Four Steps to Rotational Grazing

A well-managed pasture program can be the most economical way to provide forage to ruminant animals.

On dairy farms where pasture makes up a significant portion of the forage program, feed costs may be reduced during the grazing season by $.50 to $1.00 a day per cow. However, careful planning and sound management are needed to optimize pasture utilization and animal performance. Knowing your animals, plants, and soils and being able to respond to their needs are skills that must be developed if rotational grazing is to be successful on your farm.

Using your land resources to develop a pasture system that fits in with your total animal, forage, and crop program is an important first step in pasture management. A major goal is to provide quality pasture for the grazing animals throughout the grazing season. Information provided in this brochure can help you plan to attain this goal.

Example: A beef cow herd of thirty 1300-pound cows with calves and one 2000-pound bull is used as an example to demonstrate the four steps to rotational grazing.

Step 1. Determine the number of animal units that will be in the grazing system.

The first step to rotational grazing is to determine the forage requirements of your herd or flock based on animal units (AU). One animal unit is equivalent to the daily forage intake of a 1000-pound dry cow (about 25 pounds of dry forage per day). Dry matter forage intake varies with animal species and class. Table 1 gives some typical animal unit values for various species and classes of livestock.

Table 1. Animal units of various species and classes of livestock.

Livestock	Animal Units
*Animal units for lactating cows are difficult to determine because of supplemental feeding.	
Dairy*	
1000-lb dairy cow (maintenance)	1.0
800-lb dairy cow (last 2 months of gestation)	1.0
1000-lb dairy cow (last 2 months of gestation)	1.2
1300-lb dairy cow (last 2 months of gestation)	1.5
1500-lb mature dairy bull	1.4
550-lb growing dairy heifer	1.0
Beef cattle	
1000-lb dry cow	1.0
1300-lb dry cow	1.3

Table 1. Animal units of various species and classes of livestock.

Livestock	Animal Units
1000-lb lactating cow (first 4 months after calving)	1.4
1300-lb lactating cow (first 4 months after calving)	1.6
2000-lb mature bull	1.7
550-lb growing-finishing steer (2 lb per day gain)	1.2
Sheep/Goat	
110-lb brood ewe/doe	.15
132-lb brood ewe/doe	.17
175-lb brood ewe/doe	.20
300-lb mature ram/buck	.40
110- to 132-lb replacement ewe/doe, lambs, yearlings	.22
220-lb replacement ram/buck, lambs, yearlings	.42

Determine total AU of herd using the equation

AU X number of animals = AU
+ AU X number of animals = AU
Total AU of herd

Example: 1300-lb cow with calf = 1.6 AU, and 2000-lb bull = 1.7AU

1.6 AU X 30 cows = 48.0
+ 1.7 AU X 1 bull = 1.7
49.7 (50) AU of herd

Step 2. Estimate how many acres will be needed throughout the grazing season.

Estimating the number of acres required to pasture a herd or flock depends on both the feed requirements of the animals and the available forage produced. Pasture growth is dependent upon plant species, soil characteristics, topography, fertilization, temperature, and soil moisture. Because of the variability in pasture growth, we can only estimate the number of acres required for grazing animals. Table 2 provides some estimated values of the acres required for grazing animals on various types of pasture.

To estimate how much pasture a herd or flock will need, first calculate the total AU of the herd (Step 1). Using Table 2, estimate how many acres each AU will need during each month of the grazing season. For example, if the herd will be grazing medium- producing Kentucky bluegrass and white clover pasture in June, approximately 1.3 acres will be needed to support each AU. The same herd grazing medium-producing orchardgrass and white clover pasture would need only 0.7 acres for each AU.

Table 2. Acreage required to provide the forage needs per animal unit assuming 70 percent pasture utilization.

Pasture Species	Pasture Product	Annual DM Yield T/A	Acres required to provide needs for one animal unit*								
			April	May	June	July	Aug	Sept	Oct	Nov	Dec
Bluegrass and white clover	medium	2.0	5.4	0.6	1.3	5.5	5.5	2.2	3.5		
Orchardgrass and white clover	low	2.0	-	1.0	1.1	1.8	1.8	1.8	9.2		
	medium	3.0	-	0.7	0.7	1.2	1.2	1.2	6.2		
	high	3.5	-	0.6	0.6	1.1	1.1	1.0	5.3		
Ochardgrass plus nitrogen	low	2.0	5.4	0.8	1.3	2.8	2.3	1.8	9.2		
	medium	3.0	3.6	0.5	0.9	1.8	1.5	1.2	6.2		
	high	4.5	2.4	0.4	0.6	1.2	1.0	0.8	4.1		
Stockpiled tall fescue	medium	4.5	2.4	0.4	0.6	1.0	-	-	1.1	1.0	1.0
Summer seeded brassicas	medium	3.0	-	-	-	-	-	-	0.9	0.4	0.4

*Based on an animal unit consuming 25 pounds of dry matter forage per day with 70 percent of pasture utilized. Note: Actual acreage will depend on pasture yield, dry matter intake, and efficiency of pasture utilization.

Example: Step 1 determined that the herd contains 50 AU. The herd will be grazing medium-producing orchardgrass and white clover pasture.

May (0.7 acres/AU) X 50 AU = 35 acres
June (0.7 acres/AU) X 50 AU = 35 acres
July (1.2 acres/AU) X 50 AU = 60 acres
Aug (1.2 acres/AU) X 50 AU = 60 acres
Sept (1.2 acres/AU) X 50 AU = 60 acres
Oct (6.2 acres/AU) X 50 AU = 310 acres

For the example herd, 60 acres will be sufficient for much of the year. However, there will be excess forage in the spring, and the herd will need to receive supplemental forage in October. During this deficit period in the fall, stockpiled tall fescue or brassicas could be utilized.

Step 3. Estimate how large each paddock should be.

Paddock size depends on the AU of the herd, the amount of available pasture at the beginning of grazing, and the desired grazing period. Available pasture is pasture present in a paddock at the start of grazing minus the amount present when the animals are removed from the paddock. Depending on plant density, typical Pennsylvania pastures have about 300 pounds of pasture for each inch of height. If a herd is turned into a paddock when the pasture is 7 inches tall and taken

off when the pasture is 4 inches tall, approximately 900 to 1000 pounds of pasture are available. Table 3 provides some suggested paddock sizes (acres per AU) for rotational grazing.

Table 3. Paddock sizes based on grazing period and available pasture.

Grazing period (days)	% Pasture utilization*	Available Pasture (lb Dry Matter per Acre)		
		750	1000	1500
		Acres/AU		
*These are estimates of the percentage of pasture actually consumed. Utilization is usually improved as grazing pressure is increased.				
1	80	0.042	0.031	0.021
2	75	0.089	0.067	0.044
3	75	0.133	0.100	0.067
4	70	0.190	0.143	0.095
5	65	0.256	0.192	0.128

To calculate paddock size, multiply the suggested acres per AU by the AU in the herd.

Example: The herd will graze each paddock for 3 days when 1000 pounds of pasture are available.

0.1 acre/AU × 50 AU = 5 acres in each paddock

Use of temporary interior fences is recommended for flexibility.

STEP 4. Estimate the number of paddocks needed.

The number of paddocks needed for a rotational grazing system will depend on the number of days the animals graze in a paddock and the maximum summer rest period needed. Rest periods should be based on the growth rate of the pasture, which will vary with the season and weather conditions (Table 4).

Table 4. Paddock rest periods for rotational grazing systems.

Season	Weather Conditions	Growth Rate	Rest Period
Spring	Cool, moist	Fast	10–14 days
Spring	Warm, dry	Medium	14–20 days
Summer	Hot, moist	Slow	30–35 days
Summer	Hot, dry	Very slow	40–60 days

Since growth rate is affected by soil productivity and fertility levels, even within a pasture system, rest periods will vary. The best way to manage this situation is to have a flexible rotational scheme, moving animals to those paddocks that have reached their optimum available

pasture. Animals should be kept off a particular paddock until it reaches its desired optimum available pasture.

Spring management usually involves diverting some of the paddocks out of the rotation scheme and using the forage for hay or silage. This effectively shortens the rest period between grazings and improves utilization of rapid spring growth.

(Maximum days rest divided by number of days grazing) + 1 = paddock number

Example: The herd will graze each paddock for 3 days, and the maximum rest period between grazings will be 35 days.

(35 days rest divided by 3 days grazing) + 1 = 13 paddocks

Species and class of grazing animal may determine the grazing period. Since lactating dairy cows need consistent forage quality, the grazing period for them may be anywhere from .5 to 2 days. However, beef cows, brood ewes, and most other ruminants do not need consistent forage quality, so a grazing period of 3 or more days may suffice.

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http://extension.psu.edu/plants/crops/forages/pastures/management/four-steps-to-rotational-grazing

Strategies for Extending the Grazing Season

Several strategies can be employed to supply forage into the fall or early winter and effectively extend the grazing season by 60 to 90 days, thus reducing the need for stored feeds.

These strategies can be categorized into two major groups: 1) stockpiling (conserving cool-season forages in late summer for use in the fall and winter), or 2) utilizing forage crops that continue to grow in the fall and early winter.

Stockpiling

Not all cool-season species are adapted to stockpiling. Most species reduce their growth in the fall because of shorter day lengths and/or they lose their leaves (quality) after being frosted. Tall fescue and birdsfoot trefoil are two forage species which are suited to stockpile management because they continue to grow in the fall and do not lose leaves as readily as other cool-season species do after frost.

Tall Fescue

Tall fescue is a deep-rooted, long-lived, sod-forming grass that spreads by short underground stems called rhizomes. It is drought resistant and will maintain itself under rather limited fertility conditions. Animals readily graze tall fescue during the fall, but show some reluctance to graze it during the summer months of July and August. Some of this reduced summer palatability, which results in poor animal performance, is associated with the presence of a fungus in the plant (endophytic). Endophyte-free varieties are now available and are recommended for new seedings. Tall fescue is the best adapted cool-season grass for stockpiling (Table 1).

Table 1. Yield of grasses during three summer periods in Pennsylvania.

Species	Early Summer	Mid-summer	Fall
	----- tons/acre[a] -----		
Tall fescue	3.9	1.2	1.3
Reed canarygrass	3.8	0.8	0.7
Orchardgrass	3.1	1.2	0.9

[a] All grasses received 225 lb N/acre/year.

Table 1. Yield of grasses during three summer periods in Pennsylvania.

Species	Early Summer	Mid-summer	Fall
	----- tons/acre[a] -----		
Smooth bromegrass	3.5	0.8	0.6
Timothy	3.8	0.5	0.5
Perennial ryegrass	2.5	0.4	0.5

Adapted Varieties

Numerous tall fescue varieties are being marketed in Pennsylvania, however, only endophyte-free varieties should be selected when seedings are to be grazed. 'Johnstone,' 'Festorina,' and 'Barcel' tall fescue varieties have performed well in Penn State studies. They are endophyte-free and of high quality.

Grazing Management

Tall fescue can be part of a forage program but should not be all of it. Legumes with tall fescue improve animal performance and increase forage production during the summer. Tall fescue will withstand closer grazing and more abuse than most cool-season grasses. But it can be over-grazed to the point that vigor and production are reduced. Don't graze closer than three or four inches, and allow at least 30 days in mid-summer for the tall fescue to recover.

To stockpile tall fescue, don't graze it from mid- or late August through mid-October. Cattle and sheep perform less than optimally on it during this period. Fertilize with 50 lb nitrogen/acre and allow the growth to accumulate for use in the fall or winter.

Stockpiling and nitrogen fertilizer allow accumulation of forage, however, this results in low tiller density, increased winter injury, and slow recovery in the spring (Table 2).

Table 2. Ground cover of five cool-season grasses harvested three, five, or eight times per year.

N level	Harvests per year[a]	Species				
		Kentucky Bluegrass	Tall Fescue	Orchardgrass	Smooth Broomegrass	Timothy
lb/yr		----- % ground cover -----				

[a] Three harvests per year simulates a stockpile management system.

Table 2. Ground cover of five cool-season grasses harvested three, five, or eight times per year.

N level	Harvests per year[a]	Species				
		Kentucky Bluegrass	Tall Fescue	Orchardgrass	Smooth Broomegrass	Timothy
lb/yr		----- % ground cover -----				
	3	55	95	90	65	50
150	5	85	98	95	25	85
	8	88	98	100	15	55
	3	10	12	60	55	20
300	5	55	80	85	50	35
	8	80	100	100	25	55

The most important thing to remember is that while stockpiling can provide large quantities of herbage for late fall and early winter grazing, it will also delay recovery in the spring. At modest rates of nitrogen fertilization, stands of tall fescue will not deteriorate as fast as other cool-season grasses under stockpiling.

For more information about tall fescue, refer to Tall Fescue, Penn State Agronomy Facts 28.

Birdsfoot Trefoil

Birdsfoot trefoil is a perennial legume adapted to production on poorly drained, low pH soils. It can reseed itself, is resistant to *Phytophthora* root rot and numerous alfalfa insects, responds well to fertilization, and does not cause bloat in animals. These characteristics have expanded its use in the northern United States and southern Canada where the production of other forage legumes is limited. Birdsfoot trefoil is well suited for stockpiling since it holds its leaves at maturity and after frost, thus maintaining a relatively high level of quality.

Adapted Varieties

About 25 varieties of birdsfoot trefoil are available in the United States and Canada. Birdsfoot trefoil varieties are generally characterized by growth habit into two types, Empire and European. Both types are referred to as “broadleaf” trefoils.

Empire-type birdsfoot trefoils are better adapted for grazing situations than the European types because they have fine stems, prostrate growth, and indeterminate growth habit. The Empire

types grow slower during establishment and regrow more slowly following harvest than the European types. ‘Dawn’ and ‘Empire’ are high-yielding, Empire-type varieties that have performed well in Pennsylvania tests.

European-type birdsfoot trefoils are better adapted to hay production because they are more erect, establish faster, and regrow faster after harvest than the Empire type.

Grazing Management

To stockpile birdsfoot trefoil, avoid grazing between September 1 and the first killing frost. This period is needed to accumulate root reserves that improve winter survival and growth the following spring. The forage that accumulates during the stockpiling period can be grazed anytime after a killing frost.

Refer to Birdsfoot Trefoil, Penn State Agronomy Facts 20, for more information about production and management of this forage species.

Fall Growing Forage Crops

The growth of some forage species is not as adversely affected by cooler fall weather and shorter day lengths as are many cool-season forages. The species which seem to grow best in the fall are tall fescue, prairie grass, perennial ryegrass, and certain brassica crops. These species can provide a valuable feed supply for extending the grazing season.

Prairie Grass

Prairie grass is a tall growing perennial grass that is suited to well drained soils with medium to high fertility levels and a pH of 6.0 or greater. It is a type of bromegrass, but is different from smooth bromegrass in that it does not have rhizomes and it produces seed heads in each growth period, especially during the summer. Herbage and immature seedheads of prairie grass are highly palatable. It is an excellent grass for providing forage during droughts and for extending the grazing season well into the fall in Pennsylvania.

Fall harvesting (grazing) improves the winter persistence of prairie grass. It will persist for four to six years in Pennsylvania if properly managed. Forage quality of prairie grass compares well with other cool-season grasses but is more palatable.

Adapted Varieties

‘Matua’ is the only cultivar of prairie grass that is currently sold in the United States. This variety was developed under New Zealand grazing conditions and has been very productive in Pennsylvania. Other prairie grass varieties are being evaluated for persistence and productivity by the USDA-Pasture Laboratory and Penn State; however, none of these varieties is marketed commercially in Pennsylvania at this time.

Grazing Management

Prairie grass is an ideal grass for grazing systems because of its potential for earlier spring grazing and its fall growth can effectively extend the grazing season by as much as two months over traditional cool-season grass species. Fall yields of nearly 3.5 tons/acre are possible. In addition, because seed heads are palatable, it is not necessary to mow them to maintain animal intake as may be needed with other grasses. Yields of nearly 7 tons/acre have been achieved when harvesting prairie grass for silage.

Prairie grass should not be cut or grazed below a 3-inch stubble height because regrowth energy reserves and buds for plant regrowth are contained in this portion of the plant.

In established prairie grass stands, delaying the first spring grazing will reduce recovery rate and lower the yield potential of the next cutting. Under normal weather conditions, about 25 to 30 days of regrowth is sufficient between harvests. This period is a good balance between yield and quality of prairie grass. Generally, during this time, new shoots have developed at the base of the plant and harvesting or grazing will allow more light to reach the shoots and to stimulate their growth. An approximate 50-day growth period in mid-summer will allow the prairie grass seed heads to mature and drop seed during August which, in turn, will thicken the stand the following year.

Prairie grass persists best when managed so that monthly harvests are made during the fall; spring yield and shoot density increase when multiple harvests are made in the fall. Harvesting only once in the fall (November) has caused 98 percent of the basal shoots (source for growth the following spring) to winter kill. However, when prairie grass was harvested or grazed three times during the fall only 35 percent of the basal shoots were winter killed. Compromise is needed with regard to fall harvesting because late fall grazing reduces slightly prairie grass vigor the following spring and restricts early spring grazing.

Adequate nitrogen fertilization is essential for maximizing prairie grass growth in the fall. Nitrogen applications of 50 lb/acre are recommended after each harvest and in early fall.

For more information about the production and management of prairie grass, refer to Prairie Grass, Penn State Agronomy Facts 39.

Forage Brassicas

Brassicas are annual crops which continue to grow during the fall and into the winter. They are highly productive and digestible and contain relatively high levels of crude protein. They can be grazed 80 to 150 days after seeding, depending on the species and weather (Table 3). In addition, some varieties lend themselves to stockpiling.

Table 3. Characteristics and seeding rate of brassica forage crops.

Crop	Plant part consumed	Seeding to harvest (days)	Regrows after harvest	Seeding rate (lbs/acre)
Kale	herbage	150 to 180[a]	no[a]	3.5 to 4
Rape	herbage	80 to 90	yes	3.5 to 4
Swede	herbage and root	150 to 180	no	1.5 to 2
Turnip	herbage and root	80 to 90	yes	1.5 to 2

[a]An exception is the stemless variety 'Premier' which is ready for harvest 80 to 90 days after seeding and will regrow after harvest if not grazed below three to four inches.

Species and Varieties

Several brassica species can provide forage for grazing during the fall. These include:

Kale—The stemless variety 'Premier' has consistently survived winters in central Pennsylvania, whereas other varieties of kale usually have winter-killed in December.

Rape—Growth of rape slows or ceases at maturity until leaves senesce and die. Varieties differ in the time this occurs. For instance, 'Rangi' rape retains its leaves longer than most varieties, which makes it more suitable for stockpiling and winter grazing than other rape varieties.

Swede—The variety 'Calder' has been cold hardy in central Pennsylvania and thus ideal for stockpiling for late- fall or early-winter grazing. However, in general, all swede varieties are recommended for late-fall grazing.

Turnip or Turnip Hybrids—Pennsylvania studies have shown that 'Forage Star' turnip is more cold tolerant and retains its leaves longer in the fall than other turnip varieties. Turnip can accumulate dry matter in October as fast as field corn does in August. Growing "out of season" (October and November) makes turnip a valuable crop for late fall grazing.

Grazing Management

Proper grazing management is important to optimize the true potential of these crops. Strip grazing small areas of brassicas provides the most efficient utilization.

Rape is more easily managed for multiple (generally more than two) grazings than are the other brassica species. Approximately six to ten inches of stubble should remain after the first grazing of rape; this practice promotes rapid regrowth. Regrowth of rape may be grazed at four-week intervals. On the final grazing, the plants should be grazed close to ground level.

When turnips are grazed twice, the first grazing should remove only their tops. Turnip regrowth is initiated at the top of the root, so this part of the plant should not be removed until the second and final grazing. Like rape, regrowth of turnips can be sufficient to graze within four weeks of the first grazing.

Diseases of brassicas are generally not a problem until the plants near maturity. Stockpiling should not be attempted in fields where brassicas have high levels of foliar disease at maturity. Research has shown yield reductions of 40 percent when disease infected brassica crops were stockpiled for 45 days. Generally, 'Forage Star' turnip and 'Rangi' rape are better suited for stockpiling than other varieties because of lower disease infestation. To reduce club root rot occurrence, brassicas should not be grown on the same field for more than two consecutive years.

Yield and Nutritional Value

Dry matter digestibility at maturity generally exceeds 90 percent for all plant parts except kale stems. Unlike perennial forage crops, the dry matter digestibility of brassicas does not decrease markedly with increasing plant maturity. This characteristic makes them ideal for stockpiling. However, ruminant diets should not contain more than 75 percent brassica forage because the fiber content is too low for maintenance of proper rumen activity. With their high digestibility and low fiber content, brassicas actually should be considered as "concentrates" rather than "forage" in nutritional planning for livestock.

For more information about brassicas, refer to Use of Brassica Crops to Extend the Grazing Season, Penn State Agronomy Facts 33.

Small Grains

The use of winter cereal crops such as wheat, barley, rye, or triticale can provide fall or early winter grazing opportunities. However, certain management practices need to be modified from what is normally done for grain production. When small grains are to be used for grazing, plant them three to four weeks earlier than for grain production. Increase the seeding rate to 3 bu/acre and apply nitrogen at the rate of 40 lb/acre at planting time.

If the small grains are being planted only for pasture (with no subsequent grain harvest), there may be some benefit to mixing small grains species. This has been beneficial in the southeast United States, where small grains pastures are quite common. Mixing species of rye, wheat, barley, or triticale can help extend the grazing period and reduce the tendency for a strong peak growth period in the spring.

Grazing Management

With adequate fall moisture, grazing should be available from October through December and then again in early spring. One acre of properly fertilized and managed small grains should support one animal unit (1,000 lb animal) on a limited grazing basis.

Stocking rate and time of grazing will be somewhat determined by the intended use of the crop. If you are planning to take a silage or grain harvest, grazing should only be moderate. Heavy grazing can reduce grain yields. Moderate grazing in the fall will not result in significant silage or grain losses provided that moisture and soil fertility are adequate. In fact, fall pasturing can be beneficial where the small grain was seeded early and has made excessive growth.

Spring grazing may be started when growth resumes. If a grain or silage crop is to be harvested, grazing should be discontinued when the plants start to grow erect, just before jointing (growth stage 6). Small grains plants will be injured by grazing at any time after their growing points are above the ground.

Temporary electric fencing should provide a practical way to manage these pastures. Although small grains can be continuously grazed, a rotational or strip grazing practice may allow a higher carrying capacity (less wastage from trampling).

Small grains pasture is lush, high in protein, and low in fiber during most of the fall grazing period. Crude protein levels normally range from 15 percent to 34 percent of dry matter, making this forage an excellent protein supplement for many classes of livestock.

Animal Health Precautions

Grass tetany can occur when small grains forage is grazed by cows about to calve or those which have recently calved. This usually occurs in the spring. It is recommended that animal diets be supplemented with a mineral mix containing magnesium. Lactating dairy cows that are grazing small grain pasture should receive an additional 1 ounce of magnesium oxide/cow/day.

There is a risk of nitrate poisoning if animals graze rapidly growing and recently fertilized small grains pasture. Avoid this situation by applying nitrogen fertilizer at planting time or well before the intended grazing period.

Although rare, bloat may also be a health risk when animals graze small grains. This most likely will occur when animals are first turned onto pasture in early spring and gorge themselves with the lush forage. Bloat can be prevented by feeding some stored forage just before turning the animals onto the pasture.

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http://extension.psu.edu/plants/crops/forages/pastures/plants/strategies-for-extending-the-grazing-season