US Department of Agriculture
NATURAL RESOURCES CONSERVATION SERVICE
Plant Material Technical Note MT-127
June 2025

PLANT MATERIALS TECHNICAL NOTE

Incorporating Legumes into Wyoming Seed Mixtures

Legumes are broadleaved plants within the pea family (Fabaceae). The pea family, also known as the bean or legume family, is a large family of native and introduced species with agricultural importance. Plants of the pea family can form a symbiotic, or mutually beneficial, relationship with nitrogen-fixing bacteria called rhizobia. When legume plants are colonized by rhizobia, small structures called nodules form on the plant roots. Rhizobia live inside these nodules where they convert or "fix" atmospheric nitrogen (N_2) to plant-available ammonia (NH_3). The host plant uses fixed nitrogen and provides rhizobia with energy from carbohydrates produced by the plants in return. Fixed nitrogen from legumes can improve yields, increase protein content of the crop, and improve soil fertility for adjacent plants.

Adding legumes to seed mixes can result in many benefits. Legume species produce high quality forage and seed throughout the year making them extremely valuable to wildlife and livestock. In addition, many legumes produce showy blooms which are valuable for pollinator species and aesthetics. Legumes can serve to enhance conservation tillage systems, improve soil quality, reduce nitrogen input requirements, enhance wildlife habitat and pasture quality, restore native plant communities, and reduce soil erosion in critical areas (Figure 1). These combined factors make legumes some of our most valuable conservation plants.

Figure 1. Alfalfa is a commonly used legume for forage production, improving soil quality and fertility, and providing pollinator habitat.

Figure 2. Native grasses and alfalfa were used in this rangeland seed mix to improve livestock forage production and species diversity.

Native or introduced species of legumes are often added to rangeland, pasture, and perennial hay grass seed mixes to enhance diversity and improve quality and production. In general, pastures differ from rangeland in that they are cultivated fields planted with introduced grass and legume species while rangeland consists of predominately native species, which may be seeded with either native or introduced species depending on site objectives (Figure 2). Seeded species should be carefully chosen to meet the project objectives and site characteristics (e.g., soil texture, salinity, annual precipitation, etc.). The proportion of legumes added to grass mixes should also be carefully determined

to address species (plant and animal) compatibility, resource concerns, and site objectives.

The proportion of legumes in a seed mix will vary depending on the resource concern being addressed. The Conservation Planner should ask "What is the goal of the seeding?" The species and proportion of species should contribute to your goals and existing resources. Adding legumes to seed mixes can benefit one or more of the following resource concerns through conservation practice standard (CPS) implementation:

Reducing erosion, stabilizing sites, and improving water quality:

- Reduce erosion by wind and water; stabilize areas with high rates of erosion; reduce sedimentation (CPS 550, 512, 342, 327, 332, 386, 393, 412, 390)
- Improve water quality and quantity (CPS 550, 512, 327, 332, 412, 390)

Improving forage:

- Provide or improve forages for livestock (CPS 550, 512, 810) or forage, browse, or cover for wildlife, pollinators, and beneficial organisms (CPS 550, 327, 386, 390, 420)
- Improve or maintain livestock nutrition and health (CPS 512, 810)

Restoring desired plant communities:

- Restore a plant community to the ecological site description or another desired plant community (CPS 550, 390, 420)
- Restore hydrologic function; improve soil moisture management through increased water infiltration (CPS 550, 332)
- Improve soil health (CPS 512, 327)

Reducing erosion, stabilizing sites, and improving water quality

Grass and legume species have characteristic differences including root structure and growth form. Grasses have fibrous root systems and sod-forming or bunchgrass growth forms which are ideal for holding soil in place, filtering sediment through the above-ground biomass, and increasing water infiltration. Legumes are generally tap-rooted plants with a single crown growth form (i.e., one persistent base) which can slow water erosion and sediment but not as efficiently as grasses (Figure 3). The active growth period of grass and legume species may also differ. Select primarily grass species and *limit legumes to 20% or less of the mix* when creating a seed mix to address erosion or water quality resource concerns. Select grass species that are quick establishing, sod-forming, have robust stem diameters to withstand the force of water and wind, and grow at various times of the year. Legumes can contribute to erosion control if they have a wide base (e.g., mature alfalfa) and robust stems that remain erect during wind and water events. Avoid single-stem, low growing, or slow growing legume species (See Table 1).

Figure 3. Many legume species, including alfalfa pictured here, have a single crown and tap root.

Improving forage

Provide or improve forages for livestock: When designing seed mixes to produce livestock forage, the addition of a legume species such as alfalfa (*Medicago sativa*), sainfoin (*Onobrychis viciifolia*), cicer milkvetch (*Astragalus cicer*), birdsfoot trefoil (*Lotus corniculatus*), or clover (*Trifolium* spp.), to a grass-dominated pasture will add nitrogen to the soil, increase forage productivity and quality, influence yield persistence, and contribute to livestock nutrition. In dryland pastures, adding legumes to grass pastures has also increased forage yields over legumes or grasses planted alone. An additional benefit of adding legumes to grass pasture seed mixes is improved hay quality. Bloat is a potential problem of most introduced legumes added to pasture mixes and must be considered when designing a mix for livestock forage production.

Legume limits in livestock forage seed mixes are based on species compatibility, forage quality, and forage concerns.

- Risk of livestock loss from bloat can be reduced if bloat-causing legumes (see Table 1) are limited to 30% or less of the mix. When using non-bloat legumes such as birdsfoot trefoil, cicer milkvetch or sainfoin, legume limits can be increased in the legume/grass mix (Figure 4). However, realize these species are not as productive as alfalfa/grass mixes, they can be harder to establish, and sainfoin can be shorter-lived than alfalfa. If individual landowners implement management strategies to minimize bloating concern (e.g., removing animals that tend to be sensitive to bloating), then the legume percentages can be greater than 30% but not more than 50%.
- Balancing grass and forbs components in a seed mix is important for livestock nutrition, with the desired ratio depending on forage use and livestock type. A good grazing pasture mixture of grass:legume for a beef cow and calf operation ranges from 50 – 70% grasses and 30 – 50% legumes. Legumes have lower digestible fiber and higher non-fiber carbohydrates than grasses. Limiting legumes in the mix can improve the digestibility of the stand and overall livestock nutrition.
- When the primary use of the pasture is hay production, the legume component of the seed should not exceed 70%.
- When feeding dairy cows that require high protein and energy, a grass component as low as 20% with 80% legumes may be desirable.
- The proportion of legumes in a seed mix must consider species compatibility. In general, introduced grass and legume species have been selected for ease of establishment, high productivity, and nutritional value and can be seeded together in the recommended portions discussed. Conversely, native grass and legume species can be more variable in size and rate of establishment than introduced species and care should be taken to select native and introduced species that grow well together. When adding introduced legumes to a native grass range or pasture mix (e.g., alfalfa added to native grass mix), limit introduced legumes to ≤ 20%.

Figure 4. Sainfoin is an introduced non-bloat causing legume used as hay or grazed in pastures grass-legume mixes.

- Producers should implement properly balanced grazing management and monitor legume proportions throughout the pasture to facilitate plant productivity and maintain the forage base.

Provide or improve forage, browse, or cover for wildlife, pollinators, and beneficial organisms: Legumes provide valuable cover and nutritious forage for wildlife and nectar and pollen for native bees and honeybees. When designing seed mixes for wildlife and pollinator habitat improvement:

- Limit legumes to 10% of native species dominated upland habitat mixes designed for wildlife cover.
- Use 20 – 50% legumes in native species mixtures designed for brood rearing habitat. The higher proportion of legumes in the mix will attract insects critical for chick survival.
- Pollinator mixes should include forb and legume species that bloom in the spring, summer and fall to provide food resources throughout the growing season. Forbs should comprise 75 – 80% of pollinator mixes with no individual forb or legume species over 20% of the mix. Introduced legume and forb species generally establish quicker and are more robust than native forb or legume species. To address species compatibility, limit individual, introduced forb and legume species to 5 – 10% of the mix.

Figure 5. White and purple prairie clover are native legumes used for forge, pollinator habitat, and restoring native plant communities.

Restoring desired plant communities:
Adding legumes to seed mixes to restore a desired plant community condition can improve diversity and overall mix adaptability to variable soil and moisture conditions at the site. Diverse plant communities use resources more completely in time and space and can lead to increased productivity, increased invasion resistance, and/or reduce the need for herbicide use. A diversity of grass, forb, and legume roots help stabilize soil and improve its structure and rate of water infiltration. Their root systems improve soil tilth and fertility by contributing to soil organic matter, and legumes increase nitrogen availability in the plant community.

When restoring a native plant community to the ecological site description (ESD), use the ESD to create a seed mix that approximates the natural proportion of species, including legumes, in the plant community. For example, when seeding a native species mix in loamy soils of the Foothills and Mountains Southeast Ecological Sites, seed mix proportions should constitute 70% grasses, 15% forbs (with native legumes 5% of the forb total), and 15% shrubs. As another example, a native seed mix for loamy soil in Zone 1 High Mountains Ecological Sites should have 60% grass, 15% forbs (with native legumes up to 15% of the forb total), and 25% shrubs.

When adding introduced legumes to a seed mix, set legumes rates based on compatibility with other species. The compatibility of legumes and grass species can vary by plant characteristics and precipitation. In general, introduced species establish faster and are more robust than native species. When adding introduced legumes to a native grass mix (e.g., alfalfa added to native grass mix), limit legumes to ≤ 20% of the mix.

Summary

Ultimately, the seed mixture must be tailored to site characteristics, resource concern(s), species compatibility, landowner objectives, and management ability for a long-term successful stand. In many cases, the ≤ 30% legume rate in a seed mix is an overall conservative recommendation. With experience, a conservation planner will learn to adjust legume components based on objectives and resource concerns for a wider flexibility of seed mix proportions. Over time, grass:legume ratios can change with grazing management and species competitiveness. Producers should monitor legume proportions as species establish and throughout pasture use to maintain desired ratios.

Table 1. Plant characteristics for introduced and native legume species commonly used for conservation seeding in Wyoming. Data represent common variety; the cultivar or variety may have slightly different characteristics. Data is from USDA-NRCS PLANTS Database. For other species of interest, see the species Plant Guide and Characteristics tab on PLANTS Database. Use WY-ECS-25 Perennial Seed Mix data worksheet for additional information on species seed rate, soil adaptability, precipitation requirements, and more.

INTRODUCED LEGUME SPECIES							
Characteristics*	Alfalfa (*Medicago sativa*)	Birdsfoot Trefoil (*Lotus corniculatus*)	Cicer Milkvetch (*Astragalus cicer*)	Sainfoin (*Onobrychis viciaefolia*)	Sweetclover (*Melilotus spp*)	Red Clover (*Trifolium pratense*)	White Clover (*Trifolium repens*)
Lifespan[1]	P / Long	P / Moderate	P / Moderate	P / Short	B (A, P) / Short	B, P / Short	P / Moderate
Growth Form[2]	Single Crown	Single Crown	Rhizomatous	Single Crown	Single Crown	Single Crown	Stoloniferous
Growth Rate[3]	Rapid	Moderate	Moderate	Moderate	Rapid	Rapid	Moderate
Root Morphology[4]	Taproot	Taproot with laterals	Rhizomes	Taproot	Taproot with laterals	Taproot, branching	Taproot with stolons
Root Depth[5]	24 inches	14 inches	16 inches	14 inches	36 inches	12 inches	12 inches
Mature Height[6]	2 feet	2 feet	3 feet	2.5 feet	5 feet	2 feet	< 12 inches
Seedling Vigor[7]	High	Low	Medium	High	High	High	Low
Bloat[8]	High	None	None	None	Medium	High	Low
Palatability Graze[9]	High	High	Medium	High	Medium	High	High
Regrowth Rate[10]	Rapid	Rapid	Moderate	Slow	Slow	Moderate	Moderate
Toxicity[11]	None	None	None	None	Low	None	None
NATIVE LEGUME SPECIES							
Characteristics*	American Vetch (*Vicia americana*)	Canada Milkvetch (*Astragalus canadensis*)	Northern Sweetvetch (*Hedysarum boreale*)	Purple Prairie Clover (*Dalea purpurea*)	White Prairie Clover (*Dalea candida*)	Silky Lupine (*Lupinus sericeus*)	Silver Lupine (*Lupinus argenteus*)
Lifespan[1]	P / Moderate	P / Short	P / Moderate	P / Moderate	P / Short	P / Short	P / Short
Growth Form[2]	Single Stem	Stoloniferous	Single Crown	Multiple Stem	Multiple Stem	Multiple Stem	Multiple Stem
Growth Rate[3]	Moderate	Moderate	Moderate	Moderate	Moderate	Rapid	Rapid
Root Morphology[4]	Taproot with laterals	Taproot	Taproot with laterals	Taproot	Taproot	Taproot with laterals	Taproot with laterals
Root Depth[5]	10 inches	10 inches	17 inches	16 inches	14 inches	12 inches	12 inches
Mature Height[6]	16 inches	0.5 feet	2 feet	3 feet	2 feet	3 feet	2 feet
Seedling Vigor[7]	Low	Medium	Low	Medium	Medium	Medium	High
Bloat[8]	None	None	None	Low	Low	None	None
Palatability Graze[9]	High	Low	High	Medium	High	Medium	Medium
Regrowth Rate[10]	Moderate	Moderate	Slow	Slow	Moderate	Rapid	Rapid
Toxicity[11]	None	Slight	None	None	None	Severe	Severe

*PLANTS Database gathered data from the scientific literature, gray literature, agency documents, and the knowledge of plant specialists. Characteristics data values are best viewed as approximations since they are primarily based on field observations and estimates from literature, not precise measurements or experiments.

[1]Lifespan: A = Annual, B = Biennial, P = Perennial; Lifespan: Expected lifespan (in years) of a perennial plant relative to other species with the same growth habit. Short, Moderate, Long

[2]Growth Form: The primary growth form on the landscape in relation to soil stabilization. Multiple Stems: Producing two or more stems. Rhizomatous: Plant production of rhizomes which give rise to vegetative spread. Single Stem: One persistent base. Stoloniferous: Production of stolons which give rise to vegetative spread.

[3]Growth Rate: The growth rate after successful establishment relative to other species with the same growth habit. Slow, Moderate, Rapid (not quantified)

[4]Root Morphology: The structure and growth of plant's descending axis which anchors the plant to the ground and absorbs water and nutrients from the soil.

[5]Root Depth: The minimum depth of soil (inches) required for good growth of species average root system.

[6]Mature Height: Expected height (inches) of plant at maturity. This is an estimate of the median mature height of all plants of a species or cultivar.

[7]Seedling Vigor: Expected seedling survival percentage of the plant compared to other species with the same growth habit. Low, Medium, High (not quantified)

[8]Bloat: Relative potential of an herbaceous plant to cause bloat in livestock. None, Low, Medium, High (not quantified)

[9]Palatability Graze: Relative palatability of this plant to grazing animals. Low, Moderate, High (not quantified)

[10]Regrowth Rate: Relative rate of regrowth of a herbaceous plant after a harvest of above ground herbage. Slow, Moderate, Rapid

[11]Toxicity: Relative toxicity of the plant to either humans or livestock. None, Slight, Moderate, Severe

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