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Value of Nitrogen Fixation From Clovers and Other Legumes

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Clovers and other legumes are valuable forages in two ways. First is the large amount of high-quality forage produced without the need for nitrogen (N) fertilizer and second is the value of the fixed N that can support growth of other forages. Clover and symbiotic rhizobia bacteria found in root nodules can fix large amounts of N from the air (Figure 1). This reduces or eliminates the need for N fertilizer in fields having good clover stands. However, the rhizobia bacteria only fix enough N for it and the clover plant host. The fixed N does not leach freely into the soil and is not immediately available to the companion grass. To make use of this fixed N, you must understand where the N is fixed and stored in the plant and how to make it available to other forages in the pasture.

Although the N is fixed by rhizobia bacteria in the root nodules, it is not stored there. Most of the N is found in the topgrowth of the plant with a smaller amount in the crown, roots and nodules. Estimates for perennial legumes show that about 75-80 percent of the plant's N content is in the topgrowth. Texas A&M research showed that in crimson clover (a winter annual clover) about 90 percent of the total N was in the topgrowth and only 10 percent in the roots. Topgrowth of a typical clover plant contains 3-4 percent nitrogen (18-25 percent crude protein), which translates to about 80 lbs of N per ton of dry matter. In thin stands of clover, the total legume N content might amount to 40-50 lbs/acre in a year, but in thick stands of clover the fixed N amount could be 100-200 lbs/acre over the year.

Figure 1. Rhizobia bacteria fix N within nodules on roots of a clover plant

Legume seed must be properly inoculated with rhizobia bacteria for adequate N fixation to occur. Seed of many legumes is sold pre-inoculated with specific strains of rhizobia bacteria, but untreated seed must be inoculated before planting. The correct rhizobia must be matched to the specific legume species, so refer to FSA2035, *Forage Legume Inoculation*, for details on proper inoculation.

To release the fixed N in clovers for use by other forages, the topgrowth must be recycled through grazing animals or through plant decomposition. When hay is harvested,

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most of the N is removed from the field. However, most of the N ingested by grazing livestock is not retained in the animal's body and is excreted in manure and urine. Improved grazing management will improve manure and urine distribution across a pasture. When plants are either grazed or harvested for hay, some roots and nodules die and decay. Nitrogen is released from decaying roots, root nodules, crowns, stems and leaves. So, the majority of N from clover must be recycled through grazing animals, but some is released by decaying plant tissues in the soil and on the soil surface.

Nitrogen released from decaying plant tissue in the soil is utilized efficiently by other plants, but N recycling through grazing is less efficient. Some N from urine and manure will volatilize as ammonia and is lost from the system. Therefore, recycling of fixed N must be a continual process to take full advantage of N fixation in pastures. Field management that maintains a good content of vigorous clover will maintain good N recycling. Applying N fertilizer is a one-time event with very quick results. Nitrogen fixation from legumes is a process that must be managed over time to gain all the benefits in pastures.

Many species of clovers and legumes are adapted to Arkansas, and some fit certain forage systems better than others. In general, perennial legumes fix more N per acre than annual legumes because of a longer growing season. The amount of N recycled from perennial legumes becomes greater after the establishment year, whereas annual legumes must be planted each year or managed for reseeding. Below is a breakdown of seed cost, potential N fixation and N value for several common legume species. As seed and N prices change, the value of the fixed N will also change.

Species	Seed Cost/ Lb	Seeding Rate/ Acre	Seed Cost/ Acre	Potential N Fixed/ Year (Lbs/Acre)	Value* of N Fixed @$0.50/ Lb of N	Productive Season
Alfalfa[1]	$3.50 – $4.50	20	$70 – $90	150 – 200	$75 – $100	April – Oct.
White Clover[1]	$3.00 – $7.50	2	$6 – $15	75 – 150	$38 – $75	April – Oct.
Red Clover[1]	$2.50 – $4.00	8	$20 – $32	75 – 200	$38 – $100	April – Oct.
Crimson Clover[2]	$0.75 – $1.50	20	$15 – $30	50 – 150	$25 – $75	March – May
Arrowleaf Clover[2]	$2.00	10	$20	50 – 150	$25 – $75	April – June
Hairy Vetch[2]	$2.00	20	$40	50 – 150	$25 – $75	April – May
Annual Lespedeza[3]	$0.75	20	$15	50 – 100	$25 – $50	June – Sept.

*Does not include value of forage dry matter produced in addition to fixed N
[1]Perennial legume
[2]Winter annual legume
[3] Summer annual legume

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