The Grazier

Strategies for pasture improvement

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For top livestock performance and profitability, pastures should be maintained in a healthy, vigorous condition. Pasture improvement can be broadly divided into four management areas: fertility, species diversification, weed control and general grazing management.

Pasture fertility

Individual pasture species often have different fertility requirements for optimal production. Fertility management can be fairly straightforward with monoculture pastures but can become more challenging in mixed pastures.

In a mixed pasture the fertility level must be adequate to support the desired species with the highest fertility requirement in the mixture. In some cases the native fertility of the field may be adequate for all species present, but fertility is frequently less than par for many desired species.

Most cool-season grasses will persist and be fairly productive at soil pH of 5.5 and P_1 soil test of 20 pounds (lb.) available phosphorous (P) per acre, while most legumes will respond dramatically to higher fertility levels (see Table 1). Using liming and fertilization to alter the environment for legumes that fix nitrogen (N) usually is cost-effective and, in the long run, as productive as and less expensive than relying on grass pastures with added nitrogen.

In a cool-season-grass-based pasture, a well-established legume stand that makes up 40%-60% of the annual forage production will yield as much forage dry matter as the grass alone receiving 100-200 units of nitrogen. Appropriate pH, phosphorous and potassium (K) levels are essential to achieve high yields in legume-based pastures.

If stock are managed to return most of their manure to the pasture and not to a few concentration points, the fertility status of a pasture can be maintained with minimal annual maintenance input. Unlike nitrogen, phosphorous is very stable in the soil and is lost primarily through direct erosion of the soil particles. Removal of phosphorous in animal product is significant in dairy operations, but it is very small in most beef herds.

In sandy soils, potassium may leach out of the soil, but it is fairly stable in most silt- and clay-dominant soils.

In a grass-legume pasture, there may be little need for nitrogen fertilization, but liming and application of phosphorous and potassium may be needed along with sulfur (S), boron (B) or other micronutrients, depending upon location. Soil testing is a key tool for determining the basic level of nutrients in the soil and is an appropriate starting point for soil-nutrient management.

Forage-tissue testing may be used as a diagnostic tool for fine-tuning management. Due to the nutrient-redistribution patterns of grazing cattle, soil sampling in pastures is not as simple as in crop fields. Avoid testing within 100 feet (ft.) of water, shade or points on the landscape where animals tend to camp due to air drainage or shelter.

Sample the landscape in segments of similar topography and aspect to get a true picture of the nutrient status of the pasture. After the fertility status of the pasture has been mapped, fertilize accordingly. If the budget has limited dollars available for fertilizer, target the lowest-nutrient areas first.

Plant response to fertility is a diminishing-curve response. The lower on the nutrient-availability curve a particular area of the pasture is, the greater response per unit of applied lime, phosphorous or potassium.

Fertilization should be considered as a tool to accomplish a particular set of objectives. If annual fertilization is required to accomplish that objective, then do it. If fertilization is not needed to achieve particular objectives, then don't. Usually some level of fertilizer input is appropriate for tame pastures, but it will depend upon individual farm conditions and goals. The main point is to know why fertilization is being done and what the expected outcomes are, both biological and financial.

The nitrogen-fertilizer recommendations for grazing used in many states are actually based on yield-response functions derived from mechanically harvested swards. In swards harvested for hay the plants are allowed to grow to a more-advanced stage of maturity relative to when they are typically grazed.

The mown plant has a greater period of growth to utilize nitrogen fertilizer, and the nitrogen losses are typically lower under mown swards than grazed swards. The bottom line is that the efficiency of nitrogen applied to pasture is not nearly as great as might be thought.

The yield of forage dry matter in pastures per unit of applied nitrogen may be only about one-third of that realized in hay swards. Frequently the nitrogen cost associated with producing one more grazing day is more than what it would have cost to feed the same animal hay for that day.

This is not to say there is no place for nitrogen fertilizer in a pasture program. Targeted use of nitrogen to accomplish specific goals is well-justified. Consider a typical nitrogen-fertilizer program for a grass-dominant pasture. A common recommendation would be 60-80 units in early spring and 40 units in late summer. In spring, forage supply in the pasture is generally excessive, and we end up harvesting the surplus as hay or clipping the pasture. Why add to the problem by adding that early-spring nitrogen?

An alternative approach may be to graze for a month, clip emerging heads early, and

Table 1. Minimum soil-test levels for legume establishment and maintenance.

Legume species	pH	P_1	K
Alfalfa	6.5	30	300
Red clover	6.0	25	250
White clover	5.5	25	250
Bird's-foot trefoil	5.5	20	225
Lespedeza	5.0	20	200

apply 40 units of nitrogen to stimulate post-heading tillering. The result is a more-even distribution of yield through spring and early summer, higher-quality forage in early summer and less clipping — all for less money.

The forage dry-matter yield response per unit of nitrogen to the later 40 units may not be as great as it would have been for the earlier application, but more of the yield will be leaf and less stem for the application after heading. The economic value of a pound of forage in summer is greater than that of a pound in the spring.

Another scenario might be the use of nitrogen fertilizer on a quarter of the pasture area to stimulate early growth and use of grass-legume mixes for the main part of the grazing season. Use of 40-60 units of nitrogen on a grass-legume pasture in the spring is not detrimental to the legume if the grass canopy is being grazed off during the early-growth flush. Applying the same amount of nitrogen to a grass-legume mix in the spring and allowing it to grow to hay stage is usually fatal for legumes.

If, for some reason, a pasture is harvested and the hay or silage fed at another location, maintenance fertilization will be necessary. Each ton of grass-legume forage will contain about 12 lb. of phosphorus oxide (P_2O_5) and 40-60 lb. of potassium oxide (K_2O). Similarly, if purchased hay is fed on a pasture, the phosphorous and potassium contained in the hay will contribute equally to the fertility status of that pasture. Mechanical harvest is the primary route of nutrient removal from pasture ecosystems. Feeding hay back on the same fields from which it was harvested at least keeps the nutrients in the same general area.

Pasture species diversification

Changing the species composition of a pasture can result in increased animal output for several reasons. The one most often cited by the seed industry is that modern forage varieties are more productive or higher quality or more persistent than older varieties. Of these three factors, persistence may be of the greatest economic importance due to the high cost and land-erosion potential of reseeding pastures.

If a new variety is in fact superior to an existing variety and is at least as persistent, adding the new variety to the pasture may be cost-effective. If a new variety is less persistent than the existing pasture, the improved annual animal performance or production must be significantly better than with the older variety.

SHAUNA ROSE HERMEL PHOTOS (COURTESY *BEEF* MAGAZINE)

By adding legumes with more horizontal leaves or grasses with softer leaves, another layer of solar-energy traps covers every acre.

A second reason for diversification of pasture species is that a mixed sward makes a better solar collector than a monoculture. A basic goal of grazing management is to harvest as much solar energy per unit area as possible to maximize the production of quality livestock feed. Grass leaves are typically vertical or steeply inclined, allowing sunlight to penetrate deep into the canopy. Much sunlight can reach the soil, and the food potential of that sunlight is wasted. By adding legumes with more horizontal leaves or grasses with softer leaves, another layer of solar-energy traps covers every acre.

Thirdly, because different species have different growth requirements, some plants grow better at one time of the year than do others. Cool-season and warm-season grasses are the most obvious contrast. Through diversification a pasture is more likely to have some plants green and growing, producing quality livestock feed on more days of the year. This goes back to the basic premise of capturing more solar energy per acre.

There are times when complete renovation of a pasture and reseeding are appropriate strategies, but more often the existing pasture will respond well to change in management. The following discussion focuses on the improvement of existing pastures by introducing other species into the existing sward. Introduction of legumes into grass-dominant pastures is probably the most common form of species diversification; however, cool- or warm-season grasses can be introduced into grass swards.

Controlling existing vegetation

For new grass or legume seedlings to become established in grass sods, the existing vegetation must be controlled. Competition exists both above and below the ground and should be considered at both levels. Aboveground competition is for physical growth space and sunlight, while belowground competition is for water and soil nutrients.

The existing sod should be managed with consideration for both of these zones of competition. Simply keeping the grass short may not be adequate if a vigorous root system still exists belowground. Forward planning to weaken the existing root system is a critical management component to legume establishment. Existing vegetation may be managed through grazing, mowing, tillage, burning, chemical application or a combination of practices.

■ ***Grazing.*** If only grazing is to be used for vegetation control, timing is critical. Assuming a spring legume interseeding, heavy grazing pressure should be applied the previous fall and through winter if necessary. The strategy is to weaken the root system in order to reduce root vigor and competition for water the following spring. Grazing a vigorous sod only in the spring may be adequate for reducing aboveground competition for sunlight but may be totally inadequate for minimizing belowground competition.

Grazing pressure should be maintained in the spring until the legume seedlings have emerged and produced three or four true leaves. Once legumes have reached this

stage, rotational grazing should be employed to periodically top-graze the sward to keep the canopy fairly open, allowing sunlight to reach the legume seedlings.

Grazing management for establishing a warm-season grass into an existing cool-season grass is very similar to management for legume establishment. Newly establishing grasses are not quite as sensitive to grazing pressure as are new legumes because the growing point for grasses is located at the base of the plant, while the legume's growing point is near the top of the plant.

Soil moisture conditions should be closely monitored in grazing situations. Cattle should be removed from the pasture if soil moisture conditions are such that the cattle hooves are making more than a 1-inch (in.) imprint in the soil. The damage to new seedling stands caused by grazing when the soil is too wet usually outweighs the stand reduction that may occur if the grass is allowed to become a little more competitive.

Cool-season grasses are more effectively established in an interseeding if the seeding is done in late summer or early fall. Thus, severe grazing through mid-summer is required to prepare the sward for a cool-season grass seeding. Late summer grass interseedings are especially sensitive to drought conditions, and fall grazing should be monitored closely if soil moisture is short.

■ ***Mowing.*** As with grazing, mowing as a tool to control existing sod should begin the fall prior to seeding. Usually, mowing in October will cause the grass to use stored carbohydrates and reduce spring growth rate. In the spring, two or three mowings may be required to minimize spring competition. Each subsequent mowing in the spring should leave a little taller residual. Mowing for hay when the grass is in the boot stage will usually result in good legume regrowth in the summer.

■ ***Tillage.*** In very dense sods, such as well-established smooth bromegrass or tall fescue, light tillage may be helpful in ensuring legume establishment. Disking with the gangs set at a minimal angle will provide adequate disturbance in most cases. If soil conditions are good, a field cultivator can be used effectively, but a finishing disk generally gives best results. Disturbing as little as 25% of the sod cover can greatly increase the success rate of interseeding. For late-summer grass interseeding, a light tillage will greatly increase the likelihood of new grass establishment. Late-summer thunderstorms can provide good grass seed coverage in the disturbed sod and result in rapid germination and emergence.

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■ ***Burning.*** An early-spring burn just after the cool-season grass begins spring growth can provide very good spring vegetation control. Burning too early, prior to green-up, may result in more-vigorous grass growth and actually increase competition. Attempting to burn later may result in inadequate burn as too much new green growth prevents the fire from effectively clearing the field.

As with any use of fire as a tool on pasture or rangeland, make sure you have a plan for controlling the fire and providing rapid fire-control response if the fire gets out of control. One other caution: Weed infestations can occur following a burn of old, established pastures. Be prepared to apply weed-control measures if necessary.

■ ***Chemical control.*** Broad-spectrum herbicides such as Gramoxone® and Roundup® can be used for chemical renovation of pastures. Existing sods either may be suppressed temporarily by using lower rates of herbicide or may be virtually eliminated by using higher rates. Chemical suppression of the existing sod is particularly useful in dry years. Reduction of the evapotranspiration (ET) rate often will determine the success or failure of legume interseedings when moisture is limiting.

A single application of 1-1.5 quarts (qt.) of Gramoxone or 1 qt. of Roundup shortly after spring green-up will usually provide adequate vegetation suppression for legume establishment without eliminating the existing grass stand. Spraying and using a no-till drill provides a very effective combination.

Seeding effectively

In order for seeds to germinate, they must be in good contact with the soil or other growth media, such as dung piles or decaying plant material. Soil-seed contact can be achieved by several methods.

■ ***Frost-seeding.*** Legume seeds are typically fairly dense and will readily work into the soil given several freeze-thaw cycles. The limiting factor regarding what species can be successfully frost-seeded is tolerance to cold weather while in the seedling stage. Red and white clovers can be frost-seeded with very consistent success due to their high seedling vigor and frost tolerance in the seedling stage. Although quite susceptible to freezing in the cotyledon stage, these clover species become very hardy after the emergence of the first trifoliate leaf.

Lespedeza can be frost-seeded successfully because the soil temperature required for germination is substantially higher than for cool-season legumes. Lespedeza generally does not germinate until the risk of a late frost has passed. Alfalfa and bird's-foot trefoil are less tolerant of cold temperatures in the seedling stage and are thus more susceptible to stand

failure when frost-seeded. Seedling vigor also is somewhat lower than for red clover, and both are much less shade-tolerant than is red clover.

Check with your local Extension agent to determine when the most successful frost-seeding will occur in your area. The seed must come in contact with the soil for frost-seeding to be effective. For this reason, one of the vegetation-control methods previously described must be implemented. Spring grazing will allow some of the seed to be trampled into the soil, if soil moisture is not excessive.

If chemical suppression of the sod is to be used, it should be done the previous fall. Waiting in the spring until green growth has begun to apply herbicides makes frost-seeding much less effective. Pasture burning to retard cool-season-grass growth in the spring generally occurs too late as legume seedlings should already be up and growing by the optimum fire date.

Broadcast-seeding immediately into the ash bed following a burn also has been reported to be successful. Sod disturbance combined with frost-seeding works well as the roughened soil surface is more conducive to good seed-soil contact due to freeze-thaw activity.

If pastures are to be harrowed for manure dispersion, broadcast-seeding at the same time often gives better results than simply frost-seeding, particularly with bird's-foot trefoil and alfalfa. If a harrow is used, seeding is usually delayed until later in the spring and after the risk of late frost is lessened. Success rate is generally high if slight sod disturbance is combined with broadcast-seeding and harrowing.

■ ***No-till drilling.*** A no-till drill can be used to establish any of the common legumes in combination with any of the sod-suppression methods already described. Seeding date can be delayed until all risk of frost has passed. The drill ensures good seed-soil contact and emergence is typically much quicker and more uniform than with broadcast-seeding methods. Crops with higher seed price, such as alfalfa and bird's-foot trefoil, can be seeded with much greater confidence of success when using a drill. Optimum drilling dates can be obtained by consulting your local Extension agent.

Late-summer grass interseedings are usually very successful with no-till drilling. The greatest cause for stand failure, however, is drilling too deep. When running grass seed in late summer, some seed should be visible on the soil surface behind the drill to ensure seed placement is not too deep.

Weed control

Weeds are almost always a symptom of inappropriate fertility or grazing management. Weeds do not crowd out pasture plants. The pasture plants are thinned either through low fertility or improper grazing, and weeds take their place. A healthy, densely growing, vigorous pasture is the best weed-control strategy available. Sometimes, however, we must address the symptom as we try to cure the problem.

For nonwoody weeds — such as pigweed, lamb's-quarter, ragweed and others — heavy, concentrated grazing is often the most economical control strategy. Following grazing with clipping will often clean up a pasture. There are some biological controls, such as thistle head weevils and a virus in roses, that will greatly reduce the infestation of these weeds. These are usually effective in the long haul but may not give the quick fix for which some managers are looking. Chemical control should generally be used only for those weeds that are truly unpalatable, such as thistles and multiflora rose.

One of the greatest concerns about chemical weed control among pasture managers is the loss of legumes from the pasture if broadleaf weeds, especially thistles, are sprayed. Basically all herbicides that effectively control broadleaf weeds and brush also are very effective for killing legumes. If alfalfa is the primary legume in the pasture, the stand is likely to be eliminated, and reseeding will be required after the weeds have been eliminated.

Allowing pastures to rest at least 45 days in mid-summer will allow clovers and bird's-foot trefoil to set seed. Spraying in the fall while new thistles are in the rosette stage is an effective means of control. If mature legume plants are killed by the herbicide, a seed crop has been produced to allow re-establishment the following spring. Often rosettes can be sprayed again in the spring

before new legume seedlings have emerged.

Broadleaf weeds such as ironweed and goldenrod can be controlled with a sponge or rope-wick applicator when they are above the height of the desirable pasture. Plan to apply herbicide prior to bloom stage of perennial weeds for good control. Follow all grazing restrictions on the label whenever using a herbicide on pastures.

With any form of weed control, timing is critical. Many weeds have a narrow window of opportunity for control. For annual weed management, the goal is prevention of a new seed crop. Perennial weeds must either be killed or weakened to the point that they are no longer a problem.

Grazing management for pasture health

The best strategy for improving pastures is to implement a well-planned grazing-management system that maintains proper stocking rate on the pasture and provides a rest period for individual plants to maintain their vigor. A planned grazing program will help maintain nitrogen-fixing legumes in the pasture to supply free nitrogen into the system. Manure distribution also can be managed to minimize the needs for purchasing additional phosphorous and potassium.

The healthy pasture will better compete to prevent weed seedlings from establishing in open spots where sunshine is reaching the soil surface.

Even though this discussion has focused on fertility, diversification, and weed control as separate components, they can be managed most efficiently if considered from the whole pasture-livestock-system perspective. AJ

Editor's note: This information was taken from the Missouri Agricultural Experiment Station's *Forage Systems Update* newsletter. That article originally was written as a new chapter for the 1999 edition of the *Missouri Grazing Manual*, which will be available this month. If you're interested in purchasing a copy of the manual, contact the Missouri Forage and Grassland Council by calling (573) 499-0886 or via e-mail at mfgc@gte.net.