Maximizing Fall and Winter Grazing of Beef Cows and Stocker Cattle

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Maximizing Fall and Winter Grazing

Extending the grazing season can reduce production costs (Fowler and Stout, 1990). Labor for the winter period can be reduced to 25% of conventional wintering of beef cows in Ohio (Van Keuren, 1970). Rotational grazing takes about three hours/acre/year versus hay production which requires seven hours/acre/year (Undersander et al., 1991). The cost for feeding hay or stored feed is between $0.75 to $1.00 a day per cow, compared to $0.20 to $0.25 a day per cow for winter grazing fescue. A well-planned grazing program can provide stockpiled pasture well into winter across much of the Upper South and Lower Midwest (Gerrish, 1996).

Developing a Forage Management Strategy

Step 1. Assess Soil and Forage Resources

The first step is to assess the soil and forage resources. Soil resource assessment involves determination of soil fertility (level of nutrients) and soil pH (acidity). Low fertility and pH will reduce the persistence of legumes and hardiness of desirable grasses. It is recommended that soils be tested about every four years. Matching the soil's resources and its fertility and drainage is critical to a successful pasture system.

A forage resource inventory includes total acreage, field locations, and the forage in those fields (Roberts et al., 1993). An Ohio forage inventory should include a test for endophyte if fescue is present. Endophyte testing is available at Auburn University. Contact your county Extension agent for details.

Step 2. Determine Limiting Forage Factors

Fescue is the primary cool season grass on many operations in Ohio. The first limiting factor in this situation would be a lack of high-quality summer pasture. Introduction of warm-season grasses, alfalfa/grass mixtures, annual lespedeza, clovers, or birdsfoot trefoil are some possible options (Roberts et al., 1993). Switchgrass may be the best warm-season grass to establish in Ohio.

Brassicas, pearl millet, sorghum-sudangrass, corn stalks, and grazing corn are also potential forages for fall and winter grazing. Currently, Extension personnel are exploring several types of cereal rye for early pasture in March and April.

If your forages are unproductive, soil fertility, pH, or topography may be limiting factors. Fertilization and/or lime applications may be needed. Land that is steep, frequently wet, or frequently dry may not support a wide range of forage species. Plant persistence will be a more important factor for these areas. Forage quality would be an important factor on highly productive land.

Step 3. Assessing Animal Factors

The animal's current nutrient requirements must match the type and stage of production of your forage. You should be able to match stocking rate with current forage dry-matter production. Forage nutrient levels need to be evaluated in terms of the animal's nutrient requirements and stage of production.

Soil Characteristics and Fertility for Grazing

Soils are a fixed natural resource that can not be greatly altered. The plant and animal species need to be matched to the soil resource on a given landscape. The management level and forage production system also need to be adapted to match the soil resource base. The landscape indicates the soil types, water-runoff patterns, erosion potential, and air movement. Cold air flows into swales, and ridgetops provide positive air movement in the summer.

The Soil Survey for your county will help you to identify the soil map unit and its characteristics that will affect your grazing system. Information on the soils for the property you manage is available from the local office of the Natural Resources Conservation Service (formerly the Soil Conservation Service or SCS). Soils are assigned pasture and hayland suitability groups. Soils assigned the same suitability group require the same general management and have about the same potential productivity.

The Pasture and Hayland Soil Suitability Groups include Group A that has few limitations affecting the management and growth of forage plants. Soils in Group B are limited by droughthiness because of sand and stones throughout the soil. Group C soils are normally wet due to high water tables or soils that are saturated during the growing season. These soils generally respond to subsurface drainage. The soils in Group D are organic or muck soils and are generally not used in forage production. Group E soils have a restricted root zone of less than 20 inches, while Group F soils have a root zone of less than 40 inches but greater than 20 inches. There are just a few soils on strip mines in Ohio that have unfavorable chemical properties; these soils would be Group G. Group H soils are unsuitable for forage production because of toxic chemical properties or very steep slopes.

There are other soil properties affecting grazing systems and forage production that should be considered.

1. The surface texture and organic matter content affects new seedling establishment, water infiltration rate, and plugging during wet conditions.
2. The slope affects erosion potential and grazing patterns. Forage production on very steep slopes (i.e., greater than 25%) is extremely limited and use of farm equipment on these

areas should be limited. As the slope angle increases, animal movement is generally more along the slope. Livestock trails can concentrate runoff and increase erosion and gully formation. Extreme care must be exercised when utilizing steep areas to maintain or increase productivity.

3. The shrink-swell potential and frost action affects plant crowns and over-wintering losses in the plant stand. The number of freeze-thaw cycles will be much greater on a south-facing slope than a north-facing slope. This greatly increases heaving potential on clay soils.
4. The aspect of a hillside or facing direction of the slope can produce up to a 50% difference in production. South-facing slopes will begin forage growth earlier in the spring and continue later into the fall because the angle of the sun is more perpendicular to a south-facing slope than a north-facing slope. North-facing slopes will be more productive during mid summer while south-facing slopes are prone to droughthiness. On landscapes where these differences are greatest, different species may be selected to match soils and slope aspect. The differences in north- and south-facing slopes can be useful in designing a grazing-system paddock layout.
5. The permeability and drainage of the soil determines the type of plant species that can grow and the ability to graze this area during wet conditions. While alfalfa requires deep, well-drained soils, birdsfoot trefoil will tolerate wetter soils. Matching your soil characteristics to adapted forage species and cultivars is extremely important to a productive forage system.

Soil nutrient management is an important part of pasture management. Soil or plant tests should be taken at least once every three years to monitor nutrient levels. Soil pH should be maintained at 6.0 for grass-legume pastures with neutral to alkaline subsoils and at 6.5 - 6.8 when subsoils are acid as is found in most of the unglaciated portion of southern and eastern Ohio. Bray P1 phosphorous levels should be maintained at 30 lbs. per acre for Kentucky Bluegrass and 50 lbs. per acre for tall grass-legume mixtures. The warm-season grasses are less responsive to pH and fertility levels. Potassium levels should be maintained at or above 150 lbs. per acre K2O plus five times the CEC level of the soil. For a soil with a CEC of 10, K2O levels should be 150 + 5 x 10 or 200 lbs. per acre. To convert Bray P1 or K2O levels to ppm, divide by two. High levels of potash in combination with low levels of magnesium can cause grass tetany. A balanced fertility program can provide a balanced diet to the grazing animals.

Fertilizers can be used as a management tool to increase forage production just before times of slow plant growth. Applying fertilizer, particularly nitrogen, in the early and late summer increased production into the summer and fall. Management-intensive grazing improves manure distribution which provides a more balanced fertility program while allowing for nutrients to be recycled and reused repeatedly. High levels of nutrient transfer can occur around shade and water. These nutrients must then be purchased and applied to deficit areas. Supplement feed (i.e., hay or grain) can be fed in areas needing additional fertility. This is a very efficient way to Fertilize pasture areas difficult to cover with a fertilizer spreader.

Principles of Stockpiling

A Management Intensive Grazing (MIG) program is required if one is going strive for year-round grazing (Bartholomew and Vollborn, 1997). A MIG program can extend the grazing season in Ohio by six to eight weeks.

Spring Animals grazing cool-season perennial pastures should be maintained within paddocks that can be rotationally grazed. The paddocks can be large with rapid rotations. After the spring flush period and seedheads are controlled, pastures can be rotated with ever-increasing residual of forage, letting the paddocks build a cushion of feed for the possible summer slump periods. Another alternative would be to make hay on ungrazed paddocks of cool-season grasses. The hay can be used as an emergency winter feed or when the spring pastures are not ready for grazing. Paddocks harvested for hay in the spring could be stockpiled for use as part of the mid-summer grazing program. Winter grain crops can be used for early spring and fall-winter grazing.

Summer Late July or early August is when producers in Ohio must prepare for winter grazing. This is when turnips can be planted, nitrogen can be applied to cool-season pastures, and tall fescue stockpiling is begun for winter (Penrose et al., 1994). The stockpiling for fall-winter grazing does not need to start the same day in each field. If possible, calves should be allowed to creep graze ahead of their dams. Early weaning is also an option. Warm-season grasses can be used in summer.

Fall-Winter Fields to be grazed in mid-winter should have a southeast exposure. Controlled grazing is still as important during the fall and winter as during the spring and summer but for different reasons. In the spring, grazing is controlled to maintain forage quality and plant vigor. Winter grazing should be controlled to improve forage utilization and to reduce hay feeding. Strip grazing instead of paddocks can be used during winter grazing. A three-day or two times weekly shift for beef cows is near optimal. Annual crops, like brassicas, and crop aftermath can be utilized.

Principles of Strip Grazing

Hay-making systems can experience dry matter losses of 27% to more than 50% (Bartholomew and Vollborn, 1997). Field stockpiling forages for fall and winter grazing also includes some wasted forage due to trampling and soiling losses. The percentage of waste of field stockpiled forage can be as high as 70% when cows are given large areas at a time, similar to giving them free access to your whole hay supply. Waste can be as low as 30% when cows are given a three-day supply of forage. A low-cost fertilization program with an inexpensive "front wire" is the primary out-of-pocket input cost. There is no need for a "back wire" since the plants are dormant and will not be making regrowth.

Strip Grazing With No Hay Bales in the Field

Research at the Missouri Forage Systems Research Center compared 14-, 7-, and three-day forage allocation strips on stockpiled tall fescue. Strip grazing on a three-day frequency yielded

more than 40% more grazing days per acre than allocating a 14-day forage supply and produced the same level of animal gain. This can reduce the amount of mud compared to Feeding hay in the same location all winter.

Strip Grazing With Hay Bales in the Field

Controlled grazing is important if hay bales are left in the field (Van Keuren, 1970; Van Keuren 1971). If livestock have free access to a complete field of round bales, they will waste some of the bales. Strip-grazing gives about 60% more days of pasture compared to a situation in which cows have free access to the entire field of round bales and regrowth.

Large round bales can also be placed in a corner or along the edge of a paddock. Electric wire can be used to control access to only a few bales at a time. This may mean placing each bale 20 feet or more away from the neighboring bales. The potential of trampling the soil in wet, warm weather may result in the loss of production for that section for the upcoming year.

Strip Grazing and Heavy Snow Accumulations

If emergency feeding is necessary during a heavy snow period, plan to feed the cow on the grazing area and not in a barn. Cattle may learn to graze through heavy snow accumulations. Ungrazed paddocks should be available when it snows enough to cover the lower heights of plants. Snow will often freeze preventing cattle from utilizing ungrazed, shorter plants. Cattle can graze through 18-20 inches of fresh snow as long as a good supply of ungrazed forage is available under the snow (Decker, 1988). Once the frozen snow melts, animals can be moved back to the unused stockpiled pasture. Animals can continue to use the existing pasture if the temperature remains below freezing after a snow. Providing grain or range cubes may be cheaper than providing extra hay.

Table 1. Basic Keys for Stockpiling to Extend the Grazing Season

Spring stockpiling options to take advantage of extra forage

1. Rotate rapidly to control seedhead formation and allow forage accumulation for the summer period.
2. Graze some paddocks completely and make hay in the remaining area.
3. Carry calves over winter to utilize excess forage.
4. Accommodate a variable stocking rate by buying and then selling animals.

This fourth option may expose you to short-term price fluctuations, and there are certain animal health issues in introducing new animals to an existing herd.

Summer stockpiling options to provide forage for fall and winter

1. Remove livestock from selected areas and allow forage growth to occur.
2. Provide nitrogen applications for cool-season forages to increase accumulation and quality.

3. Plant crops, such as turnips, to provide additional forage accumulation.
4. Reduce stocking rate by selling yearlings or cull cows.

Table 2. Basic Principles for Strip Grazing

1. Give non-lactating, gestating beef cows a three- to Four-day allocation of grass. This is the best balance between your labor and forage utilization. Growing or lactating cattle should be fed (move wire forward) more often.
2. Remove animals that do not adjust to this system.
3. Animals with sore feet or animals that appear thin are culling candidates.
4. Utilize the most perishable forage species first.

   First - Legumes
   Second - Orchardgrass
   Last - Fescue

5. Select areas to be grazed based upon soil and weather conditions:

   Wet Areas - Graze during dry or frozen times
   Exposed Areas - Graze during warmer weather
   Protected Areas - Graze during severe weather

6. Move to another area if the grass gets muddy and remain there until the mud is washed off the stockpiled growth, then move back.

Potential Forages for Extending the Grazing Season

Perennial cool-season grasses and legumes form the bases of forage systems in Ohio. These forages produce about two-thirds of their growth by the end of June, with maximum growth during May and June (Blazer et al., 1956). Summer production is generally low with increased growth in the fall. Accumulation of excess spring growth to be grazed later in the summer (Mays and Washko, 1960) is one way to supply adequate summer grazing from cool-season perennials. Three mixtures of perennial cool-season pasture mixtures account for the majority of permanent pastures in Ohio. They are tall fescue mixtures, orchardgrass mixtures, and bluegrass mixtures (Boyles et al., 1996).

Fescue

Tall fescue covers more than 35 million acres in the United States, making it one of the most important cool-season pasture grasses (Bacon and Siegel, 1988). It is grown primarily in the area south of Indianapolis, Indiana; north of Macon, Georgia; east of Kansas; and west of the eastern Appalachian mountains (Siegel et al., 1984). Hoveland (1993) indicated that of 21 states surveyed, tall fescue was used primarily for hay and pasture, with 8.5 million cattle and 688,000 horses grazing these pastures.

Tall fescue has many desirable characteristics in addition to its wide range of adaptation, including being easy to establish and tolerant to heavy grazing pressure and poor soil conditions (Arachevaleta et al., 1988). Tall fescue is the most desirable grass to stockpile for late fall and winter grazing. During the fall, this grass produces higher yields of stockpiled forage of superior quality compared to most other temperate grasses. Forage quality losses from leaf deterioration after frost are lower for tall fescue compared to most other forages. This is due to Fescue's heavy, waxy cuticle that protects the leaf from weather-related losses. In southern Ohio, tall fescue will stay green and may even grow a little during warm winter days. Tall fescue forms a strong sod that is tolerant of trampling damage, which is common on wet pasture soils during the winter. Tall fescue is a sod-forming forage due to short rhizomes that allow it to spread and recover from trampling damage. Winter grazing has minimal influence on yield or quality of this grass the following season (Penrose et al., 1994). Some trampling of fescue sods will aid in successful establishment of clovers into the stand.

Considerations for Stockpiling

Two components to consider when planning to stockpile tall fescue are the desired level of forage quality and yield. Each producer should consider nutritional requirements and determine whether there is a need for high-quality forage for young animals, stockers, and lactating animals or maximum yields to stretch limited stored feed supplies.

Important management factors affecting the balance between yield and quality of stockpiled fescue are:

- Date of the last summer harvest or clipping.
- Nitrogen application date.
- Nitrogen application rate.
- Amount of legume in the pasture.

Time of Previous Harvest

In southeastern Ohio research, harvesting before stockpiling in early July, compared to mid-August, increases yield for November grazing, but results in lower quality. Yields for mid-winter harvest will be higher for August than July stockpiling. The older leaves of July stockpiled fescue do not weather as well as younger mid-August leaves.

When to Begin Stockpiling

The effect of final summer clipping date on yield and quality of stockpiled tall fescue is illustrated in results from research in southeastern Ohio (Table 3). Clipping the fescue in early July, compared to mid-August, increased yields for November grazing, but resulted in slightly lower crude protein levels. The key may be to stagger the start of stockpiling in different pastures to match use by the animals.

Table 3. Effect of Final Clipping Date on Dry Matter Yield and Crude Protein (CP) Concentration in Stockpiled Tall Fescue Forage in Southeastern Ohio.				
Final Clipping Date	Yield (lbs/acre) Nov 3	% CP		
		Nov. 3	Dec. 20	Feb. 11
July 1, 1990	3,761	13.9	10.1	9.6
Aug. 16, 1990	3,194	15.2	11.0	10.9

Quality Changes Over Time

While crude protein levels do not change drastically, total nonstructural carbohydrates (sugars and starches: energy) decrease significantly from November to March. These changes often result in poorer animal performance in late winter if tall fescue is the only source of feed.

Date of Nitrogen Application

The date of nitrogen fertilizer application can influence yield and quality of the stockpiled fescue. In general, nitrogen should be applied when the stockpiling period is initiated (soon after the last summer harvest). If nitrogen is applied during early August compared with late September, yields will be higher, but forage quality will be slightly lower (Table 4). If nitrogen is applied after mid-August in northern Ohio and late August in southern Ohio, less yield response can be expected in most years because of the shorter growing period. Forage yield and quality response to late nitrogen applications will depend on growing conditions during the fall. Later applications followed by dry weather will yield disappointing results. Early applications increase the chance of significant rainfall after nitrogen application.

Table 4. Effect of Nitrogen Application Date on Crude Protein (CP) and Acid Detergent Fiber (ADF) Concentrations in Stockpiled Tall Fescue Forage in Southeastern Ohio.						
Application Date	% CP			% ADF		
	Nov. 3	Dec. 20	Feb. 11	Nov. 3	Dec. 20	Feb. 11
Aug. 20, 1990	14.4	10.9	10.2	33.1	36.5	40.3
Sept. 24, 1990	17.3	11.3	11.8	30.0	34.6	38.9

Nitrogen Application Rate

Stockpiled fescue yield and quality are also influenced by the rate of nitrogen applied. In southeastern Ohio, nitrogen application improved forage yield and quality (Table 5) compared with nonitrogen. Highest forage yields were obtained at 92 lbs/acre of nitrogen (200 lbs/acre of urea); however, the additional yield improvement with applications of more than 50 lbs. of actual

N per acre is usually not great enough to warrant the additional expense. If moisture conditions are good, consider higher rates of nitrogen; if soil is very dry, consider the minimum rate.

Table 5. Effect of Nitrogen Application Rate on Crude Protein (CP) and Acid Detergent Fiber (ADF) Concentrations in Stockpiled Fescue Forage in Southeastern Ohio.

Nitrogen Rate (lbs/acre)	% CP			% ADF		
	Nov. 3	Dec. 20	Feb. 11	Nov. 3	Dec. 20	Feb. 11
0.00	9.4	8.4	7.2	35.6	36.2	44.6
46	14.0	10.3	10.5	32.4	36.9	39.8
92	17.7	12.0	11.5	30.7	34.2	39.4

Nitrogen and Competing Forage Species

If fescue pastures are high in summer annual grasses, such as crabgrass or foxtail, nitrogen efficiency for tall fescue growth will be low. The summer annual grasses that are growing vigorously in August will take up most of the available nitrogen, leaving little for the fescue. The summer annuals die with the first killing frost, leaving very poor quality feed while the nitrogen is immobilized (unavailable) in the slowly decaying weeds. Therefore, nitrogen fertilization for stockpiling should be limited to pastures with a vigorous fescue sod that is relatively free of summer annual grassy weeds.

Many producers are reluctant to apply nitrogen, believing that the percentage of legumes will be reduced the next season. While this is true for spring-applied nitrogen, it is not true for late-summer nitrogen applications. White clover contributes some nitrogen to fescue during the fall; its growth and nitrogen production slows greatly in the cooler and shorter days of the late summer. Apply nitrogen even when you have up to 30% of the stand composed of legumes. If the stand is over 30% legumes, nitrogen should be used during the fall rather than saved for winter.

Form of Nitrogen

The common nitrogen (N) fertilizers are anhydrous ammonia (82% N), urea (45-46% N), solutions of ammonium nitrates and urea (28-32% N), ammonium sulfate (21% N) and ammonium nitrate (34% N). When applying nitrogen in the summer, keep in mind that some forms are subject to surface volatilization resulting in loss of available nitrogen to the plants. Ammonium nitrate is an excellent form to use because surface volatilization losses are minimized (Johnson, 1995). The disadvantage of anhydrous ammonia is that it is hazardous to handle. Also, it must be injected into the soil, and on steep slopes erosion can be a problem.

Injecting nitrogen can increase the roughness of the field. Diammonium phosphate (18-46-0) is typically an inexpensive source of nitrogen if you need the associated phosphorus.

Urea and Urea-Based Fertilizer

Urea is a cheaper source of nitrogen, but the nitrogen can be completely lost under conditions favoring volatilization. Volatilization losses from urea-based fertilizers are reduced by application to dry surfaces. It is best to apply urea fertilizers just before a minimum of one-half-inch rainfall so the nitrogen is washed into the soil. In a 1997 study of nitrogen sources, 40% of the urea was lost in only five days before rainfall was received. do not use urea if the pasture has been surface limed within the past three months. Liquid nitrogen solution (28%) is usually made up of urea and ammonium nitrate, so only the urea portion is subject to volatilization losses.

Pasture Legume Density

The need for late-summer nitrogen application on fescue clover pastures should be evaluated in terms of the forage needs of each specific operation. Forage legumes can be used to economically improve forage yield and quality of tall fescue pastures. Red clover is an excellent legume species to frost seed or no-till seed into existing tall fescue stands every two years. Annual lespedeza is also an option in southern Ohio. Introducing legumes into tall fescue can reduce the need for nitrogen fertilizer, improve forage quality, and dilute the toxic effects of endophyte-infected tall fescue. Including legumes in a fescue pasture can reduce or eliminate the fescue toxicity. Fescue toxicity problems are increased with heavy nitrogen applications (Johnson, 1985).

Research in Maryland has demonstrated greater animal gains on fescue-clover pastures in the fall compared with pure tall fescue fertilized with nitrogen. But nutritive value of a legume-dominant sward will deteriorate more rapidly with freezing temperatures than a fescue dominant sward; therefore, stockpiled tall fescue-clover stands should be grazed earlier than pure tall fescue. Late-summer nitrogen applications on fescue-clover pastures can be used to increase carrying capacity to stimulate more tall fescue growth. Missouri research demonstrated that red clover persists well in fescue pastures receiving late summer nitrogen applications, provided nitrogen is not applied in the spring. Some balance in acres of N-fertilized tall fescue and tall fescue-legume mixtures would appear more appropriate than only one or the other (Matches, 1979).

Stocking Rate

One acre of stockpiled fescue in a year with normal rainfall should provide between two and three tons of dry matter per acre. This is an adequate amount of feed to carry a 1,200-lb. cow from December 15 to March 1, assuming she is not calving prior to April 1. (See Table 6 on the following page.) Exceptional stands of tall fescue can result in one acre of stockpiled tall fescue carrying one cow for up to four Animal Unit Months (AUMs) (White, 1977).

Table 6. Example of a Fescue Stockpiling Program for 30 Head of 1,200-Lb. Cows on 12 Acres of Stockpiled Forage[a].	
Inputs:	One ton of 34-0-0 nitrogen fertilizer at $225/ton Apply to 12 acres (167 lbs/acre of fertilizer) (56 lbs/acre of nitrogen)
Result Of Forage Growth:	After 90 days of growth, fescue is 12 inches tall. (12 in. x 400 lbs. of dry matter per in. = 4,800 lbs DM) Utilization rate of 70% (4,800 x 0.70 = 3,360 lbs. dry matter per acre) (3360 x 12 acres = 40,320 lbs. dry matter in 12 acres)
Estimate Number Of Grazing Days:	Cattle consuming 3% of body weight per day of dry matter (1,200-lb. cow x 0.03 = 36 lbs. of dry matter per day) (36 lbs x 30 cows = 1,080 lbs. of dry matter consumed per day 40,320/1,080 = 37-1/3 DAYS OF GRAZING or 3 DAYS PER ACRE
a Vollborn (1997)	

Forage Quality and Class of Livestock

Forage yield and quality of the stockpiled fescue will decrease as the winter progresses. In late fall and early winter, nutritive value may be adequate to support good growth rates of weaned calves or stockers, but it rapidly becomes more appropriate as a dry cow feed. Crude protein levels may not decrease greatly, but total energy will decrease significantly from November to March. If there is a difference in length of stockpiling period among pastures, begin grazing the oldest material first before it becomes too deteriorated. If some areas have a significant amount of red clover, graze them early as well, because red clover deteriorates more rapidly after frost than tall fescue.

Heifers First and second-calf heifers may require supplementation with quality hay or occasionally with energy and protein in late-winter and early-spring. Young cows are also susceptible to nutritional deficiencies during early lactation (Van Keuren and Stuedemann, 1979). One alternative is to stimulate early grass growth by planting early-growing varieties or nitrogen applications. Another alternative may be to delay calving to match forage reserves with the demands of lactation.

Backgrounding Stockpiled tall fescue pasture, along with big hay bales, is frequently used to winter calves and light-weight yearling calves. In a three-year study in Missouri (Sewell, 1984), 450- to 500-pound steer calves averaged 0.7 pounds of gain daily on stockpiled tall fescue

pasture, supplemented with fescue hay and limited amounts of cracked corn when snow-covered. Calves will usually need four to five pounds of a grain-protein mixture per head daily to average 1.2 pounds daily gain on winter fescue pasture.

Fescue Hay

Fescue hay has a reputation as being low-quality hay. Most of the reason is the haymaker and not the grass. Most hay is made at or after seed maturity. Anytime a cool-season plant matures, quality drops rapidly (Kilgore et al., 1980). Crude protein will drop 0.5% per day from boot stage to mature seed stage. Research in southern Ohio (Sulc et al., 1997) indicated that endophyte-free and endophyte-infected fescue mixed with orchardgrass had crude protein levels between 11 and 12% on May 31. The secret to fescue hay production is adequate fertility and early cutting. Early grazing of hayfields prior to plants maturing to boot stage can delay maturity and still maintain acceptable yields. Since hay quite often is not harvested until June, the first cutting of hay can be considered a "second cutting." Make hay when fescue starts to show a few seed heads.

Table 7. Management Practices for Utilizing Established Tall Fescue for Winter Grazing

1. Graze or mow the fescue down to two to three inches during July-August depending on location, yield, and quality desired. Overgrazing slows recovery while undergrazing allows low-quality growth to carry over into winter.
2. Topdress with 50 lbs. of nitrogen per acre during July-August. This is also a good time to apply nutrients according to soil tests. Do not permit the pH to fall below 6.0. Nitrogen may be reduced or omitted if an excellent stand of clover is present. Applying nitrogen each year is likely to cause the pH to drop, so lime will need to be applied more often than on less intensively managed pastures.

   The phosphate and potash application should be applied when needed. If only a small amount is needed, one could apply a two-year supply every other year.

3. If the fescue is used both spring and fall, nitrogen should be applied spring and fall. Spring-applied nitrogen does not carry over for fall growth, and fall applications of nitrogen do not increase spring performance (Kilgore et al., 1980). However, spring applications can reduce legume populations.
4. Keep livestock off until the fall growth of other pastures is grazed (usually November or December), then turn the cows on the tall fescue utilizing strip-grazing techniques.
5. If a legume is desired, overseed with 2 lbs. each of ladino and red clover per acre in February or March after the tall fescue is grazed down. This may be done by broadcasting seed and depending on freezing, thawing, and cattle trampling to cover the seed. If seeding cannot be done before spring growth starts or if the fescue thatch is heavy, better results are obtained with a sod seeder and a contact herbicide (Decker et al., 1985). Depending on how much clover you want in your fescue, seed about one-fourth of the acreage each year at this time.
6. Tall fescue usually starts spring growth earlier than other grasses, so graze the tall fescue-clover in the spring. If controlled grazing is used, grazing may be continued until August.

7. If some of the tall fescue is used for spring grazing, a hay cutting may be made when the plants are in early head. This provides hay for deficient periods and improves the quality of the tall fescue for summer grazing or second cutting hay.

Fescue Toxicity

When tall fescue is analyzed for its nutrient content, it is comparable in quality to other cool-season grasses (Bowman, 1990). However, cattle performance when consuming tall fescue has been erratic. Animals do not graze it readily during the summer months. Some of this reduced summer palatability is associated with the presence of a fungus in the plant (endophyte). Symptoms of fescue toxicosis can include decreased intake, reduced growth rate, rough hair coat, excessive salivation and urination, increased body temperature and respiration, decreased milk production, and impaired reproductive performance (Stuedemann and Hoveland, 1988). Hot temperatures in the summer may aggravate these symptoms, and cattle will generally spend more time standing in ponds and shade, resulting in less time spent grazing. Sometimes foot rot may be confused with fescue foot (Kilgore et al., 1980) because, in the early stages, both have heat and swelling in the lower limbs. However, foot rot normally has swelling and inflammation between the toes.

Animal health problems associated with endophyte-infected stands occur primarily in the summer when animals are under heat stress. The toxin produced by the fungal endophyte is less concentrated in leaf tissue than in the seedheads and stems, so the amount of toxin consumed in the fall is less than in the spring and early summer. The cooler temperatures in the fall and winter reduce the heat stress problems associated with endophyte-infected fescue.

The results of testing tall fescue samples throughout the United States indicate that close to 90 percent of tall fescue pastures have some level of endophyte-infection (Bacon and Siegel, 1988). A rule of thumb often used is that cattle gains will be reduced by 0.1 lb/day for every 10 percent increase in the level of endophyte in tall fescue.

The endophyte is transmitted only through tall fescue seed, and storing seed for 18 to 24 months before use will kill the endophyte. However, germination drops and seedling vigor is reduced after lengthy seed storage. Currently there are no commercially acceptable chemical methods to get rid of the endophyte in either live plants or seed (Bacon and Siegel, 1988). Therefore, cattle producers must be aware of the available strategies to overcome the effect of endophyte-infected tall fescue. Low-endophyte and endophyte-free tall fescue seed is readily available from most seed suppliers.

Management Strategies for Endophyte-Infected Fescue

Eradication

One of the most effective ways to eliminate endophyte-infected tall fescue is a fall application of glyphosate or products of similar activity. Early to mid-October prior to a killing frost is the ideal time to apply RoundupTM at a rate of two quarts in 20-30 gallons of water per acre. Addition of

17 lbs. of a spray-grade ammonium sulfate per 100 gallons of spray will enhance uptake of RoundupTM and effectiveness of control. An early spring seeding can then be made into the killed sod with whatever forages are desired. The fall-killing fescue program allows for more complete control than spring-applied herbicide and little potential for soil loss over winter and during the seeding process. Alternately, fescue can be killed with RoundupTM in the spring, a summer annual smother crop such as sorghum sudangrass planted, and cool season grass planted in September.

Endophyte-Free Fescue New endophyte-free varieties or varieties with very low endophyte levels are now available (Vollborn and Penrose, 1997). Farmers making new seedings of tall fescue that will be used for animal feed should select one of these new varieties. Endophyte-free tall fescue is more persistent than orchardgrass and bromegrass, yet can be less tolerant of plant stress than is a stand of infected Kentucky 31 fescue. Endophyte-infected fescue is more resistant to insects and diseases, is more drought tolerant, and actually grows better and is more productive than endophyte-free plants (Arachevaleta et al., 1988; Bush and Burrus, 1988; Penrose et al., 1997a). Grazing livestock prefer fungus-free fescue over infected fescue. Endophyte-free fescue may require substantially different management than endophyte-infected fescue, due to a greater susceptibility to overgrazing and a less hardy nature (Bacon and Siegel, 1988). New fescue-clover stands should be watched closely and if the fescue is being shaded, just enough grazing pressure should be applied to avoid a problem. Most cool season grasses are slow to establish particularly with aggressive legumes such as red clover.

Reinfection is possible. A complete kill of the infected fescue stand is required or some level of infection will be detected in the future. Wind is not likely to move infected seeds to endophyte-free fields. In addition, birds do not seem to move the seed nor would wild animals be expected to move significant numbers of seeds. However, cattle can move substantial numbers of the seeds and thus infect endophyte-free fescue fields. About 2% of the infected seed ingested by a cow can germinate and result in the establishment of infected plants. Rotational grazing between infected and non-infected pasture can aggravate the problem if mature seeds are present in the pastures.

Reseeding With Other Cool-Season Grasses Another option involving pasture renovation would be to establish a stand of another cool-season grass species such as orchardgrass in place of endophyte-infected tall fescue. This would certainly improve animal performance, but producers need to be aware that most other cool-season grasses will not tolerate the heavy use and abuse like infected tall fescue. Forage management will be more critical to ensure stand persistence in this case.

Strategic Grazing

Avoid grazing infected fescue when seed heads are present, as the toxic factors tend to increase with plant maturity. This involves keeping the forage in a vegetative state as long as possible by grazing or clipping. Grazing fescue pastures in the spring, moving cattle to other grass pastures and clipping fescue during the summer, and then grazing the tall fescue regrowth again in the fall appears to reduce toxic effects of the endophyte. Fescue hay should be cut early, and should not be the only nutrient source fed to cattle in the winter if hay fields are heavily endophyte-infected.

Dilution

An option that can be successfully used to reduce the toxic effects of endophyte-infected tall fescue without the expenses of pasture renovation is to dilute the endophyte. This can be done several ways. Supplementation of cattle consuming tall fescue with grain will also dilute the endophyte; however, feeding high levels of grain (greater than 4-6 lbs.) to cattle eating primarily a forage diet will decrease forage intake and digestibility (Lusby and Wagner, 1987).

Including legumes in a fescue pasture can reduce or eliminate the fescue toxicity. Legume choices include red clover, ladinoclover, birdsfoot trefoil, and alfalfa. Since tall fescue stands are usually very thick, it can be difficult to get legumes to persist in an established stand. Controlling height of fescue, to allow light down to the legumes, proper pH, and phosphorus levels will be critical to maintaining legumes.

Red clover is probably one of the best choices of legumes to interseed into fescue pastures because of its hardiness and ability to compete with the grass. This can be easily accomplished by mixing red clover seed with fertilizer and broadcasting the mixture in early spring. Mixing with fertilizer may actually help germination of red clover because of the abrasive action of the hard seed coat. Red clover is a biennial legume and may need to be reseeded every year to every other year, depending on forage management.

Ladinoclover, or white clover, is a perennial legume that can be used in combination with tall fescue. It grows close to the ground, and therefore will tolerate close grazing, but is not a good choice for hay production. Ladinoclover is not as competitive with fescue as red clover is, but it will produce a lot of seed to keep the legume stand persistent when hot, dry summers can kill the mature plants. White clover spreads by stolons as well as seed. In most areas of Ohio, white clover will just appear as grazing management improves.

Birdsfoot trefoil is a long-lived perennial legume, but it is not very competitive compared with red clover. It will persist in mixed stands if pastures are mown when grass competition is the greatest. It can be grazed frequently, but will not tolerate too close grazing, as about four inches of leaf material needs to be left for the stand to persist.

Alfalfa can be used in fescue mixtures, but high levels of forage management are necessary for it to persist. Alfalfa is very sensitive to frequent grazing, but it can be grazed closely, and it is an excellent choice for hay production.

Table 8. Management Practices That Help When Interseeding Legumes in a Tall Fescue Pasture.

1. Graze the pasture heavily in the fall or winter prior to establishment to help control grass competition and expose soil to enhance seed to soil contact and provide sunlight for germination.
2. Apply higher levels of P and K in spring and do not apply nitrogen.
3. Apply adequate lime since most legumes are more sensitive to acid pH and require more calcium than grasses.

4. Graze frequently to reduce grass competition and provide light to the legume seedlings.

Orchardgrass

Orchardgrass growth can be "stockpiled" in the field for winter grazing as well.

1. Graze the orchardgrass during late April and early May.
2. Remove cattle by late April (southern Ohio) to mid-May (northern Ohio). Harvest the hay by mid-June.
3. Take a second harvest, either as hay or pasture, during mid summer, when possible.
4. Stockpile the grass with the same recommendations as fescue.
5. Begin grazing in early October but complete grazing by December (December 1, northern Ohio; December 31, southern Ohio).
6. do not graze orchardgrass lower than two to three inches. Orchardgrass stores energy in the lower part of the stems and not the roots. Removing the lower part of the stems will kill the plants.

Kentucky Bluegrass

Continuous Grazing System

A. Under graze during May and early June to permit grazing during mid-summer. With some supplemental feeding, this system can supply six to eight months of medium-quality grazing in southern Ohio.

B. Graze heavily from mid-April to mid-June. From mid-June to mid-September, move all livestock to other pastures, unless favorable weather or low stocking rates permit additional grazing for short periods of time.

Return livestock to the pasture during late September and graze until the pasture is consumed or the grass is covered with snow. With such a system, using other pastures during mid-summer, cattle in southern Ohio can be on pasture for eight to 10 months during the year.

Rotational Grazing System

A. Rotational grazing of predominant bluegrass pastures can begin in late March for central Ohio. It may even appear that almost no bluegrass is present. But regrowth of bluegrass is extremely fast in April, and the paddocks will have been prepared in March for the April growth.

B. Rest periods during mid-summer for bluegrass can be as long as 40 days or more. The key is to watch the growth stage and harvest the plant at pre-boot stage.

Kentucky bluegrass is the only grass species for which deferred spring grazing is recommended. Mature bluegrass, although lower in protein and digestibility than young grass, is acceptable

medium-quality forage. The spring growth of other grasses becomes coarse and unpalatable at maturity, thus providing very low-quality forage.

The total production from an acre of bluegrass pasture is greatest when that production is utilized during the early spring. Stockpiling in the field, for summer or winter grazing, results in some loss of feed.

Other Grasses and Legumes

Smooth Bromegrass

Smooth bromegrass is a long-lived, perennial, cool-season, sod-forming grass used extensively for hay, pasture, and soil conservation (Dodds and Jacobson, 1984) in the northern Plains. It may be less vigorous with shorter rest periods. Close grazing in the spring delays regrowth from crown buds. Stands become unproductive in three to Four years if not fertilized.

Wildrye and Wheatgrasses

These cool-season grasses have potential for early and late grazing. Currently, there is a lack of acreage and seed in our area. There is more information on these grasses in the northern Great Plains than in Ohio. There are questions about their vigor in our relatively hotter, more humid environment.

Some potential varieties are:

Altai Wildrye
Canadian Wildrye
Russian Wildrye
Crested Wheatgrass
Intermediate Wheatgrass

Perennial Legumes

Interest continues in how to use various perennial legumes. Kura clover and a new rhizomatous birdsfoot trefoil are being investigated. Native perennial legumes grow well in summer and may be an excellent combination with warm-season grasses. A short list of species being investigated follows:

False indigo
Wild senna
Illinois bundleflower

Perennial Herb (Chicory)

Chicory, a perennial herb, can make excellent feed for gestating beef cows. Chicory produced a leafy growth that can be higher in nutritive value than alfalfa (Hall and Jung, 1994). Yield will vary but can be in excess of three tons per acre. Chicory has a relatively deep taproot, which makes it drought tolerant. Managed grazing can maintain stand life for five to seven years. Chicory requires nitrogen fertilization for maximum yield.

Annual Pastures

Annual forage crops can be used effectively in a forage production system, especially during the summer slump. These crops:

- Provide supplemental feed when perennial forages are less productive.
- Provide emergency feed when perennial crops fail.
- Serve as an interim crop between grazing periods of perennial forage when long rest periods are needed.
- Extend the grazing season in the fall and early spring.
- Are used as smother crops or to break disease cycles when renovating pastures.

Most annual forage crops are best used for pasture and silage rather than hay (Putnam, 1996). Double-cropping combinations are feasible with these annual forage crops (for example, small grains followed by summer annual grasses or brassicas). Brassicas such as turnips and rape can provide high-energy grazing in summer, then regrow for a late-fall or early-winter grazing. Annual crops require the purchasing of seed, fertilizer, tillage, and other associated costs of growing the crop. If the primary goal is to overcome "summer slump" on a continual basis, it may be cheaper to develop a grazing system to make sure you have enough cool-season pasture (Emmick, 1996).

Winter Cereal Rye

Winter rye is the most winter hardy of the small grains. Quick growth in both fall and spring make it the most productive of the small grains for pasture (Putnam, 1996; Samples, 1997). Forage-type varieties are available that have greater fall growth and extend the grazing season in late fall. Although best production is on fertile, well-drained soils of medium or heavier texture, winter rye is more productive than other small grains on soil with lower pH and fertility, higher clay or sand content, or poorer drainage. Winter rye matures the earliest of the small grains. Because palatability and quality of rye are unacceptable if allowed to mature past the boot stage, winter rye is the most difficult of the small grains to manage for high quality.

Establishment and Fertilization Establishment is best achieved by the use of a grain drill equipped with packer wheels, set to a one-inch planting depth. Another satisfactory method is to broadcast the seed followed by a shallow disking or harrowing and cultipacking. When seeding small grains for fall pasture, either plant in mid to late August or follow normal seeding guidelines. If small grains are planted only for pasture use, increase the seeding rate to three bushels per acre and apply nitrogen at a rate of 40 lbs/acre at planting times.

Grazing Fall and spring grazing of small grains should begin when sufficient growth is available to support livestock. Delayed planting dates and wet field conditions during the prime grazing season make grazing of small grains difficult in Ohio. Fall graze only early-seeded small grains. Begin grazing when six inches of growth is available and leave two to three inches of stubble after grazing. Heavy fall grazing increases the risk of winter kill, unless excessive fall growth is present. Do not graze when the small grain is dormant or when the ground is frozen and subsequent spring growth and/or grain production is desired. In the spring, graze only when fields are firm. Consider heavy, late-spring grazing when the plants begin stem elongation (jointing stage).

Grazing Corn

An Ohio corn breeder has developed a composite of silage corns designed specifically for grazing. Several commercial varieties are also available that may give similar results. Grazing corn can be no-tilled into a killed or suppressed sod or broadcast and cultipacked into disked ground. Graze the stand about 50 days after planting and continue for about two months after that, using poly wire to strip graze. Barrett (1998) pushed down three rows at a time with a four-wheeler and placed the fence in the middle of the downed corn.

Brassicas

Brassicas can increase mid-summer forage availability but have a particular advantage for late fall-winter grazing. Brassicas are easy to establish, fast-growing, high-yielding, high-quality, and can withstand cold temperatures.

These fast-growing crops can reach maximum quality in as little as 60 days and maximum yield in 70 to 90 days. The tops can tolerate temperatures to 15-20 degrees F and the bulbs are 5-10 degrees F hardier. In a 1994 southeastern Ohio trial, Premier Kale, a long season leafy crop, withstood temperatures of -7 degrees F and yielded more than three tons of dry matter per acre (Penrose et al., 1996).

Brassicas can be no-tilled with prior application of a burn-down herbicide. They can also be conventionally tilled with a drill, or broadcasted and cultipacked. Seeding rate should be 1.5 to 2.0 lbs/acre for turnips and swede and 3.5 to 4.0 lbs/acre for rape and kale. A real challenge is to get the seeding rates that low. If broadcasting is an option, consider mixing in fertilizer to keep the seeding rates that low. If fertility levels are adequate, the only additional fertilizer needed is 50 pounds of nitrogen. A stable form of nitrogen such as ammonium nitrate (34-0-0) is recommended to reduce volatilization.

Turnip varieties produce varying amounts of tops and bulbs, and the bulbs are usually available as an acceptable feed for cattle. Some new forage varieties produce a greater proportion of tops to bulbs. For example, in a 1994 study, the garden variety purple top turnip had 39% of the yield in the tops (6,653 lbs/dry matter/acre) 95 days after planting while a Chinese cabbage-turnip hybrid (Tyfon) had 76% in the tops (6,792 lbs/dry matter/acre) during the same time. Some important considerations include the fact that a greater percent of the tops are likely to be

consumed than the bulbs, and the tops tend to be higher in quality. In three years of Ohio trials, protein content of tops averaged 17-24% and bulbs 10-15%. Total yields for these crops can range from three to Five tons of dry matter per acre with adequate rainfall.

A farmer in Washington County, Ohio, was selected to demonstrate how brassicas can reduce stored feed costs. On August 3, 1994, 4.3 acres of pasture were seeded to purple top turnips at the rate of two lbs. per acre with a no-till drill. Thirty days after seeding, 68 lbs/acre of ammonium nitrate (34-0-0) were broadcast. All other fertility levels were adequate, and no additional fertilization was required. Samples taken on October 26 (84 days after planting) resulted in a yield of 10,306 pounds of dry matter per acre (50% tops, 50% bulbs). On October 26, 28 beef cows and their calves were placed on the turnips. The animals grazed the turnips for 45 days using strip grazing. Variable planting costs were $50/acre (Ohio State University Farm Rates, 1993). Feed costs were $0.17 per day per cow-calf unit based on 75% utilization. Comparing this to stored feed costs of mixed hay at $80/ton (Ohio State University Extension Enterprise Budgets, 1995) and consumption of 3% dry matter per day, the savings amounted to $1,045 for the period or $23 per day (Barrett and Penrose, 1996).

Available turnip cultivars include Purple Top, Rondo, Wintergreen, Forage Star, Seven Top, Barkant, and All Top. Rape cultivars include Emerald, Crystal River, Rangiora, and Bornopoli; hybrids include Tyfon and Pasja; and Kale includes Premier, Gruner, and Kepti. Most of these varieties are available from major seed dealers in Ohio.

Three years of trials in Ohio have demonstrated the potential of brassicas to extend the grazing season (Penrose et al., 1997b). For best results:

- Seed from mid-July through mid-August.
- Provide hay or stockpiled forage to improve utilization.
- Strip graze where the forage is rationed.

This proves to be the most efficient usage.

Brassicas are fairly flexible in providing nutrition for livestock. However, here are some general guidelines. Any summer grazing should be very light, with only top grazing. Graze small areas through rotational or strip grazing. After maturity, fungal diseases and rot may deteriorate the plants. Brassicas should be planted in the same area for only two years because of disease potential.

Warm-Season Grasses

The warm-season grasses do not start growing until late April to early May in Ohio (Bartholomew et al., 1994). They basically mature one month later than the cool-season grasses. These grasses make 65 to 75% of their growth in mid-summer (Jung et al., 1978), mid-June to mid-August in Ohio.

Many warm-season grasses were once native to Ohio. They died out due to crop harvesting and continuous, close grazing. The perennial warm-season grasses that are normally discussed are

switchgrass, big bluestem, indiangrass, and little bluestem. Even though they are native, the warm-season grasses are hard to establish. It may take as long as two to three years to establish these grasses in a field. However, the native grasses have no natural pests and are resistant to rusts and insects. They are also adapted to a wide range of soil and fertility conditions (Morris et al., 1982; Rasnake et al., 1990). Morris et al. (1982) reported that switchgrass and indiangrass produce well on soils with low moisture-holding capacity and low phosphorous, compared to the cool-season grasses. Warm-season and cool-season grasses cannot be grown together in continuous grazing systems because the earlier maturing cool-season grasses crowd out the warm-season species.

In southwestern Missouri, switchgrass and caucasian bluestem (an introduced warm-season perennial) are used by beef producers to supplement the tall fescue (Roundtree et al., 1974). As a side note, some people feel the planting of caucasian bluestem or any nonnative warm-season grass should probably be avoided in existing native stands. However, most all forage species in Ohio are introduced varieties from other parts of the world.

Ohio has somewhat better summer growing conditions for the cool-season grasses, with generally higher rainfall and somewhat cooler summer temperatures than in southern Missouri. However, the warm-season grasses may have a place in livestock operations as suggested by Pennsylvania researchers (Jung et al., 1978). Steers gained 1.45 lb/day on switchgrass and 1.38 lb/day on smooth bromegrass in Iowa studies (Barnhart and Wedin, 1984). Roundtree et al. (1974) reported daily gains of yearling Holstein heifers ranging from 0.8 to more than 1.5 lb/day on native grasses in Missouri.

Producers interested in using the native perennial grasses may wish to use them as mid-summer pasture. For summer pasture usage, plan on 0.33 to 0.5 acre per cow-calf unit. From 0.9 to 3.2 acres of summer pasture per cow-calf unit are needed in Ohio (Van Keuren, 1985). Warm-season grasses will be especially useful on drought soils that are low in fertility. Reclaimed mine soils would be one example.

Switchgrass

Switchgrass has been well-researched in Ohio (Van Keuren, 1985). Switchgrass should be grazed prior to heading (about May 25) for good animal acceptance and performance; grazing should be completed by July 1. If regrowth is stimulated, grazing may remain good for two or three weeks or regrowth can be grazed later in the season.

If lime is needed, apply it before the soil is tilled. Apply phosphorus and potassium according to soil-test recommendations. Do not apply nitrogen fertilizer at seeding. Nitrogen would stimulate weed competition. Some nitrogen can be applied about July after the grasses have started growing. Till soil in the spring at least a month before grasses are to be planted. A light surface tillage at seeding time will kill newly emerged weeds.

The best time to seed warm-season grasses in southern Ohio is May or early June. These grasses need warm soils to speed up germination and establishment. Seedings made in late June or early July can be successful if good soil moisture is present at seeding time.

Switchgrass can be seeded with a conventional drill into a prepared seed bed or with a no-till drill into killed sod. Drilling is recommended because it requires less seed than broadcasting and is usually more successful. Drill at 8-10 lbs. per acre pure live seed (% germination + % dormant x % pure seed) or 10-15 lbs. per acre via broadcasting. Pure live seed per acre is important, because average-quality commercial seed of native grasses tends to have lower germination than the seed of cool-season grasses. Drills are available that are specially equipped to handle this type of seed. Using such drills is the best option if they are available. Check with Ohio State University Extension or the Natural Resources Conservation Service for availability of these drills.

It is also possible to use hulled seed of some species in the legume box of a standard drill. Drop the seed on the soil surface and press it in with the packer wheels. Small, light seed may be mixed with ground corn if more bulk is needed for good spreading. Adjust the drills to place the seed one-quarter of an inch deep.

You can also mix the seed with fertilizer and seed it with a gravity-flow fertilizer spreader. First seed the field in one direction and then again in a perpendicular direction to ensure uniform coverage. Then firm the soil with a corrugated roller (cultipacker). Avoid using spinner type fertilizer equipment if possible.

Mowing is needed during the first summer to control weeds. Mow in July, clipping high enough to avoid mowing off the switchgrass seedlings (about six inches). It may be necessary to clip twice during the first summer, but do not clip the field after the end of August. Do not graze during the first year to avoid damaging the stand.

The native grasses germinate and develop more slowly than the cool season perennial grasses. What may appear to be an unsatisfactory stand of a native grass may actually be a good stand. Wait until the following summer before abandoning the seeding.

Switchgrass is suited to rotational grazing systems. Begin grazing at 12-18 inches and don't graze shorter than six inches. Stop grazing mid-September. Do not graze warm-season grasses until after seed maturity the first year.

The warm-season grasses work well in systems containing cool-season grasses and legumes in other fields. An example:

35% of forage acreage in tall fescue
55% in mixed perennial, cool-season grasses
10% warm season perennials.

Grazing Corn Stalks

One acre of corn stalks will provide approximately 1.5 to 2 AUMs of grazing. Cornstalks grazed shortly after harvest are higher in nutrient content than fields grazed 60 days after harvest (Rasby and Selley, 1992). Corn stalks should probably not be grazed in the spring.

Cattle will select and eat the grain first, then the husk and leaves, and finally the cobs and stalks. Cattle that have grain to select will consume a diet that is probably above 7% crude protein and as high as 70% TDN. This will exceed the protein and energy needs of a cow in mid-gestation. If corn is visible in the manure, supplementation with other than vitamins and minerals is probably not needed. However, when most of the grain has been consumed, protein supplementation is needed. A cow in mid- to late-gestation consuming only husk and leaves (no corn in manure) will need about 5 lbs. per day of average-quality alfalfa hay.

Cows should attain moderate body condition before calving (moderate condition score 5 to 6 using the scale 1 = very thin to 9 = very fat). Ohio State University Extension has a circular on how to score cows for body condition (Mangione, 1992). Dry cows will at least maintain body weight and may gain 0.5 lb. to 1.0 lb. per head daily grazing corn stalks that have grain, husk, and leaves to select. Heifers in late gestation should not be allowed to graze cornstalk fields after the grain has been consumed.

Fall-calving cows may need protein supplementation even if the cattle have grain to eat. Fall-calving cows may use unsupplemented cornstalk fields if new fields are made available at two- to Four-week intervals. Consider weaning fall calves at 90 to 120 days of age if crop residues are to be extensively utilized for the cows.

Protein supplementation is necessary for calves grazing cornstalks. There is some indication that a protein supplement with at least 0.36 lb. of escape protein per head per day is appropriate (Rasby and Selley, 1992). Total protein supplementation may need to be as high as 0.9 lb. per head per day. Average daily gain for calves grazing crop residue will be about 1 lb. per day.

Strip grazing can increase the stocking rate. Strip grazing is recommended if high levels of grain (8 to 12 bushels per acre) are left in the field. Unlimited access to excessive levels of grain can cause founder. However, if residue fields are strip grazed and it happens to snow, some of the best feed may be lost because the corn and husks are covered with snow. The lease rate for corn stalks is about $3 to $7 per acre.

The Potential Use of Weeds in Grazing Programs

Traditionally managed grazing systems tend to promote reduced forage specie variations compared to unmanaged grazing systems. Work by Wilson et al. (1995) in Pennsylvania suggests that practically all samples of weeds met or exceeded beef and sheep dietary recommendations for magnesium and calcium concentrations, with a lesser proportion of weed species meeting or exceeding phosphorus dietary recommendations. Several weed species had an undesirable high calcium to phosphorus ratio, but the K:(Ca + Mg) ratio indicated that weeds were not generally tetanigenic. Some weed species growing in unmanaged communities can contribute macrominerals, particularly Mg and Ca and microminerals (Cu).

Making and Maintaining Hay

It is important to minimize dry matter losses to control hay production costs. The losses start with mowing and conditioning (13.2%), raking (1%), baling losses for small square bales (2.8%) and large round bales (19.2%). Storage losses can range from 5% to 30%, and feeding losses range from 5% to 10% (Bartholomew and Vollborn, 1997). Total losses from the system will range from 27% to more than 50%.

Mowing Hay

Grass hays have the best combination of yield and feed quality when harvested when the seedhead is in the boot stage. One important note is that there is more protein in the plant in the morning than in the afternoon.

Tedding Hay

Tedding is effective in hastening the rapid, early phase of drying, but not the slower, last phase of drying (Collins, 1997). If done, tedding should be done shortly after mowing or early enough in the day that some moisture remains in the leaf to prevent losses. Do not ted hay that has dried to 50% moisture because that can increase dry matter losses and is not effective in increasing drying rate. Tedders are useful in breaking up windrows of rained-on hay to allow for redrying.

Large Round Bale Storage

Bale Placement Place bales on a well-drained location. A well-drained four- to six-inch coarse rock base will minimize bottom spoilage. The cost to put down a rock base is approximately $1.11 per bale (figuring a three-year life). If the bales are taken off the rock during cold weather, the rock's usefulness can be extended for perhaps two years. Plastic twine should be considered if the bale is to be stored for more than one season.

Bale Orientation

Orient the bales parallel to the direction of the prevailing winds. This will allow the wind to blow snow past the bales to minimize drifting and the resulting moisture soaking into the bales. Put the stem-down side of the bale to the north side of the line. The stem-down side tends to shed rain and snow better than the stem-up side. Oriented in this manner, the stem-up side will receive more sun to provide additional drying to lessen spoilage. Stacking large round bales usually increases storage losses.

Table 10. Spoilage Loss From Larger Round Hay Bales.

Inches of Spoilage	Percentage of Bale Spoilage
2"	12%
4"	23%
6"	33%
8"	43%

10"	51%

Avoiding Bottom Surface Losses

Moisture penetrates the bale on its periphery with most accumulation on the bottom. Ohio researchers (Reeder et al., 1997) concluded that effective long-term storage of round bales in humid areas required that the hay be kept off the ground and placed on a surface that allows moisture to escape and provides good aeration. An inexpensive solution that may reduce loss from approximately 25% of the dry matter yield down to 16-18% is to break soil/bale contact by elevating bales on crushed rock, poles, pallets, or some other means of providing air space between the bottom of each bale and the soil surface (Collins, 1997). Elevation is not necessary for bales covered in solid plastic since the plastic layer provides a barrier against moisture movement from the soil. Kentucky research suggested that elevation would be beneficial for net-wrapped bales.

Indoor Storage and Bale Covers

If bales are to be marketed or stored for more than one season, indoor storage or bale covers should be considered. Studies have shown outdoor storage losses range between 5 and 35%. Storage losses are usually reduced by approximately two-thirds with indoor storage and by one-half with good plastic covering outdoors. The outer four inches of a six-ft. diameter round bale contains about 25% of the total bale volume. (Think of it as throwing away 25 acres of hay for every 100 acres you bale.)

Plastic can be cut into 25- to 30-feet-wide sections and overlapping each 12 to 18 inches at the joint. Plastic will require rope strung over the top every three feet or so and staked or weighted down with old tires. The cost is approximately 50 cents per bale for plastic cover with a two-year life. Early removal and careful handling of plastic before freezing weather can lengthen the useful life of the plastic. If storing in bags, be sure to cut down the size of bale slightly.

Melted Tallow Cover

Researchers at Missouri have used melted food-grade beef tallow. Approximately 13 pounds of tallow is melted and sprayed or poured over each bale and allowed to infiltrate into the outer three to Four inches of the bale. Initial tests have indicated that the tallow will remain on the bales through the summer regardless of rainfall. Quality hay was found beneath the outer one-inch layer at the end of the summer. The cost of coating hay with tallow was $3 per bale.

By-Product Lime Cover

Research initiated by Jim Barrett, Ohio State University Extension, at the Eastern Ohio Resource Development Center, involves the use of by-product lime from water treatment plants as a bale cover. When moistened, the lime hardens and may provide a cover or perhaps an outdoor floor for bales. The lime is approved for agriculture uses.

Small Round Bales

The use of small round bales is another viable system, if you can find the equipment. The 40- to 50-pound round bales are made and left in the field where they are harvested or moved to a storage area. If the bales are left in the field, a front wire will be needed to maintain efficient consumption of the bales.

Balage

Bale Silage

Bale alfalfa at 55-60% moisture. Grasses should be baled at a slightly higher moisture. Bag or wrap bales as soon as possible. No air leaks should be tolerated. Plastic should be inspected frequently. Results are usually best with fall-harvested crops and first cuttings fed by mid-summer. The cost of bagging can be $20/ton. Bales should be smaller since they will be heavier and thus more difficult to transport (1,500 to 2,000 lbs).

The size of the bag should be slightly bigger than the bales. After placing the bale in the bag, the end should be tightly closed and double tied with good quality twine. All holes, regardless of their size, must be patched. Reusing bags increases the risk of spoilage, but reduces storage costs. A good way to inspect bags is to inflate the bags using a fan or the wind in bright light (e.g., a sunny, windy day). Then from inside the bag, look for light shining through small holes.

Hay Feeding Methods

Research shows that wastage is as much as 40% or more when cattle are allowed free access to large bales without feed racks. Feed wastage may only be 6% with rings or feeders. Unrolling has feed wastage values of 23%. Wastage is greater with low-quality than with high-quality hay.

Jim Gerrish of the University of Missouri has devised a low-maintenance hay-feeding system. The bales are pre-set during the summer for winter feeding and then ring feeders and electric fence are moved to control access. Each year, the bales are located in a different area of the field where they are to be fed. The bales are about 20-30 feet away from each other.

Other producers unroll their hay. They locate the bales at the top of a hillside or incline behind an electric wire. The bales are placed so they will unroll. Certainly, a barn or other structure should not be in the line of the bale's unrolling.

Substituting Grain For Hay

Substituting grain for hay is economical when roughages are in short supply. Since grain costs more per pound than hay, a smaller amount of grain must be fed to economically substitute for hay. This will require restricted feeding of grain.

Restriction of Hay

The most economical diets are those diets that have almost no hay at all. Dr. Steven Loerch et al. (1995) fed 3 lbs. of hay, 3 lbs. of supplement, and 10 lbs. of whole shelled corn per cow per day during November and December. The cows received 3 lbs. of hay, 3 lbs. of supplement, and 12 lbs. of corn until spring turn-out. The cows averaged 1,300 lbs. in this study. Dr. Loerch recommends taking three to Four days for adjusting the corn and decreasing hay to the two- to three-pound level. The facilities need to be fairly secure. The supplement that was used follows:

Feedstuff	%
Ground Corn	31.95
Soybean Meal	45.60
Urea	4.10
Limestone	7.80
Dicalcium phosphate	4.30
Trace mineral salt	3.20
Dyna K	2.30
Selenium premix (200 ppm)	0.40
Vitamin premix	0.20
Rumensin 60TM	0.15

Partial Restriction of Hay

Hay-restricted diets will be the most economical, but secure facilities to control hungry cattle may be limiting for some producers. Therefore, for those individuals with limited facilities, substitute grain for only part of the hay or roughage (Steeds and Devlin, 1984; Whittington and Minyard, 1988). A minimum of one-half pound of hay per 100 lbs. of body weight is suggested (approximately 5-6 lbs. of hay/day). During extremely cold weather or in pastures with little winter protection, the hay could be increased to three-fourths of a pound of hay per 100 lbs. of body weight (8 to 9 lbs. of hay/day).

Additional hay can be provided in the form of very mature, low-quality hay or straw bales placed in hay feeders. This could be provided in addition to the previously mentioned hay. This hay, however, must be purchased or produced at a very cheap price to maintain an economical diet. Moldy hay is not cheap at any price.

The amount of grain necessary for each cow will depend on the initial condition of the cow. From 8 to 12 lbs. of grain is suggested, with lower-conditioned animals receiving the higher amounts. Increase the grain allowance during the last two months before calving.

Include a protein supplement during the last two months of pregnancy if low-quality forages are fed. Lactating beef cows can be fed a 50% straw-based diet without rumen-impaction problems occurring.

Some Suggestions for Substituting Grain for Hay

1. It is generally best to replace only part, rather than all, of the roughage if your facilities will not hold continuously hungry cattle. In this situation, feed at least one-half pound of hay for every 100 lbs. of body weight (5-6 lbs. of hay). In extreme cold weather or without winter protection, increase to 8-9 lbs. of hay.
2. Provide adequate amounts of vitamin A and calcium.
3. All animals will require equal opportunity to eat at the same time.

Rental Payments

Rent is often charged using either a per- head per-month basis or a per-acre per- season basis (Miller, 1997). A typical range is $4 to $8 per month per adult-cow equivalent. A livestock owner can estimate pasture rent per unit of livestock on a monthly basis using this data: On an per-acre basis, a typical charge will be $20 to $40 per open acre for a high-quality, improved, permanent pasture that has been limed and fertilized and seeded with Fescue, orchard grass, timothy, red clover, etc. For unimproved permanent pasture, a typical charge might be $10 to $20 per open acre for unfertilized bluegrass. Excessive weeds and/or a healthy stand of broomsedge would suggest that rent might be adjusted down from the $10 to $20 per acre figure.

```
A.  Average animal weight expressed in 1,000 pounds
B.  Hay price per ton
C.  Pasture quality factor:
     0.12 = unimproved poor condition
     0.15 = fair to good permanent pasture
     0.18 = very good permanent pasture
     0.20 = excellent meadow (grass/legume)
     0.22 = lush legume pasture.

A x B x C = estimated pasture charge per livestock unit per month.

For example:
```

	1,000#	Hay/T	Factor	Rent/ Head/ Month
1,000# cow/ 200# calf	1.20	x $40	x 0.15	$7.20
1,200# diary cow	1.20	$60	0.20	14.40
120 # ewe/ 40# lamb	0.16	$40	0.12	0.76

Leasing Pasture or Buying Standing Forage

Livestock owners who want to pasture animals on someone else's land have several options, including leasing pasture or establishing a contract for sale of standing forage (Harris and Undersander, 1996). If a livestock owner wants to assume the rights and responsibilities of land ownership, a lease may be preferable. For example, the landowner will not have the right to hunt or conduct other recreational activities on the pasture without the renter's permission unless that right is written into the lease. The landowner must give notice before entering to repair fence (unless there is an emergency and the renter is absent). Under a lease, the livestock owner is obligated to maintain fences.

If the livestock owner does not want to assume the responsibilities of land ownership, a contract would be preferable. For example, the buyer of the forage does not have the right to use the property for hunting or other recreational activities. The landowner may enter the premises at any time. The landowner is responsible for maintaining fences.

Generally, landowners are not liable to third parties who incur injury on leased property. By contrast, the buyer under a contract for sale of standing forage is solely responsible for damages caused by livestock. A landowner will have a lien - the right to hold livestock for nonpayment whether the parties employ a lease or a contract.

Winter Water Systems

Heated Water Sources Water should not be hot nor in the form of ice. Drink- able water is usually between 40 and 65 degrees F. Occasionally check waterers with heaters so as to detect a "runaway." Dip a thermometer into the water. Do not allow the thermometer to rest on the bottom. Touching the heated bottom of the pan can result in higher temperatures than actual water temperature. Check the temperature over several cold days. Water temperatures of at least 40 degrees F should minimize mechanical problems and maintain animal performance.

Adequate insulation can reduce problems with water freezing and reduce electric costs in cold winters. Make sure the insulation inside the waterer is still in good condition. Conserve heat by caulking the base of the automatic waterer and seal the access door with weather proof tape. Reducing the wind on the waterer by a windbreak can also reduce electric costs.

Additional external insulation may be added to some automatic waterers. Surround the external surface with two inches or more of styrofoam. Place one-half-inch plywood over styrofoam. Put galvanized steel on the top part of the styrofoam-plywood pieces and angle iron on the vertical edges. Wrap this external insulation with some one-eighth-inch cable to keep it in place.

Stray electric current in a self-heating trough can reduce water consumption and thus reduce feed intake. Shut off the electricity to automatic waterers and check the inside for rodent nests. Make sure the connections are dry, and there is a clean, tight ground.

Non-Heated Water Sources Place input spouts on the side of troughs and directed so that incoming water circulates. By encouraging water movement, there is less chance of freezing. One producer painted the southern exposure of his metal water troughs black (inside and outside)

to absorb the day's heat, to keep the tank open during winter. The area around all permanent tanks should be graveled or otherwise treated to provide all-weather access.

Pipe Buried pipe needs to be placed 30 inches deep for freeze protection. If the pipeline is delivering gravity flow water, eliminate all the humps in the line because air could become trapped and stop the flow. Plastic or poly-pipe should not be laid in a straight line in the bottom of the trench; instead, it should be curved back and forth to allow for contraction in the cold weather. Install 101 feet of pipe for every 100 feet of trench. Stones should be removed from the bottom of the trench so the pipe is not laying on or next to potential "line breakers."

If you can gravity flow the water, use linear low-density polyethylene (LLDPE) pipe. For pressurized systems, use a rolled high-density polyethylene (HDPE). The size of the pipe needs to match the demand placed on it. Gravity flow and siphon systems will typically require 1.5-inch pipe. One-inch pipe should be sufficient for most pressurized systems.

Pump Pump alternatives where there is no electricity include the nose pump, ram pumps, sling pumps, and solar-powered pumps. The nose pumps make the cattle pump their own water by pushing against a sliding bar that brings the water into a bowl. Only one animal can drink at a time, and one pump can water about 30 cows. The ram pump can move water uphill or horizontally. This pump utilizes the energy of the moving or the falling water. A flow as little as one to three gallons per minute with a two-foot fall can drive a small water ram pump. Sling pumps are self-supporting and powered by flowing water in a stream or wind.

Cow Nutrition and Body Condition

Most reproductive failures in beef females can be attributed to improper nutrition and thin body condition. Monitor the effectiveness of the nutrition program in the long-term by herd performance records but in the short-term, by keeping an eye on the flesh or body condition score (BCS) of the cows.

Table 11. When To Evaluate BCS

1. Mid-summer
2. Weaning
3. 60 days before calving
4. Calving
5. Beginning of the breeding season

The cow's priorities for nutrition are maintenance, lactation, growth (young females), and reproduction. Consequently, reproduction is the first to go and the last to return in cases of inadequate nutrition.

The nutrition level pre- and post-calving affects the conception rate of the subsequent breeding seasons. Cows that are thin prior to calving will have a delayed onset of estrus. Thin cows after calving will have reduced conception rates.

Obesity is a problem in heifers that become fat during the growing phase. Fat heifers normally have lower than average reproductive rates. It is less serious in mature cows. However, obesity is uneconomical since fat cows are more expensive to maintain. Ohio State University Extension has a fact sheet with pictures corresponding to the body-condition scores (Mangione, 1992).

Immature cows continue to grow until approximately four years of age. These young cows should be maintained through the yearly cycle about one BCS higher than mature cows to achieve the same reproductive performance.

Body-condition changes are a more reliable guide than body-weight changes for evaluating the day-to-day nutrition status of a beef cow. Body-condition scoring also has an advantage over body weight in that scales or corrals are not needed.

The scoring system currently advocated is outlined in Table 12 on the following page. The important thing in scoring is to be consistent. You may not fully agree with everyone who scores the cows, but the relative distribution of cows within the herd can be measured.

Table 12. Body Condition Scoring (BCS) System for Beef Cattle

BCS Description

1. EMACIATED: Starving and weak. No palpable fat detectable over back, hip bones, or ribs. Tail-head and ribs project quite prominently.
2. POOR: Poor milk production and reproduction. Chances of rebreeding slim. Cow still emaciated but tail-head and ribs less prominent. Backbone is still rather sharp to the touch but some tissue exists along the backbone.
3. THIN: Poor milk production and reproduction. Ribs are still individually identifiable but not quite as sharp to the touch. Obvious palpable fat along the spine and over the tail-head with some tissue over top portion of the ribs.
4. BORDERLINE: Reproduction bordering on inadequate. Individual ribs no longer visually obvious. Individual spines can be identified on palpation but feel rounded, rather than sharp. Some fat cover over ribs and hip bones.
5. MODERATE: Minimum necessary for efficient rebreeding and good milk production. Cow has generally good overall appearance. Upon palpation, fat cover over ribs feels spongy and the area on either side of the tail-head now has palpable fat cover.
6. OPTIMUM: Milk production and rebreeding very acceptable. Firm pressure now has to be applied to Feel spinous processes. A high degree of fat is palpable over the ribs and around the tail-head.
7. GOOD: Maximum condition needed for efficient reproduction. Cow appears fleshy and obviously carries considerable fat. Very spongy fat cover over the ribs and around the tail-head. Some fat around vulva and crotch.
8. FAT: Very fleshy. No advantage in having the cow in this condition. Backbone almost impossible to palpate. Cow has larger fat deposits over ribs, around tail-head, and below vulva.

9. EXTREMELY FAT: The fat may cause calving problems. Cow extremely wasty and patchy. Tail-head and hips buried in fatty tissue. Bone structure no longer visible and barely palpable. Animal's mobility may be impaired by fat deposits.

Body Condition Scoring During the Summer

The normal grazing program can be followed if cows appear to be in adequate body condition. However, thin cows during mid-summer will likely be thin cows at weaning. When adequate amounts of low-quality forage are available, feeding a small amount of protein supplement during the late summer can efficiently increase cow body condition. Feeding 0.6 pound per head per day of protein supplement such as soybean meal (about 1.5 lbs. per head, three times per week) during late summer months (August and September) can increase cow weight by 25 pounds and condition score by 0.5 units. It has been indicated by some scientists that a supplement level of 1 to 1.5 lbs. per head per day may be more desirable to provide greater weight gains.

Body Condition Scoring Prior to Calving

Ideally, sort cows by condition at weaning time or 90 to 100 days before calving. Continue monitoring cow condition because weather and feed quality affects condition. Group cows by condition score and feed them to reach condition score of 5-7 by calving. An example would be placing all of the BCS 1, 2, 3, and 4 cows in one pen or pasture and allowing them access to higher-quality feed. Using a deworming product on the cows, or at least the thin cows, is advisable. The BCS 5, 6, and 7 cows can be fed as usual (maintain BCS). The BCS 8 and 9 cows could be grouped together and fed a lower-quality diet during the middle one-third of gestation.

A higher plane of nutrition may be required for cows with condition scores of 4 or less earlier than the last third of pregnancy. It will be easier to get weight gains in early fall before cold weather occurs, helping with insulation during the cold winter months.

Body Condition Scoring After Calving

Body condition at calving is the most critical factor in determining reproductive performance. High pregnancy rates will not occur in first-calf heifers unless they are able to gain some fat cover during the breeding period. This can be difficult to do For young stock with calves at side. Thin cows need to increase body condition, and moderate condition cows need to maintain body condition. Correcting deficiencies prior to calving is easier and cheaper.

BCS 4 If a cow is BCS 4 or thinner, she will be slow to return to heat and may not rebreed on time. Feeding a high level of nutrition after calving can sometimes shorten the postpartum interval from calving to first heat in thin cows (BCS 3-4), but the postpartum interval will usually be longer than if the cows had calved in good condition (BCS 6-7). Therefore, early weaning the calf at 50 days of age or at the start of the breeding season may have to be considered. Manage these cows with those in the BCS 6 group. The calves can be raised on self-feeders using an early weaning ration. The cows, even if quite thin, should return to estrus within

three weeks after weaning and will thus rebreed to have a calf next year. It is far easier and cheaper to make cows gain weight before calving than after calving when the added requirement of lactation is present. A parasite evaluation is certainly merited.

BCS 5 If a cow is a BCS 5, continue to Feed hay or grain and protein supplement to be sure that she does not lose condition before the breeding season. Many cows calve at condition scores less than 5 and still have excellent rebreeding rates when weather and nutrition conditions do not cause extraordinary stress during this critical period (two months before calving through the breeding season). A borderline 4-5 BCS cow that is exposed to severe environmental stress may require the calf to be removed for 48 hours, 10 days before the breeding season. This should help a stressed BCS 5 cow to return to heat and rebreed on schedule. This program will probably not work with very thin cows. The calves should be offered palatable feed and plenty of water while they are separated from their dams.

BCS 6 If she is a BCS 6 (or even fatter), continue with normal management and feeding. While good body condition at calving time is an indication that rebreeding should proceed without difficulty, good condition at calving does not guarantee acceptable rebreeding performance. Cows losing condition after calving have lower conception rates than do cows maintaining condition.

Body Condition and Weaning Time

The key to cow management in winter is to ensure that moderate body condition is achieved before the onset of cold weather. Studies have shown it is very difficult to put body condition on a thin cow during cold conditions. Cows can make substantial recovery in body condition during the post-weaning period if temperatures are moderate and forage is readily available. These conditions can be accomplished by weaning calves by early to mid-October. Weaning calves later than this may not be conducive to a "year-round" grazing program.

Matching Calving Dates to Forage Resources

The goal is to have the cows grazing green, growing forage by the time the calf hits the ground and early lactation begins. The first option might be to extend the spring grazing season. Early-season grazing of rye or fescue may still allow a March calving season. Therefore, it is not always moving to a May calving period for everyone. Kentucky researchers observed that cattle that grazed fescue with high levels of endophyte in June can have reduced pregnancy rates (Burris, et al., 1994).

Optimizing Spring Grazing The best time to begin spring grazing cool-season pastures is when the plants are three- to Four-inches tall and the soil is dry enough to support the animals without damaging the plant or the soil (Hendershot, 1998). You cannot wait until the plants reach six- to eight-inches tall to start a rotation. Subsequent sites in the grazing rotation will become too mature by not initiating grazing at three to Four inches. During a wet spring, waiting until the plants are about six-inches tall is suggested.

Graze the best-drained, accessible areas first. Start grazing in a different pasture every year, so as to aid in stand persistence and weed control. Grazing cool-season grasses in the spring that are less than three- to Four-inches tall may reduce yields the rest of the grazing season.

Later Calving will alter traditional marketing strategies. Putting a calf directly into the feedyard in February gives you a finished market animal in late summer, which can be a time of lower market cattle prices. But if the cow has a June calf, the producer can sell a 500-pound calf on March 1. This may well be one of the better calf-marketing periods. Another option is placing these calves on spring pasture and then selling them in the fall as yearlings.

Planning a Supplementation Program -Estimating Intake

In the case of gestating beef cows grazing winter stockpiled fescue or eating poor quality hay, there becomes a problem of how much the rumen can physically hold. A rule of thumb is that the maximum NDF dry matter content of the dry matter of the daily ration can only be 1.2 to 1.5% of the cow's body weight. The higher the quality of the forage, the closer to the top end of the range (1.5% NDF) can be consumed. The poorer the quality of the forage, the closer to the bottom end of the range (1.2% NDF) may be consumed. For example, a 1,200-pound gestating beef cow may be able to consume and digest enough of a 60% NDF forage to meet her daily needs. Assuming a 1.5% NDF capacity, she could eat 30 pounds of this forage dry matter (2.5% of body weight) and contain 18 pounds of NDF dry matter. This would be her physical limit. Increased nutrition needs brought about by severe weather or early lactation must be supplemented by a more digestible feed source of simply providing a higher-quality (lower in NDF) forage.

Table 13. Guidelines to Estimate Feed Intake of Beef Cows[a].

Forage Type	Class of Cattle	Dry Matter Intake (%)	As Fed Intake (lbs)
Low-quality forages	Dry	1.5	17-18
	Lactating	2.0	23-24
Average-quality forage	Dry	2.0	22-24
	Lactating	2.3	25-28
High-quality forage			
Alfalfa	Dry	2.5	28-30
	Lactating	2.7	30-32
Green Pasture	Dry	2.5	80-100
	Lactating	2.7	100-110
Silage	Dry	2.5	80-85
	Lactating	2.7	90-95
a. Rasby (1997)			

Supplementation and Substitution

Supplementing nutrients to offset deficiencies or to meet production demands is more often practiced during periods of summer dormancy or during the fall and winter months. Substitution can be practiced when forage resources are in short supply (Caton and Dhuyvetter, 1996). When forage intake is greater than 1.75% of bodyweight, supplements may decrease forage intake. When forage intake is less than 1.75% of bodyweight, supplements almost always increase forage intake.

Forage intake response is affected by the forage ratio of digestible organic matter to crude protein (DOM:CP). When DOM:CP ratio is less than 7, supplements decrease forage intake; when DOM:CP falls between 7 and 12, intake may both increase and decrease with supplements. When DOM:CP is greater than 12, all type of supplements increase forage intake.

Grouping the Herd Based on Supplement Needs

Not all the cows in a herd need the same amount and quality of feed. One of the best ways to reduce supplemental feed costs during the winter is to separate the cow herd based on feed needs and feed accordingly. A logical separation would be into three groups:

1. Replacement heifers
2. First-calf heifers and thin older cows
3. Mature cows in adequate condition.

Two-year-old, first-calf heifers do not have a mature set of teeth. That limits her bite size, and she cannot match mature cows for forage intake. Replacement heifers, first-calf heifers, and thin older cows might be combined if pasture areas are limited.

How Cattle Use Energy

The visceral organs (liver, digestive tract, heart, and kidney) comprise only 6% of total body weight but consume 50% of the maintenance energy (Ferrell, 1988). The largest single tissue that consumes maintenance energy is muscle (41% of body weight; Ferrell, 1988); however, muscle consumes only 23% of the total energy consumed for maintenance. Muscle tissue use does not greatly add to the maintenance energy requirements of penned animals but could be considerably larger for animals walking, grazing, and processing forage.

Energy Supplementation With Grain

When the protein content of the forage is high (> 10% crude protein), grains or low-protein supplements (< 20% CP) can be used. Henning et al. (1980) reported that low levels of corn supplementation (7.8% of DM intake) actually increased forage intake. However, with higher levels of corn supplementation (greater than 23% of DM intake), forage intake reduced compared to that of control sheep. Reports that low levels of energy supplementation increased

forage intake seem to occur more frequently in studies with sheep than in those with cattle (Caton and Dhuyvetter, 1997). Horn and McCollum (1987) have suggested that an energy supplement level that would minimally affect forage intake would be 0.7% of animal body weight. However, level of grain supplementation can vary with forage quality.

Digestible Fibers as Energy Sources

Studies with readily degradable fiber sources as energy supplements for grazing and forage-fed ruminants have yielded different responses than research with grains (Caton and Dhuyvetter, 1997). Soybean hulls result in only a small decrease in forage intake (Martin and Hibberd, 1990; Grigsby et al., 1992). Other sources of readily degraded fiber such as wheat midds, beet pulp, and corn gluten feed have generally not decreased forage intake as much as grain-based supplements (Caton and Dhuyvetter, 1997).

Many fibrous feeds also have high energy values. A list of fibrous feeds that offer potential for replacing hay or traditional grain sources is presented in Table 14. Research suggests that these products may actually perform better than these numbers would indicate.

Table 14. Protein, Fiber, and Energy Values of Selected Feedstuffs.

Feed	CP[a] (%)	NDF[b] (%)	NEm[c] (Mcal/lb)	NE[d] (Mcal/lb)
Corn	9.8	10	1.02	0.70
Beet Pulp	9.7	54	0.79	0.52
Citrus Pulp	6.7	23	0.91	0.61
Corn Gluten Feed	25.6	45	0.92	0.62
Cottonseed, Whole	23.0	44	1.09	0.77
Dried Brewers Grains	25.4	46	0.68	0.41
Soybean Hulls	12.1	67	0.65	0.39
Wheat Middlings	18.4	37	0.73	0.45

a Crude Protein
b Neutral Detergent Fiber
c Net Energy Maintenance
d Net Energy Gain

Replacing Hay With a Digestible Fiber Various researchers have conducted winter feeding experiments to determine the feasibility of using digestible fiber in lieu of hay as a winter feed. In one study, cows were grazed on stockpiled tall fescue and fed hay (tall fescue) ad-libitum when pasture became limiting. Feeding four pounds of soybean hulls from December through March saved approximately 625 pounds of hay per cow and resulted in less body weight loss (13 pounds) than feeding hay only (86 pounds). Estimating hay costs at $80 per ton and soybean hull costs (delivered) at $80 per ton, more than $6 per cow was saved by feeding soybean hulls.

Cottonseed hulls are very palatable but are low in nutrient content. Cottonseed hulls should be considered a source of roughage rather than a supplemental source of energy or protein.

Replacing Corn With a Digestible Fiber Other work has been done using digestible fibers as a replacement for corn. In one study steers were maintained on tall fescue. One set of steers was fed four pounds of soybean hulls and another set was fed four pounds of corn while on grass. A third set of steers received no supplement. The steers gained similarly on soybean hulls and corn (two-pounds-per-day gain), with both being greater than the gain of steers that were not supplemented (1.5-pounds-per-day gain). Digestible fibers appear to be beneficial as a supplement for growing animals that are grazing or fed hay, compared with high-energy feedlot diets.

Protein Supplementation

Limited amounts (approximately 1-2 lbs) of high protein supplements (> 30% CP) can be utilized with low-quality forages. Low-quality forages would be less than 8% crude protein and 45% total digestible nutrients. Protein supplementation has been shown to increase digestibility approximately 15% and increase forage intake approximately 25% (Table 15). There is no way to be sure, in every circumstance, that the expected increase in intake and digestibility actually occurs. The condition of the cow herd must be monitored.

Table 15. Example to Illustrate the Effect Protein Supplementation Has on Low-Quality Foragea.

Without supplementation, a cow can consume 18 pounds of dry matter from a low-quality forage source.

	18	Forage intake without supplementation
x	1.25	Increase in forage intake with adequate protein
	22.5	Total forage intake with supplementation
	0.40	TDNb content of the forage
x	1.15	Increase in digestibility with adequate protein
	0.46	TDN content of forage with supplementation

a Wagner and Goetz (1989).
b Total digestible nutrients.

High-protein supplements that do not contain urea or other nonprotein nitrogen sources do not need to be fed every day. Simply double the amount and feed every other day. Range cake or cubes (20% crude protein) can be utilized with intermediate quality forages. Altering body condition with supplements prior to cold weather may be more effective than waiting until cold weather occurs.

Nonprotein Nitrogen Sources Nitrogen sources, such as feed-grade urea, are an excellent supplement for high-grain diets. Urea and biruet can be utilized in range situations but utilization

will not be 100%. Nonprotein nitrogen sources should be fed in small amounts and at frequent intervals. Examples of calculating the value of protein in various supplements are given in Table 17.

Table 16. Energy and Protein Supplementation of Forage Diets

Protein Level of Suppl.	Low Protein 14%	Intermediate Protein 20%	High Protein[a] 30%	Digestible Fiber
Forage CP:	10%	6-10%	6%	6-10%
When feed	Every Day	Every Day	Alternate Day	Every Day
a. Alternate Day programs only suitable for all natural protein sources.				

Table 17. Approximate Urea Utilization[a].

Conditions	Dry Supplement	Block/Liquid Supplement
Weathered grass Crop residues Poor-quality hay	0-25	50
Medium-quality hay Silages Summer pasture	40-60	80
High-energy diets	90-100	90-100
a Wagner and Goetz (1989).		

The example (on the following page) demonstrates the use of "cost per unit of protein" for comparisons of protein supplements when urea is fed once a day with medium-quality hay (approximately 50% utilization).

Methods of Feeding Supplements

Trough Space Changes in trough space per animal can influence competitiveness and variations in supplement consumption (Bowman and Sowell, 1997). Wagnon (1966) observed that with three feet of bunk space per cow, less fighting and dominance/submissive behavior occurred during supplementation than when six feet was allowed per cow. The three feet of bunk space did not allow cows to Fight without backing away from the trough, and therefore fewer animals were pushed away from the supplement. When excessive trough space was allowed, dominant cows were observed to chase others away from one side of the trough and to spend more time fighting.

Feeding on the Ground One of the ways to Feed on the ground is to place the feed under an electric wire. The wire is placed about 12 inches above the ground. Allocate two Feet for each beef cow.

Effect of Supplement Form on Consumption Bowman and Sowell (1997) summarized the percentage of non-feeders for blocks, dry, and liquid supplements. Over the range of animals, environments, and supplement formulations, the percentage of non-feeders averages 14.3% for blocks, 15% for dry supplements, and 23.5% for liquid supplements. The variation in supplement consumption was greater for blocks and liquids than dry supplements. Supplement characteristics such as hardness and nitrogen content may influence variation in consumption.

Nutrient Utilization	
Product A	**Product B**
40% Crude Protein $300/ton	40% Crude Protein $225/ton 20% CP equivalent from NPN 20 x 50% = 10 Therefore 30% CP (40% - 10% = 30%)
$300/2000 lbs. = $0.15 $225/2,000 lbs. = $0.1125 $.15/.40 = $.375/lb of CP $.1125/.30 = $.375/lb of CP	
* At these prices, both products are of equal value to the beef cow.	

Mineral Supplementation

In formulating supplements for cows grazing winter forage, two often overlooked nutrients are minerals and vitamins. They have less impact than protein and energy on cow/calf performance and economics, but they should not be overlooked (Corah, 1990). While supplementation is important, over supplementation of minerals should be avoided to prevent possible environmental problems associated with runoff from waste or application of cattle waste to soil. Certain minerals can actually be toxic if supplemented in excessive amounts.

Table 18. Mineral Requirements of Beef Cattle.

	Requirement			
Growing Cattle	**Pregnant Cows Lactating Cows**	**Maximum Level**		
Calcium, %	0.45	0.3	0.45	2
Phosphorus	0.3	0.2	0.3	1
Magnesium	0.1	0.12	0.2	0.4
Potassium, %	0.6	0.6	0.7	3
Sodium, %	0.08	0.08	0.1	-
Sulfur, %	0.15	0.15	0.15	0.4

Iron, PPM	50	50	50	1000
Manganese, PPM	20	40	40	1000
Zinc, PPM	30	30	40	500
Copper, PPM	10	10	10	100
Iodine, PPM	0.5	0.5	0.5	50
Selenium, PPM	0.2	0.2	0.2	2
Cobalt, PPM	0.1	0.1	0.1	10
Molybdenum, PPM	-	-	-	5

Salt

Forages do not contain adequate amounts of salt (sodium). Sodium can be supplemented as sodium chloride or sodium bicarbonate, and both forms are highly available. Iodized salt should always be used to avoid an iodine deficiency. Cattle fed maintenance rations while confined in drylot often consume high levels of mineral mixtures, perhaps from boredom (Sewell, 1990).

Calcium

Calcium is the most abundant mineral in the body. Vitamin D is required for active absorption of calcium. Forages are generally good sources of calcium, and legumes are higher in calcium content than grasses. Alfalfa has relatively high levels of calcium but 20 to 33% is unavailable to the animal.

Phosphorus

Drought conditions and increased forage maturity (e.g., stockpiled forage) can result in low forage-phosphorus concentrations. Phosphorus supplementation becomes far more critical in cases of winter grazing than feeding hay.

Reproductive problems are common if phosphorus is deficient. Plasma phosphorus concentrations consistently below 4.5 mg/dL are indicative of a deficiency, but bone phosphorous is a more sensitive measure of phosphorus status. The ideal diet calcium:phosphorus ratio is 2:1 but ratios of 7:1 are acceptable.

Cows around calving time should have free choice access to 10-12% phosphorus mineral. An example would be one-half salt and one-half dicalcium phosphate. Cows at other times of the year and stockers would need a mineral consisting of 25-35% dicalcium phosphate or 7-8% phosphorus. Varying the phosphorus level is one means of saving money.

Potassium

Potassium levels of 0.6 to 0.8 percent of ration dry matter are considered adequate for cattle. In general, potassium levels of Ohio forages are adequate to excessive in potassium content. These

high levels can be associated with reducing magnesium absorption and thus causing grass tetany problems. Therefore, always check potassium levels before any supplemental additions.

Low concentrations of potassium have been observed in stockpiled fescue during the winter (Clanton, 1980). Leaching during the winter may cause potassium levels in fescue pasture to drop as low as 0.24-0.3 percent of dry matter during winter months (Sewell, 1990). Potassium can be supplemented to cattle diets as potassium chloride, potassium bicarbonate, potassium sulfate, or potassium carbonate. All forms are readily available. If potassium is added for winter feeding, remove it from the mixture when fescue starts growing in the spring. Growing forages are usually high in potassium.

Magnesium and Grass Tetany

Grass tetany is most common in lactating cows grazing lush spring pastures. During the early spring, climatic and soil conditions are cool and wet; plants will not contain adequate levels of phosphorus or magnesium. While both these minerals may be in adequate amounts in the soil, plant uptake is slow due to the cool, wet conditions. Fertilizing pastures with nitrogen and potassium is associated with increased incidence of grass tetany. Cows depend on a frequent supply of magnesium from the feed since mobilization of magnesium from the bone is not very efficient.

Kemp and t' Hart (1957) observed that the K:(Ca + Mg) ratios of normal and tetanigenic pastures were 1.67 and 2.37, respectively. Metson et al. (1966) reported a mean K:(Ca + Mg) ratio of 2.45 in pastures of 19 farms that collectively had a 10% incidence of tetany in beef cattle.

Magnesium absorption has been improved by feeding grains and ionophores. Legumes are usually higher in magnesium than are grasses. Magnesium oxide and magnesium sulfate are good sources of supplemental magnesium. Including 15-20% magnesium oxide in the mineral mix should reduce the problem. Adding 6-10% molasses or soybean meal will assure intake.

Fertilization and Grass Tetany

As with all crops, proper pH is the most important factor in crop management (Munson and Joern, 1996). If the soil does need lime, use a dolomitic source if soil-test magnesium levels are less than 50 ppm. If the field has recently received manure, the importance of soil-test information cannot be overstated. At the rate used by some producers, a single manure application may supply several years worth of phosphorus, and sometimes potassium. Do not apply excessive rates of nitrogen early in the spring because high nitrogen levels can reduce magnesium availability in ruminants. Maintain relatively high soil-test phosphorus levels as some research has shown that phosphorus additions can increase tissue magnesium levels and potentially even decrease potassium uptake. Delay potassium application on grasses until late spring as high potassium fertilization decreases magnesium uptake. Consider interseeding clover since legumes are higher in magnesium than grasses.

Selenium

Selenium deficiency will cause retained placentas, infertility, and white-muscle disease in calves. The normal cow requirement is 0.1 ppm. The maximum tolerable concentration of selenium has been estimated to be 2 ppm.

Selenium is generally supplemented in animal diets as sodium selenite, while seleno-methionine is the predominant form of selenium in most feedstuffs. Selenium from seleno-methionine or a selenium-containing yeast was approximately twice as available as sodium selenite or cobalt selenite in growing heifers (Pehrson et al., 1989). Availability of selenium from sodium selenate was similar to sodium selenite (Podoll et al., 1992). Vitamin E should be added to the diet along with selenium. Calves should be injected with a selenium-vitamin E solution at birth, where a problem exists. Alternate methods of supplementing selenium include injecting selenium every three to Four months or at critical production stages and using boluses retained in the rumen that release selenium over a period of months (Hidiroglou et al., 1985; Campbell et al., 1990).

Liver samples are the ideal way to determine a deficiency, with 0.25 to 0.5 ppm considered normal and 0.1 to 0.15 ppm considered deficient. Blood can also be used as an indicator with normal levels being 0.08 to 0.3 ppm with deficiencies considered being 0.002 to 0.025 ppm.

Sulfur

Requirements of sulfur for grazing cattle are not well defined (approximately 0.15%). In Australia, sulfur supplementation increased gain by 12% in steers grazing sorghum-sudangrass containing 0.08 to 0.12 percent sulfur (Archer and Wheeler, 1978). The sulfur requirement of ruminants grazing sorghum-sudangrass may be increased because of the need for sulfur in the detoxification of cyanogenic glucose found in most sorghum forages.

Dietary sulfur requirements may be higher when diets high in rumen bypass protein are fed because of the limitation of sulfur for optimal ruminal fermentation. When urea or other nonprotein nitrogen sources are fed, sulfur supplementation may be needed. Mature forage, forages grown in sulfur-deficient soils, corn silage, and sorghum-sudangrass can be low in sulfur. The typical nitrogen to sulfur ratio of a complete diet should be 10:1, nitrogen to sulfur.

Copper

Copper deficiencies can cause poor reproduction, broken bones, weak calves, and light color hair. Discoloration normally occurs first around the eyes and tips of the ears. Sometimes, changes in hair color are not noted and the effect of a copper deficiency simply occurs as reproductive problems, scours, or calves older than four months ceasing to perform. Simmental and Charolais cows and their calves were more susceptible to copper deficiency than Angus cows fed the same diet (Ward et al., 1995).

Unfortunately, with copper, the forage may contain an adequate level, but if the diet contains either high levels of molybdenum (2 ppm) or sulphur (0.25%), both of these tie-up copper, rendering a deficiency. Ideally, the copper to molybdenum ratio should be 5:1 or greater (Munshower and Neuman, 1979). Legumes were blamed for increasing the molybdenum levels on reclaimed strip ground in Montana (Munshower and Neuman, 1979). High concentrations of

iron (Phillippo et al., 1987) and zinc (Davis and Mertz, 1987) also reduce copper status and may increase copper requirements.

Recent studies indicate that copper oxide is very poorly available relative to copper sulfate (Langlands et al., 1989; Kegley and Spears, 1994). Copper sources are copper sulfate, copper carbonate, copper proteinate, and copper lysine. Injectable forms of copper such as copper glycinate or copper EDTA have been given at three- to six-month intervals to prevent copper deficiency (Underwood, 1981). Although feed-grade copper oxide is largely unavailable, copper oxide needles, which remain in the gastrointestinal tract and slowly release copper over a period of months, have been used as a copper source for cattle (Cameron et al., 1989).

Sewell (1990) suggested that producers look at the commercial mineral supplement that they are using for cattle fed fescue and similar forages to see if the label shows approximately the following percent amounts of trace minerals: Selenium 0.0008 to 0.0016; cobalt 0.0008, copper 0.04, zinc 0.08; and manganese 0.08. Steeds (1991) recommended that Manitoba producers should only buy mineral supplements containing more than 2,000 ppm (0.2%) copper.

Iodine

The iodine requirement is 0.2 to 0.3 ppm in the total diet. Goitrogenic substances in the feed may substantially increase the requirement (two- to Four-fold), depending upon the amount and type of goitergens present. Plant sources that can increase the iodine requirement are white clover and some Brassica forage such as kale, turnips, and rape. They impair iodine uptake but can be overcome by increasing dietary iodine.

Zinc

A zinc deficiency can affect reproduction, the skin, and cause swelling of the bone joints or slow healing of wounds. Zinc deficiencies tend to impair sperm production and sperm quality in bulls. Cows require 30-40 ppm zinc with diets containing 2-10 ppm considered deficient. Legumes are generally higher in zinc than grasses.

Iron

In general, iron deficiency is unlikely unless parasite infestation or disease exists and causes chronic blood loss. Availability of iron from forage appears to be lower than from most supplemental iron sources (Raven and Thompson, 1959). Iron is normally supplemented in the diet as ferrous sulfate, ferrous carbonate, or ferric oxide. However, ferric oxide is basically unavailable (Ammerman et al., 1967).

Manganese

Manganese can cause infertility, light hair color, and calves with weak pasterns. Manganese requirements are approximately 40 ppm. A deficiency has sometimes been noted with feeding corn-silage diets.

Cobalt

Cobalt affects reproduction, growth, and causes pale skin. Cobalt supplementation plus an injection of vitamin B12 should alleviate symptoms. Both cobalt and iodine requirements can be met by using blue salt free choice (Steeds, 1991). Red salt is plain white salt plus iodine. Blue salt is red salt plus cobalt.

Fescue and Trace Mineral Deficiencies

Indications are that fescue is deficient in certain trace minerals (Sewell, 1990). Selenium, cobalt, copper, and zinc may be borderline or deficient in fescue and other forages, such as crop residue and mature grasses. Sewell (1990) suggested that producers look at the commercial mineral supplement that they are using for cattle fed fescue and similar forages to see if it has approximately the following percent amounts of trace minerals as stated on the label - selenium 0.0008 to 0.0016, cobalt 0.0008, copper 0.04, zinc 0.08, and manganese 0.08. Ohio may require somewhat high copper levels than this.

Vitamins

Cattle exposed to winter feed are susceptible to vitamin A deficiencies. In most cases, early spring grass will contain fairly high levels of carotene (precursor to vitamin A) and will adequately meet the cow's requirement. Ensiling effectively preserves carotene but the availability of carotene from corn silage may be low.

Vitamin A can be supplemented in the mineral mix or by an injection. One million International Units of vitamin A palmitate intramuscularly or intraruminally when cows are palpated for pregnancy will meet their vitamin A needs for two to Four months (Wagner and Goetz, 1989). In the mineral, add 10,000 to 50,000 International Units per 0.1 to 0.2 lb of mineral mix. Be very cautious if you are mixing your own vitamin-mineral mix. Only a very small amount of vitamin A premix is needed, and mistakes in mixing can lead to toxicity situations. Vitamin A will not remain stable very long in homemade mineral mixes (approximately two to three weeks). Utilize or request protected forms of vitamin A for your vitamin-mineral mix.

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