from milk).

[7]Yearling weight EPD reflects differences in adjusted 365-day weights for progeny and is the best estimate of total growth. Progeny of Bull A can be expected to average 12 lbs more as yearlings than progeny of Bull B.

Breeders need to remember that one bull will not be optimum for all traits. High-growth bulls generally have high birth weights or low maternal milk production. Bulls with desirable EPDs may not be structurally desirable, may have only minimal testicle size, or may be light-muscled. Breeders need to prioritize their production needs and select bulls that will improve the most important traits the furthest. A bull that has optimum EPD levels for several traits can meet your production and marketing specifications and also be affordable. The percentile rank table is an excellent tool for use in multiple trait selection. The biggest advantage of EPDs is that they are simple to use as well as an accurate tool for performance predictions.

For producers who are evaluating cattle in more than one breed, it is important to realize that the EPDs are not comparable across breeds. A high breed average EPD for a trait does not indicate breed superiority for a trait.

Research is currently underway to develop systems for accurate comparisons across breed EPDs. These are not available, though, at this time.

selecting a herd bull

Herd sire selection is one of the most important decisions a breeder will make. The herd sire will influence as much as 90 percent of the change made through genetic selection. Plan a herd sire purchase carefully. Many traits are needed to successfully fill all of the beef production and marketing opportunities. You must develop a plan, identify production goals, and then be willing to visit many herds and sales to find the best herd bull that will consistently produce offspring that excel in the important selection production traits.

It stands to reason that average or poor-quality bulls produce average to poor-quality calves. These bulls are usually cheap, but remember that low-priced bulls generally sell for what they are worth. If you want superior performance from your cattle, you will have to pay premium prices for your herd sires. However, do not pay a premium price without demanding performance information on potential purchases.

You must identify the calving ease, growth, milk production, and frame size requirements needed for your cow herd. Using EPDs, you can find bulls with superior genetics for the traits that need improvement. As discussed earlier, moderate-framed bulls (frame score 4 to 6) should produce optimum cattle where replacement heifers will not be too large (high maintenance) and growth rate can still be high within a targeted frame size. A bull's milk production EPDs should be selected at a level to match the nutritional environment that the cattle will be raised in. Birth weight EPDs relate to calving ease; identify maximum weights that your cows can calve without difficulty. Remember that when you are breeding first-calf heifers, birth weight EPD is very important; sires with lower birth weight EPDs are required.

Structural soundness is important if a bull is going to successfully mate and breed cows in a pasture situation. Soundness also refers to cattle that are sound reproductively. A yearling bull should have a minimum scrotal circumference of 34 cm. If possible, have a semen evaluation to determine if the production is normal.

selecting replacement heifers

Fifteen to 20 percent of the heifer calves are needed each year as replacement females. These heifers should be above herd average, but not from the largest heifers. At weaning, keep a few more than you want to end up with, since not all heifers will breed. Keep the heifers that have desirable genetics (EPDs) for your production goals and keep the moderate-framed heifers that exhibit above-average growth traits. Of course, the heifers must be structurally sound and reach puberty before 14 months of age.

Generally, it is best to select replacement heifers from early-born, heavier heifers at weaning. The biggest and heaviest heifers for their age, though, *may not* be the best since they may become large, high-maintenance cows and may have reduced milk-producing capabilities.

crossbreeding beef cattle

Crossbreeding is a management tool that can increase net productivity by over 20 percent compared to straightbreeding. Crossbreeding offers two major production advantages:

- The desirable characteristics of two or more breeds can be combined to achieve a better combination of traits than can be found in a single breed.
- Crossbreeding gives you the benefits of *heterosis* (hybrid vigor), which allows the crossbred animal to perform better than average of the straightbred parent animals. Lowly heritable traits like fertility, calf survival, and vigor respond well to crossbreeding.

In general, crossbred females are more fertile and produce more milk than straightbreds. The crossbred calves generally grow faster and have higher calf survival rates. Thus, with improvements in fertility and growth rate, profit potential for a beef herd is generally increased.

Maximizing heterosis is the key to increased productivity from crossbreeding. Table 4.5 shows the advantage of crossbreeding for one- and two-pasture breeding systems.

To maximize heterosis, a producer must avoid backcrossing and make the most divergent matings possible by utilizing three or more breeds. It is obvious that the number of pastures limit the number of breeds that can be used. However, a successful AI program can boost the opportunities for divergent matings. Also, buying replacement females allows a producer to purchase crossbred females of maternal breeds and use a terminal sire to optimize

table 4.5 heterosis advantages for 1- and 2-pasture crossbreeding systems[a]

Type of Crossbreeding	Advantage (%)[1]
One breeding pasture	
1. Buy f_1 [2]females, terminal sire	28
2. Rotate sire breeds (3 breeds)	16
3. Composite (3 or 4 breeds)	16
4. Multiple sire breeds (2) with straight-bred females	15
5. F_1 females bred to f_1 bulls	19
Two breeding pasture	
1. F_1 females, terminal sire	28
2. Rotate sire breeds (3), terminal sire	25
3. Two-breed rotation	16

[a]After Keess and Nelsen (1988)
[1]Advantage in amount of calf weaned per cow exposed over straight breeding.
[2]Crossbred "half-blood" animal.

growth and carcass traits. Terminal sires are sires used in a crossbreeding system where all the progeny, both male and female, are marked for slaughter.

crossbreeding systems

two-breed criss-cross

This system uses two breeds with the sire of one breed mated to cows sired by a bull of another breed. Sires are generally rotated every two years. It is a simple, adaptable program for small-scale producers and allows as much as a 15 percent weaned calf weight increase over straightbred calves.

three-breed rotational cross

This cross involves three breeds, each contributing something desirable to the maternal traits of the cow or to the growth and carcass traits of the calf. Calf weight at weaning from crossing three breeds can be 19 percent greater than straightbreds. The heifer replacements are generally kept from within the herd.

terminal cross

The terminal cross involves mating a crossbred cow to a third breed that excels in growth and carcass traits. All calves are sold to the market place. The goal is to develop an efficient grazing, milking, reproductive cow and to cross it with a bull who will sire desirable market beef animals. One problem with this program is that replacement females must be obtained from outside the herd.

composite breeds

Composite breeds are any new breed that is established with contributions from two or more existing breeds. A closed composite is one that, once established, is closed to the addition of outside bloodlines. Composite breeds take a long time to develop, but generally allow a producer to utilize hybrid vigor and breed differences on a simplified basis.

f_1 bulls

Crossbred (F_1) "half-blood" bulls allow a producer to sustain a crossbred population and still capitalize on heterosis and produce a uniform cattle population. It is important to utilize F_1 bulls from *known* parents: parents with established performance information. An F_1 bull produced from parents without documented EPDs is a relative unknown quantity. As with all breeding programs, sires used should come from herds that utilize performance testing.

choosing a crossbreeding system

To be successful, a crossbreeding program must be built with a plan. You must choose a plan that will be practical and workable within your production environment. In many herds, the level of management required to use some of the more intricate crossbreeding systems, which maximize heterosis and utilize complementarity through terminal-sire breeds, are simply not feasible. For small cow herds, or herds that are not the primary or even secondary enterprise on the farm, relatively simple systems of matings are most practical. Often by just rotating the breed of sire used, heterosis advantages result in increased production.

Here are some basic questions to consider when choosing a crossbreeding system:

- Will you buy or raise replacement heifers? If you are buying replacements, then you need to purchase only terminal sires. If you will be raising replacements (in a rotational system), then the sires you use will require a balance of production and carcass traits.
- Will the bulls breed only cows, or heifers and cows? If sires are breeding heifers, then lighter birth weight sires must be used, which usually results in reduced growth and carcass performance.
- How many pastures are available? (This influences the type of crossbreeding system that can be developed.)
- How large is your herd? Small, single-sire herds must use simple crossbreeding systems.
- Will you be using artificial insemination (**AI**)? The use of AI allows a producer to use a more complex crossbreeding system by using multiple breeds and different types of sires.

breed selection

There are over 60 breeds of beef cattle in the United States—plenty of breeds available for a beef producer to choose from when developing a crossbreeding program. The descriptions presented came from the Germ Plasm Evaluation Program (**GPE**) at the USDA's Meat Animal Research Center in Clay Center, Nebraska. The GPE was started in 1969 and is accomplished by mating a representative sample of AI sires from individual breeds to a very large population of Angus and Hereford cows. Breed differences are then evaluated by analyzing the data generated by one-half blood progeny.

There often is as much variation within a breed as there is between breeds. No one breed is best for all production and marketing systems. The GPE scientists have made every attempt to secure random, unbiased samples of sires from each breed and the GPE results represent the best, unbiased data base we have for comparing breeds. As a producer, you should first identify production goals and requirements for your operation. Then choose animals from breeds that will efficiently produce an acceptable market product with minimal cow/calf problems. To find these cattle, visit many successful producers from a wide area and study the different breeds of cattle at work in a producer's operation. Next, buy cattle only from breeders with performance records, and demand data on purebred breeding stock you are considering for purchase. Finally, work with reputable producers who are raising cattle in a production environment similar to your own.

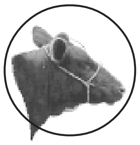
Generally in a two-breed criss-cross or a three-breed rotational system, you will want to use breeds that are comparable in size and milk production. Otherwise, you will get a wide variation of cow size and milk production, factors that determine feed requirements. Any time cow size or milk production are increased, then a better nutritional program is required to keep the cow herd reproductively sound. To maximize heterosis (and production), a terminal sire system is most productive.

The GPE information used to characterize the breeds according to their biological type is summarized in Table 4.6. Remember, there is a great deal of variation within breeds. As a producer, it is your responsibility to identify and select animals that will work profitably in your operation.

table 4.6 breeds grouped into biological types for four criteria [a]

Breed Group	Growth Rate and Mature Size	Lean to Fat Ratio	Age at Puberty	Milk Production
Jersey	X[b]	X	X	XXXXX
Longhorn	X	XXX	XXX	XX
Hereford-Angus	XXX	XX	XXX	XX
Red Poll	XX	XX	XX	XXX
Devon	XX	XX	XXX	XX
Shorthorn	XXX	XX	XXX	XXX
Galloway	XX	XXX	XXX	XX
South Devon	XXX	XXX	XX	XXX
Tarentaise	XXX	XXX	XX	XXX
Pinzgauer	XXX	XXX	XX	XXX
Brangus	XX	XX	XXXX	XX
Santa Gert.	XXX	XX	XXXX	XX
Sahiwal	XX	XXX	XXXXX	XXX
Brahman	XXX	XXX	XXX	XXX
Nellore	XXXX	XXX	XXXXX	XXX
Braunvieh	XXXX	XXXX	XX	XXXX
Gelbvieh	XXXX	XXXX	XX	XXXX
Simmental	XXXXX	XXXX	XXX	XXXX
Maine Anjou	XXXXX	XXXX	XXX	XXX
Salers	XXXXX	XXXX	XXX	XXX
Piedmonteca	XXX	XXXXXX	XX	XX
Limousin	XXX	XXXXX	XXXX	X
Charolais	XXXXX	XXXXX	XXXX	X
Chianina	XXXXX	XXXXX	XXXX	X

[a]From Meat Animal Research Center, Clay Center, Nebraska.
[b]Increasing number of X's indicate relatively higher values.



beef market grades

The importance of a uniform method and system of grading market beef has been apparent to the U.S. Department of Agriculture for many years. Standardization facilitates the industry's marketing system from producer to the retailer and consumer. Grading is simply a process of classifying units of a commodity into categories that have different characteristics or values. For beef, the grades are intended to segregate the beef supply into groups of carcasses with similar attributes of palatability and yields of cuts. In addition, the grades serve as a communication system. They provide a common language for buying and selling beef and for publishing market prices. The grades also provide an opportunity for buyers (consumers, retailers, and wholesalers) to transmit product desires back through the marketing chain so that producers can make necessary changes in livestock feeding and production practices.

beef quality grading factors

A beef carcass quality grade is based on two major factors: 1) degree of marbling and 2) degree of maturity. In addition to these factors, color, texture, and firmness of lean in the ribeye muscle are considered in determining the final quality grade. The beef quality grades are USDA Prime, Choice, Select, Standard, Commercial, Utility, Cutter, and Canner.

marbling

Marbling is the intermingling or dispersion of fat within the lean (intramuscular fat). Marbling is estimated on the lean cut surface of the ribeye muscle at the 12th rib interface. The grade standards specify more marbling for the high grades—USDA Prime and Choice—than in the lower grades.

Marbling is an indicator of eating quality; however, as it increases in amount, it also increases the caloric content, which may be considered a demerit. Marbling is associated with increased length of time on feed and hence, more feed is required to attain the higher degree of marbling. Also, marbling is highly related to the type of feed (concentrate versus roughage) as well as the animal's genetic capacity for this fat deposit.

maturity

Maturity is the second factor used in determining quality grade. It is included in the standards because the eating quality characteristics (tenderness, juiciness, and flavor) are related to animal age. Maturity refers to the physiological age of the animal rather than chronological age. The chronological age of most cattle is not known, hence, physiological indicators of maturity are evaluated in the carcass. They include bone characteristics, ossification of cartilage at various carcass locations, and color and texture of lean. (With age, lean becomes darker due to an accumulation of myoglobin, and the texture becomes coarser as the muscle fibers increase in size.)

There are five maturity groups; they are designated by the letter A, B, C, D, and E. The A and B maturities are from young carcasses. The carcasses from mature cattle are designated C, D, and E. Because of the ossification that has occurred in the bones and cartilage, these C, D, and E maturity carcasses are called "hard boned." In terms of chronological age, the cartilage areas begin to ossify when the animal approaches 30 months of age.

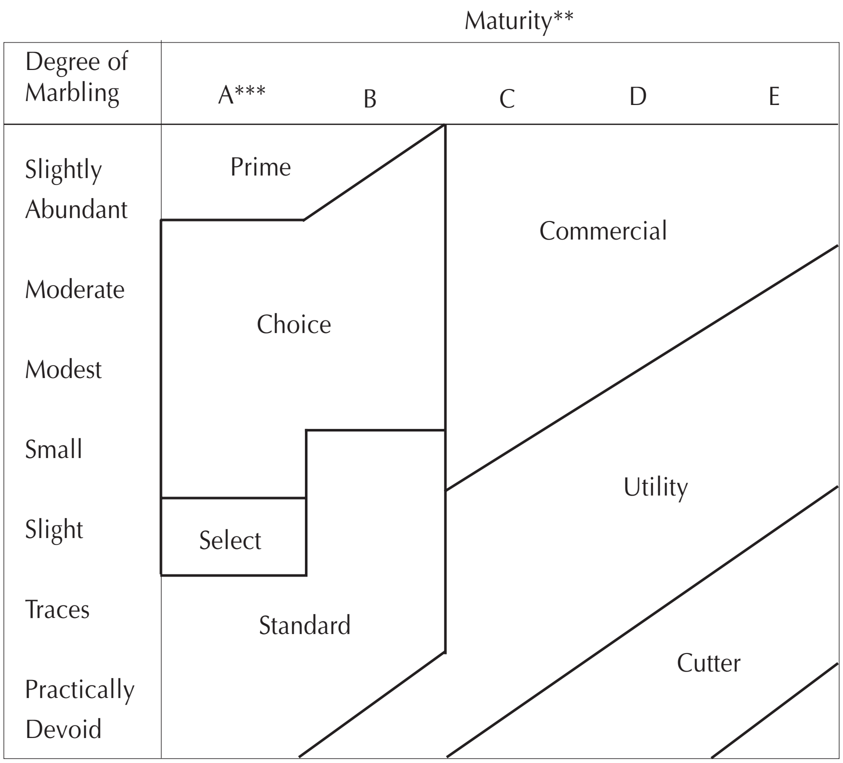
Beef from cattle 9 to 30 months is usually acceptably tender; this group is called the A maturity group. As animals increases in age from 30 months to about 42 months, ossification of cartilage increases and there is generally a decrease in tenderness. The cattle with bone cartilage and muscle quality characteristics of this maturity group are called B maturity. While they are more mature than the A group, they are still acceptably tender and consequently may qualify for the USDA Prime, Choice, Select, and Standard grades.

The collagenous connective tissue associated with the muscles also undergoes extensive cross-linkages beginning at about 42 months of age, resulting in dramatic increases in toughness. Thus, carcasses from cattle over 42 months of age (C, D, and E maturity) are generally much tougher than carcasses of either A or B maturity. Hence, 42 months is the age break in the beef quality grading standards between young and old cattle. Only cattle less than 42 months of age (A and B maturity) qualify for the USDA Prime, Choice, Select, and Standard quality grades. Carcasses over 42 months of age are only eligible to be graded USDA Commercial, Utility, Cutter, and Canner. Because C, D, and E maturity carcasses lack acceptable tenderness, they are usually not merchandised as block beef, but are boned and used in processed meat products.

determination of final quality grade

After the degree of maturity and marbling have been estimated on a carcass, these two factors are combined to arrive at a final quality grade (**FQG**). Proficiency in quality grading requires many weeks of practice, but the principles of determining the FQG can be easily acquired if you learn a few basic fundamentals. You must be able to identify the degrees of marbling in order from lowest to highest and the minimum marbling degree for each maturity group, and understand the relationships between marbling and maturity in each quality grade. Table 5.1 shows the relationship between marbling, maturity, and carcass quality grade.

table 5.1 relationship between marbling, maturity, and carcass quality grade*



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

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

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

beef yield grading

Yield grade is a numerical value from 1 to 5 based on the yield of boneless, closely trimmed (approximately 0.3 in.), retail cuts from the round, loin, rib, and chuck. These four wholesale cuts comprise approximately 75 percent of the carcass weight and almost 90 percent of carcass value; the loin comprises 17 percent of the weight and 29 percent of the value; the rib, 9 percent of the weight and 11 percent of the value; and the chuck comprises 26 percent of carcass weight and 21 percent of carcass value. The rough cuts that include the brisket, foreshank, plate, flank, along with the kidney knob, make up the remaining 25 percent of carcass weight but only about 10 percent of the carcass value.

After studying a representative number of cattle, the USDA found the following factors to have the greatest influence on carcass cutability: 1) fat thickness measured at the twelfth rib; 2) ribeye areas; 3) hot carcass weight; and 4) percentage kidney, pelvic and heart fat (**KPH**). Using these four factors, regression equations were developed that can be used to predict either the yield grade or the percentage of boneless, closely trimmed, retail cuts from the round, loin, rib, and chuck.
The equation is as follows:

Yield grade = 2.5 + (2.5 x adjusted fat thickness, 12th rib) +
(.0038 x hot carcass wt.) +
(.2 x percentage kidney, pelvic and heart fat) –
(.32 x ribeye area)

procedure for measuring or estimating yield grade factors

fat thickness

Fat thickness at the 12th rib is the measurement or estimate made at a right angle to the outer surface of the subcutaneous fat over the eye muscle, 3/4 the lateral length of the eye muscle from the backbone. The 12th rib fat thickness measurement or estimate may be adjusted up or down to reflect unusual amounts of fat covering other areas of the carcass.

ribeye area

Ribeye area is determined either by a direct grid reading of the ribeye muscle or by a planimeter reading from a tracing of the ribeye muscle. The grid reading is most often used because measurements can be made more rapidly.

hot carcass weight

Hot carcass weight is usually obtained in the packing plant using electronic scales. Hot carcass weight should be obtained before the carcass is shrouded.

kph fat

Kidney, pelvic and heart fat (KPH) is estimated in pounds for each side, the two sides totalled and divided by carcass weight to arrive at a percentage value. There is generally more kidney fat in the left side (loose side) compared to the right side (tight side). KPH will range from .5 to 8 percent and average about 3.0 percent.

reproduction

Anyone trying to show a profit with a herd of beef cows MUST make sure that every female, two years old and older, raises a calf and rebreeds in a timely manner every 12 months. To do this, you need to understand how health and nutrition affect the reproductive physiology of beef animals.

goals

Setting goals for the breeding program can be difficult and challenging. Besides the goal of having each breeding-age female calve every 12 months, you need to set some other reproductive goals for your cowherd, such as:

- Getting heifers bred to calve on or just before their second birthday
- Shortening the calving season to 60 days or less
- Getting a high percentage of the cows to settle during the first 21 days of the breeding season
- Getting a high percentage of each year's calf crop from AI service

breeding the cowherd

Nutrition plays an important part in the reproductive efficiency of a cowherd. Figure 6.1 shows the TDN requirements for a 1,100-pound cow by her stage of reproduction. From calving to breeding is the period when a cow's nutrition

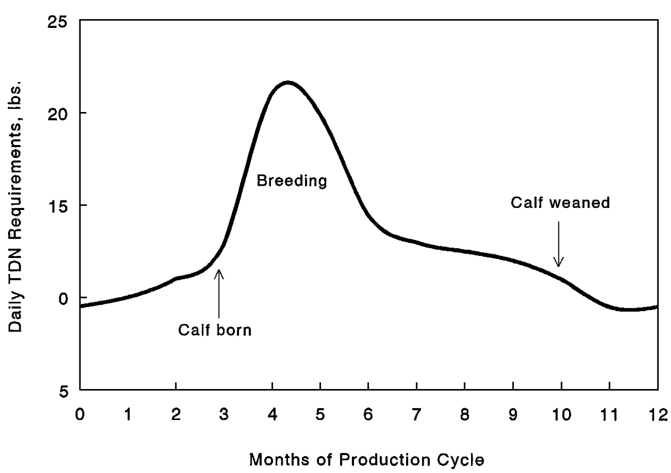


figure 6.1

needs are at the highest level. Failure to provide adequate nutrition at this time can mean a failure in the reproductive cycle. Doing everything else "right" will not offset poor nutrition.

Cows that calve late in the calving season have a hard time catching up with the rest of the cowherd in reproductive performance. Not only will their calves be smaller at weaning, but the chances are greater that late-calving cows will be late calvers again next year. Research shows that cows that calve 70 days before the next breeding season conceive on the first service at twice the rate of cows that calve only 30 days prior to the breeding season. Cows must be in good condition, and on a proper plane of nutrition, to have any chance of calving significantly earlier in the calving season the next year.

body condition score

Evaluating a cow's body condition near the time of calving will clue you as to whether better nutrition will be needed to get her rebred in a timely fashion. Body condition score (**BCS**) is a subjective numerical scale that represents the amount of external body fat a cow possesses. It ranges from 1 (very thin) to 9 (very fat). Aim for cows with a BCS in the range of 5 to 6 during the last trimester of pregnancy. Feeding cows to BCS of 7 or more will needlessly increase feed costs, while a BCS of less than 4 will seriously jeopardize breeding performance.

dystocia

Dystocia (history of difficult birthing) can also cause cows and heifers to breed later in the breeding season. No matter what their age, cows with dystocia are slower to come back into heat than cows with no dystocia. While there is little you can do to prevent dystocia (though using bulls that sire light birth weights will help), realize that cows experiencing dystocia will most likely be later to breed.

female reproductive tract

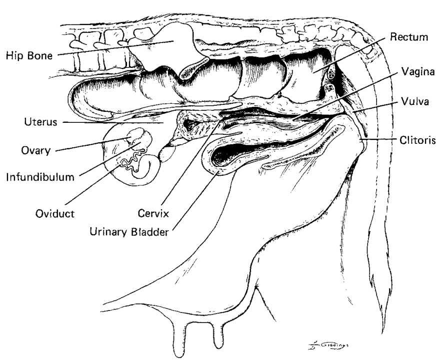


figure 6.2

Courtesy of Taylor, Robert E., Thomas G. Field. (1998) Scientific Farm Animal Production. *6th Ed., Prentice Hall, Inc., New Jersey.*

Figure 6.2 shows the reproductive tract of the cow. You need a basic understanding of the reproductive system to be able to understand reproductive problems and solutions.

The primary reproductive organ of the cow is the ovary. The ovary produces the egg or ovum and two hormones, estrogen and progesterone. The egg, once fertilized by sperm, develops into the embryo. The hormones help prepare the egg for fertilization and maintain the pregnancy.

The estrous or reproductive cycle of the beef female usually occurs over a 21-day period, but may range from 17 to 24 days. The purpose of this cycle is to prepare the egg for ovulation and the female for estrus (the period of sexual receptivity). Once the egg is ovulated by the ovary, it proceeds to the oviduct where it is fertilized if viable sperm are present. Because the egg is capable of fertilization for only a few hours, fertile sperm must be present very near the time of ovulation.

During the next 3 to 4 days the egg proceeds through the oviduct into the uterine horn. If it is a fertilized egg, it begins embryological development. Unfertilized eggs degenerate and disappear. Any resulting embryo will spend the entire gestation period in the uterine horn and receive nourishment from the cow through the membranes of the placenta.

The cervix is the neck of the uterus. This thick-walled structure serves as a passageway for sperm deposited in the vagina and for the fetus during birth. During pregnancy it is usually filled with a thick plug of mucous to prevent infections moving from the vagina to the uterus. During birth, the cervix must dilate (open) enough for the calf to pass through into the vagina. Besides serving as the final part of the birth canal, the vagina also serves as the receptacle for the penis during natural service. A bull will deposit semen in the vagina near the cervix. Proper artificial insemination technique has the AI straw passing through the vagina and the cervix and depositing semen just inside the body of the uterus.

male reproductive tract

Figure 6.3 shows the reproductive tract of the bull. The reproductive tract of the bull is composed of the testicles and other secondary organs which transport the sperm from the testicles to the vagina of the female.

The testicles are the site of sperm formation and production of the male hormone testosterone. The testicles are located in the scrotum, away from the body, because sperm formation occurs only at a temperature below normal body temperature. The scrotum regulates the temperature of the testicles by relaxing and increasing the distance from the body during hot weather, or contracting to keep the testicles closer to the body during cold weather. Injury to the testicles, from temperature or physical injury, can result in sterility of the male for 6 to 10 weeks.

Testicle size, determined by measuring scrotal circumference, is highly related to sperm production. Bulls with large scrotal circumferences will be more fertile and have the capacity to settle more cows. Daughters of bulls with large scrotums are also more fertile than daughters of bulls with smaller scrotums. However, scrotal circumference has no effect on libido, and therefore cannot be used to predict sex drive or the physical ability to breed cows.

When selecting a sire, consider sexual behavior, libido, and the physical structure of the reproductive tract, in addition to testicle size. Fertile bulls will not get cows settled if they are not sexually active. Yearling bulls can be expected to breed about 12 to 18 females per breeding season, whereas mature bulls can be expected to breed up to 40 per breeding season.

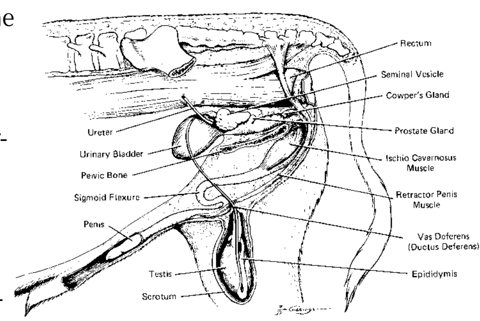


figure 6.3

Courtesy of Taylor, Robert E., Thomas G. Field. (1998) Scientific Farm Animal Production. *6th Ed., Prentice Hall, Inc., New Jersey.*

artificial insemination

All cowherd operators should give serious consideration to using artificial insemination to breed most or all of their cows. Artificial insemination allows a producer to use the most advanced genetics and avoid the cost of purchasing and keeping a bull. However, AI requires a higher level of management and greater time commitment from the operator than does natural service.

AI is particularly useful if you are using a crossbreeding system on a small number of cows. The problems and costs associated with keeping and rotating the use of bulls of different breeds can be minimized or eliminated.

A successful AI program requires a continued commitment to management, nutrition, and reproductive performance. A good program involves more than just depositing semen in a cow's reproductive tract and hoping that she gets pregnant. You must be willing and able to devote additional time each day to the beef enterprise during the breeding season, as well as additional planning and management time through the rest of the year.

A workable identification system as described in Chapter 5 is indispensable. Permanently identifying every animal in the herd facilitates proper record keeping as well as planning efforts.

Suitable working facilities are another prerequisite for building a successful AI program. You will need to closely observe and handle the cowherd on a regular basis. Chapter 4 contains information on the requirements of cattle working facilities.

A holding/sorting pen and a chute or alley are all that is really required. You should be able to get the herd into the holding/sorting pen as easily as possible. Often, luring them into the area with a small amount of feed works better than trying to drive them in. Once in the holding/sorting pen, the cow(s) to be bred can be put in the chute or alley, whichever is least disruptive to the animal. Many AI technicians prefer that the cow's head not be placed in a headgate, as the cow tends to fight the headgate and not remain calm.

In most cases, a properly managed AI program will be less expensive than owning and maintaining a bull. Semen can usually be secured for between $15 and $25 per dose and the annual costs of owning and maintaining a liquid nitrogen tank will cost another $125 to $150. AI supplies will add another $1 to $3 per service. A herd of 20 cows would cost between $27.69 and $42.45 per cow, assuming 1.3 services per cow per year. Natural service costs would include the amortized cost of the bull ($1,800 purchase price over 4 useful years = $450 per year), annual feed costs of a bull ($250 per year), as well as the costs of separate bull housing for the 9 to 10 months of the year he was removed from the cowherd. For the same 20-head cowherd, this works out to $42.50 per cow. There is an additional cost from the reduced performance usually seen from using natural sires when compared to AI-sired calves.

ai program

Once producers have committed to an AI program, they must understand the proper methods of AI. Three things are required for getting fertile cows pregnant using AI: accurate heat detection, proper timing of the insemination, and correct AI technique.

Accurate heat detection. Accurate heat detection is the most time-consuming portion of any AI program. In heat detection, you are attempting to do part of the work of the bull by observing each female in the herd for signs of heat. Heat is a regularly occurring state of sexual receptivity during which the female will accept the male. Heat is best indicated by a cow standing to be mounted by other members (both male and female) of the herd. The goal of heat detection is observing females standing solidly while being ridden. Standing heat generally lasts between 12 and 18 hours, but may be as short as 4 or as long as 24 hours.

Other behavioral changes accompany the standing heat period and should be watched for, in addition to the riding behavior. Before and during standing heat, most cows will exhibit signs of nervousness or hyperactivity. This may be noticed as excessive nervous walking, bawling, or movement when other cattle are relatively inactive. Cows that are riding other cows may or may not be in heat. The cow that is constantly trying to mount other cows should be watched closely to see if she will stand to be mounted.

The physical activity of riding or being ridden may cause a thick, clear mucus to be expelled from the vulva. This mucus is often observed hanging from the vulva or on the sides of the tail. As the cow switches her tail, the mucus is smeared over each rear quarter and will leave a very distinctive mark for several hours. This should be interpreted as a strong sign of standing heat.

Cattle in heat naturally seek each other, forming little clusters of activity. Whenever a cluster of cattle is noted and there appears to be excessive, uncharacteristic activity, that cluster should be monitored closely.

Muddy conditions create an excellent natural marker, as a cow in heat will have mud plastered on both flanks from the front legs of cows riding. Also be alert to hair that has been roughed up on the tailhead, possibly rubbed off down to the hide.

While you can't use these behavioral changes as certain signs of standing heat, watching for them will make you more successful at finding cows in standing heat.

Observe cows at least twice per day for heat. Just after sunrise and just before sunset, during the cooler parts of the day, are the most desirable times for heat detection. At least 30 minutes (longer in larger herds) should be spent observing the cowherd during each of these periods for effective heat detection.

Proper insemination timing. Once you have determined that a cow is in standing heat you must decided when she is to inseminated. Breed a female in the evening if she was observed standing that morning. Females observed in standing heat in the evening detection period should be inseminated the following morning.

Proper insemination technique. The only remaining question is: "Who should do the insemination procedure?" Professional inseminators will probably have higher conception rates than the novice inseminator. Check with beef and dairy producers in your area for the availability of a professional inseminator. On the other hand, artificial insemination is easily learned and you may wish to do your own insemination work. If so, check with your local Extension office or the agricultural staff at your local community college for information on when and where classes might be offered. Many of the major stud services also conduct classes in artificial insemination.

estrous synchronization

As a management aid, producers can synchronize the estrous cycles of a group of heifers or cows so they come into heat at the same time. This helps to minimize (or at least concentrate) the labor necessary for AI. To some degree, synchronization also reduces the necessary labor at calving by bunching up the calves being born.

Estrous synchronization is not a cure-all and requires some intensive management to be successful. It increases the cost of AI because of the cost of the drugs that are necessary to get the cows cycling together. However, when cows cycle together, the time required for heat detection is greatly reduced—or even eliminated, with some programs.

Several different synchronization programs exist on the market and more are under development all the time. All these programs involve the administration of hormones which act to hold cows out of heat or to induce heat shortly after treatment. If you are interested in synchronization, you should contact your local AI stud representative, your local veterinarian, or the nearest Extension livestock educator for the most up-to-date information and programs that are available.

Synchronization programs will not increase conception rates, and should be used on females that are cycling before the program begins. Conception rates will generally be the same as for non-synchronized females, but will occur over a period of just a few days instead of three weeks. Females not settled on the first service will still be somewhat grouped together when they return to heat 18 to 21 days after the first try.

birthing management

Once cows are bred, the next big reproductive event occurs approximately 283 days later when the female gives birth. Pay close attention to the cowherd during the calving season, especially to first-calf heifers. Nearly ten percent of all calves born in the United States die at or soon after birth. Nearly half of those deaths are the result of calving difficulty (dystocia). Being prepared to assist when trouble occurs can help you raise a higher percent calf crop.

"Being prepared to assist" means having the proper facilities, understanding the birthing process, and knowing when and how to assist. The cowherd needs to be in close proximity of the barn or other facility where they can be easily penned if assistance is needed. Nothing is more frustrating than chasing a cow in need of assistance around a pasture with no way to restrain her and assist with the birth. As stated earlier, cow-calf facilities need not be fancy, just functional.

It is *not* necessary for calves to be born in a barn. In many instances, barns can be a terrible place for birthing because the manure/bedding in the barn harbors many of the microbes that are detrimental to the health of a newborn. Barns are often drafty, damp places that block the warming influence of sunshine and clean, fresh air. Other barns are nearly airtight and poorly ventilated and expose newborns to high levels of ammonia and other gases that can cause pneumonia or other respiratory distress.

A well-drained lot with shelter from wind and rain is really all that is necessary for calves that are delivered unassisted. A cow will generally pick a protected area to give birth if one is easily available. Newborn calves that are born on dry ground, receive a belly full of warm colostrum within an hour or two of birth, and are cleaned off by their mother, can survive most of what Mother Nature can throw at them. A lot with a hill with a southern exposure is nearly ideal for calving, especially if a good sod cover can be kept on the hill to provide an area for young calves to be dry and in the sunshine.

If you are not lucky enough to have such an environment for calving and must calve in a barn, make sure the calving stalls are dry, well ventilated, yet draft-free. Once the calf has nursed each quarter of its mother's udder and is dry, the calf and its mother should be placed outside in a pasture or well-drained lot. In most cases, keeping them together in the barn will only cause problems.

calving difficulties

While most calves are born without human intervention, some require assistance if they are to survive calving. Most calves that die during birth are lost due to suffocation resulting from a long, difficult birth. Dystocia can be caused by the calf, by the cow, or by fetal position at birth.

Heavy birth weights are the primary cause of dystocia when looking at problems caused by the calf. Birth weights are influenced by breed of the sire, sex of the calf, age of the cow, and somewhat by the nutritional plane of the cow. Individual sires can also have different gestation lengths. Because of the rapid growth of the fetus during the last weeks of pregnancy, bulls that sire shorter gestation lengths will usually sire lighter birth weight calves. Bull calves are generally heavier than heifer calves at birth.

The pelvic area (birth canal) of the female also plays a part in whether or not there will be dystocia. First-calf heifers have a higher proportion of dystocia mainly because they have smaller pelvic openings. When selecting sires to use on first calf heifers, select sires with low birth weight EPDs to help offset the problem of small pelvic area of first-calf heifers.

A small number of births require assistance because of the position of the calf at birth. Figure 6.4 shows the normal position of the calf just prior to delivery. A calf in any other position will probably need some degree of assistance during delivery. Some of the more common abnormal positions include head turned back, one or both forelegs turned back, rear legs first, and breech (hind end first). If you encounter any of these positions, call a veterinarian to assist with the birth. The veterinarian will attempt to reposition the calf for proper delivery. If repositioning is not possible, the veterinarian may have to perform a caesarean section.

Inexperienced beef producers should not attempt to assist with calving difficulties. Check with your veterinarian for advice on when to assist the cow and when to call for professional assistance. Improper assistance can result in permanent damage to the cow, the calf, or both.

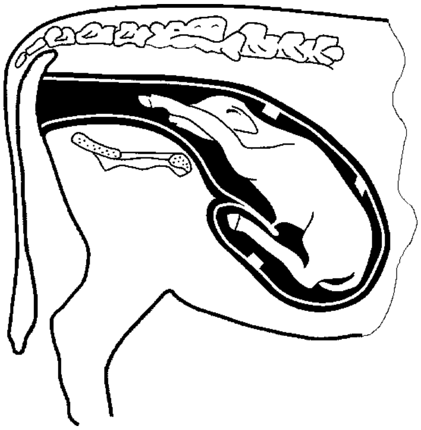


figure 6.4. calf in utero

Courtesy of Taylor, Robert E., Thomas G. Field. (1998) Scientific Farm Animal Production. *6th Ed., Prentice Hall, Inc., New Jersey.*

typical birthing sequence

The calving sequence itself can be divided into three distinct stages: preparatory, delivery, and cleaning. You need a general understanding of the birthing process so you know when, and if, assistance is necessary.

During the preparatory stage, the fetus is rotated off its back and into an upright position. Its head and forelegs are pointed toward the birth canal. This position provides the least resistance during the parturition. Rhythmic uterine contraction begins and the cervix dilates so the uterus and vagina become a continuous birth canal. The water sack ruptures and membranes hang from the vulva until the delivery stage. The preparatory stage can last up to 6 hours; you may notice only the final portions.

The preparatory stage ends and the delivery begins when the fetus enters the birth canal. This usually happens while the cow is lying down. Uterine contractions are more frequent and voluntary contractions of the abdominal muscles are noticed. The calf's forelegs and nose, surrounded by membranes, protrude from the vulva. At this point the cow is putting forth maximum effort to push the calf through the pelvic girdle.

The placenta remains attached to the uterus during the birthing process to insure an oxygen supply to the calf during birth. Once the calf passes through the vulva, the umbilical cord usually breaks and the lungs begin to function. Delivery generally takes less than 1 hour. Assistance is needed if this stage lasts longer than 2 hours.

After parturition, the placenta separates from the uterus and is expelled by uterine contractions. This cleaning phase is usually complete within 2 to 8 hours after birth.

Once the calf is delivered, make sure the mouth and nose are clear of obstructions and that the calf is breathing on its own. It may be necessary to stimulate the calf to breath by tickling the inside of a nostril with a straw, or rubbing its ribs briskly. If all appears to be normal, the best course is to leave the cow and calf to themselves and let Nature take its course. Check occasionally during the first couple of hours to make sure the calf has nursed and received colostrum milk. You don't need to help with nursing unless the calf is weak or the cow has a malformed udder.

keeping cattle healthy

Even if everything else is done right, cattle that are not healthy will not perform properly or be profitable. While the list of diseases and maladies of cattle is long, you need only to be concerned with a few that may affect your operation.

It is especially important to establish a good rapport with a local veterinarian. If a problem arises, a veterinarian can be of maximum use only by being totally familiar with your particular operation. Involve your veterinarian in establishing a herd health program that will include routine vaccinations for disease prevention as well as other management procedures. As the old saying goes, "An ounce of prevention is worth a pound of cure."

The following discussion briefly describes some of the more common diseases that can be a problem for a cowherd located in the midwest. Not all of these will be a problem in every locale. It is therefore important to work with an established veterinarian to decide which of these diseases need prevention measures in any given herd. **CAUTION:** Do not try to use this publication as a diagnostic tool. It is only meant to provide a brief background on a wide range of veterinary medicine topics. If you suspect trouble with any of these problems, consult with your veterinarian immediately.

anasplasmosis

An infectious disease of ruminants, anasplasmosis is characterized by anemia, fever, weakness, jaundice, and frequently a change in disposition. The disease attacks the red blood cells. It is transmitted by biting insects (flies, ticks, and so on), contaminated veterinary equipment, or anything else that allows the transfer of blood from one animal to another. Anaplasmosis can be prevented by controlling insect vectors, disinfecting veterinary instruments between animals, feeding antibiotics, and vaccinating. Tetracyclines are an effective treatment for animals with the disease.

blackleg

An infectious disease caused by the bacteria *Clostridial chauvoeli*, blackleg is characterized by rapid death. The animals killed by the disease are usually in excellent health and gaining weight. Often they are the best animals of their group. Blackleg usually occurs during the summer or fall months; it is uncommon in winter. Death is often the first sign of the disease, although acute lameness and depression are common. Death occurs in 12 to 48 hours. A safe, reliable, inexpensive vaccine for blackleg is the only prevention. Treatment is seldom successful.

bovine viral diarrhea (bvd)

BVD is a complex viral disease of cattle that can occur in several forms: respiratory, digestive, abortion, congenital, and laminal. BVD is transmitted by direct contact with sick or carrier animals, or by indirect contact with contaminated feed or other materials. Cattle with clinical BVD are dull, depressed, and may have mild bloat. Heart and respiratory rates are generally increased. Watery diarrhea can occur and the feces may contain mucus or blood.

Infection of a susceptible cow during pregnancy can result in fetal infection. Fetal death, with resorption, mummification, or abortion may occur following infection in early to mid-gestation. Cattle with acute BVD can die within 48 hours. Most affected cattle are anorectic and exhibit oral lesions for 2 to 4 days. Failure to make an early diagnosis may mean the animal will have no salvage value because of dehydration and emaciation. Modified live virus and inactivated virus vaccines are available and can provide significant protection from BVD. Revaccinate calves that were vaccinated before 6 months of age.

calf scours

Calf scours is an acute complex disease of newborn calves that can be caused by virus, bacteria, or a combination of both. Calf scours are characterized by diarrhea within a few days of birth. The diarrhea can cause progressive dehydration and death. Calves are more likely to get calf scours if they do not receive adequate colostrum shortly after birth, are stressed by bad weather, or have inadequate housing or hygiene. While it may be a virus or bacteria that cause the scours, death is often the result of dehydration and emaciation. Isolate sick animals from healthy ones, reduce milk consumption, replace fluid and electrolytes, and provide anti-diarrheal agents. Good cow nutrition, sanitation, colostrum feeding, and proper ventilation can help to prevent scour outbreaks. Vaccines will benefit some types of scours.

coccidiosis

Coccidiosis is a disease of young cattle (usually from 1 to 2 months up to 24 months), caused by oocysts invading the intestine and causing cell destruction. Coccidiosis is transmitted by contaminated feed, feed bunks, and water. It occurs more frequently under the stressful conditions of overcrowding, poor sanitation, weaning, shipping, sudden feed changes, or poor weather. Signs of coccidiosis include diarrhea containing blood, dehydration, anemia, fever, weight loss, and death. It can be prevented by administering a coccidiostat in the diet. Ionophores (Rumensin™ and Bovatec™) may also aid in prevention.

foot rot

Foot rot, an infection of the hoof tissue, is the primary cause of lameness in cattle. The infectious organism invades the hoof from the soil through a break in the tissue around the foot. The tissue between the hooves becomes inflamed, causing lameness. An offensive odor is usually present. Affected animals need cleaning and systemic antibiotic treatment. Foot rot can best be prevented by removing sources of injury, keeping cattle out of poorly drained areas, and adding antibiotics or sulfas to the feed.

bovine rhinotracheitis (ibr, rednose)

A viral disease of cattle caused by a virus in the herpes family, IBR is transmitted by direct contact with infected animals and infected respiratory droplets. The venereal form is transmitted through sexual contact with infected animals. Symptoms depend on the form of the disease, and include nasal discharge, eye inflammation, abortions, calf scours, and encephalitis. Laboratory analysis is required for a definitive diagnosis. Prevention requires one dose of a modified live virus vaccine or two doses of dead virus vaccine.

leptospirosis

"Lepto" is a bacterial disease that affects most farm animals as well as humans. The causal bacteria is transmitted through feed and water. Symptoms of lepto infection include elevated body temperature, labored breathing, discolored urine, lack of appetite, and abortion in the cow. Infected animals can be treated with antibiotics such as oxytetracycline, chlortetracycline, or penicillin. A blood test is needed for positive diagnosis. Draining water-holding areas will help to prevent the disease, and vaccines for leptospirosis are routinely included in most vaccination programs.

parainfluenza (pl-3)

This virus is involved in the BRD complex of diseases. While PI-3 is not normally serious alone, it does cause respiratory tract damage that can lead to the growth of resident bacteria which cause serious respiratory diseases. Treatment of the disease itself is not possible, but secondary bacterial infections should be watched for and treated with antibacterials.

PI-3 is transmitted from animal to animal through direct contact and infected respiratory droplets. A nasal discharge and a poor appetite are the primary symptoms. Positive diagnosis is possible only by laboratory analysis of blood samples. PI-3 can be prevented by a single dose of modified live virus or two doses of killed virus. The most common vaccination is intranasal.

pinkeye

This viral infection is transmitted to beef cattle by infected flies or dust. Plant pollen, shipping stress, and bright sunlight tend to worsen the disease. The eyes of infected cattle water profusely and a small ulcer may occur near the center of the eye. While prevention rates can be improved by vaccination, no reliable vaccines have yet been developed. Fly control, pasture clipping, and dust control may also help in preventing pinkeye. Affected cattle can be treated with antibacterials including furazolidone, niomycin, nitrofurazone, and penicillin.

vibriosis

Vibriosis is a venereal disease of cattle spread by sexual contact with an infected animal. Infected animals may abort, have irregular heat cycles, or be infertile. Positive identification is made with laboratory blood analysis. Once cattle are infected, no treatment is effective.

parasites

Parasites are classified as internal or external, depending on where they are generally found. The control of external parasites is generally more straightforward than that of internal parasites, because external parasites and their symptoms are easy to see. Cattle infested with internal parasites may not show obvious symptoms but may endure more economic damage.

External parasites. Cattle heavily infested with external lice will have an unthrifty appearance, will be seen scratching and rubbing excessively, and will have patches of hair missing. Flies are the easiest external parasites to recognize and can cause lowered production and general restlessness. Grubs can ruin the hide of cattle because of the holes made by the exiting larvae. Some of the blood-sucking insects can transmit blood diseases, so control can be vital. External parasites can be controlled with a program that includes one or more of the following: spraying, dipping, oilers, feed additives, pour-ons, injections, and ear tags.

Internal parasites. Internal parasites not only contribute to general unthriftiness, but can also lower the animals' disease resistance level. Cattle are infected when they ingest eggs, adult parasites, or parasite larvae. Level of infestation can be determined by analyzing fecal samples. Many internal parasites can be prevented by proper sanitation practices and by rotating pastures. Most internal parasites can be treated by a program that includes commercial worming compounds that are given to the animal by way of injection, feed additives, boluses, drenches, and pour-ons.

miscellaneous herd health practices

There are a number of other herd health practices that producers will practice to produce a quality product.

castration

It is generally recommended that bull calves not intended for breeding purposes be castrated at a young age. Intact males require separation from females, stronger fencing, and are more difficult to manage than castrated males.

dehorning

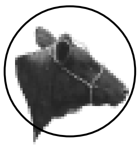
Horned animals should be dehorned. Ideally, dehorning can be accomplished genetically by using polled parents, or at the very least a sire breed that will sire all polled calves. If horned cattle are being produced, dehorning should take place as soon as horn growth is noticeable. This can be done chemically with a caustic paste or mechanically. Waiting until animals are larger only increases the stress inflicted upon the animal. Horns cause bruising and are not desirable in the feedlot or the cowherd.

culling open cows

Producers can save large amounts of feed and money by not feeding open, nonpregnant cows through the winter. Cows that calve in the spring should be examined for pregnancy when their calves are weaned each fall to determine their pregnancy status. Open cows should be culled from the herd. This procedure is usually done by a veterinarian, and can be done along with vaccinations or other herd health management procedures.

recordkeeping

As can be seen from this discussion of herd health, animals must occasionally be treated to prevent or treat diseases, parasites, or other disorders. It is advisable to revaccinate calves that have been vaccinated before 6 months of age. Read and follow all label directions carefully. All animals treated should be individually recorded stating the drugs used, dosage administered, approximate weight of the animal, and the earliest date cattle can be sold and still be in compliance with labeled withdrawal times. The National Cattlemen's Association, in conjunction with many state beef associations, has developed a Beef Quality Assurance Program. The objective of the program is: "To ensure that all cattle are fed and maintained in a proper manner in order to provide a safe beef product to the consuming public." This requires the keeping of accurate records. Contact your local beef association or veterinarian to obtain more details about the program. In many instances, information recording sheets have been developed to help producers make the recordkeeping chore an easy one.



beef cow economics

The average cow herd size in the north central region is less than 30 cows. Therefore, most herds do not generate sufficient dollars to be considered a full-time enterprise; they supplement other farm operations or off-the-farm employment. However, if managed properly, even a small herd has the potential to be profitable.

For you to earn a significant level of income from a cow herd, several things must happen:

- High calf prices
- Low production costs
- Heavy weights for calves weaned
- High percentage of all cows must wean calves

Although the beef cow enterprise generally has low demands for labor and time, gaining a profit from this enterprise requires certain management and marketing skills. Illinois' Standardized Performance Analysis Program (**SPA**) has shown that most producers have higher production costs than are necessary, making it difficult for their enterprise to be profitable and sustainable.

Some of the key factors to focus on when analyzing the economics of a cow/calf system are shown in Table 8.1. Three years of actual data on Illinois pro-

table 8.1 key factors in cow-calf economics

Critical success factors	1994-96 Illinois SPA Average	SPA Goal
Total cost per cow	$413	$275 to $325
Feed cost per cow	$266	$160 to $190
Total feed fed per cow	5,122 lbs	< 4000 lbs
Cost per ton of forage produced	$49	$35 to $50
Calf crop percentage	83.2%	90%
Pasture cost per day per animal unit	$0.35	$0.25
Pounds weaned per exposed female	413	450 to 500
Calves born during 1^{st} 63 days	84.8%	100%
Total capital invested per cow	$888	

ducers were compiled for the 1994–96 Illinois SPA average, and the SPA goal is a benchmark figure indicating approximately where producers need to be in order to be profitable.

The total cost to maintain a cow for a year is one of the most important economic indicators of the performance of a cow herd. While most producers have a good understanding of the price they are receiving for their calves and the returns their cow herd is generating, very few have an adequate knowledge of the expenses that are going into their herd. In the scenario described by the Illinois averages, weaned calves would have to bring in approximately $1.00 per pound for the average producer to break even. In most years this is not the case, so attention must be paid to keeping costs in line. Included in this $413 figure are feed costs, operating costs, depreciation costs, capital charges, and hired labor.

The single largest component of total cost per cow is total feed cost per cow. A closer look at the high feed costs incurred by Illinois producers reveals that total stored feed fed per cow is over 5,000 pounds per cow per year. Total cost per ton of forage produced is $49 and pasture cost per day per animal unit is $0.35.

Producers must do a thorough job of analyzing their feeding programs in order to identify ways of reducing costs. SPA numbers indicate that for many producers the forage production system needs to become more efficient. In many cases, the forage system is not productive enough to justify the land, labor, and equipment costs that are put into it. Producers need to carefully evaluate their own operation to determine if they can afford the time and capital investment necessary to produce and harvest their own forage. In many cases, it may be more economical to hire someone to harvest your forage. Buying hay, or an alternative feedstuff, may also prove to be the most cost effective.

Pasture and aftermath grazing numbers show that allowing the cow to harvest her own feed is usually the cheapest method available to maintain these cows. Having more than 5,000 pounds of stored feed going into the average SPA cow shows that finding methods of extending the grazing season and reducing stored feed usage are necessary. Utilizing crop residues, stockpiled forages, or rotational grazing are just a few of the methods that can allow the cow to harvest her own feed for a larger part of the year.

Reproductive performance is also important to the economics of a cow herd. Every cow must wean a calf every year. These cows also must calve within as narrow a calving season as possible. SPA numbers indicate that nearly 85% of calves are born in the first 63 days of the calving season. Maintaining a tight calving season provides a number of management advantages, including more efficiently utilizing labor and having a more uniform set of calves to market.

One thing that must be kept in mind is that there are a number of cow herd performance measures in which bigger is not always better. For example, is it more profitable in your production situation to feed and maintain a 1,200-pound cow that weans a 450-pound calf, or a 1,400-pound cow that may give you 50 more pounds of weaning weight but cost more to feed? Another example would be to determine if you can justify using a bull who may inject more weaning and yearling growth into his calves, but along with that bring higher birth weights and the potential for calving problems.

The key to answering these questions and making sound economic decisions is recordkeeping. Even though the cow/calf enterprise may not be a primary source of income, it does have the potential to be profitable if you take time to keep the records that are necessary to make decisions about your own operation.

Numerous tools are available to help maintain records for a beef operation. Consider enrolling your herd in a standardized performance analysis program through Extension or (in Illinois) the Illinois SPA Program. You may find it helpful to read the publication "Crop and Livestock Budgets" (AE 4700), available through the University of Illinois Department of Agricultural and Consumer Economics at (217) 333-1811.

For more information on issues relating to beef production, consult:

http://www.ansci.uiuc.edu/beefnet/

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