

Incorporation of Legumes into Forage Systems

Introduction

In South Carolina, the livestock industry is one of the most important agricultural activities. Most livestock systems are cow-calf operations and use perennial grasses (e.g., bermudagrass, tall fescue) as the basis of their forage systems. Perennial grasses rely on inorganic nitrogen (N) fertilizer to support forage production and animal performance. Forage legumes are a viable alternative to help reduce inorganic N fertilizer input because they can capture atmospheric nitrogen and convert it into compounds that plants can use. Legumes also improve animal performance, nutrient cycling, and sustainability of forage-livestock systems.



Background information

In association with soil bacteria, legumes can convert atmospheric nitrogen into organic forms to be available in the soil. There are annual and perennial species that can be used in South Carolina. For this project, clovers and alfalfa are the legume options that can be implemented. Before planting legumes, it is essential to ensure that soil pH is at the proper range, soil fertility is addressed, and there is no herbicide residual in the soil which can lead to stand failure. It is essential to select adapted species and varieties to the location. Below you will find a summary of the available legume options for this project:

Alfalfa (*Medicago sativa*) is well-suited for hay, silage, baleage, and grazing. It requires well-drained, high-fertility soil and limits pest and disease pressure tolerance. Soil samples to a 15-inch depth should be collected by dividing the soil profile into two layers, surface (0 to 8 inches) and subsoil (8 to 15 inches), before planting to determine pH and fertility. Soil pH should range from 6.5 to 7.0 on the surface and 5.5 to 6 on the subsoil. Adequate boron (B) and molybdenum (Mo) levels are essential for nodule formation. If seeds purchased are not inoculated, inoculant (Type A, *Rhizobium meliloti*) should be applied according to label instructions. In



monoculture, the alfalfa seeding rate is 20 to 25 lbs of pure live seeds (PLS)/acre, and the seed depth is $\frac{1}{4}$ inch. More information can be found at Alfalfa Establishment and Management or by consulting your local Extension agent.

Clovers encompass several species and include annual, biannual, and perennial options. They are listed below:

White clover (*Trifolium repens*) is a cool-season perennial legume with a creeping growth habit and high grazing tolerance. It is often planted in a mixture with other cool-season perennial forages to extend the grazing season. The optimum soil pH is from 5.5 to 6.0, and proper soil fertility is necessary for establishment, persistence, and productivity. The recommended seeding rate is 2 to 3 lbs PLS/acre, and the planting window ranges from late August to early November. Seeding depth should not exceed $\frac{1}{4}$ to $\frac{1}{2}$ inches. A mature stand of white clover can fix from 40 to 100 lbs. N/acre. In a clover-containing system, improved forage yield and quality increase animal performance. Crude protein ranges from 15 to 25% with high digestibility. Rotational grazing is recommended with a stubble height of two to four inches.



Red clover (*Trifolium pratense*) is a biennial or short-lived perennial. It grows best on well-drained loamy soil with a pH of 6 or higher but can tolerate less well-drained and moderately acid soils. Red clover is typically used as a winter annual in the Deep South. It is productive for one year in central and southern Alabama and Georgia but may remain productive for longer in the other northern regions, for example, Tennessee and Mississippi (Hoveland et al., 1981b). The recommended seeding rate is 4 to 9 lbs PLS/acre, and seeding depth should be from $\frac{1}{4}$ to $\frac{1}{2}$ inch. Red clover is low-yielding in February through March compared with other legumes but has the potential to provide a substantial amount of good-quality forage in late spring and into the summer. It is quick growing, easily established, and provides a nitrogen source and high-yielding forage rich in protein. It can be planted with other forages, such as small grains, or overseeded into warm-season perennial grass sods.



Crimson clover (*Trifolium incarnatum*) is an annual with pubescent leaves, stems, and crimson

flowers. It requires well-drained soils and does not tolerate calcareous soils. Seeding depth should be from ¼ to ½ inch. It is the earliest producing of the clover species. The peak of production occurs from March through April. It can be used for grazing or hay production with a stubble height of 4 inches. Crude protein typically ranges from 16% to 20%, and digestibility can be up to 80%.

Arrowleaf clover (*Trifolium vesiculosum*) is an annual forage characterized by non-hairy, arrow-shaped leaves with a V white watermark. Its flower becomes tinged with pink or purple colors as it matures. It requires soil with a pH ranging from 5.8 to 6.5. The planting window is late September through early November. Recommended seeding rate is 5 to 10 lbs PLS/acre of inoculated seeds, and seeding depth is ¼ to ½ inch. Consider increasing the seeding rate depending on the percentage of the inert material in pre-inoculated seeds. If the information on the seed bag indicates that the inoculation date has expired, the seed should be reinoculated before planting. It can be planted with other cool-season forages. The production peak occurs in early April through May, and crude protein ranges from 16 to 20%. Recommended stubble height is 4 inches.

Ball clover (*Trifolium nigrescens*) is an annual forage with non-hairy leaflets, white flowers, and late maturity. It is widely adapted and can tolerate poorly drained soils. The recommended seeding rate is 2 to 3 lbs PLS/acre, and the depth should be from ¼ to ½ inch. The production peak ranges from late March through May and can be managed for reseeding under grazing. Crude protein ranges from 16 to 20%.

Berseem clover (*Trifolium alexandrinum*) has oblong leaflets and yellowish-white flowers and grows as an annual forage crop. The optimal soil pH is 7 or higher, and it is adapted to loam soils. Recommended seeding rate ranges from 12 to 8 and 2 to 2.5 lbs PLS/acre for broadcast and drilling, respectively. Seeding depth should be from ¼ to ½ inch. Recommended stubble height is 4 inches and can be used in a mixture with other cool-season forages.

Species	Soil pH	Seeding Rate (lbs PLS*/acre)	Seeding Depth	Row Spacing	Notes
Alfalfa	6 - 6.5 surface, 6 subsoil	12 to 15	¼ in	14-15 in	Perennial
White clover	5.5-6	2 to 3	¼ - ½ in	**	Perennial
Red clover	6	5 to 10	¼ - ½ in	**	Biennial
Crimson clover	6	15 to 20	¼ - ½ in	**	Annual
Arrowleaf clover	5.8-6.5	5 to 10	¼ - ½ in	**	Annual
Ball clover	**	2 to 3	¼ - ½ in	**	Annual
Berseem clover	> 6	Broadcast: 8 to 12 Drilling: 2 to 2.5	¼ - ½ in	**	Annual

*Pure live seed (PLS)

Mixtures

Using forage mixtures can be an option to balance forage production, quality, and distribution in forage systems which directly impact animal performance. When using mixtures, the seeding rates must be adjusted to account for the proportion of individual species and ensure proper establishment. Then, there will be management practice adjustments required aiming to guarantee proper production and use of resources. Within the scope of this practice, we will be addressing some general aspects of the following mixtures:

Alfalfa-bermudagrass mixture: alfalfa can be interseeded into well-established bermudagrass fields. Alfalfa and bermudagrass have similar drainage and fertility requirements, and alfalfa can supply organic N to the system. Soil testing and amendments should be conducted as described before the establishment of alfalfa in monoculture. Then, before interseeding alfalfa, the bermudagrass stand should be mowed or grazed to two inches of stubble height to remove excessive forage mass. The recommended seeding rate is 12 to 15 lbs PLS/acre, and row spacing is 14 to 15 inches. This row spacing allows for the proper establishment of alfalfa and the growth of both species without outcompeting one another.



It is recommended to test annually and apply P according to the soil reports. Potassium fertilization is critical for both species, and rates up to 300 lb/acre are recommended in split applications throughout the season. Boron and molybdenum should be applied yearly, and plant tissue analysis should be conducted as needed to check nutrient levels. The recommended stubble height is four inches, and the use of rotational grazing with a resting interval between 28 and 35 days should be applied. It is essential to scout fields frequently to check for insect and disease pressure from spring through fall and address issues as needed.



Cool-season annual forage mixtures can be a viable option to extend forage production with high-quality forages and decrease the hay feeding needs. Cool-season forage mixtures need to be adjusted to meet the nutritional and production needs of the different categories in a

livestock operation. Some of the most common clovers containing mixtures include small grains and ryegrass. There is a need to adjust the seeding rates for each species based on those used to avoid competition for resources that would compromise the establishment. The recommendation for those using mixtures for the first time is to start with up to four species mixtures to learn how to calibrate the drill for proper planting and to adjust the management practices as needed. Consult your local Extension agent for recommendations of the mixture (s) that fit your operation.

Implementation

Establishment

- Before establishment, soil testing should determine amendments needed for optimal soil pH and nutrient levels.
- For clovers, soil sampling to 4 to 6 inches depth is recommended. Soil pH should be at or over 6.
- For alfalfa, it is recommended to sample to a 15-inch depth by dividing the soil profile into two layers, the surface (0-8 inches) and sub-surface (8- 15 inches). Soil pH should range from 6.5 to 7 on the soil surface and over 6 at the sub-surface depth.
- Plan to apply lime four to eight months before the establishment. Follow soil laboratory report instructions for amendments needed and consult your local Extension agent with questions.
- Before planting, the area should be prepared accordingly to ensure proper establishment. When overseeding grass stands, preparation will require mowing or grazing heavily to 2-3" stubble just before planting.
- Weed pressure should be assessed as weeds compete for resources and interfere with the establishment of planted species. When selecting a site, it is crucial to know the history of herbicide use. Products with soil residual (such as Grazon Next) may last 12 to 18 months which can result in stunting, chlorosis, or death of the newly planted species. If the site was treated with long soil residual products within the past 18 months, a soil bioassay could be conducted. Consult your local Extension agent for recommendations and questions.
- The legume species should be chosen based on the adaptability to climate conditions of the location, growing areas of growing area, and disease and pest tolerance. Most legume seeds are pre-inoculated. If seeds are improperly stored or handled, the inoculant can be inactivated. Then, seeds should be reinoculated with the proper rhizobia strain immediately before planting. All plant nutrients and soil amendments should be applied based on soil testing within a year from the planting date (ideally within 8 months). Nutrient application rates and methods should be chosen based on extension recommendations and published research.

Management

Soil fertility needs to be addressed for forage legumes to establish and be maintained properly. Nitrogen fertilizer should be used only at planting, otherwise, it interferes with nodule formation for biological nitrogen fixation.

- **For clovers**, grazing should start when the canopy height is between 8 and 10 inches and recommended stubble height is four inches.
- **For alfalfa**, the recommended potassium rate is up to 300 lbs K/acre per year, which should be split and applied to match the timing when plants adequately use. Then, based on soil and plant tissue analysis, molybdenum and boron should be applied to alfalfa fields yearly. Also, it is essential to scout areas for pest occurrence and nutrient deficiency symptoms.

Potential for bloat

Bloat is caused by an abnormal build-up of gas in the rumen. While bloat is a risk sometimes associated with grazing systems containing legumes, there are management strategies that can be used to reduce its occurrence. Never turn hungry animals into a legume monoculture for prolonged periods; they should have access to hay or grass pastures prior. Mixtures of legume-grass help to dilute the percentage of legumes consumed by animals in a given time, and the digestion speed is slower than for legumes by themselves. Provide a mineral supplement containing an ionophore which reduces the chance of occurrence of bloat on grazing systems.

Supplemental resources

1. Mullenix, K., Dillard, L., Silva, L., Dubeux, J., Tucker, J., Baxter, L., Prevatt, C., Santos, E., Garcia, L. 2023. Forage Legumes in the Southeast.
2. Silva, L.S.; Dillard, S.L.; Mullenix, M.K; Vasco, C.; M.; Wallau, Russell, D.; Tucker, J.J; Keishmer, K.; Kelley, K.; Runge, M.; Prasad, R.; Gamble, A.; Elmore, M.; Burns, M; Stanford, K. et al. Concepts and research-based guidelines for forage-livestock systems in the SE region. Southern Region SARE Professional Development Program. Available at <https://projects.sare.org/information-product/concepts-and-research-based-guidelines-for-forage-livestock-systems-in-the-southeast-region/>
3. Silva, L.S., Duckett, S., Burns, M., Aguerre, M., Bolt, B., Fischer, M., Marshall, M., Greene, J., Hersom, M., Kirk, K., Scharko, P., Smith, N. 2023. Concepts and research-based recommendations for forage systems in South Carolina. Funded by the SC Forage and Grazing Lands Coalition/NRCS.
4. Silva, L.S.; Marshall, M.; Greene, J.; Aguerre, M. Alfalfa establishment and management. Available at <https://lpress.clemson.edu/publication/alfalfa-establishment-and-management/>